Design, Construction, … issioning and Operation … ce of Infrastructure Works at Rajpura-Patiala … node in Punjab under Amritsar Kolkata Industrial Corridor (AKIC) Project "On EPC Basis"

NICDC Punjab Industrial Corridor Development Corporation Limited (NPICDCL)

Volume II: Technical Specifications

Contents

1.0 Introduction

1.1 Background

The Government of India (GoI) has undertaken the development of various Industrial Corridors across the country under the National Industrial Corridor Programme. This ambitious programme aims to develop industrial cities that will create employment opportunities, stimulate industrial growth, and promote overall socio-economic development. The Amritsar-Kolkata Industrial Corridor (AKIC) project is proposed to be structured around the Eastern Dedicated Freight Corridor (EDFC), which serves as the backbone of the initiative, while also leveraging the existing highway network along the route. Additionally, the project will capitalize on the Inland Waterway being developed along National Waterway-1, extending from Allahabad to Haldia.

The GoI has envisaged the development of AKIC to achieve accelerated industrialization and regional agglomeration of industries, particularly in Punjab. As part of this vision, an Industrial Manufacturing Cluster (IMC) has been identified at Rajpura–Patiala Node in Punjab. The National Industrial Corridor Development Corporation Limited (NICDC) has appointed consultants, comprising Antea India Pvt. Ltd in consortium with Antea Nederland B.V., to prepare the Detailed Master Plan and associated services and utilities for the IMC at Rajpura.

1.2 Amritsar-Kolkata Industrial Corridor (AKIC)

The Amritsar-Kolkata Industrial Corridor (AKIC) is being developed along the alignment of the Eastern Dedicated Freight Corridor (EDFC), covering a route length of approximately 1,839 km and traversing six states. The objective of AKIC is to optimize the existing economic and employment potential of the region, stimulate investments in manufacturing, agro-processing, services, and export-oriented industries, and foster overall economic development through the creation of high-standard infrastructure and a business-friendly environment.

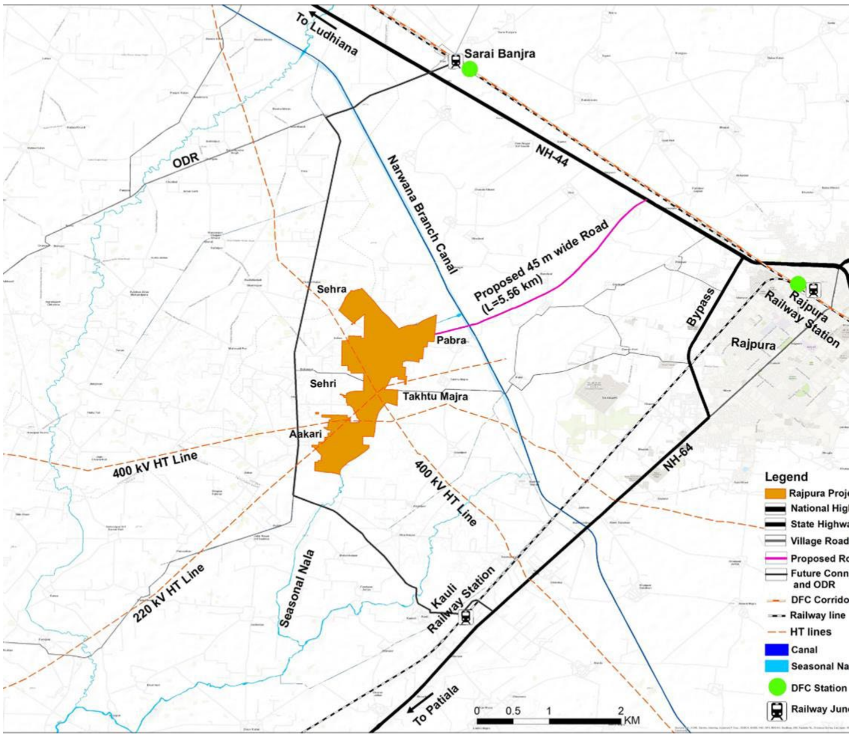
The corridor is proposed to be developed in a band of 150 to 200 km on either side of the EDFC, in a phased manner. It connects Amritsar in Punjab to Dankuni in West Bengal, passing through Punjab, Haryana, Uttar Pradesh, Bihar, Jharkhand, and West Bengal, with an influence area of about 5.5 lakh square kilometres. This densely populated region houses nearly 40% of India's population, making it a critical area for industrialization and job creation. The AKIC is expected to act as a catalyst for economic growth by addressing infrastructure bottlenecks and capitalizing on the inherent strengths of each state within the corridor.

1.3 Overview of IMC Rajpura–Patiala

1.3.1 Site Location

An area of approximately 1,100 acres has been earmarked for the development of the Rajpura–Patiala Industrial Node. The site is strategically located between the towns of Rajpura and Patiala, at an important junction of National Highway 44 and National Highway 64. This connectivity provides direct access to key urban centers such as Mohali, Ludhiana, Ambala, Baddi, and Chandigarh. The site is positioned to act as a counter-magnet to Chandigarh, thereby generating new employment opportunities for surrounding towns. . The site is a longitudinal piece of land located at distance of 11 km from the town of Rajpura. Presently it is connected to Rajpura by a 9M wide road, to Rajpura bypass however a 45M wide road is proposed to connect the site directly to NH44, from the northern end. NH64 runs parallel to the site at 7.5 km. The site is about 24Km from the town of Patiala and 54 Km from Chandigarh. Its distance from Mohali International airport is 45Km.A stream from the Narwana branch canal traverses through the site from north to south.

Figure 1-1 Site Location



1.3.2 Surrounding Development Plans

The project site falls under the Local Planning Area (LPA) of Patiala and Rajpura. The land use of the five villages surrounding the IMC boundary has been officially declared as industrial under the development plans prepared by the Punjab Urban Planning and Development Authority (PUDA). These plans clearly indicate the shift from agricultural to industrial land use, thereby ensuring that the proposed development of the IMC is aligned with regional planning strategies.

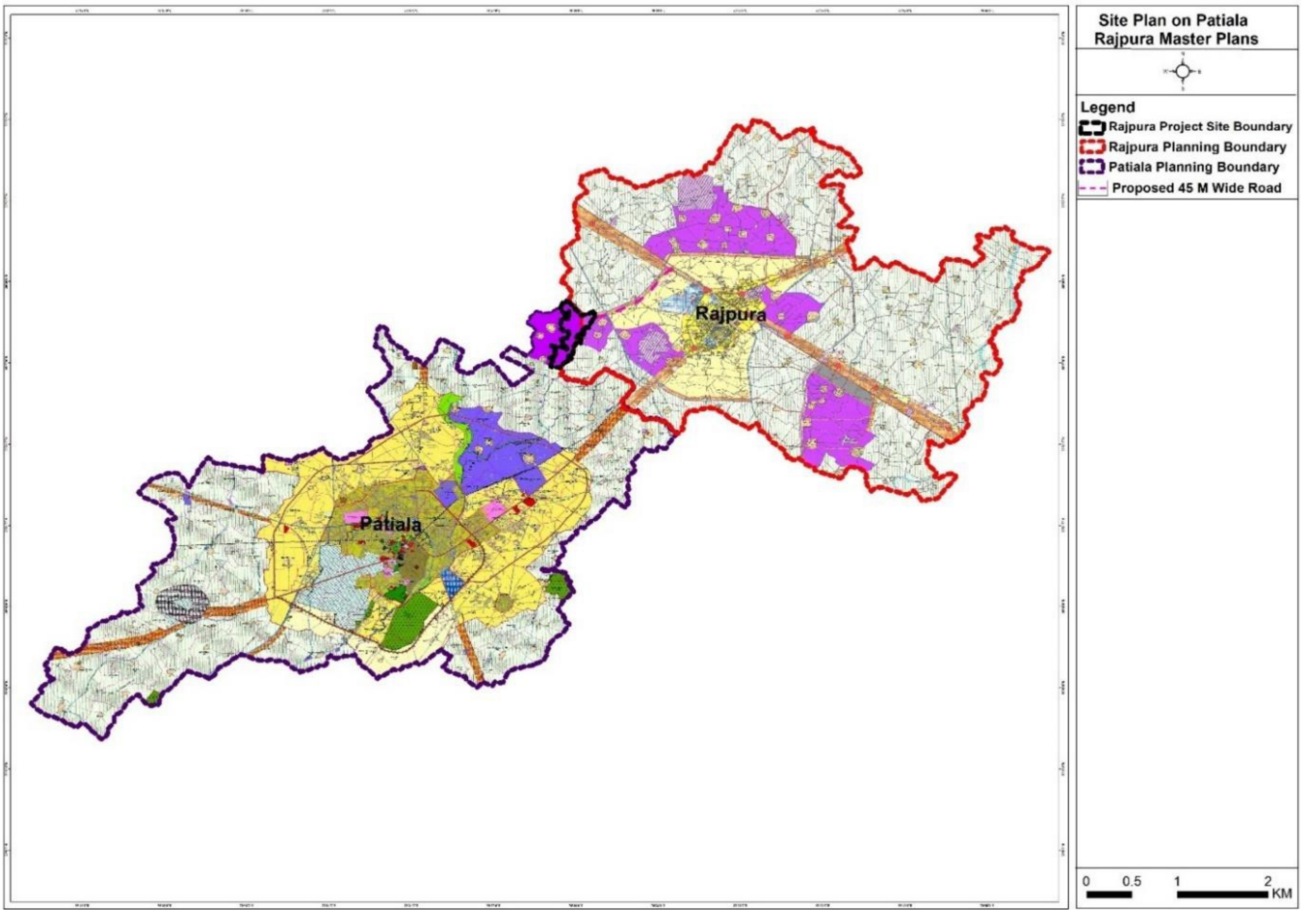


Figure 1-2: Site Location in Context of the Rajpura and Patiala Development Plans

1.3.3 Land Ownership Details

The total land area of 1,098.85 acres designated for the IMC is under the ownership of PUDA. The site is free of cultivation and tree cover, with some portions falling under seasonal water bodies and drains. Three high-tension (HT) power lines pass through the site. Importantly, the land does not include any forested areas or environmentally sensitive zones that could hinder industrial development.

Village	Planning Area	Area (Acres)
Pabra	Rajpura LPA	174.06
Takhtu Majra	Rajpura LPA	48.34

Sehra	Patiala LPA	489.77
Sehri	Patiala LPA	201.81
Aakri	Patiala LPA	184.87

Total Area: 1,098.85 acres (Source: Punjab Urban Planning and Development Authority)

1.4 Population Projections and Market Assessment

The Industrial Manufacturing Cluster (IMC) at Rajpura–Patiala is projected to generate substantial employment and attract a significant resident population. By the year 2029, when the IMC is expected to be fully operational, the total projected population within the cluster will be approximately 54,439. This comprises an estimated 31,367 industrial workforce (direct and indirect employment), 14,880 non-industrial working population, and 11,118 resident population.

1.5 Land Use Plan

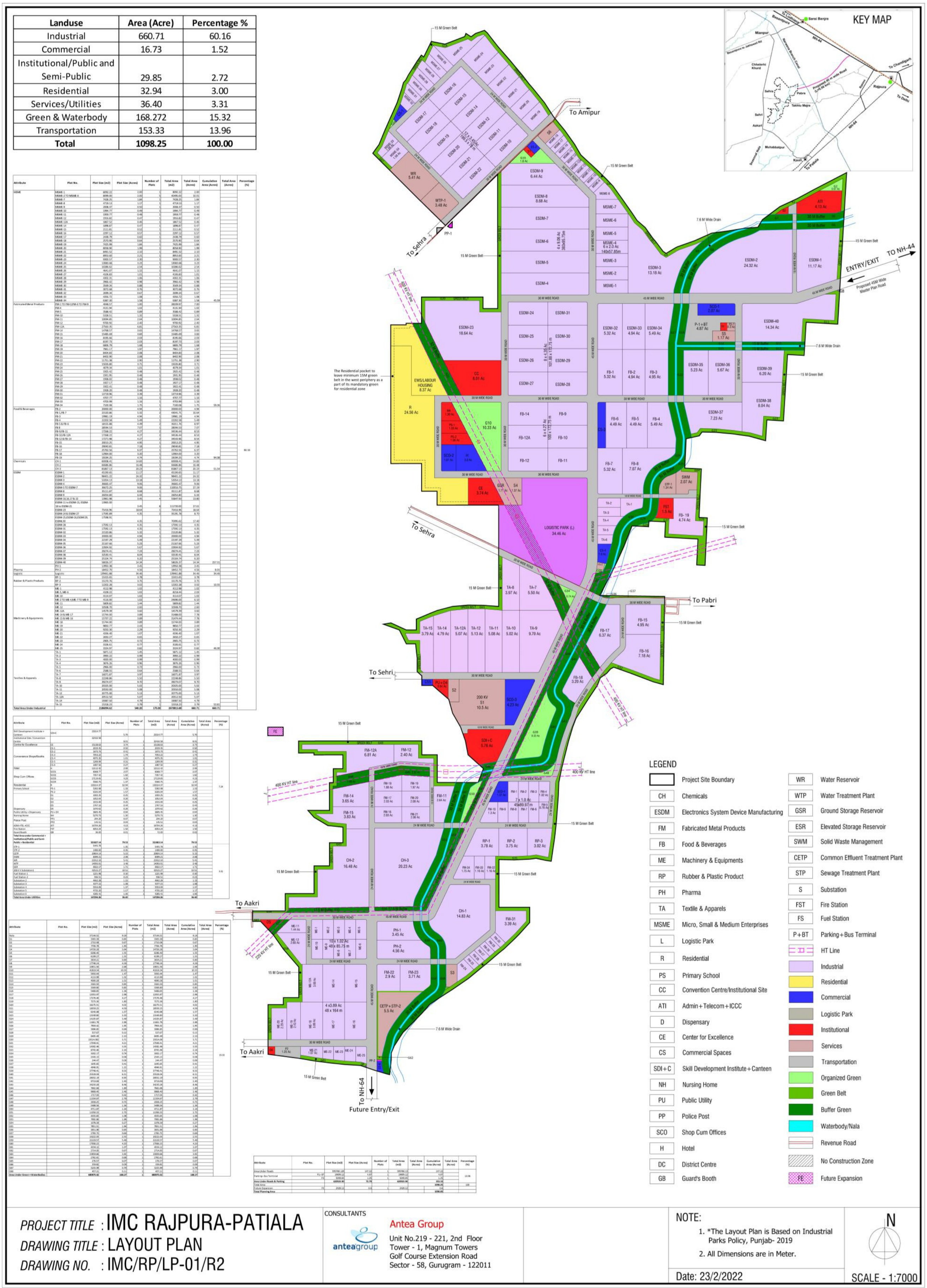
The master planning exercise for the IMC Rajpura–Patiala has been designed to achieve a balanced and sustainable urban-industrial ecosystem. Out of the total site area of 1,098.85 acres, approximately 660.71 acres (60.13%) have been allocated for industrial and logistics purposes. Around 78.04 acres (7.11%) are dedicated to commercial and support infrastructure, while 36.4 acres (3.31%) are reserved for services and utilities. A significant portion, 168.87 acres (15.37%), is designated as green and water bodies, with mandatory green buffers. The remaining 153.34 acres (13.95%) are earmarked for transportation infrastructure.

Land Use	Area (Acres)	Percentage of Total Area
Industrial & Logistics	660.71	60.13%
Commercial	16.73	1.52%
Institutional / Public & Semi-Public	29.86	2.72%
Residential	32.94	3.00%
Services / Utilities	36.40	3.31%
Green & Water Bodies	168.87	15.37%

Transportation & Parking	153.34	13.95%

Total Area: 1,098.85 acres (100%)

Landuse	Area (Acre)	Percentage %
Industrial	660.71	60.16
Commercial	16.73	1.52
Institutional/Public and Semi-Public	29.85	2.72
Residential	32.94	3.00
Services/Utilities	36.40	3.31
Green & Waterbody	168.272	15.32
Transportation	153.33	13.96
Total	**1098.25**	**100.00**



1.6 General Framework of Project Implementation

A Special Purpose Vehicle (SPV) titled 'NICDIT Rajpura-Patiala Industrial Corridor Development' has been established with equity participation from both the Central and State Governments. The SPV is entrusted with the responsibility of procurement and construction of trunk infrastructure at the Rajpura–Patiala IMC. The SPV is represented by the Vice Chairman & Managing Director, who invites bids from eligible contractors for execution of the project.

1.7 Scope of Project

The scope of works under this project is comprehensive, covering all aspects of infrastructure development and facility provision for the IMC. The contractor is responsible for understanding site conditions, reviewing the preliminary designs provided by the employer, and preparing detailed design drawings. The scope also includes engineering, construction, testing, inspection, transport, site handling, erection, commissioning, and successful operation of the facilities. It further includes four years of operation and maintenance following completion.

This project involves the following:

- Construction of Roads for approx. 19.511 km length with different ROW as stated in Chapter 2 along with Major & Minor bridges and/or cross drainage structures over natural drainage channels. The details of the total 10 nos. of Minor bridges are given in Chapter-2.
- Realignment of the portion of the Nim Sahib drain passing through the site, which is approximately 5.1 Km in length. The Nala bed of 7.2 m with 30 m corridor on either side as buffer needs to be maintained as per minimum requirements laid down by Punjab Drainage Department. Slope stabilization along the drain shall be done with Geo Mats & Grass seeding.
- Providing, Laying, Jointing & Commissioning of Raw Water Transmission main from IMC boundary at Raw Water Storage Reservoir and WTP premises (Approx. 235M length).
- Construction of water supply network on continuous pressurized supply system with house service connections of industrial and household purposes.
- Construction of 45 Million Liters capacity Water Reservoir, Raw water tank- 5.3 MLD, Domestic Water Tank -9.4 MLD in zone 1 and 4.2 MLD in Zone 2, Two nos. Fire tanks- 0.5 MLD and 0.6 MLD, water Sump/GLSR & Pumphouse at WTP premises with civil, electromechanical works.
- Construction of Recycle water supply network with house service connections of industrial and household purposes.
- Construction of treated water storage tank within WTP premises of minimum 8 hours storage capacity.
- Construction of Domestic Sewage Collection Network and Industrial Wastewater Collection network
- Construction of Storm water collection network and Disposal.
- Construction of Rainwater Harvesting Pits.
- 33kV RMUs, 11 KV RMUs, 11/0.415 KV Compact Substation, Feeder pillar including but not limited to all electrical items as detailed in Power System part of this specification. Any item not specifically mentioned in this specification but required for successful commissioning of power infrastructure shall be under scope of

contractor.

- Electrical works for STP/ CETP/ WTP plants.
- Smart street Lighting all along the road network, parkings, WTP, STP & CEPT area.
- 33kV, 11kV, 1.1kV Cables, RCC Cable trench and all other necessary equipment i.e. Cable trays, Supports, terminations, jointing cable tags etc. as required.
- Earthing and Lightning Protection system.
- Fire Hydrants on Potable Water Network along with fire water sump as per TAC recommendation and associated pumping machinery.
- Underground/Ground Level, as required for distribution of recycled water with minimum 50% storage capacity of the total recycled water demand.
- Construction of Pumphouses with Pumping machinery for Water and Sewerage as well as Industrial Wastewater, as per the designs.
- 7.5 MLD Water Treatment Plant, 1.2+0.7 MLD sewage Treatment Plant and 2 MLD Common Effluent Treatment Plant with SCADA control works and online monitoring system for inlet and outlet design parameters of sewerage at STP and effluent at CETP.
- Landscaping- Roadside tree plantations, Organized greens, formation work of Nim Sahib nallah and adjoining green buffer and parks, Peripheral Green Belt and Green Buffer area development under HT Lines civil and horticulture tasks required in the Parks, playgrounds, Green belt, and Buffer spaces beneath the HT line, GAIL Gas pipeline corridor and 30m on either side of the Nim Sahib Dain as per tender indicative drawings.
- Dadri-Nagal gas pipe line crosses through project area. The contractor has to design all road and utilities as per regulations laid down by GAIL and take NOC from GAIL before executing any works.
- Demarcate the site area with pre cast M-20 cement concrete including reinforcement permanent boundary stone of size 150 mm above ground, 300 mm below ground and pillars of total height 1.20 m at turnings/corners, fixing in ground in all types of strata's, 0.45 m above GL and 0.75 m below GL including excavation having pit size 60 cm x 60 cm x 75cm depth including fixing, firmly with hard moorum, metal obtained from excavation, including engraving "Rajpura Patiala IMC" letters on two sides and painting with two coats of yellow color cement paint, two coats of white wash to exposed sides with all labor, material including transportation etc. All works shall only begin once the demarcation of the boundary is duly approved by PMNC/Employers Engineer.
- The contractor shall design all components in accordance with the planned Phase II and Phase III developments, and shall also ensure coordination with the concerned departments for necessary approvals, as well as with other agencies carrying out separate works within the project area.

1.8 Change of Scope

The Employer reserves the right to make any change in the scope of works to ensure successful project delivery. Changes of scope may include additions, deletions, or modifications of works as deemed necessary by the Employer. In the event of such changes, the contractor shall execute the revised scope in accordance with the directions of the Engineer, without causing delays to the project schedule. Adjustments to the contract price and completion period, if any, shall be made in accordance with the contract provisions. No change of scope shall be considered for WTP, STP, CETP, land scaping work Road & drainage works.

1.9 Geotechnical Investigations

The contractor shall be fully responsible for conducting detailed geotechnical investigations required for the design and execution of the works. Preliminary soil data provided by the Employer are for reference only and should not be considered sufficient for detailed design. The contractor shall undertake boreholes, trial pits, standard penetration tests, laboratory analysis, and other relevant geotechnical studies to confirm soil properties, bearing capacity, and groundwater levels.

1.10 Surveys, Topographical Survey and Geotechnical Investigations

The contractor shall be responsible for carrying out all necessary surveys, including topographical surveys, geotechnical investigations, and utility mapping, to ensure accurate and reliable design data. The survey activities shall include the establishment of horizontal and vertical control, preparation of contour maps, demarcation of project boundaries, and identification of existing utilities within the project area.

1.11 Field Laboratories

The contractor shall establish and maintain fully equipped field laboratories at the site for the entire duration of the project. These laboratories shall be capable of conducting all routine tests required for construction materials, including soil, aggregates, cement, concrete, bitumen, and steel. The facilities shall include adequate equipment, instruments, and trained technical staff to carry out the tests in accordance with relevant IS/IRC standards.

1.12 Temporary Works

Not less than 14 days before commencing any portion of the Works, the Contractor shall submit to the Employer’s Representative for his approval comprehensive drawings and calculations for all Temporary Works which the Contractor proposes for the construction of that part of the Works. All Temporary Works costs to be borne by Contractor.

Notwithstanding approval by the Employer’s Representative of any design for the Temporary Works, the Contractor shall be entirely responsible for their safety, efficiency, security and maintenance and for all obligations and risks in regard to such Temporary Works specified or implied in the Contract.

2.0 Roads and Bridge Works

2.1 Introduction & Scope

This chapter defines the technical specifications, design requirements, and construction standards for roads and bridges under the Rajpura Patiala Integrated Manufacturing Cluster (IMC). It covers the entire spectrum of works including road geometry, pavement design, road furniture, junctions, utilities, traffic management, and maintenance requirements. It also details the design and construction of associated structures such as bridges and culverts.

2.2 Design Standards for Roads and Utilities

2.2.1 General

The design and construction of all roads and utility services shall follow the standards of the Indian Roads Congress (IRC) and Ministry of Road Transport & Highways (MoRTH) unless otherwise specified. In case of better or equivalent alternatives, internationally recognized standards (AASHTO, ASTM, or British Standards) may be adopted with prior approval and supporting certification of successful long-term performance.

The Project Road shall generally follow the horizontal & vertical alignment shown in the plan specified in Volume III- Tender drawings, unless otherwise specified by the Engineer in charge. Based on site/ design requirement, the Contractor shall finalize their Detailed Designs (Development stage) including plan & profile of the project roads and submit the same to Engineer in charge for its Consent/ Approval and Audit, before the start of the execution of project. The design so approved shall not be in contradiction with the scope of the project. For the avoidance of doubt, the provisions mentioned in technical specification and tender drawing cannot be changed, only the design of the components is to be submitted for consent/ approval.

Based on accepted DPR including Plan & profile prepared by the Contractor, the detailed work program prepared with Network Method (PERT/ CPM) shall be prepared along with commensurate deployment of all resources and got approved by Engineer before start of civil work.

2.2.2 List of Design Standards

The design standards applicable for road geometry, materials, traffic control, and structures are summarized in Table 2-1 and Table 2-2. These codes ensure safety, durability, and serviceability of the infrastructure. Only the latest revisions of the code will be applicable.

Table 2-1: Standards for Road Design

S. No	Code No	Description
1	IRC:3	Dimensions & Weights of Road Design Vehicles (First Revision)
2	IRC:32	Standard for Vertical and Horizontal Clearances of Overhead Electric Power and Telecommunication Lines as Related to Roads
3	IRC:38	Guidelines for Design of Horizontal Curves for Highways and Design Tables (First Revision)
4	IRC:69	Space Standards for Roads in Urban Areas
5	IRC:70	Guidelines on Regulation and Control of Mixed Traffic in Urban Areas (First Revision)
6	IRC:86	Geometric Design Standards for Urban Roads and Streets (First Revision)
7	IRC:92	Guidelines for the Design of Interchanges in Urban Areas (First Revision)
8	IRC:98	Guidelines on Accommodation of Utility Services on Roads in Urban Areas (Second Revision)
9	IRC:99	Guidelines for Traffic Calming Measures in Urban and Rural Areas (First Revision)
10	IRC:106	Guidelines for Capacity of Urban Roads in Plain Areas
11	IRC: SP:23	Vertical Curves for Highways
12	IRC: SP:41	Guidelines for the Design of At-Grade Intersections in Rural & Urban Areas

Table 2-2: Standards for Road Facilities

S. No	Code No	Description
Ground Improvement	IRC:113	Guidelines for the Design and Construction of Geosynthetic Reinforced Embankments on Soft Subsoils
Embankments	IRC:36	Recommended Practice for Construction of Earth Embankments and Sub-Grade for Road Works (First Revision)
	IRC:75	Guidelines for the Design of High Embankments (First Revision)
	HRB SR 1999	State-of-the-Art Report: Compaction of Earthwork and Subgrades
Pavement	IRC:37	Guidelines for the Design of Flexible Pavements (Fourth Revision)
	IRC:58	Guidelines for the Design of Plain Jointed Rigid Pavements for Highways (Fourth Revision)
Pavement Layers	IRC:109	Guidelines for Wet Mix Macadam (First Revision)
	IRC: 111	Specifications for Dense Graded Bituminous Mixes
	IRC: 126	Guidelines on Wet Mix Plant
	IRC: SP:63	Guidelines for the Use of Interlocking Concrete Block Pavement (First Revision)
Markings	IRC:35	Code of Practice for Road Markings (Second Revision)
Signage	IRC:67	Code of Practice for Road Signs (Fourth Revision)
Landscaping	IRC: SP:21	Guidelines on Landscaping and Tree Plantation
Pedestrian Facilities	IRC:103	Guidelines for Pedestrian Facilities (Second Revision)
Cycle Tracks	IRC:11	Recommended Practice for the Design and Layout of Cycle Tracks (First Revision)
Safety	IRC: SP:44	Highway Safety Code
Parking	IRC: SP12	Guidelines for Parking Facilities in Urban Roads (First Revision)
Traffic Signals	IRC:93	Guidelines on Design and Installation of Road Traffic Signals
Structures	IRC:5	Standard Specifications and Code of Practice for Road Bridges, Section I – General Features of Design (Ninth Revision)
	IRC:6	Standard Specifications and Code of Practice for Road Bridges, Section-II Loads and Load Combinations (Seventh Revision)
	IRC:24	Standard Specification and Code of Practice for Road Bridges, Section V - Steel Road Bridges
	IRC:78	Standard Specifications and Code of Practice for Road Bridges, Foundations and Substructure
	IRC:83	Standard Specifications and Code of Practice for Road Bridges, Section IX Bearings
	IRC:112	Code of Practice for Concrete Road Bridges (First Revision)
	IRC: SP:114	Guidelines for Seismic Design of Road Bridges
Protection Works	IRC:89	Guidelines for Design and Construction of River Training & Control Works for Road Bridges (Second Revision)
Drains	IRC: SP:42	Guidelines on Road Drainage (First Revision)

	IRC: SP:50	Guidelines on Urban Drainage (First Revision)
	CPHEEO	

2.3 Road Works and Construction

2.3.1 Clearing and Grubbing

All road land shall be cleared of vegetation, stumps, bushes, and organic topsoil (up to 150 mm). Serviceable material will be stacked for reuse. This ensures a stable base for subsequent earthwork. Tree cutting shall be done as per tender documents and forest guidelines.

2.3.2 Earthworks

- Excavation: Removal of soil for roadway and drains as per MoRTH Clause 301. Excavated earth shall be re-used in embankment filling, median filling and other filling locations as per earth property.
- Embankment: Constructed using approved borrow earth, compacted as per Clause 305. The Contractor shall deploy Grading, Paving and Compaction Equipment equipped with Automated/sensor System for finishing of all Grades including Embankment, and Subgrade.

  The bottom of sub grade shall be at least 1000mm above highest flood level (HFL)/ Ground water table/ Original ground level (Ground level achieved after the clearing and grubbing)/ pond level, whichever is higher.

  The side slopes shall not be steeper than 2H:1V. In case there is a ROW constraint than, suitable soil retaining structures shall be provided. For stability of slope up to 3-meter height the turfing can be adapted. For the slope more than 6 meter height, a complete slope stability analysis as per IRC:75 shall be done, and the slopes shall be compulsory protected with stone pitching. If pond ash is being utilized for construction of embankment/ approach it shall be as per IRC:SP:58. Concessionaire shall have to procure and use Pond/ Flyash preferably. In case of non-availability of the same, Concessionaire shall make their own arrangement for procurement of alternative material/ Good earth and no change of scope will be considered. No borrow area shall be made available by the employer for this work. The cost benefit, if any to the contractor for use of Pond Ash will not be passed to the Authority.

  If embankment height is more than 1.5m, toe wall/ retaining wall shall be provided at the edge of ROW to protect the earth slope.
- Subgrade: Constructed using approved borrow earth, compacted as per Clause 305. The thickness of sub-grade layer shall not be less than 500 mm, compacted to 97% of MDD, with a minimum effective CBR value of 6%. Expansive clays are prohibited. The suitable subgrade soil treatment for improving CBR shall be prior approval with supporting documents of laboratory results.

- Shoulders: Constructed paved shoulders are same as main carriageway pavement. For earthen shoulder wherever applicable, top 150mm thick granular layer shall be provided for stability and safety.

2.3.3 Pavement Layers

- Sub-base: Granular sub-base conforming to clause 401 of MoRTH Specifications. Sub-base material shall have a minimum CBR value of 30%. For pavement drainage considerations, the granular sub-base shall be extended over the entire formation width including median. The gradation of drainage layer shall be designed as IRC:37.
- Base Course: Wet Mix Macadam conforming to clause 401 of MoRTH Specifications. WMM shall be laying in two layers with plant mix method and top layer shall be laid with sensor paver.
- Primer Coat: Providing and applying Primer coat with bitumen emulsion on prepared surface of granular Base including clearing of road surface and spraying primer by MoRTH 500-3 using mechanical means as per Clause 502 of MoRTH fifth revision.
- Tack Coat: Providing and applying tack coat with bitumen emulsion conforming to IS: 8887, using emulsion pressure distributer including preparing the surface & cleaning with mechanical broom. On bituminous surface to be applied as per clause 503 of MoRTH Fifth Revision.
- Dense Bituminous Macadam (DBM): Dense graded bituminous macadam with not less than 50 mm compacted thickness with bitumen of grade according to IRC 111-2009. Prepared in Batch Type Hot Mix Plant of relevant capacity, laying with a hydrostatic paver finisher with sensor control to the required grade, level and alignment, rolling with smooth wheeled and tandem vibratory rollers to achieve the desired compaction as per MoRTH specification clause No. 505 complete in all respects.

  The minimum content of bitumen shall be 4.5% (for layer thickness of 50-75mm) and 4.0% (for the layer thickness of 75-100mm). The filler shall be only “cement” of grade approved by the Engineer.

  Bitumen VG30 confirming to IRC and MoRTH specifications shall be used for DBM base course.
- Bituminous Concrete (BC): Providing and laying Bituminous concrete with required compacted thickness with bitumen of grade according to IRC 29 with prepared in Batch Type Hot Mix Plant of relevant TPH capacity, laying with a hydrostatic paver finisher with sensor control to the required grade, level and alignment, rolling with smooth wheeled, tandem vibratory rollers to achieve the desired compaction as per MoRTH specification clause No. 508 complete in all respects.

  The minimum content of bitumen shall be 5.5% (for layer thickness of 50mm, grading 1) and 6.0% (for layer thickness of 30-40mm, grading 2). The filler shall be only “cement” of grade approved by the Engineer.

Bitumen VG30 confirming to IRC and MoRTH specifications shall be used for BC surface course

2.3.4 Ancillary Works

- Kerb stone: Supplying and laying pre-cast/cast-in-situ cement concrete Kerb M20 grade mix for median/island complete as per IRC 86 and as per Technical Specifications Clause 409 of MoRTH Fifth Revision.

  For surface water collection, channel kerb shall be provided at the edge of drain and as per requirement.

  All kerbs shall be painted with black & white /Black & Yellow stripes using the paint conforming to IS:164. Kerbs can be painted with continuous yellow for the length for which a restriction has been imposed.

- Footpaths: 60mm thick colored cement concrete Paver block shall be provided as per IRC: SP: 63 in footpath, jointed with neat cement slurry mixed with pigment to match the shade of tiles, including rubbing and cleaning etc. complete, on 20/30 mm thick bed of sand over prepared base.

  Footpath over the drain/utility duct, light shade pigment using white cement shall be provided.

  Footpath in green area shall be provided as per horticulture drawings and specifications.

  Edge block or kerb stone and toe wall shall be provided as per Typical Cross Section (TCS) and site requirements. The width of footpath shall be followed as per tender drawing (minimum width of footpath shall be 1.8m)

  Footpath shall be inclines/slopes before building entry/exit gate and junctions to match with roads.

- Cycle Tracks: 2 m wide cycle track shall be provided as per tender drawings. RCC post for separator with footpath shall be provided as per IRC guidelines.

  Cycle track shall be providing inclines/slopes (1:30 minimum) at building entry/exit gate and junctions. Cycle tracks merged with roads in 1 in 30 slopes at junctions.

  200mm plain cement concrete with 200mm GSB over compacted subgrade shall be provided at without utility duct locations.

  Skid resistance texture shall be provided for the entire cycle track. Reflective Edge marking, cycle symbol marking and cycle track sign boards shall be provided as per IRC 11 & IRC 67.

  Cycle tracks shall be covered with colored pigments using white cement/asphaltic shall be provided.

- Parking Areas: parking area shall be paved with M40 grade paver blocks. The thickness of paver block shall be 80mm to 100 mm over 20 to 30 mm sand bedding over prepared base and subbase as per

IRC: SP:63, jointed with neat cement slurry mixed with pigment to match the shade of tiles, including rubbing and cleaning etc. Location of parking shall be proposed as an approved plan.

Colored paver blocks are used for parking marks wherever possible.

- Bus Bays: Bus bay with Bus top shall be provided as per marked in Plan and profile drawings in Vol-III. The location of the bus bay shall be finalized as per detailed investigation, site requirement and approval of the Engineer in charge. The pavement crust of bus bay shall be same as main carriageway. Bus stops shall be designed as per PUDA guidelines.
- Entrance Gate: Overhead Entrance Gate shall be provided at the intersection of 45 m wide approach road of GMADA with IMC boundary, is to be designed and constructed with both faces. Overhead Gantry Board as per IRC 67 and state art works. Vertical clearance of overhead gate shall be minimum 5.5m.

2.3.5 Road Marking, Road Furniture & Safety Measures

- Road Marking: thermoplastic road marking for road edge, center line, junctions, chevron marking, bus bay, cycle track, pedestrian crossing, direction arrow, hazard marking and other required palaces shall be provided as IRC 35. The thermoplastic material shall be homogenously composed of aggregate, pigment, resins and glass reflectorizing beads. The thermoplastic material shall conform to ASTM D36/BS-3262- (Part I). The thermoplastic reflective paint shall be complied with 803.4 of MORT&H specifications.
- Road signages: Retro- reflectorized mandatory/ regulatory, cautionary/warning, and informatory sign shall be provided as IRC:67 made of high intensity grade sheeting (type XI) as per clause 801 of MORT&H specifications.

The type of traffic signs shall be provided as listed below but not limited to this. Actual no and type of traffic sign shall be finalized as per IRC:67 and Engineer in charge.

Stop sign, give way sign, horn prohibited, overtaking prohibited, no stopping, no parking, speed limit, compulsory keep left/right, cycle track, pedestrian only, Left/right hand curve, Side Road left/right, crossroad, T intersection, narrow road, road widens, gap in median, pedestrian crossing, speed Bracker, single chevron, object hazard, direction sign, advance direction sign, reassurance sign, place identification sign, bus stop, Map information sign, parking sign, facility information sign, street name sign.

Steel railing shall be provided between the main carriageway & service road. Steel railing shall be complied with as per IRC:103.

Delineators (roadway indicators, hazard markers, object markers) shall be 80-100 cm high above ground level, painted black and white in 15 cm wide strips, fitted with 80 x 100 mm rectangular or 75 mm dia circular reflectorized panels at the top, buried or pressed into the ground and conforming to IRC-79 and the drawings.

Road stud 100x 100 mm should be die-cast in aluminum, resistant to corrosive effect of salt and grit, fitted with lense reflectors, installed in concrete or asphaltic surface by drilling hole 30 mm up to a depth of 60 mm and bedded in a suitable bituminous grout or epoxy mortar, all as per BS 873 part 4:1973.

Solar studs shall be provided at Junctions and curve section.

Median & separator: Raised median shall be provied as per Typical Cross Section (TCS). 2m wide median for Typical Cross Section (TCS), 1m wide median for Typical Cross Section (TCS) 2 and 0.5m separator between main carriageway & service road shall be provided. Median shall be open and fill with good earth and planted by shrubs as per tender drawing. The separator (between MCW & service road) shall be covered with 75mm thick M15 grade PCC.

Separator/ green area between drain and utility duct shall be edged with kerb stone and fill with good earth and planted by shrubs/trees as per tender drawing.

2.3.6 Traffic Management During Construction

The contractor shall always carry out work on the road in a manner creating the least interference to the flow of traffic while consistent with the satisfactory execution of the same. For all works involving improvements to the existing road, the Contractor shall, in accordance with the directives of the Engineer, provide and maintain, during execution of the work, a passage for traffic either along a part of the existing carriageway under improvement or along a temporary diversion constructed close to the highway. Before taking up any construction or maintenance operation, the Contractor shall prepare a Traffic Management Plan for each work zone and submit it to the Engineer for prior approval. This plan should include inter alia:

- A qualified safety officer with support staff to serve as a site safety team
- Provision of traffic safety devices as per IRC: SP 55 with the following specifications
- Signages of retro-reflective sheet of high intensity grade General Section 100
- Delineators in the form of cones/drums made of plastic/rubber having retro-reflective red and white bands, at a spacing of 5 m along with a reflective tape to be tied in between the gaps of cones/drums. A bulb using solar energy is to be placed on the top of the cone/drum for delineation in the dark hours and at night.

- Barricades use iron sheet with adequate iron railing/frame painted with retro-reflective paint in the alternate yellow and black & white stripes. Warning lights at 5 m spacing shall be mounted on the barricades and kept lit in dark hours and night.
- Road markings with hot applied thermoplastic paint with glass beads.
- Safety measures for the workers engaged including personal protection equipment
- First aid and emergency response arrangements
- Details and drawings of arrangements in compliance with other sub-Sections of this Section

2.4 Geometric Design and Cross Sections

The alignment plans of the Project Highway are specified in Vol-III Tender drawing. The proposed levels (FRL) as indicated in the alignment plan shall be minimum requirement and are for guidance only. The proposed plan & profile, locations of different structures/ drains/ service & slip road/ utility ducts/gas pipelines etc. as indicated in plan & profile drawing shall be treated as minimum requirement. Based on site / design requirement, the contractor shall finalize detail project report including plan & profile of the proposed roads and submit the same to engineer in charge for acceptance, before the start of the execution of work.

The intermediate site distance to be followed for the proposed sections. All Valley curves shall be designed for Headlight Sight Distance Criteria.

2.4.1 Design speed

The project roads shall be designed for 60Kmph for Primary/Secondary, 40Kmph & 30Kmph for Tertiary Road of 24m row and 18m ROW respectively.

Design speeds given above are general and these may vary at locations due to constraints or safety requirements. Design speed has been reduced to 90^{o} band curves and a radius of less than 155m. Speed limit sign boards shall be provided at these locations.

2.4.2 Width of Carriageway

The paved carriageway including paved shoulders and shyness shall be as per Typical Cross sections shown in Vol-III, Tender drawings.

(Table 2-3): Carriageway Width

S. No.	Road classification	Proposed ROW	Carriageway Width	Configuration
1	Primary Road	45m	2x7.5m main carriageway & 2x6.0 Service Road	Two Lane dual Carriageway with Median and service roads

2	Secondary Road	30m	2x7.5m main carriageway 2.2.2m paved shoulder	Two lane dual carriageway with median and paved shoulder cum drain
3	Tertiary Road	24m	7.5m main carriageway 2x2.5m paved shoulder	Two lane carriageways with paved shoulder cum drain
4	Tertiary Road	18m	7.5m main carriageway 1.0m paved shoulder	Two lane carriageways with paved shoulder cum drain

2.4.3 Length of Road

The project roads shall be constructed at the locations and for the lengths indicated below

Table 2.4: Road length

S. No	CL_Name	Typical Cross Section (TCS)	Length (m)	(Total)	F/W (m)
1	ROW_45m_MC01	1	4830	4830	Primary Road
2	ROW_30m_MC01	2	453	7616	Secondary Road
3	ROW_30m_MC02	2	520		
4	ROW_30m_MC03	2	529		
5	ROW_30m_MC04	2	771		
6	ROW_30m_MC05	2	2729		
7	ROW_30m_MC06	2	1945		
8	ROW_30m_MC07	2	669		
9	ROW_24m_MC01	3	1473	5502	Tertiary Road
10	ROW_24m_MC02	3	640		
11	ROW_24m_MC03	3	1837		
12	ROW_24m_MC04	3	259		
13	ROW_24m_MC05	3	1293		
14	ROW_18m_MC02	4	520	1563	Tertiary Road
15	ROW_18m_MC03	4	253		
16	ROW_18m_MC04	4	454		
17	ROW_18m_MC05	4	336		
	Total=		19511		

Above the Typical Cross Section (TCS) wise length is minimum and any variations in the lengths specified in the above table shall not constitute a Change of Scope. The lengths mentioned in the above list for cross section types concerned to structures are inclusive of structure length. Chainage may be adjusted according to location of structures as per drawings. Carriageway width/ Median tapering shall be provided 1 in 50.

Junctions: Designed as per IRC: SP:41. Pedestrian safety measures must be incorporated as per guidelines of the Ministry of Urban Development. Location and type of junction layouts are provided in tender drawings.

Table 2.5 Proposed Junction

S. No.	Type of Junction	Easting(X)	Northing(Y)	Road Name	ROW	Cross road name	ROW
1	X	30°29'1.243" N	76°29'50.139 "E	MC07	30m	MC05	24m
2	T	30°28'51.777 "N	76°29'38.831 "E	MC07	30m	MC05	24m
3	X	30°28'37.865 "N	76°29'59.725"E	MC01/MC06	45/30m	MC06	30m
4	T	30°28'37.676 "N	76°30'23.657"E	MC01	45m	MC05	30m
5	T	30°28'37.822 "N	76°30'32.818"E	MC01	45m	MC05	18m
6	X	30°28'23.655 "N	76°29'59.546"E	MC01	45m	MC05	30m
7	X	30°28'23.95" N	76°29'45.006"E	MC05	30m	MC05	30m
8	T	30°28'13.309 "N	76°29'45.04"E	MC05	30m	MC05	30m
9	T	30°28'13.061 "N	76°29'59.236"E	MC01	45m	MC05	30m
10	T	30°28'9.996" N	76°29'59.239"E	MC01	45m	MC04	18m
11	X	30°27'56.481" N	76°29'57.484"E	MC01	45m	MC04	30m
12	T	30°27'54.918" N	76°30'4.043"E	MC03	30m	MC03	24m
13	T	30°27'44.454" N	76°29'50.431"E	MC01	45m	MC03	30m
14	T	30°27'37.308"N	76°29'46.649"E	MC01	45m	MC03	18m
15	T	30°27'30.451"N	76°29'42.823"E	MC01	45m	MC04	24m
16	T	30°27'30.054"N	76°29'52.166"E	MC04	24m	MC04	24m
17	X	30°27'23.758"N	76°29'39.096"E	MC01	45m	MC03	24m
18	T	30°27'23.836"N	76°29'32.276"E	MC03	24m	MC02	18m
19	T	30°27'23.783"N	76°29'22.45"E	MC03	24m	MC02	24m
20	T	30°27'15.87"N	76°29'35.064"E	MC01	45m	MC01	24m
21	X	30°27'10.934"N	76°29'22.254"E	MC01	45m	MC02	30/24
22	T	30°27'11.051"N	76°29'11.953"E	MC02	30m	MC01	24m
23	X	30°27'4.406"N	76°29'22.155"E	MC01	45m	MC01	24m
24	T	30°26'52.88"N	76°29'21.884"E	MC01	45m	MC01	30m

2.5 Pavement Design

2.5.1 Design Criteria

The pavement shall be flexible for the entire length of project roads. Pavement shall be constructed for the entire length of project roads including paved shoulders. Flexible Pavement shall be designed for a minimum design period of 20 years and effective sub grade CBR of 6% and minimum design traffic of 20 MSA for main carriageway, service road and bus bay. 25mm Mastic layer shall be provided at curve length and all junctions and 60m length of junction approach.

The Pavement crust composition shall be designed in accordance with the latest guidelines of IRC 37-2018 for flexible pavement and IRC:58 for rigid pavement.

The contractor shall mandatorily provide the DBM layer with alternative design also; omission of this layer will not be permitted under any circumstances.

2.5.2 Adopted Crust Thickness

The Pavement crust composition shall be designed in accordance with the latest guidelines of IRC 37-2018 for flexible pavement and IRC:58 for rigid pavement. Effective subgrade CBR shall be 6% and Design traffic not less than 20MSA

The tentative crust thickness is given below:

(Table 2-6) Pavement crust

S. No	Pavement layer	Crust thickness
1	Bituminous concrete (BC)	40 mm
2	Dense Bituminous Concrete DBM	95 mm
3	Wet Mix Macadam (WMM)	250 mm (in two layers)
4	Granular Subbase (GSB)	200 mm

2.6 Storm water Drain

Adequate storm water drains shall be provided for the entire project area. The detailed specifications shall be followed as section 5 of technical specifications.

Load bearing drain shall be provided as per location shown in Typical Cross Section (TCS). A perforated cover slab shall be provided at the location of load bearing drain.

The central median should have a suitable drainage system so that water does not stagnate in the median. In super elevated sections the longitudinal drains should be designed to take the discharge from one side carriageway. Suitable drainpipes at not more than 50m interval shall be provided to drain out the water from the median drain.

The drain should have adequate longitudinal slope to the nearest culvert to drain off transversely. Adequate no of chamber shall be provided for water collection as per tender drawings. Suitable drainpipes/gratings at 5m to 15 m interval shall be provided to drain out the water from the carriageway. Drain cover slab shall be tapper and matched with industries entry exit road.

Box drains shall be provided for crossing the road and other approach roads.

any variations in the drain length specified into the tender drawing shall not constitute a Change of Scope.

2.7 Bridges and Culverts

2.7.1 General

Bridges and culverts are designed as per IRC and MoRTH standards. The superstructure of all bridges, culverts and structures is to be designed for edge movement of the vehicle considering stitching of new superstructure in future due to widening for additional lane. All bridges, culverts and structures shall be designed for IRC class Special Vehicle (SV) loading as per IRC: 6 and constructed in accordance with IRC guidelines and shall conform to the cross-sectional features and other details specified herein. All structures except wherever expansion joints have been provided. The pavement layers (BC and Mastic Asphalt) shall be continued over the structures for smooth riding quality of the project highway. These structures shall be designed considering the dead load of pavement layers (BC and Mastic Asphalt). All structures shall be designed to carry utility services on the outer side of the RCC barrier as per site requirement and tender drawings.

2.7.2 Hydraulic & Hydrological Investigations

Majorly Nim Sahib Drain crossed the project area. Bridge & culverts discharge shall be designed for a 50-year return flood, ensuring adequate regime width and hydraulic efficiency. The structure shall be such as not to obstruct the flow of drain and the length of bridge shall be equal to regime width of the drain as given by the formula for regime condition in IRC: 5. It is necessary to access correctly the discharge of river, HFL, scour depth, flood frequency, intensity of rainfall and average velocity of flow.

2.7.3 Structural Details

- New bridges/culverts: The structural width for the bridges will be kept same as the formation width of road, and additional width is provided for carrying various services. The detailed cross section proposed in Tender drawing.

(Table 2-7) Details of Structures

S. No	Chainage	Span arrangement No x span Length (m)	Deck Width (m)	ROW (m)	Remarks
1	0+332	2x6	13	18	Additional arrangement for utilities (1.75m Both sides)
2	4+132	2x6	35	45	
3	2+511	2x6	25.4	30	
4	2+019	2x6	25.4	30	
5	0+256	2x6	13	18	
6	0+489	2x6	25.4	30	
7	1+613	2x6	35	45	
8	0+348	2x6	17.5	24	
9	0+872	2x6	35	45	
10	0+717	2x6	17.5	24	

Chainage may be adjusted according to location of drain as per site requirements. Span length mentioned above is square dimension, skew angle shall be applied as per site requirements, any variations in the lengths specified in the above table shall not constitute a Change of Scope. Crash barrier shall be painted with yellow & black strips as per IRC guidelines.

Protection works for embankment slope and drains bed shall be provided according to IRC: SP:13 and other IRC guidelines and as mentioned in tender drawings.

Outfall arrangement of roadside drain shall be catered in culvert/bridge design.

In addition, the above cross drainage structure shall be provided as per drainage design.

- Concrete Grades

(Table 2-12): - Grade of Concrete

Description	Concrete Grade
Superstructures	
RCC Solid Slab/RCC Multi-cell Box Structures	M30 and above
RCC Crash Barriers	M40
Substructure	
RCC substructures and foundations	M30 and above
All PCC structural members	M20 and M25
All PCC non-structural members	M15

- Reinforcement steel: This shall conform to provisions given in IS: 1786, IS: 423 (Part I). reinforcement steel shall be high yield strength deformed bars (CRS- Corrosion Resistant steel) conforming to Fe 500

2.8 General Civil Specifications

All civil works shall conform to MoRTH 5th Revision, IRC publications & special publications, policy circulars/advisory letter issued to all states/UTs and CPHEEO manuals. Only the latest codes published at least 60 days before bid submission shall be applicable.

2.9 Deviations

- Roads: No deviation from MoRTH/IRC standards. Maximum super-elevation limited to 4% on sharp curves. Speed limit to be modified as per proposed ROW alignment.
- Bridges: No deviations permitted from IRC codes.

2.10 Maintenance Requirements

The contractor shall maintain all project roads and utilities in compliance with applicable standards. Routine and preventive maintenance are mandatory.

- Daily visual inspections by contractor's engineer.

- Pre- and post-monsoon inspection of drainage and bridges.
- Emergency response for hazards or damages.
- Repair timelines: potholes (24 hrs), cracks (15 days), rutting (30 days), blocked drains (7 days).
- The Contractor shall submit with his tender to the Employer with the methodology for operation and maintenance of facility/works with the Schedule of 'Manpower' and 'Organization Chart showing the structure of the organization for his administration and operation of the Contract. The contractor shall depute a project manager for the execution and operation and maintenance contract.
- The Employer, its representatives and the Beneficiaries shall have the right to bring visitors to the site/facility. The visitors shall be received by the Representative assigned by the Employer and the Contractor shall not be in charge of such visits. The Employer's representative shall give notice to the Contractor at least 24 hours in advance for visits. The facility shall be accessible to beneficiaries' staff for sampling/review of site.
- The Contractor shall arrange for the disposal of any, grit, sand, other wastes, debris and residuals to an identified disposal landfill. The location of the landfill shall be specified by the Employer. Toxic waste shall be disposed of at a site to be agreed with the concerned local body. Unless a public sanitary landfill site can be used for the disposal of non-toxic residuals, the disposal site must be approved by the local bodies responsible for public health. The disposal costs as such outside the boundaries of the facility SHALL be borne by the Contractor

  The Contractor shall repair and rectify the Defects and deficiencies specified in this section within the time limit set forth in the table below

Table 2-14: Preventive Maintenance Schedule.

S. No	Nature of Defect or Deficiency	Time Limit for Repair/Rectification
A	**Roads**	
(a)	Carriageway and Paved Shoulders	
(i)	Breach or blockade	Temporary restoration of traffic within 24 hours; permanent restoration within 15 (fifteen) days
(ii)	Roughness value exceeding 1,800 mm in a stretch of 1 km (as measured by a calibrated bump integrator)	120 (one hundred and twenty) days
(iii)	Pot holes	24 hours
(iv)	Any cracks in road surface	15 (fifteen) days
(v)	Any depressions, rutting exceeding 10 mm in road surface	30 (thirty) days
(vi)	Bleeding/skidding	7 (seven) days

(vii)	Any other defect/distress on the road	15 (fifteen) days
(viii)	Damage to pavement edges	15 (fifteen) days
(ix)	Removal of debris, dead animals	6 hours
(b)	**Granular /Earth Shoulders, cycle track, footpath, Side Slopes, Drains and Culverts**	
(i)	Variation by more than 1 % in the prescribed slope of camber/cross fall (shall not be less than the camber on the main carriageway)	7 (seven) days
(ii)	Edge drop at shoulders exceeding 40 mm	7 (seven) days
(iii)	Variation by more than 15% in the prescribed side (embankment) slopes	30 (thirty) days
(iv)	Rain cuts/gullies in slope	7 (seven) days
(v)	Damage to or silting of culverts and side drains	7 (seven) days
(vi)	De-silting of drains	24 hours
(vii)	Railing, parapets, crash barriers	7 (seven) days (Restore immediately if causing safety hazard)
(c)	**Roadside Furniture Including Road Sign and Pavement Marking**	
(i)	Damage to shape or position, poor visibility or loss of retro-reflectivity	48 hours
(ii)	Painting of km stone, railing, parapets, crash barriers	As and when required/Once every year
(iii)	Damaged/missing road signs requiring replacement	7 (seven) days
(iv)	Damage to road mark ups1133	7 (seven) days

2.11 Staffing During O&M

For all operation and maintenance works, the Contractor shall provide skilled staff, which has adequate qualifications and sufficient experience of similar works. CV of O&M Manager, Shift-in-charge, Plant/Site Supervisors will have to be got approved from the Employer. The following Table below describes the minimum levels of staffing, and their minimum qualifications and experience in similar work that the Contractor will be required to deploy for carrying out the O&M functions:

S. No	Designation	Qualification	Experience	Shift- 1	Shift-2	Shift-3	Nos.
1	O&M Manager	Graduate Engineer (Civil)	15 years	General shift 1			1

2	Site Supervisor	Graduate Engineer-Mech/Elect/ Instrumentation/Civil	10	General shift 1			1
3	Shift-in-charge	Diploma (Elect, Mech, Civil)	5 years	1	1	1	3 (2 Elec, 1 Mech/civil)
4	Electrician	ITI (Elect.)	5 years	General shift 1			1
5	Helpers	8th pass	-	3	2	2	7
6	Security Guards	8th pass	2 years	2	2	2	6
	Total			9	5	5	19

2.12 Emergency Conditions

The contractor shall prepare a comprehensive emergency action plan covering hazardous conditions, flooding, accidents, and structural risks. The plan should detail manpower, equipment, response time, and coordination measures to ensure uninterrupted service.

The Contractor shall follow the manufacturers' recommendations with respect to equipment maintenance, consumables, the types and grades of lubricants to be used, frequency of lubrication, adjustments to be made regularly and recommended spares to be held in store.

The Contractor shall provide a Notice Boards/Display Boards at appropriate locations detailing precautions to be taken by operation and maintenance personnel in work in conformity with Industries and Labor Regulations and Department of Explosives.

The Contractor will comply with all safety rules and regulations and all inter-disciplinary measures as followed by the Employer. The Employer will not be responsible for any accident / injury to the staff or any person of the Contractor or loss or damage to any property. Further, the Employer will not provide any insurance or free medical facility to the staff of Contractor. Providing necessary security arrangements for the safety of the plant and the contractor's personnel will be the responsibility of the contractor.

3.0 Potable Water Supply Network Including Firefighting System

3.1 Introduction

Contractor shall be designing the complete potable water distribution system including raw water pump house and WTP of 14.64 MLD, Domestic water transmission network from UGT-1 to UGT-2, clear water transmission network from UGT-1 & UGT-2 to clear water distribution to service connection points with connection chamber till plot boundary in the entire project area.

3.2 Background

Potable water demand will be fulfilled through fresh water sources. The consistent water source for the proposed development is Akash Distributary which will provide 16 MLD (maximum approved quantity) of potable water. Distance from IMC Rajpura: 720 m. Regulator will be installed at tapping point at Akash. Raw water transmission line from Akash Distributary is being undertaken by PUDA and is excluded from scope. EPC contractor's scope includes coordination of the transmission line with Raw water tank (5.3 MLD), Domestic Tank (9.4 MLD & 4.2 MLD), Fire tanks (0.5 & 0.6 MLD) and Surface Water Reservoir (45 MLD).

3.3 Per Capita Water Supply

The rate of water supply to be adopted for different land uses is as per CPHEEO-1999 and NBC-2016.

Table 3-1: Per Capita Water Supply

Sl no.	Use	Units	Water requirement in lpcd			Reference
			Domestic	Treated	Total	
1	Residential Plot	LPCD	90	45	135	NBC-2016
2	Retail/ Commercial	LPCD	25	20	45	NBC-2016
3	Floating population	LPCD	5	10	15	NBC-2016
4	Logistic	LPCD	25	20	45	NBC-2016
5	Horticulture use	L/ACRE/D		25000	25000	CPHEEO-1999
6	Road & Circulation	L/ACRE/D		5000	5000	CPHEEO-1999

7	Losses	KL/DAY	15%	ASSUMED
8	Fire demand	KL/DAY	100√P KLD	CPHEEO-1999

3.4 Firefighting Requirements

As per CPHEEO-1999, water for firefighting shall be provided at (100 × P^1/2), where P is population in thousands.

Fire hydrants: Single outlet, spacing max. 90 m (IS 13039). A separate fire storage tank shall be provided. Minimum network pressure: 35 m. Fire tender with booster pump shall be proposed.

Table 3-2: Firefighting Scenario Criteria

Parameters	Minimum requirement
Fire flow per fire hydrant	**600 lpm**
Residual Pressure at the fire node	**35 m**
Number of fire hydrants in operation	**4**

3.5 Water Demand

Based on land uses and population, total water demand shall be calculated. Total demand potable (Akash Distributary & borewell) + non-potable (recycled water) is given below for reference.

Table 3-3: Tentative Gross Water Demand

Sl.No.	Description	Domestic Water (MLD)	Flushing water (MLD)	Industrial Treated water (MLD)
1	Residential	1.15	0.58	
2	Industrial working population	0.93	0.74	
3	Industrial water requirement	11.90		2.29
4	Non Industrial working population	0.64	0.44	
5	Visitors water requirement	0.03	0.06	

6	Horticulture		3.98	
7	Road washing purpose			0.74
8	Horticulture & Road washing purpose inside plots			4.05

3.6 Peak Factors

The following peak factors shall be adopted as recommended in CPHEEO manual for water supply **Table 3-4: Peak Factors**

Contributory Population	Peak Factor
For population less than 50,000	**3**
For population range of 50,000 to 2, 00,000	**2.5**
For population above 2, 00,000	**2**

3.7 Design Period for Various Components

For designing systems, a 30-year project period is recommended. The design period normally considered for various components is as under:

Civil structures:	30 years
Pumping Mains:	30 years
Mechanical and Electrical Components	15 years
Distribution System	30 years

3.8 Potable Water Underground Reservoir/Tank

Scope includes designing, erection, testing, SCADA provision, electro-mechanical compatibility, level indicators, valves, level sensors, transmitter hydraulic testing and flow measurement. The underground reservoir shall be constructed with RCC Walls and RCC Base as per approved design. The reservoir and tanks shall be construed in divisions/separators as per demand design.

Table 3-5: Reservoir Details

SL NO.	DESCRIPTION	CAPACITY (MLD)
	STORAGE-1 UGT	
1	RAW WATER TANK	5.30 (In two divisions; one corresponding as per 7.5 MLD WTP and second for 7.5 MLD WTP)
2	FIRE WATER TANK-1	0.50
3	DOMESTIC WATER TANK-1	9. (In two divisions; one corresponding as per 7.5 MLD WTP and second for 7.5 MLD WTP)
4	WATER TREATMENT PLANT SIZE	14.64
5	SURFACE WATER RESERVOIR	45
	STORAGE-2 UGT	
1	FIRE TANK-2	0.60
2	DOMESTIC WATER TANK-2	4.20 (Only for domestic water supply pumping,)

3.9 Transmission Network – Potable Water

3.9.1 Raw Water Transmission Network

Source Akash Distributary to UGT-1 & borewell to UGT-1, Raw Water Reservoir shall be constructed in RCC. Adequate capacity pumping arrangements shall be provided with 1Working+1Standby pumps arrangements. Electromagnetic flow meters shall be installed and linked to SCADA system.

3.9.2 Distribution Network

The distribution system shall operate on continuous pressurized water supply. Hydraulic design shall be based on Hazen-Williams formula for velocity and head loss calculation. The network will generally be a closed-loop system to maintain uniform pressure at reservoir nodes. Design considerations include maintaining minimum velocity of 0.6 m/s and maximum velocity of 2.4 m/s. CPHEEO manual to be follow for k-values, Special fittings such as reducers, tees, and bends shall comply with BHRA standards or equivalent, subject to approval by the Employer's Engineer/PMNC.

3.10 SCADA / Automation

Automation shall be provided as per ICT manual requirements. The EPC contractor shall install level controllers and actuated valves for automatic monitoring and control of reservoirs. Butterfly valves on pipelines larger than 300 mm shall be motorized with actuators.

3.11 Excavation Depth

All water pipelines shall be laid underground with a minimum cover of 1.0 m above the pipe crown. The contractor shall design anchoring arrangements where required to prevent pipe uplift due to high groundwater levels.

3.12 Residual Pressure

For ingle storied buildings should have a minimum residual pressure of 7 m at ferrule point. For two-storied buildings the minimum pressure should be 12 m and for three-storied buildings 17 m. To meet the fire demand, a residual pressure at the ferrule point shall be considered as 35 m

3.13 Property Connections

Service pipes should be laid up to plot boundaries in the Project area. The HDPE pipes shall be used as pipe material, with diameter determined by the required service connection size.

3.14 Design Parameters for Distribution Network

The design Parameters for Potable Water Distribution Network shall as follow:

Table 3-6: Design Parameters for Potable Water Distribution Network

S. No	Design Parameter	Valu e
1.	Minimum residual pressure at Consumer connection (unless otherwise specified by Employer/ Employer's Engineer	**17 m**

2.	Peak factor	**For Residential as per CPHEEO; for industrial to be decided as per industrial process. (minimum 2.5)**
3.	Losses as Unaccounted for water (UFW) to be considered for designing	**2% Treatment loss, 3% Pumping and Raw Water Transmission loss and Clear water transmission & distribution loss shall be restricted to 15%**
4.	Bedding	**Refer Bedding Requirements for HDPE as stated in Volume III: Tender Indicative Drawings: Wet Utilities**
5.	Clear cover over pipe	**1.0 m (minimum); increase if needed to counter flotation.**
6.	Basis of supply to consumers	**Continuous pressurized**
7.	Max. Unit head loss in the pipe	**6m/KM**
8.	Hazen William Coefficient	**140 (DI CC Lined); 150 (HDPE)**
9.	**Pipe Material**	**Below 100 mm Dia: HDPE (PE-80); PN 10 Above 100 mm and less than 1000 mm Dia: DI-K7**

The network shall be designed as per ring main unit with flow and pressure monitoring system with maximum looping for guaranteed residual head at ferrule point as per desired service level.

The network shall be optimized for 5 % loss in transmission and distribution network

3.15 Water Supply Pumping System

The water supply pumping system shall refer to the pumping system of raw water, potable water, fire water & recycled water.

Raw water Pumping stations, Potable water pump stations, and Recycle water pump stations are included in the scope of contract along with associated piping and connection work with the overall network or independent system viz. Water treatment Plant etc.

The pump houses shall be of adequate size to house the pumps of required capacity and other allied electrical and mechanical equipment, also designing and providing all PLC / SCADA / Automation requirements for required components. However, the minimum size of the pump house shall not be less than 100 sq.m with sufficient height to house Gantry crane. Scope shall include all required appurtenances for completion of the work.

The pumps shall be of horizontal centrifugal split casing type design or End Suction type design with allowance of particles as per the quality of water being handled with a semi open / closed impeller design based on the quality of water being handled.

Pumping systems shall be designed as per guidelines given for Raw water intakes, CPHEEO Manual for general water supply pumps and NBC guidelines for Fire water pumping systems. The contractor shall refer to all standards related to the pumping system mentioned in General Mechanical Specification.

- Detailed specification of the pumps and associated pipe work and valves, material of construction details etc. shall be referred from General Mechanical Specification and various other relevant sections of this tender document.
- The Pump house shall be in RCC construction of required grade as called in the tender.
- Pumping system configuration, capacity and head of pumps, type of operation shall be selected as per the guidelines of the project given in this tender. Same shall be designed and due approval of such design from Client/Consultant will be required.
- Pumps shall be selected for a speed not more than 1500 rpm.
- Suitable control/throttling system to be considered if continuous flow pumps are selected.
- Suitable Lifting equipment (Gantry Crane) for pump station to be provided as per guidelines given in General Mechanical Specification. Pumping stations requiring handling equipment up to 1 ton will be with manually operated travelling crane. Pumping stations requiring above 1 ton will be with electrically operated travelling crane.
- Suitable level measuring transmitters for pump wells to be provided. Pump wells shall be designed with min 2 compartments to allow isolation of compartments for cleaning and maintenance purposes. Suitable isolation sluice gates shall be provided as required. Sluice gates shall be of CI construction with flush bottom and rising spindle arrangement.
- Valve pit, Flowmeter Pits shall be provided with rocker pipe arrangement on upstream and downstream to take care of differential settlement. Minimum space of 600 mm from pipe flange end to adjacent wall shall be provided inside Valve Chamber.

- Velocity criteria's for water supply pumping system are as follows ➢ Individual Suction Side: 1 to 1.5 m/sec
- Individual Delivery Side: 1.5 to 1.8 m/sec
- Common Delivery Header: 1.8 to 2.2 m/sec
- The pumping system shall generally comprise the following
- Isolation gate valves on Individual Suction and isolation gate/ butterfly valve on individual delivery lines of each pump with pressure gauges on suction and delivery side. Individual delivery valves shall be motorized.
- Swing Check type or Single Door/ Multi Door type Non return valves shall be provided on the delivery line of each pump
- Pressure transmitter and Magnetic type flow meter (with bypass arrangement and valves) on common delivery header
- Suitable vibration monitoring system for all pumps and RTD and BTD's for HT motor based pumping system
- Operation of pumps shall be automatic based on the levels in the suction sump. Suitable Ultrasonic Type Level Indicating Transmitters and Level switch shall be provided for automatic start and stop operation of pumps. Necessary alarms/annunciation required for safe operation of pumps shall be provided. Instruments provided shall be interlocked and compatible with SCADA
- Suitable sized air release valve with isolation gate valve to be provided on the highest point in the delivery pipe.
- Stainless steel (SS 304) expansion bellows/ dismantling joints shall be provided between pump delivery valves and at header connection for ease of installation and dismantling.
- Equal sized/Same capacity of multiple pumps will be preferred to be selected for ease of maintenance and spares.
- The clearance between pumps / piping / valves from adjacent walls shall be not less than 1000 mm.

- It is recommended to keep a minimum distance of 1500 mm between pumps centre line and increase it as per vendor recommendations.
- Sequence of operation of pumps shall be changed every 8 hours. (Contractor ensure no. of pumps selections accordingly)
- +5% margin on the pump capacity shall be provided for all the pumps. The total head of the pump shall be selected considering peak flow and minimum design water level in the wet well for normal conditions of operation and checked for satisfactory operation under extreme conditions of operation. Minimum residual head to be considered as 3m for pump head design.
- The pump capacity and head shall be selected such that the total pump output is in excess of the design flow to ensure free flow at all flow conditions.
- Dead Volume shall be as per criteria given in Hydraulic Institute and pump vendor data.
- Minimum 15% margin over the power input to pump at duty point will be kept while selecting the motor rating.
- Contractor shall consider suitable disinfectant dosing system (chlorine/ hypochlorite) dosing system in the pumping system with suitable preparation and online dosing equipment for potable and recycle water network pumping system.
- All wetted part shall be SS 304 in pumping stations, ESR and GLSR.

The design, materials, construction, manufacturing, inspection, testing and performance of all equipment's shall comply with all currently applicable statues, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also confirm to the latest applicable Indian or equivalent standards. Other International standards are also acceptable, if these are established to be equal or superior to the listed standards. Nothing in this specification shall be construed to relieve the Contractor of this responsibility

3.16 Required Analysis of Source Water

The Contractor shall conduct laboratory test for organoleptic, chemical, and bacteriological parameters as per IS 10500:2012. The following parameter shall have checked.

Table 3-7: General Parameters Concerning Substances Undesirable in Excessive Amounts

S. No.	Characteristic
1.	Aluminium (as Al), mg/l, Max
2.	Ammonia (as total ammonia-N), mg/l, Max
3.	Anionic detergents (as MBAS) mg/l, Max
4.	Barium (as Ba), mg/l, Max
5.	Boron (as B), mg/l, Max
6.	Calcium (as Ca), mg/l, Max
7.	Chloramines (as Cl2), mg/l, Max
8.	Chloride (as Cl), mg/l, Max
9.	Copper (as Cu), mg/l, Max
10.	Fluoride (as F) mg/l, Max
11.	Free residual chlorine, mg/l, Min
12.	Iron (as Fe), mg/l, Max
13.	Magnesium (as Mg), mg/l, Max
14.	Manganese (as Mn), mg/l, Max
15.	Mineral oil, mg/l, Max
16.	Nitrate (as NO3), mg/l, Max
17.	Phenolic compounds (as C6H5OH), mg/l, Max
18.	Selenium (as Se), mg/l, Max
19.	Silver (as Ag), mg/l, Max
20.	Sulphate (as SO4) mg/l, Max
21.	Sulphide (as H2S), mg/l, Max
22.	Total alkalinity as calcium carbonate, mg/l, Max
23.	Total hardness (as CaCO3), mg/l, Max
24.	Zinc (as Zn), mg/l, Max

Table 3-8: Bacteriological Quality of Drinking Water

S. No.	Organisms
1.	All water intended for drinking: a) E. coli or thermotolerant coliform bacteria
2.	Treated water entering the distribution system: a) E. coli or thermotolerant coliform bacteria a) Total coliform bacteria
3.	Treated water in the distribution system: a) E. coli or thermotolerant coliform bacteria a) Total coliform bacteria

3.17 List of Standards and Specifications

Detailed specification for water supply system has been presented in section 12.7. Key standards have been listed below.

- CPHEEO Manual for Water Supply & Treatment, 1999
- SP 7 National Building Code of India, 2016
- Urban and Regional Development Plans Formulation and Implementation Guidelines, 2014.
- SP-35: Handbook on Water Supply, Plumbing & Drainage, 1987
- Manual on norms and standards for environment clearance of large construction projects, MoEF
- IS 1172: Code of Basic requirements for water supply, drainage and sanitation
- IS 8329: Centrifugally Cast (spun) Ductile Iron Pressure Pipes for Water, Gas and Sewage Specification
- IS 12288: Code of practice for laying of ductile iron
- IS 9523: Ductile iron fittings for pressure pipes for water, gas and sewerage
- IS 4984: High Density Polyethylene Pipes for Water Supply
- Fire Hydrant: As per IS 908 (Specification for Fire Hydrant, Stand Post Type) The hydrant shall consist of one or two sluice valves with road surface boxes, a duck foot bend, flange riser and a stand post column fitted with 63-mm male coupling(s).
- Sluice valves shall be of Class I type with cap conforming to IS 780, it shall be provided with false spindle.
- The road surface box shall conform to IS 3950.
- Duck foot bend shall conform to IS 1538 heavy duty type.

- The flange riser shall conform to IS 7181. The length of the pipe should be as required.
- Stand post column shall be of cast iron, cast in one piece conforming to Grade 20 of IS 210
- Each hydrant shall be subject to hydrostatic test and shall prove perfectly watertight under a hydraulic pressure of 200 meters head.

4.0 Recycled Water Supply Network

4.1 Introduction

The contractor shall design the complete recycled water system including transmission from Sewage Treatment Plants (STP) and Common Effluent Treatment Plant (CETP) pump houses located at the Middle and South sides, to reuse underground storage reservoirs in various project areas. Recycled water shall be distributed from these reservoirs to the project area for irrigation, industrial use, and service connections in amenity/commercial areas.

4.2 Background

Recycled water is supplied to industrial and amenity/commercial areas in addition to irrigation of landscaped and green areas. The supply is through underground tanks located within the STP and CETP complexes. The reuse water scheme, including details of storage capacity, is presented in Table 4-1: Reuse Elevated Service Reservoir Capacity and Staging Height.

4.3 Design Period for Various Components

The recycled water system is planned for a 30-year design period. Civil structures are designed for 30 years, pumping mains for 30 years, mechanical and electrical components for 15 years, and the distribution network for 30 years.

4.4 Reuse Water Underground Storage Reservoir

The scope of work includes the design, erection, and testing of underground reuse water storage reservoirs. These reservoirs shall be provided with level indicators, valves, level sensors, transmitters, and actuators with provisions for future SCADA integration. All electro-mechanical installations and network infrastructure shall be RTU compatible. Hydraulic testing shall be carried out for both transmission mains and reservoirs, and each reservoir outlet shall be fitted with an electromagnetic flow meter for flow measurement. Reservoir capacities for CETP and STPs are defined in Table 4-1.

Node & Phase	Underground Storage Reservoir	Reservoir Capacity (MLD)	Remark
Middle &	CETP	1MLD	Total demand of CETP is 10 MLD. Proposed reservoir

South			configuration is 1MLD+2MLD+2MLD =5 MLD. Since Scope in this package is for 2 MLD CETP, the reservoir capacity of 1 MLD is included in scope
	STP -1	**1.2 MLD**	A total of 2.4 MLD is planned in given area. The scope in this work is for 1.2 MLD including construction of reservoir.
	STP -2	**0.7 MLD**	Total 1.4 MLD is planned in the given area. The scope in this work is for 0.7 MLD including construction of reservoir.

4.5 Transmission Network – Recycled Water

The transmission system will include recycled water pipelines from STP-1, STP-2, and CETP to individual plots and properties across the project area.

4.6 Distribution Network

The distribution system shall operate on continuous pressurized water supply. Hydraulic design shall be based on Hazen-Williams formula for velocity and head loss calculation. The network will generally be a closed-loop system to maintain uniform pressure at reservoir nodes. Design considerations include maintaining minimum velocity of 0.6 m/s and maximum velocity of 2.4 m/s. Special fittings such as reducers, tees, and bends shall comply with BHRA standards or equivalent, subject to approval by the Employer's Engineer/PMNC.

4.7 SCADA / Automation

Automation shall be provided as per ICT manual requirements. The EPC contractor shall install level controllers and actuated valves for automatic monitoring and control of reservoirs. Butterfly valves on pipelines larger than 300 mm shall be motorized with actuators.

4.8 4Excavation Depth

All recycled water pipelines shall be laid underground with a minimum cover of 1.0 m above the pipe crown. The contractor shall design anchoring arrangements where required to prevent pipe uplift due to high groundwater levels.

4.9 Residual Pressure

A minimum residual pressure of 22 m at the ferrule point shall be ensured for meeting recycled water demand across the distribution system.

4.10 Property Connections

Service connections shall be laid up to plot boundaries. Typically, HDPE pipes shall be used as pipe material, with diameter determined by the required service connection size.

4.11 Design Parameters for Distribution Network

The recycled water distribution system shall follow as:

Key specifications include: minimum residual pressure of 22 m at service connections, minimum peak factor of 2.5 for industrial usage, and total losses (UFW) limited to 15%. Pipe bedding shall comply with requirements in Tender Drawings (Wet Utilities). Clear cover shall not be less than 1.0 m. Head loss shall be economically designed at a maximum of 10 m/km. Hazen-Williams coefficient shall be 140 for DI-CC lined pipes and 150 for HDPE pipes. Pipe material shall be HDPE (PE-80, PN 10) for ≤100 mm and DI-K7 (internal CC lined) for >100 mm and <1000 mm.

Table 4.2: Design Parameters for Distribution Network

S. No		Design Parameter	Value
1.	Minimum residual pressure at service connection (unless otherwise specified by Employer/Employer's Engineer)		22 m
	2.	Peak factor	For industrial to be decided as per industrial process. (minimum 2.5)
	3.	Losses as Unaccounted for water	Limited to 15% losses (in transmission and

		(UFW) to be considered for designing	distribution combined)
	4.	Bedding	Refer Bedding Requirements for HDPE as stated in Volume III: tender Indicative Drawings : Wet Utilities
	5.	Clear cover over pipe	1.0 m (minimum); increase if needed to counter flotation.
	6.	Basis of supply to consumers	Continuous pressurized
	7.	Max. Unit head loss in the pipe	10 m/KM (economic design approach to be followed)
	8.	Hazen William Coefficient	140(DI CC Lined); 150(HDPE)
	9.	**Pipe Material**	100 below Dia: HDPE (PE-80); PN 10 Above 100 mm & less than 1000 mm Dia: DI-K7P umping Mains: DI- K7 internal CC lined

4.12 Recycled Water Pumping System

The contractor shall design and install pumping systems for recycled water as per the specifications outlined in the Water Supply Pumping Station section. Pumps, motors, and associated appurtenances shall comply with the general specifications and standards of the project.

4.13 List of Standards and Specifications

The recycled water system shall comply with the following standards and specifications:

- CPHEEO Manual for Water Supply & Treatment, 1999
- SP 7 (2016): National Building Code of India, 2016
- URDPFI Guidelines, 2014
- SP-35: Handbook on Water Supply, Plumbing & Drainage, 1987
- MoEF Norms for Environmental Clearance of Large Construction Projects
- IS 1172: Code of Basic Requirements for Water Supply, Drainage and Sanitation
- IS 8329: Centrifugally Cast (Spun) Ductile Iron Pressure Pipes for Water, Gas and Sewage
- IS 12288: Code of Practice for Laying of Ductile Iron Pipes
- IS 9523: Ductile Iron Fittings for Pressure Pipes
- IS 4984: High Density Polyethylene Pipes for Water Supply

Other IS codes relevant to hydrants, sluice valves, and pipe fittings shall also apply as required.

5.0 Storm Water Drainage

5.1 Scope of drainage work

- Detailed design, L-sections, and construction drawings of the storm water system for the project area.
- Submission of design calculations, plans, and drawings for approval to the client.
- Construction of the storm water network as per the approved design and plans.
- Consideration of groundwater level and quality (as per the geotechnical report) in the drainage design.
- Erection, testing, commissioning, and operation & maintenance (O&M) of the system.
- For bridge/culvert locations on road, dredging/cutting of the existing channel bed to achieve the minimum required clearance. Channel grading shall be maintained to ensure smooth flow from upstream of the CD structure to the outfall.
- Regarding and channelization of Nim Sahib drain as per required discharged. All drainage plans and Nim sahib drain plans & profile shall be approved by the concerned authority before starting the work.

5.2 Design Principles

- Flood protection and efficient system performance during design storm events.
- Drainage system designed to collect runoff from roads, rights-of-way, and plots, and safely discharge it into receiving bodies.
- Surface drainage ensured by considering pavement slope, inlet spacing, and inlet capacity.
- Drainage planned considering ground slope, valleys, ridges, and land-use layout.
- Designs to ensure maintainability and prevent ingress of debris, vegetation, or other materials.

5.2.1 Type of Drain

RCC Rectangular storm water drain with cover shall be provided as shown in TCS drawings. RCC openable cover for cleaning shall be provided at maximum 30m spacing.

Drain shall be design for footpath loading and vehicle loading as per proposed TCS and plan & profile drawings. Perforated cover shall be provided as per design and approval by engineer in charge.

Chambers shall be provided as per drainage plan. For median drains, a minimum 300 mm dia pipe shall be provided for crossing the pavement.

In super elevated sections the longitudinal drains should be designed to take the discharge from one side carriageway. The median shall have a suitably designed drainage system so that water does not stagnate in the median. All median drains shall be of Cement Concrete.

Where required lined chutes shall be provided to lead the discharge to the catch pit of culvert or to a natural drainage channel.

5.3 Catchment and Hydrology

The project area is divided into sub-catchments based on topography and road layout. Outfalls are aligned with natural topography, existing channels, buffer zones, and the Nim-Sahib drain.

5.3.1 Return Periods

- Once in 5 years – storm water drains and channels.
- Once in 25 years – minor culverts.
- Once in 100 years – major drainage channels within the site.

5.3.2 Rainfall Intensity

Rainfall data (25 years daily record) was analyzed to develop IDF curves for return periods of 2, 5, and 10 years. However, the contractor must procure authenticated 100-year daily rainfall data, prepare IDF curves, and obtain Employer Engineer approval before final design.

5.4 Design Parameters

Key parameters to be considered for storm water drainage design:

5.4.1 Velocity

Maximum and minimum velocity shall be followed as per IRC: SP:50. For RCC and earthen drain

5.4.2 Longitudinal Gradient

Minimum gradient: 0.3% (IRC:SP:50-2013). Steeper gradients permitted as per site conditions with protection as required.

5.4.3 Inlet Spacing

Maximum spacing: 30 m, reduced at junctions and valley curves (IRC:SP:50-2013).

5.4.4 Freeboard

Drain Size	Freeboard
≤ 300 mm bed width	10 cm
300–900 mm bed width	15 cm
900–1500 mm bed width	30 cm
> 1500 mm	≥ 90 cm (depending on discharge)

5.5 Design Methodology

5.5.1 Rational Method

$Q = 0.00278\ CIA$

(where Q = flow, C = runoff coefficient, I = rainfall intensity, A = area).

Assumptions: peak flow when entire catchment contributes; uniform rainfall; consistent runoff coefficient.

5.5.2 Synthetic Unit Hydrograph Method

Applicable for catchments > 25 km², based on CWC flood estimation reports. Parameters computed using tp, qp, W50, W75, TB, etc.

5.5.3 Time of Concentration

As IRC: SP:13-2004 & IRC: SP:50

5.5.4 Critical Intensity

Formula: Ic = Io (2/(tc+1)) (IRC: SP:13-2004).

5.5.5 Runoff Coefficient

Land Use	Runoff Coefficient
Residential	0.35
Commercial	0.80
Industrial	0.75
Roads (Bitumen)	0.90
Parks/Buffer	0.15–0.25

5.6 Hydraulic Design

Manning's Formula: Q = (1/n) × A × R^(2/3) × S^(1/2).

RCC rectangular drains with precast RCC covers on both sides of carriageway as per TCS. Width: 1000–1800 mm, Depth: 1000–2500 mm. Inlets spaced ≤ 30 m, grated with CI covers. Energy dissipation provided at junctions.

5.7 Outfalls and Natural Drainage

Storm water will discharge into identified natural streams and Nallahs. Retention tanks in green areas will temporarily store and discharge runoff. Plot runoff (during development phase) shall connect to storm drains above water level.

5.8 Protection Works

Rubble stone pitching at outfalls shall conform to IS:1597. Stones must be durable, non-absorbent (<5% water absorption), laid with proper bonding, and joints filled with chips/spalls. Pitching thickness: 230 mm, stones ≥150×150 mm.

5.9 Standards and References

- IS 456 – Code of Practice for Plain & Reinforced Concrete
- IS 458 – Precast Concrete Pipes
- IS 4985 – Unplasticized PVC Pipes for Potable Water
- IS 12235 (Parts 1–19) – Thermoplastic Pipe Tests
- IS 12592 – Precast Manhole Covers and Frames
- IS 14333 – HDPE Pipes for Sewerage
- IS 3873 – Lining of Cement Concrete/Stone Slab on Canals
- IRC SP-42 – Guidelines on Road Drainage
- IRC SP-50 – Guidelines on Urban Drainage
- CPHEEO Manual on Sewerage and Drainage (2013)
- SP 35 – Handbook on Water Supply and Drainage
- Manual on Artificial Recharge of Groundwater (CGWB, MoWR)
- Rainwater Harvesting & Conservation Manual (CPWD, India)
- Surface Water Drainage Code (PUB, Singapore)
- Managing Urban Runoff Drainage Handbook (PUB, Singapore)

5.10 Structure Design

RCC Rectangular drain with minimum M25 grade concrete shall be provided. HYSD FE500 or higher-grade reinforcement shall be used. Vehicle load drain shall be design as per TCS and road crossing.

Pigment with White cement or asphalt shall be used for cycle track/ footpath over drain as per TCS.

6.0 Residential Sewage Network

6.1 Introduction

The residential sewage network will collect wastewater from plots and convey it to the Sewage Treatment Plant (STP) located within the project area. The system shall be designed to minimize pumping requirements, although intermediate sewage pumping stations may be provided where unavoidable. The contractor is responsible for designing the complete sewerage system from property connection chambers up to the STP, including lift stations. The scope includes gravity sewer system design, excavation, laying, jointing, backfilling, testing, and commissioning of sewer pipes. It also covers the design and construction of manholes, drop manholes, and flushing manholes using RCC M-30 with SFRC manhole covers.

6.2 Background

The sewerage network system is intended to collect domestic sewage from residential, commercial, and amenity areas, conveying it to the STP as a gravity-based system. The network will be designed for peak flow conditions using CPHEEO guidelines. Domestic sewage from industries will not be mixed with industrial effluent; a separate network is planned. The STP shall be developed in modular form under the same contract.

6.3 Sewage Generation

Sewage generation is estimated at 80% of net water supplied. Sewage generation shall be calculated as per proposed land use type. No change of scope shall be provided for any variation in sewage generation.

6.4 Rate of Infiltration

Infiltration occurs through defective sewers and manholes, influenced by groundwater and soil conditions. Despite quality control, infiltration increases with system age. For this project, infiltration allowance shall not exceed 10% of total sewage flow per day.

6.5 Design Period

The sewage network is designed for a 30-year project life. Sewers and appurtenances shall last 30 years, pumping mains 30 years, and mechanical and electrical components 15 years.

6.6 Peak Factors

Peak factors depend on population as per CPHEEO guidelines.

Table 6-1: Peak Factors for Contributory Population for Per Capita Sewage Flow

Contributory Population	Peak Factor
For population less than 20,000	3.00
For population range of 20,000 to 50,000	2.50
For population range of 50,000 to 750,000	2.25
For population above 750,000	2.00

6.7 Tentative Details of Sewerage Network

The sewerage network will use pipes of not less than 200 mm OD DWC. Materials include DWC SN8 for diameters ≤400 mm and RCC NP3 with HDPE lining for larger sizes. The total length of the network is as per indicative tender drawings. Any changes in the length of pipes shall not constitute a change of scope.

6.8 Property Connections

Service pipes will extend up to plot boundaries. Connections shall not be less than 200 mm OD DWC SN8 pipes, adjusted based on plot size and flow.

6.9 6.9 Hydraulics of Sewage Network

Hydraulic design will use gravity flow equations for circular conduits. Velocity and discharge shall be determined considering slope, pipe diameter, and roughness coefficient.

6.10 Intermediate Sewage Pumping Stations

The system will be optimized to avoid pumping stations. Where required, pumping stations shall use DI-K7 rising mains with sulfate-resistant lining, wet wells with 30 minutes retention time, submersible pumps, grit chambers, odor control systems, and SCADA automation. Pump houses will be RCC structures with SS 304 wetted parts. The pump house shall be adequate size to house the pumps of required capacity and other allied electrical and mechanical equipment, also designing and providing all PLC/SCADA/Automation requirements for required components.

6.11 Coefficient of Roughness

For DWC-PE pipes, roughness coefficients shall comply with CPHEEO Sewerage Manual, 2013.

6.12 Design Capacity of Sewers

Sewers shall be designed to run 80% full at peak flow, ensuring ventilation and preventing septicity.

6.13 Minimum and Maximum Velocity

The minimum velocity shall be 0.6–0.8 m/s depending on flow, and the maximum velocity shall be limited to 3.0 m/s to prevent scouring.

6.14 Slopes in Sewerage System

Minimum slopes by pipe size shall follow CPHEEO guidelines.

Table 6-2 provides details of minimum slopes.

S. No.	Sewer Size (Mm)	Minimum Slope (1 In)
1	150	**170**
2	200	**250**
3	250	**360**
4	300	**450**
5	375	**670**
6	450	**830**
7	**>=525**	**1000**

6.15 Bedding

Bedding will be designed as per IS 783 and CPHEEO standards. DWC pipes shall have 150 mm natural sand bedding, and RCC pipes shall use bedding factors to determine type.

Table 6-3 outlines bedding types for RCC pipes.

Bedding Factor	Type of Bedding	Type of Bedding
Up to 1.9	Granular Bedding with Carefully Compacted Backfill (GRB)	**B**
For more than 1.9 and up to 2.8	Concrete Cradle Bedding with Carefully Compacted Backfill (PCCB)	**Ab**
For more than 2.8 and up to 3.4	Reinforced concrete cradle with percentage of reinforcement `p" equal to 0.4% with carefully compacted backfill (RCCB)	**Ac**
For more than 3.4 and up to 4.8	Reinforced Concrete Encasement with percentage of reinforcement `p" equal to 1% (RCE)	**A**

6.16 Manholes

Circular manholes will be used as per IS 4111. Depths vary by sewer size, ranging from 0.9 to 14.0 m. Manholes include drop and flushing manholes. Table 6-9 provides size details.

6.17 Spacing of Manholes

Manholes will be provided at every alignment change or junction. Maximum spacing will be 30 m for service connections and up to 150 m for outfall sewers. Table 6-10 provides spacing details.

6.18 Manhole Covers

Covers shall comply with IS 12592. Types include light, medium, heavy, and extra heavy duty depending on traffic load.

Table 6-4 summarizes cover details.

Range of Depths, m	Maximum Dia Up to	Manhole Size
above 0.90 m and up to 1.65 m	560 mm	**900 mm dia.**
above 1.65 m and up to 2.30 m	600 mm	**1200 mm dia.**
above 2.30 m and up to 9.0 m	900 mm	**1500 mm dia.**
above 9.0 m and up to 14.0 m	**1200 mm**	**1800 mm dia.**

i. As per IS – 4111: 1986, For inspection, cleaning and testing of sewers, manholes should be built at every change of alignment, gradient or diameter, at the head of all sewers and branchesand at every junction. This shall be kept in mind while designing the system.

ii. The sewer shall be in a straight line between two manholes.

iii. Maximum distance between service manholes should not be more than 30 m.

Manhole spacing is limited to 30m for sewers having service connections. For Outfall sewers with no service connections the spacing can be increased, with prior approval of Employers Engineer

6.19 SCADA / Automation

Automation shall comply with ICT manual. Valves greater than 300 mm shall be actuated.

6.20 Applicable Codes and Standards

The design shall comply with the following standards and codes: CPHEEO Sewerage Manual (2013), National Building Code of India SP 7 (2005), URDPFI Guidelines (2014), and SP-35 Handbook on Water Supply, Plumbing & Drainage.

7.0 Industrial Effluent Collection Network

7.1 Introduction

The industrial effluent collection network is designed to collect wastewater from industrial plots and convey it to the Common Effluent Treatment Plant (CETP) located within the project area. While intermediate effluent pumping stations have been proposed, the contractor may optimize the design by adopting a gravity-based system to the maximum possible extent. The implementation limit of this network extends from the property connection point at industrial plot boundaries to the inlet points of the terminal effluent pumping station in the CETP premises. The layout drawing of the effluent collection system is provided in the tender drawings. The scope of work includes the design, supply, laying, and jointing of effluent pipelines with associated excavation, bedding, and backfilling. It also covers hydraulic testing of the network and manholes. Manholes, drop manholes, and scrapper manholes shall be constructed in RCC M-30 with epoxy-coated inner and outer surfaces, fitted with SFRC frames and covers.

7.2 Background

The system is planned to cater to industrial effluent generated from process units, amenity areas, and commercial plots. Effluent shall be conveyed to CETP, which will be developed in modular form under the same package. The contractor’s scope includes designing and constructing property effluent chambers at plot boundaries for connection to the network.

7.3 Industrial Effluent Generation

The expected industrial wastewater generation is 9.93 MLD across the project area

7.4 Rate of Infiltration

Infiltration may occur through defective sewers and manholes, depending on soil and groundwater conditions. Despite strict quality control, infiltration may increase with age. For this project, infiltration shall not exceed 5000 litres/km/day as per CPHEEO Manual, and in no case more than 10% of the total industrial effluent flow per day.

7.5 Design Period

The industrial effluent network is designed for a 30-year project period. Pipelines and appurtenances are designed for 30 years, pumping mains for 30 years, and mechanical and electrical components for 15 years.

7.6 Peak Factor

Unlike domestic sewage, industrial flows are less variable and depend on batch processes. After consultation with the Employer/PMNC, flows shall be finalized. For design purposes, a peak factor of 2.0 is recommended.

7.7 Tentative Details of Effluent Collection Network

The network will include pipes of at least 200 mm OD. DWC HDPE SN-8 shall be used for diameters below 400 mm, and RCC NP3 with HDPE lining for 400 mm and above. Manholes shall be RCC with 5 mm HDPE lining, spaced at not more than 30 m or at changes in alignment.

The total length of industrial effluent collection network is indicative in tender drawing. Any changes in the length of pipes shall not constitute a change of scope.

7.8 Property Connections

Service pipes shall be laid up to industrial plot boundaries. Pipes shall not be less than 200 mm OD and shall be DWC HDPE SN-8.

7.9 Intermediate Effluent Pumping Stations

Although the network should be designed to minimize pumping, intermediate pumping stations may be provided where unavoidable. Pump houses shall be RCC structures of not less than 100 sq.m, equipped with gantry and pulley arrangements. Pumps shall be submersible non-clog type with open impellers. Rising mains shall be DI K7 as per IS 8329 with sulfate-resistant cement lining. Wet wells shall provide at least 30 minutes of retention at average flow. Screens, grit chambers, odor control, SCADA automation, and lifting equipment shall be included. Pumping system design shall ensure not more than six pump starts per hour, 100% standby capacity, and compatibility with VFD operation where selected.

7.10 Coefficient of Roughness

As per CPHEEO Sewerage Manual (2013): DWC PE pipes shall have a roughness coefficient (n) of 0.010, while RCC pipes shall have n = 0.011.

7.11 Design Capacity of Sewers

Sewers shall be designed to carry peak effluent flow of the design year, running at 80% full at ultimate peak flow to ensure ventilation and avoid septicity.

7.12 Minimum and Maximum Velocity

Effluent sewers shall maintain a minimum velocity of 0.6–0.8 m/s to prevent silting and maximum velocity of 3.0 m/s to prevent scouring.

7.13 Slopes in Effluent Collection System

Minimum slopes for different pipe sizes shall follow CPHEEO Manual requirements.

7.14 Bedding

For RCC pipes, bedding shall be designed considering external loads, soil bearing capacity, and pipe material. DWC pipes shall be laid on a 150 mm sand cushion free from sharp objects.

7.15 Manholes

Circular manholes are preferred as per IS 4111 (1986). Depths range from 0.9 m to 14.0 m depending on sewer size. Channels inside manholes shall be smoothly finished to avoid turbulence.

7.16 Spacing of Manholes

Manholes shall be provided at every change in gradient, alignment, or junction. For service sewers, spacing shall not exceed 30 m; for outfall sewers, spacing may be increased subject to approval.

7.17 Manhole Covers

Covers shall be SFRC, conforming to IS 12592. Types include light, medium, heavy, and extra heavy duty, depending on traffic conditions.

7.18 SCADA / Automation

The automation scope shall follow ICT Manual requirements. Butterfly valves on pipelines above 300 mm shall be motorized with actuators.

7.19 Applicable Codes and Standards

The design shall comply with the following standards:

CPHEEO Manual for Sewerage and Sewage Treatment (2013),

SP 7 (2005): National Building Code of India,

URDPFI Guidelines (2014), and

SP-35 Handbook on Water Supply, Plumbing & Drainage (1987).

8.0 Water Treatment Plant

8.1 Introduction

The Water Treatment Plant (WTP) is a critical component of the overall potable water supply system. It has been planned with a total capacity of 14.64 MLD, out of which 7.5 MLD (in modular units of 5 MLD and 2.5 MLD) will be constructed under this phase. The contractor's responsibility covers design, engineering, procurement, construction, installation, commissioning, testing, and four years of operation and maintenance (O&M) on an EPC basis. The plant must function as an integrated system with high performance, operational safety, energy efficiency, and ease of maintenance.

8.2 Scope of Works

The scope of works includes the design, manufacture, procurement, supply, erection, installation, testing, and commissioning of the WTP along with its civil, structural, mechanical, electrical, and instrumentation facilities. The works also cover the development of internal infrastructure such as drains, stormwater channels, internal roads (minimum 3.75m), fire-fighting systems, boundary walls, lighting, and landscaping. Automation will be achieved through a PLC–SCADA system integrated with flow meters, sensors, and actuated valves to ensure fully automatic plant operations. The EPC contractor shall also provide an administrative block, laboratory facilities, staff amenities, and training programs. Operation and maintenance for four years is part of the scope and includes chemicals, consumables, manpower, preventive maintenance, breakdown repairs, and environmentally compliant disposal of sludge and waste products.

With the complete development of the Activation Area, 14.64 MLD plant is envisaged. Contractor shall prepare layout of these plants within given plot from future perspective.

The Contractor shall ensure that each individual component performs in a manner which is complimentary to that of all other components. Any items and accessories which are not specifically mentioned in the specifications, but which are usual or necessary for completion of the Works and successful performance of the System and facilities shall be provided by the successful Bidder within the tendered cost. The Contractor shall, to the maximum extent practical and feasible, endeavor to standardize on the manufacture and supply of plant and equipment so as to minimize the operation and maintenance requirements.

All design parameters of WTP components shall meet PUDA guidelines. The make of machinery and materials shall be the same or equivalent as per the PUDA approved list.

With the complete development of Activation Area, WTP 14.64 MLD for planning purpose. Contractor shall prepare master layout of WTP plants within given WTP plot from overall planning perspective, whereas Contractor shall be construct 7.5 MLD plant in this phase.

All pressure containing equipment and components shall be designed, fabricated, tested, and inspected in accordance with project specification and PUDA guidelines.

Training of AKIC Operating and Maintenance personnel.

Boundary wall with top barbed fencing for the complete perimeter of site/plot.

Construction of internal roads (minimum 3.75m), drainage, solar street lighting with backups, office complex/administrative block with running setup (including 1 PC & printer), sign boards, ventilation system, firefighting, tool & tackles, Laboratory with testing equipment’s, etc.

The whole area should have a well-designed Landscapes, tree plantations, Tiled pathways, Proper Safety hand railings at all Units area, labelled of pipes/ units.

Any other items of work which have not been specifically mentioned in specifications but are necessary for the plant as per engineering practice and safety norms and operation and guaranteed performance of the entire plant shall be deemed to be included within scope of work of these specifications and shall be provided by the Contractor without any extra cost to the Employer.

8.3 Surveys and Investigations

The contractor shall undertake topographical surveys and geotechnical investigations for soil strata, bearing capacity, and foundation design. Although preliminary site data is provided, the contractor must independently verify ground conditions and base the final design accordingly. The Employer does not guarantee the sufficiency of the data provided in bid documents, and hence responsibility lies entirely with the contractor to ensure safe and efficient design.

8.4 Workability and Maintenance

The WTP shall be designed to allow safe, convenient, and efficient operation. Adequate space must be provided between treatment units to permit the movement of equipment, safe access for operators, and future expansion if required. Permanent platforms, staircases, and lifting devices shall be included to ensure ease of inspection and maintenance. All equipment requiring routine checks shall be located at accessible positions with adequate safety provisions, including handrails, guards, and curbs. Noise, vibration, and ergonomic considerations must be taken into account.

8.5 Design Parameters

The design of the WTP shall be based on the characteristics of raw water drawn from the Akash Distributary. The raw water is expected to have seasonal variations, with suspended solids ranging from 20 mg/l during non-monsoon periods to 200 mg/l during monsoon periods. The hardness is expected to be around 100 mg/l as $CaCO_3$. The contractor shall undertake water quality tests before finalizing the design. The plant shall be designed to operate continuously on a 24x7 basis, with flexibility to run at 50% of capacity during periods of low demand. The treated water shall conform to the requirements of IS 10500:2012 for potable water standards.

8.6 Treatment Scheme

The WTP shall adopt a conventional treatment process consisting of cascade aeration for removal of volatile gases and oxidation of iron and manganese; flash mixing and flocculation for coagulation of colloidal particles; sedimentation in clarifiers to separate suspended solids; rapid gravity sand filtration to remove turbidity and pathogens; and chlorination to disinfect water before distribution. Sludge generated in the clarifiers and filters shall be collected in a sludge sump, thickened, dewatered, and disposed of in compliance with environmental norms. Wherever feasible, treated sludge may be reused for land reclamation, agriculture, or safe landfill disposal.

8.7 General Arrangement of Plant

The layout of the WTP shall ensure smooth hydraulic flow between treatment units. Adequate provision for handling heavy equipment, such as cranes and gantries, shall be made. Safety features including guards, insulation, ventilation, drainage, color-coded pipelines, and noise control measures shall be incorporated. Automation and monitoring shall be based on PLC–SCADA, covering flow measurement, turbidity monitoring, residual chlorine levels, and water quality parameters.

8.8 Pipe Materials and Valves

All pipework within the WTP shall be selected based on compatibility with the conveyed fluid. Ductile iron, mild steel, or HDPE pipes may be used depending on application. Valves such as sluice, butterfly, ball, knife-edge, and diaphragm types shall be installed at appropriate locations for process control. The material of construction shall be resistant to corrosion, abrasion, and designed for a 30-year life span.

8.9 Sludge Management and Disposal

Sludge shall be managed through thickening, dewatering, and safe disposal. Dewatering shall be performed using centrifuges, filter presses, or screw conveyors. Storage facilities shall be provided for at least 3–5 days of sludge accumulation. Sludge may be reused for agriculture, forestry, or land reclamation, subject to agronomic studies, or disposed of at Common Hazardous Waste Treatment Storage and Disposal Facilities (CHWTSDFs) as per statutory regulations.

8.10 Laboratory and Administrative Facilities

A fully equipped water testing laboratory shall be provided, capable of conducting both chemical and bacteriological analyses as per APHA methods. Equipment shall include pH meters, spectrophotometers, incubators, colorimeters, and dissolved oxygen meters. Administrative facilities shall include operator rooms, SCADA control centers, offices, and staff amenities complete with Lighting, sanatory and furniture work.

8.11 Codes and Standards

All works associated with the WTP shall comply with relevant Indian and international standards, including IS 10500 (2012): Drinking Water Quality Standards, CPHEEO Manual on Water Supply and Treatment, ASME Section VIII Div. 1 for pressure vessels, NBC (SP7): National Building Code of India, URDPFI Guidelines (2014), and APHA Standards for Water and Wastewater Examination.

8.12 Operation and Maintenance (O&M)

The EPC contractor shall operate and maintain the WTP for four years. The scope includes deployment of trained manpower, supply of chemicals and consumables, preventive and corrective maintenance, and compliance with safety and environmental norms. At the end of the contract period, the contractor shall refurbish and recondition the entire plant to ensure it remains operational for at least six months beyond the O&M term. Staffing shall cover engineers, chemists, operators, and technicians to run the plant continuously in three shifts.

8.13 WTP- Staffing requirements

The bidder shall provide all the necessary operating staff and maintenance personnel to operate the Works for a total period of 48 months.

The O&M staff shall have the min. following personnel

Table 8-2: Minimum Staffing Requirement for O&M

Position	Min Number of staff	Desired Qualifications
Plant cum HSE Manager (Common for WTP, STP & CETP)	1	Bachelor's degree in environmental/chemical engineering with minimum experience of 10 years in similar nature of work.
Chemist (Common for WTP, STP &CETP)	1	Bachelor's degree in chemistry with minimum experience of 7 years in similar nature of work.
Lab Technician (Comm on for WTP, STP &CETP)	1	Bachelor's degree in chemistry with minimum experience of 5 years in similar nature of work.
Process Engineer (Common for WTP, STP &CETP)	1	Diploma in Environmental/Chemical Engineering with minimum experience of 7 years in similar nature of work.
Mechanical (Common for WTP, STP & CETP) Engineer	1	Diploma in Mechanical Engineering with minimum experience of 7 years in similar nature of work.
E&I Engineer (Commo n for WTP, STP &CETP)	1	Diploma in Electrical Engineering with minimum experience of 7 years in similar nature of work.
Mechanical Operators	4	ITI with minimum experience of 5 years in similar nature of work.
Electrical Operators	4	ITI with minimum experience of 5 years in similar nature of work.

Required Security Staff
Required Gardner, housekeeping staff

Chemical storage building for one month storage area for all chemicals shall be constructed with all necessary safety precautions, ventilation, appropriate fire extinguishers installed.

The Contractor shall provide a detailed proposed staffing schedule before the anticipated start of the 30-day operation period for each of the sections of the Works. The schedule shall cover all categories of staff from the works superintendent to cleaners, including adequate numbers of maintenance staff.

The staffing schedule shall be prepared for operating the Plant on a 24 hour per day basis with three equal shifts of 8 hours during the complete 48-month O&M contract period.

9.0 Sewage Treatment Plant

9.1 Introduction

The scope of this contract comprises data collection, design, engineering, manufacturing, supply, erection, testing, commissioning, and successful operation of the Sewage Treatment Plant (STP) on an EPC basis with four years of operation and maintenance. The works include all civil, structural, architectural, mechanical, electrical, control and instrumentation, and infrastructure works. The plant is required to meet the design capacity and effluent discharge standards, ensuring efficient and economical performance throughout its operational life.

The Contractor shall ensure that his designs are "maintenance-friendly" and that all items of plant and equipment are designed and installed in a manner which will facilitate routine and periodic maintenance operations.

9.2 Scope of Works

The scope covers the design and construction of sewage treatment units, mechanical and electrical systems, automation and instrumentation, and associated civil structures. It includes:

- Construction of receiving chambers, screening, grit removal, equalization tanks, aeration systems, clarifiers, and disinfection facilities.
- Provision of sludge treatment facilities including thickening, dewatering, and safe disposal.
- Internal roads, stormwater drainage, chemical storage, laboratory, and administrative buildings.
- PLC/SCADA-based automation, yard lighting, ventilation, firefighting, and odour control systems.
- Four years of operation and maintenance including staff deployment, supply of chemicals, consumables, tools, and spare parts.
- With the complete development of Activation Area, STP 1 - 2.4 MLD- (1.2 MLD x 2) & STP 2 - 1.4 MLD- (0.7 MLD x 2) for planning purpose. Contractor shall prepare master layout of both STP 1 & STP 2 plants within given STP plot from overall planning perspective, whereas Contractor shall be construct 1.2 MLD x 1 in zone I and 0.7 x 1 MLD plant in Zone II.
- All pressure containing equipment and components shall be designed, fabricated, tested, and inspected in accordance with project specification and ASME Section VIII, Div 1. Material certification to BS-EN-10204:2004 shall be supplied for all items.
- Training of AKIC Operating and Maintenance personnel.

- Boundary wall with top barbed fencing for the complete perimeter of site/plot.
- Construction of internal roads (minimum3.75m), drainage, solar street lighting with backups, office complex/administrative block with running setup (including 1 PC & printer), sign boards, ventilation system, firefighting, tool & tackles, Laboratory with testing equipment's, receiving chamber etc.
- The whole area should have a well-designed Landscapes, tree plantations, Tiled pathways, Proper Safety hand railings at all Units area, labelled of pipes/ units.
- Any other items of work which have not been specifically mentioned in specifications but are necessary for the plant as per engineering practice and safety norms and operation and guaranteed performance of the entire plant shall be deemed to be included within scope of work of these specifications and shall be provided by the Contractor without any extra cost to the Employer.

9.3Surveys and Investigations

The contractor shall conduct geotechnical investigations, soil testing, and topographical surveys to validate site conditions. The findings will form the basis for the detailed design of foundations and structural works. All investigations must be carried out by approved agencies, and safety margins are to be ensured during design.

9.4Design Parameters

The STP shall be designed to treat the specified influent sewage characteristics and achieve guaranteed treated effluent quality.

- **Raw Sewage Quality**: BOD, COD, suspended solids, nutrients, pH, and temperature.
- **Treated Effluent Quality**: BOD < 5 mg/l, COD < 30 mg/l, TSS < 1 mg/l, nutrients and E-coli within prescribed limits.
- **Sludge Dewatering Quality**: Minimum 20% DS content.
- **Odour and Noise Standards**: As per CPCB/MoEF guidelines. (5 Odour Units (OU)/m3 on a 99.8 %ile on an hourly averaging basis measured at the nearest receptor.)

9.5General Arrangement and Reliability

The plant layout shall ensure ease of access for operation and maintenance, safety of workers, and efficient hydraulic flow. Reliability criteria include redundancy in pumping, aeration, and critical treatment units.

Structures and equipment shall be designed for a minimum life expectancy of 15–50 years depending on material type. Proper access platforms, handrails, lifting mechanisms, and ventilation shall be provided.

9.6Treatment Scheme

The proposed treatment process includes:

- **Preliminary Treatment**: Receiving chamber, coarse and fine screening, grit removal, and equalization.
- **Primary & Secondary Treatment**: Biological treatment through aeration/anoxic tanks, clarifiers, and membrane/SBR units.
- **Tertiary Treatment**: Disinfection (chlorination/UV) and treated sewage storage.
- **Sludge Management**: Gravity thickening, centrifuge dewatering, polyelectrolyte dosing, and off-site disposal.
- **Odour Control**: Biofilter and activated carbon-based systems covering all major odour-generating units.

9.7Process Design Criteria (Unit-wise)

Each unit shall be designed as per standard engineering practices and CPHEEO guidelines:

- **Receiving Chamber**: Adequate retention time (minimum 8 hr) and flow distribution including pumping.
- **Bar Screens**: Coarse and fine screening for full plant capacity.
- **Pumping Stations**: With VFD-based pumps, standby capacity (2W+1S), and flow meters.
- **Grit Chambers**: Aerated type for grit removal.
- **Equalization Tank**: RCC Tank With coarse bubble aeration or mixers.
- **Biological Treatment Units**: Anoxic tank for denitrification, aeration tank for BOD removal and nitrification, with DO monitoring.
- **Clarifiers**: Designed for surface loading and solids separation.
- **Sludge Units**: Sludge sump, gravity thickener, centrifuge dewatering.
- **Disinfection System**: Chlorine/UV based.
- **Odour Control Units**: Biofilter and activated carbon filter.

9.8Sludge Disposal and Reuse Options

Sludge generated shall be stabilized, dewatered, and disposed of at approved CHWTSDF sites. Possible reuse options include:

- Soil conditioning in agriculture and forestry.
- Land reclamation and landscaping.
- Briquetting for fuel applications.

Adequate sludge storage provisions for 3–8 days shall be made within the plant site.

9.9Operation & Maintenance (O&M)

The contractor shall operate and maintain the STP for four years post-commissioning. Responsibilities include:

- Staffing the plant with operators, electricians, and support staff. Minimum 4 no's of each Mechanical and Electrical operators, security staffs, Gardner, housekeeping etc shall be provided.
- Routine and preventive maintenance of all equipment.
- Refurbishing and supplying spares before O&M completion.
- Record-keeping of operational data and reporting to the employer.
- Ensuring compliance with statutory regulations and environmental norms.

9.10 Treated Sewage Utilization

Treated sewage shall be stored in a dedicated tank and pumped for reuse in irrigation, landscaping, and other non-potable applications. The design shall ensure continuous supply and compliance with reuse standards.

9.11 Safety and Environmental Provisions

The plant shall comply with all safety, health, and environmental standards.

- Odour control systems to prevent nuisance.
- Noise levels below 80 dB(A) at 1 m from equipment.
- Safe chemical storage and handling facilities.
- Adequate landscaping, fencing, and internal roads to improve site aesthetics and safety.

- in O&M period

10.0 Common Effluent Treatment Plant

10.1 Introduction

The scope of this contract covers data collection, technical studies, design, engineering, manufacture, supply, transportation to site, storage, construction, installation, testing, commissioning, and successful operation of a 10.0 MLD Activated Sludge Process-based Common Effluent Treatment Plant (CETP). The facility shall be executed on an EPC basis with four years of operation and maintenance (O&M). The scope includes all civil, structural, architectural, mechanical, electrical, control and instrumentation works, as well as necessary infrastructure such as lighting, drainage, preparatory works, and temporary works. The contractor shall be fully responsible for ensuring that the complete system, including every component, is designed and constructed to operate as an integrated unit. CETP must achieve the required treatment output efficiently, economically, and safely. To this end, the contractor shall ensure that each individual component is compatible with all others, and that all necessary accessories, even if not explicitly mentioned in the specifications, are included within the tendered cost. Standardization of equipment and components is encouraged to minimize O&M requirements.
Designs shall be 'maintenance-friendly,' ensuring that all plant and equipment are installed in a manner that facilitates routine and periodic maintenance.

10.2 Scope of Works

The designated site for the 10 MLD CETP is shown in the tender drawings. The contractor’s scope encompasses complete responsibility for the design, engineering, procurement, shop fabrication, assembly, testing, inspection, packing, shipping, delivery to site, insurance, storage, erection, start-up, commissioning, performance testing, and handing over of the plant on a EPC basis.
The CETP is planned in phases: one unit of 2 MLD, one of 4 MLD, and another of 4 MLD, making a total of 10 MLD.

Under the present contract, the contractor shall construct the 2 MLD CETP along with a 1 MLD treated water reservoir. A master layout for the full 10 MLD plant shall also be prepared to ensure proper integration of future expansions.

The works shall include submission of detailed process design, hydraulic flow diagrams, P&ID drawings, electrical and mechanical installation drawings, technical information, and supporting calculations. The contractor shall be responsible for installation and testing of all equipment, illumination of the entire plant, provision of pumps for transferring treated wastewater, and execution of a three-month trial run after commissioning.

Civil works shall be completed for the full plant capacity, whereas electromechanical works shall initially cover 50% capacity, except for certain essential items such as receiving chambers, bar screens, grit chambers, equalization tanks, sludge handling systems, and piping networks, where 100% capacity installation will be required from the outset.

Additional scope includes construction of boundary walls with barbed fencing, internal roads, stormwater drainage, water supply systems, and site clearance. Provision of a sludge handling system with briquette-making facilities and adequately designed storage. Design and installation of odour control systems, landscaping, safety railings, yard lighting, and chemical storage facilities. Establishment of laboratories, testing facilities, workshops, warehouses, lay-down areas, site services, and other infrastructure necessary for construction, commissioning, and O&M. Installation of automation and control systems, including PLC-SCADA-based operation, ultrasonic level transmitters, flow meters, and HMI panels for process monitoring.

All civil structures shall be constructed using sulphate-resistant cement with epoxy-coated interiors. The contractor must also ensure provision of commissioning spares, maintenance tools, quality inspection, and testing in line with safety standards and engineering practices.

Boundary wall with top barbed fencing for the complete perimeter of site/plot.

Construction of internal roads (minimum3.75m), drainage, solar street lighting with backups, office complex/administrative block with running setup (including 1 PC & printer), sign boards, ventilation system, firefighting, tool & tackles, Laboratory with testing equipment's, receiving chamber etc.

The whole area should have a well-designed Landscapes, tree plantations, Tiled pathways, Proper Safety hand railings at all Units area, labelled of pipes/ units.

Any other items of work which have not been specifically mentioned in specifications but are necessary for the plant as per engineering practice and safety norms and operation and guaranteed performance of the entire plant shall be deemed to be included within scope of work of these specifications and shall be provided by the Contractor without any extra cost to the Employer.

10.3 Design Parameters

The Common Effluent Treatment Plant (CETP) should be designed based on the influent and effluent quality parameters specified below. These parameters form the basis for process design and guarantee performance.

Parameter	Raw Effluent	Treated Wastewater (Guaranteed)	Unit
Flow	2 MLD	-	MLD
Hourly Peak Flow Factor	2	-	-
BOD_5	1000	< 30	mg/L
COD	2500	< 250	mg/L
Total Suspended Solids (TSS)	600	< 100	mg/L
Total Dissolved Solids (TDS)	< 2100	< 2100	mg/L
pH	6.5 – 8.5	6.5 – 8.5	-
Total Phosphorous	20	< 5	mg/L
Total Kjeldahl Nitrogen (TKN)	100	-	mg/L
Ammoniacal Nitrogen	-	< 50	mg/L
Nitrate Nitrogen	-	< 10	mg/L
Oil & Grease	20	< 5	mg/L
Minimum Temperature	20	-	°C

The scope of work under this contract begins with the receiving chamber of the 1 MLD plant, including all necessary piping, valves, and appurtenances. The raw effluent line leading up to the receiving chamber is not part of this contract. However, both the industrial effluent network and CETP design are covered under the same contract.

The contractor shall conduct geotechnical investigations, soil testing, and topographical surveys to validate site conditions. The findings will form the basis for the detailed design of foundations and structural works. All investigations must be carried out by approved agencies, and safety margins are to be ensured during design.

10.4 Performance of Treatment Plant

10.4.1 Continuous Operation

CETP shall be designed for continuous operation and capable of handling variable flows. The system must allow turndown operation at a ratio of at least 2:1 without manual intervention. With manual control, it must be possible to reduce the flow to 50% of full capacity without affecting the quality of the treated effluent.

10.4.2 Performance Test Criteria

The works shall be considered successful if the following conditions are met during the performance test:

- At least 95% of treated effluent samples meet the quality requirements specified under the 'Treated Wastewater Quality' section of the design parameters.
- At least 95% of dewatered sludge samples achieve the required solid concentration in the dewatered cake.
- Minimum 10% of analyses during the performance guarantee run test shall be conducted by an independent third-party laboratory approved by CPCB or relevant authority.

10.4.3 Plant Reliability Criteria

A part of the works shall be considered to have failed the test if:

1. Any individual item of plant or equipment fails more than twice during the test.
2. More than four different items of equipment fail in total.

A failure is defined as a condition where manual intervention is required to restore the equipment to its fully operational state. For example, the failure of a duty drive is considered one failure; if the standby drive also fails to start, it will be considered a second failure.
If the specified effluent quality is not achieved, the contractor shall submit corrective proposals to the Engineer’s Representative and implement them at no additional cost to the Employer. Modifications, alterations, or additions to the plant shall be carried out until compliance is achieved, after which the performance tests will be repeated.

10.5 Plant Reliability and Life Expectancy

The Contractor shall design and construct the Works to ensure long-term operational reliability and durability. The expected life span of various components shall be as follows:

- Concrete structures: 50 years
- Mechanical plant: 15 years
- Electrical plant: 15 years
- Control panels: 15 years
- External instrumentation systems: 15 years
- Computer systems: 10 years
- Piping: 30 years
- Chemical tanks (GRP/FRP): 30 years

These benchmarks shall guide the selection of materials, design practices, and construction methodologies to ensure the Works perform effectively throughout their service life.

10.6 General Arrangement of Plant

The CETP shall be arranged to ensure safety, operability, and ease of maintenance. The contractor shall adopt a layout that minimizes hazards, facilitates access, and provides adequate space for future maintenance and replacement activities. Special attention shall be given to access ways, lifting arrangements, and safe positioning of equipment.

General guidelines for plant arrangement include:

- Minimum clear space of 2.0 m between major equipment and adjacent structures for safe access.
- Maintenance lay-down areas adjacent to mechanical equipment.
- Provision of lifting eyes, fixed runways, or overhead cranes to remove heavy equipment.
- Pumps shall be designed for 24-hour continuous duty at full load and shall handle flows between 25% and 125% of rated capacity without excessive vibration or overheating.
- Drainage channels or sumps shall be provided in areas prone to leakage or spillage.
- Acoustic enclosures or coverings shall be installed where necessary to comply with noise limits.
- All platforms and walkways shall be of non-slip material, provided with stainless steel (SS-304) handrails at a minimum height of 1100 mm, and designed for ergonomic operation of valves and equipment.
- Proper vehicular access shall be provided for sludge handling and maintenance of blower rooms, centrifuge buildings, and other critical units.

The contractor shall ensure the provision of adequate utilities such as drainage, flushing connections for sludge lines, instrumentation accessibility, and arrangement of chemical pipelines in secure, well-labelled racks.

10.7 Staffing Requirements

The Contractor shall provide adequate staffing to operate and maintain the CETP for a period of 48 months. The operations must run on a 24-hour basis with three shifts of 8 hours each. Staff shall include operators, maintenance personnel, security, and support staff such as housekeeping and gardening personnel.

The minimum staffing requirements are as follows:

Position	Minimum Number	Desired Qualification
Mechanical Operators	4	ITI with minimum 5 years of experience in similar work
Electrical Operators	4	ITI with minimum 5 years of experience in similar work
Security Staff	As required	Experienced in industrial premises security
Gardener & Housekeeping Staff	As required	Experienced in respective duties

The Contractor shall submit a detailed staffing schedule covering all categories of employees from supervisors to cleaners before the commencement of O&M. This schedule must demonstrate adequate provision for uninterrupted operation, regular maintenance, and emergency response.

10.8 Treatment Scheme

The treatment scheme for the CETP is based on a combination of physico-chemical and biological processes, designed to meet the prescribed effluent discharge standards. The process flow is as follows:

1. Industrial effluent will be collected in a collection tank and passed through a medium coarse bar screen to remove large solids.
2. The screened effluent will then enter the equalisation tank, equipped with aeration facilities to maintain solids in suspension and homogenize the wastewater.
3. From the equalisation tank, effluent will be pumped to the physico-chemical treatment stage, comprising flash mixing, flocculation, and primary clarification.

4 The clarified effluent will undergo biological treatment through the Activated Sludge Process (ASP). This includes an anoxic tank for denitrification, followed by aeration tanks for BOD removal and nitrification.

5 The aeration system will use fine bubble diffusers supplied by positive displacement blowers with acoustic enclosures.

6 The mixed liquor from the aeration tank will flow to the secondary clarifiers, where solids are separated by gravity. Settled sludge will be recycled to the anoxic tank to maintain MLSS levels, and excess sludge will be sent for thickening.

7 The thickened sludge will undergo dewatering in centrifuges, producing a sludge cake with a minimum dry solids content of 20%. The filtrate will be recycled to the equalisation tank.

8 Treated wastewater from the secondary clarifiers will be subjected to tertiary treatment using Pressure Sand Filters (PSF) and Activated Carbon Filters (ACF) for polishing.

9 Final treated water will be stored in a treated wastewater tank with pumping arrangements for reuse or safe disposal.

This scheme ensures efficient removal of organic and inorganic pollutants, compliance with statutory discharge standards, and provision for sludge handling and odour control.

10.9 Pipe Materials and Valves

The selection of pipe materials and valves shall be based on the type of fluid conveyed, operating pressure, temperature conditions, and chemical compatibility. The design shall also ensure durability, ease of maintenance, and safety in operation. The requirements for pipe materials and valve types for different applications in the CETP are summarized in the following table.

Application	Pipe Material	Valve Type
Industrial wastewater	GRP / HDPE (PE-80)	Gate valve
Treated effluent	HDPE (PE-80) / GRP	Butterfly valve
Sludge	GRP / SS 304 / HDPE (PE-80)	Gate valve
Thickened and Dewatered Sludge	SS 304	Knife-edge gate valve
Grit line	SS 304	Gate valve
Air pipe	SS 316	Butterfly valve
Chemicals (various)	uPVC / CPVC / HDPE / GRP / SS 316 (as per compatibility)	Ball valve / Diaphragm valve
Odour control ducts and piping	GRP	Butterfly valve

All chemical lines shall be colour-banded and suitably labelled to facilitate identification along their run. Particular care shall be taken to ensure neat and functional layouts, proper support of pipework, and provisions to protect materials from degradation due to UV exposure where applicable.

10.10 Chemical Dosing Systems

Chemical dosing systems form a critical component of the CETP for effective treatment and process optimization. All chemical dosing equipment shall be designed with materials compatible with the respective chemical. Each system shall be provided with calibration columns, strainers, pressure dampers, overflow arrangements, drains, and vents. Adequate ventilation shall be provided in dosing rooms to maintain safety and operational reliability.

All dosing tanks shall be sized to store at least two days' chemical requirement, and dosing pumps shall be provided with 100% standby capacity (1 working + 1 standby). The systems shall be equipped with flow control and interlocks to ensure safe and efficient operation. The chemical dosing lines shall be clearly marked and segregated to prevent cross-contamination.

10.11 Sludge Handling and Disposal

CETP shall include a comprehensive sludge management system to handle sludge generated during the treatment process. The sludge handling process involves thickening, dewatering, storage, and safe disposal.

Sludge generated from primary clarifiers and biological processes shall first be thickened in a gravity thickener. The thickened sludge shall then be dewatered using centrifuges or equivalent high-efficiency dewatering units. The dewatered sludge shall achieve a minimum dry solid content of 20–22% to ensure suitability for transport and disposal. A briquette-making system may be incorporated to enhance sludge utilization potential.

The dewatered sludge shall be stored in a covered storage facility designed to accommodate 3–5 days' production, with adequate flooring and roofing to prevent rewetting and leachate generation. The sludge shall then be transported to an approved Chemical Hazardous Waste Treatment, Storage, and Disposal Facility (CHWTSDF) in compliance with statutory norms. All transport, tipping, and associated costs shall be borne by the Contractor.

10.12 Odour and Noise Control

Effective odour and noise control measures are essential for ensuring environmental compliance and community acceptance. CETP shall therefore be equipped with an Odour Control Unit (OCU) and designed to minimize noise emissions.

The odour control system shall cover key areas such as the receiving chamber, bar screens, equalisation tanks, wet wells, and sludge treatment units. The OCU shall consist of a biofilter followed by an activated carbon filter, designed to handle hydrogen sulphide (H_2S) concentrations up to 200 ppm (undiluted) with a removal efficiency of at least 99.9%. Air extraction systems shall provide 10–12 air exchanges per hour, and ducts shall be fabricated from GRP to resist corrosion. Fixed H_2S analyzers shall be installed at the inlet and outlet of the OCU to ensure compliance. The final odour levels at the plant boundary shall not exceed 5 OU/m^3.

Noise levels shall also be controlled to ensure that sound intensity does not exceed 80 dB(A) at a distance of 1 metre from blowers or other rotating equipment. Acoustic enclosures shall be provided for blowers, and necessary insulation shall be applied to piping and rotating equipment to minimize noise transmission.

10.13 Laboratory, Control Room and Administrative Facilities

CETP shall include well-equipped laboratory, control room, and administrative facilities to ensure smooth operation, monitoring, and management of the plant.

The laboratory shall be designed to conduct routine chemical and bacteriological analyses including pH, conductivity, alkalinity, turbidity, suspended solids, TDS, residual chlorine, ammonia, nitrates, phosphates, and microbial counts. In addition, facilities for coagulation-flocculation tests, BOD and COD analysis, and advanced spectrophotometric tests shall be provided. Laboratory equipment shall include pH and conductivity meters, BOD incubators, COD digesters, analytical balances, spectrophotometers, ovens, furnaces, and other essential instruments. Adequate space shall be allocated for storage of chemicals, glassware, and reagents.

The control room shall house the SCADA system, PLC panels, operator consoles, and communication equipment. The control room shall be located at a vantage point to provide visibility of the plant and shall be designed with adequate ventilation, lighting, and ergonomic operator stations.
An administrative block shall also be provided with office space, records storage, meeting rooms, and

operator facilities. All buildings shall be constructed in RCC framed structure with brick panel walls, plastering, painting, plinth protection, and standard doors and windows. Adequate ventilation and natural lighting shall be ensured. Minimum required office furniture and 1PC with Printer shall be provided.

List of Lab Equipment's: Analytical Lab

S. No.	Description	Qty
1.	Benchtop pH meter with buffer solutions	1
2.	Benchtop Conductivity meter	1
3.	BOD Incubator	1
4.	BOD Trak II Apparatus	1
5.	COD Digester with minimum 15 no. samples holding capacity	1
6.	Dry Thermostat Reactor	1
7.	Analytical Balance	1
8.	Thermometer	1
9.	Electrically heated temperature controlled ovens	1
10.	Desiccators	1
11.	Digestion Block	1
12.	Vacuum Pump	1
13.	Xenosep Solid phase extraction Starter Kit	1
14.	Water bath	1
15.	UV Visible Spectrophotometer	1
16.	Colorimeter	1
17.	Distilling Apparatus with Graham Condenser	1
18.	Flocculator (6 jar accommodation)	1
19.	Refrigerator	1
20.	TSS portable meter - Turbidity and solids analyzer	1
21.	TDS portable meter	1
22.	Glass wares	1 lot
23.	Lab Accessories	1 lot
24.	Laboratory Chemicals	1 lot
25.	Teflon magnetic stirrer	1 lot
26.	Kjeldahl distillation and digestion unit with hood	1
27.	Handheld DO meter	1
28.	Muffle furnace	1 no.
29.	**Set-up for Coliform count, E-coli count**	1 lot

10.14 Online Monitoring System

An online monitoring system shall be installed at critical points including the lift station and treated wastewater tank. The system shall provide real-time monitoring, validation, calibration, data storage, and transmission in accordance with Central Pollution Control Board (CPCB) guidelines. The minimum parameters to be monitored continuously are as follows:

Parameter	Measuring Range
pH	0 to 14 s.u.
Total Dissolved Solids (TDS)	0 to 150,000 mg/L
Chemical Oxygen Demand (COD)	0 to 50,000 mg/L
Biochemical Oxygen Demand (BOD)	0 to 50,000 mg/L
Temperature	0 to 100 °C
Turbidity	0 to 1000 NTU

The monitoring system shall ensure independent measurement without reliance on coefficient calculations. The data shall be integrated with the SCADA system and transmitted to regulatory authorities as required.

10.15 Operation and Maintenance Requirements

Upon successful completion, commissioning, and certification of the CETP, the Contractor shall be responsible for the operation and maintenance (O&M) of the plant for a period of four years. The O&M scope shall cover all civil, mechanical, electrical, instrumentation, and automation systems, as well as consumables, chemicals, spares, manpower, and safe disposal of sludge, screenings, and grit.

Key responsibilities during the O&M period include:

- Maintaining records of all process parameters and ensuring compliance with performance standards.
- Performing preventive and corrective maintenance of all components, including civil, electrical, mechanical, and control equipment.
- Preparing detailed operation and maintenance manuals for the plant and equipment.
- Ensuring safe collection, handling, and disposal of plant residuals such as sludge, grit, and screenings to authorized facilities (CHWTSDF).
- Implementing a tri-partite agreement to control influent quality and quantity, ensuring process stability.
- Refurbishing, repairing, and reconditioning all MEICA equipment during the final year of O&M to ensure continued operability for at least six additional months beyond contract completion.

The Contractor shall also develop and adhere to a maintenance schedule, subject to approval by the Employer. Spare parts identified through maintenance logs shall be supplied during the concluding year of the O&M period. The objective is to ensure the CETP operates safely, efficiently, and continuously in compliance with environmental regulations.

11 POWER SUPPLY SYSTEM

11.1 GENERAL

11.1.1 *Preamble*

i. National Industrial corridor development corporation (NICDC) is developing (Integrated Manufacturing Cluster) IMC Rajpura under Amritsar Kolkata Industrial Corridor (AKIC) Project spread over and area of Approx 1100 Acre.

ii. Power requirements of projects has been envisaged as approx. **160 x 2 MVA (Including Transmission and distribution losses)** which will be arranged by PSTCL and then 66KV line from 220/66kV Main receiving sub-station (MRSS) may be designed in underground trench after clearance for PSTCL. Total designing and drawings have been made on the principal of underground trench only. Power to 220/66 KV MRSS shall be transmitted by PSTCL from two sources/grids at 220kV. MRSS shall be designed, built and maintained by PSTCL. The SPV (PUDA and NICDC) shall bear the cost. Design & cost shall be validated by IMC/SPV Consultants.

iii. PSTCL shall supply power from MRSS at 66 KV to Main Receiving and Distribution GIS sub-station **(MR&DSS-1)**. Further SPV shall distribute power to 66/11kV GIS distribution Sub-station **(DSS-2 to 5)** and to plot owners falls under the area of MR&DSS-1 as per design. Distribution and metering of power in the cluster shall be the responsibility of SPV/bidder. SPV is approving authority and work has to be carried out by bidder.

11.2 66KV GIS SUBSTATION (MR&DSS-1, DSS-2 TO 5) AT RAJPURA PATIALA.

The scope defined in this document is for establishing 66kVGas Insulated Substation (GIS) at Rajpura Patiala with complete automation and civil work configuration. External work scope also defined in these documents and needs to correlate with the detailed specification and GCC & SCC attached with tender documents.

- This includes the design, engineering, manufacture, fabrication, testing at manufacturers works, delivery, unloading at site, storage, erection, testing and commissioning at site of the complete 66kV G.I.S Substation including: Indoor type 66kV SF6 gas insulated metal enclosed switchgear (GIS), 20MVA transformer at each substation along with space provision for future, 250KVA as per final calculated load 11/0.415kV Distribution compact substation for auxiliary services(1W+1S), 315-400kV common area substation as per requirement defined in BOQ, 11kV VCB Panels, 66 & 11kV Automated Switched Capacitor banks, Fire Extinguishers, Testing equipment's, associated civil works including soil investigation, internal roads, drains, necessary buildings etc., 66kV XLPE copper Power Cables, 11kV XLPE Aluminium Power Cables, Indoor & outdoor End Termination Boxes, Substation Automation with Relay & Protection, Communication (Converter) equipment's and other electrical and mechanical auxiliary systems on turnkey basis. Bidder shall also ensure GIS compatibility for line feeder and provide the ancillary equipment required for the same. For connecting 66kV GIS with primary of transformers, bidder will use XLPE copper Power Cables along with cable termination for ends and flexible conductor, structures etc. as reference layout attached with tender document. For connecting 11kV side of 66/11kV Transformer, bidder will use 11kV XLPE Aluminium Power Cables and as per attached reference layout.

- The supply will include all supporting structures, auxiliary equipment's, mechanical linkages, SF6 gas piping, auxiliary circuits wiring, interlocking devices, current and voltage transformers, cable end boxes and SF6 bus ducts.
- Supportstructurerequiredforinstallationandcommissioningofaboveequipmentsshall be provided by the bidder/manufacturer.
- It is the intent of this document to describe primary features, materials, and design & performance requirements and to establish minimum standards for the work.
- It not intended to specify the complete details of various practices of manufactures/ bidders. But to specify the requirements with regard to performance, durability and satisfactory operation under the specified site conditions.
- Whenever a material or article is specified or described by the name of a particular brand, manufacturer or trade mark, the specific item shall be understood as establishing type, function and quality desired. Products of other manufactures may also be considered in case if make is not defined in approved make list, provided sufficient information is furnished so as to enable the purchaser to determine that the products are equivalent to those named.
- Any deviation or variation from the scope requirement and/or intent of this document shall be clearly mentioned under Deviation Schedule of the Bid Proposal Sheets irrespective of the fact that such deviation/variation may be standard practice or a possible interpretation of the specification by the bidder. Except for the deviation/variations which are accepted by the purchaser before the award of the contract, it will be the responsibility of the bidder to fully meet the intent and the requirements of the specification within the quoted price. No other departure from the specification except for the declared deviation indicated by the bidder in his proposal shall be considered. The interpretation of the purchaser in respect of the scope, details and services to be performed by the bidder shall be binding, unless specifically clarified otherwise by the purchaser in writing before the award of contract.
- The drawings enclosed with the specification are preliminary drawings for bidding purpose only and subject to changes that may be necessary during detailed engineering after award, keeping the basic parameters as specified.
- **Note Contractor have to take approval from PSPCL before execution of work.**

11.3 SCOPE OF WORK AND BREIF SPECS

Design, Engineering, manufacture, testing, supply, transportation to site including port and custom clearance if required, insurance, storage, testing and commissioning of 66/11kV Substation along with external work as defined in elsewhere in tender documents but not limited to following: -

Note: - QTY shall be referred from the attached BOQ. Items mentioned in BOQ shall be provided at each substation of 66kV. Items that may require to complete the work but not defined in BOQ shall be provided by the bidder without additional charge. Rating may vary as per detailed engineering. Following points are highlighted below regarding the designing of substation.

i. 66kV XLPE copper cable 1200mm2 shall be laid from metering cubicle which to be installed by PSTCL in MRSS-1 to MR&DSS-1 directly in the GIS and the GIS should be suitable for termination of the same. No. of runs for termination and spare cable shall be decided as per maximum rating of connected load. Cable & termination kits are in the scope of the substation bidder & will be supplied/erected by the bidder in coordination with 220/66kV SS owner or as directed by electrical in-charge and PSTCL authorities. In case if 220/66kV owner asks for responsibility of laying and termination then the substation bidder and GIS panel manufacturer should be present during the termination of line cable to the GIS and they will ensure/certify the safe/correct termination of the cable to the GIS and bidder shall be responsible for loss/wear- tear/damage.

ii. 20 MVA, 66/11 kV T/Fs along with all accessories and mandatory spares as per designed layout and min qty and rating defined in BOQ.

iii. All type of Neutral CT's, Surge Arrestors, CVTs for line with their terminal connector along with mandatory spares.

iv. Lightning protection.

v. Complete Sub-Station automation including Hardware & Software. Also, utility services shall be integrated with ICCC and shall be accessible as per scope of work.

vi. Complete 66kV C&R Panels and 11 kV VCB Panels with SEMs on each T/F I/C VCB Panel.

vii. Associated mechanical & electrical auxiliaries & EOT cranes & mechanical operated crane

viii. 1.1kV grade power & Armoured (FRLS) control copper cables along with complete accessories for switchgear, metering and protection equipment's.

ix. Substation structures for sub-station towers & beams and equipment structures as required.

x. Insulator strings, hardware clamps and connectors, junction box, copper lug, glands & PVC ferrules for control cabling, fibre cleats, aluminum clamps, bolts, nuts, washers etc. for fixing control cables in trenches, galvanized iron/MS trays & clamps, ACSR conductor, GS earth wire, spares. Cables supporting angles/channels, buried cable trenches & outdoor trenches with channels with trench covers.

xi. Boltless C-Type Wedge connector & equipment interconnections shall be suitable for Single Zebra/AAC Tarantulla Conductor as required.

xii. Complete lighting and illumination of the switchyard, GIS cum Control room Building, receptacles etc. as per technical specification/BOM.

xiii. Air Conditioning system as per requirement. Ventilation system for GIS hall- AHU. The requirement of ventilation system shall be as per specifications and separate room for air handling unit to be provided adjacent/inside (as per space availability) GIS hall however their design will be in scope of bidder as per requirement.

xiv. The building should accommodate 66kV GIS Hall, control room building etc as per block layout attached with tender. Building could be multilevel if space constraints as per future provision. The successful bidder has to develop architectural & structural/foundation drawings and shall submit the same to SPV before execution. Both the building shall include indoor cable trenches, all services such as lighting, sanitary, drainage, RW pipes, collection tank, soakage pit, etc. Collection tank & soakage pit shall be required if PUDA's/Punjab Govt sewerage system is not in place

xv. The entry of power cable should be made independently transformer wise, to be provided in multilayer type trays for proper/easy maintenance purpose.

xvi. Grounding system of the substation i.e. complete Earth mat laying will be designed/quoted for soil resistivity of 50 ohms, to be tested by bidder and result submitted to Engineer-In-Charge. In case soil resistivity is more than 50ohmm then the earth mat will be designed for actual soil resistivity. The payment of extra material to be used for earth mat shall be made on pro rata basis & equi potential mat beneath the floor of GIS building as per IEEE/tech. specification/IS./IEC etc.

xvii. Complete fire - fighting equipment. NFPS system for the transformer whose rating is more than 10MVA is mandatory.

xviii. Required sets of 220V 100 AH DC battery with battery charger & DCDB along with associated accessories.

xix. 415V LT A.C. DB 400A along with associated accessories.

xx. 11/.415kV Common area substation for common service defined in tender.

xxi. 250 KVA 11/0.4 kV CSS(1W+1S) for auxiliary supplies.(Transformer Capacity may be worked out and got approved from Engineer-in charge).

xxii. Providing 11 kV Automatically Switched Capacitor Bank along with allied equipment

xxiii. Cable support structure for 66kV XLPE cable for each bay shall be of Galvanized steel and shall be designed along with civil foundation by the successful bidder after award of the contract.

xxiv. The supply, installation, erection, testing and commissioning of PLCC equipment (if required) for both ends will be in scope of bidder. The shifting of Wave Trap/CVT/protection coupler/PLCC terminal etc. if required for matching purpose will be in scope of bidder.

xxv. Special Equipment's for testing and maintenance along with mandatory spares.

xxvi. Recommended spare parts, maintenance tools and other equipment necessary for maintenance purposes for fifteen years of trouble-free service other than those specified as mandatory spares.

xxvii. Any other equipment/material required to complete the specified scope.

xxviii. Cutting/Filling of earth to required depth including leveling, dressing, compaction etc. in S/Stn. including switchyard and roads wherever required to achieve required formation level.

xxix. Foundation for SS main gantry/steel structure and equipment's as per requirement and shall got approved from structural engineer before execution.

xxx. Foundation for 20MVA transformer including associated radiator complete in all respects as per approved transformer, substation transformer, capacitor banks, forced air fans if required, along with allied equipment's complete as per tech specifications. Bidder has to submit the architectural and structure layout for approval before execution.

xxxi. Foundation for lighting poles, feeder pillar, junction box, panels & control cubicle of equipment's wherever required is a part of work.

xxxii. RCC outdoor cable trenches along with RCC covers, cable racks, trench culverts crossings the road, drainage system including drainage pipes, manholes with RCC covers whenever required, installation of pump, cable etc. complete. The design/drawings shall be evolved by the successful bidder and got approved from employer before execution.

xxxiii. Laying of roads leading to switch yard, switch house & GIS buildings (as applicable) from PUDA/PWD/village road including earth filling for road and berms, if required and PCC in front, rear or side (as applicable) of the switch house building for parking etc. The above shall be as per site requirement.

xxxiv. Provision of one/two pipe(s) culvert of suitable dia. as per technical specifications on approach road leading to switch yard & switch house/GIS building from PUDA/PWD/village road (as per site requirement).

xxxv. Fencing & Boundary wall for the S/Stn. along with main entrance gates.

xxxvi. The removal of weed growth/ tree cutting shall be responsibility of the contractor. Contractor may note that purchaser shall not pay any compensation for any loss or damage to the properties or for tree cutting due to contractor's works. Approval prior cutting of trees shall be taken from concerned authorities.

xxxvii. The GIS halls dimensions and functional details given in layout are tentative since the detailed engineering is in scope of successful bidder.

xxxviii. Construction of one no. rain harvesting system (rechargeable bore/well) for each sub-station including multistory Control room cum GIS building and yard for collection of water from switch house/GIS buildings and yard. The disposal/drainage scheme for draining rain water shall include open drains, RCC pipes, inspection chambers, manholes, RCC covers where ever required, settlement tank, sum pit-cum-pump chamber with pump motor, GI Suction delivery pipes, electric control panels, cables etc. complete in all respects. The bidder shall evolve design and drawing for drainage scheme and got the same approved before execution.

xxxix. All civil works associated with construction of buildings, indoor/outdoor equipment/tower foundations, erection of EOT crane, indoor/outdoor cable trenches, drains, services, anti fire wall, rechargeable well, sump pit-cum pump chamber, settlement tank, septic tanks etc. are in the scope of successful bidder.

xl. The Switchgear shall be complete with all necessary terminal boxes, SF6 gas filling, interconnecting power and control wiring, pressure switches, grounding connections, gas monitoring equipment and piping, support structures etc.

xli. The work to be done under this specification comprises the provision of all labour, plant, equipment and material and the performance of all work necessary for the complete installation and commissioning of switchyard on turnkey basis. It is hereby required that the contractor should provide all apparatus, appliances, material and labour etc. not specifically mentioned or included, but are necessary to complete the entire work or any portion of the work in compliance with the requirements implied in this specification is deemed to be included in the scope of contractor.

xlii. Dismantling of various existing structures if any shall be under bidder scope of work along with clearing of existing site.

THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR: -

i. Complete project management.
ii. Making conceptual drawings, shop drawings getting than approved from Engineer-in-Charge.
iii. Making As built drawings after completion of project.
iv. Making submission documents complete with warranty certificates from manufacturer / supplier.
v. Design and engineering of entire work of GIS and associate work of Substation including supply of complete documentation i.e. design drawings, design memorandums, O&M manuals for all works which shall be identified at the time of contract.
vi. Insulation coordination including studies for selection of metal oxide surge arrestors, parameters, location for complete switchyard. The specifications and quantity provided elsewhere are indicative only. The final quantities shall be worked out during detailed engineering of insulation coordination.
vii. The quality of all materials and workmanship of the complete work
viii. The Contractor shall be responsible for detailed design and engineering of overall system, sub-systems, elements, system facilities, equipment's, auxiliary services, etc. It shall include proper definition and execution of all interfaces with systems, equipment, material and services of purchaser for proper and correct design, performance and operation of the project.
ix. Contractor shall provide complete engineering data, drawings, reports, manuals, etc. for purchaser's review, approval and records.
x. The Contractor shall carry out earth resistivity measurements at the substation site(s) (based on four electrode method)
xi. For all structural works, the contractor shall prepare all fabrication drawings.
xii. All consumables, wastages and damages shall be to the account of contractor.
xiii. The contractor shall construct, erect and install all equipment and material required for completion of substation(s) covered under the project. He shall be responsible for provision of all labor, tools and tackles and supervisory staff for safe, reliable, proper and correct erection of all equipment required for successful completion of the substation(s).
xiv. The tools and plant shall include, but not limited to, special hoisting equipment, cranes, slings, consumables and all other articles and supplies as required.
xv. The contractor shall ensure periodic cleaning of work site and removal of all waste material, packaging material, surplus earth and left-over and their proper disposal.
xvi. The contractor has to employ suitable manpower and supervision personnel. Minimum manpower shall be deployed as per manpower matrix attached with tender document. The contractor is solely and fully responsible for the safety of personnel and materials. Any damages to the existing facilities shall be made good by the contractor at no extra cost to the purchaser. The contractor shall coordinate with site personnel for arranging shut down for interconnection with the existing systems, if required.
xvii. The contractor shall be responsible for the overall management and supervision of works. He shall experience, skilled, knowledgeable and competent personnel for all phase of the project, so as to provide the purchaser with a high-quality system.
xviii. The contractor's supervisory personnel shall provide operation and maintenance assistance during the warranty periods. Operation and maintenance shall be done as per tender terms and conditions.
xix. A Project execution schedule called Master Network (MNW) in the form of PERT chart/network shall

be prepared by the contractor for purchaser's approval. The MNW shall identify milestones of key event for each work/ component in the areas of engineering, procurement, manufacturer, dispatch, erection and commissioning. It shall indicate interfaces and inputs required to be given by Purchaser.

xx. For Inspections/tests to be carried out for equipment offered from within purchaser's country. All tour expenses shall be borne by purchaser.

xxi. For inspections/tests to be carried out for equipment offered from outside purchaser's country. It is envisaged that inspection/testing of all such equipment shall be witnessed. Each inspection shall be carried out by a team of 3 to 4 engineers nominated by the purchaser. Their To & Fro travel expenditure from purchaser's country to the place of inspection/testing shall be borne by the bidder including all boarding and lodging charges.

xxii. The contractor shall identify all interface issues with purchaser and other agencies, and shall be responsible for such interfacing, coordination and exchange of all necessary information.

xxiii. The approach road up to the GIS substation area shall be provided by the Purchaser. All internal roads (if any) shall have to be constructed by the contractor.

xxiv. Bidder will solely be responsible for obtaining statuary clearances for providing temporary connections for construction of power and water. The contractor shall arrange for necessary meters etc. and shall pay applicable energy and water charges as per applicable rates to the concerned authorities.

xxv. Contractor shall make his own necessary arrangements for the following and for those listed anywhere else in this specification.

- Construction power supply at all works areas.
- Provision of water supply arrangement.
- Construction office and store (open and covered)
- Construction workshop and material/field testing laboratory
- Boarding & lodging arrangement for their personnel.
- Fire protection and security arrangements during construction stage.
- Any other requirements of the state/central Government and as per the purchaser's rules, regulations and practices.
- The contractor shall make his own necessary arrangements like diesel generator sets, water etc., at his own cost so that progress of work is not affected and Employer shall in no case be responsible for any delay in works because of non-availability of power, water etc.
- Provide labour license as per Govt. Rules.
- SF6 gas filling & evacuating plant with gas cylinders shall be supplied by the bidder as per Bid Price Schedules and shall be utilized by the bidder for commissioning. The contractor would be required to hand over the same in good working condition with enough gas for one charging of complete system with 20% extra gas as indicated in mandatory spares
- EOT crane shall be provided in 66KV GIS building for GIS equipment handling during

installation, commissioning and maintenance etc. Crane lifting capacity shall be adequate to handle the heaviest package of GIS but shall not be less than 5 tonnes for 66kV System. The crane shall also be provided with speed drive mechanism. Further, the mechanical operated crane for uplifting the equipment's from ground floor to first floor should be provided adjacent to multi storey building & adequate to handle the heaviest equipment (lying at first floor i.e. control room) but shall not be less than 2 tonnes. The same should be provided as per site requirement for handling during maintenance (i.e. to & fro of equipment's from outside the ground floor to first floor) as per relevant IS & confirming to safety norms. Supply, erection, testing and commissioning of all items of work required to make the 66kV bays fully functional.

- Bidder shall submit along with the bid and also during detailed engineering the computation and calculation for enclosure loss and details about the measures taken to reduce losses so as to limit the temperature rise of enclosure as per the requirement of GIS.
- Bidder shall be responsible for complete internal and external electrical works including light fixture, poles, power points, AC system, Fire Alarm system, Ventilation system complete as required and defined in tender document.

11.4 DESIGN BASIS

The scope of electrical works shall broadly consist of the major following items (To be read in conjunction with SLDs and other layouts attached with tender document. This document describes the scope of only 66/11kV Substations and external area within 1100acre including common services etc.

i. 220/66kV Main Receiving Substation MRSS-1:
   - Power to 220/66 KV MRSS shall be transmitted by PSTCL from two sources/grids at 220kV. MRSS shall be designed, built and maintained by PSTCL. The SPV (PUDA and NICDC) shall bear the cost. Design & cost shall be validated by IMC Consultants. PSTCL shall supply power from MRSS-1 at 66 KV to Main Receiving sub-station (MR&DSS-1A). Further SPV shall distribute power to 66/11kV GIS distribution Sub-station (DSS-2 to 5) and to plot owners falls under the area of MR&DSS-1 as per design. Distribution and metering of power in the cluster shall be the responsibility of SPV. (Metering for incoming of 66 K.V. line shall be done by PSTCL)
   - Two Transformers of 220/66 KV, 160 MVA each are being proposed at MRSS-1. In this report, space and infra provision for one no. additional transformer and relevant equipment's & accessories have also been considered into upgrade the set as per future conditions. Under Ground lines shall be laid from Main Receiving Substation (MRSS-1) to MR&DSS-1 as per decision of PSTCL guidelines. For distribution Stations, 66 KV Lines GIS based panels shall be installed at MR&DSS-1 and distribution Stations (DSS-2 to 5).

ii. Five Nos. 66/11kV Electrical Substation (MR&DSS-1, DSS-2 to 5):
   - Indoor GIS Substation comprising 66kV GIS Switchgear, 11kV GIS/VCB switchgear, 415V LT Auxiliary Switchgear, 66/11kV Power transformers, 11/0.433 Auxiliary CSS, Battery & Battery Chargers, RTCC, Control panels, SCADA system with uninterruptible power supply system, 415V Diesel generator, AMF Panel, SCADA system with uninterruptible power supply system and all other Cabling, Earthing and Lightning protection system, Earth Mat, Civil work etc. Actual location of proposed S/stn shall be as per Engineer-in-charge's direction/guidelines. Tentative

location is marked on layout plan. Space provision shall be kept for future requirements. Note: SCADA system shall be supplied and installed by another agency but provision for SCADA shall be kept in this package at all required points.

iii. 11kV Ring main Units (Adequate quantity for project area as directed by Engineer-in charge), as per final plot allotment and load calculation plot wise.

iv. 11kV Compact Substation (CSS) (Adequate quantity for project area as directed by Engineer- in charge).

- Electrical for STP/ CETP/ WTP plants consisting of 11kV RMU, 11/.415kV Distribution transformers/CSS, LT Switchboards, Distribution board etc. as required.
- Lighting and Power Feeder Pillars, wherever needed. Dedicated feeder pillar shall be provided for common area services. All lighting/power feeder pillar shall be provided with MFM with SCADA compatibility with RS485 communication port. LV feeder shall be dedicated to ICT services but shall be installed in coordination with electrical services only.
- Provision of D.G. Sets is not considered for ICT, SCADA, CCTV, Traffic and other safety and security services. Instead of this LV service shall be backup with UPS of 2x15KVA on each substation area and 3X100KVA UPS for ICCC. Common services like plumbing, Street Lights, EV Charging point, Bus stop shall be feed from EB/Main power supply provided from nearest substation or through feeder Pillar installed on field. Safety and security services shall have UPS Backup. (ICT and SCADA system including CCTV shall be executed under separate package but provision to be kept for their services in this package.
- Load Calculation has been done as per industry norms defined by Punjab electricity department based on Sq. yard and the area considered in calculation is as per the area of respective plot. Load of STP, fire pumps and other common services has been considered in the calculation of common services feeders.
- In each 66/11 KV Sub Station, (DSS-1 to 5), 20MVA, 66/11 step down Power transformer shall be installed. Each 11 KV feeder shall be laid in Ring Main Pattern with one bus coupler. Bus coupler is proposed in feeder line. Each plot having load more than 4MVA but less 20MVA shall fed with 66kV line. Provision for Installing one no. additional Transformer to be kept for future. Infra shall be designed accordingly.
- DG Sets for common area service, security and safety services shall be installed later (if required) at respective substations. However, Transformer, LT panel and other distribution panel shall be installed by EPC contractor during development stage. Panels shall be designed to have provision for feeding solar power in this package and D.G. set shall may be installed in future, provision for the same shall be kept in panels and space allocation at this stage and DG set power in future. Servo shall be installed for regulating the voltage on field. Voltage drop to shall be considered as per defined parameters and electricity norms.
- Sub-station for individual Plot shall be installed by respective Plot owners as per their requirements in complying with terms and conditions agreed as per SPV and PSTCL/Local Governing Bodies Norms.
- DG sets for plot owners/consumers shall be installed by themselves for their own uses based on their load and design requirements.
- Street lighting feeder pillar shall be used for both lighting as well other common services falls within external area. Bus stop, EV charger etc. shall be fed with Feeder pillar. Suggestive layout of feeder pillar is attached with tender documents.
- 66kV, 11kV and 1.1kV XLPE Armoured Cables along with all necessary fittings and accessories

i.e. termination kits, jointing kits, cable tags etc. as required to take the power supply from MRSS-1 to MR&DSS-1 and to each 66/11kV Electrical substations (DSS-2 to 5) & to the other dedicated plot power connection (with contract demand greater than 4 MVA but less than 20 MVA), then from various DSS to 11kV RMU and 11kV/0.415kV CSS of Various plot & Utilities of external area to establish a proper distribution network.

- RCC Cable Trench for 66kV, 11kV, 1.1kV cable and OFC complete in all respects. Cables will be laid in tier formation through the cable trenches. Refer tentative /suggestive cable trench layout however actual formation shall be based on detailed engineering. Cable tray shall be used for LV services.
- Instrumentation and Fiber Optics cables, their jointing for SCADA. (Only provision to be left, OFC cable and SCADA shall be executed by another agency)
- External & Internal Lighting.
- 11/0.415 kV, outdoor type transformers or CSS / feeder pillars, Galvanized Street lighting pole including fixtures. High Mast (At strategic locations), Lighting poles, lighting panels, cabling etc. as required for street lighting, Luminaries, distribution boards etc. as required for each substation internal lighting. Street lighting and street lighting cabling for entire project area shall be as per Engineer-In-Charge's instructions/Guidelines. Transformer shall be Level-3.
- DG Sets for Critical loads of Substation. Dedicated DG set shall be provided for each Substation. DG set not required for common services. Auxiliary services shall be backup with DG sets and LV services shall be backup with UPS power.
- Earthing and lightning protection system. Earthing Mat for substation areas/plotsas per final approved design and drawings.
- Power Meters SMART TYPE (SCADA Compatible) for all plots under area.
- Power SCADA for MR&DSS-1 and 5 Nos. DSS-2 to 5.
- Contractor shall design, supply and install adequate number of 11kV RMU, CSS, TransformersStreet lighting poles/High Mast, lighting feeder pillars and adequate quantity of 66kV, 11kV & LV Cables & MS/GI Cable trays, etc. subjected to occupancy of consumers for project area in consultation with Engineer-in-charge.
- Civil works complete in all respects within substation, External area for lighting and cable laying work.
- The contractor shall design and construct the complete works necessary at site required to properly, safely and efficiently operate the electrical system and meet the electrical needs of the development and all facilities. Contractor shall lay 66kV & 11kV cables under supervision of Employer.

11.5 DESIGN CODES

- Indian Electricity act 1956.
- Guidelines laid down by P.S.P.C.L, P.S.P.T.C.L.

- BIS: Bureau of Indian Standard
- IEC: International Electro technical commission
- IS: Indian Standard
- Regulations lay down by Indian Electricity Rules
- National Electrical Code (SP 30, 2011) of India
- Bureau of Energy efficiency (BEE) CEA Guidelines
- Any other regulations laid down by the local or government authorities. / Fire Insurance

- IEC-62271-203: Gas Insulated Metal-Enclosed Switchgear for rated voltage for 72.5kV & above
- IEC-60517: Gas Insulated Metal enclosed switchgear for rated voltages of and 72.5kV above
- IEC-60376: Sulphur Hexafluoride
- IEC-62271-100: High Voltage Alternating Current Circuit Breakers
- IEC-60694: Common Clauses for high voltage switchgear and control gear standards.
- IEC-62271-100: Alternating Current Disconnectors (Isolators) and Earthing switches.
- IEC-61128: Alternating Current Disconnectors Bus-transfer current switching by disconnectors.
- IEC-61129: Alternating Current earthing switches-induced current switching.
- IEC-66044-1, Current Transformers

IS-2705:

IEC-66044-2: Voltage Transformers.

- IEC-60137, IS-2099: Bushing for alternating voltages above 1000V
- IEC-60859: Cable connections for Gas insulated switchgear
- IEC-60480: Guide to checking of Sulphur hexafluoride taken from electrical equipment.
- IEC-60099-1/4: Non-linear Resistor type arrestors for AC systems.
- IEC-60439: Factory built assemblies of low voltage alternating current breaker
- IEEE80-(2000) IEEE: Guide for safety in AC Substation Grounding

- CIGRE-44: Earthing of GIS-an application guide
- IEC-61639: metal Direct connection between power transformers and gas insulated enclosed switchgear for rated voltage 72.5kV and above
- IS-335, IEC-296, Insulating oil for Transformers and switchgear.

BS-148:

- IS-2026, IEC-76: Power Transformers
- IS-3151-1982 Earthing Transformers
- IS-3131-1965: Electrical Relays for power system protection
- IS-8468: On Load Tap Changers
- IS-1554 (Part-I) including 1976: PVC insulated electric cables for working voltage up to and 1100V
- IS-5216-1982: Guide for safety procedures and practices in electrical work and electrical power connections.
- IS-5528-1985: Guide for short circuit calculation
- IS-1966-1983: Code of practice for maintenance and supervision of insulating oil in service.
- IS-2629-1990: Recommended practice for Hot Dip Galvanising of iron and steel
- IS-2486: Specification for Insulator fittings for overhead power lines with a nominal voltage greater than 1000V
- IS-3188: Dimensions for Disc Insulators
- IS: 7098 (Part-II & III): Standard for cables, Part-II up to 3.3kV to 33kV and Part-III from 33KV to 220kV
- IS-1885: HT Supply
- IS-2713: GO (gang operated) Switch with Double Pole Structure
- IS: 1554 (Part-I): PVC Insulated (Heavy Duty) Electric Cables up to and including 1100V
- IS: 1554 (Part-II): PVC Insulated (Heavy Duty) Electric Cables for working voltages from 3.3kV up to and including 11kV

- IS: 7098 (Part-II): Crosslinked Polyethylene Insulated Thermoplastic sheathed cables for working voltage from 3.3kV to 33kV
- IS: 1367: Pole & Mast
- IS 12834-19889: Solar Photo voltaic energy systems
- IS 12762 (PT 1): Photovoltaic Devices- Measurements of current & Voltage Characteristics

1989:

- IS 10322 IEC 60529: Light Fitting and Lamp
- IS 3043/1987: Earthing
- IS 2309 IEC 62305: Lightning Protection

11.6 CLIMATE AND CONDITIONS

For IMC Rajpura the Electrical equipment selected shall be such so as to get trouble free operation during the life of the equipment, under the most stringent atmospheric conditions. The equipments shall be designed to consider the heavily polluted area.

Table 11-1: Category of load and consumers as per Climate and Conditions

S.No	Category of Loads/Consumers	Supply Voltage
1	Maximum ambient Temperature	45°C
2	Minimum Ambient Temperature	0°C
3	Maximum Design Ambient Temperature	50°C
4	Relative Humidity	Refer Detail as per IMD
5	Average number of Thunderstorms (days/annum)	Refer Detail as per IMD
6	Altitude of operation	260mtr
7	Average annual Rainfall)	Refer Detail as per IMD
8	Wind speed	Refer Detail as per IMD

11.7 BASIC ELECTRICAL DATA

i. System Of Electrical Power Supply

- The frequency of alternating current supply shall be 50 cycles per second. The voltage and frequency shall be kept within the range specified in the relevant Rules/Regulations made by the Central/state Government or Central/state Electricity Authority from time to time.

ii. Classification of Electrical Power Supply (As per P.S.T.C.L. Electricity Regulatory Commission) is defined below for allotting the power connection based on the below table.

Table 11-2: Category of load and consumers

S.No	Category of Loads/Consumers	Supply Voltage

1	DS/NRS loads not exceeding 7 kW (including motive load not exceeding 2 BHP).	Single phase 230 V (between phase and neutral)
	Industrial load including general load not exceeding 7 kW at consumer's option.	
	AP load not exceeding 2 BHP	
	Street lighting load not exceeding 7 kW.	
2	DS/NRS loads exceeding 7 kW or motive load exceeding 2 BHP but not exceeding 100 kW.	Three phase 415V (between phases)
	Industrial load including general load/demand (other than covered under (i) above) not exceeding 100 kW/100kVA	
	Bulk Supply load with contract demand not exceeding 100 kVA.	
	AP load exceeding 2 BHP/AP high technology loads not exceeding 100 KW.	
	Street Light load exceeding 7kW but not exceeding 100 kW	

S.No	Category of Loads/Consumers	Supply Voltage
	Note: Domestic consumers existing as on 1.8.2012 having load up to 10 kW shall have the option to have single phase supply or three phase supply in case their connected load after computing as per Reg.4.5 worked out to be more than 7 kW	
3	Arc furnace loads having specified protection system for suppressing voltage surge and other Large Supply Consumers (General and Power Intensive Industry) with contract demand not exceeding 4000 kVA.	Three phase 11 kV (between phases)
	DS/NRS/BS loads exceeding 100 kW/kVA but with contract demand not exceeding 4000 kVA.	
	Single Point Supply under regulations 6.6.1 & 6.6.2 with contract demand not exceeding 4000 kVA.	
	AP High Technology Supply with load exceeding 100 kW.	
4	Arc furnace loads (other than covered in (iii) above) not exceeding 20 MVA.	Three phase 66 kV (between phases) as per availability of voltage at the nearest feeding S/Stn.
	Large Supply Consumers with contract demand exceeding 4000 kVA but not exceeding 20 MVA	
	DS/NRS/BS loads including single point supply under regulations 6.6.1 & 6.6.2 with contract demand exceeding 4000 kVA but not exceeding 20 MVA.	

Source: PSERC (Electricity Supply Code & Related Matters) Regulations, 2014 Upto 7th Amendment

11.7.1 *Power factor*

- An Average power factor of 0.9 shall be considered for design purpose as per PSTCL guidelines.

11.7.2 *short circuit current of 220kV, 66kv, 11kv and .415kv*

- Following standard short time current ratings will be considered while selecting the equipment for various voltage levels. However, short circuit calculation will be performed to determine actual findings during detail designing and equipment's will be selected accordingly.

Table 11-3: Short circuit current of 220kV, 66kV, 11kV and 0.415V system

S. NO.	Description	Proposed Short Circuit Current
1	220kV	To be decided by PSTCL
2	66kV	30kA/3 Sec
3	11kV	26.2kA/1 Sec
4	0.415kV. Upto 1000kVA	27kA/1 Sec

11.7.3 System Earthing

Table 11-4: System Earthing

S. NO.	Voltage Level	System Earthing
1	220kV	Solidly Earthed System
2	66kV	Solidly Earthed System
3	11kV	Solidly earthed system
4	0.415kV	Neutral of Transformer solidly earthed

Note: Two numbers independent earthing for transformer neutral will be considered

11.7.4 *Assessment of load demand*

- As per Master plan, the plots under IMC Rajpura are classified into cluster groups consisting of Industrial, Commercial, Residential, utilities and Amenities etc. Site Plan can be referred to view the area/plots covered by respective sub-station and providing power supply as per their demand load criteria given by PSTCL.

11.7.5 *Estimated Power demand*

- Power demand is established based on Plot area of the proposed development. Since all the electrical equipment is not drawing load at the same time, a diversity factor is also taken into consideration. Estimated Power demand of IMC Rajpura is tabulated below. As per Punjab state electricity norms, load calculation has been done based on plot sqyard area defined as per below table.

Table 11-5: Demand Industrial plots (Area Based)

S. NO.	Area of plots(in Sqyard)	Estimated load in watt/sqyard
1	Up to 250	100
2	From 251 to 350	106
3	From 351 to 500	100
4	From 501 to 750	87
5	From 751 to 1000	80
6	From 1001 to 1210	78
7	From 1211 to 1500	73
8	From 1501 to 1750	71
9	From 1751 to 4500	70
10	From 4501 to 9680	72
11	From 9681 to 14520	68
12	From 14521 to 19360	66
13	From 19361 to 24200	70
14	From 24201 to 29040	79
15	From 29041 to 33880	85
16	From 33881 to 38720	92
17	From 38721 to 43560	98
18	From 43561 to 48400	103
19	Above 48400	100

Note: -

Sixty Percentages (60%) of the total Industrial load as calculated above shall be taken as colony/complex load. The load shall be converted in kVA by using a power factor of 0.90. These loading norms shall be applicable to all in process NOC cases and all new NOC applications registered after issue of these instructions. Further these norms shall be valid upto 30.09.2022.

11.7.6 *Existing EHT transmission line crossing IMC*

There are 3 Nos. of existing EHT Transmission lines, crossing IMC Rajpura below: Which shall be re – routed (if required) has to be done by concerned Department. Development in IMC shall be done to maintain clearance as per IE rules. At present 220kV line rerouting is considered and shall be under PSTCL scope. EPC contractor has to coordinate with PSTCL in re-routing of line as road sections and street lighting and trenches shall be designed accordingly. Suitable ROW to be maintained as per IE rules.

11.7.7 *illumination system*

LED Lighting system is proposed for Road lighting, substation indoor & outdoor areas. Minimum LUX levels of illumination which are recommended as per IUT-Institute of Urban Transport and Indian Standard SP: 30 – 2011 and as per IS 3646 / IS 1944 will be adopted. For Substation emergency lighting, Emergency lighting fixtures shall be fed from Inverter and DG Sets proposed for each MRSS-1, MR&DSS-1 and DSS 2 to 5. Suitable rating of inverter shall be selected with 2hr battery backup along with bypass arrangement.

Table 11-6: Recommended Illumination Level

S. No.	Particulars	Average Illumination Level 'Lux'
1	Control panel Room	300 to 350
2	Battery Room	200
3	Office & reception	300
4	Workshop/Repair Bay	350 to 400
5	Test room	450
6	Corridors	70 to 100
7	Store room	100
8	Road	30 to 35
9	Park	10
10	Switching Station or substation	300 to 350

11.7.8 Light Fitting Proposed at Various Areas

A well-designed, energy-efficient LED street lighting system should permit users to travel at night with good visibility, in safety and comfort, while reducing energy use and costs and enhancing the appearance of the neighbourhood. Lighting shall be provided at Park internal areas, street lighting, Substation areas etc. 15mtr freen belt and 30mtr buffer area near Nala. Cycle track/pedestrian area under nala's buffer area to be illuminated.

The design shall be based mainly on:

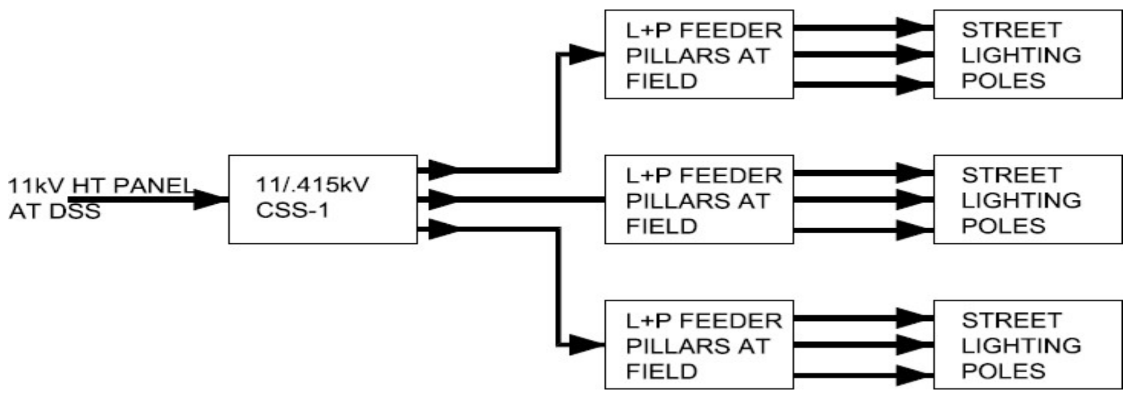
- IS 1944 /1981

- PRCENT/TR 13201-1 technical report from the European committee for standardization.
- IEC 60598
- IRC for highway / street lighting
- Energy efficient street lighting BEE

11.7.9 *Lighting Distribution*

415V Lighting feeder pillars shall be proposed for distributing power to Road lighting and lighting feeder pillars shall be fed from nearest 11kV/0.415kV Compact Substation. Lighting Feeder pillars shall be located at various location of Road corridor. 2/4 core cables shall be used for Street lighting comply guidelines. Feeder pillar shall be connected with 3.5c/4core cable of suitable size. Feeder pillars shall also be used for feeding power to traffic lights, CCTV and other ancillary services Including Supply to LV Feeder Pillars. These safety and security services shall be controlled with LV feeder pillars installed at different locations within park. The typical Schematic for Street lighting power distribution is as shown below:

Figure 11-1 Block diagram of Street Lighting Power distribution system



11.7.10 Earthing system

- Earthing design calculations will be prepared based on ERT report at site level & IEEE 80 format will be adopted to achieve the earth resistance value of less than 1 Ohm. Earthing system will be designed for actual fault level based on the short circuit calculation.
- Lightning design will be done based on IEC 62305 & required number of down conductor will be calculated & same will be represented in lightning layout drawings.

11.8 220KV/66KV /11KVSUBSTATION DESIGN WITH GAS INSULATED SWITCHGEAR (GIS)

220/66 KV Substation shall be designed and installed by PSTCL and balance by SPV. The sub-station shall be located in a safe-area close to the load Centre. Consideration shall be given to vehicular traffic or any other factor that might affect the operation of the sub-station. A separate entry of 6.0 m or as per design requirements with rolling shutter shall be provided for drawing in all equipment for erection. The main entry for operating personnel shall be provided with Double door system. The Substation shall also have an emergency door opening outwards.

220kV/66kV MRSS and 66kV/11kV distribution substation will be indoor type and 220kV, 66kV, 11kV GIS panels, Auxiliary LT panel, Battery & Battery chargers, control panel etc will be located inside the substation building. Substation building will be sized based on switchgear dimensions which are accommodated inside the room and specified adequate clearances to be maintained as per below table.

Table 11-7: Adequate clearances for Electrical equipment

S. No.	Description	Clearance
1	Front Clearance for all SB Panels	2000 mm for 11kV HT Panel
		3000 mm for 66kV & 220kV GIS or as per manufacturer’s recommendation.
2	Rear clearance for SB panel requiring maintenance from rear	1500 mm for 11kV GIS
		2000 mm for 66kV & 220kV GIS or as per manufacturer’s recommendation.
3	Side Clearance between two SB panels or from nearest obstruction	1500 mm for 11kV GIS (But not less than twice the width of each panel)
		3000 mm for 66kV & 220kV GIS or as per manufacturer’s recommendation.
4	Clearance from face off wall mounted equipment	1000 mm
5	Vertical Clearance measured from	
	- Bottom of roof slab	1000 mm
	- Bottom of lowest roof beam	500 mm
6	Battery Rack to Wall clearance	1000 mm
7	Between Battery Rack	1500 mm
8	Maximum height of Battery Rack	1600 mm

Note: In case of 66kV and 220kV GIS, front, rear and side clearance shall be as per GIS supplier’s recommendation

Equipment like oil filled transformers shall be located in Transformer Yard adjacent to the sub-station building. Oil immersed transformers with oil capacity exceeding 2000 liters, shall be provided with a soak pit of sufficient capacity to take the whole of the oil of the equipment. Where oil capacity of transformers exceeds 9000 liters, provision shall be made to drain away the oil to a separate waste oil tank/collection pit located away, through suitable drain pipes of 150 mm or 200 mm in diameter.

RCC cable trenches will be provided for cable connectivity between the EHT, HT panels & transformers. RCC cable trenches will be provided with removable precast covers. Cables are to be laid in tier formation in the cable trenches for power, control, instrumentation cables. Transformer foundation drawings, substation GA will be submitted for approval prior commencement of installation.

Adequate ventilation to be maintained inside switchgear substation room, control room and Staff area with providing VRV based AHU/ductable units, exhaust fans, louvers and windows etc. Sub-station building shall be without any columns within the switchgear room to ensure optimum space utilization.

Each Sub-station is to be provided with First aid boxes, EHV, HV & LV rubber gloves, Shock hazard charts, laminated AC and DC SLDs (final SLDs) at minimum two locations. EHV, HV & LV rubber mats shall be provided in front of all electrical switchgears & Equipment (charger/UPS/heater etc.).

All switchgears panels are free floor standing type. The foundation frames for installation will be flush with finished floor level and cable open area in trenches will be covered with MS chequered plates

All power transformers will be located outside the building & HDPE Conduit/ Cable Trenches will be provided for cable connectivity between HT Panels & Transformers. Nitrogen Injection fire extinguishing system shall be provided for all power Transformers

11.9 220KV/66KV /11KVSUBSTATION DESIGN WITH GAS INSULATED SWITCHGEAR (GIS)

220kV & 66kV indoor gas insulated switchgear will be indoor type, metal enclosed, SF6 insulated switchgear, sealed for life, complete with all accessories; foundation frames etc., all items being complete in all respects, while 11 KV Switchgears shall be VCB/SF-6.

- The GIS switch gear shall be of modular design offering high degree of flexibility. Each module shall be complete with SF6 gas circuit breaker, Disconnectors, Maintenance Grounding switches, Fast Earthing switches, voltage transformers, Current transformers, Surge Arrestor, bus & elbow sections, cable end enclosures, local control cubicle and all necessary components required for safe & reliable operation and maintenance.

- GIS switch-gear shall be of Double bus bar design having phase wise separate or three-phase common (single) enclosure.

- The required switchgear shall be capable of being supplied in a completely gas-insulated version in which case all switchgear components including the bus-bars shall be of gas-insulated type. All feeders for 220kV & 66kV GIS shall have two trip coils.

- The SF6 GIS shall be of indoor type having degree of protection as IP-42 and suitable for the climatic conditions as specified.

- The design symmetrical 3-phase short circuit rating for 220 kV GIS shall be 50kA RMS and all current carrying parts shall be capable of withstanding this current for a period of 1 second.

- The design symmetrical 3-phase short circuit rating for 66 kV GIS shall be 30kA RMS and all current carrying parts shall be capable of withstanding this current for a period of 3 seconds.

- Circuit breakers shall be SF6 gas interrupting type, of the single puffer type and shall be designed to operate at a low pressure of SF6 gas. Operating mechanism of all circuit breakers shall be fitted with independent duplicate shunt trip coils suitable for either independent or simultaneous operation. Failure of one coil shall not jeopardize the operation of other coil.

- Feeder and bus bar motor operated disconnecting switches to IEC 62271-102 shall be provided. Provision shall be made for locking the switches in either open or closed position.

- Earthing switches shall be provided on both the incoming and outgoing sides of the circuit breaker unit in order to ensure safe maintenance and/or repair work to be carried out.
- Busbar earthing switches shall be provided.
- The current Transformers shall be of the toroidal core type complying with IEC 60044-1.
- SF6 insulated voltage Transformers shall be of an inductive type fully enclosed design complying with IEC 60044-2. The rated secondary voltage shall be 110V /√3.

- It will be possible to extend the switchgear in either direction at a future date.
- The local control cubicle is generally associated to each GIS circuit breaker bay. This cubicle may provide all or part of the following functions:

  - Control i.e. means of opening and closing all switches (circuit-breaker, disconnectors and earthing switches),
  - LV supply protection,
  - Display of switch position,
  - Alarm display (SF6 thresholds, supply voltage, etc.)
  - Safety electrical interlocks, using CB, DS and ES auxiliary contacts,
  - Current / voltage meters,

- Interfacing terminals for remote control. The implemented technology will be digital, i.e. based on microprocessors, or conventional, i.e. based on electro-mechanical relays.

- Temperature-compensated gas density or pressure monitoring devices shall be provided. The devices shall provide continuous and automatic monitoring of the state of the gas and a separate device shall be provided for each gas compartment so that each can be monitored simultaneously.

11.10 11KV INDOOR SF6/VACUUM SWITCHGEAR

11kV indoor gas insulated/vacuum circuit breakers (MV switchgear) will be proposed. 11kV GIS/Vaccum panels will be indoor type, metal enclosed, SF6/Vacuum insulated switchgear, sealed for life, complete with all accessories, foundation frames etc., all items being complete in all respects.

- The two incoming feeders on the boards will not run in parallel and will be feeding the loads on the respective bus sections.

- MV Switchgear will be of single bus bar type. The breakers will be of fixed type on the floor and equipped with earth switches to earth the externally connected cables.

- Switchgear will have VCB disconnecting switch and Bus bar will be enclosed in SF6 gas/Vacumm. SF6 Gas/Vacuum will be the only insulating medium for the switchgear.
- For 11kV, the 3 Position Switch will be achieved as 2 Position ON+OFF Switch + 1 Position Earth Switch. Earth switch operation will be manual and isolator operation will be motorized. GIS/VCB panel will be provided with surge arrester.

- Each cubicle will be of the totally enclosed metal-clad type and will have a separated high voltage and low voltage compartment. All high voltage components will be encapsulated in hermetically sealed compartments. The low voltage compartment will house the control and protection devices, position indicators, and meters, instruments, signaling devices and all required wiring and terminal blocks.

- All high voltage components will be encapsulated in hermetically sealed compartments. The low voltage compartment will house the control and protection devices, position indicators, and meters, instruments, signaling devices and all required wiring and terminal blocks.

- It will be possible to extend the switchgear in either direction at a future date. However, ends of bus bars extension is envisaged and drilled holes to be carried out. Panels at extreme ends will have openings, which will be covered with plate screwed to panel.

- The relays, meters and instruments will be mounted on the instrument panel with instrument switches/ indicating lamps mounted on the hinged doors. Doors will have handle with built in locking facility. Each indoor panel will be provided with integral earth switches so as to earth the external feeders for maintenance purposes.

- All the panels will be complete in all respects including VTs, CTs of appropriate rating, protective relays, meters, audio/ visual alarms, terminal boards, etc as per requirements.

- Switchgear will be suitable with conventional local operation OPEN/CLOSE as well as remote controlled through SCADA on IEC 61850 Protocol, (Only provision, SCADA shall be designed and installed by another agency).

- The VTs are single phase metal clad type with isolator (manually operated) on the primary side which upon disconnection earths the VT circuit.

- Line VTs will be proposed for Incomers and 1no. Bus VT will be proposed per Bus Section.
- DC operating voltage will be 220V. Closing of breaker will be possible within 85% to 110% of DC voltage and tripping down to 70% of voltage.

- The design, manufacture and performance of all the equipment and material will be provided under these specifications will conform to the following IEC or Equivalent Indian Standards.

11.10.1 Technical Particulars of GIS Switchgear

Table 11-8: Technical Specifications for GIS Switchgear

Sl. No.	Particulars	220kV	66kV
1	Standards	IEC62271- 100&200	IEC62271- 100&200
2	System Earthing	Solidly earthed	Solidly earthed
3	Operating Voltage (U0/U), kV	127/220	38/66
4	Rated ambient temperature °C	50	50
5	Rated Voltage, kV	245	72.5

6	Rated short-time withstand current	As per PSTCL	30 kA/3 sec
7	Rated peak withstands current, kA (2.5 times of the symmetrical breaking current)	125	80
8	Frequency, Hz	50	50
9	Degree of protection	IP-4X	IP-4X
10	Insulation Medium	SF6 Gas	SF6 Gas
11	Conductor material	Electrolytic copper	Electrolytic copper
12	Impulse withstand voltage (Peak)	1050 kV	650 kV
13	One Minute Power frequency withstand RMS Voltage, kV	460 kV	275 kV
14	Bus bar rated current at 50°C	As per SLD	As per SLD
15	Breaker interrupter	SF6	SF6
16	Operating sequence	As per IEC	As per IEC
17	Temperature rise over design ambient	As per IEC	As per IEC
18	Spring charging motor voltage	230V AC	230V AC
19	Control voltage	220V DC	220V DC
20	Number of Tripping coils per breaker	2	2
21	Number of Closing coils per breaker	1	1
22	Protective relays	Numerical	Numerical

Sl. No.	Particulars	220kV	66kV
23	SCADA compatible, SCADA protocol, IEC 61850	Yes	Yes
24	Operating sequence	O-0.3s-CO-180s- CO	O-0.3s-CO- 180s-CO

25	Earth Switch		
25.1	Rated short-time withstand current (1s), kA	50	31.5
25.2	Rated peak making current, kA	125	78.75
25.3	Operating motor rating	240V AC	240V AC
25.4	Hand operating facilities	Yes	Yes

11.10.2 Control & protection

All protective relay schemes will be with numerical relays and complete in all respects with hardware and software. Only relays of internationally reputed companies will be provided. For SCADA communication the standard applicable will be IEC 61850.

The numerical relays will be with programmable logics capable of communicating with Substation SCADA via fiber optic serial bus through IEC Standard 61850. All the features inherently available with the numerical relays will be brought out so as to utilize the same.

All relays will be mounted at a convenient height for easy accessibility. All relays will conform to the requirement of IEC 60255 in addition to IS: 3231.

VT Voltage operated relays will be suitable for 220 volts phase to phase or as specified. Relays will have contacts and flags as required to complete the scheme. No control relays will trip the circuit breaker when relay is de energized.

All relays will be self-reset or electrically reset type as per scheme requirements. Provision will be made for easy isolation of the trip circuit for each relay for the purpose of testing and maintenance

11.10.3 *Transmission Line Protection*

Facilities shall be provided to enable one protection (main or backup) to be taken out of service for maintenance or testing without affecting the operation of the other in any way. The facilities shall include duplicate breaker trip coils, separately fused DC circuits and the use of separate CT and VT windings. The protection relays shall be arranged to initiate a single set of auto-reclosing equipment.

The line protection schemes shall contain the following protection relays:

- Distance Protection Relay
- Three phases directional over current and Earth fault relay
- Busbar protection
- Sensitive Earth fault relay
- Auto reclose Relay

- Trip circuit supervision visible from the front of the panel without having to open the panel door.
- Auto reclose IN/Out switch

11.10.4 *Transformer Protection*

The protection contains the following protection relays on the HV side:

- Biased differential protection relay for two winding Transformer.
- HV & LV restricted earth Fault relay. This should include stabilizing resistor and voltage dependent resistor.
- HV Three-Phase Over current and Earth fault Protection Relay
- Auxiliary relays with annunciator for the following transformer functions
- TX Buchholz gas; TX Buchholz surge; OLTC Buchholz gas; OLTC gas relay Pressure relief; Winding temperature; Alarm Winding temperature trip; Oil temperature alarm; Oil temperature trip; TX oil level low; OLTC oil level low.
- Standby earth fault relay.
- HV Master trip
- Trip circuit supervision relay for HV breaker

11.10.5 *Transformer Protection and Feeder Protection LV (11KV) Side*

- Three phase over current and earth fault relay
- Three phase directional over current and earth fault relay
- LV Master trip relay
- Trip circuit supervision visible from front of panel without opening relay compartment door.

11.10.6 *The Feeder Protection Of 11KV Transformer (LV) Side:*

Feeder protection relay to include the following protection functions. The functions below can be combined in one unit.

- Three phase over current and earth faults
- Sensitive earth fault

- Auto reclose function
- Auxiliary relay to indicate/lockout circuit breaker for low SF6 gas pressure
- Trip circuit supervision visible from front of panel without having to open any panel compartment door.
- Auto reclose IN/OUT switch
- Sensitive Earth Fault (SEF) isolation link or switch

11.11 POWER AND DISTRIBUTION TRANSFORMERS:

This clause specification is intended to cover 220kV/66kV and 66/11kV Power transformer outdoor application ONAN/OFAF type complete with all accessories / fittings etc. MRSS-1 will have 2x160MVA, 220kV/66kV Power Transformers to be installed by PSTCL and each Distribution substation (DSS) will have 2x20MVA, 66/11kV Power transformers. Major design considerations as mentioned below.

- Transformer will be step down type, ONAN/OFAF
- Transformer will be ON LOAD TAP CHANGING type at HV side, tap range will be +10% to -10 in step of 1.25%. RTCC panel shall be provided for OLTC.
- Phase group for the Transformer will be YNyn0 for 220kV/66kV Transformer and YNyn0 for 66/11kV. Dyn11 for 11kV Transformer.
- Winding connection will be Star at HV side & Star at LV side in case of 220/66kV and 66/11kV transformer.
- 220kV, 66kV and 11kV side will be solidly earthed through neutral current transformer.
- Neutral current transformer will be considered for restricted earth fault & stand by earth fault protections.
- Transformer will be designed for 50°C ambient temperature.
- Guaranteed losses of the transformer will be limited as per IS2026 / IEC60076
- The distribution transformer loading will be designed that each transformer is not loaded beyond approximately 80%. However, in case of emergency, 100% continuous loading will be permitted.
- Not envisaged for parallel operation of power transformers.
- Cable boxes will be suitable for operating outdoor and suitable for vertical arrangements of cables ascending to the box from below. Cable boxes for the transformers will be with the disconnecting chambers.
- Nitrogen Injection fire extinguishing system shall be provided for all power Transformers.
- 11/0.415 V or equipment’s with complete arrangement to connect the tee-off circuit breaker to the 11 kV side of the power transformer.

- The springs for closing the load break switches & tee-off circuit breaker will be motor operated.
- The opening & closing for the load break switches as well as tee-off circuit breaker will be carried out electrically from remote via SCADA, besides local / hand operation. Built in compact battery (with no maintenance of any type) with charger will be part of supply for this purpose.
- Fixed type SF-6 gas insulated / Vacuum circuit breakers shall be used in RMU. It should be maintenance free.
- The RMU shall have self-powered microprocessor-based relay for operation of the circuit breaker.
- The RMU will be complete in all respects including elbow type cable termination arrangement [with shrouds] in air from bottom, gland plate, double compression glands, foundation channels, bolts, inter connection arrangement etc.

11.12 11KV RING MAIN UNIT (RMU)

This specification clause intends to cover 11kV field RMU's complete with all accessories / fittings etc.,

- It is proposed that the entire consumer with contract demand from 100kW to 4.0MVA will receive power through 11kV Ring main units. However, all other consumers having maximum demand above 4.0MVA and below 20MVA will receive supply through 66kV GIS directly which shall be located nearest substation.
- 11kV RMUs will be installed in strategic location and at the proximity or in premises of consumer as per design requirement. Access to RMU room shall be restricted as per electricity company and state electricity regulations. RMU's shall be indoor/outdoor type based on the applications and area of installation. EPC contractor has to provide full network of RMU's with laying of cables as per load details of plot owners calculated during detailed engineering before handover.
- These 11kV RMU's power supply will be fed from 11kV GIS/Vacuum switchgear located nearest DSS substation.
- To maintain the redundancy and reliability in the power distribution network, 11kV Ring main units will be connected in a 'Ring'. Each ring will be connected to separate sources through the feeders on the different buses.
- Short circuit rating for 11kV RMU will be 25kA / 1sec or 21kA for 3 Sec.
- Outgoing feeders to plots will be considered with SMART power meter.
- The proposed RMU configuration will be 3Way to 7Way 12 kV system, extendable type, free standing floor mounted, outdoor, metal clad SF6 insulated Ring Main Unit (RMU) along with

metering, PTs, CTs etc. depending on No. of Consumers.

- RMU will be extendable type and stand alone.
- Outgoing feeder of RMU will have, Tee-off, spring operated, Circuit breaker with sealed for life vacuum interrupter complete with meters, CTs, Protective and auxiliary relays to control desired

number of 11/0.415 V or equipment's with complete arrangement to connect the tee-off circuit breaker to the 11 kV side of the power transformer.

- The springs for closing the load break switches & tee-off circuit breaker will be motor operated.
- The opening & closing for the load break switches as well as tee-off circuit breaker will be carried out electrically from remote via SCADA, besides local / hand operation. Built in compact battery (with no maintenance of any type) with charger will be part of supply for this purpose. SCADA will be installed by other agency.
- Fixed type SF-6 gas insulated / Vacuum circuit breakers shall be used in RMU. It should be maintenance free.
- The RMU shall have self-powered microprocessor-based relay for operation of the circuit breaker. The RMU will be complete in all respects including elbow type cable termination arrangement [with shrouds] in air from bottom, gland plate, double compression glands, foundation channels, bolts, inter connection arrangement etc.
- All the devices installed on field area shall be covered with fencing for safety, and security proposes and required civil work for foundation and earthing etc.

11.12.1 *Internal electrification*

The Internal electrification work shall be designed for Sub-station and other common areas where staff shall be deployed for operating and monitoring the electrical system as per BIS Code.

11.12.2 *Power and control cables*

The specification clause covers for EHT, HT, LT Power, control and instrumentation Cables required for various sub-stations & all power supply areas.

- 127kV/220kV (Uo/U) earthed grade cable shall be used to connect between the substations and to 220kV/66kV power transformers & the consumer required contract demand as more than 20MVA.
- (Uo/U) earthed grade cable shall be used to connect between the MR&DSS-1 substations to individual 66/11kV Distribution substations, 66kV/11kV power transformers & the consumer required contract demand between 4.0MVA & 20MVA.
- And (Uo/U) earthed grade cables shall be used to connect between the power transformer, 11kV GIS panels, 11kV RMU's & 11kV/415V CSS, Station transformers etc.

11.12.3 *Design Methodology for Calculation Of Eht, Ht And Lt Cables*

The following factors shall be considered for selection and sizing the EHT, HT & LT power cables & Lighting Wires.

- Maximum design ambient temperature will be considered as 50°C
- Maximum permissible power supply variation
  - Voltage variation: +/-6%
  - Frequency variation: +/-3%
  - Combined Voltage & frequency variation: +/-9%
- Maximum ground temperature
- Depth of laying wherever applicable
- Grouping of cables
- Maximum fault level for HT/EHT cable
- Maximum allowable Voltage drop power system network
- Allowable voltage drop at the terminal of the connected equipment will be maximum 5 % at full load
- Maximum allowable Voltage drop for Treatment Plant work
  - Cable between PMCC/PMCC and MCC or auxiliary switch board
    - Aux Switch board near PMCC/MCC : 0.5%
    - Aux Switch board situated remote from PMCC/MCC : 2.0 –2.5%
  - Cables between PMCC/MCC and motors : 3%
  - Cable between auxiliary switchboard and Lighting Panel : 1-1.5%
  - Cable between lighting panels and lighting points : 4%
  - During starting of heavy equipment the voltage may drop by a maximum of 15% for period of up to 45-60 seconds depending upon the duty of the driving equipment.
- Actual load current
- Lighting Wires: 1100 V grade, single core, stranded, copper conductor, PVC insulated wires conforming to IS 694 / IEC 60227 Part 1 to 5 / IEEE-719. Minimum cross section of copper wires will be 2.5 mm2 for lighting circuits and 4 mm2 for receptacle circuits.

Considering of above cable factors, the cables will be selected and sized accordingly, same will be illustrated in the cable sizing document. All the cables will be capable to work at high temperatures with in RCC cable trench for design ambient temperature 50°C.

11.12.4 *EHT Cables*

EHT cables will be 127kV/220 kV and 38kV/66kV of earthed grade suitable for use in solidly earthed system, stranded & compacted electrolytic Copper conductor, extruded semi conducting screen over conductor, XLPE insulated, extruded semi conducting insulation screen, armored, semi-conducting followed by copper wire screened, Extruded aluminum or lead alloy metallic sheathed, PVC outer sheathed, conforming to IS 7098 (Part III) or IEC 60840 or IEC 62067 and IEC 60502 for constructional details and tests..

11.12.5 *HT cables*

HT cables will be 6.35/11 kV of earthed grade suitable for use in solidly earthed system, stranded & compacted electrolytic aluminum conductor, extruded semi conducting screen over conductor, XLPE insulated, armored, semi-conducting followed by copper tape screened, extruded PVC, Type ST–2 inner sheathed, overall FRLS, PVC outer sheathed, conforming to IS 7098 (Part II), IEC 60502 for constructional details and tests.

11.12.6 *LT power cables*

LT Power Cable will be 1100 V grade, single / multi core, stranded electrolytic aluminum/copper conductor, XLPE insulated, with PVC inner sheath, armored and outer sheath made of FRLS PVC compound, generally conforming to IS-7098 (Part-II). The cables used for DC system will be of two core type. Minimum conductor cross section of power cables will be 10 mm2 for aluminum cables and below 10 mm2 it will be copper conductor. Minimum conductor cross section of power cables shall be 4 Sq.mm for Copper. Maximum size of the power cable shall be 300 Sq.mm

11.13 JUSTIFICATION FOR SIZES OF EHV / HV & LT CABLES (66 KV , 11KV & LT Cables)

<u>FOR 66 KV EHV 1C x 1000 Sq.mm Copper Armoured Conductor</u>

The single-core 1C × 1000 mm² Cu, XLPE insulated, armoured cable has been specified for the 66 kV distribution link between MRSS-1 and the DSS due to the long route, high power transfer requirement and need for high reliability. The large 1000 mm² copper conductor minimises I^2R losses and voltage drop over long distances, supports present and foreseeable future load growth and reduces the number of parallel runs or feeders required. XLPE insulation provides excellent dielectric strength, thermal stability and long-term service life under cyclic loading. Armour and appropriate metallic screening provide mechanical protection during laying and enhanced short-circuit/sheath fault performance. Using single-core cables at this voltage allows proper phase separation, ease of termination and proven performance for EHV underground/ducted distribution. The overall selection ensures safe, efficient and maintainable power delivery with improved availability for critical downstream systems.

Detailed technical justification (point-wise)

1. Application & system requirement

   The feeder carries high power over a long route from MRSS-1 to DSS; this requires a cable with large cross-sectional area to limit losses, maintain acceptable voltage profile and ensure capacity margin for future load growth.

   A single-core high-voltage cable arrangement is standard for 66 kV EHV distribution and enables correct phase spacing and easier terminations/clearances.

2. Conductor size (1000 mm² Cu) — why copper and why large

   Lower resistive losses: Larger copper area reduces conductor resistance (ohmic losses) which is critical for long runs — reduced I^2R losses improves system efficiency and reduces operating cost.

   Voltage drop control: Bigger conductor reduces voltage drop over distance keeping delivered voltage within acceptable limits without having to oversize upstream equipment or add reactive compensation.

   Thermal capacity & overload tolerance: 1000 mm² copper provides high current-carrying capacity and better thermal margin under continuous and transient overloads.

   Future proofing: Provides headroom for load growth, avoiding frequent uprating or additional feeders later.

   Mechanical & fault robustness: Larger copper conductors withstand mechanical stresses and have higher short-circuit withstand energy (I^2t) compared with many smaller parallel conductors.

3. XLPE insulation benefits

   High dielectric strength and thermal rating: XLPE allows higher operating temperatures and excellent aging characteristics under electrical and thermal stress.

   Lower dielectric losses vs older oil-filled types: Reduces overall cable losses and improves efficiency.

   Long service life: Proven longevity and resistance to thermal/cyclic stresses common in utility distribution.

4. Armouring & screening

   Mechanical protection: Armouring protects cable during handling, installation in ducts/trenches, and from external mechanical damage.

   Electromagnetic screening & sheath return: Metallic screen/sheath gives controlled return paths for fault currents, reduces electromagnetic interference to adjacent systems and eases earthing/monitoring.

   Earthing & safety: Properly bonded armour/screen supports effective protective earthing and rapid fault clearance.

5. Single-core vs multi-core decision

   Standard practice for EHV: Single-core, separately laid phase cables are the norm at 66 kV to meet phase spacing and clearance requirements and to manage mutual capacitance/inductance.

   Flexibility in routing & jointing: Single-core deployment with suitable spacing/trefoil or trestle arrangements simplifies maintenance and reduces risk of simultaneous damage to multiple phases.

6. Long route considerations

Reduced number of runs: A single 1000 mm² conductor can often replace multiple smaller conductors (fewer joints and terminations), which is advantageous on long runs because each joint/termination is a risk point.

Fewer joints = higher availability: Minimises potential failure points, reduces maintenance and the risk of outages.

Thermal dissipation & installation: Larger conductor with correct bedding, backfill and separation ensures acceptable cable operating temperature even for long buried/ducted runs.

7. Reliability & safety

Short-circuit withstand: Larger copper conductor and correct armour/screen sizing improve the cable's short-circuit mechanical and thermal performance.

Fire & environmental behaviour: XLPE (and specified sheath) selected for fire performance and environmental resistance as required by site conditions.

Operational continuity: Large single-core cables reduce need for parallel feeders, lowering complexity and improving system availability for critical loads.

8. Installation & operational notes

Ensure cable design includes appropriate: bedding, earthing of metallic screens/armour, stress-relieved termination kits, jointing procedures, and phase-spacing supports (trestles/insulators) where exposed.

Plan for monitoring: sheath voltage monitoring, temperature/ampacity monitoring and regular partial discharge / tan-delta / VLF testing as part of lifecycle maintenance.

Provide clear coordination with protection studies to ensure relay settings and fault-clearing times match the cable's thermal and mechanical withstand.

9. Standards & testing (guidance)

Cable design, manufacture and testing should comply with the relevant international and national standards for EHV extruded-insulation power cables and accessories, and site testing must include routine and type tests, insulation resistance, sheath continuity, VLF/DC/PD tests and routine heat/run tests as applicable.

FOR 66 KV EHV 1C x 630 Sq.mm Copper Armoured Conductor

The 66 kV 1C × 630 sq.mm copper XLPE armoured cable has been adopted for connecting the 20 MVA ONAN 66/11 kV transformer as it is fully adequate to carry the transformer's rated current, considering the calculated load of about 175 A on the 66 kV side. Since the installation is confined to a short route within the substation area, higher conductor sizes are not required, and 630 sq.mm copper provides ample thermal margin, negligible voltage drop, and reliable short-circuit withstand capacity. The XLPE insulation ensures superior dielectric performance and long service life under electrical and thermal stresses, while the armouring provides mechanical protection and fault safety. This selection balances technical suitability and economy, complies with all relevant IS/IEC standards, and ensures safe, efficient and dependable operation of the transformer feeder within the substation.

FOR 11 KV HV 1C x 1000 Sq.mm Aluminium Armoured Conductor

The 1C × 1000 sq.mm aluminium XLPE armoured cable has been considered from the 20 MVA 66/11 kV transformer LT side to the 11 kV VCB panel as the 11 kV side current is much higher, around 1050 A, and this size of aluminium conductor can safely withstand the load as well as short-circuit stresses at 11 kV. For the short substation route, aluminium of this capacity provides reliable thermal and electrical performance with negligible voltage drop, while being significantly more economical than an equivalent copper conductor of lower size. This makes the selection both technically suitable and cost-effective, fully complying with applicable IS/IEC standards.

FOR LT POWER CABLES

Contractor shall design and select LT cables based on the calculated LT load (current and duty), ensure conductor size, insulation, short-circuit withstand and installation method comply with applicable IS/IEC and PSPCL standards, submit full cable calculations, drawings and accessory specifications to PSPCL for approval prior to execution, and carry out supply, installation and testing only after approval (with all routine and commissioning test reports furnished).

11.14 CABLE LAYING METHODOLOGY

All **EHV cables** shall be laid in **separate RCC cable trenches** (inside or outside the substation) or, wherever applicable, shall be **directly buried in the ground / RCC Hume Pipe** as per approved drawings, with full protective measures such as sand cushioning, protective tiles/bricks, and proper backfilling.

HV and LV cables will be routed through separate RCC cable trenches with MS powder-coated or hot dip galvanized cable trays, depending on the application. Outside the substation, cabling shall be done through **buried HDPE pipes** or RCC trenches, as per the layout.

Lighting cables from feeder pillars to lighting poles/mini/high masts shall be laid through buried conduits or by direct burial, as applicable. Reference cable trench drawings shall be followed for arrangement, routing, and separation of all cables.

11.14.1 *Crossing of EHV Cables*

Where road crossing comes in way of laying power cables, the power cables shall be laid through NP-4 RCC Hume pipes, The RCC Hume pipe inner Dia shall not less than 400mm. The RCC pipes to be laid shall have minimum dept in such a way that the back filling on the top surface of the pipe shall be at least 600mm in depth. The pipe joints shall be smooth so that cables are not damaged during pulling & operation. During the crossing of utilities like water line, drainage lines, telephone line, gas lines etc sufficient care shall be taken & protection shall be made available so that other utilities do not damage the cable mechanically and / or electrically or do not effect the performance of the cable.

11.14.2 *Cable Tray & RCC cable Trench (With in Substation)*

This specification class covers for cable trays specially designed for the use in critical environment. MS powder coated and hot dip galvanized GI products cable tray provides reliable cable support in corrosive application as well as molded & metered fittings, other accessories like coupler plates, struts, etc., standard Length of cable tray shall be 3000mm and major sizes of cable trays will be proposed 150mm/300mm/450mm/600mm/900mm with 3mm thick and providing supporting structure based on working load capacity of cable tray at span of 1.5 meter interval. Maintenance walkway will be provided inside the RCC cable trench as per reference trench layouts.

All the cables will be laid on MS powder coated and hot dip galvanized GI cable trays as per application requirements supported by MS angles inside the RCC cable trench. It is proposed that instrumentation cables will be laid at the upper level of RCC cable trench followed by LT, HT, and EHT. Lowest levels will be occupied by 66kV or 220KV cables which will also require adequate clearance for cross bonding within the RCC cable trench. EHT, HT, LT XLPE cables and optical fiber cables will be laid in concrete cable trenches. The size of cable trench on respective ROW will be designed based on number of cables and cable tiers.

The relative position of the cables, laid on the cable tray will be preserved, and the cables will not cross each other. At all changes in direction in horizontal and vertical planes, the cable will be bent smooth with a radius as recommended by the manufacturers. All cables will be laid with minimum one diameter gap and

will be clamped at every meter to the cable tray. Cables will be tagged for identification with aluminum tag and clamped properly at every 20M. Tags will be provided at both ends and all changes in directions both sides of wall and floor crossings. All cable will be identified by embossing on the tag the size of the cable, place of origin and termination. All cables passing through holes in floor or walls will be sealed with fire retardant Sealant and will be painted with fire retardant paint up to one meter on all joints, terminations and both sides of the wall crossings

11.14.3 *Laying of Cables in Ground*

EHV cables shall be laid **directly buried in the ground or through RCC Hume Pipe,** as per approved drawings and site requirements. The installation shall include all protective measures such as:

- Sand cushioning around the cable

- Protective tiles/bricks above the cable route
- Warning tape at appropriate depth
- Proper backfilling and compaction in layers
- Adequate spacing and separation from other services

Street lighting cabling from respective lighting feeder pillar to street lighting poles shall be through buried underground cabling in HDPE/DWC HDPE pipe as per IS/IEC specifications

11.14.4 *Laying of Cables in HDPE Pipe*

Cable laying shall be in accordance with relevant Indian standard/IEC etc. In selection of the cables, ambient conditions will be taken into account. 1.1kV grade cables shall be laid in HDPE pipe. Cables at road crossing shall be through HDPE pipe covered with concrete encasing. The minimum cross-sectional area for HT power cables to be considered as 185 mm² however the same shall be detailed out in further design stages.

1.1 kV grade rating cable shall be laid in HDPE/DWC HDPE Pipes for pole lighting and for services who shall require electrical power. Separate colour sleeve shall be used for different voltage ratings.
In IMC Rajpura, 100% power is transmitted through Underground cables. No overhead transmission lines will be seen. All cables are proposed to lay underground through HDPE piping duct. HDPE pipes are laid in the excavated duct and the trench is closed. The cables can be pulled through these pipes, whenever there is a requirement.

HDPE conduits meets the following requirements:

- Limited duration of the installation works, Efficient mechanical protection
- Wherever the ground is subjected to particularly heavy loads and where there is considerable vibration (risk of lead crystallization).
- Avoid having to reopen a trench for the same route.
- Laying in non-touching Flat formation inside HDPE ducts

11.15 NP-4 RCC Hume Pipe

NP-4 class reinforced cement concrete (RCC) Hume pipes are heavy-duty non-pressure pipes manufactured in accordance with IS: 458-2003. NP-4 is designed for high load applications such as road/rail crossings, culverts, and EHV cable crossings where maximum mechanical strength is required.

NP-4 pipes are centrifugally cast or spun and reinforced with high tensile steel to withstand heavy superimposed loads and deep burial conditions.

Typical Properties of NP-4 RCC Hume Pipe

General Properties

- Standard: IS: 458-2003 (*Precast Concrete Pipes with and without reinforcement*)
- Class: NP-4 (Non-Pressure, Class 4 – Heavy Duty)
- Sizes: Internal diameters from **100 mm up to 2600 mm**

- Lengths: Typically **2.0 to 2.5 m** per pipe
- Joints: **Spigot & Socket** or **Collar Joint** with rubber ring or cement mortar

Mechanical Properties

Property	Test Method	Typical Requirement (per IS 458)
Crushing Strength (Three-edge bearing test)	IS 458	Highest among NP classes (e.g., for 1000 mm dia: ≥ 135 kN/m)
Hydrostatic Test Pressure	IS 458	As per table in IS 458; NP-4 suitable for heavy load zones
Load Bearing	IS 458	Designed for highway/railway loadings and deep cover >6 m

Material Properties

- Concrete Grade: Minimum **M-40** (per IS 458)
- Reinforcement: High tensile steel bars/wires as per IS 1785 / IS 432
- Cover to Steel: As per IS 458, typically ≥ 15 mm

Jointing & Installation

- Socket and Spigot ends are machine-finished.
- Jointing by rubber rings (IS 5382) or cement mortar.
- For cable crossings, collar joint with sealing is common.
- Pipes must be laid with minimum cushion depth as per **IRC/Indian Railways/NHAI norms** when used for road/rail crossings.

NP-4 RCC Hume Pipe Specifications

The following specifications are utilized by the industry for the production and acceptance of NP-4 class pipes:

- **IS: 458-2003** – Precast Concrete Pipes (with and without reinforcement) – Class NP-4
- **IS: 783-1985** – Code of Practice for Laying of Concrete Pipes
- **IS: 3597-1998** – Concrete pipes for pressure applications (if special cases)
- **IRC: SP-32** – Guidelines for Culverts and Cross Drainage Works (for road crossings)
- **Indian Railways Schedule of Specifications** – For RCC Hume pipes under track crossings

11.16 HIGH DENSITY POLYETHYLENE PRESSURE PIPE

HDPE 002DP48 is a high molecular weight high density bimodal grade produced by Lyon-dellBasell 's Hostalen slurry process with excellent Processability & Mechanical properties. This Grade meets the MFI, Density & hydrostatic Strength requirements of material grade PE100 as per IS: 4984:1995

Table 11-9: Typical Properties of HDPE Conduit

Resin Properties			
Melt Flow Index (1900C & 5 Kg)	ASTM D 1238	gm/10 min	0.22
Density @ 230C	ASTM D 1505	gm/cm3	0.948
Mechanical Properties			
Tensile Strength @ Yield (Type-IV)	ASTM D 638	MPa	
	ASTM D 638	%	
	ASTM D 790	MPa	
	ASTM D 256	J/m	
	ASTM D2240	Shore D	
Thermal Properties			
Vicat Softening Point	ASTM D 1525	0C	125
Oxidative Induction Time	ASTM D3895	Min	>30
Thermo Chemical Properties			
ESCR, F50 (10% Igepol)	ASTM D1693	Hrs.	>1000

Source: IS: 4984:1995

11.16.1 *HDPE Conduit Specifications*

The following specifications are utilized by the industry for the production of Conduit and Raceways:

Telecommunication Conduits – ASTM F2160 Standard Specification for Solid-Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD) 473-513.indd 473 1/16/09 10:17:17 AM Chapter 14 Duct and Conduit 474

Power Conduits – ASTM F2160 Standard Specification for Solid-Wall High Density Polyethylene (PE) Conduit Based on Controlled Outside Diameter (OD)

NEMA TC7 Smooth-wall Coilable Polyethylene Electric Plastic Conduit

Electrical Conduits – UL 651A Type EB and A Rigid PVC Conduit and PE Conduit – UL 651B Continuous Length PE Conduit

Premise Raceways – UL 2024 Optical Fiber Cable Raceway

11.16.1.1 *Route Marker*

Route marker will be provided along straight runs of the cables not exceeding 30 meters also for change in the direction of the cable route and underground joints. Route marker will be of cast iron painted with aluminum paint. The size of marker will be 100 mm dia with "Cable" and voltage grade inscribed on it

11.16.2 *DC Distribution System*

This specification clause covers for 220V DC Lead-Acid battery and Float cum boost battery chargers (one working + one stand by). Incoming 415V AC supply for battery charger will be fed from LT panel located inside substation & outgoing 220V DC supply will be connected to DC distribution board (DCDB), which is part of battery charger panel. The dedicated standalone DC systems are required to be provided at each substation and inbuilt DC system for field RMU will be proposed as packaged items however the specification will not applicable for RMU's DC system.

Lead Acid Battery (Ni-Cd Battery also shall be provided subjected to PSTCL/SPV approval), Float cum boost charger & DC Distribution Board

11.16.2.1 *220V Battery*

Battery offered will be Lead Acid battery (Nickel Cadmium (Ni-Cd) type also accepted subjected to PSTCL/SPV approval).

The battery backup autonomy time will be 8 hours, in case of power failure. The ampere-hour capacity will be selected to cater to all the operation of control gear, indication lamps, annunciation panels etc. A margin of about 25% will be taken to cater to the contingencies.

Battery will be complete with following accessories, as applicable, that include:

- Battery racks
- Porcelain insulators, rubber pads, etc.
- Set of inter-cell, inter-tier and inter-bank connectors as required for the complete installation.
- Electrolyte for first filling + 10% extra.

The racks will be suitable for fixing on flat concrete floor. Maximum height of battery rack shall be 1600mm. When the battery is discharged at 10 hour rate, it shall deliver 80% of C (rated capacity, corrected at 27º Celsius) before any of the cells in the battery bank reaches 1.85V/cell. The battery shall be capable of being recharged from the fully exhausted condition (1.75V/cell) within 10 hrs up to 90% state of charge. All the cells in a battery shall be designed for continuous float operation at the specified float voltage throughout the life.

11.16.3 *220V Battery Charger*

The float-cum-boost type battery charger will comprise silicon-controlled rectifiers (SCRs) connected in a full wave bridge circuit. Battery charger will be suitable for float charging the battery under normal conditions and boost charging the battery when it has discharged during service conditions. The changeover from float to boost mode and vice versa will be automatic.

The rectifier transformer will be dry type and double wound with required number of taps. The DC output voltage during float charging will be stabilized within + 1% of the set DC bus voltage. The voltage regulation will be achieved by a constant voltage regulator having fast response.

There will be provision for manual control if auto mode fails. There will be provision for manual control if auto-mode fails. Boost charging time for charging the battery to full capacity from fully discharged condition will not exceed 8 hours.

In the float charging mode, the charger will be designed for supplying:

- The DC loads of control, indication and annunciation circuits that remain energized during normal operation and the momentary closing and trip coil loads of circuit breakers, vacuum contactors; and
- The float charging current of the battery.
- 25% margin over the above load.

Battery charging equipment complete with all accessories will be housed in a free-standing sheet steel cubicle having degree of protection of IP 4X.

11.16.4 *220v DC Distribution Board (DCDB)*

The distribution board will be of floor mounting design, and it is part of battery charger panel. Entry for incoming and outgoing cables will be from the bottom. Bus bars will be of aluminum.

Incomers and outgoing circuits will be controlled by suitably rated double pole MCCBs with trip releases. DCDB will have 10% spare feeder are considered. Copper earth busbar of suitable size will be provided along the length of the DB at the bottom. Two nos. earthing terminals will be provided on the external face of the board for connection to the earthing grid

11.17 11KV COMPACT SUBSTATION (CSS)

Compact Substation (CSS) is to be designed to feed power to common area services and plumbing service basically the service that are under EPC contractor. This specification clause covers for requirement Compact Sub Station (CSS) consisting of following main components.

- 12 kV, non-extendable, metal clad SF6/VCB insulated switchgear, sealed for life, SF6/VCB
- Dry type 11/0.415kV distribution transformer.
- LV switch board having Fixed type ACB.
- Prefabricated weatherproof enclosure with IP65 protection.
- Provision for FRTU, SCADA connection for remote control and monitoring.

- For design purpose maximum ambient temperature of 50° C will be considered.
- Design to comply with latest version of IEC 62271-202.
- Control & protection system power supply will be 230V AC, 2 wire.
- Enclosure will have independent compartments for HT Meter, SF6/VCB, transformer and LV Board with suitable entry doors.

The Enclosure consisting of HT Meter, High Voltage switchgear, Low Voltage switchgear, FRTU & Transformer of the Unitized substation will be designed to be used under outdoor service condition.

The LV switchboard for CSS will be indoor 3-Phase, 4-wire, 415 V, 50 HZ, neutral solidly grounded, complete in all respects including base channels, foundation bolts and other hardware.

- There shall be adequate ventilation inside the enclosure so that hot air inside enclosure is directed out by help of duct. Louvers apertures shall be provided so that there is circulation of natural air inside the enclosure. The Package Substation should be designed & engineering to have natural cooling & ventilation only. No forced cooling / ventilation is acceptable.

- The Enclosure consisting of High Voltage switchgear, Low Voltage switchgear & Transformer of the Unitized substation shall be designed to be used under outdoor service condition.

- The final finished thickness of paint film on sheet shall be approximately 60 to 80 microns. The Color for finishing paint will be Siemens grey as per RAL 7032.

11.18 LV POWER DISTRIBUTION FEEDER PILLAR

A Feeder pillar is a cabinet for electrical equipment, mounted in the street and controlling the electrical supply to several neighborhood/interconnected feeder pillars and the common service falls in the range of respective feeder pillars in a neighborhood

Specifications

- Feeder Pillars made complying galvanized steel to BSEN ISO 1461 .
- Mini, single or double door pillars with hinges.
- IP65 with impact resistance of IK10 door seal rating for outdoor service
- Backboard made from 18mm thick GRP sheet
- Earth lead supplied from distribution pillar body to door

Rating of Feeder Pillars proposed will be installed on Road corridor, nearer to the power service connection premises, with following provisions.

- Door not fully closed alarm

11.19 SMART STREET LIGHTING SYSTEM

LED Lighting system is proposed to be provided road lighting, substation indoor & outdoor areas. Minimum LUX levels of illumination which are recommended as per IUT-Institute of Urban Transport and Indian Standard SP: 30 – 2011 and as per IS 3646 / IS 1944 will be adopted.

This specification clause covers street light poles, LED lights fittings complete in all respects for the road lighting system by HDPE underground cables under the project including exterior lighting will be provided for streets, parking areas, and open areas developed areas, as per following items of work.

The components of street lighting will be supplied and installed, complete in all respects. All the equipment's and materials used for installation will be brand new and of high quality in design and performance

Table 11-10: Recommended Lux levels for Roads, Pedestrian Crossings, Intersections, Cycle Track and Foot path

Sl. No.	Particulars	Illumination Level	Ratio of Minimum/ Average Illumination
1	Roads	30 Lux	0.4
2	Pedestrian Crossings/ Intersections	50 Lux	0.4
3	Cycle Track/Foot path	20 Lux	0.4

Source: Consultant's Input

11.19.1 *Light Fitting Proposed at Various Areas*

A well-designed, energy-efficient street lighting system should permit users to travel at night with good visibility, in safety and comfort, while reducing energy use and costs and enhancing the appearance of the neighborhood.

The design shall be based mainly on:

- IS 1944 / 1981
- PRCENT/TR 13201-1 technical report from the European committee for standardization.
- IEC 60598
- IRC for highway / street lighting
- Energy efficient street lighting BEE
- Energy Efficient Road Lighting

One of the most important civilization indexes is the development of a good transportation network. This includes streets, roads and highways that must be adequately illuminated so that a sufficient visibility is guaranteed to decrease the accident rate and increase the flow of the vehicles and safety.

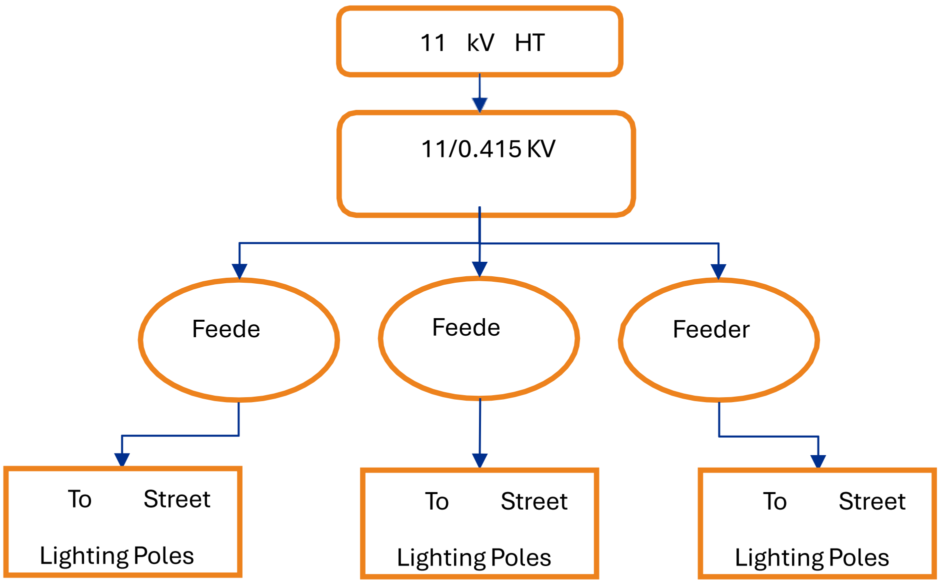
Energy-Efficient lighting systems that consist of one or more components listed below:

- Low loss ballasts
- Better monitoring and control mechanisms
- LED Lights
- Deploying energy efficient LED lamps for street lighting system with automatic control.

11.19.2 *System Concept*

The basic control required for road lighting systems is the ability to switch the lights on as darkness falls and off when the sun rises at dawn. In the interests of saving energy switching lighting on or off through astronomical timer. Following shall be considered while planning for street lighting system. Only provision of DG set shall be provided in LT panel.

Figure 11-2 Typical Hierarchy of Electrical Power Distribution for Street Lights



11.20 ELECTRICAL SUPPLY SYSTEM

415V AC - ±6%

50Hz - ±3%

System short circuit fault level - 27kA for 1Sec. / Depending on Transformer ratings

LED lamp power supply - 240V ± 10%, 50Hz ± 5%, 1 Phase, 2Wire system Earthing - Solidly earthed system

Design ambient temperature - 50 Deg. C. Design wind Speed-47Mtr/Sec

11.21 POWER SUPPLY

The voltage available for the street lighting will be 415 volts three phase and neutral 50Hz AC from the Lighting Feeder pillar to be located at road corridor. Lighting distribution system to be provided will be underground buried cables in HDPE/DWC HDPE pipes. The electrical sub transmission system is fed through dedicated 11kV CSS. Each distribution transformer in CSS is being fed from 11kV/0.415kV, star star transformer, with neutral solidly grounded which feeds a 415V, LV board (part of CSS). Each LT panel feeds a number of lighting feeder pillars of 3 phase, 4 wire, 415 V rating.

Each Ckt of feeder pillar will be capable to feed supply 500 meter in either side. Not more than 1000 W load of all LED bulbs or 10 No. of light fixtures, either of which is achievable will be kept on a single circuit. All the feeder pillar will be IP-65 degree of protection and front operated. Feeder pillar construction will be as per PTTA.

11.22 LT STREET LIGHTING PILLARS

A totally enclosed cubical Outdoor Type (IP66) Feeder Pillar fabricated in compartmentalized design from CRCA sheet of 2mm Thick for frame work and covers, 3 mm thick for gland plates i/c cleaning and finishing complete with 7 tank process for powder coating in approved shade and fabrication in transportable sections with MS base channel and power coated support frame to keep feeder pillar at suitable height (Approx. 300mm from FFL) covered with 18SWG sheet around the frame of feeder pillar or as per site requirement. The base frame to be fixed on PCC foundation with anchor bolts. Feeder Pillar will be having double door on front side with manual padlock arrangement from outside and shutter lock from inside on main door. Front side secondary/Inner door will be having 3/5mm acrylic sheet fixed on CRCA sheet. Feeder Pillar shall have common Aluminium earth bar of size minimum 25mmX3mm or (as per design requirement) at the rear with 2 nos. earth stud. Feeder Pillar shall be suitable for 415V, 3 Phase, 4 Wire 50Hz AC supply system, having bus bar as per rating, DMC/SMC bus bar supports, Solid/wired connection as per standard and control wiring with 2.5sqmm PVC insulated copper conductor S/C cable. Feeder Pillar must be equipped with lighting provision in compartment with automatic push button including control switch with required accessories, wiring etc. Also required Louver with filter for heat dissipation. The pillar is to be mounted on brick and cement concrete plinth by the road side and the dimensions should be such that it does not obstruct the normal traffic on the footpath. The L.T., street lighting pillars will have circuits as detailed below

11.22.1 *Incoming*

- Suitable size TPN MCCB of breaking capacity 35 KA Ics =Icu up to 415 V
- Suitable range of Voltmeter with VSS & protection MCB
- Suitable range of Ammeter with ASS & CT"s.
- Suitable no. of Phase indication lights LED type with protection MCB's.
- Suitable no. of ON, OFF, TRIP LED indication lamp with protection MCB's
- Provision for installing Energy meter as per electricity department requirements.

11.22.2 *Outgoing Circuits:*

TPN DB-1 (6PM to 11:55PM)- 1 Nos.

Incomer: 40/63A TPN MCB controlling 40/63A TP contactor with twin dial clock switch timer (Summer / Winter) / 0-24 hrs. Astronomical timer Switch, Auto / Manual Selector Switch, On / Off Push Button with On / Off Indication Lamps, RYB Indication on incoming side of MCB.

Outgoings: 40A DP RCCB of 30 mA controlling 6 or more nos. 10A SP MCB 9kA (In Each Phase) Outgoing feeders - 3 Sets (1 each for R/Y/B)

TPN DB-2 (6PM to 6AM)- 1 Nos.

Incomer: 40/63A TPN MCB controlling 40/63A TP contactor with twin dial clock switch timer (Summer / Winter) / 0-24 Hrs Astronomical timer switch, Auto / Manual Selector Switch, On / Off Push Button with On / Off Indication Lamps, RYB Indication on incoming side of MCB.

Outgoings: 40A DP RCCB of 30 mA controlling 6 nos. 10A SP MCB 9kA (In Each Phase) Outgoing feeders - 3 Sets (1 each for R/Y/B)

- Required no. and rating of TPN MCCB of 35kA with built-in protections including O/L, S/C and E/F protection with Digital dual source energy meter with required rating of CT's & accessories complete as required.

- Required no. and rating of TPN MCB of 10kA with Digital dual source energy meter with required rating of CT's & accessories complete as required.
- Required no. and rating of DP MCB of 10kA with Digital dual source energy meter with required rating of CT's & accessories complete as required.
- 2 nos. 6/16Amp power socket with control switch controlled by 2nos. 16Amp DP MCB
- Minimum 2nos. of spare outgoings equivalent to highest rating of switchgear available in O/G side

11.22.3 Astronomical Switch

Lighting feeder pillars will be provided to automatically switch OFF and switch ON the supplies in line with sunrise and sunset with astronomical clock. Lighting shall be divided in two separate mode of operation one for 6 to 11:55 PM. And other for 6 PM. To 6 AM. Timing for connecting lighting with type of timer shall be decided during detailed Engineering in Consultancy with SPV Electrical In-charge.

11.22.4 *Earthing*

The distribution feeder pillar will be provided with two separate earthing terminals on its casing for GI earthing. The earthing terminals will be easily accessible and so placed that the earthing connection of the distribution pillars is maintained when the cover or any other moveable part is replaced. The feeder pillar will also have an inside earth bus bar for connecting the cable gland earthing and the armouring to it. The size of the earth bus bar will be suitable to carry 50 kA for one second.

11.22.5 *Feeder Pillar Lighting & Heating*

A lamp holder with a 11 W LED lamp and operated by an internal SP-MCB will be fitted in the canopy of the feeder pillar for internal illumination. In addition, two nos. 5 pin 5/15A socket will also be provided with a separate SP- MCB onside of the pillar box. Space heater of suitable rating, with thermostat and SP-MCB will also be provided inside the pillar near the bottom to avoid any moisture condensation inside the cubicle.

11.22.6 *Danger Plate*

An enamelled sheet steel danger plate of approved design as per IS: 2551 will be fixed on the left upper front door of the pillar.

11.22.7 *Painting*

The colour for the finishing paint will be light grey as per shade no. 631 of IS:5 or other equivalent standard shade. Each coat of primer and finishing paint will be with slightly different shade to enable inspection of the painting.

11.22.8 *Wiring of fixtures*

The street light fixtures will be wired from terminal block by means of flexible (3 * 2.5 sq mm) copper conductor, PVC insulated cable through a rewire-able MCB and neutral or suitable sized MCB.

11.22.9 *Lighting Cable*

Lighting cable shall be XLPE, PVC sheathed, armored of 1100 V grade. Cable size 10/16 Sq. mm and above shall be aluminium conductor and cable size less than 10 Sq, mm shall be copper. Minimum lighting cable size shall be 4 Sq.mm copper considering the voltage drop parameters into consideration. Cabling from the junction box to fixture will be copper flexible cable. At road crossing, the cables will be taken through RCC/HDPE/DWC HDPE Hume pipe to be buried at a depth of 600 mm or as per site below the finished round level and will cover and run below the drainages on both sides of the road. The trenches excavated for embedding the RCC Hume pipe will be back filled with the excavated earth and compacted to same degree as that of the surrounding area. And surplus soil shall be disposed off.

11.23 LIGHTING POLES

The steel tubular poles will be Galvanized tubular conical types providing for the proposed roads & substation outdoor lighting within the industrial park.

11.23.1 *Factors Affecting Pole Selection:*

The following factors will be considered in pole selection/design

- Mounting Height (MH)
- Luminaire Selection and Configuration

- Auxiliary Equipment and Special Loading
- Wind Speed
- Terrain and Special Wind Regions
- Finish
- Special Requirements and Mounting Configurations
- Conformance with the BEE (Bureau of Energy Efficiency)

11.23.2 *Galvanized Tubular Poles*

- **Design**

The Tubular poles shall be designed to comply the following design codes.

- Load combination as per IS 800: 2013
- Indian standard IS 875(Part 3) 2015.
- Design life of structure shall be minimum 25 years
- Basic wind speed 47mtr/sec

- *Pole Shaft*

The pole shaft shall have conical cross section and will be continuously tapered with single longitudinal welding. There will not be any circumferential welding. All tubular pole shafts will be provided with the rigid flange plate of suitable thickness with provision for fixing 4 foundation bolts. Pole shall be PU painted. It should be complied with material grade 50 or equivalent.

- *Door opening*

The Tubular poles will have door of approximate 500 mm length at the elevation of 500 mm from the Base plate. The door will be vandal resistance and will be weather proof to ensure safety of inside connections.

The door will be flush with the exterior surface and will have suitable locking arrangement. There will also be suitable arrangement for the purpose of earthing.

- *Material*

Conical Poles - HT Steel Conforming to grade S355JO

Base Plate - Fe 410 conforming to IS 226 / IS 2062

Foundation Bolts - EN.8 grade

- *Welding*

The welding will be carried out confirming to approved procedures duly qualified by third party inspection agency. The welders will also be qualified for welding the conical shafts.

- *Pole sections*

The Tubular Poles will be in single section (upto 11 mtr). There will not be any circumferential weld joint.

- *Galvanization*

The poles will be hot dip galvanized as per IS 2629 / IS 2633 / IS 4759 standards with average coating thickness of 70 micron. The galvanizing will be done in single dipping.

- *Top Mountings*

The galvanized mounting bracket will be supplied along with the Tubular Poles for Installation of the luminaries Service window

- *Electrical connections*

Four-way connectors will be provided along with Slide lock and 1 no. 6 amps SP MCB including 2.5 sq mm PVC insulated copper conductor wires from the terminal block to the fixture and 2 nos. 32 mm dia GI sleeves of suitable length will be provided upto the service window. An earth boss is provided on the control plate along with connectors and interrupters.

- *Luminaire bracket*

The securing arrangement of the bracket arm to the column will be positive so as to ensure that the arm does not rotate and will be such that the bracket can be fixed in any four 90 Deg. position in relation to the column door opening. 8 Nos. Socket set screw of size M10 X 16mm or approved equivalent arrangement will fix the bracket on to the columns using stainless steel nut, bolt and washer assembly. Bracket will be formed to hollow section BS4848 Part 2 in steel to BS7613 grade 43C or equivalent Indian Standard.

- *Galvanizing and Painting*

All components of the pole and brackets will be hot dip galvanized after completion of fabrication. No further touching up finalizing or modification will be done after galvanizing. Poles shall be PU painted

- *Luminaire Junction / Service box*

Junction / Service Boxes is integral to street light pole / high mast and connecting cables of each pole will be complete with large enough integral junction box type or fitted inside the pole, manufactured from MS sheet of 14 sheet gauge painted with oil paint powder coating over red oxide zinc chromate primer, before final paint to be applied which would be decided by employer.

- *LED Street Light Luminaire*

Supply of LED streetlight luminaries complete with pressure die cast/extruded aluminium housing and lighting design requirements will be as per actual applications. Efficiency of driver electronics will be more than 90%. The life span of the LED source including its Driver will be greater than 50000 hours. The luminaries will conform to IEC 60598 or equivalent standard. The driver should comply with IEC 61347-2-13, IEC 61547, CISPR-15; and 61000-3-2. The luminaire wattage will be decided based LUX level as per IS standards.

11.24 LIGHTING MANAGEMENT SYSTEM

To have efficient use of light, automatic light control system is recommended. The lights will be with astronomical clock device to automatically set the timings for lights ON/OFF throughout the year in line with sun-set timings and Photocell etc.

- The external lighting shall be designed for providing average 30 to 35 lux with using 5 mtr Single arm, 5mtr post top, 7.5mtr single arm, 7.5mtr double arm, 5/7.5mtr differential arm, 9mtr single arm, 9mtr double arm and 9/5mtr differential arm, 9mtr triple arm high GI Tubular pole on roads. Street light fixtures, flood lights etc. shall be installed as required. For peripheral green belt 16mtr high mini masts are being proposed.

- Periphery lighting around plot as per lux level requirement of client or as per IS code.

High Mast Lighting/ Mini Mast Lighting

High mast/ Mini Mast Luminaire arrangement will be designed to provide for appropriate distribution of lighting either in one direction or in many directions, thus making it possible to concentrate the required number of luminaires in any zone and fix them rigidly in any one or multipolar direction(s) as needed and as per coverage area needs to be illuminated with desired lux level requirement. The Design wind velocity of mast will be 180 km/hour. The wind gust should be appropriately considered. However, all the structure will be designed for wind loading as per IS875 part-III.

The high mast column will be of hot dip galvanized to BS729 or, IS 4759 of multi sided cross-section with a continuous taper made of formed sheet steel in accordance with BS 4360 grade 43C and welded.

An access door will be provided in the base of mast of adequate dimensions to permit clear access to the back plate installed for the mounting of the circuit breaker assembly and junction box, winch, etc. The backboard will be made of steel or other non-hygroscopic material. Proposed four numbers of GI earth terminal links having minimum size of 100x75x10mm with one 12mm dia hole should be welded and Projected at a convenient location on the base of the mast for bolting joints of GI earth Strip, using M12x50mm Long Stainless Steel bolt, nut, plain and spring washer assembly, Two exclusively for the lightening conductor and other two for earthing the mast. However actual GI strip shall be selected based on short circuit fault level.

High Mast Head Frame:

The head frame will be hot-dipped galvanized steel attached to the mast by means of a steel slip-fitter and secured by at least four stainless steel set screws. It will be composed of spun aluminium or other approved weatherproof cover, housing the required number of the steel cable sheaves and associated accessories for the operation and powering of the luminaire ring.

High Mast Luminaire Ring:

The high mast luminaire support ring or carriage will be constructed of hot dipped galvanized steel channel fitted with the appropriate no. of luminaires, lamp gear mounting brackets, wiring chamber and mounting plate. The luminaire will be mounted on the luminaire rings by or rigid bracket arm assembly. It will be possible to lock each luminaire firmly in position, thus preventing any rotation or falling while moving the luminaire ring.

A weatherproof wiring terminal box will be provided constructed from a corrosion resistant material or aluminium alloy and installed on the luminaire ring. The cables installed in the luminaire ring connecting each luminaire to the wiring chamber will be factory prewired avoiding the need for field wiring and will have copper conductors with neoprene or cross linked polythene or approved equivalent insulation and sheath.

Multicore Cables inside High Mast:

The cables connecting the MCB assembly at the base of the mast to the wiring chamber on the luminaire ring will be a flexible multicore copper cable with conductors and neoprene or approved equivalent high temperature resistant insulation and sheath in accordance with BS 6977. The colour coding of the different phases of the cable will conform to the relevant cable standard. Each luminaire will have its own neutral conductor connected to the neutral bar or block.

A multicore electrical power cable will be provided terminating in the base compartment with a special industrial type multi pin-plug and a socket coupler fitted with guard and at mast head connected to the wiring chamber fixed to the luminaire ring. It will be suitable for the bending, flexible and load carrying stresses involved. The cable will be fitted with a correctly rated multi pin weatherproof plug and socket within the base compartment of the mast which will enable the cable to be disconnected before lowering the luminaire carriage. The socket must be connected to the supply side of the circuit and may either be free cable coming from the MCB box or be fixed to the MCB box in the base compartment. The wiring will be such that the plug and socket can be isolated before disconnecting.

Raising and Lowering Winch System:

The luminaire will be raised and lowered for installation and maintenance purpose by means of winching system specifically designed to be installed in the base of the mast and removed through the access door at the base of the mast. The winching system will have the lifting capacity of at least double the weight of the

luminaire ring assembly. The winching system will employ double drum as a safeguard against a single suspension steel wire rope failing.

Winches will be capable of normal winch speed operation using a heavy duty type portable power tool (including motor), which will be multispeed reversible type incorporating an adjustable torque limiting device, which can be readily adjusted and locked in any adjustment. The power tool will be equipped so that the operator can be positioned clear of the moving head frame and using pushbutton controls at the end of a 5m long flexible lead. A power unit mounting or support frame will be provided for location and securing during operation. The winch drum will be made of cast iron, mild steel or cast aluminum alloy, LM6M. Winches will be provided with handle for the use of manual operation (besides motored operation).

11.24.1 *Indoor and Outdoor lighting system to Substation*

The purpose of indoor & outdoor lighting is to provide sufficient light within the substation building /Outside the building for normal work activities.

All indoor & outdoor lighting will consist of LED light fittings. Light fittings will be ceiling or wall mounted and will not be located over HV switchgear, LV switchboards, protection panels or other equipment. Mini/high mast can used in substation area to achieve required lux level.

11.25 EARTHING AND LIGHTNING SYSTEM

This specification clause covers the technical and associated requirements for the entire earthing system for substations, required to protect persons and equipment and to allow safe service and maintenance of the installations.

The earthing system includes the underground grid, ground rods and connections. The earthing system will be designed to minimize the dangers from step, touch and transferred potentials which can occur under maximum fault conditions.

Earthing of all electrical equipment will be designed and provided as per the guidelines given in the latest IEEE-80 standard and IS-3043: Code of Practice for Earthing. The earthing design will be based on the soil resistivity measurement carried out at various locations of substation and RMU/CSS sites. Wherever required, the earth grid will be placed 600 mm below ground. Where high resistivity values are encountered chemical earthing will be employed.

The EHV, HV and LV systems are solidly earthed at the neutral point of the power transformer. The size of earthing conductors to be connected with the earthing system will be designed for an earth fault level of

50 kA (1 sec). All electrical equipment such as motors, transformers, substations, foundations, switchboards, control boards, relay and auxiliary relay boards, all other subsidiary electrical equipment as well as all metal parts of civil construction or the mechanical equipment such as transformer rails, pumps, pipes, steel structure, tanks, cable trays, etc. will be connected to the earthing system.

The ground grid will be composed of a system of galvanized conductors buried approximately 500 mm below finished ground level, excluding crushed rock surfacing. The grid system will cover the entire fenced substation area and will be extended to the outer of the substation fence. A perimeter conductor will run around the substation in a distance of 0.5m to the fence and will be connected to the inner earthing grid and to the fence in regular intervals. Where necessary to reduce the overall earth resistance, earth electrodes will be provided and connected to the perimeter of the main earth grid. A minimum of four (4) of the specified ground rods must be installed (one at each corner of the ground grid).

11.25.1 *Earthing Conductors*

Earthing conductor will be Galvanized steel. Ground leads running down from the lightning rod or air terminal rods will be hard drawn galvanized steel and will be provided with the required clamp supports mounted on the steel structure at approximately 1.5 m intervals. The cross sections of the various earth conductors will be determined in accordance with IEEE standard / IS: 3043, however, the minimum conductor cross sections will be as follows

50 x6mm	--	EHV, HV and LV switchgear Or as per design calculations
25 x6mm	--	Metal raceways and cable trays as per design calculations
25 x 6 mm	--	Intermediate terminal boxes, cabinets, panels or as per design calculations
25 X 6 mm	--	Other metal parts as may be required or as per design calculations

11.25.2 *Ground Rods*

The ground rod will be copper-covered steel of circular cross section, with a nominal diameter of 19 mm and not less than 3 meters long in section of 1.5 meters. If more than one earthing rod are necessary, they will not be less than 3 m apart. Where earth plates are indicated, they will be 600mm x 600mm minimum, of solid or lattice copper not less than 3mm thick.

Electrodes will be installed in undisturbed ground. The distance between any two electrodes will be not less than the sum of the lengths of the two electrodes. Backfill immediately surrounding plate electrodes will have a low specific resistivity and good water retention properties and will be well compacted.

11.25.3 *Earthing Hardware*

- **Steel Structure Earthing:**

Every steel structure that carries insulators or apparatuses shall be connected to the earthing grid at two different points. Operating mechanisms and motor drives placed on separate stands shall also be connected to earth in duplicate.

- *Transformer Earthing:*

The transformer tank shall be connected to earth following the same principles as for steel structures. Two numbers dedicated copper Earth pits shall be considered for Transformer neutral earthing.

- *Earthing of Lightning arrester*

Each lightning arrester shall be grounded separately with a full rated earthing connection and not via the steel structure. In addition, an earthing rod shall be driven into the ground at each earthing point of a lighting arrester as close as possible to the lighting arrester and connected to it.

- *Earthing inside Buildings*

For potential equalizing of the building, an earthing grid of 8 mm reinforcement bars shall be cast into the surface concrete of all floors of all switchgear room or basements. The connection points shall be welded. The mesh size shall not be greater than 3 x 3 m. Suitable connection points shall be brought out of the concrete to allow connection to the main earthing and to all parts of equipment and building to be earthed. The earthing grids of the different levels shall be connected at 8 to 10 m. on the periphery distributed locations.

- *Earthing outside Buildings*

As a minimum, one grading ring of galvanized steel strip shall be laid around each building at a distance of 1 m (each) and at a depth of 0.6 m. The connections to the building earthing installation shall be made within the building. All individual earthing grids shall be interconnected at spacing by not more than 5 meters. Steel fences within and around the substation area shall be connected to the earthing system at least at two different points and at maximum 10 meters intervals. All metal Poles for lighting and other types of metal structures within the substation area shall be connected to the earthing grid one connection for each item.

- *Earthing Equipment*

To meet the safety regulations before any maintenance or repair works are started on the EHV/HV/ LV power equipment, the disconnected "live" parts of the equipment shall be grounded by means of mobile earthing sets. The portable or mobile earthing sets (Substation Earthing Sets) shall be supplied by the Contractor. One earthing set shall be supplied per substation and voltage level.

For safety and reliable operation, the shields and metallic sheaths of power cables will be grounded. Metallic sheaths will be terminated at nearest earth point of the equipment where cable is terminated.

11.26 DIESEL GENERATOR SET

The specification clause covers for Diesel Generator set enclosed in an outdoor non-rusting type acoustic enclosure. It will be equipped with an auto mains failure (AMF) panel along with AC distribution panel. The complete supply will also include the necessary civil works, plumbing, cabling and other electrical works as required at site for each set. The set will have provision for remote SCADA. Under normal conditions all the loads will be fed from the 11kV grid supply. However, in case of grid failure or non-availability of grid supply due to system fault, all the essential loads, will be fed from the standby Diesel generator sets. 415V DG sets are proposed for essential loads of each MRSS/DSS and for STP, CETP WTP and SWM plants including CCTV and traffic lights but excluding street lights, Bus stop and EV charging points etc. For Common area service LT panel shall have provision for installing DG sets without any modification in existing panel as per future requirements.

11.27 POWER SUPPLY TO FIELD INSTRUMENTS

Power supply requirement for all control valves, RTU'S, field devices and accessories for Potable, Recycled, Sewerage & Industrial effluent network will be sourced from nearest feeder pillars. The power cables will be terminated to respective control valves, RTU'S, field devices and accessories of Potable, Recycled, and Sewerage & Industrial effluent network from RCC cable trenches through Double Wall Corrugated HDPE Ducts.

11.28 ELECTRICAL DESIGN CRITERIA FOR STP/CETP

Design basis

HT Supply	-	11kV, 3-Ph, 3-Wire, 50Hz,AC
LT Supply	-	415V, 3-Ph, 4-Wire, 50Hz,AC
Control Voltage	-	240V, 1 Phase, 50 Hz 415V, 3-Ph, AC System Solidly Earthed
11kV, 3-Ph, AC System	-	Solidly Earthed

- STP, CETP, WTP and SWM- Electrical Scope
- 11kV power supply will be tapped from nearest RMU.
- Power will be received at 11kV HT panel and is stepped down to 415V by means of suitably rated 11/0.415kV distribution transformers.
- Power from transformer will be fed to 415V PMCC panel and further distributed to various load centers.
- The fault level of 415V PMCC Panel will be rated as per design fault kA for 1 Sec
- Emergency back-up by means of 415V Emergency Diesel Generator set which will be connected to PMCC.
- 415V APFC panel will be provided to improve the power factor to 0.98 (lagging).
- Street lighting system will be proposed for outdoor road lighting system at STP premises.
- MCC Room: to be maintain adequate clearances between equipment for ease of maintenance. Clearance around equipment shall be maintained as per CEA regulations and equipment supplier's recommendations, whichever is higher.

11.29 SCADA (SUPERVISORY CONTROL AND DATA ACQUISITION) SYSTEM (SEPARATE PACKAGE)

Only provision in design to be kept for incorporating of SCADA and space for fibre optic cable, to be kept in trenches / cable trays. A common backbone network is setup under SCADA & ICT service. SCADA shall be used for controlling and monitoring of electrical system. ICT service contractor shall provide backbone network and electrical system integration and interface shall be under electrical scope of work. SCADA (Supervisory Control and Data Acquisition system) shall perform the following functions:

- 24 Hrs. Monitoring and control of all electrical networks from centralized control system.
- Min. time fault isolation and restoration for HT network and monitoring of LT Network in the system.
- Pre-warning of the fault in the system by monitoring of different parameters and preventive action.
- Energy auditing of the system so as to reduce the losses in the system.
- Reduce accidents of the electrical network by interlock in the system.

The control hierarchy will consist of the following levels:

- Level 1: System control from centralized control room.
- Level 2: Control at the local substation with station control unit.
- Level 3: From the switchgear mechanism box.

The data exchange between level 1 and level 2 shall be via serial fibre optic cables or GPRS system (supplied in the Communications and Security package). A typical SCADA scheme is shown in figure below:

Each MRSS and Distribution (DSS) will be provided with SCADA system where the substation panel, only provision to be kept, SCADA shall be designed and installed by other agency.

i.e. 220kV GIS EHT, 66kV GIS EHT switchboard, 11kV GIS/VCB HT switchboard shall be monitored and automated. It also covers the monitoring of FRTU placed in the Ring main unit site which are feed by respective substation. The SCADA under the MRSS and distribution substations shall share the data with central control room SCADA, where centralized monitoring of all MRSS and distribution substation shall be done. Carrier Communication can be done with power Cables with relevant infra to trap high frequency signal for internal communication of Sub-stations.

The EHT & HT (220kV/66kV/11kV) panels under substation shall be monitored at substation SCADA via Modbus communication or the numerical relays shall have substation RTU/SCADA communication over IEC61850 protocol. Multi-function metering units shall transfer measured parameters to SCADA via RTU Modbus over RS-485/RS-232, TCP/IP communication links. Note: Multifunctioning Meters to be supplied and installed by EPC Contractor with provision of SCADA, connectivity to be executed under different package.

The power SCADA for each substation shall be equipped with following hardware's,

- Operator cum Engineering Workstation for Power SCADA with 32" Monitor.
- Ethernet Switch
- Port Fiber Patch panel
- PLC/RTU Panel
- UPS System
- FRTU RMU or CSS.

The redundancy level for each SCADA unit shall be as per contract agreement, where all units shall be standalone except the communication link i.e. fiber optic network between FRTU's and MRSS/DSS local SCADA and central control room shall be redundant which is achieved by means of ring network.

The UPS power supply shall be provided in each substation SCADA control room to power the workstation and Ethernet switches. RTU's/FRTU's of RMU/CSS shall be powered from electrical power supply where, FRTU's are having inbuilt battery backup of 8 Hr. time which further used to for FRTU, Ethernet switch and control circuitry working in absence of main power supply. It also Back-up with DG Power.

Note: - For detail designing of SCADA, refer SCADA DBR considered under separate package.

11.29.1 *Smart – Power Grid*

Smart Energy Grids are energy networks that promise to enhance the operational efficiency of power supply via distributed generation with bi-directional energy and electricity flow. This objective is achieved by allowing intelligent monitoring and control of different components within the distribution and transmission lines as well as other systems from all utilities of electricity on one side, to the end user on the other side maintaining the energy and power quality, security, reliability and safety. Governments around the world are investing heavily in smart energy grids to ensure optimum energy use and supply, enable better planning for outage responses and recovery, and facilitate the integration of heterogeneous technologies such as renewable energy systems.

Smart Energy Grids present enormous engineering challenges in the design and integration of energy and electrical grids with communication and network technologies, along with substantial questions of security and privacy of different components within the grid.

"The grid," refers to the electric grid, a network of transmission lines, substations, transformers and more that deliver electricity from the power plant to home or business.

11.29.2 *Smart Metering*

Smart Energy Meters are proposed to be installed at every consumer premises to measure the energy consumed. Advanced Metering Infrastructure (AMI) takes greater control over energy costs and a more reliable energy supply for consumers. Energy meter helps utilities to have a track of how much energy is been distributed from the grid and consumed at the end point. This in turn enables precise energy accounting, demand forecasting and streamlining grid operations. Smart metering enables consumers to get energy info from utilities on their usage pattern and peak hour pricing. This also helps them in efficient billing and energy planning.

Beyond management and control, the implementation of a Smart Metering system allows several applications that join the metering data together with additional information and other devices from which both utilities and end-users should benefit. Location of Smart Meter shall be at Switchgear /Feeder Pillar as per their source of supply.

11.29.3 *Remote Monitoring*

Remote monitoring capability enables remote deliver actionable business insights. Power supply Agencies can now get a crystal-clear picture of overall grid parameters such as the I/O voltage and current, Power factor, load, losses and energy usage on the go. They can be remotely accessed and controlled under a single console and also enable quick decision making in streamlining the grid operations.

11.30 RENEWABLE ENERGY - SOLAR POWER

Sunlight is converted to electricity directly when made to fall on solar photovoltaic (SPV) modules. Systems/devices are made for various applications based on SPV modules connected with suitably designed power conditioning units for meeting electricity requirements.

11.30.1 *Solar Roof Top PV Power Systems*

It is proposed solar roof top PV power systems in IMC Rajpura on rooftops or wherever feasible to be install by respective plot owner to comply the minimum requirements as stated by state/central or local govt bodies in complying of guideline given by these agencies time to time. Minimum required quantity of power generated by each individual consumer, industrial building, commercial buildings or any other type of building can be used to partly fulfill the requirement of the building occupants. Surplus, if any, can be fed into the grid as per PSTCL guideline and net metering conditions. In grid interactive rooftop or small SPV systems, the DC power generated from SPV panel is converted to AC

Power using power conditioning unit and is fed to the grid. The generated power during the day time can be utilized fully by powering captive loads and excess power can be fed to the grid as long as grid is available based on terms and conditions of power supplying company. In case, where Solar Power is not sufficient due to cloud cover or during the night hours, the captive loads are served by drawing power from the grid. The grid interactive roof top solar system can work on net metering basis based on applicable conditions.

11.30.2 *Advantages of Solar Power*

- Utilization of vacant space for power generation.
- The grid connected roof top solar PV system would fulfil the partial / full power needs of large scale buildings.
- Can generate power for self-consumption and feed excess power to the Grid as per supply company rules and regulations complying with state and central policies.
- Generation of environmentally friendly green energy.
- Reduction in diesel consumption where DG back-up is provided.

11.30.3 *Requirements for Roof Top Solar Power Generation*

- A minimum vacant roof area of 10 Sq. meter or 100 Sq. Ft is required for installation of 1 KW system.
- Mandatory safety precautions/features shall be installed as per the norms.

11.31 ESTIMATED ELECTRICAL POWER REQUIREMENTS

Electrical Load has been Calculated Sub-station wise as per norms/guideline given by PSPCL for industries and other services in memo no. 914-939 dated 12/11/2024.

- Net Total demand load = Per sub-station + Outdoor services load + Fire pump Load + Common Area Facility Load + Street & Outdoor Lighting Load Plus load of facilities being provided in the complex.
- Transformer Losses @ 2% and transmission Losses @ 6% have also been taken calculation.
- Selection of Transformer and Switchgears have been done with a cushion of 25% extra capacity and usage of each Industry is not known at present so, if power requirement of any Industry is

more than assumed while designing system then it should be able to sustain it.

11.32 LIASONING & APPROVALS

Liaoning with Electricity Board Authorities for sanction of temporary and permanent power connection shall be in scope of EPC contractor.

11.33 LV& IT SERVICE

Every Plot owner shall have requirement of L.V Service. For that a L.V cable duct shall be provided along or inside Common Trench with Electrical duct for laying fiber optical cable by service provider. This duct shall start from A.T.S building or from available source Point of presence and shall have cable tray running on one side of trench with 50 M.M sleeves for each plot. Service provider shall clamp his main trunk Fiber Optical cable in this trench clamped to tray and through sleeves shall enter the plot premises and provide his junction box in guard room or other area allocated by plot owner for this purpose. From that point, plot owner shall distribute service as per his requirement in his factory/Plot.

11.33.1 *Power Supply to IT services*

Electrical Power with UPS Back-up to be Provided. UPS supply required for above services at control centre/Field Equipment's at Multiple Locations, which has divided as follows.

- Location No – 1

Integrated control command centre. Power to control centre shall be given at 415V sub-station with UPS Backup for critical Services. ICCC center must have provision for receiving DG power into their electrical panel.

- Location No – 2 (POP-1 & 2)

These locations shall be multiple, spread over the entire Manufacturing Cluster where ever following field equipment's are installed,

- Traffic Lights.
- CCTV Cameras.
- Communication Equipment.
- Digital Display Signage.

- Adoptive Traffic Management Parking lot.
- For Smart Solid Waste Management System, power supply shall be given depending power requirement
- Police/Emergency Response System.

At present the total complex has been divided into 45 to 50 Feeder Pillars for supplying power to following services,

- Street Lighting controlled by timer.
- Police Booths.
- Toilets Blocks.
- Bus stops

Or any other such like utility which may require power for their operation. Feeders for all field devices are being provided in all the feeder pillars and tap off boxes shall be provided as per the final location and power requirements of controlling unit of field Eqpt. As per user requirements Qty of Feeder Pillars may vary as per the final scheme. Site plan showing tentative location of Feeder Pillars and Typical Feeder Pillar SLD is attached for reference. LV services shall have UPS backup were installed either on field or on substation.

11.34 TECHNICAL SPECIFICATION OF NITROGEN INJECTION FIRE PROTECTION CUM EXTINGUISHING SYSTEM

The contractor shall provide the nitrogen injection fire protection cum extinguishing system. The fire protection system using nitrogen as fire quenching medium is required for the 10 MVA & above T/Fs. NIFPES shall act as fire preventer by preventing transformer oil tank explosion and possible fire in case of internal faults. In the event of fire by external causes such as bushing fire, OLTC fires, fire from surrounding equipment etc, it shall act as a fast and effective fire fighter. NIFPES shall accomplish its role as fire preventer and extinguisher without employing water and/or carbon dioxide. Fire shall be put out within max. 3minutes of system activation and within max. 30 seconds of commencement of nitrogen injection.

11.34.1 *Activation of NIFPES*

Mal-functioning of fire prevention/extinguishing systems is their major shortcoming which leads to interruption in power supply. The contractor shall ensure that the chances of malfunctioning of NIFPES are practically nil. To achieve this objective, the contractor shall work out his scheme of activating signals which, while preventing mal-operation, should not be too rigorous to make the operation of NIFPES impracticable in case of actual need. Transformer isolation shall be the mandatory pre-requisite for activation of the system in automatic mode or remote mode in the control room. In addition, at least following electrical-signals shall be provided in series for activating NIFPES.

11.34.2 AUTO MODE

11.34.2.1 For prevention of fire:

- Differential relay operation
- Buchholz relay paralleled with pressure relief valve
- Tripping of all connected breakers is a pre-requisite for initiation of system activation.

11.34.2.2 For extinguishing fire:

- Fire detector
- Buchholz relay paralleled with pressure relief valve
- Tripping of all connected breakers is a pre-requisite for initiation of system activation.

11.34.3 *Manual Mode (Local/Remote):*

- Tripping of all connected breakers is pre- requisite for initiation of system activation.

11.34.3.1 Manual Mode (Mechanical)

- Tripping of all connected breakers is a pre- requisite for initiation of system activation.

11.34.4 GENERAL: DESCRIPTION OF NIFPES

11.34.4.1 Schematic of the system

NIFPES should be a standalone dedicated system for each oil filled transformer. It should have a fire extinguishing (F.E.) cubicle placed on a plinth at a distance of 6-10 mtrs. from the transformer. The F.E. cubicle may be connected to the transformer oil tank (near its top) and to the oil tank placed in pit, from its bottom through oil pipes with gate valves. The F.E. cubicle should house a pressurised nitrogen cylinder connected to the transformer oil tank (near its bottom). Cable connections are to be provided from signal box placed on the transformer to the control box in the control room and from control box to F.E. cubicle. Fire detectors placed at the top of transformer are to be connected in parallel to the signal box. The signal box may be connected to a pre- stressed non-return valve fitted between the conservator tank and

Buchholz relay. Control box is also to be connected to relay panel in control room for system activation signals.

11.34.4.2 Operation

On receipt of all activating signals, drain of pre-determined quantity of oil commences thus removing high temp. top oil layer. Simultaneously nitrogen is injected under high pressure at a pre-fixed rate, stirring the oil thus bringing the temperature of top oil layer down. Nitrogen occupies the space created by oil drained out and acts as an insulating layer between the tank oil and fire on top cover. Pre-stressed non-return valve blocks oil flow from conservator tank, thus isolating it & preventing aggravation of fire.

11.34.5 *System components*

Broadly, NIFPES shall consist of the following components. It is emphasized that all components, irrespective of their exclusion in the details given below, necessary for fast reliable and effective working of NIFPES shall be considered within the scope of supply.

11.34.5.1 Fire extinguishing cubicle

it shall be made of 3 mm thick steel sheet, painted dark red from inside and outside with hinged split doors fitted with high-quality tamper-proof lock. It shall be complete with the base frame and the following: -

- Nitrogen gas cylinder with regulator and falling pressure electrical contact manometer.
- Oil drain pipe with mechanical quick drain valve.
- Electro mechanical control equipment for oil drain and pre-determined regulated nitrogen release.
- Pressure monitoring switch for back-up protection for nitrogen release.
- Limit switches for monitoring of the system.
- Flanges on top panel for connecting oil drain and nitrogen injection pipes for transformer.
- Panel lighting (CFL type)
- Oil drain pipe extension of suitable sizes for connecting pipes to oil pit.

11.34.5.2 Control box

Control box for monitoring system operation, automatic control and remote operation, with following alarms indication, light switches, push buttons, audio signal, line fault detection suitable for tripping and signaling on 110V DC/220V DC supply.

- System on*
- PNRV open*
- Oil drain valve closed*
- Gas inlet valve closed*
- PNRV closed^
- Fire detector trip^
- Buchholz relay trip^
- Oil drain valve open^
- Extinction in progress^
- Cylinder pressure low^
- Differential relay trip^
- PRV operated^
- Transformer trip^
- System out of service
- Line fault fire detector
- Line fault differential relay
- Line fault Buchholz relay
- Line fault PRV
- Line fault transformer trip
- Line fault PNRV
- Auto / Manual/Off
- Extinction release on
- Extinction release off
- Lamp test

- Visual/Audio alarm
- Visual/Audio alarm
- Visual/audio alarm for DC supply fail

The signals marked (*) shall be in the top most row of control box panel. The signals marked (^) shall follow next.

11.34.5.3 Pre-stressed non return valve (PNRV)

PNRV is to be fitted in the conservator pipe line between conservator and Buchholz relay. It shall have the proximity switch for remote alarm, indication and with visual position indicator. The PNRV should be of the best quality because malfunction of PNRV shall be of serious consequence as its closing leads to stoppage of breathing of transformer.

11.34.5.4 Fire detectors

The system shall be complete with adequate number of fire detectors fitted on the top of oil tank, OLTC/OFF ckt. tap changer rated for 141 degree C for heat sensing each fitted with two no. cable glands (water proof/weather proof).

11.34.5.5 Signal box

It shall be fitted on the transformer for terminating cable connections form PNRV and fire detectors and for further connection to the control box.

11.34.5.6 Cables

Fire survival cables, able to withstand 750 degree C, 4 core x 1.5 mm sq. for connection of fire detectors in parallel shall be used.

Fire retardant low smoke (FRLS) cable 12 core x 1.5 mm sq. for connection between transformer signal box/marshalling box to control box and control box to fire extinguishing cubicle shall be used. Fire retardant low smoke cable 4 core x 1.5mm sq. for connection between control box to DC supply source and fire extinguishing cubicle to AC supply source, signal box/marshalling box to pre-stressed non return valve connection on transformer shall be used.

11.34.5.7 Pipes

Pipes complete with connections, flanges, bends tees etc. shall be supplied along with the system.

11.34.6 OTHER ITEMS

- Oil drain and nitrogen injection openings with gate valves on transformer tank at suitable locations.
- Flanges with dummy piece in conservator pipe between Buchholz relay and conservator tank for fixing PNRV.
- Fire detector brackets on transformer top cover.
- Spare potential free contacts for system activating signals i.e. differential relay buchholz relay, pressure relief valve, transformer isolation (master trip relay).
- Pipe connections between transformer to fire extinguishing cubicle and fire extinguishing cubicle to oil pit.
- Cabling on transformer top cover for fire detectors to be connected in parallel and inter cabling between signal box to control box and control box to fire extinguishing cubicle.
- Mild steel oil tank (capacity is approximately equal to 10% of total volume of oil in transformer tank)) for each T/F with moisture proof coating and sheet thickness of minimum 5 mm, with watertight cover, to be placed in the pit. This tank shall be provided with the manhole, air vent pipe through silica gel breather, drain valve and a spare gate valve at the top.
- The location of the tank shall be approved by the employer.
- DC-DC converter 220-110V DC (optional, in case 110V, supply is not available.)
- Gate valves on oil drain pipe and nitrogen injection pipe should be able to withstand full vacuum. A non-return valve shall also be fitted on nitrogen injection pipe between transformer and gate valve.
- The F.E. cubicle shall be painted with post office red colour (shade 538 of IS-5). All the exposed parts i.e. pipes, supports, signal box etc. shall be painted with enameled paint.
- Civil works of F.E.Cubicle and oil pit are not in the scope of bidder.

11.34.7 INTERLOCKS

It shall be ensured that once the NIFPES gets activated manually or in auto mode, all the connected breakers shall not close until the system is actually put in OFF mode. Also, PNRV shall get closed only if all the connected breakers are open.

11.34.8 TECHNICAL PARTICULARS

11.34.8.1 Fire extinction period

On commencement of nitrogen injection activation to	:	Max. 30 secs. From the moment of system
		Max. 3 mins. Complete cooling.
Fire detectors heat sensing temperature	:	141 Degree C
Heat sensing area	:	800mm radius
Pre-stressed non return valve setting for	:	minimum 60 ltr. Per operation.
min. Capacity of nitrogen cylinder	:	minimum 68 ltr. water cap.

and shall hold minimum 10 cubic meter gas to 150 bar pressure

Control Box : 110V DC/220V DC

Fire extinguishing cubicle for lighting : 230V AC

11.35 TECHNICAL SPECIFICATION OF COMPACT SUBSTATION

Technical Specification for Package Substation with Vacuum Circuit breaker / SF6 as protection on HT side.

11.35.1 CODE & STANDARDS:

All equipment and material shall be designed manufactured and tested in accordance with the latest applicable IEC standards. The 12KV Package Substation Design must be as per IEC62271-202only.

The Package Sub-station offered shall in general comply with the latest issues including amendments of the following standards.

Table 11-11: Standards for Package Sub- Station

S.NO.	TITLE	STANDARDS
1	High Voltage Low Voltage Pre-Fabricated Substation	**IEC:62271-202**
2	High Voltage Switches	IEC60265
3	Metal Enclosed High Voltage Switchgear	IEC60298/C62271-200
4	High Voltage Switchgear	IEC6069
5	Low Voltage Switchgear and Control gear	IEC60439
6	Power Transformer	IS1180

11.35.2 DESIGN CRITERIA

Package Sub-station consisting of HT Meter Compartment, 11KV VCB/SF6, Transformer and Low Voltage Switchgear with all connection accessories, fitting & auxiliary equipment in an Enclosure to supply Low-voltage energy from high- voltage system as detailed in this specification. The complete unit shall be installed on a substation plinth (base) as Outdoor substation located near entrance. As per design VCB/SF6 HT switchgear shall be used to control and isolate the 11kV/433V Distribution transformer. The transformer Low Voltage side shall be connected to Low Voltage switchgear. The connection cables to consumer shall be taken out from the Low Voltage switchgear. The prefabricated-package substation shall be designed for

a) Compactness, b) fast installation, c) maintenance free operation, d) safety for worker/operator & public.

The Switchgear and component thereof shall be capable of withstanding the mechanical and thermal stresses of short circuit listed in ratings and requirements clause without any damage or deterioration of the materials.

For continues operation at specified ratings temperature rise of the various switchgear components shall be limited to permissible values stipulated in the relevant standard and / or this specification.

11.35.3 SERVICE CONDITIONS

The Package substation shall be suitable for continuous operation under the basic service conditions indicated below

- Ambient temperature: 50 Degree C Max.
- Relative humidity AS Per IMD
- Altitude of Installation upto1000m

The Enclosure of High Voltage switchgear-control gear, Low Voltage switchgear-control gear & Transformer of the package substation shall be designed to be used under normal outdoor service condition as mentioned. The enclosure should take minimum space for the installation including the space required for approaching various doors & equipment inside. De-rating, if any for the said temperature range shall be clarified by the bidder.

11.35.4 SPECIFIC REQUIREMENT

The main components of a prefabricated- package substation are Transformer, High-voltage switchgear-control gear VCB/SF6, Low-voltage switchgear-control gear and corresponding interconnections (cable, flexible, bus bars) & auxiliary equipment. The components shall be enclosed, by either common enclosure or by an assembly of enclosure. All the components shall comply with their relevant IEC standards. CSS shall have separate compartments for all above items. There should be provision of separate compartment for installing HT meter with sealing arrangement, separate swing able door lock, latches and sealing arrangement as per state electricity norms.

11.35.5 RATING:

Table 11-12: Rating for Package Sub Station

Description	Unit	Value
Rated Voltage/ Operating Voltage	kV rms	11
Rated frequency & Number of phases	Hz Nos.	50 & 3 Nos.
Rated maximum power of substation	KVA	250-1000KVA
Rated Ingress protection class of Enclosure	IP	IP-33d for Transformer Compartment and IP:55 for LT & HT Switchgear Compartment
Rated temp Class of Transformer Compartment		K10 up to 250-1000KVA
HV Insulation Level		
Rated withstand voltage at power frequency of 50 Hz	kV rms	28
Rated Impulse withstand Voltage	kV peak	75

11.35.6 OUTDOOR ENCLOSURE

The outdoor enclosure shall be made of galvanized Sheet Steel tropicalized to local weather conditions or painted galvanized sheet steel.

The CSS shall be made up of 1.6 mm thick non load bearing members and 2 mm thick load bearing members with a base frame made up of 4 mm HRCA/ ISMC channel.

The CSS shall have a 6 degrees slope to avoid water logging in case of rains or any other such issue.

The metal base shall ensure rigidity for easy transport and installation.

Substation will be used in outdoor application hence to prevent enclosure from rusting/corrosion, welding should be avoided.

Considering the outdoor application of the substation the doors shall be provided with proper interlocking arrangement for safety of operator and to avoid corrosion door should have stainless steel hinges. Enclosure must be designed to have proper ventilation without any additional forced ventilation equipment

/ Device.

Internal Arc Fault: Failure within the package substation due either to a defect, an exceptional service condition or mal-operation may initiate an internal arc. Such an event may lead to the risk of injury, if persons are present. It is desirable that the highest practicable degree of protection to persons shall be provided. The Design shall be tested for IAC AB,13.1kA/0.2 Sec as per IEC 62271-202. Type test report of arcing due to internal fault should be submitted with offer.

Covers & Doors: Covers & doors are part of the enclosure. When they are closed, they shall provide the degree of protection specified for the enclosure fixed members. Ventilation openings shall be so arranged or shielded that same degree of protection as specified for enclosure is obtained. All covers, doors or roof shall be provided with locking facility or it shall not be possible to open or remove them before doors used for normal operation have been opened. The doors shall open outward at an angle of at least 90° & be equipped with a device able to maintain them in an open position.

Earthing: All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequate terminal intended for connection to the earth system of the installation, by way of flexible jumpers/strips & Lug arrangement. The continuity of the earth system shall be ensured taking into account the thermal & mechanical stresses caused by the current it may have to carry. The components to be connected to the earth system shall include:

a) The enclosure of Package substation,

b) The enclosure of High voltage switchgear & control gear from the terminal provided for the purpose,

c) The metal screen & the high voltage cable earth conductor,

d) The transformer tank or metal frame of transformer,

e) The frame &/or enclosure of low voltage switchgear,

f) Transformer neutral have to connect with Dedicated Copper Earthing,

There shall be an arrangement for internal lighting activated by associated switch for HV, Transformer & LV compartments separately.

Labels: Labels for warning, manufacturer's operating instructions etc. shall be durable & clearly legible.

11.35.7 CODES & STANDARDS

12171 : Classification of Insulating Materials IS1180: Transformer

IS2099: Bushing for alternating voltages above 1000VCurrentIS2705: Current transformer

IS 16227 : 11KV CT & 11KVPT

IS 3202 : Code of practice for climate proofing

IS3639 : Power transformer fitting &accessories.

IS4257 :Porcelain bushing for transformer

IS 8478 : Application guide for tap changers.

IS10028 : Code of practice for selection, installation and maintenance of transformer.

11.35.8 GENERAL DESIGN FEATURES

All transformers shall be of the latest design.

The type of cooling shall be oil Cooled Natural Air cooled (ONAN) and the corresponding ratings for each transformer shall be as indicated in the specific requirements.

Each transformer shall be suitable for operation at full rated power on all tapings without exceeding the applicable temperature rise.

The transformers shall be designed to be capable of with-standing, without injury, the thermal and mechanical effects of short-circuits between phases or between phase and earth at the terminals of any winding with full voltage applied across the other winding for periods given in relevant standards. There shall be no limitations imposed by any part/component of the transformer/off load tap links to meet the short circuit level Specified.

Each transformer shall be designed for minimum no-load and load losses within the economic limit and shall be able to have minimum loss at the rated load condition.

All electrical connections and contacts shall be of ample cross sections for carrying the rated current without excessive heating.

The transformer shall be capable of continuous operation at full load rating under the following conditions.

a) Voltage variation = ±10%

b) Frequency variation = ±5%

c) Combined voltage and frequency variation (Absolute sum) =10%

11.35.9 WINDINGS

The winding insulation shall be of Class 'A" and temperature of max 50°C ambient.

Windings shall be of electrolytic copper conductors (circular in shape) of high conductivity.

Windings shall be designed to withstand the specified thermal and dynamic short circuit stresses

The windings shall be duly sectionalized. Accessible joints brazed or welded and finished smooth shall connect similar sections. No corona discharge shall result on the winding upon testing the transformer for induced voltage test as specified in IS.

The high voltage and low voltage winding shall be made of copper Conductors. HV winding will always be copper conductor.

11.35.10 CORE

The double wound Core shall be constructed from non-ageing cold rolled Grain oriented steel sheets. The built core shall be painted with high temperature resistant paint to prevent corrosion at the edges of core plates and to withstand high temperatures. By using different core material optimization of core losses shall be achieved. The yokes shall be firmly clamped between yoke channels or plates. The top & bottom yoke frames shall be secured to each other by means of tie- rods, which help in securing the winding in place.

The design of the magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and the production of flux component at right angles to the planes of laminations which may cause local heating.

Table 11-13: Design Criteria: Compact Substation

S.No.	Description	Particulars
1	Type	Three Phase, 50Hz, core type, two winding, ONAN, Transformer with OLTC with RTCC
2	Rating(KVA)	Upto 1000kVA
3	Winding material	Copper
4	No Load voltage ratio	11/0.433
5	Connection a) HV	 Delta
6	Vector Group	
7	Insulation level (Kvp/KVrms) a) HV	 75/28
8	Type of tap changer forgiving voltage variation to HV	OLTC with RTCC
9	Tapping Range	In step of 1.25% (Min 16Steps)
10	Temperature rise in oil& winding over ambient temperature	40°C /50°C
11	Class of insulations	Class A
12	Enclosure	IP00 (Without Enclosure)
13	Method of cooling	ONAN
14	No load losses at rated voltage	As per IS 1180meeting EEF-V
15	Full load losses at principal tap at 75°C (IStol)	As per IS 1180meeting EEF-V
16	Terminations a) HV	 Busbar /Cable Busbar/Cable
17	Fittings	2 Nos earthing terminals, Rating and Diagram plate, Bi-directional Rollers, Lifting lugs, OLTC with RTCC
18	Paints	RAL-7035

11.35.11 TERMINAL ARRANGEMENT

HV side and LV side of transformer will have the top busbar arrangement for connection of HT side by means of cable and LT side by means of busbar.

Technical particulars of ONAN type transformer

11.35.12 PAINTING

All steel surfaces shall be thoroughly cleaned by sand blasting or chemical agents as required to produce a smooth surface free of scale, grease and rust.

The external surface, after cleaning, shall be given a cost of high quality red oxide or yellow quoted primer, followed by filler coats.

11.35.13 ROUTINE TEST

All Routine Tests in accordance with IS 1180/ IS 2026 shall be carried out on each transformer.

- It must be possible to supply the circuit-breakers both from the top and bottom terminals without derating their performances and without jeopardizing their functionality.
- The mechanical life must be at least 10000 operations, without the need for maintenance of the contacts and arcing chambers.
- The electrical life at a voltage of 440 V AC must be and without the need for maintenance of the contacts and arcing chambers:

11.36 BATTERY

11.36.1 GENERAL TECHNICAL REQUIREMENTS

All the materials/components used in Battery Chargers and Valve Regulated Lead Acid Battery (VRLA) shall be free from flaws and defects and shall conform to relevant standards and good engineering practices.

- For 220 KV, 132 KV & 66 KV sub-stations, DC System shall consist of two (2) float-cum-boost charger and one (1) battery set for each of 220V and for 48V system. DC scheme shall consist of one (1) battery.

- Bidder shall select number of cells, float and Boost voltage to achieve following requirement :

Table 11-14: Minimum Requirements: Battery

System Voltage	Maximum Voltage during Float Operation	Minimum voltage available when no charger working and battery fully discharged up to 1.85 V per cell.	Minimum Nos of Cell
220Volt	242 Volt	**198 Volt**	107
48 Volt	52.8 Volt	43.2 Volt	23

11.36.2 CLIMATIC CONDITIONS

As per IMD Details defined in tender document.

11.36.3 *Battery Type*

The DC Batteries shall be Normal Discharge type Valve Regulated Lead Acid (VRLA) and shall conform to IS 15549: 2004/IEC 60896-21 & 22, 2004standard. These shall be factory filled, charged & suitable for a long life under continuous float operations and occasional discharges. The 220 V DC systems should be unearthed and 48V DC system is Positive Earth system. Battery sets shall be capable of operating at a peak ambient temperature of 50Deg.C. The offered battery shall be compact and shall require no maintenance. All safety equipment required for installation shall be provided by the manufacturer.

11.36.4 *Constructional Requirement*

Positive plates shall be made of flat pasted type using high corrosion resistant alloy for durability, maintenance free, long life both in cyclic as well as in float applications. The Grids are of Semi Radial Squarish grid to reduce internal Resistance and travel current in shorter time. Negative plates shall be heavy duty, durable flat plate using lead alloy pasted Semi Radial Squarish Grid. Negative plates shall be designed to match the life of positive plates and combination of positive and negative plates shall ensure long life, durability and trouble-free operation of battery. Computer controlled/PLC operated in house equipment should be deployed for preparation of lead oxide and paste to ensure consistency in paste quality &properties. Conventional / manual type of paste preparation will not be allowed.

11.36.5 *Containers & Lids*

The container & lids shall be made of polypropylene Copolymer material and shall have chemical and electro-chemical compatibility along with acid resistant and shall conform to UL-94/ ASTM-D-2863 standard. The material shall meet all the requirements of VRLA batteries and be consistent with the life of battery. The porosity of the container shall be such as not to allow any gases to escape except from the regulation valve. The tensile strength of the material of the container shall be such as to handle the internal cell pressure of the cells in the worst working condition. The container shall be capable of withstanding the rigours of transport, storage and handling. The containers shall be enclosed in a steel tray. For identification each cell / module shall be marked in a permanent manner to Indicate the Following information.

11.36.6 *Cell Covers*

The cell covers shall be made of suitable material compatible with the container material and permanently fixed with container by Hermetic Heat-Sealing technique. It shall be capable to withstand internal pressure without bulging or cracking. Fixing of pressure regulation Valve & terminals posts in the cover shall be such that the seepage of electrolyte, gas escapes and entry of electrostatic spark are prevented.

11.36.7 *Separators*

The separators used in manufacturing of battery cells shall be spun glass microporous Matrix having high acid absorption capability & resistant to battery grade Sulphuric acid along with good insulating properties. Sufficient separator overlaps and PVC shield protection to bottom edges of the plates is to be provided to prevent short circuit formation between the edges of adjacent plates.

11.36.8 *Pressure Regulation Valve*

Each cell shall be provided with a pressure regulation valve. The valve shall be self-re-sealable. The vent plug shall be made with suitable grade of fire retardant plastic material. Each valve opening shall be covered with flame barrier capable in preventing the ingress of flame into the cell interior when the valve opens and hydrogen / oxygen gas mixture is released. The valve unit shall be such that it cannot be opened without a proper tool.

11.36.9 *Terminal Posts*

Both the Positive and Negative terminals of the cells shall be capable of proper termination and shall ensure its consistency with the life of battery. The terminals shall have adequate solid copper core cross-section to avoid overheating at maximum current load. The surface of the terminal post extending above the cell cover including bolt hole shall be coated with an acid resistant and corrosion retarding material. Terminal posts or any other metal part which is in contact with the electrolyte shall be made of the same alloy as that of the plates or of a proven material that does not have any harmful effect on cell performance. Both Positive and negative terminal posts of VRLA Battery shall be colored Red and Black to make it unambiguously identifiable.

11.36.10 *Connectors, Nuts & Bolts, Heat Shrinkable Sleeves*

The connectors shall be non-corroding lead coated copper of suitable size to enable connections of cells. Copper connections shall be suitably lead coated to withstand corrosion due to Sulphuric acid/fumes. Nuts and bolts for connecting the cells shall be made of stainless steel with good acid resistant characteristics. All inter cell connectors shall be protected with heat shrinkable silicon sleeves for reducing the environmental impact including corrosive environment.

11.36.11 *Flame Arrestors*

Each cell shall be equipped with a Flame Arrestor to defuse the Hydrogen gas escaped during charge and discharge. Material of the flame arrestor shall not affect the performance of the cell.

11.36.12 *Capacity Requirements*

When the battery is discharged at 10-hour rate, it shall deliver 80% of C (rated capacity, corrected at 27º Celsius) before any of the cells in the battery bank reaches 1.85V/cell. The battery shall be capable of being recharged from the fully exhausted condition (1.75V/cell) within 10 hrs. up to 90% state of charge. All the cells in battery shall be designed for continuous float operation at the specified float voltage throughout the life. The capacity (corrected at 27ºCelcius) shall also not be less than C and not more than 120% of C before any cell in the battery bank reaches 1.75V/cell. The battery voltage shall not be less than the following values, when a fully charged battery is put to discharge at C/10 rate:

(a) After Six minutes of discharge: 1.98V/cell

(b) After Six hours of discharge: 1.92V/cell

(c) After 8 hours of discharge: 1.85V/cell

(d) After 10 hours of discharge: 1.75V/cell

Loss in capacity during storage at an average ambient temperature of 35º Celsius for a period of 6 months shall not be more than 60% and the cell/battery shall achieve 85% of its rated capacity within 3 charge/discharge cycles and full rated capacity within 5 cycles, after the storage period of 6 months. Voltage of each cell in the battery set shall be within 0.05V of the average voltage throughout the storage period. Ampere hour efficiency shall be better than 90% and watt-hour efficiency shall be better than 80%.

11.36.13 *Expected Battery Life*

The battery shall be capable of giving 1200 or more charge/discharge cycles at80% Depth of discharge (DOD) at an average temperature of 27º C.DOD (Depth of Discharge) is defined as the ratio of the quantity of electricity (in Ampere-Hour) removed from a cell or battery on discharge to its rated capacity. The battery sets shall have a minimum expected life of 20 years at float operation.

11.36.14 *Accessories along with Battery System*

Each battery shall be supplied with following accessories and devices:

- Torque Wrench.
- Cell Test Voltmeter (-3-0-+ 3) Volts with least count of 0.01 Volt

11.36.15 *Type Test of Battery*

The contractor/Supplier shall supply type tested battery per IS 15549: 2004/IEC60896-21 & 22 over the range of at least one capacity per design and should have met requirement of Service Life test as per above stated IEC standards within last seven years. The Contractor/Supplier shall submit necessary evidence enclosed along with tender documents.

- Gas Emission
- High Current Tolerance
- Short Circuit Current and DC internal resistance
- Protection against internal ignition from external spark source
- Protection against ground short propensity
- Content & durability of required marking
- Material Identification
- Valve Operation
- Flammability Rating of material

- Intercell connector performance
- Discharge Capacity
- Charge Retention during storage
- Float Service with daily discharge for reliable mains power
- Recharge behavior
- Service life at an operating temperature of 400 C for brief duration exposure time
- Impact of stress temperature of 60oC for brief duration exposure time with 3 hours discharge test
- Abusive Over discharge
- Thermal runway sensitivity

- Low temperature sensitivity
- Dimensional sensitivity at elevated internal pressure &temperature
- Stability against mechanical abuse of units during installation Test shall be conducted in accordance with IEC 60896-21 & 22,2004

11.36.16 *Routine Test of Battery*

- Physical examination test
- Visual Inspection
- Dimensions, Mass & Layout
- Marking & Packing

11.36.17 *Acceptance Test of Battery*

- Polarity Marking
- Verification of Dimensions
- Test of AH Capacity.

11.36.18 *Installation and Commissioning*

Manufacturer of battery shall supervise the installation as recommended in O&M manual/or relevant standards. All necessary instruments, materials, tools and tackles required for installation, testing at site and commissioning are to arranged by battery manufacturer/Contractors.

11.36.19 *Tests:*

All the acceptance tests as per relevant standards mentioned shall be carried out for batteries in presence of our inspecting officer free of cost. Type test certificates (not older than 7 years from the date of opening of tender) are to be submitted for approval of purchaser.

11.36.20 *Type Test Certificates:*

The tenderer will submit the complete type test certificates as per relevant standards mentioned (not older than 7 years from the date of opening of tender) for battery sets with their tenders, without which the offers are likely to be ignored.

11.36.21 *Accessories:*

Each battery set shall be supplied complete with all necessary accessories viz.stand, inter connections, cell no. Plates with sticker, multi meter complete with leads, spanners.

11.37 BATTERY CHARGER

The DC system for 220V DC is unearthed. The Battery Chargers as well as their automatic regulators shall be of static type and shall be compatible with VRLA batteries. All battery chargers shall be capable of continuous operation at the respective rated load in float charging mode, i.e. Float charging the associated Lead- Acid Batteries at 2.13 to 2.27 Volts per cell while supplying the DC load. The chargers shall also be capable of Boost charging the associated DC battery at 2.28 to 2.32 volts per cell at the desired rate.

Charger shall regulate the float/boost voltage in case of prescribed temperature rise of battery as per manufacturer's recommendation to avoid thermal runaway. Necessary temperature sensors shall be provided in mid location of battery banks and shall be wired up to the respective charger for feedback control. The manufacturer shall demonstrate this feature during testing of each charger. Each of the two chargers in this float-cum-boost charger for float mode & for boost mode shall be provided with independent transformer & associated circuitry.

The battery chargers shall be provided with facility for both automatic and manual control of output voltage and current. A selector switch shall be provided for selecting the mode of output voltage/current control, whether automatic or manual. When on automatic control mode during float charging the chargers output voltage shall remain within + 1% of the set value, for AC input voltage variation of + 1% frequency variation of + 5% a combined voltage and frequency variation of + 1% and a DC load variation from zero to full load.

All battery chargers shall have a constant voltage characteristic throughout the range (from zero to full load) at the floating value of the voltage so as to keep the battery fully charged but without harmful overcharge.

All chargers shall have load limiters having drooping characteristics, which shall cause, when the voltage control is in automatic mode, a gradual lowering of the output voltage whet eh DC load current exceeds the Load limiter setting of the Charger. The Load-limiter characteristics shall be such that any sustained overload or short circuit in DC system shall not charge the Charger nor shall it cause blowing of any of the Charger fuses. The Charger shall not trip on overload or external short-circuit.

Uniform and step less adjustments of voltage setting (in both manual and automatic modes) shall be provided on the front of the Charger panel covering the entire float charging output range specified. Step less adjustments of the Load-limiter setting shall also be possible from 80% to 100% of the rated output current for Charging mode.

During Boot Charging, the Battery Charger shall operate on constant current mode (when automatic regulator is in service). It shall be possible to adjust the Boost charging current continuously over a range of 50 to 100% of the rated output current for Boost charging mode.

The Charger output voltage shall automatically go on rising, when it is operating on Boost mode, as the Battery Chargers up. For limiting the output voltage of the Charger, a potentiometer shall be provided on the front of the panel, whereby it shall be possible to set the upper limit of this voltage anywhere in the output range specified for Boost Charging mode

The Charger manufacturer may offer an arrangement in which the voltage setting device for Float charging mode is also used as output voltage limit setting device for Boost charging mode and the Load-limiter of Float charging mode is used as current setting device in boost charging mode.

Suitable filter circuits shall be provided in all the chargers to limit the ripple content (Peak to Peak) in the output voltage to 1% irrespective of the DC load level, when they are not connected to a battery.

The charger shall be capable of delivering 20A in float mode & 30A in boost mode separately at rated voltage.

11.37.1 MCCB

All Battery Chargers shall have 2 Nos. MCCBs on the input side to receive cables from two sources. Mechanical interlock should be provided such that only one shall be closed at a time. It shall be of P2 duty and suitable for continuous duty MCCB’s should have auxiliary contacts for annunciation.

11.37.2 *Rectifier Transformer*

The rectifier transformer shall be continuously rated, dry air cooled (A.N) an of class F insulation type. The rating of the rectifier transformer shall have 10% overload capacity.

11.37.3 *Rectifier Assembly*

The rectifier assembly shall be fully/half-controlled bridge type and shall be designed to meet the duty as required by the respective charger. The rectifier shall be provided with heat sink having their own heat dissipation arrangements with natural air cooling. Necessary surge protection devices and rectifier type test acting HRC fuses shall be provided in each arm of the rectifier connections.

11.37.4 *Instruments*

One AC voltmeter and one AC ammeter along with selector switches shall be provided for all chargers. One DC voltmeter and DC ammeter (with shunt) shall be provided for all chargers. The instruments shall be flush type, dust proof and moisture resistant. The instruments shall have easily accessible means for zero adjustment. The instruments shall be of 15 accuracy class. In addition to the above a centre zero voltmeter with selector switch shall also be provided for 220 V Chargers for testing purpose.

11.37.5 *Air Break Switches*

One DC output switch shall be provided in all chargers. They shall be air break type suitable for 500 Volts AC/ 250 DC. The contacts of the switches shall open and close with a snap action. The operating handle of the switch shall be fully insulated from circuit. ‘ON’ and ‘OFF’ position on the switch shall be clearly indicated. Rating of switches shall be suitable for their continuous load. Alternatively, MCCB’s of suitable ratings shall also acceptable in place of Air Break Switch.

11.37.6 *Fuses*

All fuses shall be HRC Link type. Fuses shall be mounted on fuse carriers which are in turn mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type base. In such case one insulated fuse pulling handle shall be supplied for each charger. Fuse rating shall be chosen by the Bidder depending on the circuit requirement. All fuses in the chargers shall be monitored. Fuse failure annunciation shall be provided on the failure of any fuse.

11.37.7 *Blocking Diode*

Blocking diode shall be provided in the positive pole of the output circuit of each charger to prevent current flow from the DC battery into the charger.

11.37.8 *Annunciation System*

Audio-visual indications through bright LEDs shall be provided in all Chargers for the following abnormalities: -

- AC Power failure.
- Rectifier/chargers fuse blown.
- Over voltage across the battery when boost charging.
- Abnormal voltage (High/Low)
- Any other annunciation if required

Potential free NO contacts of above abnormal conditions shall also be provided for common remote indication “CHARGER TROUBLE” in Owner’s Control Board. Indication for charger in float mode and boost mode through indication lamps shall be provided for chargers. A Potential free contact for float/boost mode shall be provided for external interlocks.

11.37.9 *Name Plates and Marking*

The name plates shall be white with black engraved letters. On top of each Charger, on front as well as rear sides, larger and bold name plates shall be provided to identify the Charger. Name plates with full and clear inscriptions shall also be provided on and inside of the panels for identification of the various equipment’s and ease of operation and maintenance.

11.37.10 *Charger Construction*

The Chargers shall be indoor, floor-mounted, self-supporting sheet metal enclosed cubicle type. The Contractor shall supply all necessary base frames, anchor bolts and hardware. The Chargers shall be fabricated from 2.0mm cold rolled sheet steel and shall have folded type of construction. Removable gland plates for all cables and lugs for power cables shall be supplied by the Contractor. The lugs for power cables shall be made of electrolytic copper with tin coat. Power cable sizes shall be advised to the Contractor at a later date for provision of suitable lugs and drilling of gland plates. The hanger shall be tropicalized and vermin proof. Ventilation louvers, if provided shall be backed with screens. All doors and covers shall be fitted with synthetic rubber gaskets. The chargers shall have hinged double leaf doors provided on front and on backside for adequate access to the Charger’s internals. All the charger cubicle doors shall be properly earthed. The degree of protection of Charger enclosure shall be at least IP-42 as per IS: 13947 Part

-1.

All indicating instruments, control switches and indicating lamps shall be mounted on the front side of the Charger.

Each Charger shall be furnished completely wired up to power cable lugs and terminal blocks and ready for external connections. The control wiring shall be carried out with PVC insulated, 1.5 sq.mm. stranded copper wired. Control terminals shall be suitable for connecting two wires, with 2.5 sq.mm stranded copper conductors. All terminals shall be numbered for ease of connections and identification. Each wire shall bare a ferrule or tag on each end for identification. At least 20% spare terminals shall be provided for control circuits.

The insulation of all circuits, except the low voltage electronic circuits shall withstand test voltage of 2 KV AC for one minute. An air clearance of at least ten (10) mm shall be maintained throughout for such circuits, right up to the terminal lugs. Whenever this clearance is not available, the live parts shall be insulated or shrouded.

11.37.11 *Painting*

All sheet steel work shall be pre-treated in tanks, in accordance with IS:6005Degreasing shall be done by alkaline cleaning. Rust and scale shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be 'Class-C' as specified in IS:6005. Welding shall not be done after phosphating. The phosphating surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint of shade -692 (smoke grey) of IS-5 shall be applied, unless required otherwise by the Owner. The inside of the chargers shall be glossy white. Each coat of finishing synthetic enamel paint shall be properly staved. The paint thickness shall not be less than fifty (50) microns.

11.37.12 *Tests*

Battery Chargers shall conform to all type tests as per relevant Indian Standard Performance test on the Chargers as per Specification shall also be carried out on each charger as per specification. Rectifier transformer shall conform to all type tests in IS:4540 and short circuit test as per IS:2026. Following type tests shall be carried out for compliance of specification requirements: -

- Voltage regulation test.
- Load limiter characteristics test
- Efficiency tests
- High voltage tests
- Temperature rise test
- vi) Short circuit test at no load and full load at rated voltage for sustained
- Short-circuit.
- vii) Degree of protection test

- viii) Measurement of ripple by oscilloscope.
- ix) Temperature compensation feature demonstration

The contractor may be required to demonstrate to the OWNER that the chargers conform to the specification particularly regarding continuous rating, ripple free output, voltage regulation and load limiting characteristic, before dispatch as well as after installation at site. At site the following tests shall be carried out: -

- Insulation resistance test
- Checking of proper annunciation system operation

If a Charger fails to meet the specified requirements, the Contractor shall replace the same with appropriate Charger without affecting the commissioning schedule of the Sub-Station, and without any extra cost to the OWNER.

The Contractor shall present for inspection, the type and routine test certificates for the following components whenever required by the OWNER.

- Switches
- Relays/MCCBs
- Instruments
- DC fuses
- SCR
- Diodes
- Condensers
- Potentiometers
- Semiconductor
- Annunciator
- Control wiring
- Push buttons and contactors
- Makes of above equipment shall be subject to Owner's approval.

11.38 TECHNICAL SPECIFICATION FOR L.T CABELS

11.38.1 *General*

L.T. Cables shall be supplied, inspected, laid tested and commissioned in accordance with drawings, specifications, relevant Indian Standards specifications and cable manufacturer's instructions. The cable shall be delivered at site in original drums with manufacturer's name clearly written on the drums. The recommendations of the cable manufacturer with regard to jointing and sealing shall be strictly followed.

11.38.2 *Materials*

The L.T. Power cables shall be XLPE insulated PVC sheathed type Aluminium conductor Armoured cable conforming to IS : 7098 : 1988 (Part-I) with up to date amendments whereas control cable shall be XLPE insulated and PVC sheathed copper conductor Armoured/ Unarmoured cable conforming to IS:7098 (Part-I) 1988.

11.38.3 *Installation of Cables*

Cables shall be laid directly in ground, pipes, masonry ducts, on cable tray, surface of wall/ceiling etc. as indicated on drawings and/or as per the direction of Engineer-In-Charge. Cable laying shall be carried out as per CPWD specifications.

11.38.4 *Inspection*

All cables shall be inspected at site and checked for any damage during transit.

11.38.5 *Joints In Cables*

The Contractor shall take care to see that the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilization and avoiding of cable joints. This apportioning shall be got approved from Engineer-In-Charge before the cables are cut to lengths.

11.38.6 *Laying Cables in Ground*

Cables shall be laid by skilled experienced workmen using adequate rollers to minimize stretching of the cables. The cable drums shall be placed on jacks before unwinding the cable. With great care it shall be unrolled on over wooden rollers placed in trenches at intervals not exceeding 2 meters. Cables shall be laid at depth of 0.75 meters below ground level. A cushion of sand total of 250mm shall be provided both above and below the cable, joint boxes and other accessories. Cable shall not be laid in the same trench or alongside a water main.

The cable shall be laid in excavated trench over 80mm layer of sand cushion. The relative position of the cables, laid in the same trench shall preserved. At all changes in direction in horizontal and vertical planes, the cables shall be bent smooth with a radius of bent not less than 12 times the diameter of cables. Minimum 3-meter-long loop shall be provided at both end of cable.

Distinguishing marks may be made on the cable ends for identifications of phases. Insulation tapes of appropriate voltage and in red, yellow and blue colors shall be wrapped just below the sockets for phase identifications.

11.38.7 *Protection Of Cables*

The cables shall be protected by bricks laid on the top layer of the sand for the full length of underground cable. Where more than one cables is laid in the same trench, the bricks shall cover all the cables and shall project a minimum of approximately 80mm on either side of the cables. Cable under road crossings and any other places subject to heavy traffic, shall be protected by running them through Hume Pipes of suitable size.

11.38.8 *Excavation & Back Fill*

All excavation and back fill required for the installation of the cables shall be carried out by the Contractor in accordance with the drawings and requirements laid down elsewhere. Trenches shall be dug true to line and grades. Back fill for trenches shall be filled in layer not exceeding 150mm. Each layer shall be properly rammed and consolidated before laying the next layer.

The Contractor shall restore all surface, roadways, sidewalks, kerbs wall or the works cut by excavation to their original condition to the satisfaction of the Engineer-In-Charge.

11.38.9 *Laying Of Cables On Cable Tray/Surface Of Wall/Ceiling*

Cable shall be laid on perforated M.S. Cable tray. Cables shall be properly dressed before cable ties/clamps are fixed. Wherever cable tray is not proposed, cables shall be fixed on surface of wall or ceiling slab by suitable MS clamps/ saddles. Care shall be taken to avoid crossing of cable.

11.38.10 *Cables On Hangers or Racks*

The Contractor shall provide and install all iron hanger's racks or racks with die cast cleats with all fixings, rag bolts or girder clamps or other specialist fixing as required.

Where hangers or racks are to be fixed to wall sides, ceiling and other concrete structures, the Contractor shall be responsible for cutting away, fixing and grouting in rag bolts and making good.

The hangers or racks shall be designed to leave at least 25mm clearance between the cables and the face to which it is fixed. Multiple hangers shall have two or more fixing holes. All cables shall be saddled at not more than 150mm centers. These shall be designed to keep provision of some spare capacity for future development.

11.38.11 *Cables Tags*

Cable tags shall be made out of 2mm thick Aluminium sheets, each tag 1-1/2 inch in dia with one hole of 2.5mm Dia, 6mm below the periphery. Cable designations are to be punched with letter/number punches and the tags are to be tied inside the panels beyond the glanding as well as below the glands at cable entries. Trays tags are to be tied at all bends. On straight lengths, tags shall be provided at every 5 meters / at both ends only.

11.38.12 *Testing Of Cables*

Prior to installation, burying of cables, following tests shall be carried out. Insulation test between phases, phase & neutral, phase & earth for each length of cable.

a. Before laying.

b. After laying.

c. After jointing.

On completion of cable laying work, the following tests shall be conducted in the presence of the Engineer-In-Charge.

a. Insulation Resistance Test (Sectional and overall).

b. Continuity Resistance Test.

c. Earth Test.

All tests shall be carried out in accordance with relevant Indian Standard code of practice and Indian Electricity Rules. The Contractor shall provide necessary instruments, equipment's and labour for conducting the above tests & shall bear all expenses of conducting such tests.

11.39 TECHNICAL SPECIFICATION FOR CABLE TRAY

The cable tray shall be fabricated out of slotted/perforated MS sheets as channel, sections, single or double bended. The channel sections shall be supplied in convenient lengths and assembled at site to the desired lengths. These may be galvanized or painted to the desired lengths. Alternatively, where specified, the cable tray may be fabricated by two angle irons of 50mm x 50mm x 6mm as two longitudinal members, with crosses bracings between them by 50mm x 5mm flats welded/bolted to the angles at 1 m spacing. 2mm thick MS perforated sheet shall be suitably welded/bolted to the base as well as on the two sides.

Typically, the dimensions, fabrication details etc. are shown in CPWD General Specification for Electrical Works - Part II -External, 1994.

The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with 8mm Dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler plates and cable tray shall be scraped and removed before the installation.

The maximum permissible uniformly distributed load for various sizes of cables trays and for different supported span are as per CPWD General Specification of Electrical Work Part II -1994. The sizes shall be specified considering the same.

The width of the cable tray shall be chosen so as to accommodate all the cable in one tier, plus 30 to 50% additional width for future expansion. This additional width shall be minimum 100mm. The overall width of one cable tray shall be limited to 800mm.

Factory fabricated bends, reducers, tee/cross junctions, etc. shall be provided as per good engineering practice. Details are typically shown in figure 3 of CPWD General Specification of Electrical Work Part-II -1994. The radius of bends, junctions etc. shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

The cable tray shall be suspended from the ceiling slab with the help of 10mm Dia MS rounds or 25mm x 5mm flats at specified spacing as per of CPWD General Specification of Electrical Work Part II -1994. Flat type suspenders may be used for channels up to 450mm width bolted to cable trays. Round suspenders shall be threaded and bolted to the cable trays or to independent support angles 50mm x 50mm x 5mm at the bottom end as specified. These shall be grouted to the ceiling slab at the other end through an effective means, as approved by the Engineer-In-Charge, to take the weight of the cable tray with the cables.

The entire tray (except in the case of galvanized type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.

The cable tray shall be bonded to the earth terminal of the switch boards at both ends.

The cable trays shall be measured on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross joints, etc., and paid for accordingly.

Cable laid on cable tray shall be clamped on the tray at suitable intervals as per CPWD specifications.

11.40 TECHNICAL SPECIFICATION OF 11 KV SWITCHGEAR PANELS VACUUM TYPE (2000A)

11.40.1 *Scope:*

This specification covers the design, manufacture, assembly, testing at manufacturer's works before dispatch, supply and delivery F.O.R. destination as per schedule of requirement of Vacuum Type, 15 Panel 11 kV Switch boards including 11kV Bus Sectionalizer having normal current rating of 2000 Amps. with rupturing capacity of 500 MVA.

Note: Signals from protection relays in 11kV Incomer would be wired to substation automation system (SAS).

11.40.2 *Standards:*

The switchgear panels shall comply in all respects the requirement laid down in the latest editions of IS: 13118-1991, IS: 3427 & IS: 3231.

11.40.3 *Climatic Conditions:*

Refer Climate conditions defined in technical document in previous sections

11.40.4 *Auxiliary Power Supply:-*

Auxiliary electrical equipment shall be suitable for operation on the following supply system: -

a) Power devices:415 V, 3 phase 4 wire 50Hz, neutral grounded AC supply (like drive motors)

b) DC alarm, control and protective devices :220V DC, underground 2 wires for 220 KV 132 KV & 66 KV Sub-Station

c) Lighting:245 V, single phase, 50 Hz AC Supply.

Each of the foregoing supplies shall be made available by the purchaser at the terminal point for each circuit breaker for operation of accessories and auxiliary equipment. Bidders scope include supply of interconnecting cables terminal boxes etc. The above supply voltage may vary as below and all devices shall be suitable for continuous operation over the entire range of voltages.

i) AC Supply voltage + 10% & -15 %, frequency ± 5%

ii) DC Supply ± 10%

11.40.5 *Type & Rating:*

The panels 11 kV switchgear panels shall comprise of 11 kV Vacuum Type circuit breakers, instrument panels and instrument transformers etc. suitable for indoor use. The equipment shall be totally enclosed in a metal clad cubicle, dust and vermin proof with necessary isolation arrangement. Each panel shall be easily extensible on either side and should be complete with necessary internal copper connections, small wiring, L.T. fuses and supporting frame work with bolts to secure it to the floor. The Circuit Breakers shall be draw out type in horizontal position.

11.40.6 *Principal Parameters*

The breakers shall have the following ratings:

Type Vacuum

No of poles 3

Nominal system voltage11 kV

Highe stsystem voltage 12 kV

Rated frequency 50 +/-1.5Hz

Rated continuous current:2000 Amp for incoming & Bus Sectionalizer and 400rating at an ambient Amp for outgoing feeders.

temp. as specified inIS:13118-1991

(Latest edition)

Symmetrical breaking 500 MVAcapacity

Impulse with stand test 75 kV (Peak)voltage

One minute power 28 kV (rms)frequency withstand

test voltage

Short time current Not lessthan26.2kAcurrent

rating corresponding to500 MVAfor1sec.

System neutral Solidly earthed.

11.41 GENERAL DESIGN OF SWITCHGEAR PANELS:

11.41.1 *Operating Mechanism:*

The vacuum type circuit breaker shall be draw out type. The VCBs shall be suitable for operation from 220 V DC auxiliary supply. The operating mechanism shall be motor operated spring charged type. There shall be provision(s) for manual charging of closing spring and emergency hand trip. The motor used for the purpose will be suitable for 240 V AC as well as for 220 V DC.

The operating mechanism shall work satisfactorily at 85 % - 110 % of rated supply voltage. The VCB shall have 2 normally open & 2 normally-closed auxiliary contacts over & above the ones required for various control & supervision circuits.

11.41.2 *Instrument Panels:*

Each unit shall have its own instrument panel provided at the top & complete with small wiring connections from relays, instrument transformers, metering instruments, indicating instruments, selector switches & circuit breaker control switch. All wiring shall be carried out by using stranded single annealed copper conductor insulated with poly vinyl chloride insulation suitable for 650 V service and in accordance with IS:732-1963. CT/PT circuit shall use wire of not less than 4.0 mm2 cross-sectional area whereas control/alarm/supervision circuit shall use wire of not less than 2.5 mm2 cross-sectional area.

All wires will be continuous from one terminal to the other and, also will have no Tee-junction enroute. The connections shall be securely made with the help of connecting lugs duly crimped on to the copper conductor. The meters and relays shall be mounted in a convenient position so as to be readily accessible for inspection or repair. The terminal board provided in the instrument panel of VCBs will be made of moulded dielectric having brass studs, washers, holding nuts & locking nuts. All holding nuts shall be secured by locking nuts. The connection studs shall project 6 mm from the lock nut surface. NO OTHER TYPE OF TERMINAL BOARD IS ACCEPTABLE. The panels shall have a degree of protection of IP-4x. The leads from metering CTs shall be directly terminated at TTB & there from at the KWH meter/SEM with a provision to seal TTB and KWH meter/SEM. The said CT leads will be concealed to prevent their tempering enroute. Similarly PT leads from secondary box of the PT to TTB & there from to energy meter including inter panel PT leads will also be concealed to prevent their tempering. The mode & extent of concealing the metering leads of CTs & PTs to prevent their tempering (by unscrupulous operating personnel) will be discussed & mutually agreed upon with the successful bidder(s). TTB used on the instrument panel should be suitable for front connections.

Earthing of current free metallic parts or metallic bodies of the relays/switches mounted on the instrument panel and metal enclosed switchgear shall be done by a suitably sized copper conductor. Earth bus made of 25x3 mm bare copper flat will be extended through entire length of 11 kV switch-board with suitable provision to connect it to the sub-station earth at the extremities. The earthing arrangement will meet with the requirements laid down in IS : 3427 read with its latest amendment.

11.41.3 *Vacuum Interrupter:*

The Vacuum interrupter of 12 kV minimum 26.2 kA short time current rating, 2000 Amp. normal current rating capable of withstanding minimum 100 full short circuit operations as per test duty 1 to 5 of IEC-56. Vacuum Interrupters for incomers & Bus Sectionalizer as well as outgoing shall be of same type. These vacuum interrupters shall be of approved make only.

11.41.4 *Instrument Transformer:*

The secondary voltage & current rating of the instrument transformers shall match with the metering or protective equipment. The CTs shall have ratio & accuracy class as mentioned in the schedule of requirement. The CTs shall be wound/ring type in accordance with their ratings. The terminal boards associated with differential CTs, REF CTs & over current/earth fault protection CTs will be of disconnecting type having short circuiting facility &thus facilitate secondary testing of concerned protective relay without disturbing the associated small wiring. Inter- changeability of housing of CTs from one panel to another must be ensured.

A resin cast potential transformers shall be provided on the Incoming side of each panel set & shall be star/star connected as per attached Schedule of Requirement.

The neutral point of star connected secondary windings of instrument transformers shall be earthed to the main earth bus referred to in the concluding paragraph. Multiple earthing of any instrument transformers shall be avoided.

11.41.5 *Bus - Bars:*

All the panels shall be provided with one set of 3 phase 2000 Amps. heat shrunk PVC Sleeves insulated Main electrolytic copper bus bars for all switchboards and shall be connected in a separate moisture and vermin proof sheet metal chamber. The bus-bars connections & insulator supports shall be mechanically strung & rigidly supported so as to withstand the stresses generated by vibrations, variations in temperature and due to severe short circuits.

The bus bars shall be Heat shrunk PVC Sleeves insulated type and supported on insulators at short intervals keeping adequate clearance as per IE rules between bus bars and earth. The bus bar chamber shall be provided with inspection covers with gaskets & bus bar shutters. Provision shall be made for future extension of bus bar & switch board.

11.41.6 *Limit Of Temperature Rise:*

The temperature rise of the current carrying parts shall not exceed the permissible limits above the ambient temperature as per relevant standards (latest edition). However, the reference maximum ambient temperature may be taken as 500C.

11.41.7 *Bushing Insulators:*

These shall comply with the latest issue of IS : 2099 in all respects.

11.41.8 *Disconnectors Of Circuit Breaker & Their Interlocks:*

All disconnectors (isolators) of the 11 kV VCBs & interlocks between different pieces of apparatus provided for reasons of safety & for convenience of operation of switchgear shall meet with the requirement of

IS:3427-1969 read with its latest amendment. Efficient mechanical interlocking shall be provided to meet the following conditions

- It shall be possible to insert/withdraw the breaker only after circuit breaker has been opened.
- It shall be possible to insert/withdraw the breaker only when it is fully open position as well as it is in Isolated/test position.
- It shall not be possible to remove the breaker until the moveable plug unit having secondary connections has been withdrawn.
- It shall not be possible to replace in position moveable plug unit unless the circuit breaker has been racked in.
- Provision of shutters or locks shall be made to prevent access to bus bar chambers and receptacles when the circuit breaker is withdrawn.
- Provision shall be made for locking the circuit breaker closing mechanism in open position.
- Provision shall be made for locking the circuit breaker closing mechanism of Bus Sectionalizer when it is charged from one side only i.e. either from bus side or outgoing side.

11.41.9 *Cable Boxes*

Each 11 kV incoming VCB shall be provided with cable boxes suitable for receiving 2 sets of cable each comprising 3 nos 1000mm2, 11 kV single core XLPE, outer PVC sheathed cables. Accordingly, joining kits and sealing material shall be provided for 2 sets of cables. The 11kV Capacitor controlling VCB (panel with CT ratio 800-400/5A) shall be provided with 2 sets of cable boxes suitable to receive 2x3 core 11kV XLPE PVC sheathed cable of size up to 400mm2. The 11 kV station transformer VCB shall be provided with cable boxes suitable to receive 3 core, 11 kV, XLPE cables of size up to 50 mm2 (panel with CT ratio 60-30/5 A). Each cable box shall have vertical entry from below. These cable boxes shall be complete in all respects including cable glands of requisite size. The cable boxes should only be either heat shrinkable or push on type. The cable boxes for outgoing panels are not in the scope of this specification.

11.41.10 *Earthing Truck:*

One no. earthing trolley should be provided for each incomer panel. Earthing trolley must be full fault make type device which is capable of making fault at 65.5 KA(peak) and carry 26.2 KA for one second. The earthing truck for incoming panel must be so designed that it is impossible to earth a live circuit.

11.41.11 *Supervision Scheme:*

Instrument panels on each of the 11 kV VCB covered by this specification shall be provided with the following indicating lamps/relay: -

- Circuit breaker `open' Green
- Circuit breaker `close' Red
- Auto trip White
- Circuit breaker spring charged Blue

For monitoring of trip circuit both in pre-close and post- close position of the circuit breaker, 1 no. automatic trip circuit supervision relay will be provided on each of the 11 kV (incoming) instrument panel. In case of trip circuit becoming faulty, the operation of this relay shall be accompanied by visual and audio annunciation in accordance with clause 5.10.1 of the specification.

However, the trip circuit of each of the 11 kV outgoing/bus Sectionalizer /capacitor/Stn. VCB will be monitored `on demand' with the help of an indicating lamp & a push button both when the VCB is `open & closed'. The lamp will be `amber' coloured.

Circuit breaker `close' & `open' lamps will be wired so as to be on 240 V AC under `normal' condition. These lamps will be switched over to 220 V DC automatically in the event of failure of 240 V AC supply. Each of 11 kV (incoming) instrument panel will be equipped with a suitable relay for the purpose.

11.41.12 *Alarm Scheme:*

11.41.12.1 Non-Trip Alarm Scheme:

Each of 11 kV (incoming) panel will be provided with a non-trip alarm scheme comprising suitable auxiliary relay (rated for 220 V DC), accept push button, reset push button & a buzzer. It will cater to non-trip condition such as trip circuit faulty & PT secondary fuses blow `off'. The non-trip alarm scheme will meet with the following requirements: -

- The closing of an initiating contact shall actuate a buzzer and will be accompanied by a flag indication on the concerned auxiliary relay.

- The closing of an initiating contact shall glow a lamp which will not reset until the fault has cleared.
- It shall be possible to silence the buzzer by pressing `accept' push button. If after cancelling the alarm but before resetting the visual signal, the same fault persists the buzzer shall be suppressed.
- If after canceling the alarm but before resetting visual signal some other fault takes place, the alarm accompanied by flag indication on appropriate auxiliary relay shall take place.
- If after canceling the alarm and after resetting the visual signal, the same fault appears or some other fault take place, the alarm, flag indication and non-trip lamp indication shall reappear as usual.
- The non-trip alarm acceptance shall be by means of a push button and resetting of visual signal may also preferably be done through a push button.
- Means shall be provided for test checking the lamp and alarm circuit at frequent intervals.
- The equipment shall be suitable for 220 Volts DC operation.

11.41.12.2 Trip Alarm Scheme:

Trip commands due to operation of protective relay on any of 11 kV VCB constituting the switchboard will trip the concerned VCB. Its auxiliary contact will actuate a bell (provided in each of the 11 kV incoming VCB) & will be cancelled by the associated circuit breaker control handle. Auto trip lamp will glow on the concerned 11 kV VCB & there will be flag indication on the concerned protective relay.

11.41.12.3 Pt Fuse Fail Alarm Scheme:

Each of the 11 kV (incoming) instrument panel is to be provided with a relay to monitor the fuses on the secondary side of 11 kV metering PT. The failure of any of secondary fuse on the 11 kV PT will be accompanied by visual & audio indication in accordance with clause 5.10.1 of the specification. None of the 11 kV outgoing/capacitor/Stn. VCB will be provided with fuses & inter-circuit PT leads may run from one bus wire board to the other.

11.41.13 *Metering Scheme:*

Each of the 11 kV VCB will be provided with a suitably sealed ammeter (additional dials, if any, required to cover all the taps of the CTs shall be included at the time of bidding) with a selector switch facilitating measurement of phase currents as well as unbalance current. The coil of ammeter shall be rated for 5 Amp.

The instrument shall be of moving iron spring-controlled type of industrial grade `A' classification having accuracy class 1.0 & shall conform to IS:1248(1968).

Each of the 11 kV (incoming) VCB will be provided with a suitably sealed voltmeter with a selector switch. The selector switch shall facilitate the measurement of phase to phase & phase to neutral voltage of all the three phases one by one. The coil of the voltmeter shall be rated for 110 V (phase to phase). The instrument shall be of moving iron spring-controlled type of industrial grade `A' classification with accuracy class 1.0 & shall conform to IS:1248(1968).

Each of the 11 kV VCB except the 11 kV capacitor VCB & Incomer VCBs will be equipped with a three-phase four-wire Electronic KWH meter. 11kV incomer VCB will be equipped with SEM.

Each of the 11 kV (incoming) VCB will be provided with a power factor meter. The PF meter having a range of 0.5Lag - one - 0.5lead shall be of 2 element type suitable for use on three phase three wire unbalanced system. It shall be rated for 5 A CT secondary & 110 V (phase to phase) available from 11 kV PT mounted on each of the 11 kV incoming VCB. The instrument shall be iron-cored dynamometer type having accuracy class 1.0.

N.B. Routine test certificates of all the indicating & integrating instruments will be submitted along with the routine test certificates of 11 kV switchgear.

11.41.14 *Control Scheme:*

- The instrument panel of each of the 11 kV VCB will be equipped with a circuit breaker control handle of pistol grip type with spring return to neutral position and having bell alarm cancellation contacts. The control handle shall be so designed that after being operated to `close' a VCB the operation cannot be repeated until the control handle has been turned to `trip' position making it impossible to perform two closing operation consecutively.

- The rating of the control handle shall be suitable for the duty imposed by the closing and opening mechanism of VCB. The moving and fixed contacts shall be of such a shape & material to ensure good contact and long life under service operating duty. All contacts shall be readily renewable.

- The number of contacts in the control handle will be decided by the bidder keeping in view the requirements of this specification. Two pairs of contacts shall be kept spare. The total number of contacts proposed to be provided shall be stated in the bid.

- Safety against inadvertent operation due to light touch on the control handle shall be ensured.

11.41.15 *Protection Scheme:*

11.41.15.1 For Incoming Panels:

The backup protection shall be in the form of a combined over current and earth fault relay (two over current and one earth fault). The relay shall be housed in draw out flush mounting case.

This shall be triple pole having Inverse Definite Minimum Time (IDMT) characteristics with a 3/10-time current curve i.e. the relay operating time shall be 3 second at 10 times the plug setting at TMS 1. The outer element of the relay shall be arranged for over current protection and shall have a setting range of 50-200 % of 5 A (The relay for station transformer shall have a setting range of 20-80 % of 5 A) and adjustable in suitable equal steps by means of a plug board. The central element shall be used for earth fault protection with a setting range of 20-80 % of 5 A adjustable in suitable equal steps by means of a plug board (for station transformer panels, the setting range shall be 10-40% of 5 A) Each of the three elements shall be fitted with shunt reinforcing unit with hand reset operation indicator.

11.41.15.2 For Outgoing Feeders & Bus Sectionalizer Panels:

Each outgoing feeder panel shall be provided with a triple pole IDMTL type combined over current and earth fault relay (two over current and one earth fault element) conforming to the technical specification stated in the clause above and one set of triple pole instantaneous relay (high set element) in the form of two over current and one earth fault element.

The outer element of the relay shall be arranged for over current protection and shall have a setting range of 500-2000 % of 5 A (The relay for station transformer shall have a setting range of 200-800 % of 5 A) and adjustable in suitable steps.

The central element shall be used for earth fault protection with a setting range of 200-800 % of 5 A (The relay for station transformer shall have setting range of 100-400 % of 5 A) adjustable in suitable steps.

The relay shall have low transient over reach with a high pick-up/ drop of ratio. The relay will be connected in series with the triple pole combined over-current and earth fault relay referred to above and shall be so wired so as to take this (instantaneous) out, if so desired by the purchaser at any time during operation of the equipment.

11.41.15.3 For Capacitor Panel:

Each capacitor panel shall be provided with the following relays for protection of capacitor banks: -

- Triple pole non-directional IDMTL type combined over current & earth fault relay (two over current & one earth fault element) conforming to the technical specification stated above.

- 1 no. inverse time over voltage relay with setting range 100 % to 130 % of 110 V available from 11 kV PT mounted in the 11 kV (incoming) VCB along with auxiliary transformers (for external mounting) of ratio 110/103.5 to 116.5 V (in steps of one volt) to be used for compensating the error of over voltage relay.

- 1 no. inverse time under voltage relay with setting range of 50 % to 90 % of 110 V (phase to phase connections).

- 1 no. neutral displacement rely with settings 5.4, 7.5, 12.5 & 20 volts and to be fed from open delta winding of three phase (11000//3/ (110//3) Volts. Residual voltage transformer (Residual voltage transformer is not a part of this specification). The bidders offering relays with different settings than above shall technically justify their offer.

- 10-minute timer to ensure that the capacitor bank is fully discharged once it has been switched "OFF" before it can be switched "ON" again.

11.41.16 *Communication Compatibility of Relays*

All relays shall conform to the requirements of IS:3231/IEC-60255/IEC 61000 or other applicable standards. Relays shall be suitable for flush or semi-flush mounting on the front with connections from the rear. All protective relays shall be in draw out or plug-in type modular cases with proper testing facilities. Necessary test plugs/test handles shall be supplied loose and shall be included in contractor’s scope of supply.

All main protective relays (viz over current and earth fault, Restricted Earth Fault, over voltage and neutral displacement) shall be numerical type and communication protocol shall be as per IEC 61850. Further, the test levels of EMI as indicated in IEC 61850 shall be applicable to these.

For numerical relays, the scope shall include the following:

- Necessary software and hardware to up/down load the data to/from the relay from/to personal computer installed in the substation. However, the supply of PC is not covered under this clause.

- The relay shall have suitable communication facility for future connectivity to SCADA. The relay shall be capable of supporting IEC 61850 protocol (with optical port).

N.B. The relay shall be suitable for 220 V DC auxiliary supply. The relay cover & case shall be dust proof, water proof & vermin proof. Operating indicators shall be provided on all protective relays/ on their immediate auxiliary units to indicate the type of fault & phase/phases involved. It shall be possible to reset the operation indication without opening the relay case. The routine test certificates of all protective & auxiliary relays will be submitted along with routine test certificates of 11 kV switchgear covered by the specification.

11.41.17 *D.C. Fail Alarm Scheme:*

A suitable relay for monitoring the DC supply to the 11 kV switchboard shall be mounted on each of the 11 kV incoming instrument panel. The operation of DC fail scheme shall be accompanied by visual (indicating lamp on the instrument panel) & audio (ringing of hooter) annunciation. It shall be possible to silence the hooter by pressing the `accept' push button while the lamp shall continue to glow till the fault has been attended to & DC supply restored. A DC fail `Test' push button may be provided to test the lamp circuit of the scheme.

11.41.18 *Interlocking Features:*

In order to ensure proper operation and to prevent dangerous situations and maloperation, a series of interlocks must be provided to protect the operators and the switchgear itself. Fundamentally, the protection against maloperation is to be affected by software in the panel unit.

Electromechanical or software-based interlocking is acceptable.

The following interlocking dependencies must be provided:

- Limit position blocking of the switching devices
- Interdependence of disconnector and earthing switch in the same panel
- Interdependence of the disconnector and the circuit breaker in the same panel
- Interdependence of the circuit breaker and the earthing switch in the same panel
- Dependence of the disconnector on the bus Sectionalizer circuit breaker and vice versa.

11.42 TEST

All routine tests shall be carried out in accordance with IS: 13118-1991 (latest edition thereof).

11.42.1 *Type of Tests*

a) The equipment offered should be type tested. Type test report should not be more than seven years old, reckoned from the date of bid opening, in respect of the following tests, carried out in accordance with ISS-13118/IEC-56, from Govt./ Govt. approved test house, shall be submitted along with bid:

- Impulse with-stand voltage tests.
- Power frequency voltage dry & wet tests on main circuits.
- Short circuit with stand capability tests.
- Mechanical endurance tests.
- Temperature rise test

However Mechanical endurance tests and Temperature rise test conducted at Firm’s works in the presence of representative of any of the SEBs/State Power Utilities shall also be acceptable.

The remaining type test report as per clause 6.0 of ISS-13118/IEC-56 shall be submitted by the successful bidder within three months from the date of placement of Purchase Order. These type test reports will also be from Govt./ Govt. approved test house & shall not be more than seven years old reckoned from the date of placement of order.

The type test report of Voltage transformers & current transformers as per latest version of IS: 3156 & IS:2705 respectively shall be submitted along with the bid.

The type test report of relays as per ISS:3231 (latest)/IEC-60255 & conformance test as per IEC:61850 shall be submitted along with bid.

b) The 11 kV VCB & associated CTs & PTs shall be subjected to routine tests as specified in the latest version of the relevant ISS in the presence of purchaser's representative, if so desired by the purchaser. The routine test certificates of bought out components such as relays, switches, indicating instruments, KWH Meter & SEM will also be presented to SPV's inspecting officer who will forward them to the purchaser along with his inspection report for the main equipment. All test reports should be got approved from the purchaser before dispatch of equipment.

11.43 DRAWINGS:

In addition to any other drawing which the tenderer may like to furnish to explain the merits of his proposal, following drawings shall be submitted with the tender in quadruplicate:

- Principal dimensional details of 11 kV Switchgear.
- General arrangement of 15 Panel 11kV switchboard including its foundation details.
- Schematic drawings of control, metering & protection circuits in respect of 11kV incoming VCB, 11kV Bus Sectionalizer, 11kV outgoing VCB including station transformer VCB & 11 kV capacitor VCB along with detailed write-up.
- Drawing showing height of 11 kV bus bars & arrangement of bus bars v Vacuum interrupter drawing.

The successful bidder shall submit final version of drawings complete in all respects in quadruplicate within 15 days of placement of order for purchaser's approval. The purchaser shall communicate his comments/ approval on the drawings to the supplier within one month of their receipt. The manufacturer shall, if so required by the purchaser, modify the drawings and resubmit the same for purchaser's approval within two weeks of receipt of comments. Such duly revised drawings will be approved by the purchaser within two weeks of their receipt.

After receipt of purchaser's approval to drawings, the manufacturer will submit five sets of all approved drawings and five sets of manuals of instructions to our Design Office.

One set of all the approved drawings and manual of instructions will be supplied along with each equipment without which the supply will not be considered as complete supply.

In order to ensure timely receipt of all the drawings, literature & re producible etc., the purchase section of MM organization will issue dispatch instruction for dispatch of 11 kV switchgear.

11.44 SPECIAL TOOLS:

The tenderer shall separately quote for a set of special tools, if so required, for erection and maintenance of the switchgear panels.

11.45 DEVIATION FROM SPECIFICATION:

Should the tenderer wish to deviate from the provisions of the specification either on account of manufacturing practice, or any other reasons, he shall draw attention to the proposed point of deviation in the tender and submit such full information drawing and specification so that merits of his proposal may be fully understood. The specification shall be held binding unless the deviation has been fully recorded as required above.

11.46 GUARANTEED AND OTHER TECHNICAL PARTICULARS:

These particulars shall be furnished strictly as attached. Any deviation from this specification shall be clearly brought out separately.

11.47 SCHEDULE OF REQUIREMENT

Vacuum Type 15 Panels, 11 Kv Switch Boards And Each Switch Board Comprising Of The Following: -

11.47.1 *One No. Incoming Panel*

- -1 No. Triple pole, 11 kV 2000 A draw out type vacuum circuit breaker fitted with arc control device, interlocks, auxiliary switches isolating contacts, emergency hand trip device, mechanical `ON' & `Off' indicator and motor operated spring charged mechanism.
- -1 Set Bus bars 3 phase 2000A. Cable boxes located at the rear of the unit for receiving 2 set of power cables each comprising 3 no. single core 1000 mm2 11 kV XLPE PVC sheathed cables & complete in all respect with jointing kits etc. as per clause 5.9 of the specification.
- -3 No. CTs of ratio 1800-900/0.577-5 A with first core for differential protection having a minimum knee point voltage equal to 40 RCT (neglecting lead resistance) and the 2nd core for REF protection having a minimum knee point voltage of 92(RCT)V on 1800 A tap where RCT secondary winding resistance. These CTs shall conform to accuracy class PS of ISS:2705 (Part-IV) and shall have Magnetizing current as low as possible but in no case exceeding the value corresponding to class 5 P of IS:2705 (Part-III).
- -3 No. CTs of 1800-900/5 A with first core of 15 VA output & 5P10 accuracy for over current & earth fault protection and 2nd core for Ampere meter & APFC (for capacitor bank) with 15VA output & accuracy class 1.0.
- -3 No. CTs of 1800-900/1 A of 15 VA output, accuracy class 0.2S and ISF less than 5 for SEM.CT secondary terminals shall be brought out in weather proof sealable terminal box & shall be connected to SEM through TTB. Both TTBs and SEM shall be sealable type.
- -1 No. 3 phase star/star connected resin cast voltage transformer as per IS: 3156 (Part-II)1965 complete with HT & LT fuses, isolating plugs and sockets for HT & LT copper connectors, current limiting resistances as per following specifications:-

Table 11-15: Specifications: Current Limiting Resistance

Sr.No.	Core	Ratio	VA Burden	Accuracy
1.	Core-I	11000/√3/110/√3	100VA	**1/3p**
2.	**Core-II**	**11000/√3/110/√3**	**10VA**	**0.2**

- CT Secondary terminal of metering core i.e. Core-II shall be brought out in whether proof terminal box and shall be connected to SEM through TTB. Both TTBs and SEM shall be sealable type.
- -1 set Vermin and dust proof fitments.

11.47.2 *-1 set Restricted Earth Fault Protection*

It shall be single pole type for the clearance of earth faults in the protected zone. The relay shall be of high impedance type with a suitable setting to cover at least 90% of the winding & shall have a setting range of 10% to 40% of 5 Amp. or suitable voltage setting. The relay shall be complete with tuned 50 Hz circuit & stabilizing resistance. The tuned circuit will help reject harmonics produced by CT saturation and thus make the relay operative for fundamental frequency only. The stabilizing resistance may appropriately be set to avoid mal-operation under through fault conditions. The relay shall be numerical type.

11.47.3 *-1 No. Instrument Panel Mounted on Top*

-1 No. Ammeter with selector switch as per clause: 5.13.1 of the specification.

-1 No. Voltmeter with selector switch as per clause: 5.13.2 of the specification.

-1 No. PF meter with TTB as per clause: 5.13.4 of the specification.

-1 Set Triple pole combined over current and earth fault IDMTL relay as per clause: 5.15.1 of the specification.

-1 Set Over voltage relay for incomer panels only.

-1 No. Tripping relay with hand reset contacts suitable for 220 V DC auxiliary supply.

-4 No. Indicating lamps with fittings to indicate breaker `open', `close', `auto trip' & spring charged as per clause 5.10 of the specification.

-1 No. Automatic trip circuit supervision scheme as per clause 5.10 of the specification.

-1 No. PT fuse alarm scheme as per clause 5.12 of the specification.

-1 No. DC fail alarm scheme as per clause 5.16 of the specification.

-1 No. Circuit breaker control handle as per clause 5.14 of the specification.

-1 No. Alarm equipment for non-trip & trip fault annunciation as per clause 5.11.1 & 5.11.2 of the specification.

-1 No. Cubicle illumination lamp with door operated ON/OFF switch.

-1 No. 15 A power socket with switch.

-1 No. Anti-condensation tubular space heater suitable for connection to 240 V AC supply with a thermostat & a miniature circuit breaker.

-1 No. Special Energy Meter as per specification attached.

11.47.4 *-8 No. Outgoing Feeder Panels*

Each Comprising Of:

- -1 No. Triple pole 400 A, 11 kV circuit breaker fitted with Arc control devices, interlock arrangement, auxiliary switches, isolating contacts, emergency hand trip device, mechanical ON & OFF indicator & motor operated spring charged mechanism operate at 220 V DC.
- -1 Set Bus bars 3 phase 2000 A.
- -1 No. Trifurcating main cable box for receiving 3 core XLPE PVC sheathed cable up to 400 mm2 size & complete in all respects with cable glands and jointing kits etc. as per clause 5.9 of the specification.
- -3 No. CTs of ratio 300-150/5-5 A with first core of 15 VA output & 5P10 accuracy for O/C & E/F protection & second core 15 VA output & accuracy class 1.0 for metering.

- -1 No. Anti-condensation tubular space heater for connection to 240V AC supply with a thermostat & a miniature circuit breaker.
- -1 Set Vermin proof & dust proof fitments.
- -1 No. Instrument panel mounted on top & equipped as below:-
- -1 No. Ammeter with selector switch as per clause: 5.13.1 of specification.
- -1 No. KWH meter with TTB as per clause: 5.13.3 & 5.2 of the specification.
- -1 set Triple pole combined 2 O/C & 1 E/F IDMTL relay supplemented with triple pole instantaneous relay (high set element) in the form of 2 O/C & 1 E/F as per clause :
- -1 No. Tripping relay with hand reset contacts suitable for 220V DC auxiliary supply.
- -4 No. Indicating lamps with fittings to indicate breaker `open', `close', `auto-trip' & 'spring charged' as per clause 5.10 of the specification.
- -1 No. Indicating lamp with fittings & push button switch to indicate trip circuit healthy in pre-close & post-close conditions as per clause: 5.10 of the specification.
- -1 No. Circuit breaker control handle as per clause: 5.14 of the specification.
- -1 No. Cubicle illumination lamp with door operated ON/OFF switch.
- -1 No. 15 A power socket with switch.
- -1 No. Anti-condensation tubular heater suitable for connection to 240 V AC supply with a thermostat & a miniature circuit breaker.

11.47.5 *-2 No. Outgoing Feeder Panels:*

Similar to item above but with the following cable box/CTs: -

- -1 No. Trifurcating main cable box for receiving 3 core XLPE, PVC sheathed cable up to 400 mm2 size and complete with cable glands and jointing kits etc. as per clause: 5.8 of the specification.
- -3 No. CTs of ratio 400-200/5/5 A with first core of 15 VA output & class 5P10 accuracy for O/C & E/F protection & second core of 15 VA output & accuracy class 1.0 for metering.

11.47.6 *1 No. Panel for Capacitor Bank:*

The capacitor controlling breaker should be suitable to meet all conditions required for capacitor operation & should be suitable for controlling capacitive current up to 400A at 11 kV which is equivalent to 7.5 MVAR approx. & equipped similar to item No. 1.02 except KWH meter but with the following changes/additions:

- -3 No. CTs of ratio 800-400/5A output or as per required depending on final loading & 5P10 accuracy for over current & earth fault protection.
- Protection scheme including closing circuit interlock timer shall be as per clause: 5.15.3 of the specification.

11.47.7 *1 No. Station Transformer Feeder Panel:*

Similar to item No. 1.02 but with the following cable box & CTs: -

- -1 No. Trifurcating main cable box for receiving 3 core XLPE cable up to 50 mm2 size & complete in all respect as per clause of the specification.
- -3 No. CTs of ratio 60-30/5-5 A with first core of 15 VA output & class 5P10 accuracy for O/C & E/F protection & second core of 15 VA output & accuracy class 1.0 for metering.

11.47.8 *1 No. Incoming Panel Equipped Exactly Identical to Item 11.46.1 Detailed Above*

NOTE: The panels at Sr. No. 11.46.1 (incoming panels) shall be placed adjacent to the both sides of the 11kV Bus Sectionalizer and further all the outgoings' panels, capacitor panel & station transformer panel will be adjusted on both sides of the aforesaid incomer panels/site requirement. Provision shall be made to split the 15 panels boards into two parts each having an incoming panel at its end with complete non-trip alarm, trip alarm & protection schemes.

11.47.9 *1 NO. Bus Sectionalizer Panel Comprising Of:*

- 1 No. Triple pole 2000A, 500 MVA 11 kV circuit breaker fitted with Arc control devices, interlock arrangement, auxiliary switches, isolating contacts, emergency hand trip device, mechanical ON & OFF indicator & motor operated spring charged mechanism operate at 220 V DC.
- 1 Set Bus bars 3 phase 2000 A.
- 3 No. CTs of ratio 1800-900/5 A with first core of 15 VA output & 5P10 accuracy for O/C & E/F protection & second core 15 VA output & accuracy class 1.0 for metering.
- 1 No. Anti-condensation tubular space heater for connection to 240V AC supply with a thermostat & a miniature circuit breaker.
- 1 Set Vermin proof & dust proof fitments.
- 1 No. Instrument panel mounted on top & equipped as below: -
- 1 No. Ammeter with selector switch as per clause: 5.13.1 of specification.
- 1 set Triple pole combined 2 O/C & 1 E/F IDMTL relay supplemented with triple pole instantaneous relay (high set element) in the form of 2 O/C & 1 E/F as per clause:
- 1 No. Tripping relay with hand reset contacts suitable for 220V DC auxiliary supply.
- 4 No. Indicating lamps with fittings to indicate breaker `open', `close', `auto-trip' & 'spring charged' as per clause 5.10 of the specification.
- 1 No. Indicating lamp with fittings & push button switch to indicate trip circuit healthy in pre-close & post-close conditions as per clause: 5.10 of the specification.
- 1 No. Circuit breaker control handle as per clause: 5.14 of the specification.
- 1 No. Cubicle illumination lamp with door operated ON/OFF switch.
- 1 No. 15 A power socket with switch.

- 1 No. Anti-condensation tubular heater suitable for connection to 240 V AC supply with a thermostat & a miniature circuit breaker.

11.47.10 *11 Kv Incoming & Outgoing Feeder VCBS.*

- 11 kV incoming VCBs equipped exactly identical to the item 11.46.1 detailed above.
- 11 kV outgoing VCBs equipped identical to either 11.46.2 or 11.46.2 detailed above. The precise split up will be intimated to the successful bidder.
- 11kV Bus Sectionalizer equipped identical to 11.46.9 detailed above.

NOTE: These incoming & outgoing panels' bus orientation, physical dimension and auxiliary wiring etc. shall be such that these can be connected with the already installed/running 11 kV switchgear.

11.48 TECHNICAL SPECIFICATION FOR AIR CONDITIONING SYSTEM

11.48.1 *General*

- This specification covers supply, installation, testing and commissioning and handing over to PSTCL of Air conditioning system for the control room building and switch-yard panel rooms.

- Air conditioning units for control room building shall be set to maintain the inside DBT at 24DegreeC ± 2 Degree Celsius and the air conditioning system for switch-yard panel rooms shall be set to maintain DBT inside switchyard panel rooms below 24 Degree C.

- Controllers shall be provided in Control room and Battery room for controlling and monitoring the AC units in these rooms as detailed in

- Each switch-yard panel room shall be provided with temperature transducer to monitor the temperature of the panel room. The Temperature transducer shall have the following specification:.

- Sensor: Air temperature sensor (indoor use)
- Output: 4 to 20mA
- Temperature range: -5 to 60 degree c
- Resolution: 0.1 degree c
- Accuracy: 0.5 degree c or better

11.49 AIR CONDITIONING SYSTEM FOR CONTROL ROOM BUILDING.

- Air conditioning requirement of control room building shall be met using a combination of following types Air Conditioning units as required.
  - Ductable Split unit of 8.5TR.
  - High wall type split AC units of 2TR.

11.49.1 *Scope*

The scope of the equipment to be furnished and services to be provided under the contract are outlined hereinafter and the same is to be read in conjunction with the provision contained in other sections/ lauses. The scope of the work under the contract shall be deemed to include all such items, which although are not specifically mentioned in the bid documents and/or in Bidder's proposal, but are required to make the equipment/system complete for its safe, efficient, reliable and trouble-free operation.

i. Required number of Ductable split type AC units of 8.5 TR capacity with air cooled outdoor condensing unit with semi hermetic/hermetic compressors including refrigerant pipes, controls, thermostats, filters, outlet dampers, etc.

ii. Required number of Cassette type split AC units of 3TR capacity each complete with air cooled outdoor condensing unit having hermetically sealed compressor unit with cordless remote controller.

iii. Required number of High wall type split AC units of 2TR capacity each complete with air cooled outdoor condensing unit having hermetically sealed compressor and high wall type indoor evaporator unit with cordless remote controller.

iv. Copper refrigerant piping complete with insulation between the indoor and outdoor units as required.

v. First charge of refrigerant and oil shall be supplied with the unit.

vi. GSS/Aluminium sheet air distribution ducting for distributing conditioned dehumidified air along with supply air diffusers and return air grilles with volume control dampers and necessary splitters etc., suitable fixtures for grilles/diffusers and supports for ducting complete with insulation.

vii. Local start/stop facility for local starting/ stopping of all electrical equipment/ drives.

viii. All instruments and local control panels along with controls and interlock arrangements and accessories as required for safe and trouble free operation of the units.

ix. PVC drain piping from the indoor units up to the nearest drain point.

x. Supply and erection of Power and control cable and earthing.

xi. MS Brackets for outdoor condensing units, condensers as required.

11.49.2 *Technical specifications.*

11.49.2.1 Ductable split type AC units.

- Each Split Air conditioner shall have an indoor unit and an outdoor unit, designed to provide free delivery of conditioned air to the conditioned space. The indoor unit shall be suitable for mounting on the ceiling concealed above the false ceiling. Outdoor unit can be placed on the roof. Each unit shall include a primary source of refrigeration for cooling and dehumidification, means for circulation and cleaning air.

- The cabinets housing the components of indoor units & outdoor units shall be of heavy gauge sheet steel and suitable for floor mounting/mounting from ceiling. The access panels shall be of easily removable type. The entire casing shall be lined with 25mm thick insulation of totally flame proof type. Suitable drain connection shall be provided for removal of condensate collected inside a tray under cooling coil.

- The compressor shall be Semi hermetically/hermetically sealed type and complete with drive motor. The compressor shall be mounted on spring inside the lower most section of the unit so that it is easily accessible for servicing.

- Air cooled condenser of adequate surface area shall be offered. The air cooled condenser shall be made of copper tubes with external fins.

- The air handling fan shall be centrifugal type complete with belt drive and electric motor.
- Pre-filter at the suctions to remove dust particles down to 10 micron size with 90% efficiency and fine filters to remove dust particles down to 5 micron size with 99% efficiency at the outlet. All filters shall be of panel type.
- Cooling coils shall be of direct expansion type and made of heavy gauge copper with aluminium fins. Rows shall be staggered in the direction of air flow. Separate tubings from the distributor shall feed refrigerant uniformly to different sections of the coil.
- Refrigerant piping shall be of heavy gauge copper to IS:2501 or IS:1239 heavy class seamless M.S. pipe complete with thermostatic expansion valve, liquid strainer, dehydrator, liquid line shut off valve, high and low pressure gauges.
- An adequate method of condensate removal shall be provided. Condensate tray of adequate size, made of corrosion-resistant material or suitably treated with corrosion-resistant coating shall be
- provided. The tray shall be adequately insulated to avoid condensation over its external surface.
- A refrigerant strainer shall be provided in the liquid line immediately before the expansion device.
- Vibration Isolator A minimum of six 25 thick neoprene rubber pads shall be supplied for each unit.
- Cooling capacity of 8.5TR unit shall not be less than 102000 btu/hr.

11.49.2.2 High wall type split AC units

- The split AC units shall be complete with indoor evaporator unit, outdoor condensing units and cordless remote control units.
- Outdoor unit shall comprise of hermetically/semi hermetically sealed compressors mounted on vibration isolators, propeller type axial flow fans and copper tube aluminium finned coils all assembled in a sheet metal casing. The casing and the total unit shall be properly treated and shall be weatherproof type. They shall be compact in size and shall have horizontal discharge of air.
- The indoor units shall be high wall type. The indoor unit shall be compact and shall have elegant appearance. They shall have low noise centrifugal blowers driven by suitable motors and copper tube aluminium finned cooling coils. Removable and washable polypropylene filters shall be provided. They shall be complete with multi function cordless remote control unit with special features like programmable timer, sleep mode and soft dry mode etc.
- Cooling capacity of 2TR AC units shall not be less than 22000btu/hr. and shall have energy efficiency

rating of 3star or above.

- Controllers shall be provided in Control room and Battery room, one controller for each room, to control and monitoring of AC units and shall have the following facilities;
- Standby units shall come in to operation automatically when the running main unit fails
- Main and standby units shall be changed over periodically which shall be finalized during detailed engineering.
- Following alarms shall be provided:

a. Compressor On/OFF condition of each unit

b. Compressor failure of each unit

c. Power OFF to AC unit

d. High temperature in room.

11.49.3 *Warranty*

All compressors shall have minimum 5 years Warranty from the date

11.50 VENTILATION SYSTEM FOR GIS HALL

Each GIS hall shall have an independent ventilation system. Each ventilation system shall consist of two 100% capacity systems, one operating and one stand-by. To ensure that the air being supplied to the GIS hall is free from dust particles, a minimum two stage dust filtration process shall be supplied. This shall consist of at least the following:

- Pre Filters: To remove dust particles down to 10 micron in size with at least 95% efficiency.
- Fine Filters: To remove dust particles down to 5 microns in size with at least 99% efficiency.
- All the filters shall be panel type. Easy access should be available to the filters for replacement/ cleaning.

The ventilation of the GIS hall shall be of a positive pressure type with minimum 4 air changes per hour. The pressure inside the GIS hall shall be maintained 5 mm of Water above the atmospheric pressure. Fresh outdoor air shall be filtered before being blown into the GIS hall by the air fans to avoid dust accumulation on components present in the GIS hall. Each GIS hall shall be provided with motorized exhaust dampers with local control.

11.51 TECHNICAL SPECIFICATION FOR UNINTERRUPTIBLE POWER SUPPLY SYSTEM

The UPS (Uninterrupted Power Supply) shall be floor mounted; self-contained and metal clad and shall be suitable for supplying a nonlinear load. It shall be possible to open the enclosure front door when the unit is in use without exposing any live contact touch.

The UPS shall be online type incorporating minimum six plus rectifier and pulse width modulating inverter technology with microprocessor control. It shall incorporate a static bypass switch that shall operate in event of UPS failure, overload or manual initiation in order to transfer the output supply to mains without disturbance to the output supply.

The UPS shall incorporate DC under voltage trip circuit to electromechanically trip the UPS output in order to protect the batteries. The noise level of the unit shall not exceed 85 dB (A) at 1.86 m from the UPS cabinet. The output of the invertors shall be a sine wave having less than 2% THD for liner loads and less than 4% for 50% nonlinear loads. It shall be suitable for load power factors 0.7 lag to 0.9 lead.

The unit shall have a dynamic response such that 100% step load causes and output voltage transient of less than +/- 4% with a recovery of less than 5ms. The load crest factor shall not be less than 3:1.

- Indicators shall be provided for the following
- UPS Status.
- PS alarm conditions.
- The UPS shall provide output for the following purpose.
- Warning (Viz., low battery voltage).

The batteries shall be housed, within a separate matching battery cubicle suitable for location adjacent to the UPS. The batteries shall be of the rechargeable, sealed maintenance free lead acid type. The battery supply to the UPS shall be via a fused load break switch dis-connecter circuit breaker. The battery recharge time to 90% of full charge shall be approximately ten times the discharge time at full load. Terminals shall be shrouded to prevent accidental contact. The Uninterruptible Power Supply (UPS) system with SMF Lead Acid Battery shall conform to the minimum following specifications:

11.51.1 *Input*

- Input Voltage rating : [380] [400] [415] volts three-phase, Four-Wire
- Input Voltage range : + 15%, -20% of nominal 415 volts should support full load & full battery charging current.
- Input Frequency : 50 Hz NOMINAL (45Hz-65Hz)
- Power Walk in : 1, 10, 20, 30, 40 seconds (User programmable)
- Input Power Factor :Min. 0.99 lagging from 25% load to 100% load.
- Six plus Rectifier filter not acceptable
- Input Current Distortion : 7% THD maximum from 25% load to 100% load.
- Surge Protection: Sustain input surges without damage as per criteria listed in ANSI C62.41-1980.

11.51.2 *Output*

- Output Voltage Configuration: 3 Phase, 4 wire plus ground with output circuit breaker at 415 Value pure sine wave and 1 Phase, 2 wire plus ground with output circuit breaker at 220 Value pure sine wave (For Single Phase)
- Frequency: Nominal frequency +/- 0.1% for steady state and transient conditions, temperature compensated.
- Slew Rate: 1.0 Hertz per second maximum. Field selectable from 0.1 to 1.0 Hz per second maintained in sync with bypass line.
- branch fuse blowing capability : Inverter should be capable of clearing a 20% capacity of branch HRC fuse in the event of short circuit in any branch.
- Voltage Distortion: 3% RMS total harmonic distortion (THD) for up to 100% non-linear loads. 2% maximum for any single harmonic (linear load).
- Load Power Factor Range: 0.7 lag to unity.
- Efficiency: Defined as output KW / input KW at a load power factor of 0.8 lagging shall not be less than 95%.

- Overload Capability at Full Output Voltage :
    - 125% for 10 minutes (without bypass source) with voltage regulation ± 1%
    - 150% for 1 minute (without bypass source) with voltage regulation. ± 1%
- Inverter Output Voltage Adjustment: +/- 5% manual adjustment.
- Voltage Transient Response:
    - Loss or return of AC input power +/- 1%
    - Manual transfer of 100% load +/- 5%.
- Transient Recovery Time: 98% of nominal within 20 msec.

Harmonic Content:

- Maximum 1% RMS total maximum 2% any single harmonic (linear load).
- Maximum 3% RMS total for up to 100% non-linear load.

- Fault Clearing: Sub-cycle current of at least 300% but not more than 500% of normal full load current (when bypass is not available). If the short circuit is sustained, the inverter shall disconnect automatically from the critical load bus. An uninterrupted load transfer to bypass shall be automatically initiated, should the connected critical load exceed the capacity of the available on-line modules. An automatic output circuit breaker shall be provided to isolate a malfunctioning module from the critical load.
- Output Filter: Output filter shall reduce the output current distortion to 5% THD at full load non linear load.
- The inverter shall track the bypass continuously provided the bypass source maintains a frequency of 50 Hz +/- 0.5 Hz. The inverter will change its frequency at 0.1 Hz per second (adjustable 0.01 to 1.0 Hz per second) to maintain synchronous operation with the bypass. This shall allow make-before-break manual or automatic transfers. If the bypass fails to maintain proper frequency, the inverter shall revert to an internal oscillator which shall be temperature compensated and hold the inverter output frequency 0.1% from the rated frequency for steady-state and transient conditions.

Drift shall not exceed 0.1% during any 24 hour period. Total frequency deviation, including short time fluctuations and drift, shall not exceed 0.1% from the rated frequency.

- Output Voltage regulation (at default parameter settlings):
  1. ± 1% steady state for a static 100% balanced load.
  2. ± 2% steady state for a static 100% unbalanced load.
  3. ± 5% for a 0 to 100% load step.
- Output Frequency : 50 Hz ± 0.01% free running normal operation and 0.1% in Mains synchronized operation
- Output Power Factor Range : 0.9 leading to 0.8 lagging at rated KVA. The unit's KVA capacity shall not require de-rating for a 1.0 load power factor.
- Crest Factor : 3 : 1 or better.
- Short Circuit Withstand : The UPS must withstand a bolted fault short circuit on the output without damage to the UPS module.
- AC to AC efficiency : > 95% at 100% linear load, at normal input voltage with batteries fully charged.
- Acoustical Noise : < 60 dB(A) of noise, typical, measured at 1 meter from the operator surface

11.52 POWER CAPACITOR WITH APFC PANEL

Capacitors shall comply with IEC 60871 and IS 5553, 13925 including those standards referred to therein. APFC panel shall be provided for LV switchboard of Process plants.

11.52.1 *Construction of Power Capacitor*

- The internal elements of the capacitor unit shall be made of synthetic films or Kraft paper sandwiched between synthetic films as an insulator and aluminum foil as an electrode.
- After congregating several numbers of these elements, the capacitor unit shall be thoroughly dried under high temperature and vacuum condition and impregnated with synthetic insulation oil of high purity which has been beforehand completely degreased of harmful impurities not to leave any gas in the container which may cause deterioration of the dielectrics.

- The container shall be metal enclosed having ample strength and flexibility and shall be capable of adjusting the volume in the container against expansion and contraction of the impregnating oil due to change of temperature.

- The power capacitor shall have suitable mechanical fault detector to protect the capacitor from internal faults.

- The detector shall be provided with the capacitor.
- Upon detection, the faulted capacitor shall be removed from the circuit to prevent container rupturing.

- Discharge device shall have function to discharge of residual electric charge can be reduce to 50V or less within five (5) seconds at the capacitor terminal.

- Power factor compensation above 300 KVAR is to be provided with synchronous motor and condenser.

- All 3 phase MCBs or MCCBs shall be 4P type. All Single phase MCBs shall be of DP type.

11.52.2 *Feature of APFC Panel*

- The APFC panel shall be connected on main panel and the pF improvement panel shall have separate capacitors to improve the pF of the system upto 0.98 during no load and full load conditions.

- At least five steps shall be provided for switching.
- Auto control is preferred to eliminate the human error.
- The capacitor banks shall be complete with all parts that are necessary or essential for efficient operation.

- The capacitor bank shall be complete with the required capacitors along with the supporting post insulators, steel rack assembly, copper bus bars, copper connecting strips, foundation channels, fuses, fuse clips, etc. The steel rack assembly shall be hot dip galvanized.

- The capacitor bank may comprise of suitable number of single phase units in series parallel combination. However, the number of units in series shall be such that failure of one unit shall not create an over voltage on the units in parallel with it, which will result in the failure of the parallel units. The complete banks with its accessories shall be metal enclosed (in sheet cubicle), indoor floor mounting and free standing type.

- The assembly of the banks shall be such that it provides sufficient ventilation for each unit. Necessary louvers shall be provided in the cubicle to ensure proper ventilation.
- Each capacitor case and the cubicle shall be earthed to a separate earth bus in the cubicle.
- Each capacitor unit/bank shall be fitted with directly connected continuously rated, low loss discharge device to discharge the capacitors to reduce the voltage to 50 volts within one minute in accordance with the provisions of IS:13295.
- Each unit shall be non-inflammable dielectric immersed self-cooled and hermetically sealed.
- Each unit shall satisfactorily operate at 135% of rated KVAR including factors of over voltage, harmonic currents and manufacturing tolerance. The units shall be capable of continuously withstanding satisfactorily any over voltage up to a maximum of 10% above the rated voltage, excluding transients.
- The capacitor shall be of the self-healing type with a very low loss dielectric.
- All the material employed in the manufacture of capacitor shall be nontoxic and biodegradable.
- The expected life of the capacitor shall not be less than 1, 60, 000 hours.
- The p. f. correction capacitor shall be designed in such a way that they, not only, withstand high RMS current, but also to work under sustained harmonic overloads.
- The capacitors shall be characterized by the dielectric impregnated with biodegradable synthetic oil.
- The dielectric shall consist of films of polypropylene and paper.

11.52.3 *Unit Protection*

- Each capacitor unit shall be individually protected by an MCB/Contactor suitably rated for load current and interrupting capacity, so that a faulty capacitor unit shall be disconnected by the fuse without causing the bank to be disconnected. Thus, the fuse shall disconnect only the faulty unit and shall leave the rest of the units undisturbed. An effected fuse shall give visual indication so that it may be detected during periodic inspection.
- The fuse breaking time shall co-ordinate with the pressure built up within the unit to avoid

explosion. Mounting of the individual fuse may be internal or external to the capacitor enclosure

- The fuse unit and the wires and cables chosen for the capacitors of double the current carrying capacity of the normal permissible current. Similarly, the ammeter and current transformer shall also be designed accordingly.

11.52.4 *Power Factor Correction Relay*

- The relay shall be microprocessor based digital solid state type and switching device shall be solid state relay giving signal to contactors for switching ON/OFF preset number of capacitor units.

- The relay shall be suitable for automatic/manual control of power factor correction capacitors on three phase system. It shall detect the power factor lagging and leading reactive power (KVAR) component above present levels and then switch the appropriate number of capacitors "IN" or "OUT" to achieve the optimum average power factor without system operating under leading power factor condition.

- This relay/device shall have low VA burden and final switching of approximate capacitor banks shall be achieved by switching on the contractors/breakers through initiation of this device.

- The relay shall be provided with facility to automatic self-adjustment to any capacitor step value.
- The relay unit shall be provided with digital indication of power factor, preset parameters and specified installation data, no-volt relay feature to immediately disconnect all capacitor in the event of power failure, over temperature / over voltage/ harmonic over load protection, remote fault alarm indicator, power factor correction fault, LEDs for banks on inductive load, capacitive load, manual mode indication, remote alarm tripped, multiplication factor indication, and power on, manual bank and programming on button, manual bank and programming off button, manual / automatic button, alarm reset button, data scrolling button and 3 digit display.

11.52.5 *Tests*

- All tests shall be conducted in accordance with the latest edition of IS: 22534 and as applicable for the controls. Type test certificates for similar capacitor units shall be furnished.

11.53 66KV KV CVT TECHNICAL SPECIFICATIONS

- The bidder should supply CVTs with Porcelain & shall be in line with IEC 61869-5.
- The EMU tank & all exterior metal parts of the offered CVTs shall be of Aluminum only.

- EMU housing preferably Casted Aluminmum which serve better performance compare to fabricated tank against oil leakage point & rust proof.

- Capacitor stacks should consist of Jerylac / PXE oil & mix dielectric design.
- CVT should consist of Single stack till 300 kV, This will reduce installation activity at field.
- CVT should have flat pad of aluminum HV terminal & two aluminum earthing terminal pads.
- CVT should equipped with MV grounding switch handle.
- Technical specification should meet as attached..
- The CVTs are to be designed to withstand earthquake of an intensity, equivalent to 0.3g in both directions. Where, ‘g’ stands for acceleration due to gravity.

- The secondary terminals shall be brought out in a weatherproof terminal box made up of Aluminium cast with a rating not less than IP-55.

Table 11-16: Specifications: 66KV KV CVT

SL.NO	PARTICULARS	66KVVT
1	Type	Single phase, 50Hz, oil Filled, self-cooled, Hermetically sealed, Outdoor porcelain type.
2	Nominal system voltage.	66KV
3	Highest system voltage.	72.5KV
4	Frequency.	50Hz ± 5%

5	System earthing.	Effectively solidly earthed.
6	Number of phases.	3 [single phase]
7	(i)Number of secondary windings. (ii)Purpose of windings.	3 [three] Protection & metering.
8	Rated primary voltage.	66/1.732 KV
9	Rated secondary voltage.	Winding-I-110/1.732V Winding-II-110/1.732V Winding-III-110/1.732V
10	Ratio	66KV/1.732: 110V/1.732
11	Rated burden.	Winding-I (P)-50VA Winding-II (P)-50VA Winding-III (M)-50 VA/0.2 class simultaneous burden-50VA with accu. cl-0.2
12	Accuracy class .	3P/3P/0.2
13	Rated voltage factor at rated frequency.	1.2 continuous. 1.5 for 30 second.
14	Temperature rise at 1.2 times the rated primary voltage, rated frequency & rated burdens.	As per IEC-61869-5
15	Temperature rise at 1.5 times the rated primary voltage for 30 seconds, rated frequency & rated burden.	As per IEC-61869-5
16	One-minute power frequency dry withstands test voltage for primary winding.	As per IEC-61869-5

17	Wet test Pf till 300kV& switching above 300 kV	As per IEC-61869-5
`18	1.2/50 micro second impulse withstand test voltage for primary winding	As per IEC-61869-5
19 **(i)** **(ii)**	One-minute power frequency withstands test voltage for Secondary winding Between LV(HF) terminal & earth terminal	3KV [rnms] 10KV [rms] for exposed terminals & 4KV [rms] for terminals, enclosed in a weatherproof box.
20	Class of insulation.	'A' or better for EMU.
21	Material of the conductor of primary and secondary windings.	Copper for EMU
22	Minimum creepage distance.	2248 mm
24	Quality of EMU oil.	EHV Grade As per IS-335.
25	Radio interference voltage at 1.1 times maximum rated voltage at 1.0 MHZ.	<500 micro volts.
26	Partial discharge level.	As per IEC
27	Seismic acceleration-.	0.3g. .
29.	Capacitance (Pf)	8800 (+10% & -5%)

- All the equipment proposed to be supplied shall have valid type test certificates (with polymer housing) from third party, NABL accredited laboratories as per below list which are not older than 5 years.

- The supplied CVT should have provision for Capacitance and Tan Delta Measurement at Site (With EMU assembled with Capacitor Divider) at 10kV. The OEM should confirm the Max. Tan Delta Value as less than 0.5%.

- The bidder shall be Original Equipment Manufacturer (OEM) with factory in India, The offered equipment have to be designed, manufactured and tested as per relevant IEC or equivalent standard with latest amendments

- The bidder shall have in-house NABL accredited test facility for CVT routine testing.

11.54 TECHNICAL SPECIFICATIONS OF POWER TRANSFORMERS

11.54.1 *Scope*

i. This specification covers the design, manufacture, assembly testing at manufacturer's works before dispatch, supply and delivery at site as per schedule of Requirement of Power Transformers.

ii. All drawings, schedules and SPV appended to this specification shall form part of the specification and supplement the requirements specified. The equipment/materials offered by the Bidder shall be complete in all respects and, whether called for specifically or not, all accessories, hardware and services required for normal satisfactory operation of the system shall be deemed to be included in unit rates quoted. Design and manufacture shall also be such that equipment/ accessories of the same type and rating would be interchangeable.

iii. Specific reference in this specification and documents to any material by trade name, make or catalogue number shall be construed as establishing standard of quality and performance and not as limiting competition. All equipment/ accessories offered shall also be of proven design and manufacture. The make of all accessories and hardware shall be subject to SPV's approval

11.54.2 *Codes & Standards:*

All standards, specifications and codes of practice preferred to herein shall be the latest editions including all applicable official amendments & revisions as on dateof opening bid.

The following standards & codes shall be applicable:-

IS-5	Color for ready mix paints
IS-325	Three phase induction motors.
IS-335 BS-148 & IEC-296	New insulating oils for transformer (Test Procedure).
IS-13155 (1991)	Method of Test for Carbon Type (PNA) Analysis of Mineral Oils by Infrared Spectrophotometer.
IS :375	Marking & arrangement of swgr. busbars main connections and auxiliary wiring.

IS :1367	Hot dip galvanized Coating on threaded fasteners.
IS: 1866	Code of practice for maintenance of insulation oil.
IS:2026 & IEC-76	Specification for power transformers.
IS: 2099	Bushing for alternating voltages above 1000V.
IS:2147	Degree of protection provided by enclosures for low voltage switchgear & control gear.
IS : 2705	Current transformers
IS:3347	Dimensions of porcelain transformer bushings for use in lightly polluted atmosphere.
IS:3637	Gas operated relays.
IS:3639	Fittings & accessories for power transformers.
IS:6600 & IEC- 354	Guide for loading of oil immersed transformers.
IS:8468 & IEC- 214	On load tap changer
IS : 8478	On load tap changers application guide.
IS:8603	Dimensions for porcelain transformer bushings for use in heavily polluted atmosphere (36 KV Class). Dimensions for oil filled porcelain transformer bushings for use in medium polluted atmospheres.
IS:9434	Guide for sampling and analysis of free and dissolved gas in oil filled equipment.
IS:10028	Code of practice for selection, installation and maintenance of transformers.
IS:12676	Dimensions for OIP insulated condenser bushings.
IEEE :32	IEEE standard requirement terminology and test procedure for neutral grounding device.
IEEMA-9 :1990	Radiators
CBIP Publication	Manual on transformer
IS: 1271	Classification of insulating materials for electrical machinery and apparatus in relation to their stability in services
IS: 2071	Method of high voltage testing
IS: 3202	Code of practice for climate proofing of electrical equipment
IS: 5561	Electric Power Connectors
Tests as per IS	
1	All standard routine tests in accordance with IS: 2026 with dielectric tests corresponding to latest amendments of IS: 2026 shall be carried out.
2	All auxiliary equipment shall be tested as per the relevant IS. Test certificates shall be submitted for bought out items.
3	High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.

4	Following additional routine tests shall also be carried out on each transformer: a) Magnetic Circuit Test on each core shall be tested for 1 minute at 2000 Volt DC b) Oil leakage test on transformer

Equipment complying with other internationally accepted standards such as IEC, BS. USA. VDE etc. will also be considered if they ensure performance and constructional

features equivalent or superior to standards listed above. In such a case the Bidder shall clearly indicate the standards adopted, furnish a copy in English of the latest revision of standard along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

The successful bidder shall submit list of supplies and their manufacturers of all bought out items for approval immediately after placement of LOI/PO.

11.54.3 *Service Conditions:*

(A) <u>REFERENCE AMBIENT TEMPERATURES.</u>

The reference ambient temperatures for which the transformers are to bedesigned are as under:

i) Maximum ambient air temperature : 50 degree C
ii) Maximum daily average ambient temp : 40 degree C
iii) Maximum yearly weighted average ambient temp : 40 degree C
iv) Minimum ambient air temperature : minus 5 degree C
Cooling medium shall be AIR.

(B) <u>CLIMATIC CONDITIONS:</u>

i) Maximum relative humidity... 100%
ii) Yearly Average number of thunder storms .... varies from 30 to 50 at different places.
iii) Average no of rainy days per annum...................................60 days
iv) Fog: The atmosphere is subject to fog for two months in winter.
v) Number of months during which tropical monsoon conditions prevail- 3months.
vi) Dust storms occur at frequent intervals.
vii) Average annual rainfall 60cms.
viii) Maximum wind pressure: 150 Kg/Sq.m.

(C) ALTITUDE

Altitude above M.S. level not exceeding 1000 mtrs.

(D) LIMITS OF TEMPERATURE RISE:

(a) With the above service conditions given in clause-4 each transformer shall be capable of operating continuously on any tap at their normal rating without exceeding following temperature rises:

i) 35 deg. C in oil by thermometer.

ii) 45 deg. C in winding by resistance.

iii) a) Hot spot gradient (max) 15 deg. C.

b) Winding gradient (max) 11.54 deg. C.

iv) Temp. of hot spot in winding not to exceed 95^0C. when calculated over maximum annual weighted average temp. of 40^0C.

(b) The limits of temperature rise mentioned above will have to be satisfied by the manufacturer by carrying out the heat run test at the lowest negative tap. This test shall be carried out by feeding the following losses:-

1.1 Times the total losses at 75 Deg. C-at highest current tap.

(c) The oil time constant should not be less than three hours.

11.54.4 *Bay Width and Height*

The bidder may specifically note that the total length& total height of the transformer shall be such that two transformers can be adjusted in adjacent bays including fire wall (thickness of 650mm approx.) between them. The centre line of the transformer tank/ central bushing should be in line with the centre line of bay & total length of the transformer should be such that the radiator can be accommodated on either side of transformer tank in the specified bay width maintaining adequate clearances for safety and proper working on either side.

Table 11-17: Bay width and Heights

Voltage level	Bay width in mm	Bay Height in mm
220kV	16600	14500
66kV	7600	8900
11kV	3700	6750

11.54.5 Mounting Arrangement:

The transformers shall be provided with flanged, bi-directional wheels and axles. These shall be so designed that under both the directions of movement they shall not deflect as to interfere with the movement of the transformer. Wheels shall be provided with suitable bearings which shall be rust corrosion resistant. Fittings/nipples for lubrication shall also be provided or the bearing shall be of permanently lubricated type.

All wheels should be detachable and shall be made of cast iron or steel as required.

Suitable locking arrangement shall be provided for the wheels to prevent accidental movement of transformer.

The wheels are required to swivel and they shall be arranged so that they can be turned through an angle of 900 when the tank is jacked up clear off the rails. Means shall be provided for locking the swivel movements in positions parallel to or at right angels to the longitudinal axis of the tank.

The transformer shall be provided with detachable steel flanged wheels of 380mm diameter and suitable for moving transformer complete with oil.

Table 11-18: Transformer wheels suitability for mounting on rails

Transformer Rating	Rail gauge along longer axis in mm	Rail gauge along shorter axis in mm
160MVA	2 rails of 1676 mm gauge	2 rails of 3353 mm gauge with an additional third rail in between the
		rails (i.e. at the centre)
100MVA	2 rails of 1676 mm gauge	2 rails of 3353 mm gauge
50MVA & below	2 rails of 1676 mm gauge	2 rails of 1676 mm gauge

To prevent transformer movement during earthquake, clamping device should be provided for fixing the transformer to the foundation.

1. OVER LOAD CAPACITY & CONTINUOUS RATING:

a) The safe over load capacity of the transformer and the duration of over load under maximum temperature conditions (clause-4 above) without any damage to the winding or harmful effects on the insulation shall be clearly stated in the tender which must be as per IEC-354, Guide for loading of oil immersed Transformers.

(b) The transformer may be operated without injurious heating at any particular tapping at the rated KVA provided that the voltage does not vary by more than +/-10% of the voltage corresponding to that tapping.

2. TAPPING:

The tapping range shall be as given in the Schedule of Requirements:-

All the transformers should be provided with the ON load Tap changers having local manual and electric control as well as group electrical remote control from the Remote Tap Change Control (RTCC) panel. These tapings may be used to get 10% over voltage on low voltage side at no load. When under this conditions, the high voltage side experience an over voltage, the tapping shall be changed so that the continuous over excitation is limited to 10% only. The tolerance of voltage ratio at all tapings should be same as at principal tapping.

3. CORE AND FLUX DENSITY

i) The transformer should be so designed that the working flux density should not exceed 1.57 Tesla at normal voltage, frequency and ratio.

ii) Tenders with higher flux density than specified shall not be considered.

iii) The core shall be built up with thin laminations of high grade non-ageing, lowloss, high permeability cold rolled super grain oriented silicon steel. Known as MOH High B Grade or superior grade CRGO steels of maximum 0.27 mm or low lamination thickness especially suitable for transformer core.

iv) (a) After being sheared, the laminations shall be treated to remove all burrs. They shall be coated with a baked enamel insulation coating. The insulation shall be inert to the action of hot transformer oil and shall be perfectly adhesive. Paper and varnish insulation shall not be accepted. Particulars of proposed insulation shall be stated in the tender. Laminations shall be checked for burrs during stage inspection.

(b) (1) Bidder should preferably have in house core slitting/cutting facility for proper monitoring & control on quality and also to avoid any possibility of mixing of prime material with defective/second grade material. The purchaser may witness the core- slitting operation. In case the in-house core-slitting facility is not available, then the same shall be carried out in the presence of the representative of PSPCL.

(2) Inspection call notice for the purpose should be accompanied with the following documents as applicable as a proof toward use of Prime core materials :-

a) Invoice of supplier.

b) Mills test certificates.

c) Packing list.
d) Bill of lading.
e) Bill of entry certificates by customs.

Core material shall be directly procured either from the manufacturer or through their accredited marketing organization of repute and not through any agent.

Core material should be imported directly from reputed manufacturer such as Nippon Steel Corp., Japan, A.K. Steel Corp., USA, JFE Steel Corpn. Japan, POSCO, Korea & Stalprodukt, Poland. Further, manufacturer can purchasedirectly imported prime core of approved makes as per specifications fromother transformers manufacturers supplying transformers to the PSPCL with prior approval of this office. However, proper accounting of the core material in respect of both the seller and purchaser firms shall be ensured at the timeof inspection, or transformer manufacturers can purchase directly imported prime core steel laminations of approved manufacturers through the following sources:

i) Through the authorized distributors of approved manufacturers located in foreign countries.
ii) Through MMTC Ltd. Delhi (A Govt. of India Enterprises).
iii) POSCO, Korea make prime core through POSCO- India Steel Processing centre (P) Ltd. Pune in the slitted coils subject to the condition that only single slit up to 5% (MAX) out of the main coil of standard width shall be allowed or POSCO Korea make Prime core through POSCO-India Delhi Processing Centre Pvt. Ltd. Bawal, Rewari (Haryana) stock depot and POSCO-India Delhi Processing Centre Pvt. Ltd Mohali stock depot.
iv) Nippon make through their authorized dealer in India M/s Mohindra Intertrade Ltd. Delhi and from their works / stock yard at Kahne (Maharashtra)
v) JFE Steel Corporation Japan make through its authorized dealer in INDIA M/s Jay Bee Lamination Pvt. Ltd., Noida.
vi) JFE Steel Corporation, Japan make through its authorized dealer in INDIA M/s JFE Shoji Steel India Pvt. Ltd., Pune.
vii) JFE Steel Corporation, Japan make through its authorized dealer in India M/s Kryfs power Components, Silvassa
viii) Stalprodukt, Poland make through its authorized dealer in India M/s Amod Stamping Ltd. in Vadodara.

The core material shall be processed by slitting only. Welded joint/ slitted coils shall not be accepted. Only one grade and one thickness of core shall be accepted and no mixing of different grade/thickness of lamination shall be allowed. Specific grade of the Prime core used/ to be used in the manufacture of transformer for PSPCL should be specifically mentioned in the tender along with source of procurement. Only directly imported Prime Core shall be accepted. PSPCL reserves the right to accept/reject CRGO of a particular manufacturer(s) at any stage by quoting the reasons and may ask for theoriginal documents relating to import/purchase of core to check the genuineness of the core used for manufacture of PSPCL transformers for which instructions/guidelines shall be issued after issuance of P.Os if required.

v) The core shall be rigidly clamped and/or bolted to ensure adequate mechanical strength and to prevent vibrations during operation. The bolts used in the assembly of the core shall be suitably insulated and the clamping structure shallbe constructed that the eddy currents will be minimum.

vi) Construction of the core shall be such that number steps in the limb and yoke shall be matching and dimensionally identical to minimize the effect of cross fluxing and better mechanical strength.

vii) The core shall be provided with Lugs suitable for lifting the complete core and coil assembly of transformer. The Core & coil shall be fixed in the tank that its shifting will not occur when the transformer in moved or when a short circuitoccurs.

viii) The design of magnetic circuit shall be such as to avoid static discharge development of short circuit paths within itself or to the earth-ing clamping structure and the production of flux components at right angles to the plane of the lamination which may cause local heating.

ix) Every care shall be exercised in the selection treatment and handling of core steel to ensure that the laminations are flat and that finally assembled core is free from distortions.

x) The supporting frame work of the core shall be so designed as to avoid thepresence of pockets which would prevent complete emptying of the tank through the drain valve or cause trapping of air during filling.

xi) Oil ducts where necessary should be formed across the plane of the lamination and be given a

xii) suitable slope to assist oil circulation. The overall design of coreand winding should be such that free flow of oil is not obstructed.

xiii) The frame work and clamping arrangement shall be earthed by connecting to the tank body through a copper strip. Yoke bolt area should be compensated if bolts are used for fastening of the core.

xiv) The insulation of core to bolts and core to clamp plates shall be able to withstand a voltage of 2 KV RMS for one minute.

xv) Cores and windings shall be capable of withstanding shocks during transport,installation, service and adequate provision shall be made to prevent movement of core and winding relative to tank during these conditions.

xvi) All steel sections used for supporting the core shall be thoroughly sand blastedafter cutting drilling and welding.

xvii) CRGO used shall be strictly as approved vendor list.

xviii) The bidders should indicate the maximum flux density allowable continuously as well as for time intervals of 1 minute and 5secs and the limit of flux density at which core material used by them saturates.

xix) The name of the core material must be mentioned in the tender. The successful bidder shall be required to furnish magnetization curves of the core material/design calculations and such other data/documents deemed fit by the Purchaser for being satisfied that flux density is as desired.

xx) Purchaser shall inspect the built-up core for verification of flux density for which all facilities shall be

Rated system voltage (KV)	Highest system voltage (KV)	1.2/50µs positive impulse with stand voltage of line end (KV peak)	One minute PF withstand voltage Line End (KV)	Neutral End (KV)
11	12	95	38	38
33	36	170	70	70
66	72.5	325	140	38
132	145	550	230	38
220	245	1050	460	38

provided. The purchaser shall inspect/test the core material for various tests as per relevant IEC/IS to ensure quality. Core may also be inspected during horizontal assembly, built-up assembly.

NOTES:

i) The above flux density has been specified to meet with the over fluxing of the core due to temporary over voltage of the order of 31% for l min, 44% for 5 sec. that may appear abnormal conditions such as those following suddenloss of large loads.

ii) Yoke bolt area and flitch plate areas shall not be counted in the net core areaif these are provided for fastening core.

iii) The design of limb and yoke shall be so co-ordinate that there is no cross fluxing at the joints.

4. INSULATION LEVELS:-

4.1 The insulating material to be used shall be of class-„A" as specified in the latest edition of IS: 1271.

4.2 The dielectric strength of winding insulation and of the bushings shall conform to values given in IS :2026/1981 Part-III, amended up-to date except for the changes made in this specification.

4.3 The following impulse test and power frequency test voltage must be offered.

The provisions of note under clause 5.4 IS: 2026 (Part-III)-1981 should be kept in view while offering this parameter. The star connected windings of the transformers may have graded insulation category for system voltage 66KV and above

All windings for system voltage lower than 66 KV shall have uniform insulation.

5. SHORT CIRCUIT STRENGTH AND PROVISION OF SEPARATE TAPPING COIL FOR REGULATION:

a) Transformer shall be designed and constructed to withstand without damage the thermal effects for 5 seconds and dynamic effects on external short circuits specified under conditions in IS : 2026 (Part-I) 1977.

The transformer shall be provided with separate tapping coil to limit the short circuit forces. The bidder shall submit test certificates of the short circuit test, if already done on the offered design and rating for PSPCL, PSTCL or erstwhile PSEB. If the short circuit test has been carried on the offered design for some other utility, then the same should not be older than 5 years. The bidder shall submit test certificates of the short circuit test as per above conditions along with the detailed drawings of the transformer on which short circuit test has been performed duly certified by the agency who has conducted the short circuit test. The supplier shall also supply the detailed drawings of the transformer it intends to supply, along with the tender for comparison with the short circuit design of the transformer. Other-wise short circuit test shall have to be conducted on one of the units of each rating free of cost.

b) In case PSPCL gets additional Transformers tested for Short Circuit, the charges for the same shall be paid as per actual charges of CPRI **or** quoted by the firm whichever is lower **plus** to & fro transportation charges as quoted by the firm **or** actual as per transportation bill whichever are lower. However, no charges shall be paid by the Purchaser, if transformer fails during S.C. test.

6. FREQUENCY AND SYSTEM VOLTAGE:

The transformers shall be suitable for continuous operation with a frequency variation of

+/-3% from normal cycles per second without exceeding the specified temperature rise.

7. PARALLEL OPERATION:

The transformers listed in the “Schedule of Requirements” shall be capable of satisfactory parallel operation with each other if connected between the high voltage and low voltage bus bar.

In addition the transformers as mentioned in the “Schedule of Requirements” shall be capable of satisfactory parallel operation with the existing transformers.

8. IMPEDENCES:

Suppliers shall indicate the guaranteed impedance and tolerance which shall be as per IS: 2026/1977 Part-II (latest). Impedance shall include positive and zero sequence and shall be expressed in terms of the branches of the star connected equivalent diagram, all on the same KVA base and range shall be given for each branch of the equivalent circuit in turn. The percentage impendence required on normal & extreme taps have been given in the “Schedule of Requirements”. The impedance on extreme taps shall be clearly specified in the tender. In case of transformers required to run in parallel with existing T/Fs, the impedance at tap 1 & 17 must match with impendence mentioned in the “Schedule of Requirements”. Percentage tolerance allowed at extreme taps shall be as applicable to normal tap.

9. LOSSES:

The losses of each transformer shall be stated in the tender for ONAN rating (at full load at 75^0C) which should be less than:-

S. No.	Rating	No Load Losses	Load Losses (ONAF)	Load Losses (ONAN)	Auxiliary Losses	Total Losses (ONAF)	Total Losses (ONAN)
1	20 MVA, 66/11KV	13.6 KW	NA	48 KW	NA	NA	61.6 KW

However, for the purpose of arriving at comparable prices, no benefit of capitalization shall be allowed if any firm quotes losses less than the guaranteed losses.

Accuracy class of measuring instrument shall be duly taken into account during measurement of losses.

NOTE:

1. Building factor should be 1.1 or actual if more than this.
2. Stray losses should be taken as 15% of the total I^2R losses at 75 °C or actual if more than this.

10. <u>COOLING:</u>

The cooling arrangement will be as under:

S. No.	Rating	Cooling
1	20 MVA, 66/11KV	ONAN

The ONAN cooling of the transformers shall be by natural circulation of air while the circulation of oil shall be affected by natural convection, the maximum oil flow being assumed by a method whereby the return flow of cooled oil is made to enter the tank on a level with the bottom of the hot columns of oil thus, avoidingcenter heads of cold oil at the bottom of the tank. Out flow shall be arranged to coincide as nearly as possible with the hot oil level at the top of the tank so that the total available difference will be fully

employed in circulation of the oil round theshortest possible paths.

Each cooler unit shall be designed for detaching from the transformer without disturbing the oil in the transformer tank. Coolers shall be designed to withstandpressure conditions specified for the tank.

Coolers shall be designed so as to be accessible for cleaning and painting and to prevent accumulation of water on the outer surfaces to completely drain oil into the tank and to ensure against formation of gas pockets when the tank is being filled.

All coolers be attached to and mounted on the transformer tank. The arrangements of coolers shall be such that accessories may be mounted as specified hereunder.

Coolers units shall be connected to the tank through machined steel flanges welded to the cooler units and to the tank and provided with gaskets. At each cooler unit connection, there shall be provision on the tank for an indicating shut off valve which can be fastened in either open or closed position, a separate oil tight blank flange shall be provided for each cooler unit. It shall have a lifting eye, a 19 mm oil drain plug at the bottom and 19 mm air vent plug at the top. All air release/drain plugs shall be cadmium plated and gasket with them shall be neoprene type.

The radiators shall the equally distributed on either side of transformer. The maximum dimensions of the transformer should be such that the same can be accommodated without any interference within a clear bay width of 7 meters.

The motor blowers shall be direct driven suitable for continuous outdoor operation and complete with necessary air dusting. These shall be mounted independently from the radiator and in case, these are radiator mounting type use shall be made of some anti- vibration means. Care shall be taken that the blower unit is capable of being removed without disturbing the radiator structure. The bladesshall be suitably painted and shall not be of hollow sections. Suitably painted wire mesh guards with mesh not greater than 25 mm shall be provided to prevent accidental contact with the blades.

11. WINDING

The conductor used for the winding shall consist of solid drawn high conductivity copper best suited to the requirement. In case of copper strip the corners shall be rounded off to eliminate risk of injury to internal insulation during

winding and other operations. Strip conductor wound on edge should have width not exceeding six times its thickness. All permanent current carrying joints in the windings and leads shall be crimped or brazed. The windings shall be pre-shrunk during manufacture so that it is extremely unlikely that any further shrinkage takes place while in service. Provision shall be made so that in the event such shrinkage does occur, it will be possible to take up this shrinkage by means of adjustable clamping screws and end rings. The voltage between adjacent coils shall be kept as low as consistent with good design.

The windings shall be so designed that all coil assemblies of identical voltage ratings shall be interchangeable and field repairs to the windings can be made readily without special equipment. The coils shall be supported between adjacent sections by insulation used in the assembly of the windings and shall be arranged to ensure free circulation of the oil and to reduce hot spots in the windings. All threaded connections shall be provided with locking facilities. All leads from the winding to the OLTC barrier Board and bushings shall be rigidly supported to prevent injury from vibration. Guide tubes shall be used where ever practicable. The

winding shall be designed to reduce to a minimum the out of balance forces in the transformer at all voltage ratios.

The windings shall be clamped securely in place so that they will not be displaced or deformed during short circuits. The assembled core and winding shall be dried and suitably impregnated before removal from the treating tanks.

The insulation shall be made from high-density paper having high mechanical strength of minimum density:-

(i) For Conductor Insulation – 0.75 gm/cc
(ii) For Barrier insulation including spacers– Load bearing- 1.15 gm/cc
Non- Load Bearing -0.95 gm/cc

The insulation of the coils shall be treated suitably to develop full electrical strength of the windings and for this hot oil vacuum impregnation / vapor phase process shall be used for improving the electrical and Thermal properties of insulation paper. All materials used in the insulation and assembly of the winding shall be insoluble, non- catalytic and chemically inactive in the hot transformer oil and shall not soften or otherwise be adversely affected under the operating conditions.The conductors shall be transposed at sufficient intervals in order to minimize eddy current and equalize the distribution of currents and the temperature along the winding.

The transformer shall be capable of withstanding thermal and mechanical effects of

short circuits at the terminals of any winding for the periods according to IS: 2026/1977 and BS: 171 without any damage. The component of through fault current shall not exceed the appropriate value given in IS-2026.

Inspection call notice for the purpose should be accompanied with the following documents as applicable as a proof toward use of Prime winding materials:-

a) Purchase Order of the Transformer Manufacturer placed on Copper supplier.
b) Invoice of supplier.
c) Mills test certificates.
d) Packing list.
e) Bill of lading (if imported).
f) Bill of entry certificates by customs (if imported).

Winding material shall be directly procured either from the manufacturer or through their accredited marketing organization of repute and not through any agent.

12. CURRENT DENSITY:

The transformer shall be so designed that the current density at any tap should not exceed 250 A/cm^2 in HV, regulating winding and 200 A/cm^2 in LV winding.

The Purchaser shall be at liberty to inspect built up winding for its quality, weight of copper, insulation and over all weight of coil assembly. The size of conductor used for different windings shall be also be checked during stage inspection to check the current density viz-a-viz guaranteed values.

13. REINFORCED INSULATION:

At each end of H.V. winding an electrostatic shield and/or cap and ring shall be provided so as to increase the ratio of the electrostatic capacity between turns as compared with the electrostatic capacity of the high

voltage winding to earth and to the low voltage winding. High voltage winding shall preferably be interleaved.

14. INSULATING OIL:

Sufficient insulating oil of Naphthenic type (made from Naphthenic crude) conforming to BS: 148/IEC: 296 class-1 shall be supplied for first filling of each transformer. Particular attention shall be paid to deliver the oil at site free from moisture and of uniform quality through-out in non-returnable steels drums. The quantity of oil for first filling of each transformer shall be stated in tender along-with trade mark of the oil to be supplied. Use of inhibitors in oil shall not be resorted to.5% extra oil of the total quantity of oil shall be supplied along with the transformer.

15. SUPRESSION OF HARMONICS:

The transformer shall be designed with particular attention to suppression of harmonic voltages especially the 3rd and 5th. Percentage of harmonics at normal voltage and at maximum system voltage shall be stated in the tender.

16. TANK:

The transformer tank and cover shall be oil tight and shall be fabricated from good commercial grade low carbon steel suitable for welding (IS: 1977/ IS: 2062) and of adequate thickness as specified hereafter. The tank and the cover shall be of fabricated construction. All seems shall be welded and where practicable they shall be double welded. The tank shall be designed and constructed for full vacuum filling of oil and shall be capable of withstanding without leakage or distortion continuous internal gas pressure of 0.7 atmospheres with oil at operating level. The tank cover shall be bolted to the tank and the transformer design shall be such that it shall be possible to move the complete transformer unit by skidding in any direction without injury when using plates or rails.

Inspection covers with welded flange and bolted covers shall be provided on the tank cover. The inspection cover shall be of sufficient size to afford easy access to the lower ends bushings, terminals etc. The inspection windows shall be so designed/provided that the links in the transformer if any are changed (If any).

All bolted connections to the tank and connection between sections of the tank shall be provided with suitable flanges, with properly spaced bolts and suitable oiltight gaskets which shall give satisfactory service under operating conditions.

The thickness of M.S. plate for bottom, sides and top of the tank shall be adequate as per CBIP recommendations & shall be same as that of type tested transformer (short circuit test).

The transformer tank along-with radiators and other accessories shall be tested for vacuum and pressure test as per CBIP recommendations.

Special attention shall be given to the methods of making the hot oil tight joints between the tank and cover as well as between the cover and the bushings and all other outlet to ensure that the joints can be remade satisfactorily and with ease with the help of semi- skilled labour where compressible gaskets are used, means shall be proved to prevent over compression.

Suitable guides shall be provided for positioning the various parts during assembly or dismantlement. Adequate space shall be provided between the core and winding(s) and the bottom of the tank for collection of any sediment.

Lifting eyes or lugs shall be provided on all parts *of* the transformer requiring independent handling during assembly or dismantlement. In addition the transformer tank shall be provided with lifting lugs and bosses properly secured to the sides of the tank for lifting the transformer by using hydraulic or screw jacks.

The design of the tank, the lifting lugs and bosses shall be such that the complete transformer assembly filled with oil can be lifted with the use of these lugs without any damage or distortion.

All bolts and nuts used in connection with tank and fittings shall be galvanized.

The tank shall be provided with suitable lugs for the purpose of grounding with a mild steel flat.

The main body including tap-changing compartments and radiators and coolers shall be capable of withstanding full vacuum of 760 mm of mercury when empty of oil.

In addition, the design of tank, its shape, proportion *of* weight of material and construction shall be such as to best facilitate oil circulation and to ensure against transmission or magnification of noise or vibration which might be injurious or objectionable.

As far as possible the transformer tank and its accessories shall be designed without pockets wherein gasses may collect. Where pockets cannot be avoided pipes shall be provided to vent the gas in to the main buchholz relay pipe. The vent pipes shall have a minimum inside diameter of 15 mm except for short branch pipes which may have 6 mm minimum inside diameter.

The tank cover shall be provided with two pockets for mercury in glass thermometers and three pockets for the bulbs of oil and winding temperature indicators. Bulb/pocket size shall be minimum ten inches. Protection shall be provided where necessary for each capillary tube. The thermometer pockets shall be fitted with captive screwed top covers to prevent ingress of water. The pockets shall be located in the position of maximum oil temperature at CMR and it shall be possible to remove the instrument bulbs without lowering the oil in the transformer tank. Lugs on top cover shall be so positioned that tank cover remains horizontal while lifting.

Each transformer tank shall be fitted with following valves/plugs/gauge with standard screw connections for external piping.

1. One filter cum oil drain valve with plug or blanking flange (size 80 mm/100 mm) and so placed as to completely drain the oil of the transformer.
2. One no. top filter valve size 50 mm near the top of tank diagonally opposite to filter cum drain valve.

3. Three robust sampling valves with spouts suitable for taking samples of top, middle and bottom oil. The top and middle sampling values shall be brought down by internal pipe connections. Suitable name plates shall be affixed to the sampling valves. The Sampling device shall not be fitted on the filter valve.
4. At least two Nos. 15mm air release plugs on top of cover, suitably located.
5. Two pressure relief valve to operate at a pressure below the test pressure for the tank.
6. Suitable number of jacking bolts shall be provided on tank cover inspection to facilitate moving of the transformer and they shall be suitably braced in the vertical direction so that bending does not occur when the pull has a vertical component The Transformer shall be erected on a plinth about 2.5 feet high above the ground level.
7. The transformer tank should be provided with prismatic oil level gauge duly protected from external injury to show the transport oil level.
8. Inspection call notice for the purpose should be accompanied with the following documents as

applicable as a proof toward use of steel of approved makes only:-

a) Work Order of the Transformer Manufacturer placed on Tank Fabricator (if outsourced).
b) Purchase Order of the Transformer Manufacturer placed on Steel Supplier(if done by self) OR Purchase Order of the Tank Fabricator placed on Steel Supplier (if outsourced).
c) Invoice of supplier.
d) Mills test certificates.
e) Packing list.
f) Bill of lading (if imported).
g) Bill of entry certificates by customs (if imported).

Tank material shall be directly procured either from the manufacturer or through their accredited marketing organization of repute and not through any agent.

17. OIL CONSERVATOR (AIR CELL TYPE):

An oil conservator tank complete with sump, filling hole and drain valve shall be mounted and located so as not to do obstruct taking of bare connections from the transformer terminals. The capacity of the conservator tank shall be adequate to meet the requirements of expansion of the total cold oil volume in the T/F and cooling equipment from minimum ambient temperature or minus 5 deg.C to 90 deg.C. The minimum indicated oil level shall be with the feed pipe from main tank cover under not less than 15mm depth of oil and the indicated range of oil level shall be from minimum to maximum.

One magnetic type oil level gauge with alarm contacts shall be mounted at a convenient height to be read from ground level. Oil level of 30 deg. C. shall be marked on the gauge. The conservator tank shall have one oil filling hole with cap at the top and drain valve of appropriate size at the bottom. A gate valve shall be provided at the conservator to cut off oil supply to the transformer. The conservator tank will be designed in such a way that the same can withstand strong wind pressures by adding adequate stiffeners if necessary.

Each conservator shall be fitted with a double compartment breather with oil seal in which silica-gel is the dehydrating agent and designed so that:-

a) The passage of air is through the silica-gel.
b) The external atmosphere is not continually in contact with the silica-gel.
c) The moisture absorption is indicated by a change in colour of the tinned crystals and can be daily observed from distance.
d) All breathers shall be mounted at approximately 1400mm above ground level.
e) The breather should be made of superior quality see through material and should consist of two compartments placed in parallel.
f) In addition to M.O.G. prismatic type oil gauge shall also be provided.
g) Air cell of approved makes shall be provided.

18. EARTHING TERMINALS:

Two earthing pads suitable for connecting 50x8 mm mild steel flat shall be provided at positions close to the two diagonally opposite bottom corners of tank. These grounding terminals shall be suitable for bolted connection. Two earthing terminals shall also be provided each on marshaling box and any other equipment mounted separately.

19. UNDER CARRIAGE:

The transformer shall be supported on a strong structural steel base equipped with forged steel or cast steel single flanged bi-directional wheels suitable for moving the transformer completely filled with oil. Jacking pads shall be provided to make it possible to change the direction of wheel through 90 degree when the transformer is lifted on jacks and permit movement of the transformer both in the longitudinal and transverse direction shall be 1676 mm i.e. the same as that of Indian Broad Gauge Railways. Means shall be provided for locking the swivel movement in position parallel to and at right angles to longitudinal axis of the tank.

Pulling eyes and skids shall be provided to facilitate moving of the transformer and they shall be suitably braced in the vertical direction so that bending does not occur when the pull has a vertical component. The transformer shall be erected on a plinth about 2.5 feet high above the ground level.

20. BUSHING INSULATORS AND TERMINALS:

Transformer shall be fitted with bushing insulators as follows:-

a) LV bushing : 36KV class oil communicating type porcelain bushing of 2000 A rating
b) LV-N bushing : 36 KV class oil communicating type porcelain bushing of 2000 A rating.
c) HV bushing : 72.5 KV class condenser bushing of 800 A rating.
d) HV-N bushing : 36 KV class oil communicating type porcelain bushing of 630 A rating.

Note: Bushings should be suitable for 25 times rated current for 5 Sec.

Bushings for 66 KV and above shall be filled with transformer oil and there shall not be communication with the oil in the transformer. An oil gauge preferably of prismatic type shall be provided to indicate that correct level is maintained.

The electrical characteristics of bushings shall be in accordance with IS: 3347 and IS: 2099. These bushings shall be suitable for Single/Quadra ACSR zebra conductor connections. All bushings shall be equipped with suitable terminals of approved type and size and all external current carrying surfaces shall be adequately silver plated. All ends as well as all tapping on the windings shall be brought to terminals. In case of connection required outside the tank these shall be brought out to their respective terminals through well insulated bushings which shall be detachable and replaceable without disturbing the internal connections. Bushing which pass through the cover shall be removable without disturbing the transformer cover.

The bushings shall have high factor of safety against leakage to ground and shall be so located as to provide adequate electrical clearances between bushings of various voltage and between bushings and grounded parts. Bushings of identical voltages shall be inter-changeable. The insulating class of the high voltage neutral bushing shall be properly in coordination with the insulation class of neutral of the high voltage winding. Clamps and fittings made of steel or malleable iron shall be galvanized.

Each bushing shall be so coordinated with the transformer insulation that all flash-over will occur outside of the tank. All bushings shall have puncture strength greater than dry flashover *voltage.*

All the bushing shall be provided with adjustable arcing horns. During any flash-over across the arcing horns, the arc shall remain away from the bushing insulators.

The bidder is requested to give the guaranteed withstand voltage for the above referred arcing horns and also furnish a calibration curve with different settings of the co-ordination gap to enable the purchaser to

decide the actual gap setting. Bidder's recommendations are also invited in this respect.

Any stress shield shall be considered as integral part of bushing assembly. For voltage 66 KV and above, only condenser type bushings shall be accepted.

21. CENTRE OF GRAVITY:

The Central of gravity of the assembled transformer shall be low and as nearthe vertical centre line as possible. The transformer shall be stable with or without oil.

If the centre of gravity is eccentric relative to track either with or without oil, it's location shall be shown on the G.A. drawing.

22. JOINTS, GASKETS AND VALVES:

All gaskets used for making oil tight joints shall be of proven material such as granulated cork bonded with synthetic rubber. The material used should not deteriorate under the action of hot oil. All valves up-to and including 100mm shall be of gun metal or ~~of~~ cast steel and larger valves may shall be of gun metal or may have cast iron bodies with gun metal fittings. They shall be of full way type with internal screw and shall open when turned counter clockwise when facing the hand wheel. Means shall be provided for padlocking the valves in the open and close position. Every valve shall be provided with flanges having machined faces. The drilling of valves flanges shall comply with the requirement of IS: 2026/IS 3639.

23. CLEANING AND PAINTING:

While in service the equipment will be subjected to extremely severe exposure to atmosphere, pressure, high humidity and to long periods of high ambient temperature. All corrodible parts and surfaces shall be of such material and shall be provided with such protective furnish that no part of the installed equipment is injuriously effected by atmospheric conditions.

The whole of the exposed portion except bright parts shall be thoroughly cleaned by sand blasting and painted with two primary and two secondary coats of approved rust resisting paint in light grey colour (shade 631 of IS :5).

Min. 5 Litres of spare paint suitable for primary and secondary coats shall also be supplied to cover the damage to paint work which may be experienced during transportation.

24. MARSHALLING BOX:

A sheet steel vermin proof well ventilated and weather proof marshaling box of a suitable construction shall be provided for the transformer auxiliary apparatus. Wiring up- to marshaling box shall be with PVC/SWA, PVC copper cable 660/1100 volts grade.

The marshaling box shall accommodate the following equipment:

a) Temperature indicators.

b) Terminal blocks and gland plates for incoming and out-going cables and control/protection equipment.

All the above equipment except (c) shall be mounted on panels and back of panel wiring shall be used for inter-connection. The temperature indicators shall be so mounted that the dials are not more than 1600 mm from the ground level and the door(s) of the compartment(s) shall be provided with glazed window of adequate size. The transformer shall be erected on a plinth which shall be 2.5 feet aboveground level.

To prevent internal condensation, an approved type of metal clad heater with thermostat shall be provided, controlled by water tight single pole iron clad rotary switch mounted on outside of the box. The ventilation louvers, suitably padded with felt shall also be provided to prevent ingress of dust. The louvers shall be provided with suitable felt pads to prevent ingress of dust.

All incoming cables shall enter the kiosk from the bottom and the gland plate shall not less than 450 mm from the base of the box. The gland plate and associated compartment shall be sealed in suitable manner to prevent the ingress of moisture from the cable trench.

25. CONTROL CONNECTION, INSTRUMENT WIRING, TERMINAL BOARDS &FUSES

All wiring connections, terminal blocks, fuses and link shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resisting insulation.There shall be no possibility of oil entering connection boxes used forcables and wiring when 415 volts connections are taken through junction boxes or marshaling boxes they shall be adequately screened and 415 volts danger notice must be affixed to the outside of junction boxes or marshaling boxes. All wiring shall be in accordance with relevant ISS. All wiring shall be with stranded copper of 660/1100 volts grade and size not less than 4.00 Sq. mm for CT leads and not less than 2.5 Sq.mm for other connections.

All wires on panels and all multi-core cables shall have ferrules which bear the same number at both ends. The same ferrule number shall not be used on wires in different circuits on the same panel. Ferrules shall be of white insulation material and shall be provided with glossy finish to prevent adhesion of dirt. They shall be clearly and durably marked in black and shall not be affected by dampness or oil. Wiring shall in general be accommodated on sides of the box and wires for each circuit shall be separately grouped. Back of panel wiring shall be arranged so that access to the connecting stems of relays and other apparatus is not impeded. All the cables and capillary tubes of OTI& WTI, etc are to be wired properly on cable trays with the helpof suitable cleats upto the marshaling box.

Wires shall not be jointed or tied between terminal points. Wherever possible all circuits in which the voltage exceeds 125 volts shall be kept physically separated from the remaining wiring. The function of each circuit shall be marked on the associated terminal blocks.

Where apparatus is mounted on panels, all metal cases shall be separately earthed by means of copper wire.

No live metal part shall be exposed at the back of terminal board.

All fuses shall be of cartridge type and fuses and links shall be labeled.

All wiring diagrams for control panels shall preferably be drawn as viewed from the back. The overall design of wiring shall be such that various wires and ends of the same wire can be traced easily and there is convenience to access the terminations and ferrule number shall be readable with convenience.

26. DRYING OUT AND ERECTION:

The transformer shall be dried out by an appropriate method at the manufacturer's works and so arranged for transportation and storage that it may beput into service without further drying out at site. For any subsequent drying whichmay be necessary at site the manufacturer shall give details of the method recommended for using the same.

The transformer shall be designed to withstand pressure and vacuum tests asspecified by CBIP specification for power and distribution transformers.

i) Vacuum of 760mm of mercury applied to tank and cooling equipment whenempty of oil.

ii) Pressure of 508mm of mercury applied to tank and cooling equipment whenempty of oil.

iii) Pressure of 5 psi to be applied at conservator on fully assembled transformer when full of oil.

Clear instruction shall be given in the maintenance manual regarding special precautionary measures e.g., strucking of tap changer barrier or tank cover whichmust be taken before applying the specified vacuum treatments. The maximum vacuum

which the complete transformer filled with oil, can safely withstand without any special precautionary measures being taken shall also be stated in the maintenance manual. The bushing shall be capable of withstanding vacuum operation when drying the transformer.

27. DRAWINGS:

As soon as possible after the letter of award and keeping in view delivery schedule the manufacturer shall supply three copies of the following drawings in min. A3 size, which will describe the equipment in detail for approval by the Purchaser. Purchaser (i.e. Punjab State Power Corp. Ltd. (PSPCL), purchaser's ref. No. (i.e. P.O. No. & date, specification No.), Rating of Transformer should invariably be specified on each drawing. Bill of material in respect of each drawing must indicate the quantity, make and specification of each items.

i) Detailed outline General Arrangement drawing showing plan, front elevation, side elevation with all fittings and accessories etc. The following information must be specifically included on this drawing.
   a) Make of transformer oil.
   b) Electrical clearances, minimum as well as actual.
   c) The no. of radiator headers, number of radiator elements in eachheader.
   d) A small sketch showing un-tanking details.
   e) Thickness of transformer tank bottom, side & top plates.
   f) Type, shade, shade no and thickness of transformer paint.
   g) Roller, rail gauge sketch.
   h) Weight of oil, bare copper weight, windings, core, un-tanking mass, transportation mass and dimensions etc.

ii) Detailed drawing of bushings showing plan, elevation, terminal details, mounting details, make and type number, incorporating electrical characteristics, description of various parts, total creepage/protected creepage distance, weight of oil, total weight of bushing, dimension, short time rating etc.

iii) Transportation sketch showing dimensions and weights of the heaviest package & the shipping arrangements of the transformer.

iv) Rating and diagram plate.

Note: Bushing CT's for WTI‟s are to be provided on HV side. VA burden of BCT's should be 15 VA and accuracy class of BCT's should be **at-least 0.5**. Bare copper weight & weight of core should be invariably specified on the rating plate.

v) Detailed structural drawings for the transformer tank, under carriage conservator, radiators etc.

vi) Dimensional drawings of multi bolt bimetallic connectors for line ends and flexible connectors for the neutral) ends.

vii) General assembly of marshalling box. The plan view showing foundation details must be specifically included if this cubicle box is separately mounted.

viii) Wiring diagram/cabling details of control cubicle showing connections with RTCC, WTI, MOG etc.

ix) General Assembly of remote tap change control panel (RTCC)including:

a) Plan view showing foundation details indicating all audio/ visual indications.

b) Wiring diagram of RTCC panel.

c) Additional alarm and indication circuit in RTCC.

x) ON LOAD TAP CHANGER DRAWING

a) Schematic diagram of OLTC scheme along-with detail write up explaining the sequence of operation and functions of each equipment, along-with its location having master follow up operation.

b) All drawings of OLTC viz. O.D.drg., diagram of connections for drive mechanism, wiring diagram of tap change control panel.

xi) Wiring diagram/cabling details showing inter connections between motor drive-RTCC and marshaling box/control cubicle.

xii) CORE DESIGN DRAWING

a) Core dimensional drawing showing core frame size limb and yoke sections along-with step details and calculations for flux density & core weight**.**

b) Calculations for no load current, no load losses and characteristics of the core material shall also be furnished.

xiii) HV, LV and Regulating winding conductor cross-sections along-with calculations for current density.

xiv) Thermo-syphone arrangement drawing, showing tray details,internal tray arrangement and removal of tray assembly etc. showing dimensions, qty. of oil and sorbant used.

xv) Roller stopper arrangement drg.

28. (a) ADDITIONAL DRAWINGS:

The following drawings shall be supplied for reference and record inaddition to the above drawings enlisted from (i) to (xv):

(i) Schematic diagram showing flow of oil in the cooling system as well aseach limb of core and winding and cross sectional views showing duct sizes, cooling pipes etc. for the transformer/heat exchanger drawn to scale shall be furnished.

(ii) Large scale drawing of high and low voltage windings of transformer showing the nature and arrangement of insulation and terminal end connections.

(iii) Drawing showing sectional view of the HV&LV windings when viewed from top.

(iv) Detailed drawings of conservator mounted on position.

(v) Valve & plug schedule plate indicating the location of various valves on thetransformer mentioning the functioning of each.

(vi) A schedule showing the requirement of set of spare gaskets.

(vii) Any other drawing considered necessary by the Purchaser.

33. (b) INSTRUCTION MANUALS:

The successful bidder shall be required to supply 5 sets (4 sets alongwith the transformer to the consignee & 1 set to the purchaser) of instruction manuals per transformer, each properly bound in hard cover and soft copies in 5 Nos. CD (4 CDs alongwith the transformer to the consignee & 1 CD to the purchaser).

i) All drawings listed above.

ii) Erection, operation & maintenance manual for transformer/ OLTC and pamphlets for all spare parts e.g. OTI, WTI, MOG, OLTC, Buchholz relay,silica-gel and breather/pressure relief value etc.

iii) Instructions for dehydration, if any.

iv) Precautions prior to vacuum application, if any.

v) Any other information/data/documents/instructions considered necessary by the manufacturer for efficient functioning of the transformer.

Note: Four sets of instruction manuals & four sets of test results of the transformer shall be dispatched along-with the transformer to the consignee failing which transformer shall be considered supplied as incomplete. One set of Instruction manual per transformer shall be supplied to the purchaser.

29. GUARANTEED DATA AND OTHER PARTICULARS:

Guaranteed data and other technical particulars of the transformer offered shall be furnished by the Bidder in accordance with Annexure-"B" (class-13.1) of IS- 2026/1977 (part-I) and Annexure-A of this specification.

30. PLACE OF MANUFACTURE, TESTING AND INSPECTION:

The Bidder shall state in his tender, the place (s) of manufacture, testing and inspection of various portions of the work included in the tender.

The Purchaser‟s duly authorized representative shall have access to the manufacture's works at any time during working hours for the purpose of inspecting the manufacture and testing of materials, equipment and completed plant and the supplier shall provide necessary facilities for inspection.

31. INSPECTION AND TESTING:

The successful bidder shall submit complete set of drawings as already brought out in this specification within 15 days from the receipt of Letter of Award along-with the drawings (also refer clause No. 46) the suppliers will furnish the following intimation:-

a) Schedule of Manufacturing of the transformer.

b) Name of the Vendor from whom cutting of CRGO & processing of copper shall be made, in case the facilities do not exist at the supplier work.

c) Name of Sub-Supplier for manufacturing of tank.

d) The quality assurance program of the vendors/sub-Suppliers.

e) Make of the CRGO, Copper, Insulating Paper, Press Board, Tank Steel etc. Purchaser can inspect the raw material, manufacturing process at sub-supplier works for which advance intimation on manufacturing activities shall be given. All the external test reports shall be submitted to the office of the. SE/SS(D), PSPCL, Patiala directly by the testing agency.

STAGE INSPECTION

Stage inspection of transformer oil, Core Slitting, built up core (in horizontal/vertical position), windings, tank, radiators & oil filling shall be carried-out as detailed below:-

a) Transformer Oil:

Sufficient quantity (along with 5% extra) of insulating oil of Naphthenic type made from Naphthenic crude) conforming to BS: 148/IEC: 296 class-1 shall be put up for inspection at-least 3 weeks before putting up the transformer for testing/inspection of sub-supplier's works as per IS : 335/BS/IEC. The oil samples will be sealed by the inspecting officer & sent for testing by firm at any of the CPRI labs/ERDA and also PSPCL Patiala Lab. charges for which shall be borne by the firm.

b) Core Slitting:

Bidder should preferably have in house core slitting/cutting facility for proper monitoring & control on quality and also to avoid any possibility of mixing of prime material with defective/second grade material. The purchaser may witness the core- slitting operation. In case the in-house core- slitting facility is not available, then the same shall be carried out in the presence of the representative of PSPCL. Laminations shall be checked for burrs during stage inspection.

Sample of Core tested by inspecting officer at the works of the firm & in case the facility is not available, then the samples shall be sealed by the inspecting officer & sent for testing by firm at any of the CPRI labs/ERDA. Charges for the same shallbe borne by the firm.

c) Core Assembly:

i) Measurement of flux Density.

ii) Tests of CRGO sample taken from the core shall be carried-out for Carlite test (Resistance Measurement), Watt Loss Test, Lamination Thickness & Ageing Tests.

iii) Physical inspection for quality of workmanship.

iv) Verification of core frame size & core weight by taking dimensions ofLimb, Yoke & Window height, etc.

d) Winding:

i) Measurement of Cross-sectional area for current density.

ii) The measurement of weight of bare copper/cover copper by ResistanceMethod, ID/OD method, Per unit length methods.

iii) Check w.r.t. transposing of conductor at sufficient intervals.

iv) Sample of Copper will be sealed by the inspecting officer & sent for testingby firm at any of the CPRI labs/ERDA. Charges for the same shall be borneby the firm.

e) Tank:

i) Vacuum Test.

ii) Pressure Test.

iii) Dye Penetration Test

iv) Paint Peel-off Test.

v) Test on welded joints such as X-Ray testing shall be carried out on minimum one unit witnessed by PSPCL inspecting officer.

External paint shall be that already specified for the transformer & internalpaint/varnish will be as per the relevant Standard.

Note: For permissible deflection as per CBIP for pressure and vacuum test, Horizontal width shall be taken between nearest stiffeners.

f) Radiators:

Radiator shall be routine/type tested at sub-supplier works as per relevant standards. The supplier shall submit the RTC for all the radiators to the effect that the same have been routine tested in water at the specified pressure for 30 mins.The purchaser shall carry out routine tests on 20% samples randomly drawn from the inspected lot. 1 no. radiator from each lot will be subjected to the type tests.

External paint shall be that already specified for the transformer & internal paint/varnish will be as per the relevant Standard.

g) **Oil filling:** Oil filling shall be witnessed by inspecting officer at firm‟s works to ensure that oil filling is done under vacuum.

ROUTINE TESTING:

All Routine test shall be carried-out on each transformer as per IS-2026/IEC-76 & IEC-354.

TYPE TESTING

Following type tests and over-load withstand capacity as per IEC-354shall be carried-out as per IEC-76/IEC-354 & IS-2026: -

i) Temp Rise Test (For both type of cooling‟s) on 20% of the orderedquantity of each rating at random & surprise basis.

ii) Impulse Voltage Withstand Test with chopped impulse on any onephase. The impulse test shall be carried out on one unit of each rating.

iii) Power Drawn by cooling fans /oil pumps as per IS: 2026.

iv) Short Circuit Test may be carried- out on one of the units of each ratingsubject to the conditions of relevant clause.

Note: (i) & (ii) shall be done on the power transformers to be selected at thediscretion of the purchaser but shall be conducted during final testing only.

SPECIAL TESTS.

i) DGA Test before and after temp-rise test.

ii) Measurement of Tan Delta & Capacitance of Transformer windings andbushings at 5 KV & 10 KV on all units.

iii) Magnetic balance test on all units.

iv) Measurement of percentage impendence at all taps at low voltage on all units.Charges of all the above tests shall be included in the quoted prices.

NOTE:

a) The insulation resistance values of the transformer windings will be recorded at the time of carrying out routine test for one minute, ten minutes with the help of 5000V ***Digital insulation tester/*** motorized meggar (Reputed MAKE). The polarization index values (ratio of 600/60 sec. value will be accordingly calculated and recorded in the test certificates and it should not be less than 1.5. The sequence of measurement of PI values will be as under:

1. HV-Earth
2. LV-Earth
3. HV-LV

Windings should be discharged in-between so that there is no residual polarization in the windings.

b) Dissolved gas analysis test shall be got carried-out before and after the heat run test at any of the CPRI labs/ERDA/works of supplier.

c) Capacitance and Tan Delta values for each transformer and condenserbushings will be taken and recorded in the test certificates at 5 KV &10 KV. Insulation Resistance value of condenser Bushings shall also be recorded.

d) Pressure/vacuum test on empty tank and oil leakage test as per CBIP however, vacuum test shall be carried out at full vacuum.

e) Lightening impulse test with the chopped wave applications as per clause- 13 of IS: 2026/1981 (Part-III) amended up-to date. This test will be carried out on one of the limbs of HV and LV winding with positive polarity.

f) S.C. test shall be carried-out if not already carried out on the offered design and rating. However it can be carried out on one unit if necessary.

g) The bidder should clearly indicate the testing facilities available with them and test which are to be arranged outside.

Oil filling shall be witnessed by inspecting officer at firm‟s works. Supplier shall submit in house test certificates before final testing of T/F. For Testing of T/F, all measuring Instruments shall be of highest efficiency and best quality. For winding resistance measurement, digital instruments shall only be used. These shall be got calibrated form NPL/Govt. Agency and be got sealed by calibrating agency in the temper proof fashion. PSPCL reserves the right to calibrate the instruments in the manner it desires.

Losses shall be measured with “POWER ANALYZER” method only. Resistance shall be taken with Digital measuring instrument only. LV resistance can be measured with both phase to phase &

phase to neutral method, but in no case it should exceed the value mentioned in the GTP. Losses can be measured Directlyfrom CT‟s and PT‟s and not through the panel. Ratios of the measuring instruments shall be such that the multiplying factor is the minimum.

All tests shall be carried out in the presence of the Purchaser before dispatching the material. A copy of the final inspection/test report carried out by PSPCL inspecting officer will be submitted to the Purchaser for approval. No material shall be dispatched without prior inspection and approval of test certificates unless otherwise agreed to. Type and routine test certificates of all bought out items from recognized testing agency shall be submitted alongwith the final inspection/test report. OLTC scheme

including the master follower functioning shall also be checked. Only fully assembled transformer including mounting of radiators shall be put-up for inspection.

32. TESTING OF TRANSFORMER OIL:

The transformer is to be supplied oil filled. Sufficient quantity (along with 5% extra) of insulating oil of Naphthenic type made from Naphthenic crude) conforming to BS: 148/IEC: 296 class-1 shall be put up for inspection at-least 3 weeks before putting up the transformer for testing/inspection of sub-supplier's works as per IS : 335/BS/IEC. The inspected oil shall be filled in the Transformer under the direct supervision of inspecting officer. The oil will also be got tested from any of the CPRI labs/ERDA and PSPCL Patiala Lab. by the firm**.** Oil tests being conducted at Oil Testing Lab PSPCL, Patiala Rs. 5000/- should be deposited as oil testing charges per sample & in case oil sample fails, same charges will be got deposited from thefirm for repeated tests.

Oil other than filled in the transformer would be dispatched in non -return-able sealed drums epoxy coated from inside.

33. FOUNDATIONS AND FIXINGS:

All plant and equipment shall be provided with a complete set of foundation bolts, washers, nuts, plates and other fixtures as may be required and these shall be supplied by the supplier. These fittings shall be fixed by the Purchaser in the foundations, unless otherwise specified. All foundations bolts, fixtures etc. shall be supplied as soon as possible after the contract drawings have been approved.

34. PACKING, DESPATCH AND DELIVERY:

The Supplier shall be responsible for suitable packing of all equipment and marking of the consignments so as to avoid any damage during transit, storage and to ensure correct dispatch to the destination. The LV bushings if mounted on the transformer during transportation should be suitably protected with Steel Plate Cover. Damages due to

improper packing shall be to supplier's account. All parts requiring protection from moisture shall be especially packed to prevent ingress of moisture. No parts of any kind shall be packed inside other larger parts. Heavy parts shall be so mounted that there is no difficulty in attaching slings etc. for unloading at destination.

All parts shall be adequately marked to facilitate field erection. Boxes and crates shall be marked to facilitate field erection. Boxes and crates shall be marked with contract number and shall have a packing list enclosed showing the parts contained therein.

The weight and dimensions of the heaviest package of transformer shall be so arranged by bidder that the transformer can be transported up-to site in Indian Railways. It will be the entire responsibility of the supplier to obtain clearance from Indian Railways on all matters connected with dispatch of transformer and its accessories and their receipt.

The transformer is to be supplied oil filled, as such the escort should be provided to avoid theft/pilferage of oil/any other item.

35. TOOLS:

The transformer shall be supplied with a set of special tools if considered necessary for assembling and dismantling of transformer. The details of the tools etc. included in the offer shall be given along-with its item-wise prices.

36. SPARES;

A) **COMPULSARY SPARES**

Following spares shall be compulsory with each unit and the cost of the spares shall be included in the quoted price. No separate charges shall be paid for the spares.

a) Two Nos. PRV for main T/F.
b) One set (2Nos.) silica-gel breathers for main tank.
c) One set (2Nos.) silica-gel breathers for OLTC.
d) One No. refill (sorbent activated alumina) for Thermo-siphon.

B) OPTIONAL SPARES

The itemized prices for following spares and any other recommended to spares shall be given in the tender on F.O.R. destination basis like the transformer.

Sr. Description ....

Qty. No (Nos.) ....

1. HV bushing (complete assembly) 72.5 KV 800 Amps.
2. LV bushing (complete assembly) 36 KV 2000 Amps.
3. HV neutral bushing assembly 36 KV 630 Amps.
4. LV neutral bushing assembly 36 KV 2000 Amps.
5. WTI dial type along-with capillary tubing and repeater.
6. OTI dial type along-with capillary tubing and repeater.
7. Main buchholz relay.
8. Oil surge relay.

NOTE:

i) Bushing Assembly quoted under this category shall not be equipped with terminal connectors.

ii) Voltage & current rating of each bushing should be clearly mentioned.

The Ex-Works Price, ***GST*** applicable, F&I etc. shall be mentioned clearly against each item given above for comparative evaluation.

37. MOTORS: -

1. The motor shall be squirrel cage, totally enclosed weather proof type suitable for direct starting and for continuous running from 415/240 volts, three phase/single phase 50 HZ supply. The motors shall comply with IS as applicable for continuous rated machine.
2. All motors shall be capable of continuous operation at frequency 50 Hz with variation of +/-3% and
3. 415/240 V AC with 10% variation of the normal voltage without injurious over-heating.
4. All motors shall have ball or roller bearing with hexagonal nipples for greasing. In case of vertical spindle, motor shall have bearing capable of withstanding thrust, due to weight of the moving parts.
5. Varnished cambric or glass insulator shall be used for connections from stator winding to the terminal suitable for external wiring. The motor terminals shall be of stud type and totally enclosed.

38. COOLER CONTROL: -

1. Each motor or group of motors shall be provided with a 3 pole electrically operated contactor with control gear for motor operation by hand and automatically through winding temperature indicator. Provision shall be made for over load protection but no volt release coil shall not be provided.
2. All connection shall be so arranged as to allow either individual or collective operation of the motors. Alarm indication (audio and visual) for failure of fansand to indicate failure of power supply shall be provided.
3. The control equipment shall be installed in the marshaling box as specified in Clause - 29 in a readily accessible position.
4. The alarm indication for failure of power supply and failure of individual fans be provided through independent non trip alarm scheme to be wired on the remote tap change control cubicle conforming to the following: -

   i) The closing of an initiating contact shall actuate a buzzer and will be accompanied by a flag indication on the concerned auxiliary relay.

   ii) The closing of an initiating contact shall glow a lamp, which will not re-set until the fault has been cleared.

   iii) It shall be possible to silence the buzzer by pressing „Accept‟ push button. If, after canceling the alarm but before resetting the visual signal, the same fault persists the buzzer shall be suppressed.

iv) If after canceling the alarm but before resetting the visual signal, some other fault takes place, the alarm accompanied by flat indication on appropriate auxiliary relay shall take place.

v) If after canceling the alarm and after resetting the visual signal, the same fault appears or some other fault take place, the alarm, flag indication and non-trip lamp indication shall reappear as usual.

vi) The non-trip alarm acceptance shall be by means of push button and resetting of visual signal may also preferably be done through a push button.

vii) Means shall be provided for test checking the lamp and alarm circuit at frequent intervals.

viii) The equipment shall be suitable for 220 Volt DC operations.

Static facia annunciator conforming to the foregoing requirements of non-trip alarm scheme too would be acceptable.

39. ON-LOAD TAP CHANGER

The make of OLTC shall be as per the Approved vendor list. The firm will specify the preferred model/type of OLTC of the approved make it intends to use atthe time of tender evaluation alongwith the type test of the same. The same will be approved at the time of approval of drawings, in case an order is placed on the firm.

The OLTC shall be of preferably the same model/type as that with which the short circuit test has been carried out on the power transformer. In case, the firm intends to use any other model/type at a later stage, type test certificates for thesame will have to be submitted.

Each transformer shall be provided with an On-Load Tap Changer for varying the effective transformation ratio while the transformer is on Load and without providing phase displacement. The salient features of the OLTC shall be as under: -

The tap changing mechanism should be suitable for remote control operation from remote control panel in the control room in addition to being capable of local manual as well as local electrical operation.

The On Load Tap Changer shall include the following:

a) An oil immersed tap selector and arcing switch on arc suppressing tap selector, provided with reactor or resistor for reduction of make and break arcing voltages, over loads and short circuits.

b) Motor driven mechanism.

c) Control and protection devices.

d) Local tap changer position Indicator.

e) Manual operation device.

f) Make of OLTC - Indigenous make (type test certify certificates from CPRI).

g) Voltage rating-66 KV

h) Current rating-400 Amp. for 31.5 MVA and 300 Amp. for others

i) Control voltage-220 Volt (AC).

The on-load tap changer shall be designed so that the contacts do not interrupt arc within the main tank of transformer. The tap changer selector and arcing switch on arc suppressing tap selector switch shall be located in one or more oil filled compartments. The diverter switch should be provided with gas vent and buchholz relay/OSR. It shall be designed so as to prevent the oil in tap selector and diverter switch compartments from mixing with the oil in transformer. The barrier Board between OLTC and the T/F tank shall preferably be made of silicon bonded resin paper (SBRP)/ fiber glass. The tap changer shall be capable of permitting parallel operation with other transformers of the same type. The transformers shall give full load output on all taps without exceeding the limit of permissible temperature rise in oil and winding. The manual operating device shall be so located on the transformer that it can be operated by a man standing at the level of transformer track. It shall be of robust construction and shall be capable of frequent operations. It shall not be possible to operate the electric drive when the manual operating gear is in use.

Necessary interlocks blocking independent control when the units are in parallel shall be provided.

The controls shall be so arranged as to ensure that when a tap change operation has commenced, it shall be completed independently of the operation of control relays or switches. Local or remote-control switch shall cause one tap movement only until, the control switch has returned to the off position between successive operations. Under abnormal conditions such as may occur when the contactor controlling one tap change sticks, the arrangement must be such as to switch off supply to

the motor so that an out of step conditions is limited to one tap difference between the units. Limit switches shall be provided to prevent over running of mechanism.

The transformer and the tap changing equipment shall be designed to permit full rated operation with tap changing equipment temporarily installed in any intermediate position. Details of out of step protection provided for the taps should be furnished in the tender.

The control scheme for the tap changer shall be provided for independent control of the tap changer when the transformers are in independent service.

In addition, provision shall be made to enable parallel control also so that the tap changers of two or more transformer will be operated simultaneously when one unit is in parallel with another so that under normal conditions the tap changer will be become out of step and this will eliminate circulating current. Additional features like “Master/Follower" and visual indication during the operation of motor shall alsobe incorporated.

A mechanical tap position indicator shall be provided on the tap changer in addition to remote indication equipment in the control room on remote control cubicle of OLTC. Necessary inter locks, for independent control when the units are in parallel shall be provided.

The whole of the motor drive unit comprising the motor and its control gear including contactors indicator, local electrical push buttons, five-digit operation counter, handle for manual control etc. as well as terminals for the control and indication wiring shall be housed in a dust proof kiosk mounted on the tap changer. A heating element with thermostat and a switch shall also be provided in kiosk for ensuring trouble free operation of the drive-in cold weather. Arrangement shall be made for padlocking the kiosk. Tap position indication shall be visible by a number appearing in a small glass window on the front of the kiosk. For remote indication, an indication type instrument or digital type shall be provided on the panel.

Any enclosed compartment not oil filled shall be adequately ventilated. All contactors, relays coils or other parts shall be suitable protected against corrosion or deterioration due to condensation, fungi etc.

The oil in the compartments of the main tap changing apparatus which do not contain contacts used for making or breaking current shall be maintained under conservator head by means of a pipe connection from the highest point of the chamber to the conservator. This connection shall be controlled by a suitable valve and shall be arranged so that any gas leaving the chamber will pass into the gas and oil actuated relay. A separate oil surge relay with trip contacts, shall be provided for the on-load Tap Changer Chamber.

Each compartment in which the oil is not maintained under conservator head shall be provided with a suitable direct reading oil level gauge.

A permanently legible lubrication chart shall be fitted with the driving mechanism chamber.

Local electrical control switches and the Local operating gear shall be clearly labeled in suitable manner to indicate the direction of operation of tap changer.

The prices shall include necessary indoor and outdoor equipment except for power and control cables (between the tap chamber and control room) which will be provided by the purchaser based on the information furnished by the Bidder. Complete particulars of the on-load top changer gear including the capacity of the motor shall be stated in the tender.

The remote-control panel of OLTC gear to be installed in the control room should match in colour and dimensions with the purchaser's transformer control panel for which detailed would be furnished to the successful bidder.

In addition to the fittings, auxiliaries and accessories considered necessary by the bidder the following shall be provided:

A) FOR LOCAL ELECTRICAL CONTROL

i) Raise/lower selector switch with an intermediate 'OFF' position.

ii) Auxiliary transformer (if necessary) along-with fuses and links.

iii) Step by step contactor.

iv) Thermal Over-Load Relay for the motor.

v) Reversing contactor.

vi) ON/OFF automatic trip air circuit breaker for motor supply.

viii) Local/Remote change over selector switch.

B) <u>FOR REMOTE ELECTRICAL INDEPENDENT CONTROL</u>

i) All equipment listed in (A) above.

ii) Tap position indicator for mounting on control panel in the control room.

iii) Single lamp and buzzer, for indicating "Tap change in progress".

iv) Raise/lower switch push button type with intermediate off/position for remote-control.

v) Emergency stop button (push button type) with ~~video~~ ***visual*** indication.

vi) Visual and alarm indication for non-completion of operation within pre-set time.

vii) Provision of interlocking system for blocking independent control when the units are to run in parallel by providing inter lockable phase sequence selector switch.

viii) All audio/visual indications should be brought to the RTCC panel. **Local/Remote Switch installed on OLTC Panel: Additional 01 NO & 01 NC contacts shall be provided for taking signal to RTCC for SCADA purposes.**

RTCC: RTC position indicator should be SCADA compatible having Output signal of 4-20mA for SCADA purposes.

NOTE: All equipment and their connections in RTCC panel should be properly marked. The buzzer/bell (industrial type) should be provided.

C) <u>FOR SIMULTANEOUS PARALLEL OPERATION OF TRANSFORMER:</u>

i) All equipment listed in (B) above.

ii) Out of step relay along-with auxiliary relays, contactors and other equipment including a buzzer

iii) and single lamp to indicate the out of step indication when transformer in one of pair of group of rating in parallel are one tap out of step and also to trip the circuit breaker. .

iv) Control selector switch to enable to run a transformer as "Master/Follower" or independent in a group.

v) Selection switch for individuals/parallel operation.

D) <u>ADDITIONAL PROVISION ON REMOTE CONTROL PANEL:</u>

In addition to all the equipment listed above, the following additional provisions shall be made on the remote-control panel.

i) Switch for remote/manual electrical control of fan motor. Separate switch shall be provided for each fan motor.

ii) Remote lamp indication for fans' working.

iii) Audio/Visual indication for supply failure to fans suitable for 220V ACoperation.

iv) Remote winding and oil temp. indicators.

v) DC supply isolators, DC supply on indication & DC failure hooter along-with cancellation.

40. <u>THERMOSYPHON FILTER ARRANGEMENT:</u>

Thermo-syphon filter arrangement shall be provided on the transformer for preserving the quality of transformer oil. The filter assembly shall be mounted on the transformer as well as ground supported and connected with pipes and shut off valves. Suitable instructions required to be followed for commissioning, dismantlement & maintenance of the filter arrangement, re-generation and storage of the adsorbent etc. must be included in the instruction manual. A detailed drawing showing internal arrangement shall also be required to be submitted. Suitable capacity pump (along-with motor) shall also be provided to boost circulation of oil. The pump and motor should not be in main pipeline. It should be in bypass pipe line having suitable valve to isolate from main pipe line. The main pipe lines should have two shut off valve at the bottom.

Note: The pump and motor should be weather proof (Flow well Type).

The oil & sorbent capacity required in the Thermo-Syphon Filter is as under:

i)	Qty. of oil	2.0 % of total oil by wt.
ii)	Qty of sorbent	1.25% of total oil by wt.

Note :

1. Oil conservator tank for main transformer, OLTC, Transformer bushing shall be suitable to take care of oil expansion upto 115 deg. C or more. If the oil temperature rises beyond 115 deg. C a release should be provided.
2. Tap changer Terminal Connectors, Current transformers etc. shall be rated to 1.8 times the highest current rating at any tap.

41. <u>DELIVERY</u>:

The delivery schedule of the transformers under procurement is as under please:

"Commencement with one unit within two months from the date of approval of drawings and completion in 10 equal monthly instalments thereafter. The exact quantity (size wise and month wise) will be stipulated in the Purchase Order depending upon the ordered quantity. The drawings shall be submitted by the firm within 15 days from the date of issue of Letter of Award and these drawings shall be approved by the purchaser within 15 days after the receipt of drawings & additional 3 days shall be allowed for postal transit time.

Further, if the supplier delayed the submission of the drawings/clarifications regarding the

drawings beyond 15 days, then the deemed date in regard to Contractual Delivery Period shall be considered from 15 days for drawings submission from the date of issue of Letter of Award and 15 days for drawings approval after the receipt of drawings & additional 3 days for postal transit time.

Further, the quantity to be procured may be changed as per actual requirement even after placement of PO and the firm is required to take timely prior consent from PSPCL before offering any quantity for Stage/Final Inspection."

SECTION-II-B

FITTINGS AND ACCESSORIES:-

Each transformer shall be complete with the following fittings and accessories:

1. One 150mm (6") dial type indicating thermometer (OTI) of robust pattern mounted on the side of the transformer at a convenient height to read the temperature in the hottest part of oil and fitted with alarm and trip contacts. Provision in the OTI for connection to repeater in RTCC shall also be provided.
2. 2 Nos. 150mm dial type winding hot spot temperature indicators (WTI) placed in HV/LV winding as described below:-

   It shall be indicating type responsive to the combination of top oil temperature and winding current calibrated to follow the hottest spot temperature of transformer winding. The device shall have *an* additional pointer to register the highest temperature reached. Each winding temperature indicator should have three sets of contacts. Two contacts of the one of the WTI shall be used for trip and alarm purpose, wiring of which will go to the main control and relay panel of the transformer (external control cables from the marshaling box to the C&R panel to be provided by the purchaser).

   Third set of contacts shall be spare. Provision in the WTI for connection to repeater in RTCC shall also be provided.

   The contacts of each WTI should be adjustable to close between 60^{0}C to 120^{0}C and shall reopen when the temperature has fallen by any desired amount between 10^{0}C to 25^{0}C. However, supplier should mention in the manuals the actual adjustable settings of these contacts".

Repeaters for both WTI s shall also be provided in the RTCC panel.

3. One conservator along-with two no. shut off valves, oil surge relay, breather connecting pipe etc. exclusively for OLTC.
4. Two pressure relief valve/device (PRV) of minimum 6 inch size for main tank and one No. PRV for OLTC of size 3 inch (approx.) with provision for trip contacts.
5. Two nos. PRV should be provided on the T/F on opposite sides.
6. Inspection covers with jacking bolts in the top cover plate of the tank.
7. One filter cum oil drain valve with plug or blanking flange: size 80mm.
8. One filter valve at top of transformer tank size 50 mm.
9. Three oil sampling valves for taking samples of top, middle & bottom oil.
10. Set of lifting lugs/jacking lugs and eye bolts on all parts for ease of handling.
11. One double float gas/oil surge detecting (Buchholz) relay in the pipe connecting the conservator with tank, complete with alarm and tripping contacts to detect accumulation of gas and sudden

change of oil pressure, complete with two shut off valves on conservator side as well as tank side and a coupling to permiteasy removal without lowering flange/oil level in the main tank. The size

of shut off value shall be 80mm.

12. Two grounding terminals on diagonally opposite bottom corners of tank. However, if provided on the length side of tank then this grounding terminal shall be out-siding the rail gauge.
13. One ONAN/ONAF cooling equipment comprising of suitable radiators with shut off valves, air release, drain lugs and fans etc.
14. Skids and pulling eyes on both sides.
15. One marshaling box housing dial type thermometers for winding and oil temperature indicators, heater, complete wiring and local/auto selector switch and supply isolating switches with H.R.C fuses.
16. Two thermometer pockets for mercury in glass thermometer.
17. A set of universal type bi-metallic multi-bolt double grooved conductor clamps each capable of receiving single 0.4sq inch ACSR zebra conductor for HV side, LV neutral &HV Neutral & Quadra ACSR zebra conductor for LV side of appropriate size. Also, the terminal connector should be of Quadra configuration for LV side.
18. Suitable bi-metallic flexible connectors for neutral terminals.
19. Suitable size bi-directional wheels for 1676 mm rail gauge in both direction - 4nos.
20. One OLTC along with remote control panel with each transformer complete with wiring, oil surge relay, PRV etc.

a) OLTC conservator pipe and valves diameter should be 25 mm.
b) The height of RTCC panel should be 2312 mm & shade of paint should be of No. 631 of IS :5.

21. The following plates in English shall be fixed to the transformer tank at about 1750 mm above ground level :-

a) Rating Plate bearing data as specified in IS: 2026/1977, it must contain insulation levels of various windings. Impedance at tap 1/5/17. Short circuit duration, control voltage of OLTC, WTI, CT ratio besides other information.
b) Terminal marking plate showing the internal connections & voltage vector relationship of various windings in accordance with IS: 2026/1977 (Latest Edition).
c) Diagram place showing the location and function of all valves and air release cocks/plugs.

22. A plate showing the rated no load voltage at various taps shall be affixed on the remote control panel in order to facilitate the operator in deciding the tap position on which the transformer is to be operated corresponding to the incoming voltage.
23. Oil conservator (Air Cell type) for main tank complete with magnetic type oil level gauge, filling hole and cap, drain valve size 19mm. shut off valve inter connecting pipes etc. Magnetic type oil level gauge shall be provided with low oil level alarm contacts and a dial showing minimum, maximum and normal oil level. The gauge shall be readable from the transformer base level. Silica gel breather with oil seal shall be fitted as already prescribed. Breather should be made of see

through material and should consist of two compartments placed in parallel. One drainpipe upto floor level with one valve may be provided.

24. One no. thermo-syphon filter arrangement with pump.

25. One no. ladder with provision for anti-climbing device.

26. Any other item which is not included above but is essential for the satisfactory operation of the equipment.

SECTION –II-C

SCHEDULE OF GUARANTEED CHARACTERISTICS OF NEW TRANSFORMER OIL (IN DRUMS)

S. No.	CHARACTERISTICS	REQUIREMENT
A.	**Function:**	
1	Viscosity at 40°C, mm^2/s(Max)	15 mm2/s
2	Viscosity at 0°C, mm^2/s(Max)	1800mm^2/s
3	Pour Point, °C(Max)	-20°C
4	Water content in mg/kg (Max)	40 mg/kg^3
5	**BREAKDOWN VOLTAGE:**	
	5.1. New unfiltered oil, kV (rms) (Min.)	30kV
	5.2. After filtration, kV (rms) (Min)	70 kV
6	Density g/ml (Max.)	0.895 at 20°C
B.	**REFINING / STABILITY:**	
7	Appearance	Clear, Free from sediments & suspended matters
8	Acidity, mg KOH/g(Max.)	0.01 mg KOH/g
9	Interfacial Tension at 27°C, mN/m (Min.)	40 m N/m
10	Corrosive Sulphur	Not Corrosive
11	Potentially corrosive Sulphur	Not Corrosive
12	DBDS	Not Detectable (< 5 mg/kg)
13	Inhibitor according to IS 13631/IEC 60666	Un-InhibitedOil: Not Detectable (<0.01%)
14	Metal Passivator additives according to IS 13631 / IEC 60666	Not Detectable (< 5 mg/kg)

15	2-Furfural and related compounds content	Not Detectable (< 0.05 mg/kg) for each individual compound
C	**Performance**	
16	**Oxidation Stability (164 Hrs) as per new IS**	
(a)	Total acidity, mg KOH/gm (Max.)	1.2 mg KOH/g
(b)	Total sludge value, % bywt (Max.)	0.8%
(c)	Dielectric dissipation factor (tan delta) at 90°C(Max)	0.500 (at theend of oxidation stability test)
D	**Health, Safety & Environment**	
17	Flash Point, °C (Min.)	135°C
18	PCA Content, % (Max.)	3
19	PCB, mg/kg	Not Detectable (< 2 mg/kg)
20	PNA Analysis	N-46%(Min)
		P-46 %(Max.)
		A-8 %(Max.)
E)	**<u>CHARACTERISTICS OF OIL IN THE TRANSFORMERS.</u>**	
	The important characteristics of Transformer oil after it is filled in the Transformer (after 3 months & within one year) shall be as follows :-	
	Characteristics	**Permissible Limit for Satisfactory use. (after energization)**
1	Electric Strength (Breakdown voltage KV). (Min)	60 KV (Prior to energization)
2	Water contents (PPM)(Max)	25 PPM
3	Specific Resistance (Resistively) ohm-cm at 90 deg.C.(Min)	20 x 10^{12} ohm-cm
4	Dielectric dissipation factor (Tan delta) at 90 °C. (Max)	0.01
5	Neutralization value (Total acidity) (Max)	0.2 mg KOH/g

6	Sediment and/or precipitable sludge	Absent
7	Flash Point (Min)	135 °C
8	Interfacial tension at 27 °C(Min)	0.030 N/m

SECTION –II-D

LIST OF RECOMMENDED VENDORS

Sr. No.	**Item**		**Recommended Vendors**
1.	Winding-Conductors	a)	By self
		b)	Bhandari Cond. (P) Ltd.
		c)	Shakti Insulated Wires Ltd. Ankleshwar
		d)	Shree Cable Bhopal
		e) f)	M/s INCAB Jamshedpur
		g)	Delta Conductors. Mumbai. KSH International, Mumbai.
		h)	Vimlesh Indsustries Sonepat
		i)	KEN Electricals, Rewa.
		j)	Signet Conductors. Rewa
		k)	SCR Wire Products, Banglore
		l)	Tumkur & Rima Conductors, Banglore.
		m)	Technical Associates Ltd., Lucknow.
		n)	BCPL Conductors Pvt. Ltd.
		o)	Precision Wires.
2.	Insulating Paper	a)	H. Weidmann
		b)	Munksio
		c)	Krammerer
		d)	Dupont
		e)	Elof Hansen, Sweeden
3.	Press Board & Press Board	a)	H.Weidmann
	Components.	b)	Fighom, Sweden.
		c)	Raman, Mysore
		d)	Mistubishi (Japan).
		e)	Senapathy Whitley Ltd., Bangalore.
4.	C.R.G.O.	a)	Nippon Steel corp. Japan
	(MOH High B Grade or Superior)	b)	J.F.E.Steel. Corp.Japan
	{for slitting refer para 8(iv)(b) of the Tech Spec}	c)	AK Steel Corporation U.S.A.
		d)	POSCO works Phohang Korea
		e)	STAL Produkt, Poland
5.	Gaskets	a)	M/s TALBROS
		b)	M/S Nu-cork, Gurgaon
		c)	M/s SRB Cork Sheet Vadodara.
		d)	M/s Cortica Mfg. India Chennai

		e)	M/s Packings & Jointings
		f)	Bharat Corrub Industries, Vadodara

		g)	Indian Cork Industries, Delhi.
6.	Radiators	a)	SELF
		b)	BHEL/TELK
		c)	CTR. Pune
		d)	PE Engineers, Hyderabad.
		e)	Deepthi Radiator, Bangalore.
		f)	M/s Hi-Tech Switchgear, Bombay
		g)	TTP Banglore
		h)	Tarang Engineering Pvt. Ltd., Nagpur.
		i)	ECE Industries Ltd., Sonepat.
		j)	Technical Associates Ltd., Lucknow.
7.	Terminal Connectors	a)	Milind Engineering Works
		b)	Vinavak& Co.
		c)	M/s Nootan, Baroda.
		d)	M/s UtsavBina.
		e)	PEE VEE Engineering Bangalore.
8.	CT‟s, PT‟s	a)	BHEL
		b)	Automatic Electric (P) Ltd.
		c)	CGL, Nasik
		d)	Kappa Electricals.
		e)	Prayog Electricals (P) Ltd.
		f)	Mahindra Electrical Works, Thane
		g)	A.U.Electro Machines. Allahabad.
		h)	Narayan Power
		i)	Mehru, Bhiwadi
9.	Insulating Oil (Napthenic Base)	a)	Raj Petro Specialties Pvt. Ltd., Silvassa
		b)	Apar Industries. Ltd., Silvassa/Mumbai
		c)	Savita Chemicals, Silvassa/Mumbai
		d)	Columbia Petrochem, Silvassa
10.	WTI, OTI, RTD	a)	Perfect Control/ perfect Instruments.
		b)	Precimeasure.
11.	Magnetic Oil Gauge	a)	SukrutUdyog, Pune.
		b)	Atvus Industries
12.	Valves (Gate/Butterfly).	a)	Leader valves
		b)	Bombay Metal & Alloys Mfg. Ltd.
		c)	AUDCO.

		d)	PETSON Ind./Petson Valves.
		e)	Punjab metals works Jalandhar.
		f)	Manixon Industrial Corpn. Agra.
		g)	Mala Metals Jalandhar.
		h)	Apex, Punjab
13.	Buchholz Relay/ Oil Surge Relay	a)	Instruments & Controls.
		b)	PRAYOG.
		c)	Atvus.
		d)	P & B Weir Electric UK.
		e)	Sukrut, Pune
14.	Thermal over Load Relays/ Contactors	a)	English Electric (GEC A)
		b)	Siemens
		c)	L&T
15.	Fuses	a)	English Electric (GEC A).
		b)	Siemens.
16.	Miniature Circuit Breakers	a)	S&S Switchgears.
		b)	Siemens.
		c)	L &T
		d) e)	MDS. Tele Mechanique.
		f)	Merlin Gerin
17.	Terminal Blocks	a)	Elmex
		b)	Phonix.
		c)	Connect Well
		d)	Technoplast
		e)	Essen
		f)	Toshan
18.	Tank Steel	a)	Steel Authority of India Ltd. (Tested Steel).
		b)	Rashtriya Ispat Nigam Limited
		c)	Lloyd Steel
		d)	Essar Steel
		e)	JSW (Jindal) steel
		f)	Tata Steel
19.	Pressure Relief Devices (PRD‟s)	a)	ATVUS.

		b)	SUKURT
20.	OLTC	a)	TELK
		b)	BHEL
		c)	CGL
		d)	C.T.R.
		e)	Easun-MR
		f)	OLG
21. a)	Bushings 66 KV		TELK, S&S, CGL, WSI, JSI, ALSTOM, WSI, JSI, Yash High Voltage Insulators Vadodra, Transformer and rectifier (Switchgear Division)
b)	Bushing for 66 KV Neutral &11 KV		WSI, JSI, CJI, Genesis
22.	Fabrication of Tank	a)	By self
		b)	G.T.V. Gwailor or Bhopal MECH. & FAB. Bhopal,
		c)	Electro Mechanical, Bhopal.
		d)	Jyoti Fabricators, Allahabad
		e)	Sangam Structuralas Ltd Naini (Allahabad)
		f)	Simco, Banglore
		g)	Satyam Industries, Bhopal
		h)	Kaushal Equipment Manufacturer, Rabale, Mumbai
23.	Air Cell of Conservator	a)	Unirub, Pune
		b)	Rubber Product Thane
		c)	Pronal, France
		d)	Nu-Cork, Bhiwadi
24.	Oil Pump	a)	SPP, UK
		b)	Best & Compton
		c)	CGL
		d)	Flow well Meters & Pumps
25.	Cooling Fan	a)	Areva T & D Kolkata
		b)	EPC Kolkata.
		c)	Marathan Electrical Ltd
		d)	Khaitan Calcutta
		e)	Crompton Greaves
26.	Porcelain Insulators	a)	W.S.I Ltd.

		b)	BHEL
		c)	Jayshree
		d)	CJIKhujra
		e)	IEC
		f)	Modern Insulators
		g)	Luster Ceramics
		h)	Sarvana insulators

NOTE: The Material of above vendors is to be used. However, in case of any deviation prior approval of Design Office is required.

Section II-E Bill of Material

I. Power Transformer complete with all fittings and accessories as per section II-B

II. Compulsory spares:

a) Two Nos. PRV for main T/F.

b) One set (2Nos.) silica-gel breathers for main tank.

c) One set (2Nos.) silica-gel breathers for OLTC.

d) One No. refill (sorbent activated alumina) for Thermo-siphon.

III. 5 % Spare Extra Transformer Oil

IV. Min. 5 Litres Spare Paint.

V. 5 sets (4 sets alongwith the transformer to the consignee & 1 set to the purchaser) of instruction manuals per transformer, each properly bound in hard cover and soft copies in 5 Nos. CD (4 CDs alongwith the transformer to the consignee & 1 CD to the purchaser).

SECTION-III

SCHEDULE OF REQUIREMENTS

S.N0.	DESCRIPTION OF MATERIAL	QTY
1.	20 MVA 66/11KV ONAN Cooled oil immersed outdoor type transformer suitable for 3-phase 50 C/S frequency. Star-Star connected in accordance with ISS vector group YnYnO (with brought out neutral for solidly grounding) without stabilizing winding. The transformer will be fitted with OLTC gear of 66 KV,300 Amps rating with HV varying from +5% to -15% in equal steps of 1.25% at 66 KV and 2.5% at 33 KV (if required) tapping being provided on separate tapping coil with Percentage impedance on 20 MVA base at 75 deg.C as 10% at principal tap, 10.5% at tap 1 and 9.25% at tap 17. The transformer shall be dispatched oil filled. Transformer oil (Naphthenic Base) for radiators & conservators etc. along-with 5% extra quantity corresponding to the total quantity of oil per transformer shall be dispatched directly in non- returnable epoxy coated steel drums. The transformer shall be complete with all fittings and accessories as per Specification. The transformer shall be capable of satisfactory parallel operation with each other and with similar existing transformers. The following extra spares with each transformer shall form part of supplies:- 1. Two Nos. PRV for main T/F. 2. One set (2Nos.) silica-gel breathers for main tank. 3. One set (2Nos.) silica-gel breathers for OLTC. 4. One No. refill (sorbent activated alumina) for Thermo-siphon.	10Nos.

ANNEXURE-A

SCHEDULE OF GUARANTEED AND OTHER TECHNICAL PARTICULARS TO BE FURNISHED BY THE MANUFACTURER

Sr. No.	Description	Units	20 MVA 66/11 KV
1. (a) (b) (c)	 Name of the Manufacturer Place of manufacture/works Confirming to Standard		
2.	Service:		
3.	Normal continuous rating under site conditions at any tap at ONAN/ONAF:		
a)	HV winding (i) AT ONAN (ii) AT ONAF	MVA	
b)	LV winding (i) AT ONAN (ii) AT ONAF	MVA	
4.	Rated Voltage:		
	a) HV winding	KV	
	b) LV winding	KV	
5.	Rated frequency:	Hz	
6.	Number of phases:		
7.	Connections:		
	a) HV winding		
	b) LV winding		
8.	Connection Symbol: a) HV-LV		
9.	Tapping:		
	a) Range		
	b) Number of Steps		
	c) For high voltage variation/ for low voltage variation.		
10.	Reference ambient temperatures:		
	a) Maximum ambient air temp.	deg.C	
	b) Maximum daily average ambient temp.	deg. C.	
	c) Maximum yearly weighted average temp.	deg. C.	

	d) Minimum Ambient air temp.	deg.C	
11.	Type of cooling:		

12.	Temperature Rise:		
a)	Top oil	deg.C	
b)	Winding	Deg.C	
c)	Hot Spot temperature calculated over an annual weighted temp. of 40 deg.C.	deg.C.	
d)	Limits of hot spot temperature for which transformer is designed as per IS :6600/ IEC-354.	Deg.C.	
e)	Temperature gradient between winding and oil.	Deg.C.	
13.	Losses (Maximum):		
a)	No load loss at rated voltage on principal tapping at rated frequency	KW	
b)	Load loss at rated current at principal tapping at 75^{0}C on both ONAN/ONAF.	KW	
c)	Auxiliary Losses on principal tapping at rated frequency	KW	
d)	Total losses (NLL + LL at ONAN/ONAF + AL)	KW	
e)	Stray Losses	KW	
14.	Impendence voltage at rated current for the Principal tapping at 75 deg.C.		
a)	HV-LV	Percent	
15.	Reactance at rated current and rated voltage		
a)	HV-LV (positive sequence)	Percent.	
b)	HV-LV (zero sequence)	Percent	
16.a)	No load current at rated voltage and rated frequency	Percent	
b)	Power factor of no-load current at rated voltage and rated frequency.		
c)	No load current at (Approx. calculated valves)		

	I) 75% voltage ii) 80% voltage iii) 85% voltage iv) 90% voltage v) 95% voltage vi) 100% voltage		

	vii) 105% voltage viii) 110 % voltage ix) 115 % voltage x) 120 % voltage xi) 125 % voltage xii) 130 % voltage xiii) 135 % voltage xiv) 140 % voltage		
17.	Insulation level:		
a)	Separate source power frequency voltage withstands:		
	i) HV winding	KV rms.	
	ii) LV winding	KV rms.	
b)	Induced over voltage withstand:		
	i) HV winding	KV rms.	
	ii) LV winding	KV rms.	
c)	Full wave lightening impulse withstand:		
	i) HV winding	KV peak	
	ii) LV winding	KV peak.	
d)	Voltage to earth for which star point will be insulated:	KV rms	
18.	Efficiency at 75 deg.C unit power factory:		
a)	At full load	Percent	
b)	At ¾ full load	Percent	
c)	At ½ full load	Percent	
19.	Regulation at full load at 75 deg.C. at normal Tap:		
a)	At unity power factor	Percent	
b)	At 0.8 power factor lagging	Percent	
20.	Equipment for ONAN/ONAF cooling		

a.	State:		
i)	Radiators on main tank		
ii)	No. of fans on each side.		
iii)	Separate cooler bank.		
b.	State ONAN rating		
c.	State ONAF rating		
21.	Number of coolers or cooler banks per T/F.		
22,	Rating of each cooler or cooler bank.		
23.	Details of ON-Load Tap changer		

b)	Type		
c)	Rating:		
	i) Rated voltage ii) Rated current iii) Step voltage iv) Number of steps		
d)	Control		
e)	Auxiliary supply details		
f)	Voltage control		
g)	Parallel operation		
h)	Protective devices.		
i)	Approx. over all weight	Kg.	
j)	Approx. over all dimensions	mm.	
k)	Approx. over all quantity of oil	Liters	
24.	Terminal arrangement		
a)	High voltage		
b)	Low voltage		
c)	Neutral		
25.	Masses (Kg):		
a)	Bare copper used.		
i)	For windings		
ii)	For leads and connections		
b)	Windings:		
i)	With insulation		
ii)	Soaked in Oil		
c)	Core:		
i)	CRGO Laminations		
ii)	Supporting frame work.		
d)	Core & Winding package		
e)	Tank, fittings and accessories		
f)	Oil		
g)	Total weight (as erected)		
26.	Approximate quantity of oil required for first filling (Liter):		
27.	Approximate overall dimensions:		
a)	Length	mm	
b)	Breadth	mm	
c)	Height	mm	
28.	Dispatch details:		
a)	Approximate mass of heaviest package (Kg).		
b)	Approximate dimension of largest package.		

i)	Length	mm	
ii)	Breadth	mm	
iii)	Height	mm	
29.	Un-tanking height	mm	
30.	Thickness of Transformer tank:		
a)	Sides	mm	
b)	Bottom	mm	
c)	Top	mm	
31.	Overall dimensions of HT Bushing:	Drawing shall be furnished.	
32.	Working flux density as a percentage of knee voltage.		
33.	Percentage of harmonics at normal frequency and at Max. system voltage.		
34.	Continuous overload in percent.		
35.	Maximum current density in winding at CMR at any tap:		
	a) HV winding b) LV winding c) Regulating (tap) windingfor 66 KV	Amp/cm^2 Amp/cm^2 Amp/cm^2	
36.	Maximum flux density in core at normal voltage at Normal Tap & frequency.		
a).	Core	Weber/M2	
b).	Yoke	Weber/M2	
c).	Maximum flux density under worst Operating conditions.	Weber/M2	
d)	Maximum flux density under 31% over voltage for 1 min.	Weber/M2	
e)	Maximum flux density under 44% over voltage for 5 Secs.	Weber/M2	
37.	Core		
a)	Material of core laminations		
b)	Grade of core material		
c)	Thickness of Core laminations.		

d)	Whether core plates are cold rolled grain oriented.		
e)	Insulation of core laminations.		
f)	Insulation of core bolts		
g)	Insulation of core bolt washers.		
h)	Details of oil cooling ducts:		

	i) Whether in the plane or at right angle to the plane of winding.		
	ii) Across the plane of lamination.		
38.	Typing of winding		
a)	HV winding i) Main Winding ii) Regulating winding		
b)	LV winding		
39. a)	Insulation of LV winding/ Density (gm/cc)		
b)	Insulation of HV winding/ Density (gm/cc)		
c)	Insulation between LV & HV winding. / Density (gm/cc)		
d)	Insulation between HV & regulating winding/ Density (gm/cc)		
40.	Maximum out of balance force in winding on short circuit at terminals.		
41.	Type and detail of winding hot spot Temp. indicator		
42.	Total volume of conservator for:		
	a) Main Tank		
	b) OLTC		
43.	Volume of conservator between the highest and lowest levels for :		
	a) Main Tank		
	b) OLTC		
44.	Maximum Resistance per phase at 75^{0}C.		
	a) HV winding (66 KV)		
	b) LV winding		
45.	Calculated time constants:		
46.	Wave from for impulse test		
47.	Inter-turn Insulation:		

a)	Extent of extreme end turns	%	
b)	Reinforcement	%	
c)	Extent of end turns reinforcement		
d)	Extent of turns adjacent to tapping reinforced	%	
48.	Type of axial coil supports:		

a)	HV winding		
b)	LV winding		
c)	Regulating winding		
49.	Type of radial coil supports:		
a)	HV winding		
b)	LV winding		
c)	Regulating winding		
50.	Whether HV winding is inter- leaved. Details of special arrangement (if any) made to improve stress conditions.		
51.	Size of cooling ducts.		
52.	Drawing to scale indicating flow of oil in the radial and axial ducts of each limb and winding.		
53.	Withstand pressure of tank.		
54.	Withstand pressure of cooling equipment.		
55.	Buchholz relay description data		
56.	Bushing : HV/LV		
ii)	Dry flash over voltage		
iii)	Wet flash over voltage		
iv)	Dry 60 sec. withstand test voltage (KV)		
v)	Wet 30 sec. withstand test voltage (KV).		
vi)	Puncture withstand test.		
vii)	Full wave impulse with- stand test voltage 1.2. Micro Sec. (KVp) wave (Positive)		
viii)	Creepage distance (mm)		
ix)	Recommended gap setting (mm)		
x)	Weight of assembled bushing (Kg.).		

xi)	Free space required at the top for removal of bushings.		
xii)	Short time withstand capacity.		

11.55 TECHNICAL SPECIFICATION OF 66KV GIS

11.55.1 *Scope:*

The specification covers scope of design, engineering, fabrication, manufacturing, shop assembly, inspection and testing before supply, transportation, delivery at destination, unloading & storage at site, site erection, site testing, commissioning and putting in to successful operation complete with all materials,

support structures, anchoring bolts, accessories, commissioning spares & maintenance spares, special spanners, tools & tackles, any specific required ancillary services, SF6 Gas for first filling &spare, etc., for efficient and trouble free operation along with for 66 kV metal (aluminium alloy) encapsulated SF6 gas insulated switch-gear suitable for INDOOR/ OUTDOOR installation.

11.55.2 *Applicable Standard*

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions. And all consider all other relevant standard for applicable to GIS.

. **Table 11-22: List of Applicable Standards: 66 KV GIS**

S.No.	Standard No	Standard Description
1	IS:5	**Color for ready mix paints.**
2	IEC 62271-203	**Gas Insulated metal-enclosed switchgear for rated voltages above 52KV**
3	IEC 60376	**New sulphur hexafluoride.**
4	IEC 62271- 100	**High voltage alternating current Circuit breakers**
5	IEC 62271-1	**Common clauses for high voltage Switchgear and control-gear standards**
6	IEC 62271-102	**Alternating current dis connectors (isolators) and earthing switches.**

7	IEC 61128	**Alternating current dis connectors. Bus-transfer current switching by dis connectors**
8	IEC 61129	**Alternating current earthing switches. Induced current switching**
9	IEC 61869-1	**Current transformers**
10	IEC 61869-2	**Voltage transformers**
11	IEC 60137	**Bushings for alternating voltages above 1000 V**
12	IEC 60859	**Cable connections for gas-insulated switchgear**
13	IEC 60480	**Guide to checking of sulphur hexafluoride taken from electrical equipment**
14	IEC 60099-1/4	**Non-linear resistor type arresters for AC systems**
15	IEC 61439	**Factory-built assemblies of low-voltage switchgear and control gear**
16	IEC 60427	**Report on synthetic testing of high-voltage alternating-current circuit breaker**
17	IEC 60840	**Power cable & Accessories for 30kV to 150kV**
18	IEC 62067	**power cable & Accessories above 150kV**
19	IEEE 80(2000)	**IEEE Guide for Safety in AC Substation grounding.**
20	**CIGRE-44**	**Earthing of GIS- an application guide.(Electra no.151,Dec'93)**

11.55.3 Service Conditions:

Table 11-23: Service Conditions

A. Climate Condition		
1	Max. Temperature	**40 C**
2	Min. Temperature	**-2.5 C**
3	Max. relative humidity	**Owner to specify**
4	Min. relative humidity	**Owner to specify**
5	Seismic Zone	**Owner to specify**
6	Max Wind pressures.	**Owner to specify**
7	Altitude above mean sea level	**Owner to specify**
B. Aux. Power Supply		
1	AC Supply	**415/240 Volts ±10%, 3-phase, 4-wire, 50 Hz :± 5%**
2	**DC Supply**	**110V ±10%.**

11.55.4 Electrical Parameter:

Table 11-24: Electrical Parameter

Rated System Voltage / Highest System/Equipment Voltage	**kV**	**66/72.5**
One min. Power frequency withstand voltage	kV rms	**140**
Across open isolator	kV rms	**160**
Across the open gaps of CB	kV rms	**140**
Rated Lightning Impulse withstand voltage (1.2/50 µs peak value)		
Phase to phase	kVp	**325**
Phase to earth	kVp	**325**
Across open isolator	kVp	**375**

Across the open gaps of CB	kVp	**325**
Rated Frequency	Hz	**50**
Rated Continuous current at 40 0C ambient temperature Bus bar	Amps	**3150**
Feeder and Transformer Bay	Amps	**2500**
Rated Short circuit Withstand current for 3 seconds	kA	**40**
Rated dynamic withstand current	kAp	**100**
Partial Discharge (at 1.1 Un)	pico- coulombs	**5(max.)**
System Neutral earthing		**Solidly earth**
Maximum SF6 Gas leakage rate per year	**% per year**	**0.1%**

11.55.5 Specifications:
11.55.5.1 Design Concept, construction&performanceofSF6 GIS:

- It is understood that each manufacture has its own particular SF6 GIS design concept and it is not the purpose of this specification to impose unreasonable restrictions. However, in the interest of safety, reliability and serviceableness, the switch gear offered shall meet the following minimum requirements.

- The station layout and equipment rating shall be based on the single line diagram and general layout enclosed. The supplier has to work out an optimum layout and building size based on the specific features of his product within the constraints of overall dimensions of the plot.

- All equipment, accessories and wiring shall have tropical protection, involving special treatment of metal and insulation against fungus, insects, and corrosion.

- Furthermore, no part of the enclosure, or any loose parts may fly off the switchgear in such an event, and no holes may burn through the enclosure. The material and thickness of the enclosures shall be such as to withstand an internal flashover without burns through a period of 500 ms at rated short time withstand current. All grounding connections must remain operational during and after an arc fault.

- Proper grounding for mitigating over voltages during disconnector operation shall be included.

- Viewing windows shall be provided at the Disconnector and earthing switches to ensure that each contact position can be inspected easily from the floor level. Each section shall have plug-in modules or easily removable connection pieces to allow for

- Easy replacement of any component with the minimum of disturbance to the remainder of the equipment.

- The number of transport/shipping splits shall be minimized to keep installation time of GIS to a minimum.

- The arrangement shall afford maximum flexibility for routine maintenance. Equipment removal and SF6 handling should be accomplished with ease.

- The ease of operation shall be ensured.
- In general the contours of energized metal parts of the GIS and any other accessory shall be such as to eliminate areas or points of high electrostatic flux concentrations. Surfaces shall be smooth with no projection or irregularities, which may cause corona. The transformer and accessories shall be so designed as to facilitate inspection, cleaning and repairs. The requirement of Indian Electricity Rules shall be kept in view.

- Switchgear in digital World: High Voltage Gas Insulated Switchgear: Digital features for predictive maintenance.

- As a predictive maintenance solution for an O&M team of user, there needs to be an automatic and real time status update feature integrated within the switchgear. This feature might be based on stand-alone system or integrated within substation control system/ SCADA. This feature should offer following capabilities and monitoring of parameters digitally on the laptop / tablet / mobile phone of O&M users (authorized by the purchaser) on real time basis, duly complying with latest cyber security norms.

    - SF6 gas density -> Actual value, and email/ SMS notification on the threshold value set by user.

    - Ambient temperature actual value

    - Cubicle temperature of Circuit Breaker

    - CB operating position (ON / OFF)

    - Readiness to switch ON the CB (based on Spring charged position and sufficient Gas pressure)

- No. of CB operations performed.
- Fleet view (GPS based mapping of GIS location)
- Weather information (web based)

Towards the predictive maintenance approach, the switchgear shall also additionally provide below trending parameters (based on the historical operational statistics), enabling user to plan the maintenance activities proactively in most economical way and avoid any unwanted outage.

- SF6 gas density -> Predicted time to next alarm.

- Circuit Breaker mechanical life -> prediction of remaining life, before major overhauling.

This data should be available on real time basis, and also downloadable with historical logging of above referred KPIs.

Above functionalities must be factory tested during the Routine testing/ Customer inspection, and ready to operate at site.

11.55.5.2 Modular Design & Future extensions

- The GIS switch gear shall be of modular design offering high degree of flexibility. Each module shall be complete with SF6 gas circuit breaker, Dis-connectors, Maintenance Grounding switches, fast Earthing switches, voltage transformers, Current transformers, bus & elbow sections, cable end enclosures, Surge Arrestor, local control cubicle and all necessary components required for safe & reliable operation and maintenance. All the three phases of the Busbar and associated equipment's like breakers, disconnector, instrument transformers & earthing switches etc., as detailed in enclosed single line diagram are to be three phase encapsulated in gas filled metallic enclosure, for 66kV class

- The bus bars shall be sub-divided into compartments including the associated bus bar disconnector. Bus bars are partitioned at each bay with an objective to isolate Busbar compartment for the purpose of extension and at the same time avoid damage to adjacent bays in the event of fault.

- Materials used in the manufacture of the switchgear equipment shall be of the type, composition, and physical properties best suited to their particular purposes and in accordance with the latest engineering practices.

- The switchgear shall be of the freestanding, self-supporting dead-front design, with all high-voltage equipment installed inside gas-insulated, metallic grounded enclosures, and suitably sub-divided into individual arc and gas-proof compartments.

- Arc faults caused by external reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear. The GIS shall be designed so that any component of the GIS can be easily removed. As minimum flexibility in the layout arrangement, it shall be possible to remove the circuit breaker with both/single busbar remaining in service and it shall be possible to remove the dis connector of the bus bars, with one bus bar remaining in service.

- Where bus Coupler / sectionalizer is specified and in case of any internal arc fault in a busbar, busbar disconnector or sectionalizer, repair work must be possible without shutting down the complete substation and at least one half of the substation must remain in operation. Documents indicating sequence of repair work steps and description of necessary restrictions during work shall be submitted with the technical bid.

- Each bay module should be equipped with suitable arrangement for easy dismantling and refitting during maintenance without disturbing other units.

- The maximum temperature in any part of the equipment at specified rating shall not exceed the permissible limits as stipulated in the relevant standards.

- There shall not be any kind of interference to the connected & nearby equipment and system when the equipment is operated at maximum service voltage.

11.55.5.3 Maintenance and repair of a circuit breaker

- The positioning of the circuit breaker in the GIS shall be such that it shall be possible to access the circuit breaker of any feeder from the front side for routine inspection, maintenance, and repair without interfering with the operation of the adjacent feeders.

- The GIS shall be so designed that any component of the GIS can be removed easily. With minimum flexibility in the layout arrangement, it shall be possible to remove the circuit breaker with both bus bars remaining in service and it shall be possible to remove the disconnector of the bus bars, with one bus bar remaining in service. It shall also be possible to remove circuit breaker drives without dismantling circuit breaker

11.55.5.4 Interchange ability

- As much as possible, all the parts shall be of standard manufacturer with similar parts and assemblies being interchangeable.

11.55.5.5 Future Extension

- The modular design of GIS switch gear shall be capable of extension in the future on either end by the addition of extra feeders, bus couplers, bus-bars, circuit breakers, Disconnector, and other switch gear components without drilling cutting, welding or dismantling any major part of the equipment. The required intermediate compartment is to be considered to keep at-least one busbar in service during future extension. The Vendor is required to demonstrate clearly in his submitted documents the suitability of the switchgear design in this respect. The arrangement shall be such that expansion of the original installation can be accomplished with minimum GIS down time. In case of extension, the interface shall incorporate facilities for installation and testing of extension to limit the part of the existing GIS to be re-tested and to allow for connection to the existing GIS without further dielectric testing.

- The SF6 GIS shall be of INDOOR having degree of protection as IP-42 and suitable for the atmosphere of the location, which is heavily polluted, windy, sandy desert & service condition indicated at Sino 3.

- The required switchgear shall be capable of being supplied in a completely gas-insulated version in which case all switchgear components including the bus bars shall be of gas- insulated type.

11.55.5.6 Specification requirements

- The 66 kV GIS switchgear shall be with Single busbar or Double busbar (as indicated in SLD/BOQ of respective tender) design having three phase encapsulated enclosure. It shall consist of Line, Bus Coupler & transformer bays as indicated in attached Single line Diagram. This configuration shall meet within the given area indicated in layout plan attached with respective tender.

11.55.5.7 Current Rating

- The current rating of the switchgear should be assessed on the following requirements
- Capable of handling power to an extent of as to an ambient day-time mean temperature between – 5 deg C and + 40 deg C

- The switchgear described in this specification is intended for continuous duty at the specified ratings and under all system operating conditions including sudden change of load and voltage within its ratings and at specified ambient conditions 24 hours a day, 365 days a year unless indicated otherwise.

11.55.5.8 Electrical, Mechanical and Thermal Capability

- The assembled equipment shall be capable of withstanding the electrical, mechanical, and thermal ratings of the specified system. All joints and connections shall be required to withstand the forces of expansion, vibration, contraction, and seismic IV requirements without deformation or malfunction and leakage. The apparatus shall be capable of withstanding the specified environment.

11.55.5.9 Insulation level

- The switchgear and other equipment shall be designed for a maximum operating voltage and rated impulse withstand voltage as specified in cl. 2.3. The switchgear may require to be installed in an unmanned distribution network with predominantly overhead interconnection or EHV cable. Circuit breakers shall be capable of interrupting line, transformer, capacitor bank & cable charging currents of the magnitude indicated in the data schedules.

11.55.5.10 Physical arrangement

- The layout shall be properly designed by the bidder to completely accommodate the present & future requirements of the substation as per the furnished single line diagram and the enclosed site plan. They may be adjusted as necessary to suit the manufacturer’s standard design and owner’s need.

- The arrangement of the switchgear offered must provide adequate access for checking and maintenance.

- Optimized arrangements are required to reduce installation time, minimize maintenance & repair cost, provide ease of operation, and facilitate future expansions.

11.55.5.11 Gas Sectionalization

- The switch-gear gas enclosures must be sectionalized, with gas tight barriers between sections or compartments.

- The sections shall be so designed as to minimize the extent of plant rendered inoperative when gas pressure is reduced, ether by excessive leakage or for maintenance purposes, and to minimize the quantity of gas that has to be evacuated and then recharged before and after maintaining any item of equipment.

- For limitation of any internal arc to the concerned bay and to reduce the extent of necessary gas works of each section of the bus-bar must be sectionalized bay by bay.

- Sectionalization shall ensure that circuit breaker enclosure will not include any other equipment in its gas compartment except current transformer being a passive module.

11.55.5.12 Expansion Joints and Flexible Connections

- The layout shall sufficiently take care to the thermal expansion / contraction of the assembly by the provision of expansion joints. Expansion joints shall be placed in between any bay section of the bus-bar. All joint surfaces shall be machined, and all castings shall be spot faced for all bolt heads or nuts and washers.

- If necessary, the number and position of expansion joints or flexible connections are to be determined by the manufacturer to ensure that the complete installation will not be subject to any expansion stresses which could lead to distortion or premature failure of any piece of the SF6 equipment, support structures or foundations.

- Bracing shall be provided for all mechanical components against the effects of short circuit currents specified under system parameter. The design of the equipment shall be such that the agreed permitted movement of foundations or thermal effects does not impair the assigned performance of the equipment.

- The seismic study calculations for all the supports shall be submitted to ensure care taken.

- The continuity of service during thermal expansion / contraction and vibrations shall be ensured. Expansion joints, flexible connections and adjustable mountings shall be provided to compensate for reasonable manufacturing and construction tolerances in the associated equipment to which the GIS may be connected. Required sliding plug-in contacts for conductors shall be provided. This is to ensure that unreasonably excessive accuracy is not required when installing such equipment and constructing the associated foundations or support structures, e.g. transformers or the interconnection of isolated sections of switch-gear by means of long GIS bus-bar or duct installations. Flexible joints may also be provided to allow more efficient maintenance and future extensions of the GIS.

11.55.5.13 Barrier and Non-Barrier Insulators

- Support insulators shall be used to maintain the conductors and enclosure in proper relation. These support insulators may be of two types. Barrier insulators which are employed to isolate gas compartments and non-barrier insulators which allow the gas pressure to equalize.

- The gas barrier insulators sealing to the conductors and the enclosure wall shall be designed to withstand the maximum pressure difference that could occur across the barrier, i.e. maximum operating pressure at one side while a vacuum is drawn at the other side & in case of internal arc fault with a safety factor of 2.

- The support insulators and section barriers / insulators shall be manufactured from the highest quality material. They shall be free from all voids and the design shall be such as to reduce the electrical stresses in the insulators to a minimum. They shall also be of sufficient strength to ensure that the conductor spacing and clearances are maintained when short circuit faults occurs.

- Tests shall be carried out during the manufacture of the Switchgear to ensure that all parts of the equipment are free of partial discharge with a partial discharge extinction voltage which is at least 10% higher than the rated voltage.

- The insulators shall have double O-ring grove arrangement on each side to reduce the gas leakage in GIS.

11.55.6 *Gas seals, Gas Density & pressure, and other requirements.*

- Double sealing of O-ring type shall be used for sealing the connections between the switch-gear modules. The leakage rates shall be kept to an absolute minimum under all normal pressure, temperature, electrical load and fault conditions. The guaranteed leakage rate of each individual gas compartment and between compartments must be less than 0.1% p.a. for the service life of equipment.

- Piping and fittings for gas monitoring and gas supply shall be avoided. The gas monitor device should be installed at each individual compartment of the module. Each gas compartment must be independent, external gas pipe connections should be avoided to minimize leakage.

- All gas compartments shall be fitted with filter material which absorbs the residual moisture and moisture entering inside the High-voltage enclosure. Filters in gas compartments with switching devices must also be capable to absorb the gas decomposition products resulting from the switching arc.

- The rated pressure of the SF6 insulating gas in the metal-clad equipment shall be as low as is compatible with the requirements for electrical insulation and space limitations to reduce the effects of leaks.

- The SF6 switchgear shall be designed for use with SF6 gas complying with the recommendations of IEC – 60376 at the time of the first charging with gas.

- Connections including bolts and nuts shall be adequately protected from corrosion and easily accessible with the proper tools.

- All components shall be fire retardant and shall be tested in accordance with relevant standards. Gas emissivity when the Material is heated shall be minimal.

11.55.6.1 Gas Treatment Requirements

- Under normal operating conditions it shall not be necessary to treat the insulating SF6 gas between major overhauls. In all gas compartments permanent efficient filters and desiccants shall be effective for the duration of time between major overhauls. Notwithstanding this, the insulators in the circuit breaker shall be made of epoxy resin composition that will resist decomposition products in contract with moisture.

11.55.6.2 Gas Monitoring Devices

- Dial type temperature compensated gas density monitoring devices with associated pressure gauge shall be provided. Pressure gauges or density monitors shall have two-stage temperature compensated pressure (gas-density continuous monitoring) switches with 6.5-20mA analog output. Analog signals shall be available on IEC 61850 protocol for reporting to SCADA. Bidder shall consider necessary converter module in LCC for converting 6.5-20mA signal to IEC61850 protocol for reporting to SCADA. The devices shall provide continuous & automatic monitoring of the state of the gas in SCADA:-

- i) "Gas Refill" Level- This will be used to annunciate the need for gas refilling.
- ii) "Breaker Block" Level- This is the minimum gas density at which the manufacturer will guarantee the rated fault interrupting capability of the breaker. At this level the device contact shall trip the breaker and block the closing circuits.

- It shall be possible to test all gas monitoring relays without de-energizing the primary equipment and without reducing pressure in the main section. Disconnecting type plugs and sockets shall be used for test purposes. DN20 and DN8 valve is to be provided for filling and density monitor connection respectively. In any case DN8 valve for filling will not be acceptable.
- Four potential free electrical contacts shall be provided with each and every alarm condition.

11.55.7 *Conductors*

- The conductors shall be made of Aluminum alloy suitable for specified voltage and current ratings. The electrical connections between the various gas sections shall be made by means of multiple contact connectors (plug-in type) so that electrical connection is automatically achieved when bolting one section to another. Field welding of conductor is not acceptable. The surface of the connector fingers and conductor on such connections shall be silver plated. Both, the conductors as well as the contacts for the conductor connections must be designed for the continuous rated current of the switch gear under the ambient conditions furnished and shall not exceed the permissible temperature rise.

11.55.8 *Enclosures*

- The metal enclosures for the SF6 gas insulated equipment modules shall be made from Aluminum alloy. Suitable anti corrosive paints Color RAL 7032 must be applied on the exterior of the enclosures. The enclosure shall be three phase encapsulated. The external fixtures should be made of corrosion-resistant material and should be capped where required. Internal portion of the enclosure shall be painted for better insulation strength.

- Bellow compensators shall be made of Stainless steel to preserve the mechanical strength of the equipment at the connection portions to deal with the following problems:

  - Expansion and Contraction of outer enclosure and conductor due to temperature variations.

  - Mismatch in various components of GIS.

  - Vibration of the transformer and switching equipment.

  - Dimensional variations due to uneven settling of foundation. e) Seismic forces as mentioned in climatic condition.

- Standard paint Color RAL 7032 shall be used with satin mat finish having high scratch resistance. Same paint color shall be used for auxiliary component of GIS main enclosure.

- The gas-filled enclosures shall conform to the pressure vessel code applied in the country of manufacturer. Gas section barriers including seals to the conductor and enclosure wall shall be gas-tight and shall be capable of withstanding the maximum pressure differential that could occur across the barrier, i.e., with a vacuum drawn on the one side of the barrier and on the other side, at least the maximum gas pressure that can exist under normal operating or maintenance conditions and in case of internal arc fault.

- The finish of interior surfaces of the metal-clad enclosures shall facilitate cleaning and inspection. High quality primer followed by two coats of anti-corrosive paint of glossy white shade shall be used such that they will not deteriorate when exposed to the SF6 gas and other vapors, Arc products, etc., which may present in the enclosures. They shall also not contain any substances which could contaminate the enclosed gas or affect its insulating properties over a period.

- Circuit breaker enclosure shall be casted aluminum enclosure; welded enclosure for the same will not be acceptable.

11.55.9 *General Finish and Cleaning*

- The equipment shall be manufactured and assembled at the manufacturer's works under conditions of the utmost cleanliness.
- Very dusty / sandy conditions may exist at the site hence, whenever possible, the complete feeders or major assembly of components should be shipped as transport units. Before the metal clad enclosed sections are joined together and charged with the SF6 gas they must be thoroughly cleaned.
- Paints shall be carefully selected to withstand heat and weather conditions. The paint shall not scale-off or crinkles or gets removed by abrasion due to normal handling.
- Enough of all paints and preservatives required for touching up at sites shall be furnished with GIS.

11.55.10 *Sf6 Gas filling, SF6 gas recovery and Evacuating Plant for 66kV GIS unit*

- All apparatus necessary for filling, evacuating, and recovering the SF6 gas into and from the switch-gear equipment shall be supplied by the bidder to enable any maintenance work to be carried out.
- Where any item of the filling and evacuating apparatus is of such a weight that it cannot easily be carried by maintenance personnel, it shall be provided with facilities for lifting and moving with the overhead cranes.
- The apparatus for filling, evacuating, and recovering all gases to be used shall be provided with all necessary pipes, couplings flexible hoses, tubes and valves for coupling to the switch-gear equipment.
- The gas compartments shall preferably be fitted with permanent vacuum couplings through which the gas is pumped into or evacuated from the compartments.
- Details of the filling and evacuating apparatus that will be supplied, and a description of the filling, evacuating and recycling procedures, shall be provided with the bid.

- Gas filling and Evacuating Plant preferred to have a gas storage facility of 300 Litres capacity. For substation less than 5 bays two empty cylinder shall be provided.

- Make: - DILO or equivalent make and Model:- Piccolo or equivalent(≤5 bays)

Make: - DILO or equivalent make and Model: - Economy or equivalent (≥5 bays)

11.55.11 *Support Structures*

- All supporting structures necessary for the support of the GIS equipment including associated parts such as anchor bolts, beams etc. shall be supplied. Sufficient attachment points to the apparatus and concrete foundations drawing shall be furnished to ensure successful installation, with required clearances, while taking into account thermal expansion and contraction. Seismic Zone V Earthquake requirements are also to be considered.

- Any scaffolding or a movable platform, required for maintenance, shall also be supplied.

- All steel structure members shall be hot-dip galvanized after fabrication. Unless otherwise specified, minimum mass of zinc coating for Galvanizing shall be 610 gm/square meter. Under marine environment, the fabricated structures shall have a minimum overall Zinc coating of 900 gm/square meter. All field assembly joints shall be bolted. Field welding shall not be acceptable.
- Non-corrosive metal or plated steel shall be used for bolts and nuts throughout the work. Manufacturer shall provide suitable foundation channels and anchor bolts to support the

- Switchgear assemblies. All mounting bolts, nuts and washers shall be provided to fasten the switchgear base frames to the foundation channels.

- Foundation channels and anchor bolts shall be installed in the civil works in accordance with instructions provided by the manufacturer.

11.55.12 *Auxiliary Equipment*

The following items shall be included for a complete installation:

- Control system including local control cabinets.
- Cable and wiring between individual items of supplier supplied equipment.
- Name plates.
- All ladders, platforms, stairs, walkways, and supports necessary to operate and maintain all

equipment safely and efficiently.

- Special tools and tackles for installation on returnable basis.

11.55.13 *Safety Precautions*

- The switchgear must provide a maximum degree of safety for the operators and others in the vicinity of the switch gear under all normal and fault conditions. The safety clearances of all live parts of the equipment shall be as per relevant standards.

- It must be made impossible to touch any live part of the switchgear unwillingly, i.e. without use of tools or brute force.

- An operator standing in the normal operating position should not be endangered by any moving external part of the switchgear.

11.55.14 *Interlocks:*

- Electrical interlocks must be provided to ensure absolute and reliable protection against potentially harmful Mal-operation of the switchgear. All interlocks that prevent potentially dangerous mal-operations shall be so constructed such that they cannot be defeated easily, i.e. the operator must use tools and/or technique to over-ride them only in case of emergency. Padlocking facility for each drives shall be provided.
- The following functions shall be provided:
    - The operator must be forced in to the only safe and logical sequence to actuate the circuit breakers, disconnector & earthing switches.
    - The actual, completely closed or completely opened position of all switching devices must be checked before and after each move.
    - Implementation of logic checks and issuing the resultant signals Enabled or Blocked for the switching device.

- If in-spite of all possible safety measures if any arc occurs, the following is required.
    - The effects of an internal arcing fault must be limited to the related gas compartment.
    - Each gas compartment must have its own automated external pressure relief device to

provide instant and safe discharge of accidental overpressure during internal arc. Rupture diaphragms shall be preferably used as pressure relief mechanisms. The bursting pressure of relief device should be effectively coordinated with the rated gas pressure and the pressure rise due to arcing. PRD shall be positioned such that it will not be below any circuit breaker or disconnector drive.

- All earthing connections must remain operational.
- The enclosure of the switch gear must withstand the thermal effects of an arc at the full rated short circuit current until the nearest protective relay has acted and tripped the breaker.
- To limit the effects of an internal arc the switch gear shall be suitably subdivided into individual arc and gas-proof compartments, at least for Busbar together with bus-bar isolator and earthing switch, Circuit breaker Line isolators and earthing switch, (Line, transformer) Instrument transformers.

Following requirements are to be followed-

- The bracing/welding of all components subject to mechanical forces caused by short circuit currents shall be capable so as to withstand the effects of at least 2.5 times the rated symmetrical short time withstand current.
- The thermal rating for all current carrying parts and insulating materials shall be a minimum of three seconds for the rated short time withstand current.
- All components of the switch gear which are on ground potential shall be electrically interconnected and effectively earthed.

11.55.15 *Special Tools, Tackles and Equipment's*

- Special tools, tackles and equipment that are required to perform installation, commissioning, operation & maintenance of the gas insulated switch gear shall be included in scope of supply. Minimum following tools shall be supplied.
    - Dew point and Purity measurement meter with Sf6 pump back facility
    - SF6 gas leakage detector
    - Gas-service carts in line with A.19.
- The tools shall be shipped in separate containers, clearly marked with the name of the equipment for which they are intended.
- The requirement of HV testing during commissioning or repairing or replacement shall be fulfilled by successful bidder by arranging the required HV testing equipment at no extra cost to owner. No delay shall be permitted on account of the non-availability of the HV test equipment's.

- Equipment for GIS installation, testing and HV testing shall be owned by GIS OEM, which shall have better quality, precision and calibration validity.

11.55.16 *Grounding of GIS:*

- GIS will be housed on GIS floor. The bidder will provide under-ground mat below the substation. The bidder shall also provide adequate number of Galvanized steel risers to be connected to grounding mat, as per relevant standards and in consultation with MSIL during detailed engineering, in the event of an order.

- The bidder shall supply entire material for ground bus of GIS such as conductor, clamps, joints, operating and safety platforms etc. to be laid / embedded in GIS floors. The bidder is also required to supply all grounding connectors and associated hardware material for:

- i) Connecting all GIS equipment, Bus duct, enclosures, control cabinets, supporting structures etc. to the ground bus of GIS

- ii) Connecting ground bus of GIS to the ground mat risers.
- The grounding arrangement of GIS shall ensure that touch and step voltages are limited to safe values as per IEEE std. 80-2000. The enclosures of the GIS shall be grounded at several points such that there shall be a grounded cage around all live parts. The ground continuity between each enclosure shall be affected over flanges, with or without links or straps to bridge the flanges. Copper/Aluminum straps shall however bridge the metallic expansion bellows. The grounding switches shall be connected to ground through the enclosure. Individual ground leads for the ground switches are not allowed. The inductive voltage against ground in each part of the enclosure shall not be more than 15 Volts.

- Where operating mechanism cabinets are mounted on the switchgear, the grounding shall be made by separate conductor. Bay control cabinets shall be grounded through a separate conductor.

- All conduits and control cable sheaths shall be connected to the control cabinet grounding bus. All steel structures shall be grounded.

- Each removable section of catwalk shall be bolted to the support structure for ground continuity.

- The enclosure grounding system shall be designed to minimize circulating currents and to ensure that the potential rise during an external or internal fault is kept to an acceptable level. The guidelines of IEEE Std. 80-2000 on GIS grounding, especially the transient ground potential rise caused by high frequency phenomena, shall be taken into consideration while designing the grounding system for GIS.

- The manufacturer shall furnish readily accessible connectors of sufficient mechanical strength to withstand electromagnetic forces as well as capable of carrying the anticipated maximum fault current without overheating by at least from two paths to ground from the main ground bus.

- Provisions of IEC 517 & 694 regarding safeguards in grounding of connected cables, testing during maintenance and other safety measures shall be ensured.

- Earthing conductors shall be designed to allow flow of short circuit current. Conductors with copper bars are preferred over copper wires.

11.56 DETAILED TECHNICAL REQUIREMENTS FOR GIS COMPONENTS

11.56.1 *Circuit Breaker:*

- General:
- The GIS circuit breakers shall comply with the following general requirements for circuit breakers and the latest revisions of the relevant IEC-62271-100 specifications

- Circuit – breakers shall be of single pressure, single break, self-compression self-blast / auto puffer type with SF6 as arc quenching & insulation medium and with a minimum- maintenance contact system

- 66 kV class enclosures shall be three phases encapsulated metallic type.
- Ratings of the circuit breaker shall be as per enclosed technical parameters.
- They should be shipped as a completed three-phase unit within a complete bay module.
- Each circuit-breaker shall have spring-spring drive mechanism ensuring proper closing and opening and shall permit checking of adjustments and opening/closing characteristic. The ON/OFF latches shall be mechanically interlocked with each other. The circuit breaker shall be completely factory assembled, adjusted and tested.

- The total break time from energizing the trip coil at rated control voltage to final arc extinction shall be as short as possible, but in any event not greater than 3 cycles i.e. 60 ms.

- The circuit breaker shall be capable of breaking all currents from zero up to the specified maximum fault current in accordance with the relevant IEC recommendations.

- The breakers are to be restrike-free.
- The circuit-breakers shall be capable of tripping and re-closing (Auto reclose) according to the specified duty cycle without derating: O – 0.3 s – CO – 3 min. – CO.
- Breaker shall be suitable for following switching duties:
    - Terminal faults
    - Short line faults
    - Out of phase switching
    - Interruption of small inductive current including transformer magnetizing inrush currents.
    - Interruption of line and cable charging currents.
- The circuit breaker shall meet all the double Circuit overhead transmission line and cable characteristics for any type of fault or fault location, and also for line charging and dropping when used on an effectively grounded system. Effect of second circuit in parallel shall also be considered.
- The circuit breakers shall be capable of being operated locally or from remote. Local operation shall be by means of an open/close control switch located in the bay control cabinet.
- The minimum guaranteed nos. of maintenance free operations of circuit breaker shall be 10000 nos (M2 class).
- The Drive shall have sufficient stored energy for completing 1 OCO with auxiliary power switched off.
- The breaker layout arrangement shall be vertical and shall provide higher mechanical stability and ease in maintenance. The operating principle of the breaker shall ensure minimized dynamic floor loading. Low reaction forces on foundations especially dynamically, are favorable and considered in the elevation.

11.56.2 *Closing Device*

- The closing coils shall be suitable for operation at any voltage between 110% and 85% of the nominal control voltage measured at the device terminals.

- The breaker shall close correctly when an electrical closing pulse of 50 msec. duration is applied to the closing coil.

11.56.3 *Tripping Device*

- All electrical tripping coils shall be suitable for operation at any voltage between 110% and 70% of the nominal control voltage measured at the device terminals.

- Each circuit-breaker shall be equipped with two shunt trip system. The one shunt trip system shall be electrically separated from the other system.

- The emergency hand tripping (mechanical) device shall be provided in the operating mechanism which shall be outside of the drive mechanism for ease in access. The same shall be padlocked in normal condition.

11.56.4 *Anti-Pumping*

- The circuit-breaker mechanism shall be provided with means to prevent pumping while the closing circuit remains energized, should the circuit breaker either fail to latch, or be tripped during closing due to the operation of the protective relays.

11.56.5 *Operating Mechanism*

- The breaker shall include suitable spring operating mechanism to assure proper opening & closing operations. The provision shall be made for checking adjustments and opening characteristics. The mechanism shall be capable of re-closing within the range specified in the applicable standards. The mechanism shall include dual trip coils. Charging of opening mechanism shall be possible in the event of failure of the motor drive.

11.56.6 *Spring Operated Mechanism*

- Spring operated mechanism shall be complete with motor, opening spring, closing spring with limit switch for automatic charging and all necessary accessories to make the mechanism a complete operating unit.

- As long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible.

- After failure of power supply to the motor, at least one open-close-open (O-C-O) operations of the circuit breaker shall be possible.

- Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring.
- Motor rating shall be such that it requires only about 15 seconds for fully charging the closing spring.
- Closing action of the circuit breaker shall compress the opening spring ready for tripping.
- When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation.
- The mechanism shall be in dust proof box with IP55 (Outdoor application) and IP43 (Indoor application).

11.56.7 *Auxiliary Switches*

- Each breaker shall have auxiliary switches with adequate number of NO and NC contacts all wired to terminals located in the local control cabinet of the circuit breaker bay. 20 % spare contacts should be provided.

11.56.8 *Indicating Devices*

- Position indicators shall be provided to clearly indicate whether a circuit-breaker is open or closed.

Table 11-25: Position Indicators: Circuit Breaker

	Status	Color
Open position	Open	**Green**
Closed position	**Closed**	**Red**

- Each circuit-breaker shall be provided with an operation counter to record the number of tripping operations performed. The counter may be located at the local control cabinet.
- All position indicators and counters shall be readable at a convenient elevation i.e. from the place of operation.

11.56.9 *Gas Connections*

- Necessary valves and connections shall be provided to assure ease in handling the SF6 gas.

11.56.10 *Timing Test*

- Timing tests are to be carried out after the switch gear has been completely charged with SF6 gas.

11.56.11 *Testing Facility*

- Timing test facility shall be provided with switchgear such that it is not necessary to open up any gas section to make test connections to the circuit breaker terminals.

- All details of test facilities to be provided shall be submitted with technical bid.

11.57 PRINCIPLE PARAMETERS

11.57.1 Circuit Breaker

Table 11-26: Parameters: Circuit Breaker

Sr No.	Particulars	66 kV
1)	Enclosure	**Three phase**
2)	Enclosure material	**Aluminum Alloy**
3)	Rated voltage	**72.5 kV**
4)	Rated current	**2000A**
5)	Rated frequency	**50 Hz**
6)	Rated short-circuit breaking current Duration	**40 kA rms, 3 sec**

7)	Rated break-time	**3 cycle**
8)	Rated short-circuit making current	**100kAp**
9)	Difference for simultaneity of 3 poles	**4 ms (Max.)**
10)	**Rated insulation level under minimum SF6 gas pressure**	
a)	Power frequency withstand voltage	**140 kVrms**
b)	Lighting impulse withstand voltage Switching impulse voltage	**325 kVp (As per IEC 62271-1)**
9)	Rated operating sequence	**O-0.3s-CO-3min-CO**
10)	Type of operating mechanism for circuit Breaker	**Spring –Spring**
11)	Rated control voltage - Closing coil - Tripping coil	**110 VDC** **110 VDC**
12)	Mechanical Endurance class	**M2**
13)	Electrical Endurance class	**E2**
14)	Restriking probability class	**C2**
15)	Rated line charging breaking current	**50 (Max. over breaking**
		capacity **voltage factor1.4 PU)**
16)	Rated cable/GIB charging breaking current	**160 A**
17)	Rated capacitor bank switching current	**400A**
18)	Rated out of phase making and breaking current in % of rated short circuit breaking current	**10kA**
19)	Characteristic for short line fault related to ratedshort circuit breaking current	**As per IEC 62271 - 100**
20)	TRV characteristics	**As per IEC 62271 - 100**
21)	Inductive current breaking capability	**Switching No Load currentof transformer**
22)	First pole to clear factor	**As per IEC 62271 - 100**
23)	Opening time in ms	**Not more than 40**
24)	Closing time in ms	**Not more than 70**
25)	Noise level at the base of CB	**As per NEMA standard**
26)	No of tripping coils per breaker	**2(and 1 emergency hand tripping)**
27)	**No of closing coils per breaker**	**1**

11.57.2 Disconnector Switches and Maintenance Grounding switches

- The GIS disconnector switches, and grounding switches shall comply with the following general requirements of disconnect switches and the latest version of the relevant specifications IEC 60129, 61128, 61129, 61259.
- Disconnect switches shall be gang operated and three phase for 66 kV group operated, no break, with one common motor operated mechanism for all the three poles. They shall

also have facilities for emergency manual operation and necessary handles shall be provided.

- Disconnect switches and grounding switches shall have electrical interlocks to prevent grounding switch from closing on an energized section.
- Interlocks with other bays for bus transfer switching shall be done through bay control cabinets. Actuation of the emergency manual operating device shall also disable the electrical control. Disconnector in open condition shall be secured against reclosure.
- Disconnecting switches and adjacent safety grounding switches shall have electrical interlocks to prevent closure of the grounding switches when the disconnecting switches are in the closed position and to prevent closure of the disconnecting switch when the grounding switch is in the closed position. The disconnector shall be pad lockable in the close & open position.
- Interlocks
- Interlocking devices must provide absolute and positive protection against potentially harmful mal operations of the switchgear. The following functions shall be assured:
  a) Forcing the operator into the only safe and logic sequence to actuate breakers, switches, isolators and grounding switches.
  b) Checking the actual fully closed or fully open position of all switching elements before and after each move.
  c) Providing the logical checks and issuing the resulting PERMISSIVE or BLOCKED signals for the switchgear.
  d) Indicating positively the absolute condition/position of the supervised equipment.
  e) Local manual and remote electrical operation of all essential functions.
  f) Local emergency unlocking facilities via safety-key switches under the full responsibility of the operator.
- Intrabay and interbay interlocking shall be provided.
- Electrical interlocking arrangement shall be fail-safe type.
- Mechanical interlocks for Isolator & Earthing Switch combined module shall be fail-safe type.
- All main contacts, male and female, shall be silver plated.
- Each disconnect switch and grounding switch shall open or close only due to motor driven or manual operation independently. The switch contact shall not move due to gravity or other means, even if a part fails. Once initiated, the motor mechanism shall complete an open or close operation without requiring the initiating contact be held closed. Operation of respective end position limit switches shall only disconnect the motormechanism. There should also be a torque limter for protection against over run in case of inadvertent failure of drive mechanism in any intermediate position of the disconnector travel path.The disconnect switches and grounding switches shall be located as shown in the Single Line Diagram.
- The disconnect switches shall be capable of interrupting the charging current of the connected GIS bus & associated components.

11.57.3 *Duty requirements:*

- The disconnecting switches shall have breaking capabilities as per IEC requirements. Contact shielding shall be designed to prevent restrikes and high local stresses caused by the transient recovery voltages when currents are interrupted.

- The bus disconnecting switches shall reliably handle capacitive currents due to the making and breaking of switchgear components as well as commutation currents due to bus bar reconfiguration.
- The fast acting ground switches, used for overhead double circuit lines and underground cable feeders shall be capable of switching induced current as per IEC requirement.

11.57.4 *Short Circuit Requirements*

- The rated peak short-circuit current or the rated short time current carried by an isolator or earthing switch for the rated maximum duration of short circuit shall not cause:
    a) Mechanical damage to any part of the isolator or earthing switch.
    b) Separation of the contacts or contact welding.
    c) A temperature rise likely to damage insulation.

11.57.5 *Access for maintenance and repair:*

- Suitable means of access should be provided in each disconnect-switch and grounding-switch housing and mechanism for repair and/or maintenance of contacts.

11.57.6 *Operation Mechanism.*

- Mechanism shall be arranged mechanically, electrically, so that all three phases of any particular disconnect switch or grounding switch operate simultaneously.
- All mechanisms shall be suitable for electrical motor operation to achieve a fully automatic operation. For emergency situations manual operation shall be possible. Handles or hand cranks shall be provided, together with all necessary operation rods and rod guides. Manual operation shall be prevented if the interlocking system does not allow the operation of the switch.
- The auxiliary supply shall be electrically decoupled from the motor when the switch is operated manually.
- The mechanisms shall be arranged for locking in the open and in the closed position. Facility shall be available to allow the switch to be padlocked in any position.
- The drive mechanism should contain torque limiter facilities within to avoid over run of the disconnector.
- Disconnecting operating mechanism of all disconnector/ isolator & earth switches shall beat easy operable height.
- The isolator shall be provided with positive continuous control throughout the entire cycle of operation.
- The operating pipes and rods shall be sufficiently rigid to maintain positive control under most adverse conditions and when operated in tension or compression for isolator closing. They shall also be capable of withstanding all torsional and bending stresses due

to operation of the isolator.

- It shall not be possible, after final adjustment has been made, for any part of the mechanism to be displaced at any point in the travel sufficiently to allow improper functioning of the isolator when the isolator is opened or closed at any speed.
- High speed operated earthing switch mechanisms shall be provided with a mechanism with stored energy to always assure completed operations.
- The mechanism shall be in dust proof box with IP55(Outdoor application) and IP43(Indoor application).

11.57.7 *Auxiliary Switches:*

- All disconnecting switches shall be provided with electrically independent auxiliary switch, directly driven by the common operating shaft. Each disconnect switch and grounding switch shall furnished with sufficient Nos. of NO — NC as per entire scheme requirement plus two (2) NO-NC electrically independent contacts terminated up to terminal board, atuser’s disposal. The auxiliary switches shall indicate the position of the switch contacts,and shall be independent of the motor operation.

11.57.7.1 Position Indicators

- Mechanically connected position indicators shall be provided externally to permit observation of close/open position of the disconnect switch and grounding switch. The place of Position Indicators should be easily visible from the place of operation of respective equipment.

Table 11-27: Position Indicators: Auxiliary Switches

	Status	Colour
Open position	Open	**Green**
Closed position	**Closed**	**Red**

Table 11-28: Technical parameter Disconnectors and Maintenance type earthing Switches

Sr. No.	Particulars	Parameters
1)	Enclosure	**Three phase**
2)	Enclosure material	**Aluminum Alloy**
3)	Rated voltage	**72.5 kV**
4)	Rated current	**2000 A**
5)	Rated short-time current Duration	**40 kA rms, 3 sec**
6)	Rated control and operating voltage	**110 V DC**
7)	Type of operating mechanism	**Motor operated**
8)	Type	**Mechanically & electrically ganged operated**
9)	Rated insulation level	

a)	Power frequency withstand voltage	
	- phase to phase, between phases	**140 kV rms**
	- Across the isolating distance	**160 kV rms**
b)	Lightning impulse withstand voltage	
	- phase to phase, between phases	**325 kV peak**
	- Across the isolating distance	**375 kV peak**
10)	Mechanical Endurance Class	**M2**
11)	**Bus transfer switching capability**	**1600A**

11.57.8 Fast Acting Grounding Switches

- Fast acting grounding switches can be located at the terminal of HV/EHV overhead line/ cable. They shall be able to switch safely load currents of overhead lines. They must have fault making capability and be able to switch on a live line. Applicable standards are IEC 60129, 60517, 61129. The fast-acting grounding switches shall comply with the following general requirements of fast acting grounding switches and the latest revision of the relevant IEC specifications.

- Fast acting grounding switches shall be of three phase, encapsulated, three phase linkage group operated by a maintenance-free self-contained electrical motor. They shall also have facilities for emergency manual operation and the necessary operating handles or hand cranks shall be supplied.
- Fast acting grounding switches shall be electrically or padlocked with related disconnector, to prevent the fast acting grounding switch from closing on an energized bus section.
- All main contacts, male and female, shall either be silver plated or shall have silver inserts. Each fast-acting grounding switch shall open or close only due to motor-drive or manual operation but shall be operable from local only. The switch contact shall not move due to gravity or other means, even if a part fails. Once initiated, the motor mechanism shall complete an open or close operation without requiring the initiating contact to be held closed.
- Each fast-acting grounding switch shall be fully insulated and connected to ground by a removable bolted link in order that the grounding switch may be used for various test purposes. The insulation shall be capable of withstanding an applied DC impulse voltage of 30 kV for cable testing.

11.57.9 *Operation Mechanism.*

- Mechanisms shall be coupled either electrically , so that all three phases of any particular fast acting grounding switch operate simultaneously without any discrimination.
- All mechanisms shall be equipped with a motor suitable for operation from the auxiliary supply, and a set of springs so arranged that energizing of the motor will cause the springs to be charged and then released. The springs in turn shall close the fast acting grounding switch.
- Motors shall be suitable for operation at any voltage between 85% and 110% of the rated auxiliary voltage, measure at the motor terminals.
- For emergency situations manual operation shall be possible. Handles or hand cranks shall

be provided, together with all necessary operation rods and rod guides.
- The auxiliary energy shall be electrically uncoupled from the motor when the switch is operated manually.
- The mechanisms shall be arranged for locking in the open and in the closed position.

11.57.10 *Auxiliary Switches*

- Each fast acting grounding switch shall be furnished with sufficient Nos. of NO — NC as per entire scheme requirement plus two (2) NO-NC electrically independent contacts, suitably terminated at terminal blocks, at user's disposal. The auxiliary switches shall indicate the position of the switch contacts, and shall be independent of the motor operation.
- Position Indicators/ Mechanically connected position indicators shall be provided externally to ascertain the open/close position of the grounding switch. It should be easily visible from the place of operation of equipment.

Table 11-29: Position Indicators: Auxiliary Switches

	Status	Colour
Open position	Open	**Green**
Closed position	**Closed**	**Red**

- Visual verification shall be provided for each pole of each disconnect switch and grounding switch to permit visual inspection of each switchblade position.
- Test Facility
- Each fast acting grounding switch shall be fully insulated and connected to ground by a removable bolted link in order that the grounding switch may be used for various test purposes. The insulation shall be capable of withstanding an applied power frequency voltage of 3 kV.
- High Speed earthing switches shall be capable of interrupting line coupling currents upon opening and in worst conditions closing.

11.57.11 High Speed Earthing Switch:

Table 11-30: Specifications: High Speed Earthing Switch

Sr. No.	Particulars	66kV
1)	Enclosure	**Three phase**
2)	Enclosure material	**Aluminum Alloy**
3)	Rated voltage	**72.5 kV**
4)	Rated short-time current	**40kA rms, 3 sec**
5)	Rated peak withstand current	**100 kA peak**
6)	Type of operating mechanism	**Stored energy mechanism**
7)	Rated control and operating voltage	**110 V DC**
8)	Power frequency withstand voltage	**140 kV rms**
9)	Lightning impulse withstand voltage	**325 kV peak**
10)	Electrical Endurance class	**E1**
11)	Mechanical Endurance class	**M1**

12)	**Rated induced current switchingcapability**	**As per IEC 62271 – 102 class B**

11.57.12 Maintenance Earthing Switch: 66kV

Table 11-31: Maintenance Earthing Switch: 66kV

1)	**Enclosure**	**Three phase**
2)	Enclosure material	**Aluminum Alloy**
3)	Rated voltage	**72.5 kV**
4)	Rated short-time current	**40kA rms, 3 sec**
5)	Type of operating mechanism	**Motor operated**
6)	Electrical Endurance class	**E0**
7)	Mechanical Endurance class	**M2**
8)	Power frequency withstand voltage	**140 kV rms**
9)	**Lightning impulse withstand voltage**	**325 kV peak**

11.57.13 Current Transformers:

General

- The current transformers provided for each phase shall be supplied in accordance with the following general requirements and the latest revisions of the relevant IEC 61869 specifications.
- The current transformers must be suitable for continuous operation when installed on the conditions.
- The current transformer shall be ring / toroid type, multi ratio with fully distributed secondary windings with relay accuracy as per IEC 60185 , incl. IEC 61869, multi core as per requirement and shall be mounted inside the high voltage enclosure.
- The secondary terminals of current transformers shall be placed outside the high voltage enclosures, mounted in suitable, accessible terminal boxes and the secondary leads of all the current transformers shall be wired to shorting type terminals.
- It shall be possible to test each current transformer without the removal of gas through the insulated grounding switches.
- The number and position of the current transformers shall be relative to the circuit-breakers, disconnecting switches and ground switches as detailed in the attached single line diagram.

- Each current transformer shall be provided such that the enclosure current does not affect the accuracy or the ratio of the device or the conductor current being measured. Provision shall be made to prevent arcing across the enclosure insulation.

11.57.14 *Rating and Diagram Plates*

- Rating and diagram plates shall be provided. The information to be supplied on each plate shall be as specified in the relevant IEC specification.

11.57.15 *Voltage Transformer: SF6 insulated:*

- Each voltage transformer shall be metal enclosed, SF6 insulated in accordance with relevant IEC 61869. The location, polarity, ratios, and accuracy shall be as specified. Construction:
- VTs should be in segregated compartment and not forming a part of bus bar.
- A voltage transformer should be tested onsite at 80% (235kV) of Power Frequency voltage so that it does not have to be disconnected during dielectric testing may be specified. The metal housing of the transformer should be connected to the metal enclosure of the GIS with a flanged, bolted, and gasketed joint so that the transformer housing is grounded to the GIS enclosure. Adequate measures shall be provided to prevent any unacceptable impact on the secondary control and protection circuits, which might result from fast transients (VFT) or Ferro-resonance.

11.57.16 *Covers and shields:*

- Special covers and any necessary corona shields should be supplied so that the system can be pressurized and dielectrically tested after removal of the transformer

11.57.17 *Primary and secondary terminals:*

- Primary and secondary terminals should have permanent markings for identification of polarity, in accordance with IEC.
- Provision shall be made for grounding of the secondary windings inside the local control cabinet.
- Test condition for tests at site: Power frequency tests for the completed GIS at site shall be possible without removing the VT. The primary and secondary neutral terminal points, intended to be earthed, should be insulated and shall withstand power frequency voltage of 3 kV rms for 1 minute. The VT shall be capable to withstand discharge current arising from capacitance of underground cable circuits

11.57.18 Technical Data Requirement:

Table 11-32: Technical Data Requirement:

Sr. No.	Particulars	Parameters
1	Rated voltage	**66kV**
2	Highest system voltage	**72.5kV**
3	Rated frequency	**50 Hz**
4	P F (dry) withstand voltages	**140 kV**
5	Voltage factor	**1.2 continuous 1.5 for 30s**
6	1.2/50 micro sec. lightning impulsewithstand voltage	**325 kVp**
7	**Earthing**	**Effective**

11.57.19 66kV PT details

Table 11-33: 66kV PT details

Purpose	Ratio	Burden	Class of accuracy
Metering	66KV/√3 110V/√3	**50 VA**	**0.2**
Protection	66KV/√3 110V/√3	**50 VA**	**3P**
Protection	**66KV/√3 110V/√3**	**50 VA**	**3P**

11.57.20 Bushings:

- Outdoor bushings shall be provided for connection of conventional external conductors to SF6 GIS if asked in general layout plan.
- Suitable clamp & connectors shall be supplied with bushing. The dimensional and clearance requirements for the metal clad enclosure shall be maintained as per requirement of relevant standards.
- All the bushings shall have an impulse & power frequency withstand level that is higher or equal to the level specified in Technical Specification.
- Only SF6 insulated composite silicon bushings will be accepted. The terminals on the outdoor bushings shall be a solid stem with dimensions specified.

11.57.21 *Metal-Enclosed Surge Arresters:*

- 114kV, 10kA, Cl-3 hermetically sealed, Gapless, ZnO, Surge arrestor, suitable for use with GIS, for each phase, at the 66kV line underground cable entry/ GIB terminals of GIS shall be provided, if indicated in SLD/BOQ of respective tender. Each Surge Arrester shall be provided with self-leakage current monitoring device at convenient elevation.
- They shall have adequate thermal discharge capacity for severe switching surges, long duration surges and multiple strokes. The surge arresters when provided with pressure relief devices shall be capable of withstanding the internal pressures developed during the above discharges without operation of the pressure relief devices.
- The ground connection shall be sized for the fault level of the GIS. It shall be insulated from the GIS-enclosure and grounded externally to permit periodic maintenance and monitoring of the leakage current.
- If the arresters are not equipped with removable links, special covers and any necessary corona shields should be supplied so that the system can be pressurized and dielectrically tested after removal of the arrester.
- Access to the arrester ground connection, when it is provided with means for leakage current monitoring should not be obstructed.

11.57.22 *Gas sections*

- The GIS enclosures shall be divided into several gas sections separated by gas-tight barriers. Each section shall be provided with necessary valves to allow evacuation and refill of gas without evacuation of any other section. Location of gas barrier insulators is to be clearly discriminated outside the enclosure by a band of distinct colour normally used for safety purposes.
- The gas system proposed shall be shown on a “gas single line diagram” and submitted with

the technical bid and in the event of an order for approval. It should include the necessary valves, connections, density monitors, gas monitor system and controls, indication, orifices, and isolation to prevent current circulation. Means of calibrating density monitors without de-energizing the equipment should be specified by the supplier.

- For the purpose of gas monitoring and maintenance, the GIS shall be divided into various individual zones in each bay. The CB gas zone shall be independent from all other gas compartments and shall meet the requirement of relevant IEC.
- Each gas zone shall be furnished with a gas monitoring system consisting of a gas density continuous monitoring device provided with two electrically independent contacts which operate in two stages as follows:

a) First alarm: At a gas density normally 5 to 10% below the nominal fill density.

b) Second alarm: Minimum gas density to achieve equipment ratings.

In special cases determined by the supplier, a third stage with a set of contacts may be necessary in certain areas. Provisions shall be made for connecting pressure gauges, service cart, and moisture test instrumentation to any one of the gas sections.

11.57.23 *Insulating Gas and gas leakage rate*

- The GIS shall be furnished with sufficient sulfur hexa fluoride (SF6) gas to pressurize the complete system in a sequential approach, one zone or compartment at a time to the rated nominal density. The guaranteed leakage rate of each individual gas compartment and between compartments must be less than 0.1% p.a. for the service life of equipment.
- The quality of new filled-in SF6 gas shall meet the following requirements in line with IEC 60376.
- SF6 > 99.90 % by weight
- Air < 500 ppm by weight (0.25 vol.-%) CF4 < 500 ppm by weight (0.1 vol.-%) H2O < 15 ppm by weight (0.012 Vol-%) Mineral oil < 10 ppm by weight
- Acidity, in terms of HF < 0.3 ppm by weight Hydrolysable fluorides,
- In terms of HF < 1 ppm by weight

11.57.24 *Reuse or recycling of removed gas:*

- The supplier should provide guidelines or recommended practices for the reuse or recycling of SF6 gas removed from the equipment. These guidelines should be consistentwith current industry practices, as they pertain to the effect of SF6 on global warming; i.e. SF6 gas should be reused and recycled whenever possible and never be necessarily released into the atmosphere. Clear instructions shall be provided by bidder about handling, recycling & treatment of new and used SF6 gas. During commissioning dew point of SF6 gas shall be measured and documented. Components may be filled with N2 for transportation and refilled with SF6 at site.

11.57.25 *Permanent gas Treatment Device:*

- Means shall be provided inside each enclosure for treating the SF6 gas by the use of Desiccants, driers, filter, etc. to remove impurities in the gas.
- All gas compartments shall be fitted with static filter material containers that will absorb residual and entering moisture inside the high voltage enclosures. Filters inside thebreaker compartment shall also be capable of absorbing gas decomposition products resulting from the switching arc.

11.58 PORTABLE PARTIAL DISCHARGE MONITORING SYSTEM FOR GAS INSULATED SWITCHGEAR

11.58.1 *General:*

- The equipment shall be used for detecting different types of defects in Gas Insulated Stations (GIS) such as Particles, Loose shields and Partial Discharges as well as for detection of Partial discharges in other types of equipment such as Cable Joints, CTs and PTs.
- It shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 10 KHz — 500 KHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principal of operation shall be on acoustic technique and the method of measurement shall be non-intrusive. The instrument is able to detect partial discharges in cable joints, terminations, CTs and PTs etc., with the hot sticks.
- Detection and measurement of PD and bouncing particles shall be displayed on built in large LCD display and the measurement shall be stored in the instrument and further downloadable to a PC for further analysis to locate actual source of PD such as free conducting particles, floating components, voids in spacers, particle on spacer surfaces etc.

11.58.2 *Technical Specification:*

- Measurement shall be possible in noisy environment.
- Stable reading shall be possible in presence of vibrations within complex GIS assemblies, which can produce signals similar to PD.
- Equipment should have necessary synchronizing circuits to obtain PD correlation with power cycle and power frequency.
- The equipment shall be battery operated with built-in-battery charger. It shall also be suitable for 230V AC/50 Hz input.
- Measurement shall be possible in the charged switchyard in the presence of EMI/EMC.
- Supplier should have supplied similar detector for GIS application to other utilities. Performance certificate and the list of users shall be supplied along with the offer.
- Instrument shall be supplied with standard accessories i.e., re-locatable sensors with mounting arrangements, connecting cables (duly screened) to sensors, Lap-top PC, diagnostic software, carrying case, rechargeable battery pack with charger suitable for 230V AC, 50Hz supply connecting cables (duly screened) to view in storage.
- The function of software shall be covering the following:

- Data recording, storage and retrieval in computer - Data base analysis

- Template analysis for easy location of fault inside the GIS
- Evaluation of PD measurement i.e, Amplitude, Phase Synchronization`.
- Evaluation of bouncing/loose particles with flight time and estimation onsize of particle.
- Report generation

- To prove the suitability in charged switchyard condition, practical demonstration shall be conducted before acceptance.
- Supplier shall have "Adequate after sales service" facility in India.
- Necessary training may be accorded to personnel to make use of the kit for locating PD sources inside the GIS
- Instrument shall be robust and conform to relevant standard.

11.58.3 *GIS Connection:*

- Connection Scheme is to be provided in line with what specified in Tender SLD for Bidding purpose.

11.58.4 *Line to GIS*

- 66 kV class: by GIS SF6 to air bushing (wall bushing or GIS bus duct) to line termination gantry by conductor. GIS bus duct to be considered from connection Gantry to Gas Insulated Switchgear. (As specified in SLD /SECT DRG / BOQ).

11.58.5 *GIS to Transformer*

- 66kV side by GIS SF6 to OIP condenser bushing (Transformer Incomming) by GIS busduct (As specified in SLD /SECT DRG / BOQ).
- When the SF6 to the bushing of an oil-insulated transformer / reactor is connected, the transformer/reactor bushing must be oil-tight, gas-tight and pressure resistant. Any temperature related movement and irregular setting of the switchgear's or transformer's/reactor's foundations are absorbed by the expansion fittings.

11.58.6 *Local & Remote Control and Operation*

11.58.6.1 General

- One local control cabinet (LCC) of OEM of GIS shall be supplied for the local control and operation of each bay. Each LCC shall contain the local control, interlocking, operation and indication devices for the associated GIS bay.
- The LCC shall be mounted on each GIS bay. The LCC's shall be located with sufficient space for access and the possibility to work at the equipment even when the LCC doors are open, or directly at the switchgear in front of the related circuit breaker.
- The LCC's shall be installed indoor and care must be taken with the design to ensure that all LCC's are drip and splash proof. The LCC's shall also be dust and vermin proof. LCC shall comply degree of protection class IP-42 according to IEC60529. The control and operation circuits shall be well shielded and with safety measures to protect operator fromtouching energized parts. Power frequency withstand of control circuits shall be 2 kV for 1 minute.
- The LCC should have required arrangement for control and operations of GIS fromRemote

i.e. from the control room through SCADA as well as SCADA compatible control and protection panel.

- The LCC shall include all required functions for control and supervision of a complete GISas well as the marshalling of all connections to and from the GIS bays.
- Safe station operation is ensured through following base functions.
  i) Feeder & station interlocking, depending on the position of all high voltage components with their blocking functionality.
  ii) Blocking of commands when crank handle of disconnector or earthing switches is introduced.
  iii) Extensive circuit breaker supervision through "Anti-Pumping", pole discrepancy, Gas density and position supervision of circuit breaker,

11.58.6.2 Required features for conventional local control cabinets

The LCC's shall be provided with the following features:

- A mimic diagram showing the single line diagram. Position indictors, on/off switches for the HV devices and local / off / remote switches shall be installed on or adjacent to the various symbols of the mimic diagram.
- The following devices shall be supplied as a minimum:
  1. Circuit breaker control switches with ON – OFF indicating lamps. – Circuit breaker "local-remote" selector switch.
  2. Disconnect switch, control switch with ON — OFF indicating lamps. - Grounding switch, control switch with ON — OFF indicating lamps. - Mimic bus including symbols according to the single line diagram. - Monitoring control fall high voltage switching devices in a bay.
  3. Digital display of current, voltage, active and reactive power, power factor etc.

- Any interposing relays and control switches associated with the circuit breakers disconnect switches ,grounding switches etc.
- The alarm and indication for devices specified e.g. gas, DC & AC supervision.
- MCB and links (Fuse shall not use). These shall be installed in the interior of the LCC's
- Terminal blocks for the terminating and marshalling of auxiliary supply circuits, control, interlocking, and indication & alarm circuits from the GIS and for cable connections to the remote control room or the owner's control system.
- Each LCC shall be furnished with a guarded resistance heater to prevent the internal equipment from humidity deposit. The heater shall be rated 230 V AC and fed through a two pole MCB disconnect switch and controlled by reputed make humidity controller.
- A fluorescent lamp and a duplex convenience outlet rated 230 V AC, 15 amps with ground fault interrupter shall be installed in each LCC.
- The Local control cubicle shall be fitted with pre wired interface terminal blocks for connection to user's control & protection panels. The interface includes CT & PT inputs for

protection & Measuring system, Protection trip 1 & 2 signals, Aux switch contacts etc.

11.58.7 *Wiring Requirements*

- Each circuit breaker shall have control suitable for operation on 24 V DC/230V AC with two electrically independent trip circuits. The miniature circuit-breakers (MCB) shall be provided for the closing circuit and an independent separate MCCB unit of suitable rating shall be provided for the primary and back up trip circuits.
- Wiring shall be complete in all respects to ensure proper functioning of the control, protection, and monitoring and interlocking schemes.
- DC circuit for trip coil 1 & 2 shall be wired separately.
- Wiring shall be done with flexible 1100V grade (MSIL approved Make & Techcnical Specification), FRLS, PVC insulated, switchboard wires with 2.5 mm2 stranded copper conductor. The control wire in a grouped environment shall not convey flame, continue to burn. Wiring between equipment and control cubicle shall be routed through G.I. rigid conduits and shall be done by PVC & screened cable only, with safety measures to protect operator from touching energized parts.
- Each wire shall identify at both ends with permanent Printed bearing wire numbers as per Contractor's wiring diagram.
- Wire termination shall be done with crimping type connectors with insulating sleeves. Wires shall not be spliced between terminals.
- All spare contacts of relays, push buttons, auxiliary switches etc. shall be wired up to terminal blocks in the control cubicle.
- Terminal blocks shall be 1100V grade, stud type with engraved numbers suitable for termination of at least two numbers of 2.5 mm2 stranded copper conductor. Terminal blocks for CT, PT, auxiliary AC & DC supply shall be disconnecting link type.
- Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished.
- Terminal blocks shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.
- Terminal connectors that carry power supply should be shrouded from adjoining connectors.
- Manufacturer shall provide all control wiring and terminations internal to the switchgear and connecting the switchgear to the bay control cabinets.
- All control cables shall be shielded. Cable shields shall be grounded. Grounding connections shall be as short and direct as possible and shall terminate at the point of entry to cabinets or terminal boxes.
- Co-axial type cable glands suitable for use with shielded cables shall be used at each termination.
- All control cables shall be installed and terminated in such a manner as to limit the effects of transient electromagnetic voltages on the control conductors to an acceptable level.
- Any cabling within GIS shall be supported on cable tray. No cable shall be in hanging position.
- Insulator cones shall be embedded in full return current carrying metal fixing rings in order

to avoid mechanical stresses to the cast resin part and to impart full conductivity across the flange connection. Earthing of different gas

- Compartments/enclosures is not allowed with cross bonding with any metal strips.

11.58.8 *Connections within the GIS and their LCC's*

- All cable connections between the various GIS modules and the LCC's shall be made by prefabricated multi-core cables with multipoint plug in connections on both the ends. PTs & CTs circuit shall be wired with crimped type copper lugs.
- All cables shall be shielded and adequate for their application (indoor / outdoor). The cables shall be fire retardant low smoke.
- The length and the number of terminal points of control wiring & SF6 gas connections shall be minimized.
- The electrical connections between the various gas sections shall preferably be made by means of multiple contact connectors so that electrical connection is automatically achieved when bolting on section to another. The surface of the connector fingers and conductor tubes on such connections shall be silver plated. "Harting" terminal connector to be used for this purpose

11.58.9 *Name plates*

- Name plates of the following types shall be furnished in a convenient central location to provide information for operation and maintenance.

a) Gas Single Line Diagram showing all HV devices in a single line diagram with the gas sectionalizing of the GIS indicated. Also shown shall be the GIS nomenclature, a legend, Manufacturer's type and serial number and year of manufacture.

b) GIS Rating / Name plate:

- Manufacturer's name & address, type & designation, Sr. No, Maximum ambient temperature, System frequency, Maximum continuous voltage, Maximum continuous current at 40oC ambient temperature, Basic Impulse Level, Power Frequency one minute voltage, Short circuit current, rms., symmetrical Short time (rms) current & duration, symmetrical Momentary current, peak, Total weight of gas at rated density, Rated gas pressure at 20oC. Opening pressure of the bursting disc, recommended moisture limits of insulation gas (PPMV), Auxiliary voltages, Contract/Purchase Order numbers, Total weight of the equipment
- Equipment nameplate containing nameplate rating information for all HV modules (like circuit breaker, disconnect switches, current transformer, voltage transformer, surge arrester, etc.) as required in relevant IEC.
- Nameplates showing serial numbers and similar data specific to individual components shall be mounted on the components. Each instrument transformer must have its own rating plate mounted adjacent to each terminal box cover, will all terminal and ratio markings. Each bay auxiliary control cubicle must be identified with its designation to which it is assigned.

11.58.10 *Type Tests:*

Following type test reports from NABL/STL laboratory, as specified in IEC standard 62271 — 203 (amended up to date) shall be submitted for the offered type, rating of GIS invariably with the technical bid. Bid without type test reports will not be considered for evaluation. 72.5 kV GIS to be supplied shall have valid type test certificates as specified in IEC standard 62271-203 not older than 10 years from originally scheduled date of bid submission.

The type test reports submitted in this tender shall be of the same switchgear model which is offered & also from same factory from where the switchgear is intended to supply Type test shall be conducted from below lab: -

a) KEMA, Holland
b) CESI, Italy
c) IPH, Germany
d) EDF, France
e) CERDA, France
f) PEHLA, Germany
g) CPRI and ERDA India

i. Tests to verify the insulation level (Lightning impulse and HV power frequency test with PD) test on each GIS device (CB, Disconnector, bus, etc).
ii. Dielectric tests on auxiliary circuits.
iii. Tests to prove the radio interference voltage (RIV) level.
iv. Tests to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit.
v. Tests to prove the ability of the main and earthing circuits to carry the rated peak and the rated short time withstand current.
vi. Tests to verify the making and breaking capacity of the included switching devices.
vii. Tests to prove the satisfactory operation of the included switching devices.
viii. Tests to prove the strength of enclosures.
ix. Verification of the degree of protection of the drives.
x. Gas tightness tests
xi. Electromagnetic compatibility tests (EMC).
xii. Additional tests on auxiliary and control circuits.
xiii. Tests on partitions.
xiv. Tests to prove the satisfactory operation at limit temperatures.
xv. Tests to prove performance under thermal cycling and gas tightness tests on insulators.
xvi. Tests to assess the effects of arcing due to an internal fault.
xvii. Tests on solid dielectric components (operating rods, spacers, etc)
xviii. Test on Auxiliary switches (Electrical & Mechanical Endurance, Heat run, IR & HV test)

Important note for type tests: If the above specified type test are not available that bidder shall invariably confirm to carry out the required type test/s, special tests, before commencement of supply, without affecting delivery schedule, free of cost, at NABL approved laboratory, or at suppliers worksin presence of owner representative, in the event of order.

11.58.11 *Routine / Acceptance Testing:*

- During manufacture and on completion, all equipment shall be subjected to the Routine tests as laid down in IEC Standard IEC 62271-203. All the acceptance tests shall be carried out in presence of Owner representative on offering the material for inspection and testing by successful bidder. Tests shall include the following:

i. Dielectric test on the main circuit.
ii. PD test both conventional(IEC 60270) and UHF methods
iii. Tests on auxiliary and control circuits.
iv. Measurement of the resistance of the main circuit.
v. Leakage test.
vi. Design and visual checks.
vii. Pressure tests of enclosures.
viii. Functional tests
ix. Tests on auxiliary circuits, equipment and interlocks in the control mechanism.
x. Pressure test on partitions
xi. LCC – Complete functional & interlock test as per approved drawings with LCC duly connected to respective Bay GIS module in all respect.
xii. - HV test with conventional and UHF measurement
xiii. CT and VT testing at NABL accredited laboratory.
xiv. Visual inspection for Sealable CT for metering purpose
xv. 30kV DC testing on the line side earthing switches

11.58.12 *Test Certificates:*

- Certified reports of all the tests carried out at the works shall be furnished in required number copies for approval of the Owner.
- The equipment shall be dispatched from works only after receipt of Owner/ Purchaser's written dispatch clearance & approval of the test reports.
- Routine test certificates of bought out components shall be furnished.
- Type test certificate on any equipment or component if so desired by the Owner shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

11.58.13 *Tests after installation of complete GIS at Site:*

- After installation and before being put into service, the GIS shall be tested in order to check the correct operation and dielectric integrity of the equipment as laid down in IEC 62271-203. The successful bidder shall furnish a commissioning test plan and a statement method for the tests on site.
- Tests shall include the following:

i. Dielectric tests on the main circuits.
ii. Dielectric tests on auxiliary circuits.
iii. Measurement of the resistance of the main circuit.
iv. Gas Leakage tests.
v. Checks and verifications.
vi. Gas quality verifications.
vii. On site power frequency voltage withstand test with PD test.
viii. Functional & interlock tests for all items
ix. Demonstration of operational compatibility with SCADA
x. Visual inspection, checks & verifications.
xi. Mechanical operation tests of circuit breakers, Disconnectors and earthing switches and high-speed earthing switches
xii. Tests on CTs and VTs. Full di-electric tests on CTs and VTs.

11.58.14 *Required test equipment*

- During the onsite tests, the supplier shall provide all necessary test facilities and equipment for the switch-gear power frequency tests, i.e. test bushing or test cable, test adapter, test transformer or resonant test set etc on returnable basis

11.58.15 *Spares:*

- Bidder shall submit a list and supply of following spares.
  1. Recommended spare parts for three (3) years after guarantee period of satisfactory and trouble-free operation.
  2. Commissioning spares iii) Maintenance spares
  3. Special tools, tackles & spanner required during commissioning, operation and maintenance.
- All spares indicated in list for above shall be considered in the scope of supply.
- Each list shall be complete with specification, ratings, type, make, identification number, unit rate, quantity etc.

11.58.16 *Drawings, Data & Manuals:*

- Drawings, Data and Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions on Contract and/or elsewhere in this specification for approval and subsequent distribution after the issue of Letter of Intent.
- To be submitted with the Bid:

Typical general arrangement drawings of the equipment’s indicating space requirement, room dimensions, crane capacity etc.

Technical Specifications of equipment and special tools explaining construction features, principle of operation, special features etc.

- Comprehensive QAP, FQP, SLD, Gas Schematic diagram, Technical brochures, building requirements, Earth mat design, List of recommended spares, special tools or fixtures, O&M manuals, environmental guide for handling SF6 gas & decommissioning, estimated time schedule for installation & commissioning, bill of materials, and any other documents required for successful commissioning & operation of complete GIS.
- *Control and protection:*

Block & principle diagram showing proposed scheme, layout & equipment arrangementdrawings, catalogues & brochures of offered devices.

Successful bidder shall submit 3 sets of Book bound volume in A4 Colored print of followingdrawings & data for approval before commencement of supply:

i. A comprehensive Manufacturing Quality assurance plan with effective quality assurance system.
ii. Field Quality plan indicating instruction & procedures sequenced for storage, assemble, maintenance and disassembly.
iii. Assemble and maintenance clearance requirements.
iv. Dimensional general arrangement drawing showing disposition of various fittings, name plates indicating equipment ratings.
v. Structure Plan with details and loading
vi. Foundation plan indicating loadings for all GIS equipment, supporting structure and anchor bolt arrangements.
vii. Assembly drawing for erection at site with part numbers and schedule of materials Transport/shipping dimensions with weights.
viii. Control schematic and wiring diagrams.
ix. Gas schematic Diagram
x. Gas system installation procedures, gas handling procedures.
xi. Grounding arrangement and ground bus details including Manufacturer's recommendation on Grounding of reinforcement bars of Column foundation.
xii. Calculation of Voltage rise for GIS enclosure
xiii. Calculated point to point resistance for each assembly.
xiv. Calculation for Surge Protection
xv. Any other relevant drawing or data necessary for satisfactory installation, operation and maintenance.
xvi. Operating instruction & manuals for GIS and its accessories
xvii. The manual shall clearly indicate method of installation, checkups and tests to be carried out before commissioning of the equipment.
xviii. The bidder shall note that the approval of drawings & documents by the Owner does not relieve him of his contractual obligation.

The bidder may note that the drawings, data and manuals listed herein are minimum requiredonly. The bidder shall ensure that all other necessary write-up, curves, etc. require to fully describe the equipment are to be submitted with the bid.

All drawings shall be prepared by using AutoCAD and documents shall be generated usingElectronic version. The paper copy of the drawings & document shall be

Submitted for approval & reference. All final drawings and documents shall be submitted in PanDrive in AutoCAD 2010 and MS office format as applicable for Owner's future reference. Also AutoCAD version of Main GA drawings is to be submitted for Owner's layout finalization.

11.58.17 *Maintenance:*

The operational integrity of the GIS switchgear shall not subject to external influences, such as pollution, moisture, dust etc. As a consequence of this GIS switchgear should be practically maintenance free; however, the details of inspection required at regular interval shall be indicatedin the offer. Visual inspection shall be required not below 9 (Nine) years interval. Major inspection shall not be required often than every 17 years. During inspection it must not be necessary to open theswitchgear enclosures for interrupt operation of substation. Provision of functional testing of the close and trip coils, auxiliary switches, pressure and control switches etc. shall be provided.

Following minimum maintenance period shall be accepted.

(a) Circuit breaker: 6000 closing and opening rated current or 9 interruption per phase at max rated fault current.
(b) Disconnector: 10000 closing and opening operations.
(c) Fast acting earth switch: 2000 closing and opening at normal operations / 2 making operations on to max rated fault current.

The bidder shall provide the services of experienced persons, supervisors, engineers, experts,etc., for complete specified work for satisfactory operation.

The bidder shall have dedicated localized after sales & service team which should be capable anyactivity to operate complete GIS satisfactorily.

11.58.18 *GIS Civil Requirement*

Bidder must be submitted their equipment's civil requirement with technical offer.

i. GIS Room Dimension, Room Height, Drawings.
ii. 3.5 T EOT Crane requirement.
iii. GIS equipment foundation drawings.
iv. Relay & control room requirement.
v. Other requirements need to be mentioned in technical offer.

vi. The bidder shall provide complete floor plan detailing the fixing positions, levels and size of fixing bolt pockets and foundation required for all equipment's. Drawings giving similardetails shall be provided.

vii. All static and dynamic loads plus dimensional tolerances shall be given on these drawings

11.58.19 *Trainings*

Training to Five (5) persons of Owner construction, installation, commissioning, and O&M shall be imparted by bidder free of cost at Manufacturer Factory or Training Center. Duration of the complete

training shall be 3 working days, covering minimum below specified curriculum. Any other specific area may be brought to notice and included.

- General Explanation for GIS
- Layout and Architecture of GIS
- Gas Sectionalisation of GIS
- Construction of CB
- Operating Mechanism of CB
- Maintenance of CB
- Overhaul of CB (Interrupting chamber)
- Overhaul of CB (Operating Unit)
- Construction of DS/ES
- Maintenance of DS/ES
- Overhaul of DS/ ES
- Construction of Bus/ Cable head/ SF6 – air bushing
- Maintenance of Bus/ Cable head/ SF6 – air bushing
- Overhaul of Bus/ Cable head
- Overhaul of various transformer connections
- Construction & Maintenance of Lightning Arrester 18. Construction & Maintenance of VT/CT
- Construction & Maintenance of Local control panel
- Erection of GIS at site.
- Installation & Testing of GIS at site
- Type tests of GIS
- Routine tests of GIS.

Bidder shall at his cost arrange for the above training facilities and in addition shall bear all living expenses plus inland travel expenses of all the trainees. The Purchaser shall only pay to and from passage of the trainees.

11.58.20 *Shipment storage and installation:*

All equipment's shall be suitably packed and protected during shipment/transportation. Each shipping unit shall be sealed in a clean dry condition with leak-tight shipping covers securely mounted for shipment. All covers to be removed during installation shall be clearly marked. Each shipping section shall be carefully sealed and filled with dry gas to a slightly positive pressure to prevent the entrance of moisture and contamination.

The packing method for the GIS equipment shall be standard and it shall be guaranteed that each component of the equipment will not be damaged, deformed or lost. The storage instructions shall be submitted by bidder for long term storage. Component requiring indoor storage shall be so identified. Gas insulated switchgear (GIS) shall be properly packed to protect during ocean shipment, inland transport, carriage at site and outdoor storage during transit and at the site. Completely assembled bays (subject to transport limitations) of the GIS shall be transported as one shipment unit.

Packing materials shall be dust and waterproof. All packages shall be clearly, legibly and durably marked with uniform block letters on at least three sides. Fragile items like bushings, CTs, VTs, LAsand fully assembled bays shall be securely packaged and shipped in containers. Silica gel or approved equivalent moisture absorbing material in small cotton bags shall be placed and tied at various points on the equipment wherever necessary. As far as possible, transshipment should be avoided.

Shock indicators shall be provided on the packages to confirm that GIS has not suffered any shocks during shipment, transport, handling, etc. The Shock recorders readings are tobe noted on receipt of equipment at site and reported to user & manufacturer in case the readings are exceeding the permissible values. It shall be at discretion of user to accept or reject the same.

11.58.21 *Quality Assurance*

Superior quality control system shall be adopted to assure high product quality. Raw materials of thebest commercial grade quality and high reliability shall be used in the manufacture of GIS. High reliability of materials shall be ensured so as to keep maintenance work to a minimum.

A quality assurance plan for major components such as breakers, disconnecting switches, lightning arrestors, earth switches, etc. with in-process inspection methods, tests, records, etc. shall be submitted with the technical bid. Customer hold points will also be included in the plan, which shall bemutually agreed by the PURCHASER and MANUFACTURER, and approved.

Table 11-34:Guaranteed Technical Particulars for Gas Insulated Substation

Sr No	Particulars	To be Filled by BIDDER
1	**General**	
2	Name of manufacturer (OEM)	
3	Country of Origin	**INDI A**
4	Delivery from (location)	
5	Type & Designation	
6	Type tested at Name of LaboratoryAddress of laboratory	
7	Installation (indoor or outdoor)	
8	Standards applicable	
9	No. of Phases	
10	Single or Three Phase design	
11	**Configuration**	**66 kV**
i	Number of Incoming Feeder bays	
ii	Number of transformer bays	
iii	Number of Bus coupler bay	
iv	GIS to transformer connection	
v	GIS to Incoming Overhead Line connection	
vi	Number of VT,CT	
vii	Number of SA	
	Future extension possibility	
12	**Service conditions**	
i	Ambiant Air Temp. in Deg. C	
ii	Max Temp. in Deg. C	
iii	Min Temp. in Deg. C	
iv	Daily Average Temp. in Deg. C	
v	Solar Radiation W/sq mtr	
vi	Altitude above MSL, in mtr	
vii	Pollution class	
viii	Creepage distance, in mm/kV	

ix	Relative humidity	
x	Condensation	
xi	Vibration level	
xii	Noise level	
xiii	Induced Electromagnetic Disturbance, in kV	

xiv	Seismic conditions	
a	Vertical	
b	Horizontal	
13	**Enclosure**	
i	Code of pressure vessel	
ii	Type of manufacturing	
iii	Design temperature in Deg.C	
iv	Material	
v	Material grade & applicable standard	
vi	Outside diameter in mm	
vii	Minimum Wall Thickness, in mm	
viii	Painting Shade & Thickness	
a	- External	
b	- Internal	
ix	Degree of Protection	
x	Inductance in H/mt	
xi	Capacitance in pF/mt	
xii	Resistance in Ohm/mt	
xiii	Expansion Bellow	
a	Material	
b	Min allowable adjustable displacementLongitudinal Transverse	
xiv	Sealing system	
a	Type	
xv	Estimated life in years	
xvi	Barrier	
a	Material	
b	Dielectric strength	
14	**Support Structure**	
i	Material	
ii	Minimum thickness of galvanizing	
iii	Foundation channels /Anchor bolts	
15	**Grounding**	
i	Grounding Material	
ii	Grounding of complete GIS	
iii	Grounding of individual compartment	
iv	Grounding at flange joints	
16	**System Parameters**	**66 kV**
i	Highest System voltage in kV	
ii	Rated voltage of System in kV	
iii	Rated voltage of Equipment in kV	
iv	Rated Insulation level Phase to Earth and between Phases	

a	One Min Power Frequency withstand voltagekVrms	
b	Switching impulse withstand voltage, kVp	
	- Phase to Earth	
	- Between Phases	
c	Lightning Impulse withstand voltage, kVp	
iv	Rated Frequency	
v	Rated current in Amp	
vi	Rated current at 40 °C (equipment) in Amp	
vii	Rated current at 40 °C (bus bar) in Amp	
viii	Rated short circuit withstand current kArms	
a	Duration in sec	
b	Peak, kAp	
ix	Enclosure withstand time for an internal faultin sec.	
x	Estimated total energy loss at	
	100 % of rated capacity	
	75 % of rated capacity	
	50 % of rated capacity	
	25 % of rated capacity	
xi	Measures taken to minimize Over Voltage	
xii	Phase labeling	
xiii	**Auxiliary supply (AC Voltage, Frequency;DC voltage**	
	- Operation	
	- Control	
	- Illumination & heater	
17	**Delivery conditions**	
i	Bays fully assembled at works	
ii	Dimensions of longest section for transportation	
iii	Weight of heaviest package	
iv	Pressure of SF6 gas during transportation	
v	SF6 gas monitoring system provided duringtransportation	
18	**Bus Bar**	**66 kV**
i	Configuration (Single / Double)	
ii	Nos of Phases	
iii	Material	
iv	Size	
v	Rating	
vi	Current density adopted	
vii	Current density as per type test report	
viii	Short time current withstand rating in kA	
viii	Short time current withstand rating in kA	
ix	Duration	
x	Resistance per phase	
xi	Surge impedance	
xii	SF6 immersed insulator	
a	Material	
b	Dielectric strength	
xiv	Maximum Partial Discharges measured atHSV	

19	**SF6 Gas**		
i	Applicable standard		
ii	Quantity of SF6 Gas of complete GIS at fillingpressure, in kg		
iii	Quantity of SF6 Gas of **largest** compartment GIS at filling pressure, in kg		
iv	Nos of Gas compartments		
v	Quantity of SF6 Gas of **individual** compartment GIS at filling pressure, in kg		
vi	Maximum permissible dew point, in Deg.C		
vii	Composition of Gas		
a	SF6 > 99.90 % by weight		
b	Air < 500 ppm by weight (0.25 vol.-%)		
c	CF4 < 500 ppm by weight (0.1 vol.-%)		
d	H2O < 15 ppm by weight (0.012 Vol-%)		
e	Mineral oil < 10 ppm by weight		
f	Acidity, in terms of HF < 0.3 ppm by weight		
g	Hydrolysable fluorides, In terms of HF < 1 ppm by weight		
	PRESSURE	**in MPa**	**in kg/sqcm**
vii	Design pressure		
a	Circuit breaker		
b	Other compartments		
ix	Rated filling pressure		
a	Circuit breaker		
b	Other compartments		
x	Type tested pressure.		
a	Circuit breaker		
b	Other compartments		
xi	Routine test pressure		
a	Circuit breaker		
b	Other compartments		
xii	Operating pressure of PRD		
a	Circuit breaker		
b	Other compartments		
xiii	Alarm Pressure		
a	Circuit breaker		
b	Other compartments		
c	CB lock out Pressure		
d	Over pressure signaling		
xiv	Maximum SF6 Gas leakage rate, in % peryear		
xv	Density Monitor to be provided for eachIndividual gas compartment		
20	**Circuit Breaker**	**66 kV**	
i	Applicable standard		
ii	Type		
iii	Designation		
iv	Operating Mechanism type		
v	Nos. of phases		
vi	Rated current in Amp		
vii	Mechanical Endurance class		

viii	Electrical Endurance class	
ix	Restrike probability class	
x	Rated SC breaking current	
xi	Rated SC breaking current - single phase test	
xii	Rated Line charging breaking current	
xiii	Rated Cable charging breaking current	
xiv	Capacitor bank switching capability	
	BC1BC2	
xv	Inductive current	
xvi	Reactive current	
xvii	Out of phase making & breaking current	
xviii	Rated short line fault current	
xix	TRV characteristic	
xx	First Pole to Clear factor	
xxi	Nos. of interrupters per phase	
xxii	Type of arc control device provided, if any	
xxiii	Type of arcing contacts	
xxiv	Material of main contact	
xxv	Material of Arcing contacts	
xxvi	Filter material	
xxvii	Timings of operations	
a	- Opening at nominal control voltage	
	- Opening at minimum control voltage	
b	Closing time at nominal control voltage	
xxviii	Maximum pole discrepancy time TrippingClosing	
xxix	Rated operating duty cycle	
xxx	Tripping Coils	
	No of coils	
	- Rated Voltage	
	- Rated Current	
	- Rated Watts	
	- Resistance	
xxxi	Closing Coil	
	- Rated Voltage	
	- Rated Current	
	- Rated Watts	
	- Resistance	
xxxii	Spring Charging Motor	
	- Rated Voltage	
	- Rated Current	
	- Rated Watts	
xxxiii	Spring charging time at rated Aux supply	
xxxiv	Spring charging time at min Aux supply	
xxxv	Maintenance required after nos. of operationat	

i	No load	
ii	Rated current	

iii	25% of rated SC current	
iv	50% rated SC current	
v	Rated SC current	
e	Provision of anti pumping	
f	No of operations after switching off of motorAux. supply	
xxxvi	Provision of Manual trip	
xxxvii	Electrical interlocking	
xxxviii	Padlocking	
xxxix	Type of Operation counter provided	
xxxiii	Spring charging time at rated Aux supply	
xxxiv	Spring charging time at min Aux supply	
xxxv	Maintenance required after nos. of operationat	
i	No load	
ii	Rated current	
iii	25% of rated SC current	
iv	50% rated SC current	
v	Rated SC current	
e	Provision of anti pumping	
f	No of operations after switching off of motorAux. supply	
xxxvi	Provision of Manual trip	
xxxvii	Electrical interlocking	
xxxviii	Padlocking	
xxxix	Type of Operation counter provided	
21	**DISCONNECTORS**	**66 kV**
i	Applicable standards	
ii	Type	
iii	Rated current in Amp for	
	- Bus disconnector	
	- Line disconnector	
	- Transformer disconnector	
	- PT disconnector	
iv	Maximum Current that can be safelyinterrupted by the Isolator	
	Inductive	
	- Capacitive	
v	Rate Short time withstand Current in kA, for 3sec	
vi	Rated peak short time Current, kAp	
vii	Rated bus charging current, in Amp	
viii	Type of contacts	

ix	Material of contacts	
x	Current Density at minimum cross section(A/mm2)	
xi	Rated lightning impulse withstand voltage across the open gap, kVp	

xii	Rated Power Freq withstand voltage acrossthe open gap, kVrms	
xiii	Mechanical Endurance class	
xiv	Type of Operating Mechanism	
xv	Operating Motor details	
v	Rate Short time withstand Current in kA, for 3sec	
vi	Rated peak short time Current, kAp	
vii	Rated bus charging current, in Amp	
viii	Type of contacts	
ix	Material of contacts	
x	Current Density at minimum cross section(A/mm2)	
xi	Rated lightning impulse withstand voltage across the open gap, kVp	
xii	Rated Power Freq withstand voltage across the open gap, kVrms	
xiii	Mechanical Endurance class	
xiv	Type of Operating Mechanism	
xv	Operating Motor details	
v	Rate Short time withstand Current in kA, for 3sec	
vi	Rated peak short time Current, kAp	
vii	Rated bus charging current, in Amp	
viii	Type of contacts	
ix	Material of contacts	
x	Current Density at minimum cross section	
	(A/mm2)	
xi	Rated lightning impulse withstand voltage across the open gap, kVp	
xii	Rated Power Freq withstand voltage acrossthe open gap, kVrms	
xiii	Mechanical Endurance class	
xiv	Type of Operating Mechanism	
xv	Operating Motor details	
	- Type	
	- Rated Voltage	
	- Rated Current	
	- Rated Watts	
xvi	Operating Time	
	--Closing - Opening	
xvii	Mechanical indication on drive shaft	

22	**Maintenance Grounding Switch**	**66 kV**
i	Applicable standards	
ii	Type	
iii	Rate Short time withstand Current in kA, for 3sec	
iv	Rated peak short time Current, kAp	
v	Rated lightning impulse withstand voltage across the open gap, kVp	
vi	Rated Power Freq withstand voltage acrossthe open gap, kVrms	
vii	Type of Operating Mechanism	
viii	Operating Motor details	
	- Type	
	- Rated Voltage	
	- Rated Current	
	- Rated Watts	
ix	Operating Time	
	--Closing - Opening	
x	Mechanical indication on drive shaft	
23	**Fast Acting Grounding Switch**	**66 kV**
i	Applicable standards	
ii	Type	
iii	Rate Short time withstand Current in kA, for 3sec	
iv	Rated peak short time Current, kAp	
v	Rated induced current switching capability Rated capacitive current switching capability	
vi	Rated lightning impulse withstand voltage across the open gap, kVp	
vii	Rated Power Freq withstand voltage acrossthe open gap, kVrms	
viii	Electrical Endurance class	
ix	Type of Operating Mechanism	
x	Operating Motor details	
	Type	
	- Rated Voltage	
	- Rated Current	
	- Rated Watts	
ix	Operating Time	
	--Closing - Opening	
x	Mechanical indication on drive shaft	
24	**Current transformers**	**66 kV**
i	Type	
ii	Material	
iii	Position of Current Transformer	

iv	Reference Standard	
v	Rated Continuous thermal current	
vi	Rated Short Time current	
vii	Duration	
a	**Feeder Bay CT**	
i	Metering Core	
	Ratio	
	- Output Burden	
	- Accuracy Class	
	- ISF	
ii	Protection Core -1	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
	- ALF	
iii	Protection Core -2	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
	- ALF	
b	**Transformer Bay CT**	
i	Metering Core	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
	- ISF	
ii	Protection Core -1	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
	- ALF	
iii	Protection Core -2	
	- Ratio	
	- Accuracy Class	
	- Minimum Knee Point Voltage at highest ratio	
	- Maximum Excitation Current at Vk	
	- Maximum Resistance at highest ratio	
iv	Protection Core -3	
	- Ratio	
	- Accuracy Class	
	- Minimum Knee Point Voltage at highest ratio	
	- Maximum Excitation Current at Vk	
	- Maximum Resistance at highest ratio	
c	**Bus Coupler Bay CT**	**66 kV**
i	Metering Core	
	- Ratio	

	- Output Burden	
	- Accuracy Class	
	- ISF	
ii	Protection Core -1	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
	- ALF	
iii	Protection Core -2	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
	- ALF	
25	**Voltage Transformer**	**66 kV**
	Type	
	Position of Voltage Transformer	
	Reference Standard	
	Rated Over Voltage Factor - Continuous	
	Short Time Over Voltage Factor	
	Duration	
	Partial Discharge Level	
	Thermal Rating of Primary Winding	
26	**Line & Bus VT**	**66 kV**
i	Metering Core	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
ii	Protection Core -1	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
iii	Protection Core -2	
	- Ratio	
	- Output Burden	
	- Accuracy Class	
27	**Enclosed Surge Arrester**	**66 kV**
ii	Name of Manufacturer	
iii	Arrester Class & Type (with mfr typedesignation)	
iv	Applicable Standard	
v	Rated system voltage (kV)	
vi	Rated Arrester Voltage (kV)	
vii	Max continuous operating voltage (MCOV) –(kV)	
viii	i)Nominal Discharge Current (KA) with 8/20Micro-second wave	
	ii)Max resistive component of cont current at MCOV-mA crest	
	iii)Max capacitive component of cont current at MCOV -mA crest	

ix	Long Duration Discharge Class	
x	Min. Energy Discharge Capability (KJ/KVrating)	
xi	Max. switching current impulse residualvoltage (KVP) 1000 Amps 250 Amps	
xii	Pressure Relief Class KA (rms)	
xiii	High Current short duration impulse withstandlevel with 4/10 micro-second wave (KA) peak	
xiv	Over –voltage withstand capability – KV	
	a) 100 Seconds	
	b) 10 Second	
	c) 1.0 Second	
	d) 0.1 Second	
	e) Reference Voltage (KV)	
	f) Reference Current (KA)	

xv	Surge counter	
xvi	Leakage monitor	
28	**Local Control Cubical**	**66 kV**
i	Name of Manufacturer (OEM of GIS)	
ii	Location in GIS	
iii	Material	
iv	Sheet Thickness	
v	Degree of Protection	
vi	Padlocking arrangement	
vii	Major components of LCC	
	Bay control mimic diagram	
	- Control Switches	
	- Indicating lamps	
	- Position indicators	
	- Annunciation scheme	
	- Auxiliary relays	
	- Contact multiplication relays	
	- System parameters display	
	- Heater with thermostat	
	- Interface terminal blocks for relaying &protection	
29	**GIS to Line connection**	**66 kV**
	Bus bar rating	
	Bus bar connection	
30	**GIS to Transformer connection**	**66 kV**
	Bus bar rating	
	Bus bar connection	
31	**Maintenance**	
i	Maximum down time for replacement orremoval of any part	
ii	Maximum down time for degassing and re-filling the biggest compartment	

iii	Time between two refilling of SF6 gas.	
iv	Recommended period for overhauling	
v	Operation and Maintenance manual attached	
vi	Nearest local service centre	
vii	Minimum time of availability of local service	
viii	Availability of spares at local service centre	
ix	List of recommended spares attached?	
x	List of recommended special tools, etcattached?	
xi	List of commission spares attached?	

12 HORTICULTURE WORK

12.1 Introduction

12.1.1 *Special Conditions*

1. *Work under this contract shall be executed as shown on the tender drawings and given in the specifications and required at site whether specifically shown or not.*

12.1.2 *Scope of work*

Work under this contract shall consist of furnishing all labour, materials, equipment appliances and all transportation necessary to completely carry out all works relating to horticulture works described herein and shown on the drawings.

1. *All right of ways to have roadside plantations, footpath, cycle track, drains, gutters, access ramps for disabled, camber and slopes as per tender indicative drawings in Vol III; and*
2. *The Nim sahib natural drain has to be channelized, with development of 30-meter-wide green belt and adjoining organized green areas including tree lined Pathways, foot over bridges over nalla, cycle track, lighting and plumbing and electrical works as per tender indicative drawing Vol III*
3. *The green areas mentioned as buffer in Layout plan below the HT lines, will also be constructed as Landscaped parks and tree lined footpaths as per tender indicative drawings in Vol III*
4. *Various Parks i.e. Park- 1, 2, 3, 4, 5 and 6 will be constructed with pedestrian footpath, lake, pergola, pavilions, open air theater and other landscaping features, complete with plumbing, lighting and electrical works as per tender indicative drawing Vol III*

12.1.3 *Specifications*

12.1.3.1 *Work shall be carried out strictly in accordance with the specifications attached to this tender.*

12.1.3.2 *Works not covered in the specifications shall be carried out as per relevant C.P.W.D. Standards/PUDA guidelines and specifications of materials.*

12.1.4 *Execution of work*

12.1.4.1 *The work shall be carried out in conformity with the contract drawings and within the requirements of Architectural, HVAC, Plumbing, Electrical, Structural and other specialized service drawings.*

12.1.4.2 *The contractor shall co-operate with all trades and agencies working on the site.*

12.1.4.3 *On award of the work the contractor shall submit a schedule of work in the form of a PERT chart or Bar Chart for approval of the LANDSCAPE ARCHITECTS / EMPLOYERS / CONSTRUCTION MANAGER. All dates and time schedules agreed upon shall be strictly adhered to.*

12.1.4.4 *The contractor shall provide all facilities to LANDSCAPE ARCHITECT / EMPLOYER or his authorized representative to make frequent inspection of their nursery and ascertain the progress/quality of various categories of plants grown by them.*

12.1.4.5 *The safe custody and up-keep of various categories of plants brought to the site is the sole responsibility of the Contractor and he shall employ sufficient supervisory personnel to ensure the safety of these items.*

12.1.4.6 *The site of work may be handed over to the Contractor for start of work in phases, as soon as the same are available and the Contractor in turn shall start work in these areas forth with. Nothing extra shall be payable for such phased execution of work.*

12.1.4.7 *While excavating/executing the work, the Contractor shall ensure that existing cables/pipelines/structures/fittings are not damaged and if due to negligence, these are damaged the same shall be set right at costs borne solely by the Contractor.*

12.1.4.8 *The Contractor shall keep the nursery and site of works neat and clean during the execution of the work. Any debris founds at or near the site of work shall be got removed immediately as and when so required by the LANDSCAPE ARCHITECT/ CONSTRUCTION MANAGER.*

12.1.4.9 *The contractor shall co-ordinate his work with other agencies employed by the Clients and ensure that the works of other agencies are not hampered in any way during the execution of the contract.*

12.1.4.10 *On completion of the work, the nursery and site of works shall be thoroughly cleaned and all debris removed before the site is handed over satisfactorily.*

12.1.4.11 *The Contractor shall, without any additional charge to the Client, renew or replace any dead or defective plants/grass and shall fully maintain the whole landscape for a period of twelve months after the certified date of completion of at the site of works.*

12.1.5 ***Drawings***

12.1.5.1 *Contract drawings are diagrammatic but shall be followed as closely as actual construction permits. Any deviation made shall be in conformity with the architectural and other services drawing.*

12.1.5.2 *Lighting, Electrical and plumbing or other services arrangements and drawings are to be prepared in line with the Landscape Architectural drawings as indicated in Tender drawings*

12.1.5.3 *Contractor shall verify all dimensions at site and bring to the notice of the LANDSCAPE ARCHITECTS / CONSTRUCTION MANGERS any or all discrepancy or deviations noticed. LANDSCAPE ARCHITECTS decision shall be final.*

12.1.5.4 *Any drawing supplied with the tender shall be returned in good conditions along with the tender.*

12.1.5.5 *All drawings issued by the LANDSCAPE ARCHITECTS for the work are the property of the EMPLOYER and shall not be copied, reproduced or used on any other works than intended without the written permission of the EMPLOYER.*

12.1.6 ***Materials***

12.1.6.1 *All plant materials used in this work shall conform to the specifications and as laid down in schedules Vol III .*

12.1.6.2 *All materials used on the project shall be approved by the LANDSCAPE ARCHITECTS / CONSTRUCTION MANAGERS before use.*

12.1.6.3 *Contractor may be required to purchase such plant materials of particular kind or from a particular source if in the opinion of the CONSTRUCTION MANAGERS / LANDSCAPE ARCHITECT the same is necessary and required for the proper and reasonable compliance of the specifications and in the interest of better quality of work.*

12.1.7 ***Reference Drawings***

12.1.7.1 *The contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on site.*

12.1.7.2 *All corrections, deviations, and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings. All changes so made shall be initialed by the LANDSCAPE ARCHITECTS / CONSTRUCTION MANAGERS.*

12.1.8 *Site Order Book*

12.1.8.1 *The contractor shall maintain a site order book at the site office.*

12.1.8.2 *All instructions relating to the job issued by LANDSCAPE ARCHITECTS / CONSTRUCTION MANAGERS / EMPLOYER shall be recorded by the CONSTRUCTION MANAGERS / LANDSCAPE ARCHITECTS along with contractors compliance.*

12.1.8.3 *Contractor is bound to carry out all such instruction given to him.*

12.1.9 ***SPECIFICATIONS FOR HORTICULTURAL WORKS***

12.1.9.1 ***SCOPE OF WORK:***

The Planting Contractor shall provide all horticultural operations and services specified on the drawing and in the schedule of quantities as specified herein or both, including:

a. *Provide labour, equipment, services and transport*

b. *Provide all plant material.*

c. *Provide topsoil for all plants.*

d. *Provide fertilizers, chemicals and manure and stakes as specified.*

e. *Preparation of planting locations.*

f. *Prepare plants pits, back filling, prepare "saucers" for watering, adding soil after settlement.*

g. *Spraying before planting.*

h. *Staking, supporting, wrapping and tying plant materials.*

i. *Transplanting.*

j. *Disposal of debris and unused materials.*

k. *Guarantee of trees and plants for a period of twelve months after handing over of site of works.*

l. *Free visiting, inspecting and consulting for the period of three months at the site of works.*

12.1.9.2 ***PLANT MATERIALS/LAWNS***

a. *Area - All exterior ground area, except surfaces occupied by structures and paving as well as areas indicated to be undisturbed or planted (trees, shrubs, ground covers, creepers, vines. annual plants, etc.). shall be planted as shown on drawings.*

b. *Materials -*

i. *Topsoil shall be fertile, friable, natural topsoil typical of locality, and shall be obtained from a well-drained site that is free of flooding. It shall be without admixture of subsoil or slag and shall be free of stones, lumps, plants or their roots, sticks and other extraneous matter and shall not be delivered or used while in a frozen or muddy condition.*

ii. *Top soil as delivered to the site shall have an acidity range of PH 7 to 8 and shall not contain less than 5% organic matter. Test report for the same shall be provided by the Contractor.*

C. Ground Preparation

a. *Grading - Grade lawn areas to finish grades, filling as needed or removing surplus dirt and floating areas to a smooth, uniform grade as indicated. All lawn areas shall slope to drain.*

i. *Where no grades are shown, areas shall have a smooth and continual grade between existing contours (such as walks, curbs, catch basins- elevation at steps or building) and elevation shown on plans. Roll. Scarify, rake and level as necessary to obtain true, even lawn surfaces. all finish grades shall meet approval of the ENGINNER IN CHARGE or LANDSCAPE ARCHITECT or his authorized representative, before lawn is laid.*

b. *Natural fertilizer – manure shall be well- rotten unleached, Okhla khad or cattle manure or equivalent free from sawdust shavings, refuse and harmful chemicals, manure shall contain no lumps which will not pass a 2 inch sieve. Spreading of 1-inch thick layer of manure on the ground and mixing with the good earth shall be carried out by the contractor.*

c. *After incorporation of fertilizer in the soil, the lawn bed, shall be fine graded to remove all ridges and depressions, and depressions and surface cleared of all stones 1- inch or more in diameter and of other debris. At-least 1- inch layer of manure to be spread on the ground and mixed with earth for grassing. Ref. given specification for lawn bed preparation.*

d. *Planting of rooted cuttings grass at a regular distance of 5cm center to center or as per Tender Indicative drawings.*

or

e. *Laying grass carpet directly on prepared ground.*

12.1.9.3 ***Lawn maintenance***

a) *Maintenance shall consist of watering, weeding, fertilizing, liming, disease and pest control, aerating, protective spraying, replacement of unacceptable material and any other procedure consistent with good horticultural practice necessary to ensure normal, vigorous, and healthy growth of all planted areas.*

b) *Keep all planting areas free from weeds and undesirable grasses.*

c) *Mow all grass areas at regular intervals, which will keep grass height from 2.5cm. Remove all grass clippings during or after mowing.*

d) *Make periodic tests during the maintenance period to determine the degree of compaction existing in all lawn area. If soil is compacted to a degree that water and air penetration impaired, the contractor shall aerate these areas to the satisfaction of the Engineer in Charge.*

e) *Maintenance shall also include all temporary protection fences, barriers and signs and all the other work incidentally to proper maintenance.*

f) *Upon completion and inspection of all repairs or renewals necessary in the judgement of the ENGINEER IN CHARGE, the ENGINEER IN CHARGE shall certify the same in writing to the EMPLOYERS.*

12.1.9.4 ***PLANT MATERIALS – TREES, SHRUBS, GROUNDCOVERS, CREEPERS, VINES, ETC..***

a. Plantation/ tree list – plants are listed in the drawings. The plant list is Tender drawings are indicative for type of plant, spacing etc. shall be verified with IRC: SP:2 and PUDA guidelines.

b. Nomenclature – the names of the plants/ trees to confirm to standardized botanical names.

c. Quality and general requirements of plants.

- ***i.*** *Plants shall be typical of their species and variety, have normal growth habits, well-developed branches, densely foliated with vigorous and fibrous root systems.*
- ***ii.*** *Plants shall be free from defects and injuries. Bark shall be free from abrasion.*
- ***iii.*** *Each bundle of plants and all separate plants shall be properly identified by weatherproof labels securely attached there to before delivery to the project site.*
- ***iv.*** *No plants shall be delivered to the project site, except for required samples, until inspection has been made in the field or at the nursery, or unless specifically authorized.*
- ***v.*** *B & B (Balled and Burlap) plants must be moved with the root system as solid units in balls of each firmly wrapped with burlap. The diameter and depth of the balls of earth must be sufficient to encompass the fibrous and feeding root system necessary for the healthy development of the plant. No plant shall be used when the ball of earth surrounding its roots have been badly cracked or broken preparatory to or during the process of planting or after the equipment required in connection with its transplanting has been removed. The plant and ball shall remain intact as one unit during all operations.*
- ***vi.*** *Container grown stock shall have been grown in container long enough for the root system to have developed sufficiently to hold its soil together, firm and whole. No plant shall be loose in container.*
- ***vii.*** *All plants shall be hardy under climatic conditions similar to those in the locality of the project. When plants of kinds or sizes specified are not available substitution may be made upon request by the Contractor if approved by the LANDSCAPE ARCHITECT.*
- ***viii.*** *All trees, soon after planting shall be properly supported to ensure their safety against wind or other factors, which may effect it adversely. Required stakes per tree shall be provided by the contractor.*

d. Size of Plants

- ***i.*** *All plant shall be equal to or exceed the sizes given in the plant list, which are minimum acceptable sizes. Plants shall be measured before planting, with branches in normal position.*
- ***ii.*** *Trees shall be minimum length as specified and shall be straight and symmetrical with a crown and having a persistent main stem. The size of the crown shall be in good overall proportion to the height of the tree shall be measured from the top of the root ball or pot. In case of palms, ht will be measured from top of root bell to the point of branching of leaves.*
- ***iii.*** *Shrubs shall be well formed with a crown typical of die species and variety. Shrub height dimension shall be the average height of the top of all stems and not of longest stem.*
- ***iv.*** *Ground cover plants shall be at least one year old and shall be supplied in 8 inch earthen or other suitable pots.*
- ***v.*** *Creepers and vines shall have at least 4 runners, and shall be supplied in 8 inch earthen or other suitable pots.*

12.1.9.5 ***TOP SOIL MIXTURE***

- ***i.*** *Soil - Topsoil shall be friable foam material, fertile, typical or the cultivated topsoils of the locality, containing at least 5% of decay organic matter. Topsoil soil shall be taken from a well-drained arable site. shall be reasonably free of subsoil, stones., weeds, earth, clods, sticks. Roots or other objectionable extraneous matter or debris and shall contain no toxic materials.*

ii. *Representative samples shall be tested for fertility and general texture by the Contractor from a recognized commercial or government agency the contractor shall submit a report of the same. No topsoil shall be delivered in frozen or muddy condition.*

- ***a.*** *Manure - Shall be well rooted unleached free of harmful chemicals and other substances, which may effect plant life. Manure shall be free of weeds, straw leaves or inorganic debris. Manure shall be well rotted.*
- ***b.*** *Compost Mixture - The ratio of the mixture of the topsoil to manure shall be:*
- ***c.*** *70% topsoil*

iii. *30% manure*

- ***a.*** *Fertilizer shall be complete fertilizer consisting of nitrogen, phosphorous and potash. It shall be applied by weight in two applications. The first application shall be within one week before planting on the top 6 inches of soil. The second application shall be done, as the LANDSCAPE ARCHITECT will think is needed.*

12.1.9.6 ***PLANTING OPERATIONS***

i. *Time of planting - Planting operations shall be conducted under favorable weather conditions, the Contractor will be notified by the Engineer in Charge's representative when areas of work are sufficiently clear of construction work for the Contractor to commence work on planting.*

ii. *Planting - Shall be done by experienced workmen familiar with planting procedures under the supervision of a qualified foreman.*

iii. *Plants Pits shall be excavated with vertical sides, except for these designated to be planted in beds. Plant pits shall be of the following sizes.*

- ***a.*** *Trees – 0.9m dia, 0.9m depth min. for small trees, for large trees as specified in tender, tree pits shall be large enough to accommodate the root ball + 1/3 root depth on all sides.*
- ***b.*** *Large Shrubs and climbers - 0.6m dia and 0.6m depth.*
- ***c.*** *Medium & small shrubs bed - 0.45m depth of bed & in case of individual shrubs, 0.45m dia & 0.45m depth.*
- ***d.*** *Ground Cover bed - The bed shall be dug a depth of 30 cms.*

iv. *Engineer in Charge shall inspect and approve plant pits before the contractor proceeds with placing of plants.*

v. *Topsoil shall be made ready for planting before plants are delivered to the site. The pits/beds shall be given anti termite treatment before backfilling.*

- ***a.*** *Placing of plants - Plants shall be centre of pits plumb and straight.*

vi. *The Engineer in Charge shall inspect and approve placing of plants before the contractor proceeds with further operations.*

- ***a.*** *Final Considerations - Topsoil shall be compacted around basin of balls to fill all voids. Roots shall be properly spread out and topsoil carefully worked in among them.*
- ***b.*** *Watering - Immediately after plant pit is backfilled, a shallow base slightly larger than pit shall be formed with a ridge of soil to facilitate and contain watering. After planting, cultivate the soil between plant pit and rake smooth. Spray the soil with water to settle.*
- ***c.*** *Guying and staking - All plants shall be inspected for injury to trunks, evidence of insect infestation and improper pruning, staking shall be done immediately after planting. Trees shall stand straight after staking.*

vii. *Engineer in Charge shall inspect and approve plan pits before the contractor proceeds with placing of plants.*

12.1.9.7 ***AFTER PLANTING CARE***

a. Watering - Water trees and other plants by watering twice within first 24 hours of the time of planting.

12.1.9.8 ***GUARANTEE***

i. *Period - All plants and lawns shall be guaranteed by the contractor for DLP & O&M period after the certified date of completion of work at site.*

ii. *Conditions - During this period, any plant that is missing, dead or not true to name or size as specified, or not in satisfactory growth shall be replaced immediately of approved size and shape solely at the cost of the contractor.*

iii. *Replacement - All replacements shall be plants of the same species, variety and size as specified in the plant list. The cost of replacement resulting from removal, loss or damage due to the occupancy of the site of works only in any part, or vandalism or acts of neglect on the part of others, in which case the cost will be borne by the Employers.*

12.2 CIVIL WORK

A. EARTH WORK: The following shall not be measured separately and shall be deemed to be included in the rates quoted:

1. Site clearance such as clearing of shrubs, brushwood, underground and roots.
2. Setting out the work profile, etc.
3. Excavation either straight or curved in plan or to any desired shape.
4. Bailing, pumping out or otherwise removing all water which may accumulate in the excavation from all cause excepting river seepage, broken water mains and the like.
5. Use and waste of necessary `Timbering' in places where considered necessary by the Architect.
6. Provision of adequate barriers, lighting, gangways across open trenches, etc. for protection of workmen and public.
7. Getting out and throwing spoil clear of area being excavated or depositing clear of edge of excavation to avoid falling in, as directed by Architect.
8. Trimming all sides plumb and square, levelling at bottoms and clearing out all loose earth slips or falls from excavation before concreting.
9. Disposing surplus soil as directed within site including spreading to proper levels and grade as shown and consolidating.
10. Work at all depths and locations, unless otherwise specified.
11. Earth used for filling shall be free from stone, shingle or boulder, salt, organic or other foreign matter, All clods of earth shall be broken or removed.

B. CONCRETE WORK- PLAIN AND REINFORCED: The following shall not be measured separately and shall be deemed to be included in the rates quoted.

1. All necessary operations for the proper weighing, mixing, handling, transporting, placing and vibration of concrete as directed/required.
2. The plates shall have fairly flat surface with undulation not exceeding ±3mm.
3. The pattern of shuttering including the deployment of various sizes of plates shall be got approved in advance from the engineer-in-charge. The shuttering plates will be so laid that the joints in both the directions are in one line.
4. Nothing extra shall be paid for semicircular shape, irregular shuttering, additional height in shuttering and it should be considered in the quoted rates.
5. Finishing the exposed surfaces of concrete to fair and even surfaces as directed.
6. Small linear labours including mouldings, chamfers, splays, rounded or coved angles chases beads, grooves, rebates, drips etc.
7. Incidental labour (i.e. stops, mitres, returns, rounded ends, junctions dishing, etc.) in connection with linear or super labours.
8. Providing holes and pockets for bolts, balustrades and other inserts (for fixing precast units etc.) as per details.
9. Forming joints or any kind (plain, rebated, locking, tongued and grooved etc.)
10. Leaving construction joints, expansion joints, dummy joints etc. wherever directed.
11. Building in or embedding ends of precast and other units shown.
12. Embedding rainwater pipes and the like as shown.
13. In case of precast concrete, all operations like hoisting, holding in position, levelling, aligning, adequate temporary supports and stiffening as directed, roughening of contact surfaces at construction joints, effecting the various connections as per details bolting, grouting with cement mortar, etc. as per drawings.
14. Adequate protection of edges and corners from damage during construction in approved manner.
15. Work either straight or curved, plain or circular, or of any shape.
16. Work at all heights, depths and locations, unless otherwise mentioned.
17. Keeping the work well wetted for at least 14 days after the casting.
18. Contractor will take necessary precautions such as watertight shuttering, suitable mechanical compaction etc. to ensure a leak proof structure.
19. Contractor will take necessary precaution such as tank tested against any leakage by filling the tank with water & maintain it for 7 (seven) days up to total height including free board including all necessary arrangements & water required.
20. In case of any leakage, the contractor shall take at his own cost necessary required measures to the satisfaction of the Employer.
21. It should be ensured that all joints between the shuttering plates do not exceed 3mm.

C. BRICK WORK: Following shall be considered inclusive in the rates quoted and will not be considered for payment whatsoever:

1. Hacking and roughening of concrete or other surfaces in contact with masonry for proper bonding.
2. Raking out joints to specified depth either for plaster or pointing or finishing the joint flush as the work proceeds as directed.
3. All scaffolding, ladders, platform, staging and plant required in the execution of work to any height or depth.
4. Levelling up and preparing top of walls for damp proof courses, pre-cast units etc.
5. Building in holdfasts and other such inserts.
6. Keeping the work well wetted for seven days.
7. All cutting, dressing, trimming and waste including cutting to required shapes.
8. All necessary templates, pattern moulds, mockups etc.
9. Rough cutting and waste.
10. Forming chases for edges of concrete floors or other unit, for sealing in of waterproofing layers etc.
11. All profiles as shown in the drawings for planter toe wall, Dwarf wall, steps etc. or other similar locations. Nothing extra shall be paid for rectangular, square, curved or chamfered or other small nature work, brickwork.
12. The bricks shall be soaked in water for at least 24 hours before use.
13. Anchoring hoop iron reinforcement in column/wall

D. PAVING WORK: Following shall be considered inclusive in the rates quoted and will not be considered for payment whatsoever: -

1. The stone of the type mentioned or as approved shall be brought as a single lot so as to reduce variation in shade and texture.
2. Stone shall be free from cracks and homogeneous in texture.
3. All pieces of stone fixed shall be true to square at all the edges.
4. Use and waste of all temporary fillets, side forms, templates, moulds, straight edges etc.
5. Final preparation of the base, sub-grade or sub-floor including minor trimming of the base to remove slight undulations, only if necessary.
6. Before spreading the under layer, the base shall be cleaned of dirt, laitance, loose material, etc., well-watered and covered with a coat of cement slurry by using a minimum cement content of 2.75 kg. Per square meter.

7. Providing bedding layer of mortar as specified in the case of slabs, tiles etc., to correct levels or slopes as called for.
8. Cutting, rubbing and polishing where applicable.
9. Rounding off corners, edges and junction of floors with skirting or dado.
10. Work in narrow widths, borders, bands etc and at all heights, and locations, and in curvature profile as shown unless otherwise mentioned.
11. All stones shall be machine cut and machine polished or as specified.
12. All corners of stone and tile work shall be mitred.
13. All the edges of stone shall be polished the same as that of the surface.
14. Curing, protection and cleaning shall be the responsibility of the contractor.
15. Mortar shall be filled behind stones/tiles so as not to sound hollow later.
16. All joints shall be finished with hairline and shall be filled with white or grey cement mixed with pigment to match the shade of stone/tiles.
17. All joints shall be straight in the line and right angles as per the case.
18. The work includes circular or curved work unless specifically noted and nothing extra shall be paid on this account.
19. Providing white cement layer under all white / light coloured stone shall be deemed to be included and nothing extra shall be payable on this account.
20. VITRIFIED - ACID OR ALKALI RESISTANT TILES

    i. Manufacture and Finish

    a) The tiles shall be of vitreous ware and free from deleterious substances. The iron oxide content allowable in the raw material shall not exceed two percent. The tiles shall be vitrified at the temperature of 1100 C and above and shall be kept unglazed. The finished tile, when fractured shall appear fine grained in texture, dense and homogenous. The tiles shall be sound, true to slopes, flat and free from flows and manufacturing defects affecting their utility.

    b) The tiles shall be conforming to IS 4457. The tiles to be tested for water absorption, compressive strength, acid resistance as per IS 4457. Sampling procedure for acceptance tests and criteria for conformity to be as per IS 4457. The tiles shall be of the required colour.

    ii. Dimensions and Tolerances

    Ceramic unglazed vitreous acid-resistant tiles shall be made in three sizes namely 98.5 X 98.5 mm, 148.5 X 148.5 mm and 198.5 X 198.5 mm. They shall be available in the following thickness: 35, 30, 25, 20 and 15 mm. The depth of the grooves on the underside of the tile shall not exceed 3 mm. Tolerance on length, breadth and thickness of tiles shall be + 2 percent.

    iii. Shape

    The tiles shall be square shaped pr Rectangular. Tiles shall be checked for squareness and warp as per IS 4457.

iv. Performance Requirements

The tiles when tested in accordance with the method given in IS 4457, shall conform to be requirement specified in the code (IS 4457).

v. Loss in Abrasion

The maximum percentage of loss in abrasion of the ceramic unglazed vitreous acid resistant tiles determined in accordance with the procedure laid down in IS 1237, shall be as mentioned in IS 4457.

vi. Marking

Tiles shall be legibly marked on the back with the name of the manufacturer or his trade mark. Manufacturer's batch number and year of manufacture. Each tile may also be marked with the ISI certification mark.

vii. Preparation of Surface and Laying

Preparation of surface and laying to be according to CPWD specifications, except the cement used to be acid and or alkali resistant cement and cement mortar to be used to be acid and or Alkali resistant mortar. Thickness of bedding of mortar for flooring to be 10 mm or specified on the item and for dado/skirting to be 12 mm or specified on item.

viii. Pointing and Finishing

As per CPWD Specifications, except that cement used for pointing to be acid and or alkali resistant cement.

ix. Rate

The rate for flooring shall include the cost of all materials and labour in volved in all the operations described above. For tiles of sizes upto 0.16 Sqm, unless otherwise specified in the description of the item. Nothing extra shall be paid for the use of cost (Sawn) tiles in the work.

E. RAILING WORK: The work shall include the following within the rates quoted: Nothing extra shall be paid:-

1. All forging, pressing, reducing to required size, shape and figure, drilling, tapping, punching, countersinking for screws, grinding etc, and every description of workmanship that may be necessary to fabricate, finish erect and fix in position all railing work in good, substantial, and perfect manner.
2. All necessary templates, pattern moulds, mock-ups etc.
3. All cutting, dressing, cutting to required sizes and shapes, trimming and waste.
4. Necessary hoisting equipment, derricks, cranes, temporary supports, scaffolds, staging, bracing, connection etc., required for fabrication, assembling staging and erection at all heights, including removing away the same after fixing steel work in final position as per drawings.
5. Preparation of surface, phosphating and priming cost for all mild steel work.
6. All joints shall be properly mitred or notched as approved by the Engineer-in-charge.

7. All joints shall be welded, bolted or riveted as mentioned in the drawing or as approved by Engineering-in-charge.

8. All welded joints shall be properly finished by grinder.

F. SPECIFICATION FOR PATH

1. BAJRI PATHS

i. Preparation of Sub-Grade The formation for a width equal to that of the bajri path shall first be cut to a depth, below the proposed finished level, equal to the thickness of the course of brick aggregate (due allowance being made for consolidation) and dressed off in level to the finished profile. In case of made up soil, adequate watering shall be done so that earth settles down as much as possible and the same rolled up with a minimum three tonnes or light power roller, as directed by the Engineer-in-Charge.
ii. Laying and Packing Brick Aggregate: Shall be as specified as per CPWD Specification 16.7.6 except that brick aggregate shall be used instead of stone aggregate and laid to 7.5 cm depth unless specified otherwise.
iii. Consolidation: Shall be as specified as per CPWD Specifications in 16.7.7 except that rolling shall be done by three tonnes or light power roller instead of by heavy road roller as directed by the Engineer-in-Charge.
iv. Rolling with Blinding Materials: Shall be as specified as per CPWD Specifications 16.7.10 except that rolling shall be done by three tonnes or light power roller instead of by heavy road roller as directed by the Engineer in-Charge.
v. Measurements The finished work shall be measured between the kerb or channel stones or brick edging etc. as the case may be. Length and breadth shall be measured, correct to a cm. The area shall be calculated in square metres, correct to two places of decimal.
vi. Rate The rate shall include the cost of materials and labour involved in all the operations described above.

2. BRICK EDGING

i. Edging Trenches of specified width and depth shall first, be made along the edges of the wearing course of the road to receive the bricks. The bed of trenches shall be compacted to a firm and even surface and then the bricks shall be laid with its length at right angle or parallel to the side of the road depending upon the width of edging as specified in the item. The bricks shall be abutting against the wearing course, true to line, gradient and in camber with the finished road surface at the edge.
ii. Finishing Berms and road edges shall be restored with excavated earth and consolidated by manually. All surplus earth including rubbish etc. shall be disposed off as directed by the Engineer-in-Charge.
iii. Measurements Length of the finished work shall be measured in running metres along the edges of the road correct to a cm.
iv. Rate The rate shall include the cost of materials and labour involved in all the operations described above.

3. FENCING WITH G.I. BARBED WIRE AND RCC POSTS

i. Materials R.C.C. posts and struts shall be as specified in CPWD Specifications 16.1.12. G.I. Barbed wire shall be as per IS 278.
ii. Spacing of Posts and Struts The spacing between posts shall be three metres centre to

centre, unless otherwise specified, or as directed by the Engineer -in-Charge to suit the dimensions of the area to be fenced. Every 15th, last but one end post and corner posts shall be strutted on both sides and end posts on one side only.

iii. Fixing of Posts and Struts Pits 45 x 45 cm and 75 cm deep or as directed shall first be excavated true to line and level to receive the posts. In the case of struts, pits 70 x 45 x 75 cm deep or as directed shall be excavated to suit the inclination of the strut so that it is surrounded by concrete by not less than 15 cm at any point. The pits shall be filled with a layer of 15 cm thick cement concrete 1:3:6 (1 cement: 3 fine sand: 6 graded stone aggregate 40 nominal size) . The posts and struts shall then be placed in the pits, the posts projecting 1.2 m or to the specified height above ground, true to line and position. The cement concrete 1:3:6 shall be filled in upto 15 cm for posts and 25 cm for struts below ground level at the base of the concrete so that the posts are embedded in the cement concrete block of size 45 x 45 x 60 cm and strut in block of size 70 x 45 x 50 cm. The concrete in foundations shall be watered for at least 7 days to ensure proper curing. The remaining portions of pits shall be filled up with excavated earth and the surplus earth disposed off as directed by the Engineer-in-Charge and site cleared.

iv. Fixing G.I. Barbed Wire The barbed wire shall be stretched and fixed in specified number of rows and two diagonals. The bottom row shall be 14 cm above ground and the rest at 12.5 cm centre to centre. The diagonals shall be stretched between adjacent posts from top wire of one post to the bottom wire of the second post. The diagonal wires will be interwoven with horizontal wires by fixing the odd- rows of wires first , then the diagonal cross wires and lastly the even rows of wires. The barbed wire shall be held to the R.C.C. posts by means of G.I. staples fixed to wooden plugs or G.I. binding wire tied to 6 mm barnibs fixed while casting the posts. Turn buckles and straining bolts shall be used at the end posts, if so specified.

v. Measurements Total length of G.I. barbed wire shall be measured in running meter correct to a cm.

vi. Rate The rate shall include the cost of labour and materials involved in all the operations described above but excluding the cost of posts, struts, turn buckle, straining bolts and excavation and concrete in foundations for which separate payments shall be made under respective items.

4. 75 MM THICK COMPACTED BED OF DRY BRICK BALLAST

i. Collection of Material Before the start of work brick aggregate 40 mm nominal size unless specified otherwise, shall be stacked for the entire work and record measurements done as per para 16.4 CPWD Specifications.

ii. Preparation of Sub Grade The formation for a width equal to that of the area shall be cut to the depth below the proposed finish level, equal to the thickness of the course of brick aggregate (due allowance being made for consolidation) and dress off in level to the finished profile. In case of made up soil, copious water shall be poured so that earth settles down as much as possible and the same rolled up with 3 tonnes or light power roller, as directed by the Engineer-in-Charge.

iii. Laying and Packing Brick Aggregate Brick aggregate shall be racked off the stack with the racks so as to leave behind mud and dust. It shall be spread evenly over the prepared surface to the required depth with a finishing material to avoid segregation. Brick aggregate shall be carefully laid and packed, bigger size being placed at the bottom to 7.5 cm. depth unless specified otherwise. After that the area shall be grouted with fine sand.

iv. Consolidation The bricks aggregate shall be consolidated by dry rolling with 3 tonne or light weight power roller as directed by the Engineer-in-Charge.

v. Measurement The measurement of the finished work shall be taken in sqm. correct to two places of decimal. Length and breadth shall be measured in metre correctly to a centimeter.

5. GRANULAR SUB–BASE

i. Scope This work shall consist of laying and compacting well-graded material on prepared subgrade in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grades and cross-sections shown on the drawings or as directed by the Engineer-in-charge.

ii. Materials

iii. The material to be used for the work shall be natural sand, crushed gravel, crushed stone, crushed slag or combination thereof depending upon the grading required. Use of materials like brick metal, Kankar and crushed concrete shall be permitted in the lower sub-base. The material shall be free from organic or other deleterious constituents and shall conform to the grading given in MORTH specifications, Gradings III and IV shall preferably be used in lower sub-base. Grading V and VI shall be used as a sub-base-cum-drainage layer. The grading to be adopted for a project shall be as specified in the Contract. Where the sub-base is laid in two layers as upper sub-base and lower sub-base, the thickness of each layer shall not be less than 150 mm.

iv. If the water absorption of the aggregate is determined as per IS : 2386 (Part 3); if this value is greater than 2 per cent, the aggregate shall be tested for Wet Aggregate Impact Value (AIV) (IS: 5640). Soft aggregates like Kankar, Brick ballast and laterite shall also be tested for Wet AIV (IS: 5640).

v. Construction Operations

vi. Preparation of Sub-Grade: The surface of the sub grade to receive the Granular Sub-base shall be prepared to the specified lines and crossfall (Camber) as necessary and made free of dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled with 80 – 100 kN smooth wheeled roller until firm surface is obtained, if necessary, by sprinkling water. Weak places shall be strengthened, corrugations removed, and depressions and potholes made good with suitable materials, before spreading the aggregate for GSB. Where the existing surface over which the sub base of GSB is to be laid is black topped, to ensure effective internal drainage, furrows 50 mm x 50 mm (depth of furrows increased to reach bottom of bituminous layer where necessary) at one metre intervals shall be cut in the existing bituminous surface at 45 degrees to the central line of the carriageway at one metre intervals in the existing road before the GSB is laid.

vii. Spreading and compacting: The sub-base material of grading specified in the Contract and water shall be mixed mechanically by a suitable mixer equipped with provision for controlled addition of water and mechanical mixing. So as to ensure homogenous and uniform mix. The required water content shall be determined in accordance with IS:2720

(Part 8). The mix shall be spread on the prepared sub-grade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation, or other means as approved by the Engineer-in-charge. Moisture content of the mix shall be checked in accordance with IS:2720 (Part 2) and suitably adjusted so that, at the time of compaction, it is from 1 to 2 per cent below the optimum moisture content (OMC).

viii. Immediately after spreading the mix, rolling shall be done by an approved roller. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 kN weight may be used. For a compacted single layer upto 200 mm the compaction shall be done with the help of a vibratory roller of minimum 80 to 100 kN static weight capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional crossfall or on super elevation. For carriageway having crossfall on both sides, rolling shall commence at the edges and progress towards the crown. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and crossfall (camber) shall be checked and any high spots or depressions, which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 km per hour. Rolling shall be continued till the density achieved is at least 98 percent of the maximum dry density for the material determined as per IS : 2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

6. FACTORY MADE CEMENT CONCRETE INTERLOCKING PAVER BLOCK

i. Base Interlocking paver block to be fixed on the bed not more than 30 mm or specified otherwise thick of coarse sand of approved specification and filling the joints with the sand of approved type and quality or as specified and as directed by Engineer-in-charge.

ii. Interlocking Paver Block Factory made precast paver block of M-30 or otherwise specified grade to be used. Paver blocks to be of approved brand and manufacturer and of approved quality. Minimum strength as prescribed by manufacturer and as per direction of Engineer-in-Charge for the grade specified to be tested as per method mentioned in specification of subhead cement concrete of CPWD Specification 2019 Vol. I.

7. KERB STONE (PRECAST)

i. Laying

ii. Trenches shall first be made along the edge of the wearing course of the road to receive the kerb stones of cement concrete of specified grade. The bed of the trenches shall be compacted manually with steel rammers to a firm and even surface and then the stones shall be set in cement mortar of specified proportion.

iii. The kerb stones with top 20 cm. wide shall be laid with their length running parallel to the road edge, true in line and gradient at a distance of 30 cm. from the road edge to allow for the channel and shall project about 12.5 cm. above the latter. The channel stones with top 30 cm. wide shall be laid in position in chamber with finished road surface and with sufficient slope towards the road gully chamber. The joints of kerb and channel stones shall be staggered and shall be not more than 10 mm. Wherever specified all joints shall be filled with mortar 1:3 (1 cement : 3 coarse sand) and pointed with mortar 1:2 (1 cement: 2 fine sand) which shall be cured for 7 days.

iv. The necessary drainage openings of specified sizes shall be made through the kerb as per drawings or as directed by the Engineer-in-Charge for connecting to storm water drains.

v. Finishing Berms and road edges shall be restored and all surplus earth including rubbish etc. disposed off as directed by the Engineer-in-charge. Nothing extra shall be paid for this.

8. CEMENT CONCRETE PAVEMENT

i. All materials shall be as per latest CPWD Specifications

ii. The mix shall be as per CPWD specifications and approved by Engineer-in- Charge. For the purpose of tendering the contractor shall base his rate on the assumption that the quantity of cement used for one cum. of finished concrete shall be 340 kg. or M - 30. If the actual quantity of cement required to be used as a result of the laboratory test is different from that assumed above, necessary adjustment in the cost due to short cement used shall be made on the basis of issue rate of cement including storage charges plus 2.5% for handling charges. However, under no circumstances the quantity of cement to be used shall either exceed 350 kg./cum or fall below 330 kg. per cum of finished concrete.

iii. Compaction of Concrete

a) Compaction shall be carried out by electrically (or) diesel operated needle and screed vibrators as stipulated hereafter. Needle vibrator should be used all over the area for obtaining initial compaction of concrete. These should be of diameter not less than 4.5 cm. If the vibrator are pneumatic the pressure must not be below 4 kg/sq.cm. If electrically operated, they should have a minimum frequency of 3500 impulses per minute

b) There should be at least three needle vibrators working in any bay. A vibrating screed consisting of a steel or timber section weighing not less than 15 kg. per metre with a tamping edge of not less than 7 cm width and having a vibrator mounted thereon shall follow needle vibrators to obtain full compaction. The face of the wooden tamping edge of the screed shall be lined with M.S. Plate rigidly fixed by means of counter sunk screw. Where screed vibrators are used for compaction, a standby unit shall always be maintained ready for use, should the other one go out of order. Where electrically driven vibrators are employed, a standby diesel pneumatic unit shall be kept ready for use in case of power failure. At the discretion of the Engineer-in-Charge, for compaction at edges and joints, vibrators may be supplemented by hand tamping and rodding for securing satisfactory results. Under no circumstances, honey combing of concrete at joints or elsewhere shall be permitted.

c)When using screed vibrator for compaction it should not be dragged over the concrete. During the initial passes it shall be lifted to the adjacent forward position in short steps, subsequently, it shall be slowly slided over the surface with its axis slightly tilted away from the direction of sliding and the operation repeated until a close, dense surface is obtained.

d) Concreting shall be carried out in one operation between the expansion joints and construction joints without any break at the dummy joints. 16.37.8.5 Concrete shall be deposited on the base as near the joints as possible without touching them. It shall then be shoveled against the sides, maintaining equal pressure and deposited approx. 50 mm higher than the depth of the joints, care being taken that it is worked well around the joints. The concrete shall not be dumped from the bucket directly upon or against the joints. 16.37.8.6 Workmen shall not be allowed to walk on freshly laid concrete and proper cat walk shall be provided with independent supports beyond concreting bays.

iv. Finishing of Concrete

During compaction, any low or high spots shall be made up by adding or removing concrete. After longitudinal floating has been completed but while concrete is still plastic, the slab surface shall be tested for trueness with a 3 m straight edge. Any depressions or high spots showing departure from the true surface shall be immediately rectified. High spots shall be cut down and refinished. Depressions shall be enlarged to about 8-10 cm and filled up with fresh concrete, compacted and finished.

v. Brooming

a) After belting and as soon as the surplus water, if any, has risen to the surface, the pavement shall be given a broom finish with an approved steel or fiber broom not less than 45 cm wide. The broom shall be pulled gently over the surface of the pavement from edge to edge. Adjacent strokes shall be slightly overlapped. Brooming shall be perpendicular to the centre line of the pavement and so executed that the corrugations formed shall be uniform in character and width and not more than 1.5 mm deep.

b) Brooming shall be completed before the concrete reaches such a stage that the surface is likely to be torn or unduly roughened by the operation. The broomed surface shall be free from porous or rough spots, irregularities, depressions, and small pockets such as may be caused by accidental disturbing of particles of coarse aggregates embodied near the surface. The brooming shall be of uniform pattern all through

vi. Construction Joints

Construction joints shall be provided as shown in the drawing and also at places where concreting is stopped due to unforeseen circumstances. The joints shall be straight and vertical through the full thickness of the slab. While concrete in adjacent bay is still green, flats of suitable size shall be drawn along the edge and a groove of size 10 mm × 25 mm deep shall be neatly formed and finished. The edges of the groove shall be full nosed. After curing of concrete is complete, this groove shall be thoroughly cleaned of all sand dust and shall be perfectly dried and filled with hot poured sealing compound conforming to grade B of IS 1834. Before filling with sealing compound the faces of concrete of the joint shall be coated with primer of approved brand to a depth of 25 mm at the rate of 2.6 liters per 10 square meters. Bitumen emulsion shall not be used as primer.

vii. Measurements

For the purpose of ascertaining the quantity of concrete in the pavement, thickness shall be measured by means of a scale correct to the nearest 2 mm. The thickness of the concrete pavement slabs shall be taken on either side of the pavement at each dummy joint at four corners of the slab immediately after removal of the side forms. In case the average thickness of the slab exceeds the specified thickness, payment shall be restricted to the specified thickness.

viii. Rate

The rate of the item for concrete in pavement shall include the cost of all materials and labour including charges for machinery tools & plants required in all the operations described above. The rate also includes all cost of setting up the laboratory at site and carrying out the quality control measures/tests enumerated above by the contractor at his own cost in the presence of Engineer-in Charge or his authorized representative and submission of test results on completion of tests to the Engineer-in-Charge thereof.

A. SPECIFICATION FOR WATER PROOFING OF LAKE

i. Water Proofing over PCC in Lake

a. Providing and Laying of Slurry for First Layer The consistency of the slurry should be such as to cover the desired area by using 0.488 kg of blended cement per sqm of area. On deciding the correct quantity of water required per sqm. area the required quantity of slurry should be prepared which can be applied over the desired surface within half an hour of mixing with 0.488 kg. of grey cement + 0.253 kg. water proofing compound as per manufacturer specifications + x litres of water per sqm. area and the required quantity of slurry thus prepared should only be used for first application. The first layer shall be applied with painting brushes over the specified and dampened area carefully including the corners, holes on the surfaces and joints of pipes in concrete etc. and the application should continue at least upto 150 mm height of fixtures of pipes from the surface. The surface on application shall be air cured for 4 hours.

b. Providing and Laying of Slurry for Second Layer The quantity of slurry required for second application to be covered within an hour of mixing shall be prepared with 0.242 kg. cement + 0.126 kg. water proofing compound + y litres of water per sqm. area and the required quantity of slurry thus prepared should only be used for second application. The application of 2nd layer of slurry is same as for first layer.

c. The applied surface shall be allowed to air cure for 4 hours and thereafter water curing shall be done for full 48 hours. In case no further work as described above is to be taken up immediately on completion of water proofing treatment due to any reason it is recommended to protect the treated portion with cement plaster 1:4 as a protective layer for which separate payment shall be made to the contractor.

d. Measurement Length and breadth shall be measured along the finished surface correct to a cm and area shall be worked out to nearest 0.01 sqm.

e. Rate The rate shall include the cost of all labour and materials involved in all the operations described above. The cost of plastering shall be measured and paid for separately

ii. CRYSTALINE WATER PROOFING

a. Material Crystalline water proofing mortar consists of Portland cement, specially treated quartz sand and a compound of active chemicals. The active chemicals react with moisture and the by-products of cement hydration to cause a catalytic reaction, which generates an insoluble integral crystalline complex. These crystalline complexes grow in the presence of water and block the capillaries of the concrete and minor shrinkage cracks, thus water proofing the concrete. Chemicals activation begins when the power is mixed with water and may take several days to completely block the capillaries, depending on ambient temperature and environmental conditions. It can be applied to the positive or negative water pressure sides of a structure.

iii. Technical Specification/ Parameters:

a. The crystalline water proofing mortar shall confirm to EN1504-3 having Compressive Strength Class R4 > 45 MPa and adhesive bond strength Class R3 > 1.5 MPa supplied from an approved manufacturing unit having CE approval confirming to EN 1504-3R3.

b. It has no corrosion effect on reinforcement steel according to test norm DIN V 18998. The maximum chloride content less than 0.1%.

c. The crystalline water proofing mortar, when used in the concrete, will have no detrimental side effects in terms of Alkali Silica Reaction (ASR), corrosion of Steel Reinforcement etc.

d. The crystalline water proofing mortar performance shall not be affected by wear abrasion of the treated concrete surface and crystalline treated concrete shall not require protection layer.

e. The crystalline water proofing mortar shall be non toxic and suitable for use in potable water facilities- NSF listed as per ANSI 61 listing or DVGW-W347, Germany or equivalent and a declaration of performance certificate supervised by a reputed European/US third party.

f. The manufacturer shall submit guarantee in respect of crystalline water proofing mortar performance for 10 years against any leakage.

iv. Preparation of Surface

All surfaces to be patched, repaired or sealed with crystalline water proofing mortar must be clean and sound. Crack should be routed out to a U-shaped groove, size 25 mm wide and 25 mm deep. Tie holes should be roughened prior to filling. Spalled and honeycombed area must be thoroughly cleaned and chiseled back to sound concrete prior to repair. Remove all dirt, cement laitance, form release agents, curing compounds, paints, coating, etc. by means of wet or dry sand blasting, high pressure water jet or other approved mechanical means. Surfaces must be well moistened to a dull dampness at the time of application. The concrete should be damp with no wet sheen on the surface.

v. Mixing

(i) For routed cracks, coves and non-moving joints: Add water to crystalline water proofing mortar powder until a medium stiff, trowelable consistency reached. The texture of the mix should be pliable enough to be trowelled into the cracks with some pressure, but not so pliable that it would run out or sag out of the crack. The approximate mixing ratio (by volume) is 4.5 parts crystalline water proofing mortar powder to 1 part water. Alternatively, 450gm of crystalline water proofing mortar powder to 100 ml of water is to be mixed or as specified by the manufacturer specification. (ii) Tie holes and pointing applications: Add only a small amount of water. Mixed consistency should be that of “dry earth,” holding a shape when squeezed in your hand but easily crumbled when pressed between fingers. Mix only as much material as can be used within 20 minutes.

vi. Application Procedure

(i) For sealing cracks and faulty construction joints, routed out/making U-shape groove size 25x25mm and then priming the surface with integral crystalline slurry @0.05 kg per running meter and while the surface is tacky filled the groove upto surface crystalline mortar @1.50 kg per running meter. Once crystalline mortar is touch dry then finally applying two coats of integral crystalline slurry @0.05 kg per running meter per coat.

(ii) For repairing spalled & honeycombed areas, prepared the surface and chisel back upto sound concrete and then primed the area with integral crystalline slurry @0.70 kg per sqm. and while the surface is tacky repair and level the honeycomb area with crystalline mortar @ 22.70 kg per sqm. for an average thickness of 10mm. Once crystalline mortar is touch dry then finally two coats of integral crystalline slurry @ 0.70kg per sqm. per coat.

(iii) For patching of tie rod holes, prepared tie rod hole surface and primed the area with integral crystalline slurry @ 0.07 kg per sqm and while the surface is tacky repair and filled the tie rod holes with crystalline mortar @ 0.040 kg per hole. The crystalline mortar shall be tightly rodded into tie rod holes or packed tightly. For 25x25x25 mm hole, use 0.040 kg per hole to fill the tie rod hole.

vii. Curing

Provide protection against extreme weather conditions, such as heavy rain or freezing conditions, during the setting period. Curing is not normally required except during hot, low humidity weather. In these conditions, a light mist of water approximately 25 hours after the repair is completed will help to ensure a controlled cure. In extreme dry heat, water misting may be carried out at required intervals more frequently.

viii. Precaution / Special Consideration

Crystalline mortar shall not applied at temperatures below 40ºF (4ºC), to a frozen substrate or if temperatures will drop below freezing during the curing period (approximately 24 hours). This product is not recommended for use in expansion or construction joints. Crystalline mortar can be applied in (13 mm) layers not exceeding 2.5 inch (approximately 6.5 cm) to prevent shrinkage cracks in the mortar.

ix. **Storage / Shelf Life**

Crystalline mortar shall be stored in a dry enclosed area off the ground at a minimum temperature of 7ºC. Self life when stored in proper conditions in unopened, undamaged packaging is one year.

x. **Measurement**

Faulty construction joint will be measured by measuring the length in running meter correct to two places of decimal. Repair of honeycombed area will be measured in square meter correct to two places of decimal by measuring the length and width of treated area correct to two places of decimal. For repair of tie rod holes, the measurement shall be done for each number of hole.

xi. Rate

The rate includes the cost of all the labour and material involved in all the operations described above.

I. SPECIFICATION FOR SLOPE STABILIZATION OF DRAIN

1. Preparatory Works

Before the earth work is started, the area coming under cutting and filling shall be cleared of shrubs, rank vegetation, grass, brushwood, trees and saplings of girth up to 30cm measured at a height of one metre above ground level and rubbish removed up to a distance of 50 metres outside the periphery of the area under clearance. The roots of trees and saplings shall be removed to a depth of 60cm below ground level or 30 cm below formation level or 15 cm below sub grade level, whichever is lower, and the holes or hollows filled up with the earth, rammed and leveled.

2. SETTING OUT AND MAKING PROFILES

A masonry pillar to serve as a bench mark will be erected at a suitable point in the area, which is visible from the largest area. This bench mark shall be constructed and connected with the standard bench mark as approved by the Engineer-in-Charge. Necessary profiles with strings stretched on pegs, bamboos or 'Burjis' shall be made to indicate the correct formation levels before the work is started. The contractor shall supply labour and material for constructing bench mark, setting out and making profiles and connecting bench mark with the standard bench mark at his own cost. The pegs, bamboos or 'Burjis' and the bench mark shall be maintained by the contractor at his own cost during the excavation to check the profiles.

The ground levels shall be taken at 5 to 15 metres intervals (as directed by the Engineer-in-Charge) in uniformly sloping ground and at closer intervals where local mounds, pits or undulations are met with. The ground levels shall be recorded in field books and plotted on plans. The plans shall be drawn to a scale of 5 metres to one cm or any other suitable scale decided by the Engineer -in- Charge. North direction line and position of bench mark shall invariable be shown on the plans. These plans shall be signed by the contractor and the Engineer-in-Charge or their authorized representatives before the earth work is started. The labour required for taking levels shall be supplied by the contractor at his own cost.

3. ROUGH EXCAVATION AND FILLING

Excavation for earth from borrow pits, cutting hill side slopes etc. shall be described as rough excavation and shall be done as specified in clause 2.7, 2.8 and 2.9 of CPWD Specifications

Wherever filling is to be done, the earth from excavation shall be directly used for filling and no payment for double handling of earth shall be admissible. Filling of excavated earth shall be done as specified in clause 2.10 of CPWD Specifications. In case of hill side cutting, where the excavated materials is thrown down the hill slopes, payment for filling excavated earth shall not be admissible.

4. Measurements shall be as specified in clause 2.11 of CPWD Specifications.

5. FIXING OF EROSION CONTROL COIR BLANKET (ECB)

Erosion control Coir Mat coir minimum weight of 700 gsm as per specifications shall be supplied and fixed. The maximum width of roll shall be 2 m. The work includes dressing of slopes to proper profile & removing loose rubbles, muck & loading to the point as directed by engineer-in-charge.

Providing and placing soil conditioner at rate of 200 grams per sqm and fixing of adjacent panels of geomat with MS –U-pins having diameter of 6 mm of dimension 12-inch x 3-inch x 12-inch. Geomat shall be laid on slopes/berms as per approved scheme and providing of grass sods with vettiver/ and placing of grass seeds (styolo Hemata) on geomat. Watering of the surface till complete cover of vegetation over Coir Geotextile with all labour , tools & materials along with lead & lift etc. complete

6. GRASS SEEDING ON CONTROL COIR MAT

Grass seeding shall be done in two rounds; one before laying the ECB and second on top of the ECB.

For first round around 350 gms of sweet earth mixed with seeds shall be used per sqm. Earth shall be mixed with vermicompost and cocopeat to create the planting medium. Depending on the soil quality any improvement nutrients like DAP (Diammoina phosphate), Humic acid, Neem powder etc. shall be added to the soil mix.

For second round soil mix will be spread on the ECB just enough to cover the seeds (around 25mm thick). Water gently after spreading seeds and soil.

For Immediate germination of seeds. The seeds must be soaked in water for min 12 hours prior to seeding. The wet seeds mixed with cocopeat or any soil conditioners shall be applied as described.

7. Technical Specifications

Preparation of ground for grassing by excavating to a depth of 0.25m removing all foreign bodies, refilling the excavated area with the mix of good earth, fine sand and manure in ratio 2:1:1, along with soil improvement nutrients (1.0 kg/sq.m of vermicompost, 0.1 kg/sq.m of neem cake, 0.1 kg/sq.m of gypsum, 0.025 kg/sq.m each of DAP and MOP).

Grade surface to finish levels, as indicated on grading plans. All finished areas shall slope to drain. Where no grades are shown, the areas shall have a smooth and continual grade between existing or fixed controls (such as walks, curbs, catch basins, elevations at steps or building) and levels shown on plans. Roll, scarify, rake and level as necessary to obtain true, even grassing surfaces. All finish grades shall meet approval of the site in-charge before grassing is done.

Grass seeds to be sprinkled in a ratio of 10 gms per sqm below the ECB and 15 gms per sqm above the ECB

Scientific Name : Stylosanthes hamata

Shape wheat shaped Size 0.4-0.6mm

Seed colour Wheatish Brown

Age: less than a year, good for germination