

Schedules

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Schedule-A - Site of the Project

1.0 The Site

- 1.1** Site for the Service areas, SAB (part of Activation Area) in Dholera Special Investment Region (DSIR) is as described in **Annexure-I** of this Schedule-A.
- 1.2** The dates of handing over the Site to the Contractor are specified in **Annexure-II** of this Schedule-A.
- 1.3** An inventory of the Site including trees and any other immovable property on, or attached to, the Site shall be prepared jointly by the Authority Representative and the Contractor, and such inventory shall form part of the Agreement.
- 1.4** The part of Draft Town Planning Schemes (TP2A&TP4A) showing SAB site superimposed over sanctioned Development Plan (land use plan) is specified in **Annexure-III**.
- 1.5** The status of the Environment clearances is given in **Annexure-IV**.

Annexure I – Site*(Schedule-A)***1.0 SITE**

The proposed Service Area Buildings (SAB) sites are within the government land. Each of the site area is about ~400sqm and abuts the major road in Activation Area.

It would facilitate tapping into the existing as well as proposed infrastructure like power, water, storm water drain, along this road. Each SAB location is very strategic, in terms of accessibility, visibility, and availability of infrastructure and connectivity.

The key parameters considered for building design:

The Service Area Building Layout provides the infrastructure requirements necessary to house the city utilities in each of the respective Service Areas and Primary POP1.

The proposed Service Area building requires emergency vehicle access on three sides. The minimum allowable access from the perimeter wall is 4.5 meters. Each proposed Service Area building requires the duct bank/RCC Trench as mentioned in Schedule B.

The objective of the Service Area Building is to provide the infrastructure requirements necessary to house the city utilities in each of the respective Service Areas. The design and engineering details presented in this document are for a typical Service Area and must be replicated in all identified Service Areas; furthermore, they comply with all applicable standards, global practices and the requirements specified in the ICT Consultant's RFP.

The sites for SAB lies within the following given coordinates for each one

Sl. No.	Service Area Nos.	Points	X-Co-ordinate	Y-Co-ordinate
1	19	A	210254.608	2458070.915
		B	210246.999	2458053.990
		C	210227.447	2458062.806
		D	210235.046	2458079.709
2	23	A	212141.460	2459682.351
		B	212124.124	2459675.789
		C	212116.522	2459695.844
		D	212133.866	2459702.410
3	24	A	211404.822	2459832.085
		B	211387.928	2459839.710
		C	211396.742	2459859.263
		D	211413.645	2459851.634
4	25	A	210668.116	2460002.613
		B	210660.500	2459985.713
		C	210640.945	2459994.524
		D	210648.563	2460011.429
5	26	A	210553.328	2459183.538

Sl. No.	Service Area Nos.	Points	X-Co-ordinate	Y-Co-ordinate
		B	210536.460	2459191.186
		C	210545.289	2459210.733
		D	210562.176	2459203.077
6	27	A	209163.334	2458611.976
		B	209146.381	2458619.485
		C	209155.067	2458639.096
		D	209172.020	2458631.587
7	28	A	209566.232	2459107.340
		B	209558.626	2459090.415
		C	209539.072	2459099.227
		D	209546.670	2459116.132
8	29	A	209621.125	2459786.529
		B	209638.099	2459779.032
		C	209629.413	2459759.422
		D	209612.459	2459766.910
9	30	A	210136.195	2460404.782
		B	210128.577	2460387.885
		C	210109.020	2460396.691
		D	210116.643	2460413.598
10	31	A	210187.975	2461167.177
		B	210180.360	2461150.277
		C	210160.805	2461159.088
		D	210168.423	2461175.993
11	32	A	211101.625	2460515.326
		B	211084.732	2460522.955
		C	211093.552	2460542.506
		D	211110.453	2460534.872
12	33	A	210951.223	2461805.338
		B	210935.512	2461815.174
		C	210946.885	2461833.359
		D	210962.604	2461823.518
13	34	A	211974.603	2461875.227
		B	211960.527	2461887.286
		C	211974.474	2461903.580
		D	211988.558	2461891.514
14	35	A	211761.644	2460721.630
		B	211746.463	2460710.994
		C	211734.149	2460728.555
		D	211749.337	2460739.196
15	36	A	212798.441	2460596.433

Sl. No.	Service Area Nos.	Points	X-Co-ordinate	Y-Co-ordinate
		B	212811.872	2460583.660
		C	212797.098	2460568.111
		D	212783.660	2460580.891
16	37	A	212868.594	2459921.590
		B	212881.063	2459907.876
		C	212865.200	2459893.440
		D	212852.724	2459907.162
17	TP2W 23	A	209955.707	2464204.651
		B	209972.545	2464218.810
		C	209960.317	2464233.352
		D	209943.479	2464219.193

Index Maps and Location Maps of the project are given at **Appendix A-1**.

1.1 Seismicity

The Dholera Special Investment Region falls under the Zone III of the Seismic zoning map of India – IS: 1893-2002.

2.0 Existing Features And Utilities / Services

Utilities/Services are under construction on site and to be connected with each of the Service areas.

The following list of services and systems must be considered for each Service Area.

Equipment

1. Cellular towers (desirably monopole for use by 7-8 telecoms)
2. RF boxes for towers (to be provided by telecom service providers)
3. Compact distribution transformers for power supply
4. Electric distribution cabinets (for the vicinity)
5. FO cabinets for city fiber and FTTx
6. FO to RF convertors for antennas
7. HT & LT Power, control and metering equipment
8. RTU and SCADA of water utilities and its Power, control and metering equipment
9. Street light Power, control and metering equipment
10. Bus Shelter Power, control and metering equipment
11. CCTV Power, control and metering equipment

12. Wi-fi Power, control and metering equipment
13. Fibre optic cables and its networking
14. Control/monitoring equipment for water, gas etc.
15. Radio transmitter/repeater
16. Cable TV equipment
17. Microwave towers
18. Uninterruptable Power Supply (UPS) and diesel generator (DG) and Other smart city equipment etc.

Annexure-II – Land Details

(Schedule-A)

Existing Land Ownership

The existing land for each of the SAB primarily comprises Dholera Industrial City Development Limited (DICDL) ownership land.

Land Use (As per sanctioned Development Plan)

The proposed land uses of site as per sanctioned Development Plan are Industrial, Residential, High Access Corridor and Recreational land uses.

1.0 Handing over of Site to Contractor

Details of handing over of Site to Contractor are given in table below;

Table 1

S. No.	Site Details
1	The average size of these plots available for the construction is 18.5mx21.5m. That is 397.75 SQ.M. These sites abut major roads of Activation area. The sites for Service Area Buildings will be handed over within 15 days of signing of the Agreement

Annexure – III - Draft Town Planning Scheme and Development Plan

(Schedule-A)

1.0 Location of Service Area Buildings (SAB) superimposed over sanctioned Development Plan (land use plan) is shown below;



Annexure – IV - Site Topography

(Schedule-A)

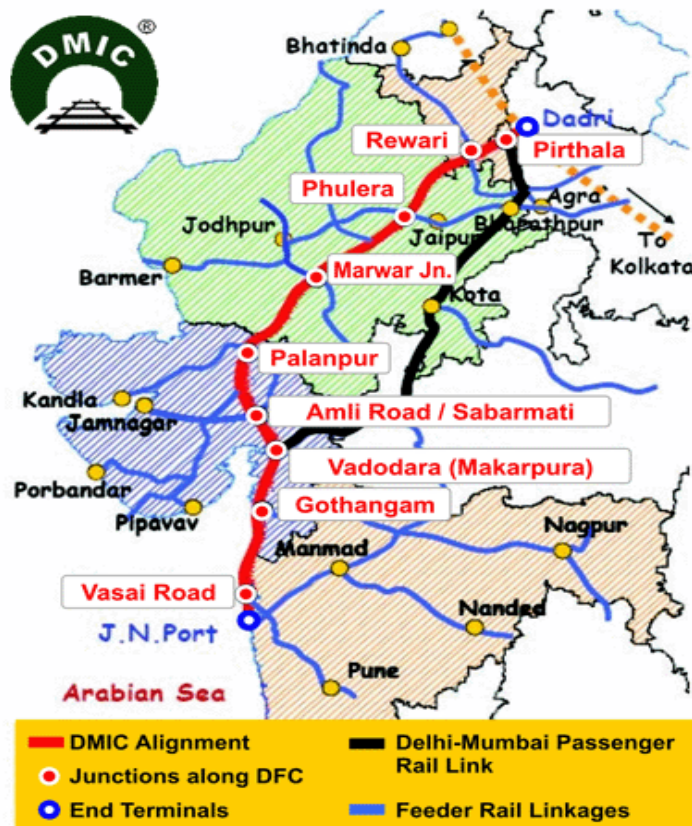
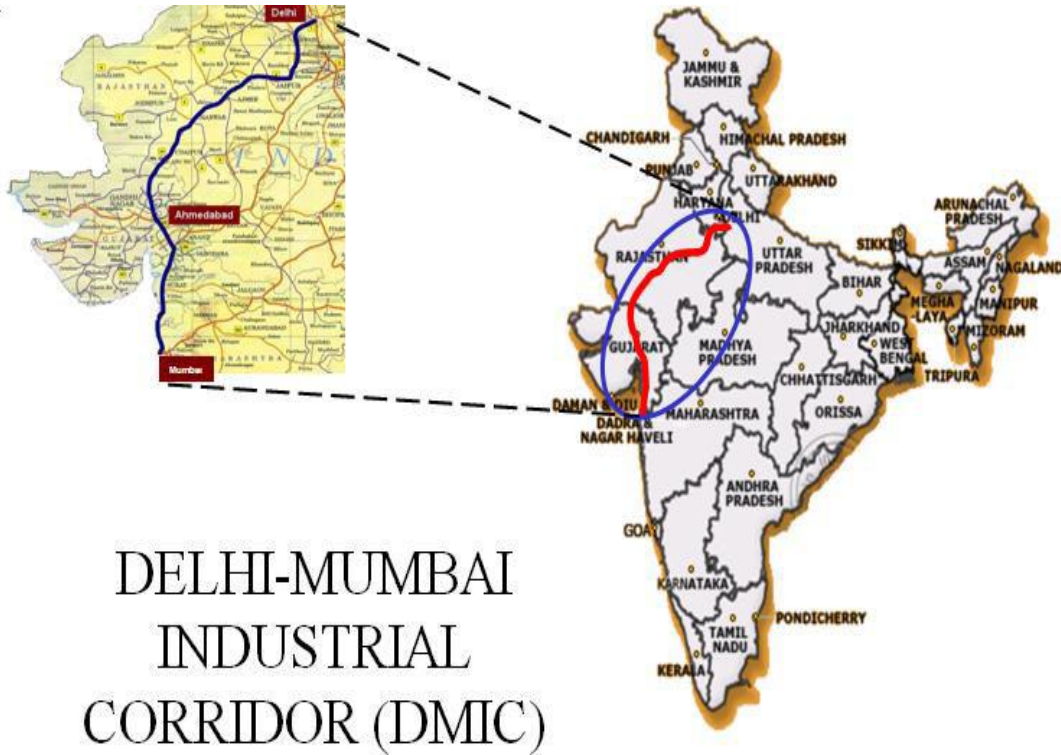
- 1.0** The site is topographically flat. The area is low lying, sloping towards the Sea in east and prone to water logging during heavy rains. Each of the sites would have to be filled up by about 2 m to come up to the proposed road levels. There are no trees, ponds, natural drain channels or electric HT lines on the site. Water table is around 3.0 m from Ground Level in March 2014. This will rise up to 1.5 m in monsoon with high tidal period. The soil mainly consists of alternate layers of gravels, fine to coarse grained sand and clay. Chemically the soils are loamy, mixed montmorillonitic, calcareous and mostly saline. The soils of Dholera region is characterized by shrinking and swelling property.

Annexure – V - Environment Clearances

(Schedule-A)

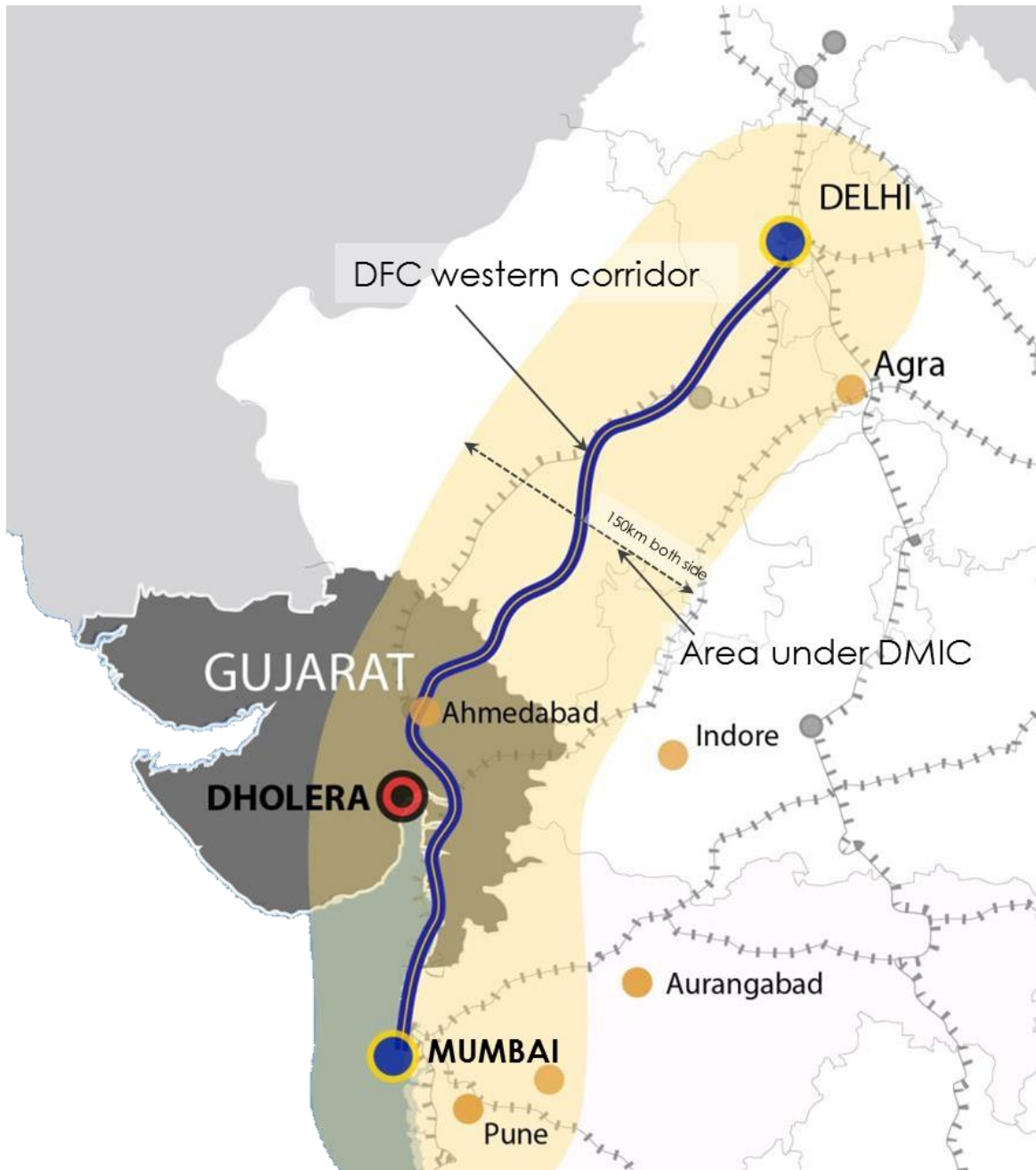
- 1.0** The Environment clearance for Dholera Special Investment Region (DSIR) has been obtained.

Appendix A 1 - Index Maps and Location Maps



**DELHI MUMBAI INDUSTRIAL CORRIDOR (DMIC) /
DHOLERA SPECIAL INVESTMENT REGION (DSIR)**

Map-1



INDIA / GUJARAT / Dholera Special Investment Region (DSIR)

Map 2



Map 3

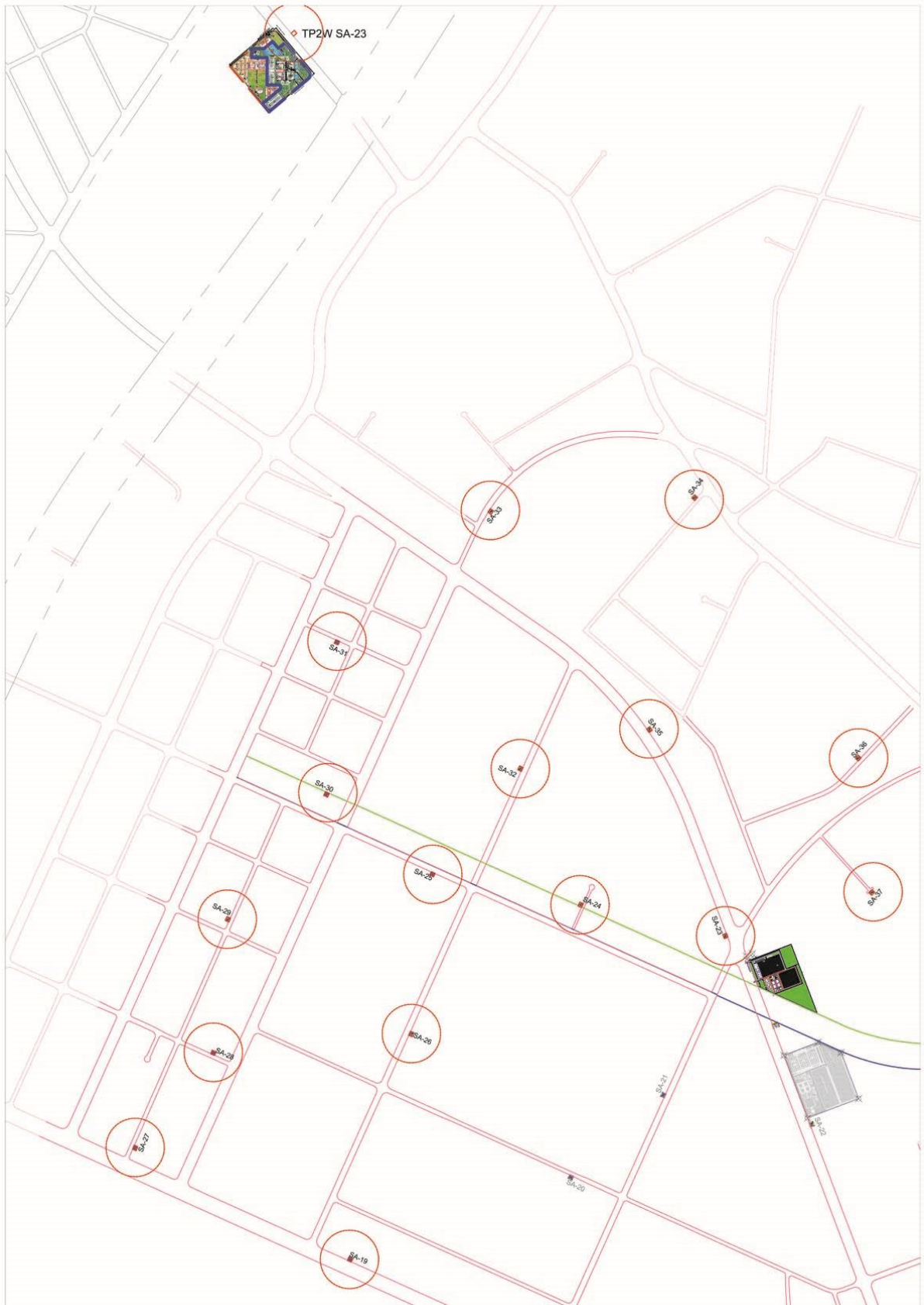


Table :- 3

List of Service Area Co-ordinate as below :

S. No.	Service Area Nos.	Points	X-Co-ordinate	Y-Co-ordinate
1	19	A	210254.608	2458070.915
		B	210246.999	2458053.990
		C	210227.447	2458062.806
		D	210235.046	2458079.709
2	23	A	212141.460	2459682.351
		B	212124.124	2459675.789
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		B	209146.381	2458619.485
		C	209155.067	2458639.096
		D	209172.020	2458631.587
7	28	A	209566.232	2459107.340
		B	209558.626	2459090.415
		C	209539.072	2459099.227
		D	209546.670	2459116.132
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		B	209638.099	2459779.032
		C	209629.413	2459759.422
		D	209612.459	2459766.910
9	30	A	210136.195	2460404.782
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		D	210116.643	2460413.598
10	31	A	210187.975	2461167.177

S. No.	Service Area Nos.	Points	X-Co-ordinate	Y-Co-ordinate
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		C	210160.805	2461159.088
		D	210168.423	2461175.993
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		B	211084.732	2460522.955
		C	211093.552	2460542.506
		D	211110.453	2460534.872
12	33	A	210951.223	2461805.338
		B	210935.512	2461815.174
		C	210946.885	2461833.359
		D	210962.604	2461823.518
13	34	A	211974.603	2461875.227
		B	211960.527	2461887.286
		C	211974.474	2461903.580
		D	211988.558	2461891.514
14	35	A	211761.644	2460721.630
		B	211746.463	2460710.994
		C	211734.149	2460728.555
		D	211749.337	2460739.196
15	36	A	212798.441	2460596.433
		B	212811.872	2460583.660
		C	212797.098	2460568.111
		D	212783.660	2460580.891
16	37	A	212868.594	2459921.590
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		D	212852.724	2459907.162
17	TP2W 23	A	209955.707	2464204.651
		B	209972.545	2464218.810
		C	209960.317	2464233.352
		D	209943.479	2464219.193

Schedule B - Development of Service Area Buildings (SAB)

SCOPE OF WORKS

Development of the 17 nos. of Service Area Buildings (SAB) shall include design and construction of the following as described in this Schedule-B and in Schedule-C.

1.0 GENERAL

- 1.1.1 Contractor shall be responsible for making the facilities fit for the intended purpose while performing all of its obligations covered under the Contract Document in its entirety. The work shall be done in accordance to the drawings approved by the statutory authorities.
- 1.1.2 Currently tender drawings and Design Criteria, Brief Technical Specifications for certain items of work are available. Scope includes further detailing, as deemed necessary (without changing the foot print of the proposed “buildings and space planning”, design intent), developing required specifications, preparing Good for Construction (GFC), coordinated drawings and construct entire campus in accordance with the same. The scope shall also include preparation of as-built drawings before handing over the work to the Employer, maintaining the Quality assurance & Quality control (QA&QC) including control, corrective actions, reporting and arranging for regular inspections by all concerned.
- 1.1.3 Contractor shall coordinate time to time with the Roads & Services contractor and Master System Integrator (MSI) of Activation area, Power Distribution Licensee (DISCOM) of DSIR, Employer’s Engineer for implementation of Service area buildings, as certain facilities will be installed / executed within Service areas by the above mentioned contractors. For a smooth implementation, a frequent coordination is required and Service area contractor shall take the responsibility and lead in all the matters in this regard.
- 1.1.4 As deemed necessary by the Employer/Employer's Engineer/PMNC, Contractor shall execute necessary mock-ups of all items/activities related to the Work performed required under this Contract as indicated below and the cost for the same shall be deemed to be included in the Contract price.
- 1.1.5 The Contractors are advised to visit the site before submitting the Proposal for the works.
- 1.1.6 The Scope includes all temporary works required for the completion of works, testing and commissioning and handover till Defect liability Period .
- 1.1.7 The Scope includes all consumables required for the completion of works , testing and commissioning and handover till Defect liability Period.
- 1.1.8 Execution of the work on site shall commence only after the approval of the employer / Employer’s engineers including but not limited to design, material etc.
- 1.1.9 Liasoning work for getting power from local electricity supply board and water from local water supply board for all service area buildings. All official charges will be paid by client on submission of documentary proofs.
- 1.1.10 Contractor has to coordinate with Roads & Services contractor to design and construct the connection of Potable water pipelines, Sewerage Lines, Storm water Drainage with the trunk infrastructure of Roads and Services for Activation Area. Please refer the Drawing volume for detail.
Provision for sitting arrangement of Security guard along with required furniture and other

functional items as required and approved by Employer's Engineer.

All the utility services for the service area building shall be designed and constructed by the contractor.

Contractor shall also design and construct the alignment and connection of all the service area building's utility services to the nearest city wide trunk infrastructure network of corresponding utilities and services.

The internal clear depth of all the RCC trenches mentioned in clause no. 1.1.11, 1.1.12, 1.1.13, 1.1.14, 1.1.15 and 1.1.16 shall not be less than 600mm.

All the RCC trenches mentioned in clause no. 1.1.11, 1.1.12, 1.1.13, 1.1.14, 1.1.15 and 1.1.16 shall be with precast concrete covers.

- 1.1.11 Contractor has to coordinate with Roads & Services contractor and Power Distribution Licensee of DSIR to design and construct the connection of incoming and outgoing HT & LT Power Cable and its RCC trench with the trunk infrastructure of Roads and Services for Activation Area. There will be minimum one combined HT & LT RCC trench or as required as per detailed design. For this purpose, contractor has to design and construct a combined HT< RCC trench which will have precast covers and minimum 3 numbers of required size manholes / handholes at entry of the service area plot and near the equipment. The clear dimension excluding wall thickness of the combined HT & LT RCC trench mentioned above will be minimum 610mm. The internal space of HT trench will minimum 230mm and space for LT trench will be 230 mm. There will be internal brick partition wall of 150mm to separate HT & LT trench. There shall be one separate LT RCC trench connecting the Compact substation, DG set and the Main LT Panel of the service area building. The clear dimension excluding wall thickness of separate LT RCC trench connecting the Compact substation, DG set and the Main LT Panel shall be minimum 1100mm. Please refer the Drawing volume in Appendix B XVI for detail
- 1.1.12 Contractor has to design and construct the connection of RCC ICT duct and its RCC trench including 30 nos. of 50mm HDPE ducts within the RCC ICT duct of the trunk infrastructure of Roads and Services for Activation Area with Service area building with all the required accessories like manholes/chambers, hand holes, etc. in coordination with Roads & Services contractor and Master System Integrator (MSI) of Activation area. There shall be at least one number of manhole/handhole at the entry of service area plot and one near the ICT shaft of the service area building. The clear dimension of this RCC trench excluding wall thickness shall be minimum 600mm. There shall be one redundant route of the RCC ICT duct mentioned above connecting the RCC ICT duct of the trunk infrastructure of Roads and Services for Activation Area and Service area Building. These two numbers of RCC ICT trench will directly connect to the ICT shaft of the service area building. Please refer the Drawing volume in Appendix B XVI for detail.
- 1.1.13 Contractor has to design and construct the connection of RCC Power duct and its RCC trench of the trunk infrastructure of Roads and Services for Activation Area with Service area building with all the required accessories like manholes/chambers, hand holes, etc in coordination with Roads & Services contractor, Master System Integrator (MSI) and Power Distribution Licensee of DSIR.. Please refer the Drawing volume in Appendix B XVI for detail.
- 1.1.14 Contractor has to design and construct the connection of 4way and 5 way HDPE duct networks of Street Lights and its RCC trench of the trunk infrastructure of Roads and Services for Activation Area with all the required accessories like manholes/chambers, hand holes, etc in coordination with Roads & Services contractor and Master System Integrator (MSI) of Activation area. There shall be at least one number of manhole/handhole at the entry of service area plot and one near the equipment location inside the service area building. The clear dimension of RCC trench excluding wall thickness for laying of 4way and 5 way HDPE duct network of Street Lights shall be minimum 500mm. Please refer the Drawing volume in

Appendix B XVI for detail.

- 1.1.15 Contractor has to design and construct the connection of 4way and 5 way HDPE duct network of Bus Bays and its RCC trench of the trunk infrastructure of Roads and Services for Activation Area with all the required accessories like manholes/chambers, hand holes, etc in coordination with Roads & Services contractor and Master System Integrator (MSI) of Activation area. There shall be at least one number of manhole/handhole at the entry of service area plot and one near the equipment location inside the service area building. The clear dimension of RCC trench excluding wall thickness for laying of 4way and 5 way HDPE duct network of Bus Bays shall be minimum 400mm. Please refer the Drawing volume in Appendix B XVI for detail.
- 1.1.16 Contractor has to design and construct the connection of Multiway HDPE duct network of Water utilities and its RCC trench of the trunk infrastructure of Roads and Services for Activation Area with all the required accessories like manholes/chambers, hand holes, etc. in coordination with Roads & Services contractor and Master System Integrator (MSI) of Activation area. There shall be at least one number of manhole/handhole at the entry of service area plot and one near the equipment location inside the service area building. The clear dimension of RCC trench excluding wall thickness for laying of Multiway HDPE duct network of Water utilities shall be minimum 400mm. Please refer the Drawing volume in Appendix B XVI for detail.
- 1.1.17 There shall be minimum 2 numbers of Electrical shaft (each having clear dimension excluding wall thickness of 740mm), 2 numbers of ICT shaft (each having clear dimension excluding wall thickness of 600mm), 2 numbers of Plumbing shaft (each having clear dimension excluding wall thickness of 500mm), 1 number of HVAC shaft (having clear dimension excluding wall thickness of 845mm), 1 number of Fire Hydrant Shaft and 1 number of DG fume shaft (having clear dimension excluding wall thickness of 500mm) throughout all the floor till terrace of the service area building. Please refer the Drawing volume in Appendix B XVI for detail.
- 1.1.18 The Contractor has to make the temporary arrangement to house the outdoor unit of HVAC system of the ground floor and make it operational till the terrace of the service area building is not ready. Once the Terrace of the service area building is ready, necessary arrangement has to be made to shift & permanently install the outdoor unit of HVAC system of the ground floor to the terrace of the service area building. Similarly, Contractor has to make all the required temporary arrangements to house any utility coming in or out of the ground floor that is necessary to make the ground floor complete and operational in all aspects and then shift & permanently install such utilities at their respective final location as per the approved layout and detailed drawings
- 1.1.19 The trunk infrastructure construction for TP2W is not been taken up yet, so provisions for all the services and the components described in above scope of work to be made by the contractor for the service area no. TP2W 23. In addition to that contractor also need to explore, suggest and implement the permanent power and water connection to activate this service area also

2.0 SPECIFICATIONS AND STANDARDS

The Service Area Buildings (SAB) shall be designed and constructed in conformity with the Specifications and Standards given in Schedule-D.

- **Appendix B I** : Details of Population
- **Appendix B II** : Details of Built-up area
- **Appendix B III** : Scope of Architectural and Landscape Works
- **Appendix B IV** : Scope of Civil and Structural Works
- **Appendix B V** : Scope of Electrical Works
- **Appendix B VI** : Scope of HVAC Works
- **Appendix B VII** : Scope of Fire Fighting Works
- **Appendix B VIII** : Scope of Plumbing Works
- **Appendix B IX** : Details of Fire Detection Alarm System, Smart Card based access and CCTV surveillance
- **Appendix B X** : Deleted
- **Appendix B XI** : Deleted
- **Appendix B XII** : Scope of Storm Water Drainage network
- **Appendix B XIII** : Deleted
- **Appendix B XIV** : Scope of Solid Waste Management Works
- **Appendix B XV** : Scope of IBMS / BAS Works
- **Appendix B XVI** : Tender Drawings

Appendix B I

1.0 Population details

These SABs will be a utility Building and will be occupied by the few persons (5 to 10) on regular / occasional basis.

Appendix B II

1.0 Built-up area details

Built-up area details for each building are as given below in Table: 2

Table No. 1: Built – up area details

AREA STATEMENT- SERVICE AREA BLOCK- DHOLERA				
		Area (sqmt)	Area (sqft)	
a	Total plot area	397.75	4279.79	
b	Ground coverage	99.5	1070.62	25.00%
c	Building ht.			
c1	Up to Terrace Floor	17.05mtr		
c2	Up to Parapet	18.40mtr		
c3	Up to Mumty	19.45mtr		
S. No.	DESCRIPTION	BUILT-UP AREA (sqm)	FAR AREA (sqm)	REMARKS
1	Ground Floor	97.46	83.20	
2	First Floor	99.36	85.20	
3	Second Floor	99.36	85.20	
4	Third Floor	97.11	77.24	
5	Terrace Floor	15.21		
	Total Area (Sqmt)	408.50	330.84	
	Total Area (Sqft)	4,397.09	3,561.16	
	SAY	4,400.00	3,565.00	

Appendix B III

1. Architecture & Landscaping works

1.1. Scope: The scope includes design, detailing, procurement, supply, construction, furnishing, testing and execution for "SAB" [Service Area buildings].

Items of work include

- Painting
- Door and Windows including Fire Doors
- Glazing & Facade works
- Stone cladding
- Flooring and finishing
- GRC Works
- Fabrication works
- Dry Partition/Glass partition
- Ceiling Finishes
- False Ceiling
- False Flooring
- Wall Finishes
- Waterproofing and Insulation works
- Gates including automation
- Utilities fixtures and accessories
- Any other works shown in the Appendix B XVI but not specifically mentioned above

1.2. Look & Feel of the Project

The Contractor shall study the drawings (Appendix B XVI), visualizations, specifications, material finishes indicated in the contract document and understand all parameters of the design including the architectural look & feel intent of the design. All Finishes as per the **Table No 2&3**, below

Table No. 2

S. No.	Location	Flooring	Skirting / Dado	Wall	Ceiling
1	Entrance lobby / reception	20 mm thk. Polished Kota stone flooring with sealer coat/Industrial Vitrified Tiles	20 mm thk. Polished Kota stone flooring with sealer coat/Industrial Vitrified Tiles	Acrylic Emulsion paint	NA
2	Ramps	Flamed Kota Stone	Flamed Kota Stone	NA	NA
3	Passages : Public / visitor areas	20 mm thk Polished Kota stone flooring with sealer coat	20 mm thk Polished Kota stone flooring with sealer coat	Acrylic Emulsion paint	595x595 Metal ceiling tiles with bevel edge, standard perforation 2.5mm dia with Gypsum border
4	Staircase [all others] : treads, risers, landings	20 mm thk Polished Kota stone flooring with sealer coat	20 mm thk Polished Kota stone flooring with sealer coat	Acrylic Emulsion paint	NA
5	Wet Areas : Male / Female / physically handicapped toilets, Pantry, janitor rooms	AntiSkid 300x300mm vitrified tile flooring with 3mm spacer and matching grout	300x300mm vitrified tile flooring with 3mm spacer and matching grout	Acrylic Emulsion paint	Gypsum
6	Utility Rooms : AHU, Electrical, Battery	20 mm thk. Industrial Vitrified Tiles	20 mm thk. Industrial Vitrified Tiles	Acrylic Emulsion paint	595x595 Metal ceiling tiles with bevel edge, standard perforation 2.5mm dia with Gypsum border
7	Utility Rooms : Hub, Server, UPS & stores	600x600 mm Removable Steel Flooring Tiles- For 450mm Raised Floor	NA	Acrylic Emulsion paint	595x595 Metal ceiling tiles with bevel edge, standard perforation 2.5mm dia with Gypsum border
8	Office	Vitrified Tiles	itrified Tiles	Acrylic Emulsion paint	Gypsum
9	Terrace [4th floor]	Mosaic Tiles	Mosaic Tiles	NA	NA

Table No. 3

Sr. No.	Description	Specification
1	Waterproofing - Terrace [w/o landscape]	Membrane Waterproofing as per manufacturer's specification
2	Waterproofing - Toilets / wet areas	Waterproofing of Tapecrete as per manufacturer's specification
3	Glazing / windows	Fixed/Openable Glazed Window
4	Doors : Fire rated	2000 mm wide Entrance Door
5	Doors : Non Fire rated	35-45 mm thk. Wooden Doors & glass doors as per specification
6	Exterior walls	Weathershield Exterior grade paint
7	Exterior columns	Exposed fair finish concrete
8	Exterior Ground floor walls	Weathershield Exterior grade paint
9	Mural	As per design
10	Pavements/ footpaths	60 mm thick precast concrete Pavers & grass pavers of approved make
11	Fencing	NA
12	Compound wall	Boundary Wall in Exposed fair finish concrete with Ferrocement Jaali / Screens in Natural Grey finish
13	Gates	M.S. gate as per design
NOTE: The above table shall be read in conjunction with architectural drawings in for final finishes		

1.3. Construction Documents / Documents

The Contractor shall provide multiple options of the design of necessary element of the Work for the Employer's Engineer to review along with Employer / PMNC

1.4. MOCK-UP

The following mock-ups as per Table no 4 shall be demonstrated by the Contractor:

Table No 4: Mock-up

Item	Extent / Size
1. Facade / Glazing systems	Height - One floor Width - 03 modules [including one operable module, if any]
2. GRC Screen with SAB Number	1.0 x 1.0 M
3. GRC mural	1.5 x 1.5 M.
4. Stone cladding, including window glazing, aluminium louvers, flashings and interface details	6.0 x 6.0 M
5. Mud plaster	3.0 x 3.0 M
6. All finishing items including but not limited to toilets, flooring, wall cladding, doors & windows, false ceiling, etc.	Toilets - 01 module including all fittings, fixtures and modular partitions Hard & soft finishes - approx 5 sq. m., including all typical interfaces and details.
7. SS Railings and other metal fabrication works	Min 2.0 RM including all types of details [turns, bends, ends, etc]

1.5. Documents at Site

The Contractor shall maintain in a conspicuous place on the site a copy of development permission and a copy of approved drawings and specifications.

2. Deleted

Appendix B IV

1. CIVIL AND STRUCTURAL WORKS

1.1 Scope : The Contractor shall design and construct the Works of SA buildings that includes Utility block, ancillary structures, compound wall, fencing, pavements, hardscape, storage tank, drains, etc . The Scope of Work includes but is not limited to the following in relation to the design, construction, and operation of the Works:

- Land filling of the service area building plots:

Earth filling as per the detailed design within the service area building plots from 'plinth level minus 1.2 mtr level' to plinth level is in the scope of this contract. However earth filling may need to be carried out by the contractor below plinth level upto the ground level as per the standards and specifications depending on the site conditions at the time of appointed date

- Prepare Design Basis Report based on the design intent and submit for approval
- Carryout out Structural Design based on approved Civil Structural Design Criteria.
- Submit Structural stability certificate for all structures and components from government authority by own cost.
- Proof checking by accredited agencies at bidders cost before submitting for the approval of the Employer.
- Setting out the works: Site Topographic Survey and Geotechnical Investigations as deemed necessary by the Contractor. Site Clearing, Site Grading, Excavation includes excavation for sump pits / lift pits.
- Foundation & substructure works. Foundation type for SA building shall be pile foundation only. For clear understanding of the soil condition, Employer is providing reference data set related to soil testing and geo-technical information conducted during various construction projects within Activation Area. Contractor needs to do its own soil testing and geo-technical survey for proposed works.
- Implement Anti termite treatment / Water proofing / Insulation works.
- Superstructure RCC works
- Masonry
- Plastering
- Structural Steel work
- Ancillary PCC / RCC works including equipment foundations / pedestals, etc.

1.2 Deleted

1.3 Tentative details of geotechnical survey and soil testing for nearby areas are provided along with this document for general understanding of the contractors. These details should be considered as reference only and final geotechnical survey, soil testing, etc. shall be carried out by the appointed contractor for detailed design of service area buildings.

1.4 Design Philosophy

Civil & Structural works shall be designed as precast / RCC Structure and not as a Steel structure. For large spans in building PT (Post tensioned) slabs and beams shall be adopted.

Appendix B V

1. ELECTRICAL WORKS

1.1. Scope: The scope of work shall cover the design, engineering, manufacture, assembly, testing at manufacturer's works/ test labs, supply, delivery, properly packed for transport to site, unloading, storing at site of all equipment, erection and commissioning, test at site, performance guarantee test run, training of Employer's personnel and handing over of the complete electrical system along with mandatory spares as per the terms & conditions. Any sizing or rating of equipment provided are indicated as minimum sizes or ratings. contractor to design the complete system and shall consider the requirements in totality before arriving at the sizing of equipment and components. All the load and sizing calculation including all the drawings has to be approved by Employer's Engineer. The brief scope shall be comprising of, but not limited to the following:

- Liasoning work for getting power from local electricity supply board for all service area buildings. All official charges will be paid by client on submission of documentary proofs.
- Approval from all respective authorities for getting power, DG set, Electrical inspector etc. All official charges will be paid by client on submission of documentary proofs.
- Low Tension (LT) Side equipment requirements such as LT breakers (O/D & I/D both), LT Distribution Boards (LT DB), Auto Transfer Switches (ATS), Switchgears, Power Distribution Boards, Diesel Generator (DG) sets, DG Panel, DG synchronization panel, Uninterrupted Power Supply (UPS) Input Panel, UPS Output Panel, UPSs, Building Panels, HVAC Panels, Common area Power and Lighting Panels, etc., as per detail design and Single Line Diagram (SLD). For SLD, please refer Appendix B XVI
- Complete Power supply arrangement, Load and Rating calculations for LT breakers (O/D & I/D both), LT Distribution Boards, ATS, Switchgears, Power Distribution Boards, DG sets, DG Panel, DG synchronization panel, UPS Input Panel, UPS Output Panel, UPSs, Building Panels, HVAC Panels, Common area Power and Lighting Panels/DBs, etc., shall be done as per detail design, clause 1.3.1, 1.3.1.1 and SLD, SAB site and floor plans in Appendix B XVI. . Also provide each feeder/DB/panel wise load detail in schematic
- Separate LT distribution network for each utility (mentioned in clause 1.3.1.1) as per detail design from Energy Meter till the connected load. Please refer Single Line Diagram in Appendix B XVI. Necessary bus couplers / Tie breakers / ATS to be considered for change over function from one source to another in LT Distribution Boards and floor level Distribution Boards (DB).
- All switchgears like ACB & MCCB (as panel incomer only) shall be considered with TCP/IP open protocol for monitoring & controlling from SCADA / IBMS.
- Astronomical timer considered for external lighting
- For other areas like ELV systems, computers & security systems UPS considered with 0.5 hr. battery backup with N+1 configuration.
- 15% Spare capacity to be considered at building level main LT panel with outgoing feeders.
- 10% lighting to be considered on UPS as emergency lighting
- Complete Power supply arrangement including panels, Current transformers (CT), Potential transformers (PT), LT meters for utilities fed through DG set, LT cables, cable trays, cable termination, earthings, earthing terminations, MCBs, MCCBs with MFM, RCBOs, ATS, Bus Bars and all other the required apparatus and accessories required for commencement of power supply and end to end connection from each utility's LT meters (DSICOM's LT

meters) outgoing feeders to each utility's LT Distribution Boards incoming feeder and each utility's LT Distribution Board's out-goings feeders till the incoming feeders for street lighting MDB, SCADA & RTU power distribution boards of all water utilities, Gas control power distribution boards, , CCTV & City Sensor power distribution boards, Wi-fi power distribution boards and upto service equipment of MSI (Master System Integrator) installed on all the floor and rest other services but not limited to the entire power and control distribution network of HVAC, Plumbing, Fire Fighting, Intelligent Building Management Systems (IBMS), SCADA, Service area plot and building CCTV, Access Control, entire building's room and floor wise point wiring, entire building's room and floor wise raw power and lighting distribution network including its DBs, etc. and all equipment inside service area building (SAB).

- Bus Bay/Shelter Lighting , Bus Bay Advertisement power distribution boards, Bus Bay Passenger Information system power distribution boards
- . LT Distribution Boards shall have completely SCADA control incomers and outgoings.
- Fire Fighting Panels, Fire Alarm Panel, Plumbing Panels, Potable Water Panel
- Separate HVAC panels for RTU & SCADA control room, office room, UPS room, Network/Telecom Room, RF Box room, Third floor room, etc. The incoming of each HVAC panel shall be fed through its respective utility's LT Distribution Board. Surge arrestors for Main & Sub main Power Distribution boards.
- All LT Power, control cables length and sizes as per the requirements.
- Building PDB (Building PDB will have outgoing feeders for External & Internal Lighting MLDB, Emergency Lighting, Common area Power and lighting, input to UPS panel, CCTV for Building Security, HVAC panel of office room and UPS room, Fire Fighting, Access Control, IBMS, etc), External & Internal Lighting MLDB & DB, Emergency DB , Common area Power and lighting DB, CCTV Panel & DB for Building Security, Access Control DB & Panel, IBMS DB & Panel, ,
- CCTV & City Sensor Panel, Telecom Panel, UPS Panel & Building Panel are to be fed through DG Panel. Energy meters to measure energy consumption of each utility/load shall be provided for all the outgoing feeders of DG panel.
- Building Security(CCTV) Panel, RTU & SCADA Panel of water utilities, 2nos. of Emergency Distribution boards are to be fed through UPS Panel
- Separate LT Distribution Boards with Auto transfer Switches and required number of outgoing feeders have to be provided for utilities/loads that are to be fed through DG Panel and UPS Panel. 2 nos. of spare LT Distribution Boards with Auto transfer Switches to be provided. All other LT Distribution Boards with required number of outgoing feeders have to be provided with RCBO. Please refer SLD in Appendix B XVI.
- Cable carrier system with necessary cabling accessories such as cable trays, cable tray bends cable tray supports cable glands, lugs, touch proof termination and jointing kits etc.
- Fire proof sealing system comprising of fire stops and fire breaks.
- Lighting system including LED Fittings and fixtures along with occupancy sensors and in built battery for emergency lights.
- Common area and outdoor Lighting along with boundary lighting overall lighting system comprising of LED lighting, astrological timers based distribution boards, lighting transformers, light fittings, lighting poles, Power socket, associate lighting switches/sockets, associated cable, conduit and wiring.
- DG set of minimum 250KVA Capacity or of higher capacity as per the detailed design requirements with 485Ltr inbuilt Diesel Storage Capacity tank, with fuel level, Automatic DG

synchronizing panel, related power and control wiring also taking all required DG set related government permissions and clearances of all relevant departments.

- UPS system for critical equipment suitable as per the load requirement or minimum 2 nos. of 30KVA capacity with 30 Minutes backup having 2 x 100% BC (Float cum boost chargers), manufacturers recommended spares and required capacity DCDB.
- Electrical SCADA system able to communicate and control all the equipment like UPS, DG Set, all LT Distribution Boards including incomers & outgoings of main & sub main panels, etc. Proposed SCADA system should integrate with SAB BMS system and city level command centre.
- Maintenance Free Earthing system comprising of Earthing Electrodes, Earthing strips/ conductors and associated accessories.
- Building Lightning Protection system as per NBC 2016, calculation shall not take into consideration the height of the proposed monopole cellular/microwave towers whereas sizing shall be done so that it shall be covering minimum adjoining 30% nearby area along with proposed Service Area Building. There shall be overlapping on area protected by single lightning arrestor. Each lightning arrestor shall have at least 40 % overlapping for overall building premises. There shall be minimum Eight Down conductors for each lightning arrestor. Each down conductor shall have complete physical isolation with structure and shall be connected to dedicated earth pits
- Miscellaneous items such as Local control push buttons, Welding Receptacles, etc
- Safety Equipments such as rubber mats, SLD, shock treatment charts, sign boards, smoke detectors and its mitigation system, fire fighting equipment for electrical fire.
- Electrical shaft to be sealed with fire rated materials at every floor.
- All related civil works required for completion, commissioning but not limited to RCC trenches, plinth work, foundations of Compact substation, electrical switch yard, HT & LT meters, APFC, Capacitor panel, etc., as approved by Power Distribution Company (DISCOM) and Employer/Employer's Engineer.
- Maintenance requirements as per Schedule E

1.2. System Design Requirements

- The following design criteria shall be considered by the Contractor for the equipment and services supplied under this contract:
- Safety to personnel and equipment during the operation and maintenance.
- Reliability of service.
- Minimum fire risk.
- Ease of maintenance and convenience of operation of SAB from remotely via SCADA
- Automatic protection of all electrical equipment through selective relaying system along with relay co-ordination.
- Electrical supply to equipment within the design operation limits.
- Adequate provision for future extension and modifications.
- Fail safe features.
- Suitability for applicable environmental factors.
- Maximum interchangeability of equipment.
- The design and equipment shall ensure satisfactory operation under variations of voltage $\pm 10\%$, frequency (+) 5% to (-) 5%, combined voltage and frequency 10% for A.C., -15% to

+10% for DC as may be met under operating conditions, including those due to starting loads and short circuit and other fault conditions.

- The contractor shall calculate the total power requirements for the development by summing up the power requirement for each floor in according to the design requirements for each of the buildings.
- The power allocation of 138 VA/sqm (13VA/sft) load shall be provided for the office areas including the common utilities such as plumbing, HVAC, fire fighting, etc. This shall cater for the lighting, power and other systems installed.
- The contractor shall submit detailed load calculation for the development taking into account the acceptable diversity factors and providing a margin of (10%) contingencies for the total power for the peak hour loads which has to be approved by the Employer's Engineer. The internal electrical power shall be tapped from the riser / electrical room located on each floor. All the SLDs related to end to end electrical and protection infrastructure system has to be approved by Employer's Engineer.
- System grounding
11 kV : Unearthed system
415 V : Solidly earthed
- Minimum Fault level (For all equipment)
11kV: 31.5 kA for 1 Sec
415V: 50 kA for 1 Sec
230V : 12kA for 1 Sec
110V DC: 10kA for 1Sec

1.3. Specific Requirements for Electrical Equipment

The following are the additional design requirements that shall be considered as minimum Quantities for each Service Area plot and Building.

- LT metering arrangement: LT meters are the point of power supply by the Power Distribution Company (DISCOM).
- Contractor to design, supply and install all the necessary arrangement required for extending power supply from each LT meter to the respective Utilities/loads
- Contractor to coordinate with DISCOM regarding arrangement, supply and installation of housing required for LT meters and its isolation arrangement. All LT meters to be housed within weather proof enclosure of two channel sliding aluminium sections with opaque glass which shall be approved by Employer's Engineer and DISCOM.
- All required ancillaries such cable, cable tray, RCC trench, MCCB, RCBO, earthing, all types of termination, etc shall be supplied and installed by the contractor.
- All the necessary lock and key arrangement for safe guarding of LT meters shall be provided by the contractor

1.3.1. LT Distribution Boards

- Supplying, Assembling, erecting, testing and commissioning of 415V & 230V, 3 Phase, 50 Hz., 4 wire system, sheet steel clad, dust and vermin proof cubical and Indoor type floor mounted, free standing extendible type LT Distribution Boards/Panel compartmentalized design and fabricated out of 2 mm CRCA sheet steel complete with suitable size of Aluminium Bus bars, Electrical interlocks as per the various status of all the equipments indicated on the drawings. Providing & Fixing of base plate / channel, P/F the following Switchgears, complete with earth Bus bar throughout the length of the panel, terminal arrangement for Incomings / Outgoings cables and also outgoing terminations for various

sizes of cables, The incoming and outgoing feeders shall be accommodated in a modular multi-tier arrangement, adequate size bus duct/ cable alley, Painting, Earthing, Numbering, Danger plate etc. complete as required as per specifications and drawing attached. (Panel should have proper arrangements for future expansion, etc. complete as required.)

- Main LT Distribution Boards/panels shall be metal clad, self-standing dust proof construction, fully drawout type and IP 54.
- For feeders rated more than 400A, ACB with Numerical protection/built in microprocessor release, discrete multi-function meters or metering as part of ACB shall be provided. For all other rating feeders Microprocessor based MCCB shall be used. All ACB feeders shall be compatible for remote control, metering and monitoring.
- Incomer and busbars be rated for full load current of the total load connected plus a margin of 20%, rounded off to the next standard rating. All outgoing feeder modules from each PCC shall be rated for the full load current plus 10% margin, rounded off to the next standard rating. All PCC shall be provided with 20% spare feeders.
- Incoming feeders shall have MCCB/RCBO breaker. All the incoming feeders with MCCB should have RYB phase indicating lamps, CT and Multi Function Meters (MFM). Multi function meter at panel incomer side shall conform to standard IEC 62053 for active and reactive energy. It should be compliant with PMS standard IEC 61557-12 and shall have four line LCD display, two DI/DO, RS 485/ethernet connectivity ports. RS485 module shall be connected with building IBMS and SCADA. Outgoing feeders shall have MCCB/RCBO breaker.
- Load, Rating calculations and number of incoming and outgoing feeders has to be done as per detail design, clause 1.3.1.1, SLD and SAB site and floor plans in Appendix B XVI which shall be approved by Employer's Engineer
- For remote metering in SCADA for current, line voltage, bus voltage, kW, KWH either separate transducers or soft data shall be taken through communication of MFM's looped and interfaced to SCADA. Architecture shall be submitted for approval.
- Digital flush type class -I accuracy multifunction meter with power load manager ,showing V, A, PF, KVAH, KWH etc. with 3 Nos. current transformers of 800/5 ratio, 15 VA Class 1.0 metering.
- Red ON indicating lamps with 2A SP MCB backup protection.
- 2 Set of three phase indicating lamps along with 2A SP MCB backup protection.
- Suitable arrangement to receive incoming cables for 800 Amps.
- Control fuses, control terminals & wiring as required.
- Under/ over voltage, master trip along with current transformers of 800/5 ratio, 15 VA Class 1.0 metering. - 1 set.
- One automatic Battery charger consisting of:
 - Transformer & Rectifier.
 - DC Ammeter.
 - DC Voltmeter.
 - ON/Trickle/Boost selector switch.
 - Charger ON/ TRICKLE/ BOOST indications etc.
- BUSBAR : Electrolytic high conductivity aluminium three phase and neutral busbars rated at 415V, 1000 amps, 35kA, insulated with heat shrinkable coloured PVC sleeves & clip on

shrouds for joints. The busbar sizing calculations shall be submitted for approval by EE, considering all derating factors.

1.3.1.1. Type of Utilities

Below table shows the indicative load of various utilities. The detailed engineering has to be carried out by the contractor in coordination with other service providers and as directed by Employer/Employer's Engineer.

Each Utility mentioned below shall have separate LT Distribution Boards as per clause 1.3.1

Sr. No.	Utility/Load/User Type	Indicative load in KVA
1	Street Light	95
2	Wi-fi	11
3	CCTV & City Sensor	9
4	Bus Bay Lighting	3
5	Bus Bay Advertisement Boards	3
6	Bus Bay Passenger Information System	3
7	Telecom with its HVAC	98
8	RTU, SCADA and Actuators with its HVAC	15
9	Building Panel including Common Area Power & Lighting, office HVAC, CCTV, IBMS, UPS with its HVAC etc.	50
10	Fire Fighting Pump + Water Pump	25
11	Second Floor RF Box Room with its HVAC	25
12	Third Floor	30

- All the mounting arrangements, cables, cable trays, earthings, all type of terminations, etc., from the LT meter till the respective utility/load is in contractor's scope
- Contractor to provide 2nos. of spare LT Distribution Boards with ATS having capacity suitable to supply 50KVA of load each and 1nos. of spare LT Distribution Boards having capacity suitable to supply 25KVA of load

1.3.2. DG SETS & EQUIPMENTS

- Supply of Silent Type Diesel Generating Set of minimum 250 KVA, 3 phase & neutral, 50 c/s. 415 A.C. rating, comprising of following Diesel Engine, Alternator, Sound Attenuated Acoustic Enclosure as detailed in technical Specifications and other associated accessories:

A. DIESEL ENGINE:

- Type: Multi-cylinder water cooled with direct radiator, Turbo charged with charge air cooling.
- No. of strokes : 4
- Fuel injection :Direct
- Maximum speed : 1500 RPM
- Rated power : 310 BHP (minimum)
- Cooling of Cylinders : Water cooled with Radiator
- Engine Starting : Battery starting.
- Starting position : Universal. Auto/Manual

B. ALTERNATOR;

- Type : Brushless.
- Actual Power 250 KVA at 50 deg C.
- Frequency : 50 Cycles/sec.
- Supply system :3 phases & neutral
- Connection : Star.
- Rated voltage : 415 Volts.
- Rated rpm. : 1500 rpm. max.
- Casing protection : As per IP-23
- Insulation : Class `H'.
- Voltage : Automatic voltage
- regulator : regulator (Motorized)
- Power factor : 0.8.
- Controller : Type 3100 or latest / similar

C. ACCESSORIES:

- The Diesel Engine shall be equipped with minimum following/ as indicated in the specifications, devices/ accessories built-in type including all standard fittings.
- Fuel supply pump with manual venting pump.
- Radiator
- Turbo charger with air filter (dry/oil bath type) and damper.
- Charge air cooler.
- Suction fuel filter.
- Lube oil filter.
- Hour meter and RPM indicator.
- Battery Starting Mechanism.
- Instrument/Indication panel complete with the followings;
 - Starting Switch with key
 - Lub. Oil Temp. gauge
 - Lub. Oil pressure gauge
 - Water Temp. gauge
- Control devices and HMI Display for safety and monitoring along with indicators.

D. OTHER ACCESSORIES/EQUIPMENT

- Common base/foundation frame.
- Fly wheel and flexible coupling.
- Automatic voltage regulator (AVR).

- Lube oil filter.
- Fuel oil filter.
- Day storage tank for minimum 750 ltr capacity fabricated out of 3mm thick MS sheet, with M.S. fuel pipe line, high & low level indicator and alarm contacts.
- Mild Steel Class-C type pipe line shall be installed from the entry of service area plot till the diesel storage tank and DG set for filling of diesel
- Residential type silencer
- Anti-vibration pads
- Necessary SMF batteries of required AH capacity with leads and mounting frame etc.
- The cost of initial charge of lubricants, coolant, fuel (day storage tank) etc
- All the above housed in a suitable Sound attenuated enclosure as per specifications/ latest CPCB norms and as required
- Receiving, unloading, shifting, erecting, testing and commissioning etc. of Silent Type Diesel Generating Set of 250 KVA, 3 phase & neutral, 50 c/s. 415 A.C. rating, comprising of Diesel Engine, Alternator, Sound Attenuated Acoustic Enclosure as detailed in above item including associated accessories etc. complete as required as per CPCB norms & site requirement.
- Providing and fixing in place mild steel 'B' class exhaust piping complete with all fittings, long bends, MS angle/ channel supports, painting, 50 mm thick 48 kg/cu.m density, mineral wool or equal insulation covered with 24 SWG Aluminium sheet cladding etc. complete as required.
- 150 mm dia (for 250KVA DG)
- Providing and fixing in place required expansion bellows of SS material with GI nuts, GI bolts, GI washers etc. as required.
- 150 mm dia (for 250KVA DG)
- Providing, designing, welding, fixing & painting (two coats of primer & two coats of synthetic enamel paint of approved shade) with suitable sizes of angle iron / MS channels supports for DG fume pipes chimney as per CPCB approved norms & complete as required. (support details shall be got approved before execution).
- DG set **shall** be housed within the service area plot but outside the building footprint keeping the required clearances as per the standards on all four sides of the DG set.

1.3.3. DG POWER PANEL

- Supplying, Assembling, erecting, testing and commissioning of 415V, 3 Phase, 50 Hz., 4 wire system, sheet steel clad, dust and vermin proof cubical and Indoor type floor mounted, free standing extendible type DG power Panel compartmentalized design and fabricated out of 2 mm CRCA sheet steel complete with suitable size of Aluminium Bus bars, Electrical interlocks as per the various status of all the equipments indicated on the drawings. Providing & Fixing of base plate / channel, P/F the following Switchgears, complete with earth Bus bar throughout the length of the panel, terminal arrangement for Incomings / Outgoings cables and also outgoing terminations for various sizes of cables, The incoming and outgoing feeders shall be accommodated in a modular multi-tier arrangement, adequate size bus duct/ cable alley, Painting, Earthing, Numbering, Danger plate etc. complete as required as per specifications.
- Incomer:

- 1 Nos. 400 amps, 35 KA (Ics=Icu) TPN MCCB with overcurrent and short circuit Microprocessor based release
- Outgoing feeders:
- 2 Nos. 250 amps, 35 KA (Ics=Icu) TPN MCCB with overcurrent and short circuit protection
4 Nos. 125 amps, 35 KA (Ics=Icu) TPN MCCB with overcurrent and short circuit protection
- 3 Nos. 125 amps, 35 KA (Ics=Icu) TPN MCCB with overcurrent and short circuit protection
- 1 No.63 amps, 35KA, 4P MCB with overcurrent and short circuit releases protection
- Digital flush type class -I accuracy multifunction meter with power load manager ,showing V, A, PF, KVAH, KWH etc. with 3 Nos. current transformers of 400/5 ratio, 15 VA Class 1.0 metering.
- Red ON indicating lamps with 2A SP MCB backup protection.
- 1 Set of three phase indicating lamps along with 2A SP MCB backup protection.
- Suitable arrangement to receive incoming cables for 400 Amps.
- Control fuses, control terminals & wiring as required.
- Under/ over voltage, master trip along with current transformers of 400/5 ratio, 15 VA Class 1.0 metering. - 1 set.

1.3.4. BUSBAR

- Electrolytic high conductivity aluminium three phase and neutral busbars rated at 415V, 500 amps, 35kA, insulated with heat shrinkable coloured PVC sleeves & clip on shrouds for joints. The busbar sizing calculations shall be submitted for approval, considering all derating factors.

1.3.5. UPS

- Supply of minimum 2nos. 30KVA (1W+1S)) high performance IGBT/ PWM based fully microprocessor controlled (three phase Input & three phase Output) online UPS system suitable for input and output parameters as per specifications. The UPS shall have inbuilt zig zag K rated isolation transformer at inverter output. The UPS shall be provided in powder coated fan cooled enclosure painted in colour as per specifications. The UPS shall be suitable for normal, emergency, recharge, by-pass and maintenance mode. The system be expandable in such a manner that addition of another module of similar capacity can double the system output with common by-pass. The UPS shall have a microprocessor based display and control panel. UPS shall have own batteries with 30 minute battery back-up. Complete system must be provided as per specifications approved drawing and as per site requirement including inter connecting cables from battery to UPS, UPS to panel etc.& supports for complete system as approved by the Engineer in charge.

- Below mentioned minimum Quantities are for each Service Area plot and Building

S. No.	Minimum Description of Items for UPS	Unit	Minimum Qty.
1	Supply of 30KVA high performance IGBT/ PWM based fully microprocessor controlled (three phase Input & three phase Output) online UPS system suitable for input and output parameters as per specifications. The UPS shall have inbuilt zig zag K rated isolation transformer at inverter output. The UPS shall be provided in powder coated fan cooled enclosure painted in colour as per specifications. The UPS shall be suitable for normal, emergency, recharge, by-pass and maintenance mode. The system be expandable in such a manner that addition of another module of similar capacity can double the system output with common by-pass. The UPS shall have a microprocessor based display and control panel. UPS shall have own batteries with 30 minute battery back-up. Complete system must be provided as per specifications approved drawing and as per site requirement including inter connecting cables from battery to UPS, UPS to panel etc.& supports for complete system as approved by the Engineer in charge.		
1.1	30KVA UPS described as above	Each	2

- UPS are provided for critical system loads, servers and work stations, BMS, FACP (Fire Alarm Control Panel) & FARP (Fire Alarm Repeater panel), CCTV and Emergency lighting etc with 3hrs battery back-up.
- The UPS will be 3ph to 3 ph, 50 Hz, Modular type, On-line, Redundant UPS power supply and with static bypass. The UPS output will be connected to the UPS DB for further distributions.
- During normal operation, the AC Supply will be fed to UPS Distribution boards through UPS and a small trickle charging current will be feeding to tubular lead acid battery for charging. Once the AC supply fails, for a momentary time till the DG picks up the battery will feed the UPS distribution loads through UPS

1.3.6. UPS PANEL

Supplying, assembling, erecting, connecting, testing and commissioning of dust, damp and vermin proof wall mounting factory built sheet steel enclosed non-drawout modular type Panel fabricated out of suitable sized angle iron and flats, base channel and covered with 2.0mm thick PCRC sheet, duly painted complete with earth bus, aluminium bus bar, numbering & sign writing, interconnection & including the cost of connection through bus bar / copper conductor flexible connection with necessary interlocking with existing panel as shown in drawing as per specification and mounted with the minimum followings as below.

1.3.7. UPS INPUT PANEL

INCOMING: 1 no. Auto Transfer Switch (ATS), 1 Nos. 125amps, 415V FP MCCB '35ka' with overcurrent and short circuit TM release for Auto Transfer Switches(ATS). 2 Set of three phase R,Y,B, ON indicating lamps, along with 2A SP MCB backup protection.

BUSBAR: 150Amps, 4P AL Bus Bar including in different sections of the panel for connection to various outgoing feeders as per drawing.

OUTGOINGS: 3 Nos. 100 Amp 415 volts, FP, 25KA MCCB. Red indication lamps for MCCB/MCB ON. UPS I/P Panel as above

1.3.8. UPS OUTPUT PANEL

- INCOMING: 2 Nos. 100 Amp 415 volts, TPN, 25KA MCCB as incomer breaker. 2 Nos. 0 to 100 Amp ammeter with selector switch with 100/5A CTs. 2 Set of phase indicating lamp with MCB
- BUSBAR: 150Amps, 4P CU Bus Bar including in different sections of the panel for connection to various outgoing feeders as per drawing
- OUTGOINGS: 6 Nos. 415 volts, Four Pole, 35KA, MCCB & MCB as per Drawing, 01A.MAIN SINGLE LINE DIAGRAM-SH-1A-R-1 (Refer Drawing Volume)
- EXTERNAL LIGHTING Panel Supply, assembly, erection, connecting, testing & commissioning of LT weather proof dust and vermin proof (IP-65), outdoor feeder pillar, fabricated out of suitable sized angle iron and flats and covered with 3mm thick CRCA sheet steel including canopy, duly stove enamel painted, both sides (front and rear) openable with locking arrangement, rubber gasket cable glands, etc. Bakelite phase separators and bus bar supports including RCC 1:2:4 (1 cement: 2 coarse sand : 4 graded stone aggregate 20mm nominal size) foundation, 450 mm deep and 150 mm above the ground. The feeder pillars shall be complete with 3 phase and neutral bus bars of capacities as described below and moulded case circuit breakers (MCCBs) with adjustable overload relay, copper FRLS control wiring with 1.5sq.mm, complete in all respects as per specifications as required.
- INCOMING:- 63A 4P MCCB (25ka) with thermal magnetic release & rotary handle - 1no.3 Phase and neutral (100%N) aluminium bus bars of 150/ 100 amps. Capacity.
- Minimum OUTGOING:-70 AMP. TP CONTACTOR WITH NO/ NC CONTACTS -1 set.24 HOUR TIMER - 1 set.20A 4P MCB (10ka) - 5 nos.16A DP MCB (10ka) - 2 nos.63A 4P MCB (10ka) - 1 no.16 AMP. SWITCH & SOCKET - 1 no. with in the feeder pillar. External Lighting Feeder Pillar as above

1.3.9. HVAC Panels

Below mentioned are the minimum Quantities for each Service Area plot and Building.

There should be separate HVAC panel for RTU and SCADA room, Office room, Telecom Room, UPS room and RF box room, Third Floor room, etc. The incoming of each HVAC panel shall be fed through its respective utility's LT Distribution Board. HVAC panel and its end to end infrastructure for each Utility to make it complete in all aspects is in the scope of the contractor.

1.3.10. Fire Fighting Panel

There shall be 1 set of Firefighting panel described as below for each Service Area plot and Building

S. No.	Minimum Description of Items for Fire Fighting Panel
1	Fire Fighting Panel
	Electrical Fire Motor Control Panel of cubical construction, floor mounted type, fabricated out of 2mm. thick CRCA sheet, compartmentalized with hinged lockable doors, dust and vermin proof, powder coated of approved shade after 7 tank treatment process, cable alley, interconnection with solid aluminium strip / single core PVC insulated FRLS copper conductor cable, having suitable mountings for switchgears and accessories and internal control & power wiring with suitable rating PVC insulated FRLS copper conductor, earth terminals, numbering etc. complete in all respects, suitable for operation on 415 V, 3 phase 50 HZ AC supply with enclosure protection class IP 42 with 700 Amp aluminium bus bar etc complete as required.
	Incoming
a)	MCCB, 4 Pole, 160A, 25 KA with adjustable thermal magnetic release and rotary handle (ICS= ICU= 25 KA upto 415 V) - 1 set.
b)	Digital Ammeter (0 - 600 A), 96 mm. sq. CT operated with inbuilt selector switch with 3 Nos. CT's of ratio 160/5 A, 15 VA burden and accuracy of class 1.0 - 1 Set
c)	Digital Volt Meter (0-500 V) 96 mm. sq. with inbuilt selector switch and control MCBs - 1 Set
d)	Phase Indicating coloured LED (RYB) with control MCBs - 1 Set
	Bus Bar :
	Electrolytic high conductivity aluminium three phase and neutral busbars rated at 415V, 200 amps, 50Hz, AC, insulated with heat shrinkable coloured PVC sleeves & clip on shrouds for joints.
	Outgoing for Main Fire Pump
a)	MCCB 3 Pole, 160 A (with adjustable thermal magnetic release and (Ics=Icu=25 KA upto 415 V), with CT operated digital Ammeter (0 - 160 A), with 3 CT's of 160/5 A, 10 VA, accuracy 1.0, ASS and coloured LED for on (Red) indication and rotary handle - 3Set
b)	Fully Automatic Star Delta Starter suitable for sprinkler Pump motor of minimum 40KW and (as per the recommendation of pump manufacturer) complete with over load protection, current sensing type single phase preventer complete with contactors, push button, indicators LED type Auto/manual selector switches all accessories and FRLS copper conductor wiring etc. as required - 1Set
	Outgoing for Pressurization Pump(Jockey)
c)	MCB 3 Pole, 40 A, 10 KA with CT operated digital Ammeter (0 - 60 A), with 3 CT's of 60/5 A, 10 VA, accuracy 1.0, ASS and coloured LED for on (Red) indication with adjustable thermal magnetic release and (ICS = 10 KA upto 433 V) and rotary handle - 2Set
d)	Fully Automatic Star delta Starter suitable for Jockey Pump (Minimum 7.5 HP capacity) complete with over load protection, current sensing type single phase preventer complete with contactors, push button, indicators LED type Auto/manual selector switch all accessories and wiring etc. as required - 2 Set

S. No.	Minimum Description of Items for Fire Fighting Panel
	MCB TP+N Pole, 40A, 10 KA 'C' - 2 Set
	MCB Double Pole, 10 A, 10 KA 'C' - 2 sets.
b)	Diesel Engine Control suitable for (diesel pump)
e)	Auto / Manual selector switch and 3 attempt Starting device, Electronic timer, Relays, Auxiliary switches, Rotary switches, Tripping relays, Contactors, Push button for manual Start / Stop etc. to make the equipment automatic as per functional requirement.
f)	Battery charging unit suitable for 24 V DC with boost and trickle charger, selector switch, with suitable rating transformer, rectifier, RC filter network, fuses on AC and DC protection, 0 - 30 V DC Digital Volt meter, 0 - 20 A DC Digital Ammeter, the charger should be cut off when the engine is started and the batteries shall be charged from battery charging alternator provided in the engine.
	Suitable rating & type standard relays, contactors and other accessories for automatic operation of diesel engine
g)	Indication LED's for high / low lub, oil pressure, water temperature, engine on indicator, with suitable alarms, acknowledgement button etc.
i)	System Controller
j)	system controller to control operation of Main Electric Fire Pumps, Diesel Engine Pump, Jockey Pumps, Terrace Pump in sequence as per specification consisting of relays, timers, sensors, annunciation window for fault indication, complete as per specification.
k)	First Jockey pump will start than hydrant and sprinkler pump start, in case of failure of power diesel pump will start.
	Colour coded internal wiring and connections etc. with suitable size Fire Retardant Low Smoke PVC insulated copper cable / solid aluminium strip / bus bar from incoming to bus bar and from bus bar to switch gears / MCCB, starters, meters, selector switches, indicating LED's, interlocking and sequence operation arrangements.
l)	Terminal facility for repeat indicator of various audio and visual indications.
m)	First Jockey pump will start than hydrant and sprinkler pump start, in case of failure of power diesel pump will start.
n)	Colour coded internal wiring and connections etc. with suitable size Fire Retardant Low Smoke PVC insulated copper cable / solid aluminium strip / bus bar from incoming to bus bar and from bus bar to switch gears / MCCB, starters, meters, selector switches, indicating LED's, interlocking and sequence operation arrangements.
o)	Terminal facility for repeat indicator of various audio and visual indications.

CABLES for end to end firefighting panel network

XLPE insulated PVC sheathed armoured aluminium conductor cable of 1.1 KV grade on existing cable tray / surface including clamps, ties etc. as required.
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1.3.11. POINT WIRING

- Wiring for light point/ fan point/ exhaust fan point/ call bell point with 1.5 sq.mm FRLS PVC insulated copper conductor single core cable in surface / recessed medium class PVC conduit, with modular switch, modular plate, suitable GI box and earthing the point with 1.5 sq.mm. FR PVC insulated copper conductor single core cable etc as required.
- For details, refer the electrical drawings in Appendix B XVI
- Wiring for light / power plug with 2 x 4 sq. mm FRLS PVC insulated copper conductor single core cable in surface / recessed medium class PVC conduit along with 1 No. 4 sq. mm FR PVC insulated copper conductor single core cable for loop earthing as required.
- Wiring for light / power with 4 x 4 sq. mm FRLS PVC insulated copper conductor single core cable in surface / recessed medium class PVC conduit along with 2 Nos. 4 sq. mm FR PVC insulated copper conductor single core cable for loop earthing as required.
- Wiring for IPv6 port (Ethernet port) with STP Cat6 cable
 - Wiring for TV antenna socket outlet
 - Wiring for Telephone socket outlet

1.3.12. Distribution Boards

- Supplying and fixing following way, single pole and neutral, sheet steel, MCB distribution board, 240 V, on surface/ recess, complete with tinned copper bus bar, neutral bus bar, earth bar, din bar, interconnections, powder painted including earthing etc. as required. (But without MCB/RCCB/Isolator)
- Supplying and fixing following way, single pole and neutral, sheet steel, MCB distribution board, 240 V, on surface/ recess, complete with tinned copper bus bar, neutral bus bar, earth bar, din bar, interconnections, powder painted including earthing etc. as required. (But without MCB/RCCB/Isolator) 12 Way, Double Door
- Supplying and fixing following way, horizontal type three pole and neutral, sheet steel, MCB distribution board, 415 V, on surface/ recess, complete with tinned copper bus bar, neutral bus bar, earth bar, din bar, interconnections, powder painted including earthing etc. as required. (But without MCB/RCCB/ Isolator) 4 way (4+24), Double door, 6 way (4+18), Double door, 8 way (4+24), Double door
- Supplying and fixing of following ways surface/ recess mounting, vertical type, 415 V, TPN MCB distribution board of sheet steel, dust protected, duly powder painted, inclusive of 200 A, tinned copper bus bar, common neutral link, earth bar, din bar for mounting MCBs (but without MCBs and incomer) as required. (Note : Vertical type MCB TPDB is normally used where 3 phase outlets are required.) 12 way (4 + 36), Double door
- Supplying and fixing 5 A to 32 A rating, 240/415 V, 10 kA, "C" curve, miniature circuit breaker suitable for inductive load of following poles in the existing MCB DB complete with connections, testing and commissioning etc. as required.

Single Pole

- Supply and fixing following rating, double pole, 240 volts, MCB, 'C' curve in the existing MCB DB complete with connections, testing and commissioning etc. as required. 40 amps & 63 amps
- Supplying and fixing following rating, four pole, 415 V, isolator in the existing MCB DB complete with connections, testing and commissioning etc. as required. 40 amps & 63 amps
- Supplying and fixing following rating, double pole, (single phase and neutral), 240 V, residual current circuit breaker with overload protection (RCBO), having a sensitivity current 30 mA

in the existing MCB DB complete with connections, testing and commissioning etc. as required. 40 amps (30mA) & 63 amps (30mA)

- Supplying and fixing single pole blanking plate in the existing MCB DB complete etc. as required.
- All the distribution boards **shall** have IPv6 Port (Ethernet Port) along with required end to end cabling (STP Cat6) and associated network equipment throughout the service area building
- All the distribution boards **shall** TV antenna socket outlet along with required end to end cabling and associated network equipment throughout the service area building
- All the distribution boards **shall** Telephone socket outlet along with required end to end cabling and associated network equipment throughout the service area building

1.3.13. CABLE, CABLE TRAYS, RACE WAYS & EARTHING

- Supply, fabricating and installing following size of G.I. perforated type cables trays including suspending from ceiling with MS angle, rods connection pieces, G.I. nut bolts, G.I. washers, fasteners etc. complete as required & approved by the Engineer Incharge. (Quantity shall be confirmed at site as per final layout/ route/ application etc. & to be executed accordingly.)
- The cables shall be 11000V un-earthed grade, single / multicore, stranded aluminium, XLPE insulated with PVC inner sheath, armoured and overall sheathed with specially formulated Fire Retardant Low Smoke (FRLS) PVC. Single core cables shall have aluminium wire / formed wire armour, whereas multicore cables shall have galvanised steel strip armour.
- LT power cables shall be 1100V grade, single / multicore, stranded aluminium conductor, XLPE insulated, with PVC inner sheath, armoured and outer sheath made of specially formulated FRLS PVC compound.
- The overall voltage drop shall be limited to 5% and the voltage dip shall be limited to 15%.
- The LT control cables shall be 1100V grade, multicore, 2.5 sq.mm cross section, stranded copper conductor having 7 strands, PVC insulated, inner PVC sheathed, galvanised steel wire/formed wire armoured and outer sheath made of FRLS PVC compound conforming to the performance requirements outlined above shall be used . The cables shall conform to IS:1554 (Part-I) - 1988 / IEC-502 (1983) in all other respects.
- Cable carrier system shall be designed for 70% loading.
- Power cables and control cables shall run in different shafts. Separate riser and cable trays shall be provided for the LV system
- Separate riser and cable trays shall be provided inside the Electrical shaft, ICT shaft & HVAC shaft throughout the building.
- All cabling/wiring works shall be concealed wiring except for risers and in other areas where public or tenants do not have access or approved areas by the Employer.
- Supply, laying, testing and commissioning of 1.1 kv grade XLPE insulated PVC sheathed steel armoured aluminium stranded conductor ISI marked LT Cables in trenches/ ducts/ through RCC pipes under roads on cable trays of following sizes, complete all as specified (as per CPWD specifications for External Electrical works), i/c clamping, dressing, earth work digging, sand filling, bricks protection, back filling etc. as required & approved by Employer's Engineer. (Tagging to be provided with aluminium strips on both the ends as approved).
- Cables & end terminations for cable sizes from 3 ½ core 300 sqmm XLPE to 4 core 4 sqmm XLPE shall be done as per the standards and requirements.

1.3.14. LIGHTNING CONDUCTOR

- Building Lightning Protection system as per NBC 2016, calculation shall not take into consideration the height of the proposed monopole cellular/microwave towers whereas sizing shall be done so that is shall be covering minimum adjoining 30% nearby area along with proposed Service Area Building. There shall be overlapping on area protected by single lightning arrestor. Each lightning arrestor shall have at least 40 % overlapping for overall building premises. There shall be minimum Eight Down conductors for each conventional lightning arrestor. Each down conductor shall have complete physical isolation with structure and shall be connected to dedicated earth pits

1.3.15. Lighting System

- The rates shall include all components that may be required to make the supply and installation as per IS codes complete in all respects such as : All lamps Internal wiring & point wiring between accessories to distribution boards and Earthing terminal
- Electronic ballasts/drivers should be used for Light fittings to be installed with effective reflectors. Only energy efficient type LED light fixtures to be used for all type of indoor as well as outdoor lighting.
- Lighting lux shall be consider as per below mentioned table for particular area and rest of area as per mentioned in IS.

Sr.	Application area	Illumination level (Lux)
1	Control & Network Room that has Data rack (front & back both of the racks) for SCADA, Telecom Cabinets, RF Boxes, etc.	500
2	Staircases	100 - 150
3	Reception, Pantry and Store	200 – 250
4	Electrical and UPS Room	250-300
5	Corridor	70
6	Toilet	100

- All the indoor lighting system inside the building required to achieve the lux level mentioned in the above table are in the scope of the contractor
- Below mentioned minimum Quantities are for each Service Area plot and Building

S. No.	Minimum Description of Items for LIGHTING FIXTURES with all fixing accessories etc. as required.	Unit	Minimum Qty.
1	1X15W LED LIGHT	Nos.	22
2	1X18W LED LIGHT	Nos.	7
3	1x40W LED LIGHT	Nos	25
4	1x10W LED MIRROR LIGHT	Nos	1
5	1X18W LED TUBE LIGHT	Nos	12

- The luminaries shall be selected with highest technical efficiency and also aesthetic requirements as approved by EE. On site sample for each type of light fixtures as directed by Engineer incharge to be executed by contractor for final selection prior to procurements.
- The Lighting panels used for street lighting will be additionally provided with a timer device having twenty four hour hand set dial with a facility for setting ON & OFF times. There will be a provision of selecting either the manual control or the automatic control. The selector switches will be mounted on the front door of the switchboard. Outdoor Feeder pillars will be required to feed the street light load.
- The required number of Pole mounted LED fixture for approach road and outdoor area to achieve a lighting level of 30 lux. In addition to this, landscape lighting shall be provided with planter Light/ Bollard light, post top lights, step lights, etc. for the front elevation of the building facade lighting shall be proposed. Wall mounted bracket light may be proposed for the rear side and non-exposed part of the building. The luminaries shall be selected to suit architectural, functional and aesthetic requirements.
- Below mentioned minimum Quantities are for each Service Area plot and Building

S. No.	Minimum Description of Items for EXTERNAL LIGHTING	Unit	Minimum Qty.
1	LT weather proof dust and vermin proof (IP-65), outdoor feeder pillar, fabricated out of suitable sized angle iron and flats and covered with 3mm thick CRCA sheet steel including canopy, duly stove enamel painted, both sides (front and rear) openable with locking arrangement, rubber gasket cable glands, etc. Bakelite phase separators and bus bar supports including RCC 1:2:4 (1 cement: 2 coarse sand : 4 graded stone aggregate 20mm nominal size) foundation, 450 mm deep and 150 mm above the ground. The feeder pillars shall be complete with 3 phase and neutral bus bars of capacities as described below and moulded case circuit breakers (MCCBs) with adjustable overload relay, copper FRLS control wiring with 1.5sq.mm, complete in all respects as per specifications as required.		
	INCOMING:-		
a)	63A 4P MCCB (25ka) with thermal magnetic release & rotary handle - 1no.		
b)	3 Phase and neutral (100%N) aluminium bus bars of 150/ 100 amps. Capacity.		
	OUTGOING:-		
a)	70 AMP. TP CONTACTOR WITH NO/ NC CONTACTS -1 set.		
b)	24 HOUR TIMER - 1 set.		
c)	20A 4P MCB (10ka) - 5 nos.		
d)	16A DP MCB (10ka) - 2 nos.		
e)	63A 4P MCB (10ka) - 1 no.		
	16 AMP. SWITCH & SOCKET - 1 no. with in the feeder pillar.		
	External Lighting Feeder Pillar as above	Set	1

S. No.	Minimum Description of Items for EXTERNAL LIGHTING	Unit	Minimum Qty.
2	Standard 6.0 metre high (above ground) hot dip galvanized (grading of galvanisation average 70 micron or better as per IS2629 or equivalent) octagonal pole, as per IS 875 Part-3, with stiffeners, chain, allen bolt, single arm bracket one metre long, foundation bolt, anchor plate, template, nut and washers galvanized, factory finish base plate of size 250 x 250 x 12 mm etc. complete as required. The pole shall be made of 3 mm thickness sheet with tolerance of +/- 5%. The column shall also be provided with flush door at the bottom with proper strengthening to the cutout of the door opening, a junction/ looping box with Heavy duty 3 phase, 32 Amp connector with 16A DP MCB including all accessories complete as required. (make & model will be selected by the client).	Nos	15
3	Solar power Street Lighting LED luminaire Fixture complete with 7.5 meter long Octagonal GI poles as per approved makes and as per standard design. The luminaire shall be of aluminium die cast construction with minimum IP65 protection with inter-connection copper cable from solar panel to battery, to controller and to luminaire etc as required.		
	The storage capacity of the battery should be sufficient to run the full load for 18 hours on rainy/ heavy cloudy days. The unit should also have an additional AC charging arrangement to charge the batteries in case of very long heavy cloudy days		
	A junction chamber of size 300mm/ 100mm with cable termination arrangement connector block and 1 No. 10 Amp SPMCB shall be provided. The street light fixture shall be 1 x 70 watt capacity with LED bulbs of white colour of 1 watt each. the fixture shall be complete with control gear for auto switching ON, switching OFF supplementary power charging in case of non-availability of solar power on very long heavy cloudy days etc. as required. The solar panel shall be of sufficient capacity to charge the sealed maintenance free battery of minimum 160 AH capacity. The RCC pedestral shall be made of 1:2:4 ratio as required.		
	The column shall be smooth surface finished degreased, derusted, primary coated, cavity sealed and painted with PU based self-curing polyurethane based automotive paint. Complete item will be finalised by the client/ consultant.	Nos	2
4	Following LED luminaries (IP-65) with housing made of single piece high pressure die cast aluminium alloy/ as per standards, energy efficient copper ballast, heat resistant toughened flat glass / cover glare free, pole mounting mechanism etc. (make & model will be approved by the client).		
4.1	Post top fixture (Bajaj cat. LED POLE LIGHT - BAJAJ BRIL 45W LED WH or Panasonic make APT010404 or equivalent from approved Philips, Panasonic, Wipro makes). pole light.	Nos	15

Cable for lighting poles should be layed in HDPE duct and then the HDPE duct should be buried underground. All the required Cable work, HDPE duct work for cable laying, hand holes, earthing etc. work for end to end lighting system is in the scope of the contractor.

1.3.16. Control Philosophy

- A highly reliable, microprocessor-based Electrical SCADA system with substation automation system complying to International automation standard IEC – 61850 shall be provided for the SAB Electrical system Control, metering and monitoring. All HT and LT switchgear shall be controlled from SCADA.
- Each switchgear whose incomer, buscoupler and outgoing breaker feeder are controlled from SCADA shall be provided with two IEC-61850 compliant managed ethernet switches. The IEC-61850 compliant numerical relays shall inturn be connected to both these switches either to form a ring or radially connected, so that loss of one connection does not result in loss of communication with any device. These switches shall be provided with fibre optic (FO) ports for interconnection with other switchgear switches, which form part of the IEC-61850 LAN network. Further interconnection to the SCADA shall be through redundant server.

1.3.17. System Earthing

1.3.17.1. Protective Earthing

Earthing system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, Relevant Indian Standards and codes of practice and Regulations existing in the state of Gujarat where the systems are to be installed. Complete earthing systems comprising of required earth connections necessary for effective and permanent bonding to earth be constructed by Contractor. Fully maintenance free earthing units only to be constructed for the entire earthing scope of works.

1.3.17.2. Maintenance Free Earthing

Earthing System Supply, Installation, testing and commissioning of advance maintenance free chemical gel earthing system of 3 meter length, 25.4 mm dia copper bonded UL listed & CPRI tested CHEMRODE of 250 microns molecular bonding along with 50 Kgs of RESLOW grounding minerals (Ground Enhancement Compound). The chemical compound shall be tested for the contents from BIS (Bureau of Indian Standards, Govt of India) & NABL accredited laboratory in India. The testing laboratory shall be an ISO 9001 & ISO 14001 certified. chemrode Shall be tested & certified by CPRI Bangalore for 25 KA rms & 50 KA peak.

Where ever earth pits are needed maintenance free earthing system and pits be deployed and the system shall consist of (but not limited to):

- a) Earth electrodes.
- b) Highly conductive and eco-friendly backfill compound.
- c) The connection from each maintenance free earth pit to the equipment/junction box shall be arranged by the Contractor by Bolting of 50x6mm GI strips using Bi-metallic Connectors & Stainless Steel M12x50mm Long bolt, nut, plain and spring washer
- d) **Inspection chamber and masonry Work. Each maintenance free earth pit shall be of precast type.**
A 400X400X400 mm (inside dimension) concrete box (wall thickness min. 50 mm) with smooth cement plaster finish shall be provided on the top of the pit. A concrete lid 25 to 50 mm. thick (or advised by Employer's Engineer), with pulling hooks, painted black shall be provided to cover the earth pit. PVC sleeve of appropriate size shall be provided in concrete wall to take out earthing.

1.3.17.3. Separate earthing for electrical equipment

There should be separate earthing network/ring network for Electrical Substation equipment. For this purpose there shall be minimum 2 nos. of maintenance free pits. This

network has to be extended to each floor through GI earthing strip of minimum size 50x6mm and shall be connected to a separate earthing Junction box to be provided at each floor and terrace which will act as a tapping point of earthing to be done for electrical substation and panel equipment at respective floors.

There should be separate earthing network for other electrical and power equipment of service area building. For this purpose there shall be minimum 4 nos. of maintenance free pits. This network has to be extended to each floor through GI earthing strip of minimum size 50x6mm and shall be connected to a separate earthing Junction box to be provided at each floor and terrace which will act as a tapping point of earthing to be done for electrical/power equipment at respective floors.

1.3.17.4. Separate earthing for Transformer

There should be separate earthing network/ring network for Transformer. For this purpose there shall be minimum 4 nos. of maintenance free pits. This network has to be extended to each floor through GI earthing strip of minimum size 50x6mm and shall be connected to a separate earthing Junction box to be provided at each floor and terrace which will act as a tapping point of earthing to be done for electrical substation and panel equipment at respective floors.

1.3.17.5. Separate earthing for DG

There should be separate earthing network/ring network for DG set. For this purpose there shall be minimum 4 nos. of maintenance free pits. This network has to be extended to each floor through GI earthing strip of minimum size 50x6mm and shall be connected to a separate earthing Junction box to be provided at each floor and terrace which will act as a tapping point of earthing to be done for electrical substation and panel equipment at respective floors.

1.3.17.6. Separate earthing for HT & LT Meter

There should be separate earthing network/ring network for HT & LT Meters. For this purpose there shall be minimum 2 nos. of maintenance free pits. This network has to be extended to each floor through GI earthing strip of minimum size 50x6mm and shall be connected to a separate earthing Junction box to be provided at each floor and terrace which will act as a tapping point of earthing to be done for electrical substation and panel equipment at respective floors.

1.3.17.7. Separate earthing for Lightning Protection

There should be separate earthing network/ring network for Lightning Protection. For this purpose there shall be minimum 2 nos. of maintenance free pits. This network has to be extended to each floor through GI earthing strip of minimum size 50x6mm and shall be connected to a separate earthing Junction box to be provided at each floor and terrace which will act as a tapping point of earthing to be done for electrical substation and panel equipment at respective floors.

1.3.17.8. Separate Clean earth / Delta earth for ICT & Network Equipment, electronic and control equipment

There should be completely separate Clean / Delta type of earthing network/ring network for ICT & network equipment, electronic and control equipment of any kind as per latest IS codes apart from earthing network for Electrical Substation equipment as well as other electrical and power equipment of service area building. For this purpose there shall be minimum 4 nos. of maintenance free pits

This network has to be extended to each floor through GI earthing strip of minimum size 50x6mm and shall be connected to a separate earthing Junction box to be provided at each floor and terrace which will act as a tapping point of earthing to be done for ICT & network equipment, electronic and control equipment at respective floors.

1.3.17.9. Earthing for Street Lighting Distribution Boards

Earthing for Lighting Distribution Boards will be done Roads & Services Contractor. Provision has to be made for the space required for such type of earthing pits. Provision has to be made for the space required for laying the earthing strip and earthing cable from the earthing pit to the Lighting Distribution Boards in coordination with Roads & Services Contractor.

Note: In accordance with the above, the end to end laying equipment for earthing network has to be provided by the service area building contractor.

Appendix B VI

1. HVAC Works

1.1. Scope: The Scope of works shall cover the design, engineering, Supply, Installation, Testing and commissioning of the complete Air-Conditioning and Ventilation System of the buildings. The scope includes all the related things like procurement, manufacture, testing at manufacturers' works, packaging, transportation, shipping, unloading at port, transportation to site, unloading, storage, insurance, transportation from stores to erection site etc. Any sizing or rating of equipment provided are indicated as minimum sizes or ratings. Contractor to design the complete system and shall consider the requirements in totality before arriving at the sizing of equipment and components. All the load and sizing calculation including all the drawings has to be approved by Employer's Engineer. The brief scope shall be comprising of, but not limited to the following:

Below mentioned minimum Quantities are for each Service Area plot and Building

Sr. No.	Minimum Description of Items for HVAC
1	HI-WALL SPLIT UNIT
	Supply, Installation, testing and commissioning of following capacity Hi Wall type split air-conditioning unit suitable to operate between 180-260 volt, 50 Hz, 1 phase power supply, with air-cooled evaporator with coil, fan, and fan motor, air-cooled condenser with hermetically sealed rotary/ scroll compressor(with R-410a), condenser coil, propeller fans controls, control panel, including control wiring & power cable between ODU to IDU, cordless remote, Necessary supporting arrangement for indoor unit, M.S. frame duly Powder Coated/ Epoxy painted as per approved shade by architect to locate Outdoor Unit with necessary vibration isolation arrangement as per site condition etc. The Unit should be at least 3 Star rated (on the date of procurements, the minimum EER value of the units should be as per ECBC-2017). The Refrigerant pipe size and gas quantity should suit to the copper pipe length at actual. The capacity guarantee should be ensured by the manufacturer. The provided unit should have inbuilt automatic voltage stabilizer with time delay relay
	Civil Work such as wall hole making, wall chisling, refilling of chiseling part with mortar etc. as per site condition.
	Nitrogen pressure testing for leakages & flushing during installation & after commissioning between IDU & ODU with flare nuts
	The Outdoor unit Compressor must be provided with 5 Year Warranty Period.
	Main electrical power at ODU to be provided by other agency.

1.1 Minimum Quantities of HI-WALL SPLIT UNITS for each Service Area plot and Building

S. No.	Location	TEMP (°C)	Quantity	Type Indoor Unit	Equipment Tonnage (Each)	Equipment CFM (Each)	Outdoor
1	Control Room at Ground Floor	23.8±1	(1 working + 1 Stand by)	Hi wall	2.11	671	2 Nos. DX type out door unit (1 working + 1 Stand by)
2	Office space at First Floor	23±1	(1 working)	Hi wall	2.11	671	1 No. DX type out door unit
3	UPS Room at First Floor	23.8±1	(2 working + 1 Stand by)	Hi wall	1.6	530	3 Nos. DX type out door unit (2 working + 1 Stand by)
4	Network Room at First Floor	23.8±1	(2 working + 1 Stand by)	Hi wall	1.28	428	3 Nos. DX type out door unit (2 working + 1 Stand by)

2	DUCTABLE SPLIT UNIT
	Supplying, fixing, testing and commissioning of 5.5TR Ductable split air-conditioning unit suitable to operate from 415+10% volt, 50 Hz, 3 phase power supply, with air-cooled evaporator with coil, fan, and fan motor, air-cooled condenser with hermetically sealed scroll compressor (with R-410a) including first charges of gas, condenser coil, propeller fans controls, inter connection control panel. Compressor should be protected with inbuilt thermal protector, internal pressure relief valve, high pressure cutout & low pressure cutout. Refrigerant pipe size and gas quantity should suit to the copper pipe length at actual. The capacity guarantee should be ensured by the vendor. The minimum EER value of the units should be as per ECBC-2017.
	Nitrogen pressure testing for leakages & flushing during installation & after commissioning between IDU & ODU with flare nuts
	The Outdoor unit Compressor must be provided with 5 Year Warranty Period.
	Main electrical power at ODU to be provided by other agency.HVAC contractor has to provide complete electrical arrangement including isolator/MCB, control panel, cabling etc.

2.1 Minimum Quantities of DUCTABLE SPLIT UNIT for each Service Area plot and Building

S. No.	Location	TEMP (°C)	Quantity	Type Indoor Unit	Equipment Tonnage (Each)	Equipment CFM (Each)	Outdoor
1	Network Room at Second Floor	23.8+1	(1 working + 1 Stand by)	Ductable	6.4	2295	2 Nos. 8 HP VRF/VRV type outdoor unit (1 working + 1 Stand by)

REFRIGERANT PIPING WITH CABLE, DRAIN PIPING, PROPELLER FAN, etc., all other accessories required for end to end HVAC networks are in the scope of the contractor.

VRF outdoor units shall be installed on the Terrace with all the required accessories.

NOTE: Please refer the drawing volume for location of HVAC indoor and outdoor units

1.2. DESIGN PARAMETER

1.2.1. General

- a) The contractor shall check the design and assume responsibility for the proper functioning of the system in accordance with the design parameters noted hereunder.
- b) Cooling load calculations shall be performed by the Contractor and submitted for review by Client.

1.2.2. Ambient Conditions:

Outside design conditions considered for nearest Weather Station – Ahmedabad in summer are:

- a) Dry Bulb 42.3 °C
- b) Wet Bulb 25.5 °C

1.2.3. Inside Conditions:

Air-conditioning System:

All the spaces to be air-conditioned are to be maintained at design temperature of 23.8 ± 1 °C and RH 50 ± 5 %.

Building material thermal property to be field verified.

The Designed lighting load will be 1.5 W/ Sqft. in all the areas.

Minimum Fresh Air Requirement for Air-conditioned area:

1 ACH/as per ASHRAE 62.1-2013

Ventilation System:

The Ventilated areas to be designed based on Ventilation air changes per hour (ACH) requirements which are as follows:

Sr. No.	Space	Ventilation ACH
1.	Store	3
2.	Toilets	10
3.	Electrical / LT Room	15

1.2.4. Design Parameter for Exhaust air ducting shall be:

- a) Maximum flow velocity : 600 m/min
- b) Maximum velocity at supply air outlet : 150 m/min

1.2.5. Design Parameter for Supply/ Fresh air ducting shall be:

- a) Maximum flow velocity : 450 m/min
- b) Maximum friction : 0.1 in. WG/100 ft. run
- c) Maximum velocity at supply air outlet : 210 m/min.

Below mentioned minimum Quantities are for each Service Area and Building

S. No.	Minimum Description of Items with all fixing accessories etc. as required.	Unit	Minimum Qty.
1	Ceiling Fan- 1200MM	Nos.	2
2	Exhaust Fan : 450 mm sweep	Nos.	6

1.3. System Design Requirements

1.3.1. Air-conditioning System

DX type system and Variable Refrigerant Flow (VRF/VRV) System is proposed to meet the air-conditioning requirements of the area on Ground Floor, First Floor and Second Floor.

Air-conditioning indoor units catering the major areas shall be Cassette type units and Hi-Wall type. The Outdoor units shall be top discharge type and preferred to be located outside on terrace, exposed to atmosphere. The indoor units shall be connected to the outdoor unit located on the terrace by Refrigerant Copper Piping and Electrical Cabling running above the false ceiling through the shaft for drainage. Server room shall be air-conditioned by Hi-Wall type indoor units. The Server room shall have Dx Split unit air conditioners along with VRF

type Hi-wall. Server room will be air conditioned with VRF system during office time and with DX split type units at other times.

Venetian blinds to be provided to reduce the heat gain from glazing.

All heat load calculation shall be done by the contractor and shall furnish for the approval of the Employer's Engineers.

All installation arrangements have to be approved by the Employer's Engineers before installation.

1.3.2. Ventilation System

The Ventilation for the DG Set/ Switch gear Room on Ground Floor is provided through Propeller fans for exhaust air.

The Toilet blocks, Battery Rooms and Pantry shall be forced ventilated by means of Propeller fans for exhaust air.

1.4. GENERAL REQUIREMENT

1.4.1. Air-conditioning System

VRF Units and Wall Mounted DX Units Catalogues and technical Manual, Equipment General Arrangement (GA) and shop drawings along with Operation, Installation and Maintenance Manual shall be furnished by the Contractor for the Employer's Engineer approval.

The Unit shall deliver the required capacity after considering de-rating. The Unit shall be factory assembled and tested. It shall be charged with refrigerant at the time of delivery.

1.4.2. Ventilation System

The Ventilation fan specifications, for fans shall be shall be furnished by the Contractor for the Employer's Engineer approval. Final selection or rating charts/ performance curves for fans with duty point marked, detailed working (fabrication/ construction) drawings for complete ventilation equipment/ system including ducting, final G.A drawings for fans, detailed foundation / mounting arrangement drawings for fans, static and dynamic loads for fans, wall/ roof opening requirement details, operation and maintenance manuals etc. shall be furnished by the Contractor for the Employer's Engineer approval.

Drive motors for all ventilation fans shall be rated at least 15 % higher than the power requirement at duty point or 10 % higher than the maximum power requirement at selected speed, whichever is higher. Starting torque requirements of fans shall also be considered to finalize the motor ratings.

The fans selected shall have steep curves to ensure nearly constant air flow even for a significant variation in static pressure.

The contractor shall ensure that the fans selected shall be conveniently installed in the allocated fan rooms/ spaces without any installation and maintenance problems.

1.5. Associated works

- The complete electrical work related to air conditioning services, shall be carried out by Contractor.
- The scope includes the associated civil works like providing RCC/PCC foundations, pedestals for equipment like ACs, AHUs, pumps & fans etc., and necessary plumbing works like providing floor and condensate drains in the equipment rooms.
- All associated Electrical Works are also in the scope of Contractor. These shall be installed in accordance with approved shop drawings of, and under direct supervision.
- All associated Plumbing Works are also in the scope of Contractor. Detailed specifications are mentioned in the electrical section. These shall be installed in accordance with approved shop drawings of, and under direct supervision.
 - a. Providing sump pumps and necessary piping for drainage of air conditioning plant room and other machine rooms located below ground level.
 - b. Providing floor drains in air handling unit rooms/Area.
 - c. Disposal of condensate drain from fan coil units / ceiling suspended units beyond the condensate drain riser.

Appendix B VII

1. FIRE FIGHTING

1.1. Scope : The Scope of works shall cover the design, engineering, Supply, Installation, Testing and commissioning of the complete Fire Fighting system including Fire alarm system for each service area plot and building . The scope includes all the related things like procurement, manufacture, testing at manufacturers' works, packaging, transportation, shipping, unloading at port, transportation to site, unloading, storage, insurance, transportation from stores to erection site etc. Any sizing or rating of equipment provided are indicated as minimum sizes or ratings. Contractor to design the complete system and shall consider the requirements in totality before arriving at the sizing of equipment and components. All the load and sizing calculation including all the drawings has to be approved by Employer's Engineer. The brief scope shall be comprising of, but not limited to the following:

1.2. The tentative requirement for firefighting is 2nos. of underground firefighting tanks with capacity of 50KL each and one overhead tank with a capacity of 10KL connected by a submersible pump placed at the underground firefighting tank controlled by level sensors to keep overhead tank filled all the time. The final demand calculation has to be done by the contractor during the detailed design

1.3. Inlet of firefighting storage should be taken through the potable water supply network for the main trunk infrastructure

1.4. System Design Requirements

- Main design components include Wet risers and the hydrant System including all pumps and pipe networks.
- Pumps shall be of three types, namely

Below mentioned minimum Quantities are for each Service Area plot and Building

S. No.	Minimum Description of Items	Unit	Minimum Qty.
1	Supply, Installation, Testing and Commissioning of Electric Driven Main Fire Pump suitable for auto operation & consisting of following: complete in all respect as required.	Set	1
a)	Horizontal Split casing type, centrifugal, multistage, pump of cast iron body and bronze impeller with stainless steel shaft, mechanical seal to ensure a minimum pressure of 3.5 kg/sq. cm. at highest and farthest outlet at specified flow of 2280 lpm at 60 Mtr. head confirming to IS 1520.		
b)	Suitable HP squirrel cage induction motor, TEFC synchronous speed 1500 RPM (with permissible slip), suitable for operation on 415 volts, 3 phase 50 Hz. AC with IP 55 protection for enclosure, horizontal foot mounted type with Class-' F' insulation, confirming to IS-325.		

S. No.	Minimum Description of Items	Unit	Minimum Qty.
c)	Common base frame fabricated out of M.S channel of suitable size, flexible coupling, coupling guard, foundation bolts and pressure gauge with valve etc. Suitable cement concrete foundation duly plastered, with anti vibration pads etc. complete as per manufacturer's design & standards and as per detailed specifications.		
2	Supply, Installation, Testing and Commissioning of Diesel Engine Driven Main Fire Pump suitable for auto operation and consisting of following: complete in all respect as required.	Set	1
a)	Horizontal Split casing type, centrifugal, multistage pump of cast iron body and bronze impeller with stainless steel shaft, mechanical seal to ensure a minimum pressure of 3.5 kg/sq.cm. at highest and farthest outlet at specified flow of 2280lpm at 60 Mtr. head confirming to IS 1520.		
b)	Suitable HP 1500 RPM, 4 stroke, cold starting type Diesel Engine with Heat Exchanger confirming to relevant BIS & IS Standards, complete with all required accessories / system, fuel oil filter, lubricant oil pump with filter, 2 Nos. starting batteries of 180 AH capacity each with suitable angle iron stand, engine starting panel having all the controls meters, gauges, tachometer, hour meters, starting switch with keys for manual starting, auto starting mechanism, 24 Volts electric starting equipment, Diesel Tank for 8 hrs continuous running of diesel engine, having minimum capacity of 200 Ltrs. (tank made out of 3mm thick M.S. Sheet with filling Cap, drain Cock, diesel indicator duly mounted on M.S. angle) exhaust pipe of minimum 30 Metre length, duly insulated with 50 mm. thick glass wool with 1.0 mm. thick aluminium sheet cladding, exhaust residential silencer, stop solenoid for auto stop in the event of fault with audio indications, painted with post office red colour etc. as required.		
c)	M.S. fabricated Common base frame, flexible coupling, coupling guard, foundation bolts and pressure gauge with valve etc. Suitable cement concrete foundation duly plastered, with anti vibration pads etc. complete as per manufacturer's design & standards and as per detailed specifications.		

S. No.	Minimum Description of Items	Unit	Minimum Qty.
3	Supplying, Installation, Testing and Commissioning of Electric Driven Pressurization Pump (Jockey Pump) suitable for auto operation and consisting of following: complete in all respects as required.	Set	1
a)	Horizontal type, centrifugal end suction type pump of cast iron body and bronze impeller with stainless steel shaft, mechanical seal, gland packing and flow of 180 Ipm at 60 Mtr. head confirming to IS:1520.		
b)	Suitable HP squirrel cage induction motor TEFC type 2900 RPM suitable for operation on 415 volts, 3 phase 50 Hz. AC with IP 55 class of protection for enclosure, horizontal foot mounted type with Class -'F' insulation, confirming to IS:325.		
c)	Common base frame fabricated out of M.S channel of suitable size, flexible coupling, coupling guard, foundation bolts and pressure gauge with valve etc. Suitable cement concrete foundation duly plastered, with anti vibration pads etc. complete as per manufacturer's design & standards and as per detailed specifications.		

- All Accessories, but not limited to field instruments like pressure gauge & pressure switch and control cabling including junction box, erection hardware, etc., to MCC & diesel engine control panel should be included
- Electrical panels, Fire Alarm Panels, Cabling & earthing from MCC panels to various fire fighting system, control wiring & interlocking.
- Instrumentation and Control equipment shall be complete with primary elements, initiating contacts for alarms, instrument impulse lines, fittings, power and control cables with suitable glands and terminations and instrument installation hardware.
- 4mm thick wrapping & coating for underground piping with proper testing.
- Sprinkler System for the complete development (within the scope of this contract).
- Contractor shall carryout the hydraulic calculation using validated software
- Fire extinguisher including mounting fixtures, anchor bolts, clamps, structures, etc for all buildings in all the areas.
- Air Vessel of continuous welded construction with flanged discharge header on the top of each riser
- Photo luminescent signage.
- Fire alarm system
- Firewater Storage at underground of building and Terrace level of each building
- Yard hydrant system around buildings
- Minimum Two nos. Internal hydrant system in each level
- Pump room/house shall be underground with suitable access as per the standards

Minimum quantity of Fire Extinguishers mentioned below are for each Service Area and Building ,

S. No.	Minimum Description of Items Fire Extinguishers	Unit	Minimum Qty.
1	Supply, installation, testing and commissioning of ISI marked (IS:15683) portable chemical fire extinguisher, water (gas pressure) type capacity 9 litres with gun metal cap and nozzle and complete in all respects including initial fill and wall suspension brackets as required	Nos.	2
2	Providing and fixing fire extinguisher of carbon dioxide type consisting of brand new high pressure steel cylinder bearing IS: 7285 mark, wheel type valve bearing IS:3224 mark internal discharge tube, 1 meter long high pressure discharge hose, non conducting horn, suspension bracket, fully charged bearing IS: making fixed to wall as directed.		
2.1	4.5kg capacity cylinder	Nos.	4
3	Providing and fixing portable fire extinguisher, dry powder type (gas cartridge) with cylinder initially fully charged with dry powder (ABC type) of 6 Kg. complete with standard discharge valve with tube, CI bracket for wall mounting etc. conforming IS : 15683:2006	Nos.	8

Tentative Location of Fire Extinguishers can be found in tender drawings

1.5 Associated works

- The complete electrical work related to Firefighting including , but not limited to installation of pumps , shall be carried out by Contractor.
- All associated Plumbing Works are also in the scope of Contractor.
- The Scope includes the associated works like Structural works for pipe supports for above ground pipes, wall supports, hose cabinet supports, etc., Civil works like wall opening, chipping of foundation, grouting of foundations, sand filling and compacting for underground pipes, etc.,
- Painting of equipment, piping, supports etc. with 2 coats of primer & 2 coats of synthetic enamel as per IS: 5 shade 536 (Fire Red).
- Supply of One set of special erection and maintenance tools and tackles.
- Start up and Essential spares.
- Recommended spares for 5 years operation.
- Anchor fasteners required for pipe supports of all the systems which are engineered by vendor and all anchor bolts, nuts, washers and inserts to be embedded in concrete for the equipment and piping.
- Shop inspection (in Vendor's works & at project site after installation along with all required calibrated measuring instruments)

Appendix B VIII

1. PLUMBING

- 1.1. Scope :** The Scope of works shall cover the design, engineering, Supply, Installation, Testing and commissioning of the complete Plumbing system including Internal and External Water Supply , Internal and External drainage including Sewerage ,Storm water drainage, Rain water harvesting system of SA buildings. The scope includes all the related things like procurement, manufacture, testing at manufacturers' works, packaging, transportation, shipping, unloading at port, transportation to site, unloading, storage, insurance, transportation from stores to erection site etc. Any sizing or rating of equipment provided are indicated as minimum sizes or ratings. Contractor to design the complete system and shall consider the requirements in totality before arriving at the sizing of equipment and components. All the load and sizing calculation including all the drawings has to be approved by Employer's Engineer. The brief scope shall be comprising of, but not limited to the following:
- 1.2.** The tentative requirement for potable water is 1no. of underground potable water tank with capacity of 25KL and one overhead tank with a capacity of 1KL connected by a submersible pump placed at the underground potable water tank controlled by level sensors to keep overhead tank filled all the time. The final demand calculation has to be done by the contractor during the detailed design
- 1.3.** Inlet of potable water storage should be taken through the potable water supply network for the main trunk infrastructure
- 1.4. System Design Requirements**
- All the transfer pumps, connection between underground tanks and transfer pumps, related piping, valves and accessories etc.
 - Auto level sensors with required controls like solenoid valve for each tanks (both underground tanks and overhead tanks) for automatic operation of transfer pumps.
 - Transfer pumps for potable water system Water supply
 - Separate piping to each over head tanks through trench with required supports.
 - Overhead tank capacity to be worked out and accordingly design to be prepare for construction.
 - Complete distribution of potable and non potable water distribution for each building.
 - Works to include for air vents, , water meters, valves, pressure gauges, P&S traps, Floor gratings, Gully trap, man holes, inspection chambers, required piping connections etc.
 - Cabling & earthling from MCC panels to various plumbing/ sanitary system, control wiring & interlocking.
 - Field instruments like pressure gauge & pressure switch and control cabling including junction box, erection hardware, etc., to MCC
 - Instrumentation and Control equipment included in the package unit shall be complete with primary elements, initiating contacts for alarms, instrument impulse lines, fittings, power and control cables with suitable glands and terminations and

instrument installation hardware.

- Supply & Installation of following complete Sanitary Fixtures and Fittings as per the model and make mentioned in the tender specifications.
 - a. EWCs
 - b. Pantry sink
 - c. Cocks & taps
 - d. towel ring, soap dispenser, toilet paper holder, twin coat hook etc.
 - e. Following sanitary fixtures shall be considered.
 - i. two way Bib cock angular
 - ii. Pillar cock straight
 - iii. Allied Health Faucet
 - iv. Stop cock straight

1.5. Associated works

- The complete electrical work related to Plumbing works including, but not limited to cabling and earthing of various fixtures and control wiring shall be carried out by Contractor.
- The Scope includes the associated works like Structural works for pipe supports for above ground pipes, wall supports, hose cabinet supports, etc., Civil works like wall opening, chipping of foundation, grouting of foundations, sand filling and compacting for underground pipes, etc.,
- Painting of equipment, piping, supports etc. with 2 coats of primer & 2 coats of synthetic enamel as per relevant IS codes.
- Start up and Essential spares.
- Recommended spares for 5 years operation
- Anchor fasteners required for pipe supports of all the systems which are engineered by vendor and all anchor bolts, nuts, washers and inserts to be embedded in concrete for the equipment and piping.
- Supply of One set of special erection and maintenance tools and tackles.
- Cutting holes, chases & like through all types of walls /floors and finishing for all services crossings, including sealing, frame works, fire proofing, providing sleeve, cover plates, making good structure and finishes to an approved standard.

1.6. Approved Make

EWC & Sanitary Fixtures: Kaiser, Gebrit, Jaguar

Appendix B IX

1. FIRE DETECTION ALARM SYSTEM, SMART CARD BASED ACCESS, NETWORK & VIDEO MANAGEMENT AND CCTV SURVEILLANCE

1.1. FIRE DETECTION ALARM SYSTEM: The scope includes design, detailing, procurement, supply, installation, equipping, testing, commissioning and execution of ICT Solution consisting of Fire Detection & Alarm System and Public Address system, Smart Card based Access Control System, CCTV Video Surveillance System, Network Management System, Visitor Management System, BMS for common areas and ancillary structures, in accordance with the tender requirements. Any sizing or rating of equipment provided are indicated as minimum sizes or ratings. contractor to design the complete system and shall consider the requirements in totality before arriving at the sizing of equipment and components. All the load and sizing calculation including all the drawings has to be approved by Employer's Engineer. The brief scope shall be comprising of, but not limited to the following:

Below mentioned minimum Quantities are for each Service Area plot and Building

S. No.	Minimum Description of Items for FIRE ALARM SYSTEM	Unit	Minimum Qty.
1	Microprocessor based intelligent, analogue addressable, modular, networkable, expandable, 1 loops with each loop capacity (minimum 125 detector + 125 devices per loop) fire alarm control panel with hot redundancy with minimum 6" approx. graphic touch screen display / LCD display with 640 Character with soft keys for displaying alarm, events and operating functions, compatible with graphic user interface for pin point the identification of the fire location and fire alarm system control, diagnostic functions for total current consumption, Day/ Night operation function, Remote maintenance service feature etc. The panel shall capable to operate on 240 volts AC power supply, automatic battery charger, 24 volts, sealed lead acid maintenance free batteries sufficient for 24 hours normal working and then be capable of operating the system for 30 minutes during emergency condition as per detailed specifications complete as required. The panel shall be either UL approved .		
	The fire alarm panel shall software integrate the 20 zone digital public address and voice evacuation system.		
	The fire alarm panel shall be equipped with all hardware and software to integrate fire alarm system with CCTV System, BMS, existing fire alarm system through BacNET, MODBUS interface.	Nos.	1

S. No.	Minimum Description of Items for FIRE ALARM SYSTEM	Unit	Minimum Qty.
2	Fire Command Station including Graphic User Interface softwares for Fire Detection, Digital Public Address & Voice Alarm (PAVA) and 2 way communication. The GUI based main network software shall be capable of graphically representing each facility being monitored with floor plans and icons depicting the actual locations of the various systems; and / or fire sensors' locations. The GUI software shall be located in the control room in one of the Floors and shall monitor all the Floor Fire Detection, Digital PAVA and 2 way communication panel connected with each other. The software shall provide the facility to Monitor and Control all the Digital PAVA as well as 2 way communication from main control room. The item will include integration with BMS UL approved.	Nos.	1
3	Intelligent Addressable photoelectric smoke detection feature including mounting base with LED etc. complete as per specification as required. UL approved.	Nos.	19
4	Addressable type Heat detectors (constant and rate of rise temperature) complete with base i/c base mounting box & mounting accessories and an integral microprocessor capable of making alarm decisions based on fire parameter information stored in the detector head. It should also be capable of full digital communications with the fire alarm panel, complete as per specifications.	Nos.	3
5	Response indicator lamp assembly mounted on walls/partitions etc. in dust tight enclosures, complete as required.	Nos.	5
6	UL/CE listed addressable Control Module.	Nos.	3
7	2 way communication Fire Fighter's Telephone Jack fitted on wall including the cast of breaking and making good the wall wherever required, complete in all respects as per specifications complete as required. (UL 9th Edition Approved)	Nos.	3
8	2 way communication Fire Fighter's Handset complete with all accessories as per specifications complete as required.	Nos.	2
9	Photo luminescent safety signage made up of photo luminescent material of rare earth aluminates, non-radioactive working on the principle of high energy for safety signs with monograms processed on 1.2 mm thick aluminium sheet including arrangement for fixing on wall / ceiling etc. complete as required (single sided) (size 150 mm x 300 mm)		
9.1	Exit Sign and Internal Hydrant illuminated Sign.	Nos.	3
10	UL/CE listed addressable Monitor Module.	Nos.	3
11	Hooter cum Strobe of intensity minimum 90db suitable for Alarm siren.	Nos.	3
12	Intelligent addressable Manual Call Point /Pull station break glass type with alarm LED as detail complete as required.	Nos.	3

1.2. Smart Card based Access Control System

The features in the design should include

- (i) Contact less card based solution
- (ii) Visitor pass with company detail

- (iii) Manually / Remotely operated Boom barriers for vehicle movement
- (iv) Electrically operated door lock
- (v) The location of access control locations should include all critical locations like the Entry, services areas, roof, machine areas
- (vi) RFID cum biometric readers for doors.
- (vii) electromagnetic door locks (600 lbs, Smart Cards (Mifare Desfire, 4KB) with dual side printing with colour in front & B&W on back. Plastic Card Holder with Lanyard)

1.3. CCTV Video Surveillance System

- The main objective is to monitor and record the activities, movement of people and vehicles through entry points inside the building, monitor the rooms and to monitor the perimeter of the service area plot.
- Cameras to be positioned at all areas to enable a total secured building.

Below mentioned minimum Quantities are for each Service Area plot and Building

S. No.	Minimum Description of Items for CCTV SURVEILLANCE SYSTEM	Unit	Minimum Qty.
1	1/3" Super HAD CCD High Resolution 580 TVL, coloured fixed dome camera with 2.8-10mm varifocal LENS, Minimum illumination 0.001 lx, 24 V DC operation, having features like wide dynamic range, True Day Night, Digital Noise Reduction, picture in picture, Quad View, backlight compensation, line lock and phase adjustment, UL listed etc. complete as required	Each	11
2	1/3" Super HAD CCD High Resolution 580 TVL, coloured fixed BOX camera, Minimum illumination 0.001 lx, wide dynamic range, CS mount 2.7 to 13mm LENS, Outdoor IP66 Weather-Proof Housing, 24 V DC operation, UL listed etc. complete as required	Each	7
3	21" Full HD/4K high resolution colour monitor with HDMI ports, USB Ports, 3.5mm Jack, etc. UL listed etc. complete as required	Each	1
4	12 V DC power supply unit etc. complete as required	Each	14

S. No.	Minimum Description of Items for video recording shall be placed in the office room of POP1 identified as Service area no. 25	Unit	Minimum Qty.
1	Network video recording. The minimum video surveillance storage system shall be provided for 24 Hrs x 30 Days basis at 30fps for 272 channels at MPEG-4 compression and record resolution of 720-1080p with bandwidth of 652.80 Mbps & 2.40 Mbps Per Camera, minimum 700TB SATA HDD capacity , Embedded LINUX, H.264 compression, HDMI ports, SVGA ports, USB ports, Multi-screen Channel 1,4,8,16,32,272 eSATA port.32 channels D1 resolution playback simultaneously (forward/ reverse, fast playback, slow playback, freeze). Online monitoring through internet, UL Listed etc. complete as required with 42" Full HD/4K high resolution colour monitor with HDMI ports, USB Ports, 3.5mm Jack, etc. UL listed etc. complete as required	Each	1

1.4. Network Management System

The features in the design should include

- (viii) 12 Port Managed Network Edge / Access Switch, 10/100 Mbps with POE,
- (ix) 8 Port Managed Network Edge / Access Switch, 10/100 Mbps,
- (x) 24 Port Managed Network Aggregation Switch, 10/100 Mbps,
- (xi) Network Management Server / Workstation with software,
- (xii) Network Rack (42U),
- (xiii) PVC Conduit pipe + installation,
- (xiv) AT6 Cable + installation

1.5. Visitor Management System

The features in the design should include

- (i) work stations
- (ii) Smart Cards (Mifare Plus, 1KB) with dual side printing with B&W in front & B&W on back. Plastic Card Holder with Lanyard to be supplied
- (iii) Laser Printers (A4 Size printing)
- (iv) Smart Card Printer (Dual side thermal-dye sublimation Card Printer with dual side lamination)

1.6. Associated Works

- All associated electrical / civil work related to above works including, but not limited to cabling, earthing and structural works for support / fixing of various fixtures , wall openings , grouting , foundations , sand filling and control wiring shall be carried out by Contractor.
- The Contractor will carry-out any interfacing / Integration of the systems as required between the systems and also with the BMS (Lift, AHU, Lighting, DG Set Panels)
- Required UPS Power only will be made available by the Employer. The power cabling & Ethernet / Optical Fiber cabling, Ethernet Switches and other network hardware shall be provided by the Contractor.

Appendix B X

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Appendix B XI

1. ROAD WORKS

- 1.1. Scope:** The scope of proposed road works includes development of internal roads/driveways, pathways and parking areas within Service area plot site. The Contractor shall carry out, and be responsible for, the design and execution of the works, including any site surveys, subsoil investigations, materials procurement and testing, and all other things necessary for proper planning, design and construction.
- 1.2. Merging and connecting the Service area plot entry with external road/approach road network:** The scope of road network includes appropriate entry of the building from the main road as specify by the client / employer engineers. This includes demolition of external road for access, connecting the required services to the service area buildings, rebuilding of external road as per the details provided by the employer's engineer / employer. During this process, any impact to but not limited to the main / trunk services, external road, pavement, plantations, street lights etc shall be rectify / rebuild / reconstruct / re installed at the level of employer satisfaction at the cost of the contractor. Contractor shall design and construct road connection between service area plot boundary to adjacent/Nearest TP road. The scheme of road connection (as mentioned below) between SA plot boundary and TP road shall be approved Employer / EE. This work also includes any dismantling required for the connection.

Appendix B XI (a)

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Appendix B XI (b)

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Appendix B XI (c)

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Appendix B XI (d)

1.0 Pavement Design

Design and Construction of pavement of roads, footpaths and parking areas shall conform to the Standards and Specifications as per Schedule D.

1.1 Type of Pavement

The pavement types for different roads, parking areas and footpaths shall be as given below in Table: 9

Table 5: Type of Pavement

Pavement for	Main Carriageway (Internal Roads)	Car Parking Areas
Pavement type	Rigid (Cement Concrete) pavement & Cement concrete interlocking paver block pavement with High SRI pavers	Cement concrete interlocking paver block pavement with High SRI pavers & Cement Concrete Interlocking Grass Pavers

1.2 Design Requirements

Notwithstanding anything to the contrary contained in the Schedules, the Contractor shall design the pavement for minimum MSA / CPVD as given below in Table:6

Table 6: Design Requirements

Pavement for	Main Carriageway (Internal Roads) - CPVD	Parking Areas
Traffic (MSA / CPVD)	150>450	As per Schedule D

Appendix B XII

1. STORM WATER DRAINAGE NETWORK

- 1.1.** The Scope of Work for proposed storm water drainage system under this contract includes but is not limited to the following in relation to the design, supply, construction, testing and commissioning of storm water drainage system of the Works:
- a. Storm water collection and disposal system
 - b. Excavation, dewatering, ramming, refilling, and disposal of surplus excavated soil for pipe / box trench.
 - c. Construction of all type inspection chambers
 - d. Supply, laying jointing, testing and commissioning of RCC NP-2 pipe/ indicated in the layout plan of storm water drainage system.
 - e. Hydraulic Testing and commissioning of the entire work.

Appendix B XIII

1. Deleted

Appendix B XIV

1. SOLID WASTE MANAGEMENT

1.1. Scope : The Scope of works is to ensure that the entire solid waste generated in the SAB building is managed .It includes collection and segregation of waste at source using color coded bins under hygienic conditions and then disposal of in the city wide SWM system.

1.2. Collection and Segregation of Solid Waste:

- 100% collection of solid waste from all SAB Buildings.
- Segregation of waste at source.
- Separate wet and dry waste collection system.
- Collection at pre-informed time (Once a day) from all waste generation source
- Provision of three colour coded bins (wet, dry and recyclables) for waste collection from common areas.

1.3. Deleted

1.4. Disposal of Recyclables and Inert:

- The recyclables like paper, plastic and metal to be stored in the utility area for a maximum duration of 15 days and then be sold to authorised vendors for handling recyclables.
- The inert to be stored in utility waste handling area and will be sent to the nearest authorised municipal solid waste landfill site.
- Any hazardous waste generated from the complex like used DG oil; old batteries etc to be handed over to SPCB authorized hazardous waste handling vendors.

1.5. Deleted

1.6. Deleted

Appendix B XV

1. Integrated Building Management System (IBMS)/ Building Automation System (BAS)

1.1. SCOPE:

An **Integrated Building Management System (IBMS)** or a more recent terminology **Building Automation System (BAS)** is a computer-based control system that shall be installed in buildings along with the required hardware and integration software that controls and monitors the building's mechanical and electrical equipment such as Plumbing, Heating, Ventilation, Lighting, Power System, , Fire Alarm & Detection Systems, including the security systems like; Public Address System, Access Control, Visitor Management, Network management, CCTV Surveillance & Intrusion systems.

There will be 1 (one) IBMS for each Service Area plot and Building

The System provider shall furnish and install the IBMS, incorporating distributed control techniques and standard open communication networks. The system shall be implemented as an integrated, open solution, which enables Service Center connectivity through standard Building Operating System (BOS) interface.

The integrated systems shall include controls and monitoring of the whole building (BMS and Security) and common areas wherever applicable.

This details below explains briefly the Building Management, and Security Systems that are suggested for the project. Basic essential components of these systems are Design Parameters and Explanation on the areas of implementation of each system.

The BMS will perform the following general functions:

- Building Management & Control.
- Serve as operator Man – Machine interface.
- Managing and monitoring conditions (e.g. Temperature).
- Control monitoring.
- Notification of system faults and alarm controls.
- Data Collection & Historisation.
- Alarm Event & Management.
- Trending.
- Reports & MIS Generation.
- Maintenance & Complaint Management.
- Network Integration.

BMS facilitates the following utilities / areas:

- (i) HVAC - Sequential start-up, loading, unloading, sequential shutdown and monitoring of important parameters for HVAC.

- (ii) Supply / Exhaust fans of smoke free lobbies - control and status monitoring.
- (iii) Switchboards - monitoring of important parameters and status for HV and LV Main Switchgear.
- (iv) Lighting Controls - control of common area lighting distribution boards.
- (v) DG set- Monitoring of important parameter and status.
- (vi) Fire protection system.
- (vii) Monitoring of control panel, pumps and water tanks.
- (viii) Fire and potable water system - control of pumps and monitoring of tanks and pumps.
- (ix) The system shall comprise controllers located near the equipment they monitor / control. Signals from this equipment shall be connected to the controllers. The controllers shall be connected to each other over a bus and terminated at the Man Machine Interface (MMI). The MMI shall include PCs and printers and serves as the operator's interface to the system.
- (x) The hardware and software integration required for bringing the informations of individual BMS and CCTV network from all service areas to the POP1 is in the scope of the contractor. This has to be done in coordination with MSI.1 number of MMI shall be placed in the office room of POP1 identified as Service area no. 25
- (xi) Common BMS (POP1) room for all the service areas with future expansion to be planned

The PC software shall feature a graphical user interface (GUI) for simplicity and ease of use. The software features shall include alarm presentation, report generation, trending of parameters, historical storage, etc.
- (xii) Building automation (cooling/heating control, ventilation control, pumps, etc.)
- (xiii) Lighting control of service area building and plots
- (xiv) Access control system for service area building and plots
- (xv) CCTV Video monitoring system for service area building and plots
- (xvi) Fire Detection & Alarm system for service area building and plots
- (xvii) Back-up power / UPS Control
- (xviii) Water consumption metering
- (xix) Electricity consumption metering
- (xx) Cooling energy consumption metering

1.2. SYSTEM REQUIREMENTS:

The IBMS shall consist of software and hardware; the software program configured in a hierarchical manner that integrates the various subsystems.

System integration shall enable significantly lower energy consumption, real-time control and monitoring, and dynamic graphics according to needs. System integration shall create better environmental air quality, radically improved energy performance and increased water efficiency. System integration shall also allow for efficient system maintenance and full-scale service provisioning with radically lower cost and better quality services. Easy access to building systems shall ensure that everything is in perfect condition and functions in the optimal way at all times. Should anything disturbing happen, immediate response shall be

available. Integration shall facilitate undisturbed conditions in the building and sustainable development through minimized energy consumption, first-class security and significantly lower life cycle costs.

1.3. SYSTEM ARCHITECTURE / SPECIFICATIONS:

The system shall be implemented as an integrated, open solution, which enables Service Center connectivity through standard Building Operating System (BOS) interface.

The system shall be completely modular in structure and freely expandable at any stage. Each level of the system shall operate independently of the next level up as specified in the system architecture. For example, Control Level shall operate independently without support from Management Level. The system shall be fully consistent with the latest industry standards.

To enable efficient functional system integration and to provide maximum flexibility and to respond to changes in the building use, the system offered shall support the use of LonWorks, Modbus, M-bus, Ethernet TCP/IP and Internet communication technologies.

1.3.1. Service Level shall allow the systems to be connected without additional software to one or several Service Center(s), for providing centralized remote monitoring, alarm and fault detection of connected building management and security systems.

1.3.2. Management Level shall provide a uniform view to all systems through the open Building Operating System (BOS) platform. All the systems - controls of cooling, ventilation and lighting, consumption measurements, access controls, fire alarms and CCTV systems - shall be integrated with the BOS using device drivers.

1.3.3. Control Level shall consist of a distributed network of smart controllers, which communicate to each other subsystems using compatible interfaces. Connectivity towards Management Level shall utilize standard TCP/IP protocol.

1.3.4. Field Level shall consist of sensors and devices with industry standard interfaces.

1.3.5. Systems shall be accessed through the Building Operating System (BOS). Professional User Interface:

The system shall enable a client-based User Interface for professional usage and for central monitoring of systems (Service Center usage). The professional User Interface shall allow for at least the following:

- Alarm monitoring and alarm handling by multiple operators
- Intruder alarms
- Fire alarms
- Alarms from electrical and mechanical systems
- System maintenance alarms
- Video monitoring
- Remote diagnostics

- Peak load management
- Remote diagnostics of system/devices
- Consumption reports for energy management and billing
- Logs and reporting
- User profile and role management
- Access rights management
- Door controls
- Camera views
- Alarm list browsing

- lighting controls

The professional User Interface shall be implemented as a client application, which includes an automatically adapting tree structure of the building, building's parts, individual spaces, different systems and parts of systems. The tree structure can be used for navigation through the system.

All subsystems connected to Building Operating System can be accessed through the same graphical User Interface. The client software can be installed to unlimited number of remote computers or laptops. The client software shall allow for remote Internet usage of several sites using the same client.

The professional User Interface shall show system views, floor plan views. Each alarm message shall include shortcut to relevant graphical system and floor plan view.

Appendix B XVI

1. Tender Drawings

All the drawings are indicative only. The contractor has to prepare the final drawings as per the detail design in coordination with Roads & Services Contractor of Activation Area, MSI (Master System Integrator) of Activation Area, Power Distribution Licensee/DISCOM of DSIR, PMNC and other stakeholders, which has to be approved by the Employer's Engineer.

Some of the installations like Video wall, MMI, NVR even though shown in all the drawings need not be replicated in all the buildings and will be placed only in POP1 identified as Service area no. 25

Please refer to the page no. 318

Appendix B XVII

1. Reference Data for soil testing and geo-technical survey

Reference data set related to soil testing and geo-technical information conducted during various construction projects within Activation Area. Bidder to request to the Employer and collect the data related to soil testing and geo-technical information conducted during various construction projects within Activation Area from the Employer's office .

Schedule C - Project Facilities

1.0 The Contractor shall design and construct the Project Facilities in accordance with the provisions of this Schedule C. Such Project Facilities shall include;

(a) Architectural :

1) Service area blocks

- SA number block approx 1558 mm x 2237 m in GRC, painted and illuminated with focus lights
- Mural approx 2140 mm x 2292 m in GRC, painted and illuminated with focus lights

2) Utility Corridor

- All services routed through an underground RCC trench and the required type of water, sewerage, etc., pipelines as a part of utility corridor, from trunk infrastructure of roads and services contract of activation area to each service area plot and building.

(b) Deleted

(c) Civil and Structural:

1) Earthquake preventive measures: Earthquake cannot be prevented. However, earthquake can be sustained by designing earthquake resistant structures using Indian Standards.

2) Disaster (flooding) resistant building design :

- a) Elevating as much of the building as possible above the design flood level.
- b) Designing the building foundation and any portions subject to flooding to withstand design flood conditions and loads.
- c) Using flood damage resistant materials for any portions of the building below the design flood level.
- d) Local inhabitants have adopted strategy to overcome problem of flooding, by a raised plinth.

(d) Ancillary facilities : Ancillary facilities shall be provided in accordance with the provisions as per Schedule B& D and shall include :

- 1) Compound wall with barbed wire fencing (Height of minimum 2 feet) of minimum 75 meter length around each of the SA plot or as specified by the Employer's Engineer.
- 2) Chain link fencing of minimum 40 meter length as specified by the Employer's Engineer.
- 3) 02 Entry / Exit gates along with CCTVs
- 4) External signage like building name, entrance gate, including its illumination and Internal signage like entry, exit, toilets, office etc.

(e) **Electrical Power Supply:** The building will be provided with permanent electrical supply, LT Distribution Boards, , Auto Transfer Switches (ATS), Auto Mains Failure(AMF), DG Set and its Panel, UPS with UPS panel and Battery Bank for backup power facilities and Substation Automation System, Normal and emergency light fixtures, Normal and emergency power, Building facade lighting, gate illumination, bollards etc. in accordance with the provisions as per Schedule B & D.

(f) **HVAC:** The building will be provided with air conditioning, mechanical ventilation and exhaust facilities in accordance with the provisions as per Schedule B & D.

HVAC facilities shall include:

- 1) Split AC and its outdoor unit
- 2) VRF/VRV Out door units shall be provided on terrace of service area building.
- 3) VRF/VRV indoor units considering for Ground to Second Floor.
- 4) Copper piping with insulation for DX condensing units & VRV/VRF system.
- 5) Ventilation system for complete service area building including but not limited totoilets, electrical rooms, etc.,

(g) **Fire Fighting facilities:** The building will be provided with Firefighting facilities including wet risers, sprinklers, fire hydrants and portable fire extinguishers in accordance with the provisions as per Schedule D & I and requirements of the statutory authorities.

Fire Fighting facilities shall include:

- 1) Underground (UG) and Terrace level water tanks for fire fighting system
- 2) Fire pumps, external and internal hydrant pumps, sprinkler pumps, jockey pumps - electric & diesel engine driven
- 3) Piping connection between UG tanks to the suction header, pump connections, further distribution with required valves, accessories etc.
- 4) Required electrical MCC cum instrument control panels with controls like pressure switch etc. to make the system to work automatically.
- 5) Fire extinguishers, internal hydrants and yard hydrants.
- 6) Piping connection between OHT to the wet riser with required valves, accessories etc
- 7) Internal hydrants with hose reel box, fire hoses, nozzle etc at each level.
- 8) Piping, valves, accessories required for the complete system.

(h) **Plumbing and Sanitary facilities:** The building will be provided with sanitation facilities including fully functional and equipped washrooms and potable water supply in accordance with the provisions as per Schedule B & D.

Sanitary facilities shall include:

- 1) Underground (UG) water tanks for each potable, non potable and fire fighting system
- 2) Individual transfer pumps (working) for each system (potable and non potable)
- 3) Standby transfer pump one number per six service area buildings for each potable and non potable system to be stored at Administrative Building / or any of the Service area as directed by the employer
- 4) Complete sewage, waste and rain water piping
- 5) Complete water supply (both potable & non potable) distribution from OHT to each level as per the design and requirements.

- 6) Piping connection between UG tanks to the suction header, pump connections etc.
 - 7) Sanitary fixtures and fittings.
 - 8) Piping, valves, accessories required for the complete system
 - 9) Rain water collection from roof top
- (i) **The building will be provided with fire detection and alarm system, integrated building management system (IBMS)/ building automation system (BAS), Network management system, Visitor management system, Smart card based access and CCTV surveillance facilities in accordance with the provisions as per schedule B & D.**
 - (j) **Deleted**
 - (k) **Deleted**
 - (l) **Deleted**

2.0 Details of Visual Branding Elements for Service Area Building

a. Visual Brand Language System

The Visual Brand Language System is an integral part of Service Area Buildings covering defined aspects of the project in order to achieve a consistent and connected feel, which celebrates the articulated brand image and expresses the values of a modern, culturally rich, contextually relevant, sustainable, people-centric and livable industrial township.

b. Iconography – Reference Palette

Following graphic elements, based-on and derived-from Indus Valley Seals, specifically those from Lothal, can be used wherever applicable with approval of Employer’s Engineer.





c. General Specifications - Desired Finishing for Visual Branding Elements

Following graphic elements, based-on and derived-from Indus Valley Seals, specifically those from Lothal, can be used wherever applicable with approval of Employer’s Engineer.

I. Fair Faced Concrete

All fair faced concrete works to be completely smooth and free from overflow-edges, burrs, pitting and any abnormal surface imperfections. In case of fair faced concrete, after removal of formwork, is not required to have any further finishes on it like plastering, etc. The concrete surface shall be free from honeycombing and excessive air holes, fins and projections.

All formwork / shuttering to be done in smooth pre-coated shuttering ply, steel and / or glass reinforced plastic with provision for embossed / debossed artworks / equi-spaced bolt-holes with securely fitted serrated/ knurled SS ferrules / hemispherical impressions, element joints, metal studs for embossing at pre-determined grid locations defined in the drawings.

II. Ferrocement

All ferrocement / ferrocement ‘Jaali’ Screens and related works, wherever applied, to be completely smooth and free from overflow-edges, burrs, pitting and any abnormal surface imperfections. All constituent materials shall comply with relevant IS codes.

d. Street Lighting

Control Box Access Panel (with three integral partitioned units as explained elsewhere) shall be embossed with the graphic of a Lothal Seal from the Iconographic Palette (As approved by the Employer’s Engineer). Pole Base and Control Box to have holes to facilitate concealed and electrically safe transfer of wiring from bottom to top of each pole as well transfer to & from adjacent poles, as required.

The pole can be of variable heights as specified for defined applications and locations. The top component, holding the luminaire arms with four possible luminaire configurations - single sided, dual sided, three / four-sided, is shown under.

Poles shall have modular attachments to mount cameras, Wi-Fi equipment and lightning arrestors, as required. Provision for mounting of Fabric / Flex banner (Modular clip-on) will be part of the solution.

The detailed specifications of all the street lighting equipment have been given in various schedules (**Schedule C & D**).

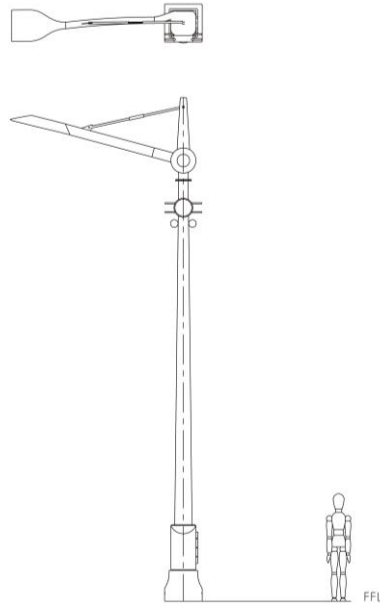
Typical Illustrative Drawings are shown under:



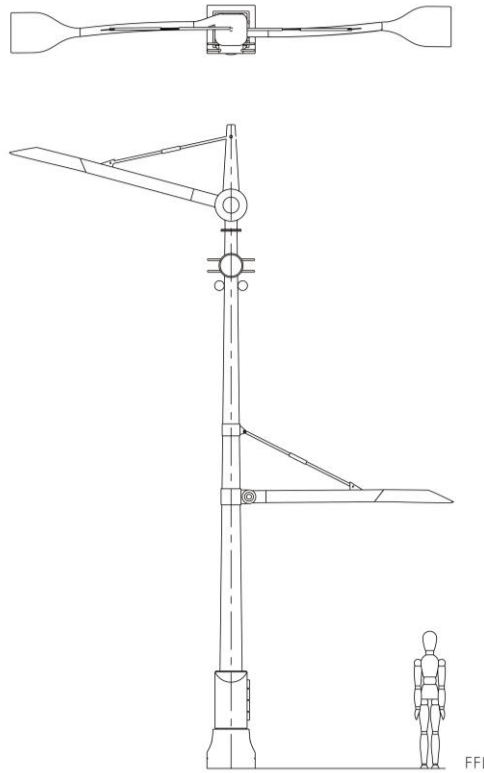
Typical Illustrative Drawings - Modular & Scalable Lamp Post System



Typical Illustrative Drawings - Exploded view: Showing detachable modules / extension-arms for flex / fabric banners



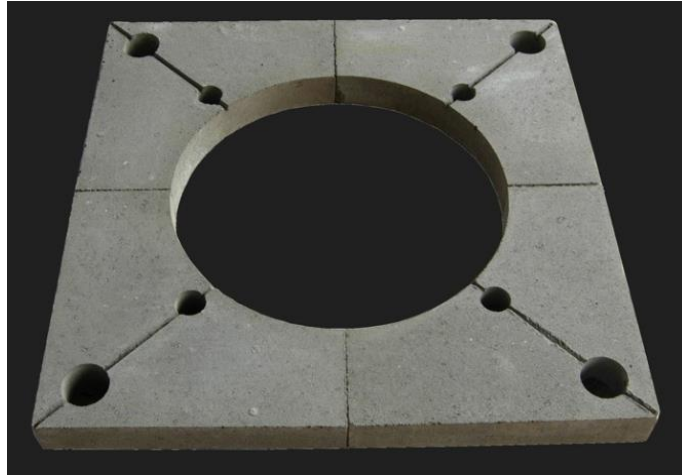
Typical Illustrative Drawing - Lamp Post with Single Offset Arm



Typical Illustrative Drawing - Lamp Post with Dual Offset Arms – Staggered Heights

e. Tree Grating

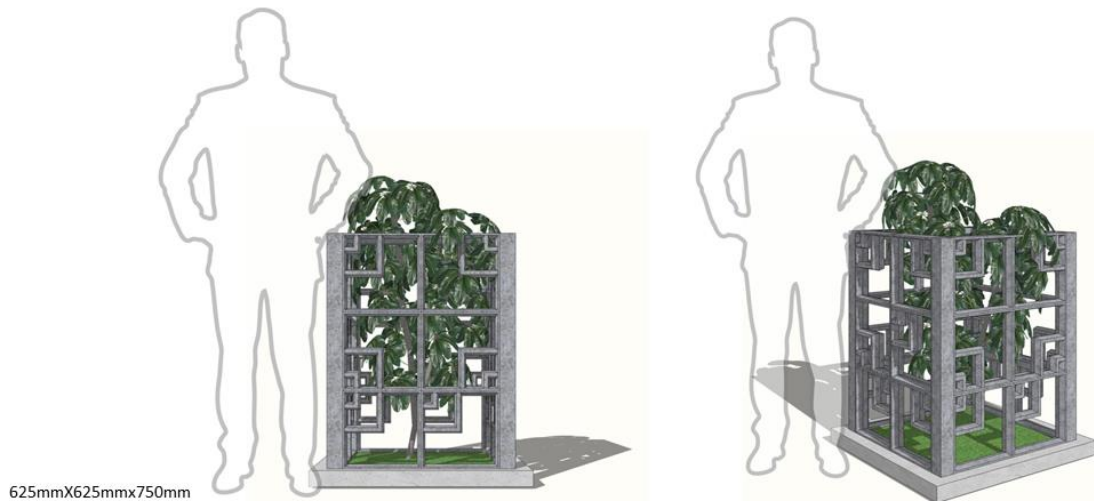
Typical Illustrative Drawing is shown under:



f. Tree / Sapling Protection

Typical Illustrative Drawings are shown under:

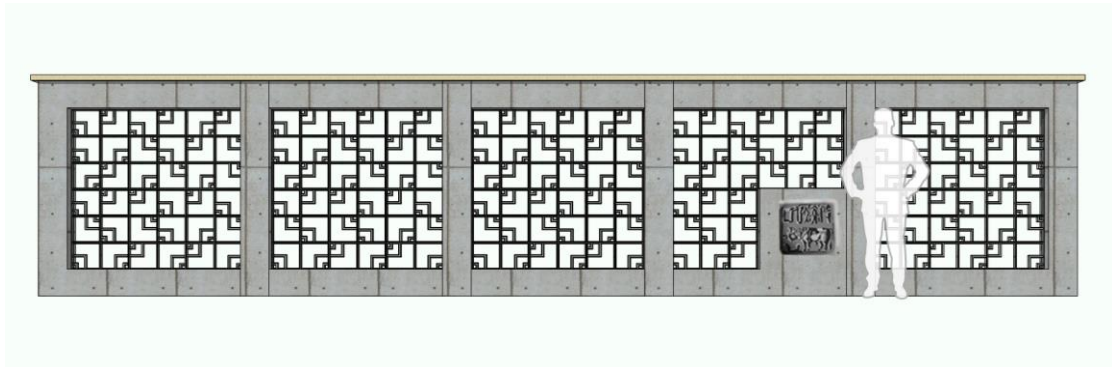
Based on standard 250 mm Ferrocement Module



3.0 “JAALI’ SCREENS & GENERIC BOUNDARY WALL

2000mm high (or as necessary), 250mm x 250mm Fairfaced Concrete column and beam profile as per design with equi-spaced bolt-holes with SS ferrules / hemispherical impressions, element joints, along with a 19 mm thick Kota stone coping sloped inside (with suitable overhang and edge profiling to facilitate rain-water overflow).

The 'Jaali' elements are modular Ferrocement elements, located neatly and securely fixed into reinforced concrete frames. The Boundary Wall is either in a linear/ straight-line configuration or configured in a zig-zag pattern as approved by the Employer’s Engineer.



Typical Illustrative Drawing - Straight/ Linear Boundary Wall

Schedule D - Standards & Specifications

All designs, materials, works and construction operations shall conform to the Standards and Specifications given below.

Where the Contractor intends to use an alternative to these Standards/Guidelines for delivering an equal or better product, he shall be permitted to use such alternative subject to the following conditions:

He shall demonstrate that the proposed alternatives conforms to any of the following international Standards, Codes of Practice, Specifications, Guidelines, etc.

In case the Consultant intends to use any alternative material/technology/method, whether patented or otherwise, that is not specifically covered in the Indian or International Standards as listed below, but the use of which has been permitted on similar projects (similar in category of buildings) as the Building Projects, he would be permitted, its use on certification by the owners of such similar projects regarding the continued successful performance of such materials, technologies, methods, procedures or processes for at-least 5 years of the service life of the project. Such a certification shall be supported with details of critical performance parameters.

Such other reference standards published by the following that may be considered:

DIN	Deutsche Industries Norman (German Standards)
AFNOR	Association Francaise de Normalisation (French Standard Institute)
BSI	British Standard Institute
ASTM	American Society for Testing and Materials
ANSI	American National Standards Institute

The above is the list of codes included for guidance and compliance with applicable portions only and the omission of any from the list does not relieve the contractor from compliance therewith.

Latest version of the Codes, Standards, Specifications, etc., notified/published at least 60 days before the last date of bid submission shall be considered applicable.

Where the Standards and Specifications for a work are not given, Good Industry Practice shall be adopted to the satisfaction of the Employer's Engineer

Notwithstanding anything to contrary contained in Schedules, all reinforcement for Reinforced Cement Concrete (RCC) works shall be Corrosion Resistant Steel only.

1.0 STRUCTURE WORKS

Standards and Specifications of following project components are given in this section;

- a) Structure design works should follow the latest applicable IS codes and the updates thereof.

The Structure works design shall comply with the all the specified minimum requirements of the Authorities Structures analysis , design and detailing works shall be done by the latest software's.

- b) The Structural design shall be vetted by a Accredited Structural Engineer approved by the Employer This approved design shall form the basis of Construction.
- c) Notwithstanding anything to contrary contained in Schedules, all reinforcement for Reinforced Cement Concrete (RCC) works shall be Corrosion Resistant Steel only.

- 1.1 The relevant Indian Standard Codes, as given below, shall be followed for structural design:

Table 1: Code for structural works

Code	Description
IS-875 (Part 1) – 1987	Code of Practice for Design Loads (other than earthquake) for buildings and structures – Unit weights of buildings materials and stored material.
IS-875 (Part 2) – 1987	Code of Practice for Design Loads (other than earthquake) for buildings and structures – Imposed loads.
IS-875 (Part 3) – 1987	Code of Practice for Design Loads (other than earthquake) for buildings and structures – Wind loads.
IS-875 (Part 4) – 1987	Code of Practice for Design Loads (other than earthquake) for buildings and structures – Snow loads.
IS-875 (Part 5) – 1987	Code of Practice for Design Loads (other than earthquake) for buildings and structures – Special loads and load combinations.
IS: 456 – 2000	Code of Practice for Plain and Reinforced Concrete.
IS: 1786 - 1985	Specification for High Strength Deformed Bars and Wires for Concrete Reinforcement
IS: 432 (Part 2) - 1982	Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for Concrete Reinforcement – Hard Drawn Steel Wire.
IS: 1343 – 1980	Code of Practice for Prestressed Concrete
IS: 13920 - 1993	Ductile detailing of reinforced concrete structures subjected to seismic forces - Code of practice
IS: 14268 - 1995	Uncoated Stress Relieved low relaxation seven-ply strand for Pre stressed Concrete – Specification

Code	Description
IS: 2062 – 1999	Steel for General Structural Purposes. Specification.
IS: 1161 – 1998	Specification for Steel tubes for Structural Purposes.
IS: 800 – 1984	Code of Practice for General Construction in Steel.
IS: 1893 – 2002	Criteria for Earthquake resistant design of structures.
IS: 2210 – 1998	Criteria for Design of Reinforced Concrete structures and Folded plates.
IS : 269 – 1989	Specification for Ordinary, rapid hardening and low heat Portland cement.
IS : 455 - 1989	Specification for Portland blast furnace slag cement.
IS : 1489 -1991	Specification for Portland pozzolana cement
IS : 383 - 1970	Specification for coarse and fine aggregates from natural sources for concrete.
IS : 516 -1959	Method of test for strength of concrete.
IS : 432 -1982	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
IS : 4990 -1993	Specification for plywood for concrete shuttering works
IS : 2645 -1975	Specification for integral cement water proofing compounds.

1.2 Deviations – The Followings deviations from the Table above to be applicable

Table 2 indicates the Loads to be considered for the design of the Structure

Table 2

Loading Area	Load Intensity (KN/m ²)
Inaccessible Roof	0.75
Accessible Roof	1.50
For Sloping Roof with slope greater than 10 degrees (if applicable)	0.75 kN/m ² less 0.02 kN/m ² for every degree increase in slope over 10 degrees, subject to a minimum of 0.40 kN/m ²
Terrace Roof Slab (with landscape)	3.00
Terrace Roof Slab (without landscape)	3.00
Office Floor Slab (BPO / IT - typical)	4.00
Balconies, Corridors, passages, lobbies and staircases including fire escapes – as per the floor serviced (excluding stores)	4.00
Storage Area	5.00

Loading Area	Load Intensity (KN/m²)
Pantry	3.00
Kitchen	3.00
Cafeteria	4.00
Toilets	2.00
Electrical room (H T/ LT Panel room)	5.00
AHU / HUB	5.00
Mechanical room	5.00
UPS rooms/Transformer/Battery room	10.00
Data Center/Server	12.50
Training	5.00
Library	5.00
Lobby	5.00
Activity Center/Meditation/Yoga	5.00
Gymnasium	7.00
Administration room	5.00
Auditorium (without fixed seating)	5.00
Pump house	5.00
Control Panel	10.00
Compactor storage areas	10.00
Chiller room	18.00
DG room	20.00
Parking/ Ramp	5.00
Landscape/ Lawn	5.00

The surcharge loading for retaining walls shall be minimum of 10.0 kN/m².

2.0 ARCHITECTURE & FINIHING WORKS

The Codes, Standards and Technical Specifications applicable for the design and construction of project components are:

The following list is included for guidance only and the omission from the list does not relieve the contractor from compliance there with:

Table 3: Codes for Architectural and Finishes

Code	Description
IS 1200	Mode of measurement.
IS 269	Ordinary portland cement.
IS 3812, 1981	Flyash for use as pozzolana and admixtures,
IS 2386	Method of test for aggregate for concrete.
IS 516	Method of test for strength of concrete
	Coarse and fine aggregate from natural sources for concrete.
IS 1077, 1970	Method of test for Bricks.
IS 456	Code of practice for plain and reinforced concrete.
IS 1597	Code of practice for construction of stone masonry.
IS 1597 PART 1	Code of practice for construction of rubble stone masonry.
IS 1130	Marble (blocks, slabs and tiles)
IS 287	Recommendation for maximum permissible moisture contents of Timber used for different purposes.
IS 1141	Code of practice for seasoning of timber.
IS 6313 PART 2	Anti-termite measures in buildings, pre-constructional chemical treatment measures.
IS 2571	Code of practice for laying in situ cement concrete flooring
IS : 226	Structural Steel (Standard Quality)
IS : 451	Technical Supply Conditions for Wood Screws
IS : 800	Code of Practice for Use of Structural Steel in General Building Construction
IS : 806	Code of Practice for Use of Steel Tubes in General Building Construction
IS : 813	Scheme of Symbols for Welding
IS : 814	Covered Electrodes for Metal Arc Welding of (part I & II) Structural Steel
IS : 816	Code of Practice for Use of Metal Arc Welding for General Construction in Mild Steel
IS : 822	Code of Practice for Inspection of Welds
IS : 961	Structural Steel (High Tensile)

Code	Description
IS 73	Paving bitumen.
IS 702	Industrial Bitumen
IS 1322	Bitumen felts for waterproofing and damp proofing.
IS 1609	Code of practice for laying damp proof treatment using bitumen felts.
IS 13711 & 13712	Ceramic tiles
IS 13630 Part 1 to 13	Testing for Ceramic tiles
IS 104	Specification for ready mixed painted, brushing, zinc chrome, priming.
IS 137	Ready mixed paint, brushing, matt or egg-shell flat, finishing, interior Indian standard colour as required.
IS 5410	Cement paint, colour as required.
IS 6241	Method of test for determination of stripping value of road aggregate.
IS 2720	Density test of aggregate.

2.1 FALSE CEILING WORKS

2.1.1 Mineral fiber Techzone (Module TZ7) ceiling system

Providing and installing Mineral fiber Techzone (Module TZ7) ceiling system has a ceiling module of 1200mm and the on centre spacing between two adjacent technical zones is 1950 mm. The Techzone orientation is such that the main runners run perpendicular to the technical zone. Dune field panel is of size 600x1200x16mm mm. The 1200 x150 mm technical zone formed is where the technical elements like lighting fixtures & air diffusers would be installed. Where there are no technical elements the technical zone would be covered by using Dune or Metal Technical Panels of size 1200mm x150mm. The Dune panels should have Humidity Resistance (RH) of 99%, NRC 0.5, Light Reflectance $\geq 85\%$, Thermal Conductivity $k = 0.052 - 0.057$ w/m K, Colour White, Fire Performance UK Class 0 / Class 1 (BS 476 pt - 6 &7), suitable for Green Building application, with Recycled content of 32%.

The panels shall be laid on Armstrong Suprafine38 with 15 mm wide T - section flanges colour white having rotary stitching on all T sections.

Technical zones of 150mm width to be formed by using 2 parallel 1200mm cross tees which are interlocked between the main runners. Warranty Certificate and Test Reports for NRC, CAC and Fire rating shall be provided by Vendor.

Installation to be carried out by Trained Installation team & Installation should be carried out as per manufacturer recommended procedure.

SUSPENSION SYSTEM accessories shall be of same make consisting of M6 Anchor Fasteners with Vertical Hangers, A pre Straightened Hanger wire, thickness of 80gsm and a tensile strength of 344-413 MPa, along with Adjustable hook clips, galvanized spring steel for 2.5mm with a minimum pull strength of 110 kg. The adjustable clip also consists of a 3.5 mm aquiline wire to be used with the main runner.

Contractor should be submitted the Manufacturer (Material & Installation) Specification, Shop Drawings & get approval from the Architect & Engineer In Charge before start any work on site. Moc-up/ sample shall be getting approved before execution of work.

2.1.2 Fiber Acoustical Suspended Ceiling System with ANF (Board) edge tiles

Providing & Fixing of Mineral Fibre Acoustical Suspended Ceiling System with ANF (Board) edge tiles with 24mm exposed grid of Armstrong or equivalent.

The tiles should have Humidity Resistance (RH) of 90%, NRC 0.5, Light Reflectance $\geq 85\%$, Thermal Conductivity $k = 0.052 - 0.057$ w/m K, Colour White, Fire Performance UK Class 0 / Class 1 (BS 476 pt - 6 & 7) in module size of 600 x 600 x 15mm, suitable for Green Building application, with Recycled content of 34%.

The tile shall be laid on Prelude38 with 24 mm wide T - section flanges colour white having rotary stitching on all T sections and a load carrying capacity of 15.34Kgs/M² & pull out strength of 100Kgs. The T Sections have a Galvanizing of 90 grams per M² and need to be installed with Suspension system of same make.

The Tile & Grid system used together should carry a 10 year warranty.

SUSPENSION SYSTEM accessories shall be of same make and consisting of M6 Anchor Fasteners with Vertical Hangers with a Galvanized Thickness of 80gsm, A pre Straightened Hanger wire, thickness of 80gsm and a tensile strength of 344-413 MPa, along with Adjustable hook clips of 0.8mm thick, galvanized spring steel for 2.68 mm with a minimum pull strength of 110 kg as per manufacturer specification. The adjustable clip also consists of a 3.5 mm aquiline wire to be used with the main runner. Installation shall be carried out as per manufacturer's specification.

Contractor should be submitted the Manufacturer (Material & Installation) Specification, Shop Drawings & get approval from the Architect & Engineer In Charge before start any work on site. Laid sample shall be getting approved before execution of work.

Making cut outs/ openings for electrical fixtures, tube lights/ air-conditioners, grills, diffusers etc & providing additional sections for strengthening the openings/ cutouts, making grooves between wall & board or as per drawing /instruction of EIC.

2.1.3 Channeled Woodworks perforated panels false ceiling system

Channeled Woodworks perforated panels false ceiling system of approved make having width 128mm, thickness of 15mm and length 2440 mm, made of a 830 Kg/M³ high density fibre board substrate with a laminate finish of approved shade and a melamine balancing layer on the reverse side. The boards shall have a special G14 perforation pattern where the visible surface has a "Helmholtz" fluted perforation of 2mm width and 14mm of visible panel each. The panels shall provide a minimum sag resistance of RH90 and a fire rating class of 1 as per Part 7 of BS 476. The edges of the panels shall be "tongue-and-grooved" to receive special clips for installation. The back of the perforated panel shall have sound absorbing non-woven acoustical fleece having NRC of 0.55. The panels shall be mounted on as per manufacturer/ installation instructions and approved by the Architect/ Engineer-in-Charge.

The panel shall be laid on suitable grid of same manufacturer with a load carrying capacity of minimum 15.5 Kgs/M. Main Runners with C3 coupling & Cross Tees to have Hardened XL2 clip. The T Sections have a Galvanizing of 90 grams per M² with pullout strength of 100kg. Suspension system for grid to be of same make.

Test Reports for Fire rating and NRC shall be provided by Vendor.

SUSPENSION SYSTEM accessories shall be of same manufacturer and consisting of M6 Anchor Fasteners with Vertical Hangers, A pre Straightened Hanger wire, along with Adjustable hook clips, galvanized spring steel. Accessories like Wooden Baton, Backing material, skirting, edge beading, and powder shall be used as required.

Contractor should be submitted the Manufacturer (Material & Installation) Specification, Shop Drawings & get approval from the Architect & Engineer In Charge before start any work on site. Laid sample shall be getting approved before execution of work.

Making cut outs/ openings for electrical fixtures, tube lights/ air-conditioners, grills, diffusers etc & providing additional sections for strengthening the openings/ cutouts, making grooves between wall & board or as per drawing /instruction of EIC.

2.1.4 GI Lay in Plain metal ceiling

GI Lay in Plain metal ceiling of Armstrong or equivalent consisting of 600x600mm Lay in tiles of pre coated galvanized steel in 0.5 mm thickness in Global white color tile to be laid on Armstrong grid systems with 15mm wide T - section flanges color white having rotary stitching on the Main Runner, 1200 mm & 600 mm Cross Tees.

The tiles would have Fire Performance of Class A2-s1.d0 as per EN13501 standard in module size of 600 X 600 mm suitable for Green Building application, with Recycled content of 25%.

The grid should be of same make with 15mm wide T - section flanges color white having rotary stitching on all T sections i.e. the Main Runner with C3 coupling, 1200 mm & 600 mm Cross Tees with Hardened XL2 Clip having a web height of 38 mm and a load carrying capacity of 14 Kgs/M. The T Sections have a Galvanizing of 90 grams per M2 with pull out strength of 100 Kgs.

The Tile & Grid system used together should carry a 10 year warrantee. Warranty Certificate and Test Reports for Fire rating shall be provided by Vendor.

SUSPENSION SYSTEM accessories shall be same make consisting of M6 Anchor Fasteners with Vertical Hangers, A pre Straightened Hanger wire, along with Adjustable hook clips, galvanized spring steel for 2.68 mm. The adjustable clip also consists of a 3.5 mm aquiline wire to be used with the main runner

Contractor should be submitted the Manufacturer (Material & Installation) Specification, Shop Drawings & get approval from the Architect & Engineer In Charge before start any work on site. Laid sample shall be getting approved before execution of work.

3.0 ELECTIRCAL WORKS

Standards and Specifications for the Design and Construction of Electrical works are given in this section;

3.1 BACKGROUND

The contractor shall comply with all the minimum requirements of the Design and Construction of Electrical works as per the Latest Standards, Statutory requirements , National Building codes and all other relevant regulations

3.2 CODES AND STANDARDS

The system, design, materials, equipment, installation, testing and commissioning shall, in addition to all other applicable codes and standards, comply with the latest requirements of the following standards, codes, principles and specifications issued by Indian standards or IEC codes :-

Table 4: Codes for Electrical Works

Codes	Description
IS 335	Insulating oil
IS 2026	Power transformers (part I - V)
IS 10028	Code of practice for selection, installation and maintenance of transformers
IS 2099	Bushing for alternating voltages above 1000 V
IS 4257	Porcelain bushings for transformers
IS 3639	Power transformer fittings and accessories
IS 2705	Current transformers
IS 8468	On load tap changer
IS 8478	Application guide for tap changers
IS 6600	Guide of loading of oil immersed transformer
IEC 2544	Creepage distance for insulators & bushing congenial
IEC 76	Power transformers
IEC 214	On load tap changers
IEC 616	Terminal and tapping markings for power transformers
IEC 551	Determination of transformer and reactor sound levels.
IEC 137	Bushings for alternative voltage above 1000V.
IEC 354	Loading guide for oil immersed transformer
IS: 3043	Code of practice for earthing.
IEEE: 32	Neutral Grounding Devices, standard requirements, Terminology & procedure.
IS 1271	Classification of Insulating Materials.
IS 2099	Bushing for alternating voltages above 1000 V
IS 2705	Current transformers
IS 3202	Code of practice for climate proofing
IS 3639	Power transformer fittings and accessories
IS 4257	Porcelain bushings for transformers
IS 11171	Dry type Transformer
IS 8478	Application guide for tap changers
IS10028	Code of practice for selection, installation and maintenance of Transformers
IS 1248 & 3107	Direct acting Electrical indicating instruments
IS 2099	Bushings for alternating voltages above 1000V
IS 2516	AC Circuit Breakers

Codes	Description
IS 2705	Current Transformers
IS 3156	Voltage Transformers.
IS 3427	Metal enclosed switchgear and control gear for voltages Above 1000V but not exceeding 11000 V
IS 6875	Control switches for voltages up to and Including 1000V AC and 1200 V DC
IEC 56	HV alternating current circuit breakers.
IEC 137	Bushings for alternating voltages above 1000V
IEC 298	AC metal enclosed switchgear and control gear for rated voltages above 1kV and up to and including 72.5 kV.
IS 2147	Degree of protection for enclosure
IS 3842	Specification for electrical relays for AC system
IS 2208	Specification for HRC cartridge fuse links up to 650 Volts.
IS 5082	Wrought Al. And aluminum alloys, bars, rods, tube and Sections for electrical purposes.
IEC 694	Common clauses for high voltage switchgear and control gear standards.
IS 1248 & 3107	Direct acting Electrical indicating instruments
IS 2959	AC contactors up to 1000V
IS 13947	AC Circuit Breakers
IS 2705	Current Transformers
IS 3156 & 4146	Potential Transformers.
IS 4047	Specification for air break switches and combination fuse switch units for voltage not exceeding 1000V.
IS 6875	Control switches for voltages upto and including 1000V AC and 1200V DC.
IS 1822	Motor duty Switches
IS 12021	Specification for control transformer.
IS 8623	Factory built assembly of switchgear & control gear for voltage not exceeding 1000V
IS 13947 (Part I)	Degree of protection for enclosure
IS 3842	Specification for electrical relays for AC system
IS 2208 & 9224	Specification for HRC fuses.
IS 5082	Wrought Al. and aluminium alloys, bars, rods, tube and sections for electrical purposes.
IS 4237	General requirement for switchgear & control gear for voltage not exceeding 1000V.
IS 3231	Electrical relays for power system protection

Codes	Description
IS 375	Marking and arrangement for switchgear bus bars, main connection and control aux. wiring.
IS 5578	Guide for marking of insulated conductors.
IS 3618	Pre-treatment of MS sheets for phosphatising.
IS: 4722	Specification for rotating machinery
BS: 649	Performance and testing of diesel engines for general purposes.
IS 4729	Measurement and evaluation of vibration of rotating electrical machines.
IS 1950 (1962)	Code of Practice for Sound insulation of Non Industrial Buildings.
IS 8084-1976	Interconnecting bus bars for AC voltages above 1kV
IS 8623 (part-2)	Factory built assemblies-particular requirements of bus bar trunking systems.
IEC 439 (part-2)	Particular requirements of bus bar trunking systems
IS 13925	Shunt capacitors for power system
IS 3231	Electrical relays for power system Protection
IS 2705	Current Transformers
IS 1248	Direct acting electrical indicating instruments
IS 2147	Degree of protection
IS 5578	Marking & arrangement of switchgear, bus bars, main connection and auxiliary wiring
IS: 1554 (PART-I)-	PVC insulated (heavy duty) electric cables working voltage up to and including 1100V
IS: 7098 (PART-II)	Cross-linked polyethylene insulated PVC sheathed cables for working voltages from 3.3 kV up to and including 33 kV
IS: 8130	Conductors for insulated electric cables and flexible cords.
IS: 5831	PVC insulation and sheath of electric cables.
IS:3975	Mild steel wires, strips and tapes for armoring of cables.
IS:2633	Methods of testing weight, thickness and uniformity Of coating on hot dipped galvanized articles.
IS: 209	Specification of zinc.
IS: 3961(PART-II)	Recommended current ratings for PVC insulated And PVC sheathed heavy duty cables.
IS: 10418	Wooden drums for electric cables.
IEC: 540 & 540A	Test methods for insulation and sheaths of electric cables and cords.

Codes	Description
IS: 10462 (PART I)	Fictitious calculation method for determination of dimensions of protective coverings of electrometric and thermoplastic insulated cables.
IS: 10810 (PART 58)	Oxygen Index test
IEC 146	Semiconductor Converters
IEC 1131-2	Programmable Controllers
IEC Publication 947, 1988	
IEC Publication 439, 1985	
IS 13947, 1993	Specifications of Low Voltage Switchgear & Control Gear
IS 8623, 1993	Specifications of Low Voltage Switchgear & Control Gear assemblies.
Indian Electricity Act, 1910	
Indian Electricity Rules, 1956	
National Electrical Code 1985	
EN50081-1	EMI Emissions standard
EN50082-1	EMI Immunity standard
Electrical safety	EC730-1 and CE directives effective from 1 January 1996.
IEC 146-4	Method of specifying the performance and test requirements
IEC 146-5	Switches for UPS
IEC 439	Low Voltage switch gear and control gear assemblies
IEC 801	Electromagnetic compatibility for industrial process Measurement
IEC 950	Safety of IT equipments including electrical business equipments
1000-2-2	Electromagnetic compatibility – Compatible levels for low frequency conducted disturbances and signaling in public low voltage power supply systems
1000-4	Electromagnetic compatibility – Testing & measurement techniques
IS 3043	Code of practice's for earthing in Electrical installation.
IEEE 1100	Recommended practice for powering and grounding of sensitive Electronic equipment.
IEC 62305- 2	– Risk Management
IEC 62305-3	Protection against Lightning.
IS/IEC 62305	Protection Against Lightning Part 2 Risk Management.
IS 2309	Code of Practice for the protection of Building
IEC 62561 -2 & 7	Earthing and Bonding

Codes	Description
IEC 62561 – 7	Earth Enhance Material
IEC 62561 – 2	

4.0 UPS

4.1 MECHANICAL DESIGN

The UPS shall be contained in two rugged steel cabinets one containing the power electronics and the other containing the batteries and single phase distribution outlets;

The UPS and battery cabinets shall be capable of conversion between Tower / Stack and Rack-Mount configurations;

The power electronics cabinet dimensions including terminations shall be

Rack configuration 263 x 432 x 773mm (10.35 x 17 x 30.43 in.) (Height x Width x Depth), requires 6U of rack space and the side rack mounting brackets shall increase the overall width to 482mm (19 in);

Tower configuration 432 x 263 x 773mm (17 x 10.35 x 30.43 in.) (Height x Width x Depth);

4.2 SYSTEM CHARACTERISTICS

System Capacity:

The system shall be rated for .8 Pf output:

- 6,000VA or 4,800W whichever limit is reached first (6kVA model).
- 10,000VA or 8,000W whichever limit is reached first (10kVA model).
- 15,000VA or 12,000W whichever limit is reached first (15kVA model).
- 20,000VA or 16,000W whichever limit is reached first (20kVA model).
- 30,000VA or 24,000W whichever limit is reached first (30kVA model).

Input:

AC input nominal voltage:

- 220/230/240VAC, single phase, 3 wire (L + N + G) Up to 7.5 KVA
- 380/400/415VAC, three phase, 5 wire (L1+L2+L3+N+G); for above 10 KVA

AC input voltage window:

- Full Load, 160 -275V (Line-Neutral) for single phase input or 277 -476V (Line-Line) for three phase input;
- Half Load, 100 -275V (Line-Neutral) for single phase input or 173 -476V (Line-Line) for three phase input;

Input frequency range: 40-70Hz;

Input Power Factor; > 0.98 at 100% load

Input Current Distortion: < 4% at 100% load, 230VAC (<7% for 3 phase output)

Crest factor: 3:1.

UPS Output:

AC Output Nominal Output: (Customer configurable)

220VAC, 230VAC or 240VAC, Single Phase three wire, 50/60Hz; up to 10 KVA

380VAC, 400VAC or 415VAC, Three phase five wire, 50/60Hz; above 10 KVA

AC output voltage distortion: Max. 2% @ 100% linear load; Max. 5% @ 100% non-linear Load;

AC output voltage regulation (Static): +/-1%;

Voltage Transient Response : +/- 8% maximum for 100% load step

Voltage Transient Recovery within < 10ms recovery time;

Output Voltage Harmonic Distortion:

<2% THD maximum for a 100% linear load

<5% THD maximum for a 100% non-linear load

Overload Rating:

Online: 105% - infinite; 125% - 1 minute; 150% - 30 seconds;

In bypass: Overload is limited by the external input circuit breaker feeding the UPS.

System AC-AC Efficiency:

> 91 % for 6, 10kva

> 94% for 15 and 20 kva

> 96 % for 30 kva

Output Power Factor Rating: 0.2 –1.0 lagging, nominal: 0.8 lagging.

Output frequency: 50/60 +/- 3Hz tracking or 50/60 +/- 0.1Hz tracking (user selectable);

Output connectors:

Single phase: Hardwire 3-wire (Phase + N + G),

Three phase: Hardwire 5-wire (3 Phase + N + G)

Output frequency Slew rate: 1.0Hz/Sec, 0.5Hz/Sec 0.25Hz/Sec

4.3 ENVIRONMENTAL

Storage Ambient Temperature:

- 15° to +45° C (+5° to +113° F) charge the UPS battery every 6 months.
- +30° to +70° C (+86° to +158° F) charge the UPS battery every 3 months.

Operating Ambient Temperature: 0°C to +40°C (+32°F to +104°F). (+25°C (+77°F) is ideal for most battery types).

Relative Humidity: 0 to 95% non-condensing

Storage altitude: 15,240m (50,000 feet) above sea level

Operating altitude: 3,000m (10,000 feet) above sea level. At an altitude of 3,000 m the UPS shall be capable of supporting a load of up to 90% of its nominal capacity.

Audible noise:

- a. <50dBA at <70 % load at 1m,
- b. <60dBA at >75 % load at 1m

4.4 INPUT PFC POWER STAGE

The input PFC power stage of the UPS shall constantly rectify the power imported from the mains input of the system, converting the input mains AC power to DC power for precise regulation of the DC bus voltage, battery charging, and output power stage (inverter) regulated output power.

Input Current Total Harmonic Distortion: The input current THD_1 shall be held to 6% or less at full system load, while providing conditioned power to the critical load bus, and charging the batteries under steady-state operating conditions. This shall be true while supporting loads of both a linear or non-linear type. This shall be accomplished with no additional filters, magnetic devices, or other components.

Input Current Limit:

The input converter shall control and limit the input current drawn from the utility supply

Overloads at low line input voltages shall draw power from the battery, (battery assist mode) in order to support the load and maintain the input current below the set current limit points.

Charging:

The battery charging shall maintain the DC bus float voltage of +/-219V, +/-1% at the nominal temperature of 20°C (68°F)

The battery charging circuit shall contain a temperature monitoring circuit, which will regulate the battery charging current to optimize battery life.

The battery charging circuit shall remain active when in automatic Bypass and in Normal Operation.

The battery charging system shall adjust the charging current by automatically sensing the number of battery modules and by monitoring the individual battery current. Maximum charger power shall be 3kW.

4.5 OUTPUT POWER STAGE (INVERTER)

The UPS output power stage (inverter) shall constantly recreate the UPS output voltage waveform by converting the DC bus voltage to AC voltage through a set of IGBT switches. In both online operation and battery operation, the output power stage (inverter) shall create an output voltage waveform independent of the mains input voltage waveform. Input voltage anomalies such as brown-outs, spikes, surges, sags, and outages shall not affect the amplitude or sinusoidal nature of the recreated output voltage sine wave of the output power stage (inverter).

Overload Capability: The output power stage (inverter) shall be capable of withstanding 150% overload for 30 seconds or 125% overload for 1 minute or 105% overload for an indefinite length of time. The system shall transfer to bypass if the overload persists and then return back on-line when the overload is removed.

Battery Protection: The UPS shall have monitoring and control circuits to limit the level of discharge on the battery system.

4.6 AUTOMATIC BYPASS

As part of the UPS, a system automatic bypass switch shall be provided. The system automatic bypass shall provide a transfer of the critical load from the Inverter output to the automatic bypass input source during times when the inverter cannot support the load. Such times may be due to prolonged or severe overloads, or UPS failure. The UPS shall constantly monitor the output current, as well as the bypass source voltage, and inhibit potentially unsuccessful transfers to automatic bypass from taking place.

The design of the automatic bypass switch power path shall consist of an electromechanical bypass contactor and series SCR's.

Automatic Transfers: An automatic transfer of load to bypass shall take place whenever the load on the critical bus exceeds the overload rating of the UPS. Automatic transfers of the critical load from bypass back to normal operation takes place when the overload condition is removed from the critical bus output of the system. Automatic transfers of load to bypass shall also take place if for any reason the UPS cannot support the critical bus.

Manual Transfers: Manually initiated transfers to and from bypass shall be initiated through the UPS interface display or via the serial communications port.

4.7 DISPLAY AND CONTROLS

Control Logic: The UPS shall be controlled by an embedded microcontroller which performs the following functions:

Monitoring quality of input, bypass and output voltages;

Monitoring vital parameters of the UPS;

Executing the state machine;

Intelligent battery management;

Remaining runtime calculation;

Self-diagnostics, self-test and proactive fault detection;

Communication to the host server via serial port;

Communication to the Network Interface Card or another SmartSlot accessory card if equipped.

Display Unit: A microprocessor controlled display unit shall be located at the front of the system. The display shall consist of an alphanumeric display with backlight, providing system status, LED alarm indicators and a keypad consisting of pushbutton switches for control and status reading selection.

Metered Data: The following metered data, shall be available on the alphanumeric display:

Year, Month, Day, Hour, Minute, Second of occurring events

Source and Bypass Input Voltages

Output AC voltage

Input, Bypass and Output AC currents

Input, Bypass and Output Frequency

Battery voltages and currents

Internal and battery pack temperature

Event log: The display unit shall allow the user to display a time and date stamped log of the 100 most recent status and alarm events.

Alarms: The display unit shall allow the user to display a log of all active alarms. The following minimum set of alarm conditions shall be available:

Input Frequency outside configured range

AC adequate for UPS but not for Bypass

Low/No AC input, startup on battery

Number of Batteries changed since last ON*

Number of Batteries increased*

Number of Batteries decreased*

Need Battery Replacement*

UPS Fault

On Battery

Shutdown or unable to transfer to battery due to overload

Load Shutdown from Bypass. Input Frequency Volts outside limits

Fault, Internal Temp exceeded system normal limits
System level fan failed

Runtime is below alarm threshold

Load is above alarm threshold

Load is no longer above alarm Threshold

Minimum Runtime restored

Bypass is not in range (either frequency or voltage)

UPS in Bypass due to Internal Fault

UPS in Bypass due to overload

Low Battery Shutdown

Low Battery Warning

Controls: The following controls or programming functions shall be accomplished by use of the display unit. Pushbutton switches shall facilitate these operations.

Silence audible Alarm

Display or set the date and time

Transfer critical load to and from bypass

Test battery condition on demand

Set intervals for automatic battery tests

Adjust set points for different alarms

Communication Interface Board: A communication interface shall provide the following communication ports which can be used simultaneously:

RS232 Serial Port #1

RJ-45 Interface port for PowerView Display

RJ-45 Ethernet connection, on installed Network Management Card

4.8 BATTERY

External SMF Battery

The UPS battery system shall comprise of user replaceable external batteries providing 192VDC nominal for the positive DC bus rail and 192VDC nominal for the negative DC bus rail.

The battery blocks shall be of the Valve Regulated Lead Acid (VRLA) type.

The UPS shall incorporate an Intelligent Battery Management system to continuously monitor the health of the battery system and notify the user if that system is weak or needs replacing.

General description for Batteries

Batteries shall be of the Sealed Lead-Acid type.

Two separate, isolated 192 V battery systems shall be provided. One cable shall be wired to each 192 V battery system. Two cable assemblies shall be included with the UPS, one for each 192 V battery system.

Each battery system shall have identical Amp-hrs capacity.

Ground wires shall be supplied for connection from the UPS to each battery enclosure grounding point.

Charging:

The intelligent battery management system shall contain a temperature monitoring circuit and compensation algorithm that regulates the battery charging current so as to optimize battery life. The UPS shall monitor the temperature of all proprietary battery packs and use the highest one as a reference to adjust the battery float voltage.

The battery charging circuit shall remain active when in bypass or on-line.

Charging system shall automatically adjust the maximum charger power, up to 3kW, based on the installed proprietary battery capacity and current through each battery string to avoid excessive charging that could result in bloated batteries. Each proprietary battery pack shall report its battery currents and temperature to UPS through CAN communication

4.9 ACCESSORIES

4.9.1 REMOVABLE INPUT/OUTPUT ELECTRICAL TERMINAL

The input and output terminal connections shall be designed to be removable trays for easy electrical connection and unit removal.

The removable input and output trays shall contain a means of configuring the system for 1 or 3 phase input and output as well as for single or dual feed input.

4.9.2 SOFTWARE AND CONNECTIVITY

Network Adaptor: Built in SmartSlot Network Management Card shall allow one or more network management systems (NMS) to monitor and manage the UPS in TCP/IP network environments.

Unattended Shutdown

The UPS, in conjunction with a network interface card, shall be capable of gracefully shutting down one or more operating systems when the UPS is operating in the battery mode. Network Shutdown software shall be available with the UPS.

The UPS shall also be capable of using an RS232 port to communicate with the host computer by means of serial communications so as to gracefully shut down one or more operating systems during an on battery situation.

4.9.3 REMOTE UPS MONITORING, CONFIGURATION AND CONTROL

The following three methods of remote UPS control, configuration and monitoring are available:

Web Monitoring: Remote monitoring shall be available via a web browser such as Internet Explorer.

RS232 Monitoring: Remote UPS monitoring shall be possible via either RS232 or contact closure signals from the UPS.

Simple Network Management Protocol (SNMP): Remote UPS Monitoring shall be possible through a standard MIB II compliant platform.

4.9.4 SOFTWARE COMPATIBILITY

The UPS manufacturer shall have available software to support graceful shutdown and remote monitoring for the systems detailed on the following web link:

EXECUTION START-UP

Start-up is requested, factory trained service personnel shall perform the following inspections, test procedures, and on-site training:

Visual Inspection:

Inspect equipment for signs of damage.

Verify installation per manufacturer's instructions.

Inspect cabinets for foreign objects.

Inspect battery chassis and modules.

Inspect power chassis

Mechanical Inspection

Check all UPS and internal power wiring connections.

Check all UPS and nuts, and/or spade lugs for tightness.

Electrical Inspection:

- Verify correct input and bypass voltage.
- Verify correct UPS control wiring and terminations.
- Verify voltage of all battery modules.
- Verify neutral and ground conductors are properly landed.
- Inspect external service bypass panel for proper terminations.

Site Testing:

- Ensure proper system start-up.
- Verify proper control functions.
- Verify proper bypass operation.
- Verify system set points.
- Verify proper inverter operation and regulation circuits.
- Simulate utility power failure.
- Verify proper charger operation.
- Document, sign, and date all test results.

On-Site Operational Training: During the factory assisted start-up, operational training for site personnel shall include key pad operation, LED indicators, start-up and shutdown procedures, maintenance bypass and AC disconnect operation, and alarm information.

4.9.5 MANUFACTURER FIELD SERVICE

Worldwide service: The UPS manufacturer shall have a worldwide service organization available, consisting of factory trained field service personnel to perform start-up, preventative maintenance, and service of the UPS system and power equipment. The service organization shall offer 24 hours a day, 7 days a week, 365 days a year service support.

Replacement parts: Parts shall be available through the worldwide service organization 24 hours a day, 7 days a week, 365 days a year. The worldwide service organization shall be capable of shipping parts within 4 working hours or on the next available flight, so that the parts may be shipped to the customer site within 24 hours.

4.9.6 TRAINING

UPS service training workshop: A UPS service training workshop shall be available from APC. The service training workshop shall include a combination of lecture and practical instruction with hands-on laboratory sessions. The service training workshop shall include instruction about safety procedures, UPS operational theory, sub-assembly identification

and operation, system controls and adjustment, preventative maintenance, and troubleshooting.

4.9.7 ISOLATION TRANSFORMER

This shall be provided with following.

1. Transformer capacity : Rating as per calculation in kVA
2. Transformer Ratio: 415V/415Volts.
3. Tappings: nil
4. Frequency : 50hz, +6% to -6%
5. Type of cooling : natural air cooling
6. Insulation class : class H
7. Vector group : dyn11
8. Core material : CRGO m6 grade
9. Conductor : electrolytic grade super enameled copper conductor
10. Impedance : <4%
11. Regulation : <4%
12. Insulation resistance : >1000m ω
13. Dielectric strength: 2.5kv/2min
14. Leakage current : <20micro amps
15. Coupling capacitance : <0.1pico farads
16. Common mode noise attenuation : 80db
17. Shielding : double shielding
18. Noise level : <70db
19. Ambient temperature : 0-45 $^{\circ}$ c
20. Temp. Rise : 115 $^{\circ}$ c over and above ambient
21. Degree of protection : ip-32
22. Wiring : with cable/bus bar
23. Fittings : lifting eye bolts and suitable un drilled gland
24. Plates will be provided
25. A static screen shall be installed between primary and secondary windings & shall be connected to an isolated terminal.
26. The mounting angles shall be isolated from the core of transformer.
27. Built in temp. sensor with indicator shall be provided on primary & secondary windigs.
28. Noise level shall be less than 40dB(A).
29. Suitable input and output terminals shall be provided on transformer.
30. Transformer shall be capable of 15% overload.

Insulation Monitoring Digital Ammeter

- i) Range - 0- 10 mA
- ii) Supply Voltage - 240V
- iii) Max Power Consumption - 2VA
- iv) Power ON & alarm LED.
- v) Alarm relay with one changeover contact.
- vi) Response value (settable) 0- 3 to 8 mA. Response delay 1 sec.
- vii) Digital Milli ammeter shall be highly sensitive core balance CT operated.

Core Balance CT

- i) This shall be highly sensitive core balance CT.
- ii) CT internal diameter shall not be more than 40mm.
- iii) Max leakage capacitance shall not exceed 2 mF.

5.0 LIGHTNING PROTECTION:

This part of IEC 62305 provides the requirements for protection of a structure against physical damage by means of a lightning protection system (LPS), and for protection against injury to living beings due to touch and step voltages in the vicinity of an LPS.

Lightning is one of the most devastating natural phenomena. There are many discharges during lightning storms and some of them can even reach hundreds of kilo amperes. The electrical discharges are a great hazard to people, animals, buildings and electronic equipment's. Until now, there is no device that can prevent lightning formation or lightning strikes. However, it is possible to create a path (divert) for the lightning discharge to the ground which will minimise the damage to the environment through a well-designed Lightning Protection System (LPS). The purpose of a lightning protection system is to protect buildings from direct lightning strikes and possible fire or from the consequences of lightning currents (non-igniting flash). If national regulations such as building regulations, special regulations or special directives require lightning protection measures, they must be implemented. If these regulations do not specify a class of LPS, a lightning protection system which meets the requirements of class of LPS III according to IEC 62305-3 (EN 62305-3) is recommended as a minimum. In principle, a risk analysis, which is described in the IEC 62305-2 (EN 62305-2) standard (see chapter 3.2.1), should be performed for an overall assessment.

5.1 An external LPS is intended to:

- a) intercept a lightning flash to the structure (with an air-termination system);
- b) conduct the lightning current safely towards earth (using a down-conductor system);
- c) disperse the lightning current into the earth (using an earth-termination system).

An internal LPS prevents dangerous sparking within the structure using either equipotential bonding or a separation distance (and hence electrical insulation) between the external LPS components and other electrically conducting elements internal to the structure.

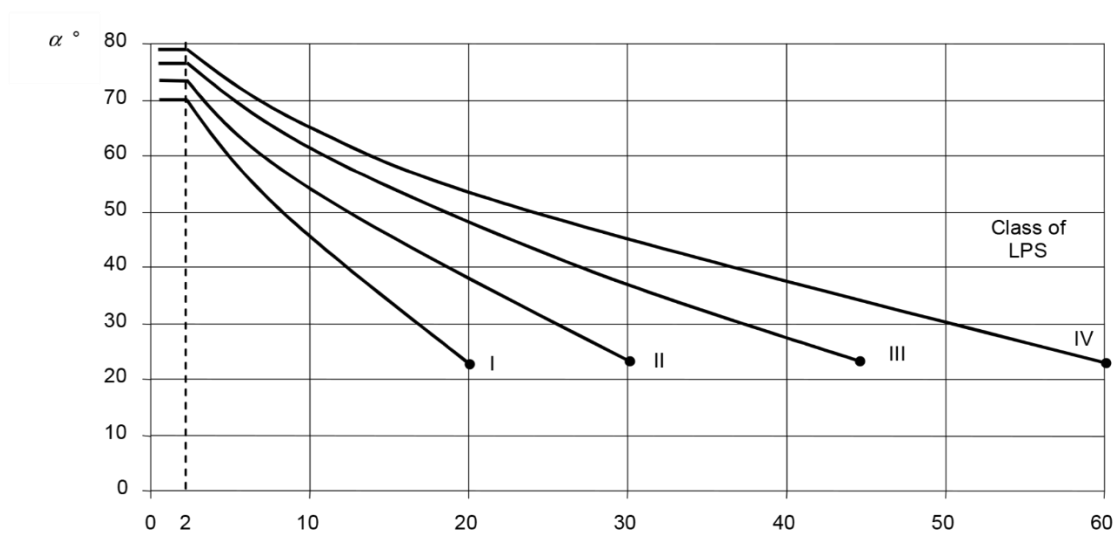
5.2 Lightning Current & Protection levels

In order to define lightning as a source of interference, lightning protection levels I to IV are laid down. Each lightning protection level requires a set of

- maximum values (dimensioning criteria used to design lightning protection components to meet the demands expected to be made of them).
- minimum values (interception criteria necessary to be able to determine the areas with sufficient protection against direct lightning strikes (radius of rolling sphere)).

Maximum value of rolling sphere radius, mesh size and protection angle corresponding to the class of LPS

Protection Method			
Class of LPS	Rolling Sphere Radius r m	Mesh size W m	Protection angle α
I	20	5 x 5	As per figure below
II	30	10 x 10	
III	45	15 x 15	
IV	60	20 x 20	



LPL levels basic design consideration:

Class of LPS	Lightning current		Interception probability	Rolling sphere radius (m)	Mesh size (m)	Down Conductor Spacing
	MINIMUM	MAXIMUM				
1	3 kA	200 kA	98%	20	5 x 5	10
2	5 kA	150 kA	95%	30	10 x 10	10
3	10 kA	100 kA	88%	45	15 x 15	15
4	16 kA	100 kA	81%	60	20 x 20	20

5.3 Protection Class for the structure as per LPL (Lightning Protection Level)

Application	LPL*
Computer Data Centres, Military Applications, Nuclear Power Stations, High raise Hotels/Hospitals, airports, essential services such as telecom towers	I
EX-Zones in the industry and chemical sector, Low raise Hospitals & Hotels, fuel retail outlets, gas station, compressor station etc.	II
Schools, Banks, Residential Buildings, Temple, Churches, Mosques	III or IV

5.4 Air Terminal System:

An air-termination system shall be installed to protect the upper part of tall structures from direct lightning strike (i.e. typically the topmost 20 % of the height of the structure) and the equipment installed on it.

for positioning air-termination systems on roofs shall also apply to those upper parts of structures. In addition, for structures taller than 120 m, all parts which may be endangered above 120 m should be protected.

Materiel Description: For Mesh (Horizontal) arrangement 8 mm dia Aluminium round conductor. For Vertical Air terminal: 16 mm dia, 10 mm dia APS make solid aluminium rod.

5.5 Connectors & Joints:

Materiel details	Connector Type
Aluminium to Aluminium	Aluminium, Gun Metal
Aluminium to Steel	Gun Metal

5.6 Air Terminal Holder:

For Concrete / RCC Roof: The fixing of roof conductor holder 8 mm round at every 1 meter and shall made of DMC (Draught mould compound) with min height of 50 mm. The Holder can be fixed with glue and screw.

For Metal shed: The fixing of roof conductor holder 8 mm round at every 1 meter and shall made of DMC (Draught mould compound) with min height of 50 mm. The Holder can be fixed with heavy duty glue.

If any structure like AC panel, Vent, ducts etc need to protect from Vertical Air Terminal after calculation of separation distance.

5.7 Down Conductor:

In order to reduce the probability of damage due to lightning current flowing in the LPS, the down-conductors shall be arranged in such a way that from the point of strike to earth:

- a) several parallel current paths exist;
- b) the length of the current paths is kept to a minimum;

c) equipotential bonding to conducting parts of the structure is performed according to the requirements.

Typical value of the distance between down- conductor and between ring conductors according to the class of LPS

Class of LPS	Typical distance m
I	10
II	10
III	15
IV	20

5.8 Down Conductor Holder:

For Concrete wall: The fixing of down conductor holder 8 mm round at every 1 meter and shall made of DMC (Draught mould compound) with min height of 50 mm. The Holder can be fixed with screw and fastener.

5.9 Test Joint:

At the connection of the earth termination, a test joint should be fitted on each downconductor, except in the case of natural down-conductors combined with foundation earthelectrodes. For measuring purposes, the joint shall be capable of being opened with the aid of a tool. In normal use it shall remain closed. The test joint shall be in IP 65 rated box and copper bus bar of 25 x 6 x 150 mm.

5.10 Earthing arrangement:

An earthing system or grounding system connects specific parts of that installation with the Earth's conductive surface for safety and functional purposes.

For earth-termination systems, two basic types of earth electrode arrangements apply.

5.11 Type A arrangement:

This type of arrangement comprises horizontal or vertical earth electrodes installed outside the structure to be protected connected to each down-conductor. In type A arrangements, the total number of earth electrodes shall be not less than two.

5.12 Type B arrangement

This type of arrangement comprises either a ring conductor external to the structure to be protected, in contact with the soil for at least 80 % of its total length, or a foundation earth electrode. Such earth

electrodes may also be meshed.

5.13 Materiel used for Type A and B:

Earthing Rod: JK Low carbon high tensile copper bonded ground rod ul listed & CPRI Tested of dia 25.4 mm, length 3000 mm with pure copper 99.9 % coating of 250 micron as per IEC 62561 – 2. JK Reslow Earth Enhance Material as per IEC 62561 – 7 is used along with the ground rod to reduce earth resistance value.

Lightning Counter: At least two lightning strike counters need to installed in two down conductors as per IEC 62561. The Counter shall have facility to record 7 digits lsr1.

6.0 MAINTENANCE FREE EARTHING SYSTEM

6.1 Earth termination clamp

- a) Earth Termination Clamps or Copper Bus Bars of below mentioned specifications should be used wherever necessary as per requirement suitable for 25x6mm GI Flat Strip or 16/35 sq.mm unarmored Al Cable conductors or tapes.
- b) Earth Termination clamps should be of Gunmetal material.
- c) Copper bus bar of size 250mm x 50mm x 6mm having electrical conductivity of 101% IACS, minimum 99.9% copper content shall preferably be exothermically welded to earth electrode or connected with the help of two number stainless steel nut bolts of appropriate size. This Bus Bar shall have 4 holes of 12 mm dia. (2 on each side) for connecting earthing conductor.
- d) Bi-metallic Connectors & Bi-metallic Lugs should be used for termination of 25x6mm GI Flat Strip or 16/35 sq.mm unarmoured Al cable conductors respectively.
- e) Three stainless steel washers & one spring washer shall be supplied along with each M12x50mm Long stainless steel nut & bolt for any necessary connection and termination.

6.2 Installation of Earth system

- a) The earth electrode shall be installed in a bore of min 300mm made by auguring the required depth of min 10ft to meet out the earth resistance value of lesser then one ohm.
- b) Wherever auguring is not feasible, pit shall be made and suitable size of PVC pipe shall be used to fix the electrode.
- c) At the center of the hole the electrode shall be driven and around the electrode the highly conductive and ecofriendly backfill material shall be filled. Highly conductive and eco-friendly backfill material can be poured in either dry or slurry form.
- d) Earth enhancement material (minimum around 15 kg, to be increased as per resistance encountered) shall be filled into augured hole in slurry form and allowed to set. After the material gets set, the diameter of entire composite structure shall be minimum of 300 mm or as per applicable standards covering entire length of cylindrical hole.
- e) The PVC pipe shall be removed simultaneously as the backfill compound is poured.
- f) If watering of Earth pit is required for curing, the same has to be done by contractor.
- g) The pit should be very compactly rammed with watering for 2-3 days and extra soil should be added if required.

- h) Trench of 600 mm (depth) x 300 mm (wide) from the earth pit to the nearest point of connection should be made.

6.3 Inspection chamber

- a) A 400X400X400 mm (inside dimension) concrete box (wall thickness min. 50 mm) with smooth cement plaster finish shall be provided on the top of the pit. A concrete lid 25 to 50 mm. thick (or advised by Employer's Engineer), with pulling hooks, painted black shall be provided to cover the earth pit. PVC sleeve of appropriate size shall be provided in concrete wall to take out earthing.
- b) Connections.
- c) On the total height of the concrete inspection chamber, at least 250mm shall be provided below ground level. Necessary sand cushioning shall be done.
- d) The masonry work shall be white washed inside and outside.
- e) Care shall be taken regarding level of the floor surrounding the earth so that the connector is not too deep in the masonry or projecting out of it.
- f) On backside of the cover, date of the testing and average resistance value shall be written with yellow paint on black background.
Important – All the masonry works must have pre- approval from Employer's Engineer and must match with road works planned.

6.4 Measurement of earth electrode resistance

- a) The earth resistance shall be measured using fall of potential method as per para 37 of IS: 3043.
- b) The successful working of the earthing pits implies that the Voltage between Neutral & Earth will never be more than 2 Volts.
- c) The effective earth resistance of each installation shall be less than 1 ohm in dry condition for all installations and less than 0.5 ohms for ATMs, Data Processing Centers etc.

7.0 ELV Works

7.1 ICT Infrastructure – Data & Telecom Infrastructure

- Complete installation shall be done in accordance with installation practices for a well structured cabling system, using components from a single vendor to ensure consistent and assured performance. The structured cabling distribution network shall serve as a vehicle for transport of data, video and voice telephony signals over a common network throughout the network.
- Devices and services that shall run on the passive network shall include, but not limited to, the following:
 - a.) Wired LAN access
 - b.) Wireless LAN access
 - c.) Voice communications servers and IP/SIP end-points
 - d.) IP-based CCTV/Surveillance Cameras
 - e.) Access Door Controllers
 - f.) DDC controllers for IBMS

- g.) Various devices and controllers for AV system
- h.) Video-conferencing equipment
- Cabling installation for data and voice communications shall originate at networking racks and terminate at IOs terminated at wall.
- Installation, termination and identification of wiring between station outlets and networking distribution rack(s) and networking distribution rack(s) and main rack(s), shall be considered part of the system integrator's work.
- All cables and terminations shall be tested @500 MHz identified, labelled and documented at all locations.
- The system integrator carrying out the SITC shall make the system entirely operational for its intended use, by addition of components specific to its make/model even if not specifically mentioned in the BoQ.

Supported applications, but not limited to:

- Ethernet Applications – wired Ethernet and wireless as per IEEE 802.11a/b/g/n/ac
- IEEE 802.3af Data Terminal Equipment (DTE) Power via Media Dependent Interface (MDI)
- Telecom – BRI, PRI and Digital Subscriber Loop (DSL) Applications
- Voice, Video and ISDN Applications

References & Standards, but not limited to:

- TIA / EIA
- International Electro technical Commission (IEC)
- European Committee for Electro technical Standardization (CENELEC)
- American National Standards Institute (ANSI)
- Institution of Electrical and Electronics Engineers (IEEE)
- Wherever there is reference to multiple standards and/codes, the ones most recent and most stringent shall apply.

It shall be the responsibility of the system integrator and OEM manufacturer to ensure that:

- The Passive Components of structured cabling distribution network will be free from manufacturing defects in material and workmanship under normal and proper use.
- All Passive Components in the structured cabling distribution network shall meet or exceed the relevant component specification of the EIA/TIA 568-B, ANSI/EIA/TIA 568-C.2, TIA/EIA 568-C.3 and ISO/IEC 11801: 2002 standards; or later version as applicable at the time of installation.
- The structured cabling distribution network compliant channels will meet or exceed the Guaranteed Channel Performance as per relevant standards in the structured cabling distribution network Performance Specifications in effect at the time of installation.

- The specifications for items in this section, applies to the following:
 - a.) CAT6/CAT6A cable and associated components such as Patch Panels, IOs/RJ45 Jacks, Patch Cords
 - b.) Single-Mode fiber optic cable and associated components such as distribution shelves, LIUs, pigtails and patch cords
 - c.) Networking Racks – for termination of networking cables

7.2 Cat6/cat6a & fiber optic cabling system

Following common specifications shall apply to all CAT6/CAT6A standards based structured cabling components, i.e., Cable, Patch Panel, IOs and Patch Cords.

- All components of the structured cabling system shall be from the same OEM manufacturer.
- As per structure cabling, LV integrator should have to consider maximum 90 meter CAT6A cable length from rack side patch panel to LAN I/O.
- Cabling system, conforming to ANSI/TIA/EIA 568-C.2 CAT6A Cabling system, ISO/IEC 11801 2nd edition, EN-50173-1.
- The cabling system components must be UL listed or equivalent.
- Cable conductor shall be 23 AWG solid bare copper.
- Operating Temperature shall be -20 Deg. C to +60 Deg. C.
- Delay skew shall not exceed 45 ns/100 m.
- 24 port loaded CAT6/CAT6A patch panel termination patten shall be TIA/EIA 568 A and B and shall be fully powder coated.
- CAT6/CAT6A patch cord shall be 24-26 AWG, multi stranded copper and shall be available in different length and color.
- Fiber optic cabling system shall meet or exceed relevant component specification of ITU-T G.652A, B, C & D, IEC - 60793-2-50, TIA/EIA 568-C.3.
- Fiber optic core shall be As per Telecordia GR20, ITU-T G652D, IEC-60793-2-50, TIA/EIA 492-CAAB.

7.3 Electronic Security – IP based Video Surveillance System / CCTV System

General

- The Surveillance System components must be TCP/IP based components working on the same backbone network as the Data Network (LAN).
- The 3rd party VMS system which is part of the tender should be capable of integrating in future with Video Analytics (VA) Systems from reputed and leading 3rd party VA system providers.

- Surveillance system shall network based storage for the specified time and quality as specified.
- Surveillance system must be scalable in terms of equipment (no. of cameras), storage capacity and licenses.
- True open platform functionality is an essential aspect of this specification; cameras from different OEMs must be able to integrate seamlessly with the specified 3rd party VMS platforms without any loss of features and functionality. Similarly, specified VMS platforms must also be able to integrate with a variety of cameras from different manufacturers.
- OEMs for cameras shall have to be different from the OEMs of VMS system so as to ensure openness of solution and to avoid dependency on any single brand.
- For better saving on storage and bandwidth the compression used shall be H.264 high profile for all types of cameras and devices. H.264 high profile shall be a common requirement for all cameras and devices irrespective of whether mentioned in individual sub-sections or not or if mentioned otherwise.
- All cameras shall be vandal resistant as per IK10 rating.
- All cameras shall be ONVIF Profile S compliant.
- Cameras shall have a wide dynamic range of between 85 to 95dB (for Fixed Box/CS-Mount and Indoor Dome/Mini-dome models and between 120 to 130dB (for indoor/outdoor PTZ models) for ensuring good image performance in varying light conditions.

References & Standards, but not limited to:

- ONVIF compliant and supporting H.264 High profile.
- Complete range of IEEE and ISO/OSI model standards and Ethernet protocols.
- UL listed, certified & approved components.
- Ruggedized, IP66 rated enclosures.
- IK10 or IEC 62262 compliant vandal-resistant enclosures.
- Full set of IEEE802.x, ANSI/EIA/TIA-568-C.2 standards, ISO/CENELEC specifications.
- G.711 (64kbps) and G.726 (32kbps) supported codecs for bi-directional audio.

7.4 Camera Specification:

- The camera shall have the capability to stream JPEG and H.264 high profile video in TCP protocol H.264 in UDP (unicast/multicast) protocol.
- The camera shall support JPEG and H.264 high profile compression. The camera shall be able to select the high quality mode in JPEG 1920 x 1080at minimum 25fps. The camera shall also be able to support full HD mode of 1920X1080 in H.264 compression mode with 30fps.
- The network interface shall be an 8-pin RJ-45 connector, 10Base-T/100Base-TX Ethernet. Both IPv6 and IPv4 shall be supported.

- The camera shall support the following Network protocols: TCP/IP, UDP/IP, HTTP, HTTPS, RTSP, RTP, RTP/RTCP, FTP, SMTP, DHCP, DNS, DDNS, NTP, SNMP, UPnP, IGMP, ICMP, ARP.
- The camera shall have both FTP client and server capabilities.
- The PTZ camera shall be capable of 360 degree pan rotation and a minimum tilt range of -14° to 180°.
- The camera shall support multi-casting and uni-casting.
- The camera shall have a 2D and 3D noise reduction capability for reducing AGC noise to provide clear images without motion blur.
- The camera shall incorporate a built-in optical, auto-focus zoom lens, and shall have digital zoom capability.
- The camera shall offer IR cut filter that switches on/off to enhance low-light sensitivity during B/W mode.
- The camera shall have auto-iris type vari-focal lens as a standard accessory.

Video Management Software (VMS) Specification:

- The application must be able to support multiple brands of surveillance cameras at the same time.
- The VMS shall support ONVIF or PSI alliance – industry standards for the interface of IP-based physical security products.
- The VMS shall be based on a true open architecture that shall allow for use of non-proprietary workstation and server hardware, non-proprietary network infrastructure and non-proprietary storage.
- All video streams supplied from analog cameras or IP cameras shall be digitally encoded in H.264 or better compression formats and recorded simultaneously in real time.
- The VMS shall be able to retrieve and set the current position of PTZ cameras with presets.
- The VMS shall be able to use multiple CCTV keyboards to operate the entire set of cameras throughout the system, including cameras of various manufacturers' brands, including their PTZ functionalities.
- The VMS shall support mobile apps for various popular smart phones and tablets, including e.g., Apple iPod Touch, iPhone, and iPad., RIM BlackBerry smart-phones, Android-compatible smart-phones and tablets.
- It shall support monitoring of live camera, receive alarm push notifications, save snapshots locally on device or control PTZ.
- The VMS shall support Archiving, Failover and standby functionality, Unified web client and smart phone applications etc.

Video Surveillance Storage:

- The Video surveillance storage system shall be provided for 24 Hrs x 30 Days basis at 30fps.
- The Storage system shall be in High Availability (HA) mode.
- The storage system shall be RAID supported.
- The proposed solution shall support and be configured for FC & iSCSI protocols.
- The device should have the following certifications - FCC Class A or CE Mark for immunity against electromagnetic emissions.
- The device should have the following quality and safety standard certifications - CAN/CSAC22.2-60950/UL60950.

7.5 Fire Detection & Alarm System (FAS)

- The fire alarm system shall comply with requirements of NFPA Standard 72 (2013), IS 2189 (2008) and NBC (2016) for Protected Premises Signalling Systems. The system shall be electrically supervised and monitor the integrity of all conductors.
- The fire alarm system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994
- The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard for fire alarm applications. It should be FM (Factory Manual) approved and the installation shall be in compliance with the UL listing.

Manual Call Point:

The manual call point should be activated by manual push. The MCP shall instantaneously give a fire signal in the panel.

Random Sample Testing:

About 5% of all fire alarm components shall be subjected to random testing by connecting to the panels.

All smoke detectors shall be tested as given above and later cleaned with a vacuum cleaner.

Testing of Earthing system:

The earth continuity conductor including metallic parts of the equipment's shall be tested for earth to electrical continuity. All tests shall be carried out as per IS 3043 and resistance of complete installation shall not be more than one ohm.

COMMISSIONING AND ACCEPTANCE TESTS

The commissioning and acceptance tests shall be apart from the standard or routine tests prescribed and normally conducted by the manufacturer /Design-Build Contractor and will be irrespective of the fact whether the same are covered by such tests or not.

- a. Each sounder circuit shall be energized separately, and the sound level reading taken to check for conformity with the minimum standards.
- b. Mains failure performance.
- c. Battery disconnection test.
- d. Open circuit of each sounder circuit to be tested.
- e. Short circuit of each sounder circuit to be tested.
- f. The results of the above tests either by fault warning or fire alarm shall be recorded in the log books which will be signed both by the Design-Build Contractor and the employer's Representative.

6. TESTS AT SITE

- i) All commissioning tests at site will be in line with BS5839 / NFPA-71 and 72.
 - a. Loop Checking.
 - b. Double address.
 - c. Short circuit
 - b. Checking of smoke detectors, Heat detectors etc. by simulation.
 - c. Functional tests for fire alarm panel.
 - d. The Mock trial of the complete Fire Detection and Alarm system.
 - e. Cause and effect matrix.

References & Standards:

- NFPA standard 72, 2013 edition.
- National Building Code (NBC) 2016
- Indian Standard – IS 15908, Selection, Installation and Maintenance of Control and Indicating Equipments for Fire Detection and Alarm System-Code of Practice – 2011
- Indian Standard – IS 2189:1988, Code of practice for selection, installation and maintenance of Automatic Fire Detection and alarm system (second revision).
- IS: 2175 : Heat Sensitive Detectors.
- IS: 11360 : Smoke Detectors.
- BS: 5445, UL/FM/ NFPA/ : Fire Detection and Alarm System.

- VDS/EN54/LPCB

BS 5839	Code of practice for installation of fire alarm system
IS 2189	Code of practice for installation of automatic fire alarm system

Codes	Description
BIS 15908 -	Selection, Installation and Maintenance of Control and Indicating Equipments for Fire Detection and Alarm System--Code of Practice (2011)
IS:2189:1988	- Code of practice for selection, installation and maintenance of Automatic Fire Detection and alarm system (second revision)

Gas based Suppression System (GSS)

General

- The fire suppression system shall include and not be limited to gas release control panel, CCOE approved seamless cylinders, discharge valve (with solenoid or pneumatic actuator), discharge pipe, non-return valve and all other accessories required to provide a complete operation system meeting applicable requirements of NFPA 2001 standards and installed in compliance with all applicable requirements of the local codes and standards.
- The system shall be properly filled and supplied by an authorized OEM (Original Equipment Manufacturer).
- Key Component of the system along with calculation software of the system shall be approved by UL/FM.
- Generally the key components of the (NOVEC) 1230 system shall comply with NFPA 2001 standards and have the approval from US EPA (Environmental Protection Agency) for use as a total flooding fire extinguishant for the protection of occupied space:
 - Must have zero ozone depletion potential (ODP).
 - Be efficient, effective and does not require excessive space and high pressure for storage.
 - Be commercially available.
 - Contain the required key components such as valves and its accessories, actuators, flexible discharge and connection hoses, check valve.
- The system shall be designed with the minimum design concentration as per NFPA 2001 (Latest Edition) guidelines & as applicable to class 'A' & 'C' risks. The NOVEC 1230 agent shall be stored in seamless steel cylinders and dry nitrogen shall be added to provide additional energy to give the required rapid discharge. At the normal operating pressure of 42 bar /25 bar at 21Deg C, the agent is a liquid in the container.

Aspiration Smoke Detection System (ASD)

Following codes & standards to be followed for Aspirating Smoke Detection:

References & Standards:

- The entire installation shall be installed to comply one or more of the following codes and standards:
 - AS 1670.1-2004, AS1603.8 – 1996, , ASNZS 3000
 - Fire Industry Association (FIA), Code of Practice for Design, Installation, Commissioning & Maintenance of Aspirating Smoke Detector (ASD) Systems
 - NFPA Standards, US
 - NEC Standards, US
 - NZS 4512 : 2003

Approvals

- All the equipment shall be designed, tested, approved, and listed by:
 - LPCB (Loss Prevention Certification Board), UK
 - FM (Factory Mutual), US
 - UL (Underwriters Laboratories Inc.), US
 - ULC (Underwriters Laboratories Canada), Canada

7.6 Public Address System & Emergency Communication System (PA)

- The Public Address system shall comply IEC 60849

References, Standards and Certifications for PA system shall be:

- IS 1881 code of practice for indoor installation of Public Address System
- IS 1882 code of practice for outdoor installation of Public Address System
- EN-60849
- ISO
- BS 5839
- EVAC specification

7.7 Access Control System (ACS) & Entrance Control System (ECS)

General

- The ACS & ECS System components must be TCP/IP based components working on the same backbone network as the Data Network (LAN).
- Access Control System must be a fully modular, scalable system that can be adapted for use with all configurations, from the most basic to the most advanced, and with all kinds of architecture, from the simplest to the most complex.

- Access Control System should be an upgradeable system consisting of several modules for managing all electronic security functions and having integration capabilities:
 - Access control.
 - Video surveillance.
 - Supervision.
- In essence the Access Control System shall provide the following:
 - Multi-site management
 - Web interfacing,
 - Openness to other systems,
 - Guard tour management,
 - Logic controllers.
- ACS system shall have multi server architecture.

Access Control Controller Specification:

- The ACS controller shall be TCP/IP based.
- The Controller shall have RS-485

Access Control Reader Specification:

- The ACS reader shall support multi factor authentication like bio-metric (PIN and/or IRIS), PIN and RFID.
- The reader shall be POE supported, Ethernet based.
- The reader shall have optical biometric sensor.
- The reader shall be IP65 rated weather proof.

Access Control Software Specification:

- The application software program shall be a true 32-bit (should also be compatible with 64-bit OS & hardware), ODBC compliant application.
- The application software shall be a modular and scalable, networked access control system having centralized architecture, capable of handling large corporations with multiple remote sites. The system shall allow for easy expansion or modification.
- The application software shall support time attendance, access control and visitor management facilities from anywhere.
- The application software shall support seamless integration with 3rd party application.

References & Standards:

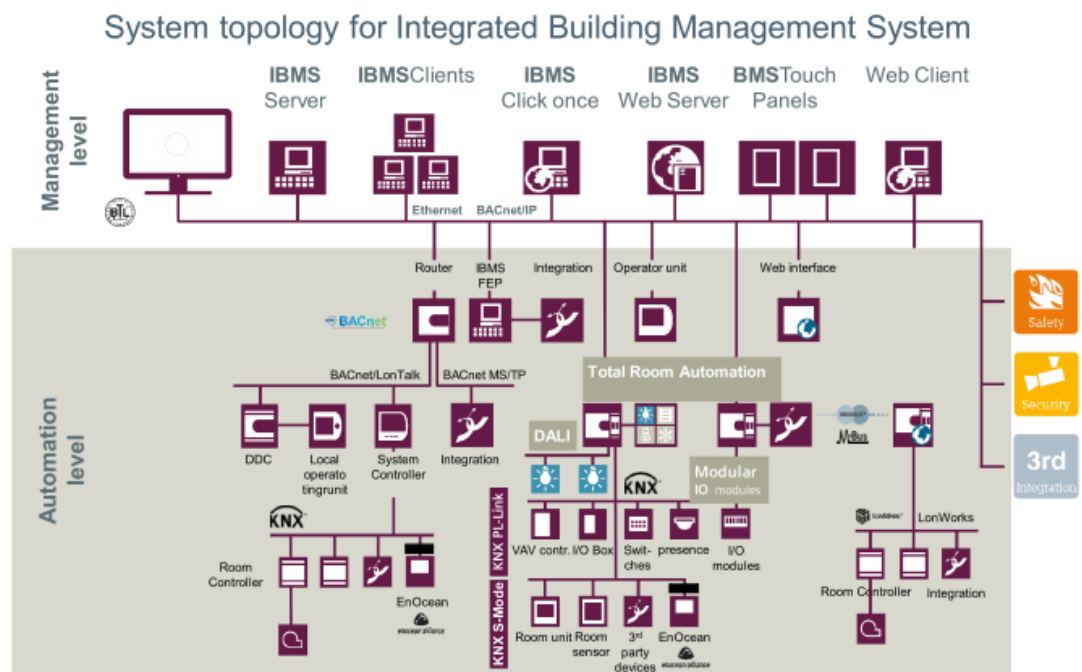
- BS EN 50133-1 Alarm systems – access control systems for use in security applications
- BS EN50133-7 Application guidelines for access control systems
- EN 12209-1 Electro-mechanical locking devices

- BS 7807- Code of practice for Integrated Systems

7.8 Integrated Building Management System (IBMS)

- IBMS shall be based on open, interoperable and integrated architecture.
- The shall be a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate various technologies and communication protocols such as BACnet/IP, RS485, OPC Client-Server, HTTP, ODBC, Active X as per well accepted international standards such as the ANSI/ASHRAE Standards in one open, interoperable system for automation of diverse utilities and services such as HVAC, Fire Fighting, CCTV, Plumbing and electrical systems& ELV system etc.
- The integrated BMS platform shall employ state of the art design with facilities such as - navigation window, primary pane, secondary pane and operation area, drag and drop features, copy and paste, search and replace, unified workflow for all disciplines, multi-language support, intuitive operation, secure, fast and efficient operation and a seamless integration of 3rd party systems.
- The PC software shall feature a graphical user interface (GUI) for simplicity and ease of use. The software features shall include alarm presentation, report generation, trending of parameters, historical storage, maintenance schedule generation based on equipment run hours, programming of sequence schedules, implementation of duty cycling, etc.
- System requirements
- General requirement
- Include a digital (DDC) building technology control system to operate technical equipment in buildings. The system must be able to carry out comprehensive measuring, control, optimization, and monitoring functions. All applications deployed are tested, documented, and used multiple times. The possibility for free programming of individual system components should be available to individually modify customer-specific requests.
- Online Engineering
- Zero Downtime for Software modification
- Does not need an engineering dongle for minor graphic page modifications
- System up-to-datedness
- Product lifecycle
- The system provider must offer a transparent product lifecycle to ensure the required consistency. All equipment offered for this project must be contained in the current product portfolio. The existing system environment must allow for easy and smooth integration of devices and extensions.
- System continuity
- Products employed must be labeled with a brand for a global standard that secures the interaction of products from various manufacturers. Products bearing these brands can also be employed together when manufactured at a interval of more than 10 years.

- Architecture
- Three system levels
- A building automation and control system featuring system architecture as per ISO EN 16484-3 is required. The three system levels must be interconnected via communications.
- Management level
- Automation level (automation stations/individual room control)
- Field level (field devices)



- Automation stations
- The system offered must provide largely decentralized intelligence to achieve high operational and plant availability. The devices are autonomous components that can independently execute assigned automation and control.
- Implement third-party systems
- Third-party systems must be able to be integrated on both management and automation levels to ensure full system consistency. Default interfaces must be provided. Third-party protocol implementation must be possible and require little effort. To do this, all hardware and software required for integration, all required services, clarifications with other technical and mechanical building installations, interface testing, data transmission testing, data point generation/integration as well as plant picture creation, backup, test protocol generation and specific documentation must be included in total costs.
- Location-independent operation
- The building automation and control system technology must allow for location-independent operation and management of all messages and trends on all available types and views for the entire building automation and control system.

- Consistency
- Uniform system
- The supplier must prove that the required functions originate from a single manufacturer and using one automation and control system, where the hardware and software are developed in a manner that allow for simply modification while operational for subsequent function extensions or changes.
- Implement new data points
- Building automation and control must be coherent to ensure possibility of future extensions and changes. This means that data points must be acquired once only, and then be provided automatically as needed to operator units and management level.
- Integration of open standards
- General Interfaces
- The building automation and control system must be extendible to ensure long-term operation and provide all standard interfaces commonly available on today's market.
- Implement via BACnet
- Default protocols and suitable physical communications media must guarantee interoperability (ISO standard). Use only listed protocols and communications media. Third-party systems are integrated via BACnet. Provide only data required to efficiently and economically operate building services plants.
- Integrate fire detection systems
- Fire detection system BACnet-based
- BACnet-based fire detection systems supporting BACnet BIBB AE-LS-B as well as objects LifeSafetyPoint and LifeSafetyZone as per the PICS (Protocol Implementation Conformance Statement) document must be able to be integrated for best deployment of a building automation and control system. The following functions must be supported:
 - Alarms and events from the fire detection system must be identified clearly and unambiguously.
 - Signaling device states must be displayed as per the BACnet standard.
 - Instruction texts must be able to be added to detectors and zones.
 - Situational and floor plans as well as dynamic symbols must be able to be used for visualization.
 - A technical hierarchy, e.g. building, building part, zone, detector, must be provided to the operator for ease of operation.
- UL Certified Fire System Management Software & EN Certified Fire System Management Software
- The BMS Monitors and controls up to 63 XLS / MXL nodes, 16 Desigo Fire Safety FACPs, 64 IP cameras*, Apogee Building Automation panels and up to 20,000 addressable detection devices
- Supports CO detection with ASAtechnologyTM
- Seamless Integrated environment for advanced fire system management - EN Standards
- Seamless Integrated environment for advanced fire system management - UL Standards

- UL Listed and ULC-S527 Standard for Control Units and Fire Alarm systems (for monitoring-only purposes)
- UL Listed to 864 9th Edition Standard for Control Units and Accessories;
- CSFM [#7300-0067:0267] for 'Fire Alarm Control Unit Accessories'
- Integrate Modbus devices
- Decentralized integration of third-party devices via Modbus
- Modbus-capable devices must be able to be connected to a BACnet-capable automation station via decentralized interface module for bidirectional data exchange. The automation station provides the following functions:
 - Event-oriented communication
 - Peer-to-Peer (cross communication)
 - Alarm and message processing, distribution to local operator units and building automation and control system.
 - Scheduler program with weekdays
 - Calendar function
 - local trend recording in device buffer (long-term trend).
 - Integrate via OPC
 - Integrate third-party devices via OPC
 - OPC servers must be able to be connected to a BACnet network for bidirectional data exchange.
 - The integration required must form a high-performance link between OPC and BACnet via presentation as OPC client in OPC and BACnet server in BACnet. The function extends far beyond simple mapping and transfer of OPC items to BACnet. The following functions must be ensured to achieve the required openness.
 - Direct mapping of OPC items to BACnet objects, for display and operation by BACnet clients.
 - Grouping of OPC items to create standard integrated BACnet objects.
 - Event-driven transfer of alarms in the BACnet network
 - Trend server with its own data maintenance for trendlog objects.
 - Cross communications (peer-to-peer) with other BACnet servers
 - Integrate third-party devices via OPC
 - The system must be OPC Foundation tested and certified and must be able to integrate and process, but also to provide real-time data as OPC data points. The System processing must include Alarming, Trending, Scheduling, Reporting and allow cross communication with other integrated devices.
 - The System must be support the OPC specification:
 - OPC Data Access
 - Power failure
 - Data backup

- The data must be saved for extended periods of time in case of power failure or extensions or removal of automation stations.
- The applications and all vital operating parameters (including setpoints, scheduler values, etc.) must not be lost due to a power outage. Other operating values such as alarms, trend data, etc. must be capable of being saved locally on the automation station.
- System time
- Time format
- Time synchronization in BACnet: UTC time (coordinated universal time)
- The building automation and control system must have a uniform system time. To this end, a time master supporting BACnet BIBB DM-UTC-A as per the PICS document must be defined. The time master must receive the DCF77, GPS or Internet NTP signal and provide it synchronized to all remaining system devices.
- Subsystem autonomy
- The automation stations must autonomously run their own time if the time master fails. The building automation and control time must be resynchronized automatically after the time master becomes available again.
- Self monitoring and self diagnosis
- Watchdog
- The building automation and control system must monitor itself to always know its latest and current status. A watchdog function helps detect and signal failed system devices and restarts them in a defined mode.
- Self diagnosis
- Self diagnosis must be available to quickly detect errors. It must provide information on system function and load.
- e.g. CPU and memory load must be displayed.
- General plant operating states
- Overview of operating modes
- There are five higher operating modes for all plants:
- Local emergency operation without automation station functionality (direct via I/O module or directly on the control panel as agreed to with owner).
- Local manual operation with automation station functionality (control panel in the control panel).
- Local - manual operation via visualization on the management level (all functions on the local automation station are set to Auto).
- Scheduler program under the condition that all plants are enabled for automatic operation.
- Automatic detection.
- All control functions of the automation stations must be set to and remain on automatic for highest plant availability, if a plant or aggregate is switched to MANUAL. In individual cases, automatic mode must change over to this unit in case of redundancies when a plant or aggregate is switched off locally.
- All safety and interlocking functions must take highest priority for operation independent of operating mode.

- Automatic detection
- The plants of the building automation and control system are switched on and off either automatic, or dependent on time or event. The following functions apply to the actual plant descriptions. All control loops, safety and interlocking functions must be guaranteed to work regardless of operating mode.
- Controlled via scheduler program
- All plants must be set to automatic for this operating mode. The plants of the building automation and control system must be switched on and off by individual use via a day, week, month, or annual scheduler program.
- Manual operation
- Different options are required for manual operation.
- Manual operation via management level (remote operation)
- Manual operation via local operator unit or laptop directly at the control panel.
- Manual operation via operator unit or directly at the control panel.
- Manual operation generally is possible only if the corresponding automation station is running. Manual operation allows for manually overriding scheduled plant switchings. Plants switched off by schedule can be switched on via plant switching command. Manual control of the plant switching command is equal to automatic control, i.e. the scheduled control is retained for as long as the scheduler remains active.
- Search & Replace function
- must allow for Mass Changes in parameters can be done across the entire installed system (eg. Operating hours change, set point etc)
- Energy efficiency and references to applicable standards.
- General
- The building is constructed under strict energy guidelines. The control technology deployed must contain all functions required to efficiently consume energy.
- Energy efficiency class "C" as per EN 15232.
- Standard EN15232 serves as the basis for energy efficiency functions. The system supplier must prove that the functions are as described by the standard. This tender was established based on Class C criteria.
- Requirements from EN 50001 placed on building automation and control system.
- The processes defined in standard ISO 50001 to improve energy efficiency must be supported by the data from the building automation and control system. In other words, all required data and information, measurement and analysis functions as well as outputs and display must be provided in accordance with this standard.
- Energy efficiency monitoring and evaluation.
- Support of eu.bac guidelines, part 4.
- Energy monitoring and evaluation is required for the entire building automation and control system. The basis forms the eu.bac guidelines - EEBACS Certification Scheme, Certifying Energy Efficiency of Building Automation and Control Systems, at first delivery and during the lifetime, Part 4: Specification of Key Performance Indicators.
- Management level

- Visualize quality state.
- A violation of the energy efficiency limits values for monitored measured values on the management level must be displayed using colors or symbols. Easy to interpret symbols provide the operator with a quick overview on the state of monitored plants, components, etc. Bar charts or pie charts or similar are still required for display of the overall state of monitored plants or the entire building. The operator must recognize how many (in percentages) of the total number of monitored measured values are in the quality state "good" or "bad", or, however, monitoring and evaluation is disabled. The quality state indicates whether the monitored measured value is within or outside the energy-efficient range. Violations of monitored limit values are displayed on the one hand through the quality state "bad" and, on the other, assessed as an indication that resulted through a fault operation, manual intervention, error or false or incorrect parameterization, in non-energy-efficient operation of components, aggregate or plants, ultimately resulting increased consumption (electricity, water, natural gas, etc.). An individual weighting of the calculation of resulting quality states must be possible since multiple measured values can be evaluated within a building or plant. The parameters for weighting, monitoring, evaluating and forming the quality state can be set based on read and write access rights. As an alternative: Make possible the simple navigation to an appropriate user program.
- Automation level
- Key performance indicators on the automation level.
- Monitoring and evaluation of measured values for primary plants (components and plant parts, software/program/system functions, set points, et.) must occur directly on the automation level. Monitoring and evaluation is intended to recognize unfavourable operations of plants/components early on and thus lower or optimize energy consumption and wear and tear.
- Monitoring and evaluating analog measured values.
- The following monitoring and evaluation must be able to be implemented for analog measured values (sensors, setpoint, modulating control of valves, dampers, variable speed drives, etc.):
- Determine the minimum value (lowest value) within a defined timeframe.
- Determine the maximum value (lowest value) within a defined timeframe.
- Determine the average value (lowest value) within a defined timeframe.
- Determine the longer period (in hours) during which the measured value moves between freely definable limit values.
- Determine deviation that the measured value deviated from the upper and lower set point within a defined timeframe.
- The determined value is monitored to a minimum and maximum and displayed as quality state for breach and/or exceeding thereof. The value from the current timeframe is displayed; the value from the previous timeframe is also displayed and made available to the trend data. The evaluation ceases for a fault to the measured value (sensor interrupt, module fault, etc.), until the measured value once again assumes a reliable state. This fact must also be recognizable in the trend data.
- Monitoring and evaluation of digital and multi-stage measured values.
- Digital measured values (messages, switching commands, operating modes, etc.) must be definable as key performance indicators and make possible the following evaluation and monitoring:
- Determine the runtime (operating hours) within a defined timeframe.

- Determine the switch-on frequency within a defined timeframe.
- Determine the runtime (operating hours) for each stage within a defined timeframe.
- Determine the switch-on frequency for each stage within a defined timeframe.
- The determined value is monitored to a minimum and maximum and displayed as quality state for breach and/or exceeding thereof. The value from the current timeframe is displayed; the value from the previous timeframe is also displayed and made available to the trend data. The evaluation ceases for a fault to the measured value (sensor interrupt, module fault, etc.), until the value once again assumes a reliable state. This fact must also be recognizable in the trend data.
- Monitoring and evaluating metered values.
- Metered values (consumption meters, pulse meters, etc) must be definable as key performance indicators and make possible the following evaluation and monitoring:
 - Determine the difference value (consumption value within a defined timeframe).
 - The determined value is monitored to a minimum and maximum and displayed as quality state for breach and/or exceeding thereof.
 - The value from the current timeframe is displayed; the value from the previous timeframe is also displayed and made available to the trend data. The evaluation ceases for a fault to the measured value (sensor interrupt, module fault, etc.), until the value once again assumes a reliable state. This fact must also be recognizable in the trend data.
- Evaluation over different timeframes.
- Monitoring and evaluation must be able to occur over definable timeframes (annually, monthly, weekly, daily, hourly, 15-minutes).
- Weighting of monitoring and evaluation criteria.
- Since an aggregate or component may include multiple evaluations, it is required to be able to weigh them so that they are included differently in the calculation of the resulting quality state.
- Engineering tools and engineering efficiency
- Engineering efficiency
- System and tool platform
- Creating solutions must be as efficient as possible, i.e. programming on construction sites; use of pre-defined application blocks, fast exchange of standard functions, etc. The goal is to achieve the maximum required level of flexibility at as little expense as possible.
- Preloaded application on devices.
- Applications portfolio.
- Prefabricated and tested must be loaded in a fix manner on the devices prior to commissioning. They can be used in the basic functions without the use of additional engineering tools.
- Harmonized tools and workflows.
- Consistent tools
- Uniform data and functions must be used by the building automation and control system in a consistent manner throughout all tools to achieve a high level of data consistency. In other words, all data is only entered once in the system. Consistent tool processes avoid a manual exchange of data (Import/Export).

- Transparency for customers.
- Data backup
- A data backup concept must be presented that provides the current state of a project in a form that is useable and complete to the customer. It includes raw data from plants, applications, engineering data (e.g. DP, labeling, links, parameters), documentation.
- Customer changes
- The technical operator at the customer be able independently make simple changes to the project. Potential training must be provided by the contractor.
- Corporate performance.
- Performance for implementation.
- Performance on communication network.
- Establish communications network
- The required communications network is part of the building automation and control system's scope of delivery. All control, monitoring, and communications tasks must run on this network. The communications network comprises all three system levels.
- Management level
- Automation level.
- Field level.
- The approved network concept must be documented in full and handed over operational.
- Supplier support.
- The supplier must have all expertise and capacity required to support and advise the expert planner on hardware and network structure definition in dependence of the selected operating concept.
- Engineering offerings
- Offerings on programming
- The contractor provides all services to successfully operate the specified plants and systems. This includes:
 - General review and detailed requirements listing by the expert planner.
 - Detailed listing of the functions and specifications listed in this document.
 - Present a detailed communications concept.
 - Work required to engineer or parameterize the building automation and control system.
 - Edit and program all required control, operating, signaling and logging functions including system-related programming.
 - Create data point list featuring all entries required by standards.
 - Review and implement the described measuring concept.
 - Set switching times, setpoints, and control parameters as per the targets defined and agreed to with the expert planner.
 - Review the device application with regard to adherence to targets, especially regarding the described energy efficiency.

- Document the project concerning functions, communications, system topology, and control panels/panels.
- Offerings on commissioning
- The contractor provides all services to successfully commission the specified plants and systems. This includes:
 - Create configuration and parameterization lists.
 - Review and ensure working communications across the entire building automation and control system including all devices on the network.
 - Check network load and resulting reaction times.
 - Test the modules and automation stations, all inputs and outputs including associated documentation (cold commissioning).
 - Test the safety functions for control and processing algorithms (e.g. with regard to technical and mechanical installations interaction and simulated operating failure or faults).
 - Unambiguous labeling of all network components, user address, and/or operating materials.
 - Comprehensive data point test including review of all connected sensors and actuators.
 - Check all cabling in the building for adherence to installation guidelines.
 - Check all bus terminators and voltage supply.
 - Setting of required configuration parameters.
 - Commission the connected sensors and/or actuators together with the other mechanical and electrical installations.
 - Review of planned automation functions as per specifications.
 - Log set and measured values.
 - Log required function for energy efficiency.
 - Final documentation
 - A final, comprehensive documentation must be provided following building automation and control system acceptance. To create such documentation, the system must allow for complete and current data export. As a result, the complete data set must be able to be exported any time featuring up-to-date data.
- Offerings for training
- The contractor provides all services to train maintenance staff. This includes the following topics:
 - Structure, properties, and functions of the installed building automation and control system.
 - Training on all operating options. (Room operation, emergency switch, control switch, operator units, management level, etc.).
 - Detailed operation of all management station functions. (Reports, analyses, trends, interpretation of alarms, alarm handling, data backup, etc.).
 - Troubleshooting and diagnosis on system and plants.
 - Adapt simple functions, implementation of updates, etc.
- Service offerings
- Service covering all electrical and mechanical installations

- This project contains several, individual electrical and mechanical installations. The supplier must therefore be able to offer a comprehensive service concept covering all types of building installations. Possible service offerings must be documented and submitted together by the contractor
- Management level requirements
- General
- General
- All information comes together at the management level. The management level is the graphical, interactive interface for the operator to the automation station and the integrated plants and plant parts.
- The operator can display, query, process, save, or print any plant information via the peripheral units at the management level. System operation must be simple, i.e. dialog-driven. The plants are displayed in synoptic images and the values and states are presented and displayed dynamically. Special programs are used for higher control, optimization functions, maintenance and energy management.
- Operating system for building automation and control system
- All data servers, operator workspaces etc. for the building automation and control system must be compatible with the current, common 64-bit Windows operating system. As a result, the current Windows version (at least 6 months after release by Microsoft) must be supported as well as the previous version as a minimum. Adjustment to the customer network is targeted. The building automation and control system must thus be able to be installed on any commonly available PC environment.
- Data exchange via various subsystems
- If several subsystems are used, various data must be exchanged between the automation stations (outside temperature, demand and coordination signals, etc.).
- Automate recurring tasks
- The building automation and control system must take care of recurring tasks to lower the operator's workload. This includes, for example, cyclical report generation triggering, plant release at various conditions, or automatic adjustment of setpoints or alarm limits.
- Designed for use with fire life safety systems (UL certified)
- The management station must have passed performance and environmental tests by the Underwriters Laboratories (UL). To combine the comfort and fire life safe system, the management station must provide all the relevant functions:
 - Visualize and treat events
 - Graphically monitor and control the life safety system
 - Know where to start as highest priority events are highlighted.
 - Directly navigate to the triggering element of an event.
 - Quickly navigate to custom operator instructions and graphical display of event locations.
 - Store and retrieve fire alarm system activity data.
 - Distribute fire monitoring and control capabilities across the network of the management stations.
 - Provide Operating Procedure checklists to guide the operator, under stress conditions, during the treatment of life safety events.

- Send out automatic remote notification of responders through email.
- View and schedule automatic history reports.
- SCADA platform
- The management station must be based on a SCADA platform, which must be fully compliant with the BACnet B-AWS profile. It must enable the integration of any type of building equipment, such as HVAC and lighting.
- Help functions
- The software shall provide an online, context-sensitive help, including an index, glossary of terms, and the capability to search help via keyword or phrase.
- Single Client License concept
- Easy configurable client as the same can be used as Desktop or Web client in Floating configuration
- Hardware requirements
- Minimum hardware requirement (Plants from +/- 5000 up to +/- 20'000 data points)
- Large system (up to 20 clients)
- A client / server system for large sites is required. The hardware and software environment must fulfil the following definition:
- Type: Server 19" Rack
- Processor:
 - 1x Xeon E5-2690 or
 - 2x Xeon E5-2690
- HDD: 4x Seagate Constellation 2 SAS 2000GB 7.2k Hot Plug SED
- Graphic Card:
 - On-board video graphics or
 - AMD Radeon 7750 1GB or
 - Nvidia GeForce GT 610 1GB
- RAM: 32GB DDR3-1333 4x 8GB
- Recommended software environment
 - Windows Server 2008 R2, 64bit Edition
 - MS SQL 2008 R2 Standard or
 - MS SQL 2008 R2 Enterprise
- Network requirements
 - Local Network
 - 1000 Mbps up/down
 - Latency <lt/>10ms
 - Range defined
 - 1 server

- Max 50 clients (10 Installed + 40 Remote/Web)
- Max 4 drivers
- Max 64 Cameras
- Additional: System must be to extent with a dedicated SQL server if a high data throughput is required.
- Minimum hardware requirements (plants with greater safety requirements)
- Hardware requirements as redundant server system
- The PC at the management level as a redundant server system must have hardware satisfying the described requirements.
- 5 GB of available RAM.
- 8 GB RAM.
- Windows 2008 Server.
- Dual Xenon (or equivalent) at 2.8 GHz.
- NAS or SAN.
- VMware ESX 3.5.
- Multi-Monitor Support-(Max 4 Nos)
- 4 simultaneous views of critical systems , Reduction of client workstation licensing & hardware cost
- User profiles
- Plant overview
- Individual views
- Individual, specific, or own views must be able to be set up to broaden plant overview. These views must cover various electrical and mechanical installations or follow geographic or organizational criteria and must allow personalized hierarchical “tree” views that represent the workstation, control systems, geographical facility layouts, and mechanical equipment relationships.
- User privileges
- The building automation and control system must allow users to define, change, or delete predefined reactions as per their user privileges.
- Multi language possibility
- The user interface must be able to support minimal three languages simultaneously in one system.
- Related Items
- Information of any data point available in multiple pages
- Access to trend, scheduler, reports, data sheets"
- Graphics
- General
- Operator interface to CAD system

- The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, point alarm association. Graphics software shall permit the importing of CAD symbol, or scanned pictures for use in the system.
- Operating messages
- Operating messages must be able to be displayed and evaluated at the management level. Graphics shall be capable of displaying the status of points that have been overridden by a local priority switch, for points that have been designed to provide a field local priority override capability.
- Full graphics mode
- A fully graphic management level featuring ergonomic images must be available. The system must be designed for operation, monitoring, optimization, and logging of all connected automation stations in real-time.
- Graphics creation
- User shall be able to add/delete/modify system graphics and state text for digital points, from standard user interface without the need of any external or specialized tools.
- Navigation
- The navigation through various graphic screens shall be optionally achieved through a hierarchical “tree” structure. Graphics viewing shall also include dynamic pan zoom capabilities and include the ability to switch between multiple layers with different information on each layer.
- Vector Graphics & Multi-layer with Depth support
- The system must support for Autocad import of plan with Zoom in & Zoom Out facility through scroll mouse feature & must enable simplified and un-cluttered view of all utilities (FAS, ACS, CCTV etc.) on any typical floor plan.
- Pictures
- Graphic symbols and standard
- The plant pictures must satisfy ergonomic needs of operators. The displayed graphic symbols must correspond to the generally valid standard for HVAC symbols (DIN 19227) and ASHRAE guidelines. Symbols must be supported as two or three dimensional graphics. Capability to create color graphic floor plan displays and system schematics for each piece of mechanical equipment, including, but not limited to, air handling units, chilled water systems, hot water boiler systems, and room level terminal units. Associated prints of standard plant pictures must thus be provided and installed by the contractor.
- Object-oriented graphics
- The building automation and control system must offer dynamic, high-resolution graphics. The graphics must be object-oriented. Each symbol must be able to display several states in the same, consistent format. At the same time, several views must be able to be open concurrently, and all views must be updated dynamically.
- Continuous update and display.
- Measured values, setpoints, user settings, and alarms must be displayed immediately and continuously. State changes must be indicated via symbol, e.g. using animation or changing the color, in general, however, graphic presentation, or text.
- Dynamic 3D & HD Graphics

- Must support for Dynamic 3D & HD Graphics symbols for better clarity, aesthetics, effective use of change in display technology
- Sensor types.
- Temperature sensor
- Outside air sensor
- Outside air sensors must allow for high-quality temperature measurements to promote efficient and ecologically meaningful control. A temperature measuring concept including wind and solar radiation is required.
- Duct sensor
- Sensors acquiring temperature values via mean value acquisition are required to retain the necessary flexibility for sensor integration in air ducts.
- Humidity sensor
- Outside sensor
- Only maintenance-free sensors are used. The supplier must provide proof that the offered sensors feature compensation of inherent temperature. The sensor build must ensure protection against dust.
- Duct sensor
- Only maintenance-free sensors are used. The supplier must provide proof that the offered sensors feature compensation of inherent temperature. The sensor build must ensure protection against dust.
- Air quality sensor
- Duct sensor
- Duct sensors may not feature additional duct mounting housings or other sealing masses for exchange during operation. Installation depth must be seamlessly adjustable to achieve a small product range. The sensor's design does not require sophisticated orientation to the flow direction in the duct.
- Pressure sensor
- Absolute pressure sensor
- Robust sensors ideal for measuring static and dynamic overpressure at intensive load changes are required for pressure control of liquids and gases. The related sensor build must ensure that the sensors are immune against humidity and temperature deviations in the long term.
- Differential pressure sensor
- Sensor with highly stable membrane are required to monitor differential pressure of air and non-aggressive gases. Robust sensors ideal for measuring static and dynamic overpressure at intensive load changes are required for pressure control of liquids and gases. The related sensor build must ensure that the sensors are immune against humidity and temperature deviations in the long term.
- Flow sensor
- Flow monitor
- For flow monitoring of liquids, sensors of fiberglass reinforced plastic or in robust gun metal. The sensors must be constructed to be insensitive to contamination and have a high level of media resistance. Multiple configurations for the output signal must be possible to permit matching to a specific application.

- Flow switch
- Maintenance-free sensors with reed contact is specified to monitor the flow of liquids. The sensors must be deployable to a wide nominal range to optimize application. The reed contact must be a proximity switch. The set switching point must be stable and independent of pressure.
- Air velocity sensor
- The sensor used must be immune to contamination regardless of the flow direction. However, these sensors must be able to be adapted to various velocity measuring ranges without auxiliary tools to avoid measuring accuracy disadvantages. Multiple configurations for the output signal must be possible to permit matching to a specific application.

References & Standards:

The IBMS software shall be designed and developed to the following standards:

- ISO 9001 (2000).
- ISO/IEC 15504 Level 3 or higher
- SEI CMM Level 5 (American Software Engineering Institute - Capability Maturity Model).
- ECBC 2007, UL 916, NBC 2016, ASHRAE/ANSI-135(2004).
- Besides, adherence is required to industry standards and certifications such as UL, ULC and BTL certification of products and EN compliance.

7.8.1 LIST OF Preferred MAKES

Building Management System		
1	Main Control System/ IP DDC Controllers	Azbil (Yamatake), Siemens, Honeywell Trend, Schneider
2	Temperature, Air humidity Sensors (Duct, Room)	Azbil (Yamatake), Siemens, Honeywell Trend, Schneider
3	Building Management Software	Azbil (Yamatake), Siemens, Honeywell Trend, Schneider
4	Differential pressure switch Air flow / Water Flow switch/water Level switch	Azbil (Yamatake), Siemens, Honeywell Trend, Schneider
5	Water Flow meter	Invensys/ Kele/ Honeywell/ Sontay/Forbes/Marshal
6	Water Pressure Transmitter/ Level Transmitter	Invensys/Kele/ Honeywell/ Sontay/Forbes/Marshal
7	Motorized Butterfly valves/ actuators	Rapid Cool/Audco/ Johnson/Siemens/Belimo

Building Management System		
8	Current/Voltage/Power Factor/Frequency/KWH Transducers with digital display/Electronic Meter	Situ Electro Instruments Pvt.Ltd./ Secure metres Ltd./ Enercon/L&T
9	Switching Relays	PLA/OMRON
10	Flame proof level switch	Veksler/ Minilec
11	Electromagnetic Lock	Trimec/ Dafikas
12	Electric Actuators for 2-way ON/OFF valves	Danfoss/ Emtrack/ Johnson/ Honeywell/ Siemens/ Trane/ Cyclon Controls.
13	Transducer	GFR-Germany, SETO / Equivalent
14	CAT 6 Cable	AMP, Molex
15	OFC Cables	Tyco-AMP , Molex, HFCL
16	Power Cables	Avocab, Finolex, Havells, Polycab, KEI
17	Communication Cables	Polycab , Excel , LAPP kabel
18	Network Storage	DELL , HP , IBM, Fujitsu
19	Servers & Workstation	DELL , HP , IBM, Fujitsu
20	Printer	HP/Epson
21	LIU's & Network Accessories	Tyco-AMP , Molex, Panduit
22	Junction Boxes	Rittal, Pyrotech, BCH, Pramod Electrical
23	Racks	President , APC , Valrack
24	MS Conduit	BEC, AKG , NIC
25	Cable Trays & Accessories	AKG, SSI, BEC

7.9 LIST OF APPROVED MAKE / OEM MANUFACTURER FOR ELECTRICAL & ELV WORK MATERIALS

- | | | |
|---------------------------------------|---|--|
| 1) Rigid PVC Conduit | : | ISI approved & manufactured from virgin material.
BBC, Precision, POLYCAB |
| 2) Accessories for conduit | : | Same make as of pipe. |
| 3) Flexible Copper Wires | : | FRLS type : Avocab, Havell's, Finolex, Polycab, KEL. |
| 4) Switches | : | MK(Blenze), Legrand(Arteor), Crabtree Schneider (Opale) or as per Interior approval |
| 5) LED Light Fixture or | : | any kind of light source
Phillips, Wipro, Surya, OSRAM, Arlited, Crompton, Keselec Schreder, Havell's, Zumtobel, Regent, Riggiani, Lance, Ligman, PUK, Disano.
(As suggested by architect - Sample to be approved) |
| 6) LT Panel | : | Ambit Switchgears, Expel Prosys, Shivanjali switchgears |
| 7) LED lamp souce | : | CREE, NICHIA, OSRAM |
| 8) Ceiling Fans | : | Crompton, Usha, Orient, Havell's |
| 9) Fan box | : | Cast Iron Type Only |
| 10) Exhaust Fan | : | Crompton, Almonard, |
| 11) Call bell | : | Anchor Ding Dong type. |
| 12) PVC tape | : | Steel grip, Anchor |
| 13) Distribution boards | : | Havell's, Legrand (Ekinoxe),Schneider MG, L&T, Hager.
Factory fabricated. Double door type |
| 14) ACB / MCCB / MCB /
ELMCB & Acc | : | Havell's, Legrand (DX3), Schneider MG,L&T, Hager. |
| 15) DB Surge protector | : | Legrand, Schneider, L&T, Hager, OBO |
| 16) Timer | : | Legrand, Schneider, L&T, Hager, Theben |
| 17) RTPFC Panel manufacturer : | : | Datar, EPCOS, L & T or Readymade As per Switchgear make |

18) Metal Clad and Wheather proof Plug-socket	:	Havells, Legrand, Schnieder, L&T, Hager
19) LT Cables	:	Avocab, Finolex, Havells, Polycab, KEI, Cords, Ravin Cable
20) HT Cable	:	Avocab, Havell's, Finolex, KEI, Polycab
21) HT Joint Kit	:	Raychem, 3M
22) Panel Fabricators	:	CPRI Approved panel builders only
23) Load Manager / Energy Meter: (Suitable for PC Connected and LAN with open protocol, Sample to be approved)	:	Conzerve, Secure, Elmeasure, Rushabh.
24) Meters(Digital : V,A,PF etc)	:	Conzerve, Secure, Elmeasure.
25) Relay	:	Siemens, L&T, ABB, Schnieder
26) Connectors	:	ELMEX, Wago, Connectwell.
27) Glands	:	Compression type, Heavy duty and deep threading with rubber-ring and double washers. (Sample to be approved) HMI, Comet, Dowell's
28) Cable Lugs	:	Dowell's, 3-D (long neck)
29) Button holder, Angle holder, ceiling rose	:	Anchor, CPL
30) M.S. Boxes	:	Fabricated out of CRCA sheets / Angle / Strip continuously welded (sample to be approved) with Powder coating / Colour coating.
31) Whether protected junction boxes	:	Spelsberg, Hensel, SCAME
32) Ladder & Perforated type Cable Tray	:	Elcon, Rushabh, MEK, Indiana
32a) Wire Mesh Cable tray	:	Legrand , OBO
33) Raceway	:	OBO, MK (Ega), Legrand
34) Anchor Fastener	:	Hilti, 3M
35) Current Transformer	:	AE, Virat, Narmada
36) Indication Lamp	:	LED Type : Schneider, L&T, RASS, Salzer
37) Voltage Selecter Switch	:	L&T, Salzer
38) Ameter Selecter Switch	:	L&T, Salzer
39) Fire Stoppers	:	Hilti, 3M, OBO
40) Maintenance free / Chemical Earthing	:	JK,LPI,HAKEL

- 41) Lightning Arrestor : **APS, LPI, HAKEL**
- 42) UPS : **Arrow, Hitachi-Hirel, APC, Emerson**
- 43) Transformer : **ABB, Voltamp, Cromption**
- 44) HT Breaker panel : **C & S, Schneider, ABB, L & T, Expel Prosys**
- 45) D G Set : **Sudhir Gensets, Gmmco, Sterling & Wilson**
- 46) Stabilizer : **Suvik, Belltronics, Protek-G, Consul**
- 47) Power pack : **Gogate / Eq.**
- 48) Isolation Transformer : **Automatic Electric, Servomax, Aplab**
- 49) Street Light/ External Lighting/Architecture Poles: **NIV ENGINEERS, SKIPPER, BAJAJ**
- 50) Single Phase A.C. Contactor: **MDS/ L&T/ Siemens**
- 51) 4 Pole Three Phase A.C. Contactor: **L&T/ Siemens**
- 52) Auto manual switches (3 way): **Kaycee/ L&T**
- 53) Auto manual changeover switch: **Kaycee/ L & T**
- 54) Current Relays: **Sitn/Minilec/Sntry**
- 53) Fire Alarm Panel: **Cooper, Esser, Gent**
- 54) Fire Pumps: **Lubi, Kirloskar, Grundfos**
- 55) HVAC: **Zeco Aircon, Blue Star, Hitachi, Samsung, LG**

Special Notes:

- The successful bidder will have to supply the makes from above in consultation with the Employer's Engineer without any extra cost.
- However, the final decision for accepting make specified by the contractor would be of Employer's Engineer.
- As far as possible, the contractor will have to place order directly to the manufacturer OR it's authorized dealer.
- The Employer's Engineer have right to check the challans of supplier.
- The MCB, MCB & DBs must be of same make.
- Make of components required to be used by contractor to complete the installation, if not mentioned anywhere, shall be required to GOT IT APPROVED by Employer's Engineer before installation in writing manner.
- The contractor shall submit the sample of each item / component of above mentioned approved make for the approval of the Employer's Engineer before placing the final order to the manufacturer OR it's authorized dealer

8.0 HVAC WORKS

Design Parameters

8.1 Variable Refrigerant Flow Air-Conditioners

8.1.1 Indoor Units:

The Variable Refrigerant Flow air-conditioners comprises of multiple indoor units and condensing/outdoor unit connected via single refrigerant circuit. The units shall be of ceiling cassette type and Hi-Wall type and shall be designed for refrigerant R- 410 A with self-contained direct expansion types evaporating coil gas distributor in fan coil unit with linear expansion valves. Evaporation coils shall be aluminium fins mechanically bonded copper tubes Factory leak tested.

The Ceiling Cassette units shall be factory assembled, wired and run tested. The unit should have adjustable air outlets such as 1, 2 or 4 ways as per site requirement with swing louvers and adjustable blades from sides. An airflow control mechanism must be factory built-in to distribute the air evenly over the vane's upper and lower surfaces to prevent the air from hitting the ceilings. Air intake must be from center bottom of the unit through fixed decorative blade grill and factory supplied washable air-filter. The fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. Fan motor shall be low noise with multi-speed motor with internal thermostat. Cassette unit should be equipped with drain water lift up mechanism. Refrigerant pipe and condensate drain connection to be in separate corners for easy installation and maintenance.

The Hi-wall unit will be wall mounted type. The Hi-wall units shall be factory assembled an, wired and run tested. The unit shall include pre-filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel. The indoor unit shall incorporate a one-piece insulated drain tray. The drain connection shall be of suitable size and be connected to gravity condensate system or a suitable condensate pump as per schedule of quantity.

The units shall be equipped with Auto Restart function, which allows the unit to start in the same mode prior to the power failure.

Condensing/outdoor unit shall house compressor and condenser and shall be of heavy gauge corrosion resistant carbon steel and shall be suitable for mounting in open space.

Corded Remote controller shall be provided with each Indoor unit. Wherever specified separately cordless remote controls shall be provided. Remote controller shall have a liquid crystal display and shall incorporate the following control functions.

On/ off, fan speed selection, set temperature selection and adjustment, operation mode selection, auto swing selection, filter cleaning identification, full fault diagnostics display, and 24 hour programmable timer.

8.1.2 Compressor

The compressor shall be either hermetic or semi-hermetic (Scroll) as specified in data sheet and shall be mounted on vibration absorbers. Outdoor unit shall be equipped with at least one inverter compressor up to 12HP, two inverter compressors up to 24 HP and above this, three inverter compressors. Oil heater shall be provided in the compressor casing.

8.1.3 Condenser

The air cooled condenser shall be with seamless copper tubes and aluminium fins and low noise propeller type fans with safety guard. The noise level shall not be more than 60 dB(A) at normal operation measured horizontally 1m away and 1.5m above ground level. It should also be provided with duty cycling for switching starting sequence of multiple outdoor units. Speed of axial fans shall not exceed 960 RPM for fans with impeller diameter above 450 mm and 1440 RPM for fans with impeller diameter 450 mm and less. The impeller shall be statically and dynamically balanced. The condensing unit shall be designed to operate safely when connected to multiple indoor units, which have a combined operating nominal capacity up to 130 %. The outdoor fans shall accommodate a short length of ductwork, where required, in order to expel discharge hot air when units are sited internally.

8.2 Air Cooled DX - Hi-wall type Split Unit

The unit shall consist of an outdoor unit (air-cooled condensing unit) and an indoor unit (evaporating unit) and an electronic remote control unit.

a) Out Door Unit:

The outdoor unit shall house the compressor, condenser with fan, in a sheet metal cabinet. The cabinet shall be pre-treated and powder coated for long life in outdoor installation, and shall have acoustic lining for noise reduction. The condenser coil shall be made from copper tubes and aluminium fins firmly bonded. The Condenser fan shall be propeller type with water proof, design for low noise. Compressor shall be hermetically sealed scroll type, suitable for single phase 230V + 6%, AC, 50 Hz power supply, with built-in overload protection, mounted on vibration isolator rubber mounts.

b) Indoor Unit:

The indoor unit (Evaporator Unit) shall have a plastic moulded body, housing the finned cooling coil made out of 6.5mm dia copper tubes and aluminium fins, capillary tube for

expansion, drain pan, silent centrifugal fan with single phase motor, automatic swinging vanes etc.

The Split Units installed in Server Room shall be provided with an Automatic Change over circuit with timer to have one A/C unit running and other unit on standby. The units should be provided with the provision to provide status digital input signal to the SCADA system.

c) Electronic Control Unit:

A cordless remote electronic control unit having the functions of temperature setting, ON-OFF for fan & compressor, speed control of evaporator fan, shall be provided along with the indoor unit. The control unit shall also have facilities of programming the automatic start stop of the unit.

d) DRAIN PIPING

The drain piping shall be made out of rigid PVC pipes of 10 Kg/cm² class. The piping shall be supported by clamping on MS angle 25mm x 3mm running continuously below the pipe. The piping shall be insulated with 6mm thick closed cell nitrile rubber sleeves. U trap shall be provided in the drain connection of each IDU. All pipes support/clamps shall be painted with red oxide primer followed by two coats of synthetic enamel finish paint.

8.3 Air Cooled DX - Tower type Split Unit

The unit shall consist of an outdoor unit (air-cooled condensing unit) and an indoor unit (evaporating unit) and an electronic remote control unit.

a) Out Door Unit:

The outdoor unit shall house the compressor, condenser with fan, in a sheet metal cabinet. The cabinet shall be pre-treated and powder coated for long life in outdoor installation, and shall have acoustic lining for noise reduction. The condenser coil shall be made from copper tubes and aluminium fins firmly bonded. The Condenser fan shall be propeller type with water proof, design for low noise. Compressor shall be hermetically sealed scroll type, suitable for single phase 400V + 6%, AC, 50 Hz power supply, with built-in overload protection, mounted on vibration isolator rubber mounts.

b) Indoor Unit:

The indoor unit (Evaporator Unit) shall have a floor mounted plastic molded body, housing the finned cooling coil made out of 6.5mm dia copper tubes and aluminum fins, capillary tube for expansion, drain pan, silent centrifugal fan with single phase motor, automatic swinging vanes etc.

c) Electronic Control Unit:

A cordless remote electronic control unit having the functions of temperature setting, ON-OFF for fan & compressor, speed control of evaporator fan, shall be provided along with the indoor unit. The control unit shall also have facilities of programming the automatic start stop of the unit.

d) DRAIN PIPING

The drain piping shall be made out of rigid PVC pipes of 10 Kg/cm² class. The piping shall be supported by clamping on MS angle 25mm x 3mm running continuously below the pipe. The piping shall be insulated with 6mm thick closed cell nitrile rubber sleeves. U trap shall be provided in the drain connection of each IDU. All pipes support/clamps shall be painted with red oxide primer followed by two coats of synthetic enamel finish paint.

8.4 Refrigeration Piping

The refrigeration piping shall be complete with externally equalised thermostatic expansion valve, liquid line strainer, dehydrator with replaceable drying agent and liquid line shut-off valve.

For refrigerant R-410A, copper tubes to IS 10773 shall be used. Fittings and pipe joints shall conform to the requirements of ANSI B 31.5.

The piping shall be designed for an internal pressure representing the most severe condition of coincident pressure and temperature expected in normal operation.

Piping shall be designed for not less than the internal pressure given in Table-1. For refrigerants not listed in the Table-1 the design pressure for the higher pressure side shall not be less than the saturated vapour pressure of refrigerant at 60^oC for air cooled systems. For low pressure side, the design pressure shall not be less than the saturated vapour pressure of the refrigerant at 32.5^oC. For refrigerants not listed in the Table-1 and having a critical temperature below 55^oC, the design pressure for the high pressure side shall not be less than 1.2 times the critical pressure and design pressure for low pressure side shall not be less than 2 Kg/sq.cm (g).

TABLE - 1

REFRIGERANT NUMBER	REFRIGERANT NAME	MINIMUM INTERNAL DESIGN PRESSURE		
		HIGH PRESSURE SIDE (Kg/cm ² (g))		LOW PRESSURE SIDE (Kg/cm ² (g))
		WATER COOLED	AIR COOLED	
R-22	Monochlorodifluoro methane	20	26	13
R-410A	R-32/125 (50/50)	-		

Test pressure for piping shall be 1.1 times of design pressure. The pressure shall be gradually increased until a gauge pressure which is the lesser of one-half of the test pressure and 1.75 Kg/cm² (g) is attained and preliminary leak checks shall be carried out. Thereafter, the pressure shall be gradually increased in steps until the test pressure is reached. The pressure shall then be reduced to the design pressure and leakage examination shall be made. The design pressure shall be maintained for 48 to 72 hours. A pressure relief valve/device shall be provided on test pressure line having a set pressure slightly above the test pressure. Nitrogen shall be used as test medium. Oxygen or any combustible mixture of gases shall not be used within the piping for testing. Water or water solutions shall not be used as a test medium.

Vacuum testing shall be done for medium vacuum of around 40 mm Hg absolute and held with vacuum pump in operation for at least 4 hours. Thereafter unit shall be sealed and vacuum held for at least 12 hours. Vacuum break shall be done using refrigerant and pressure raised to standing pressure in refrigerant cylinder.

A selector switch enabling the running of the air handling fan alone or fan with cooling shall be provided. Interlock shall be provided such that compressor can start only after starting the air handling fan. Provision shall also be made to interlock the compressor with the air cooled condenser fan motor. Safety devices such as high/low refrigerant pressure-stat and compressor oil pressure-stat, hermetic motor winding thermostat etc. shall be provided. HP and OP cut out shall be manual reset type while LP cut out shall be auto reset type. In case electrical heating is specified in data sheet, following provision shall be made.

- (a) Adjustable thermostat to control the temperature and a safety thermostat.
- (b) Safety interlocks to cut off the electrical supply to the heater whenever there is failure of air flow.

The refrigerant piping and refrigerant and oil charging shall be carried out at site. Refrigerant and oil shall be supplied along with the unit till the unit is handed over to the PURCHASER. Exposed refrigerant piping shall have anti-corrosive coating. Noise power level of Indoor Units measured at 1.86 m from unit shall not exceed 55 dB (A).

8.5 Central Control Monitoring

Central Control Monitoring shall be provided. The specifications for the Central Control Monitor are as follows:-

- MMI - man machine interface for monitoring all the VRF units should be provided.
- MMI shall be inter-linked by means of daisy chained network with VRF units.
- A gateway shall be provided to connect all the VRF units to IBMS.
- Gateway shall support BACnet / Modbus / LON / TCP /IP protocols for IBMS interface.
- All the operational parameters shall be monitored and controlled from the IBMS.
- Contractor shall consider configuration of the above in consultation with their principle for complete functioning of the system with optimized hardwares and softwares.
- MMI should be from the same vendor of VRF for compatibility.

8.6 Electrical

A terminal box on starter panel suitable for connecting external 3 phase, 4 wire cables shall be provided.

The unit shall be provided with single phase preventers for all motors.

Microprocessor based starter panel shall be provided separately for each unit.

The starter panels for indoor and outdoor units shall be pre-wired at the factory and shall be complete with starters for all motors. The panels should have the provision to provide status digital input signal to the SCADA system.

Wiring between starter panel and indoor / outdoor units shall be carried out at site.

The control wiring shall consist of a 2-core, non-polar, screened cable and shall be installed separate to the mains power wiring and linked to each successive unit.

Three phase power with MCCB shall be provided for each Outdoor Unit.

HVAC Contractor shall Design, Manufacture, Supply, Test and Commission the Electrical Panels required for all the equipment pertaining to HVAC System.

8.7 Sheet Metal Ducting:

a. Duct Materials

The ducts shall be fabricated from galvanised steel sheets conforming to IS: 277.

All duct work, sheet metal thickness and fabrication unless otherwise directed shall strictly meet requirements, as described in IS:655 with latest amendment.

The thickness of sheet for Rectangular Ducts shall be as follows:

Private size of duct (mm)	Sheet thickness (mm)		Type of joints	Bracing if any
	G.I.	Alum		
Up to 750	0.63	0.8	G.I. Flange	-
751 to 1000	0.80	1.00	25x25x3mm angle iron frame with 6mm dia nuts and bolts	25x25x3mm angle iron at the interval of 1.5 m
1001 to 1500	0.80	1.00	40x40x5mm angle iron frame with 8mm dia. nuts & bolts.	40x40x3mm angle iron at the interval
1501 to 2250	1.00	1.50	50x50x5mm angle iron to be cross braced diagonally with 10mm dia. nuts & bolts at 125mm centre	40x40x3mm angle iron at interval of 2 m
2251 and above	1.25	1.80	50x50x6mm angle iron frame 10mm nuts & bolts at 125 mm centre	40x40x3mm angle iron at the interval of 1.2 m

The thickness of all four sides shall be determined by the thickness required for the longest side of the duct from the above table.

The gauges, joints and bracings for sheet metal duct work further confirms with the provisions as shown on drawing.

Ducts larger than 450 mm shall be cross braced.

Changes in section of duct work shall be affected by tapering the ducts with as long a taper as possible. All bracings shall be taken off at not more than 45° angle from the axis of the main duct unless otherwise approved by the Engineer.

All ducts shall be supported from the ceiling by means of M.S. rods of 9mm (3/8") dia. with M.S. angle size 40mm x 40mm x 6mm at the bottom.

The thickness of GSS sheet for Round Ducts shall be as follows:

Duct Diameter (mm)	Spiral Seam	Long Seam
Up to 350	0.63 /24 G	0.63 /24 G
351 to 650	0.63 /24 G	0.80/ 22 G
651 to 900	0.80/ 22 G	1.00/ 20 G
901 to 1250	1.00/ 20 G	1.00/ 20 G
1251 to 1500	1.25/ 18 G	1.25/ 18 G
1501 to 2100	1.25/ 18 G	1.50/ 16 G

b. Installation

During the construction, the contractor shall temporarily close duct openings with sheet metal covers to prevent debris from entering ducts and to maintain openings straight and square, as per direction of Engineer.

Great care shall be taken to ensure that the duct work does not extend outside and beyond height limits as noted on the drawings.

All duct work shall be of high lock former quality approved galvanised sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be tight and shall be made in the direction of air flow.

The ducts shall be reinforced where necessary, and must be so secured in place as to avoid vibration of the duct and its support.

All air turns of 45° or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration. All ducts shall be fabricated and installed in accordance with modern design practice. The sheet metal gauges and fabrication proceedings as given in I.S. specifications shall be adhered to and shall be considered as an integral part of these specifications.

The duct work shall be varied in shape and position to fit actual conditions at building. All changes shall be in accordance with accepted air conditioning duct design and subject to Engineer's approval. Contractor shall notify the Engineer of any difficulty in carrying out his work before fabrication.

Sponge Neoprene rubber or approved gaskets shall be installed between duct flanges as well as between all connections of sheet metal ducts to walls, floor columns, heater casings and filter casings. Sheet metal connections shall be made to walls and floors by means of galvanised steel angles anchored to the building structure with anchor bolts and with the sheet bolted to the angles. Sheet metal connections shall be as shown in the drawings or as directed by the Engineer.

The ducts shall be supported from the structure by means of metallic fasteners of 'hilti' or approved make with pneumatic gun and procedure approved by Engineer in the R.C.C. work. In no case the duct will be rested upon the false ceiling/boxing or on supports grouted in the wall.

Flanges and supports are to be black mild steel and are to be primer coated on all surfaces before erection and painted with aluminium paint thereafter. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and finish similar to the adjacent ducting, as specified.

Joints, seams, sleeves, splitters, branch takeoffs and supports are to be as per duct details as specified or as decided by Engineer.

Joints requiring bolting or riveting may be fixed by hexagonal nuts and bolts, stove bolts or buck bolts, rivets or closed centre top rivets or spot welding self tapping screws must not be used. All fixtures must have a permanently non-corrosive finish such as cadmium plating or galvanising as appropriate. Spot welds and bronze welds are to be coated on all surfaces with zinc rich paint, as approved by Engineer.

Flexible joints are to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvas or as directed by Engineer. On all circular spigots the flexible materials is to be screwed or clip band with adjustable screw or toggle fitting.

For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.

Flexible joints are to be not less than 75 mm and not more than 125 mm between faces. Both ends of the ducts at such joints shall be provided with chicken screen. The duct work should be carried out in a manner and at such time as not to hinder or delay the work of other agencies especially boxing or false ceiling contractor.

c. Miscellaneous

All ducts above 450mm to be cross braced to provide rigidity to the ducts.

All duct work joints to be square or approaching square with all sharp edges removed.

Sponge rubber gaskets also to be provided behind the flange of all grilles.

Longitudinal and circumferential joints of toilet extract air duct shall be further sealed with flexible permanent mastic to avoid unwanted infiltration of outside air into the duct work and thus affecting the system exhaust adversely.

Each shoot from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grille through the shoot.

Inspection doors measuring at least 450mm x 450mm are to be provided in each system at an appropriate location as directed by Engineer.

Diverting vanes must be provided at the bends exceeding 500mm and at branches connected into the main duct without a neck.

Proper hangers and supports should be provided to hold the duct rigidly to keep them straight to avoid vibrations. Additional supports to be provided where required for rigidity or as directed by Engineer.

The duct should be routed directly with a minimum of directional change.

The duct work shall be provided with additional supports/ hangers, wherever required or as directed by the Engineer, at no extra cost.

All duct supports, flanges, hangers and damper boxes etc. shall be given 2 coats of red oxide paint before installation and one coat of aluminium paint after the erection, at no extra cost.

All angle iron flanges are to be welded by electric arc welding and holes to be drilled.

All the angles iron flanges are to be connected to the GSS duct by rivets at 100mm centres.

All the flanged joints to have 4 mm thick felt packing stick to the flanges with shellac varnish.

The holes in the felt packing are to be burnt through.

The G.S.S. duct should be lapped 6 mm across the flanges.

The duct should be supported by approved type supports at a distance not exceeding 2.4m.

Sheet metal connection pieces, partitions and plenums required shall be constructed of 1.25 mm (18 gauge), sheet thoroughly stiffened with 25 mm x 25 mm angle iron braces and fitted with access door.

Duct sections in general shall be provided with 16 gauge galvanised weld mesh with about 6 mm centre for rat protection in the supply air ducts at AHU/fan outlets, return air openings in AHU room and above return air slits in conditioned spaces as directed by the Engineer at no extra cost.

d. Supply and Return Air Grilles

The supply and return air grilles shall be made of powder coated extruded aluminum sections. The supply air grilles shall be provided with screw operated opposed blade volume control device made of extruded aluminum in black anodized finish. All grilles shall have soft continuous rubber / foam gasket between the peripheries of the grilles and surface on which it has to be mounted. The colour of grilles shall be as per the approval of the Engineer in Charge.

e. Square / Rectangular Ceiling Diffusers

The square / rectangular ceiling diffusers shall be made of powder coated extruded aluminum construction with flush fixed pattern. The diffusers shall have Anti-Smudge ring and spring loaded removable central core in various pattern for air flow direction. The diffusers shall have minimum three cones. The diffusers shall be mounted by concealed screw fixing arrangement. The colour of diffuser shall be as per the approval of the Engineer in Charge

f. Louvers

The Louvers shall be of Aluminium construction and shall consist of parallel metallic blades. The width and angle of blade shall be such as to minimise the entry of water and snow inside. The minimum percentage of free area shall be 35% to 37%. Bird screen of 10 mm² and minimum 16 G screen shall be provided on outer face of louvers, wherever the louvers are exposed to atmosphere. The frame of louver shall have a sill extension of 50 mm to provide drip ledge so that rain water drains outside and shall have suitable frame work for installation of filter.

g. Gravity Louvers

The gravity louvers shall be of Aluminium construction and shall consist of parallel metallic blades. The minimum percentage of free area shall be 35% to 37%. Blades of gravity louvers

shall be smoothly working against force of propeller fan. When the propeller fan starts all blade of gravity louvers should be smoothly full open with force of air flow by propeller fan and all blade shall be closed tightly in frame without any air gap when fan is switched off.

h. Filters

The filter section of 10 micron shall be washable type synthetic extended media pane filters having GSS frame. The media shall be supported with High Density Polyethylene (HDPE) mesh on one side and expanded aluminium mesh on the other side. The efficiency of the filters shall be 90% down to particle size of 10 microns.

8.8 Insulation:

a) Refrigerant Piping

Closed cell, Elastomeric Nitrile Rubber tubing insulation of Minimum 13 mm thickness with fire performance to Class 'O' as per BS 476 Part 6:1989 shall be used for insulation of Refrigerant lines. For Outdoor piping 25 mm thick insulation shall be selected. Thermal conductivity of insulation shall not exceed 0.038 W/mK at an average temperature of 30 deg C. Insulation shall have all joints suitably bonded and shall be protected, with woven GRP Mat finished with coloured epoxy paint to withstand outside ambient conditions and UV radiation when exposed to atmosphere. The product shall have temperature range of -40 to 105 deg C.

b) Underdeck Insulation

Under deck insulation shall be used. Insulation shall be 25 mm thick nitrile rubber with conductivity not to exceed 0.038 W/m K. The product shall have temperature range of -40 to 105 deg C. Material shall be fire rated for Class O as per BS 476 Part 6:1989.

8.9 Ventilation Fans:

Tube Axial Fans-

a) Impeller

The impeller shall be of die cast aluminium alloy with integrally cast aerofoil sectioned blades and hub. Impeller shall be fixed to motor shaft by a thrust plate and bolt reverse to direction of rotation, in addition to key lock. The critical speed of impeller shall be minimum 1.5 times of the operating speed. The impeller shall be statically and dynamically balanced to G 6.3 grade as per ISO: 1940.