
DETAILED PROJECT REPORT

**PROPOSED CONSTRUCTION OF 2ND IT PARK BUILDING IN TECHNOLOGY
PARK CAMPUS, UMSAWLI, EAST KHASI HILLS
(ABOUT 11 KM FROM SHILLONG) MEGHALAYA**



SUBMITTED BY:
Arc Test House & Consultant LLP,
Sector-62, Noida



SUBMITTED TO:
Meghalaya Information
Technology Society
NIC Building, Secretariat Hill,
Shillong

1.1 About MITS:

The Meghalaya Information Technology Society (MITS) is a society registered under Information Technology Department, Government of Meghalaya, and the Meghalaya Societies Registration Act, 1983.

Meghalaya Information Technology Society (MITS) was established in the year 2008 under Meghalaya Society Registration Act 1983 and is the designated state nodal agency which carries out various projects and capacity building programs under National e-Governance Plan (NeGP). MITS has been driving various ICT projects, ICT promotional schemes, capacity building programs and other ICT enabling assistance activities in the state of Meghalaya. The major focus has been to implement and rollout various projects and framework belonging to the National e- Governance Plan (NeGP). MITS has achieved a commendable rate of implementation of NeGP initiatives and it has been able to establish some of the important infrastructure in the field of e-governance like the MSWAN, MSDC, Common Service Centers (CSCs), State Portal and State Service Delivery Gateway (SSDG) etc. MITS is the State Nodal Agency for implementing the Technology Park at New Shillong.

1.2 Vision of the Technology Park

“To promote entrepreneurship and technological innovation primarily in the ICT, ITeS, and Electronics sectors, by providing facilities which are self-sustainable and an environment, which is conducive for attracting investment, expertise and talent from high potential individuals and organizations, thereby generating employment and contributing to the socio-economic development of the State ad the region and building ‘Brand Shillong’ as a preferred investment destination.

INDEX

S.NO.	DESCRIPTION	PAGES
1.	DETAILED PROJECT REPORT (ARCHITECTURE)	1-9
2.	DESIGN BASIS REPORT (STRUCTURE)	10-15
3.	DESIGN BASIS REPORT (PLUMBING & FIRE FIGHTING)	16-74
4.	DESIGN BASIS REPORT (HVAC)	75-148
5.	DESIGN BASIS REPORT (ELECTRICAL)	149-237
6.	LIST OF MAKES	238-259

Contents

A. ARCHITECTURAL DESIGN.....	1
1.1 LOCATION PLAN.....	1
1.2 GOOGLE IMAGE	1
1.3 PROPOSED SITE PLAN	2
1.4 AREA STATEMENT	2
1.5 ARTISTIC IMPRESSION	3
1.6 BUILDING PLANS	6
1.7 COMPARATIVE FACILITIES TO EXISTING IT BUILDING	8
1.8 ESTIMATED COST.....	9
B. STRUCTURE.....	10
1.1. SCOPE OF STRUCTURAL DESIGN	10
1.2. CODES AND STANDARDS FOR STRUCTURAL DESIGN.....	10
1.3. LOADS AND FORCES.....	10
1.3.1. Dead Load (DL).....	10
1.3.2. Live Load (LL)	11
1.3.3. Wind Load (WL)	11
1.3.4. Seismic Load (EQ).....	11
1.4. COMBINATION OF LOADS	12
1.4.1. Load Combination for Concrete Structures	12
1.4.2. Load Combination Used	12
1.4.2.1. Serviceability Combs.....	12
1.4.2.2. Column and Beam.....	13
1.5. CONCRETE STRUCTURES AND FOUNDATIONS	14
1.5.1. Design and calculation.....	14
1.6. DESIGN PARAMETERS.....	14
1.7. SEPARATION BETWEEN ADJACENT UNITS.....	15
1.8. SOIL PARAMETERS.....	15

DETAILED PROJECT REPORT

PROPOSED CONSTRUCTION OF 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG, MEGHALAYA

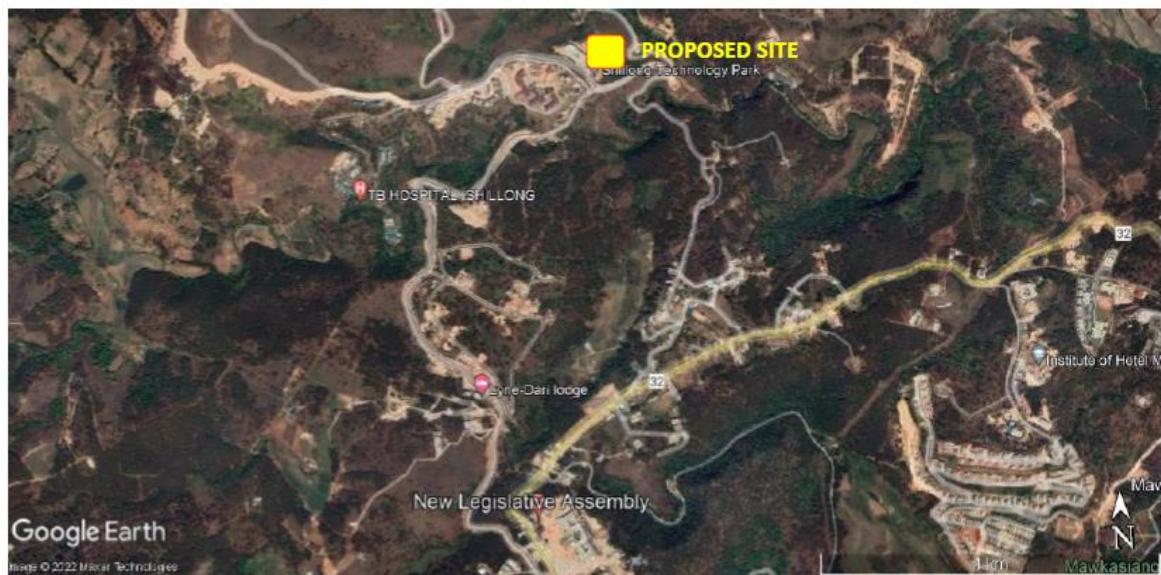
(ARCHITECTURE)



A. ARCHITECTURAL DESIGN

1.1 LOCATION PLAN

LOCATION PLAN



1.2 GOOGLE IMAGE

GOOGLE IMAGE



1.3 PROPOSED SITE PLAN

PROPOSED SITE PLAN



AREA CHART BUILDING		
S.NO.	DESCRIPTION	NEW BUILDING (BUILT UP) (SQ.M.)
1	GROUND FLOOR	3000.00
2	FIRST FLOOR	3000.00
3	SECOND FLOOR	3000.00
4	THIRD FLOOR	3000.00
5	FOURTH FLOOR	3000.00
6	GRAND TOTAL (SQM.)	15000.00

1.4 AREA STATEMENT

AREAS

AREA CHART BUILDING		
S.NO.	DESCRIPTION	NEW BUILDING (BUILT UP) (SQ.M.)
1	GROUND FLOOR	3000.00
2	FIRST FLOOR	3000.00
3	SECOND FLOOR	3000.00
4	THIRD FLOOR	3000.00
5	FOURTH FLOOR	3000.00
6	GRAND TOTAL (SQM.)	15000.00

PARKING CALCULATION				
S.NO.	DESCRIPTION	NEW BUILDING (FAR) (SQ.M.)	PARKING REQUIRED @ ONE CAR FOR 75 SQ.M. AREA	PARKING PROVIDED
1	GROUND FLOOR			
2	FIRST FLOOR	2500.00	33	88 IN GROUND FLOOR & 50 ON SURFACE PARKING
3	SECOND FLOOR	2500.00	33	
4	THIRD FLOOR	2500.00	33	
5	FOURTH FLOOR	2500.00	33	
6	GRAND TOTAL	10000.00	132	138

1.5 ARTISTIC IMPRESSION

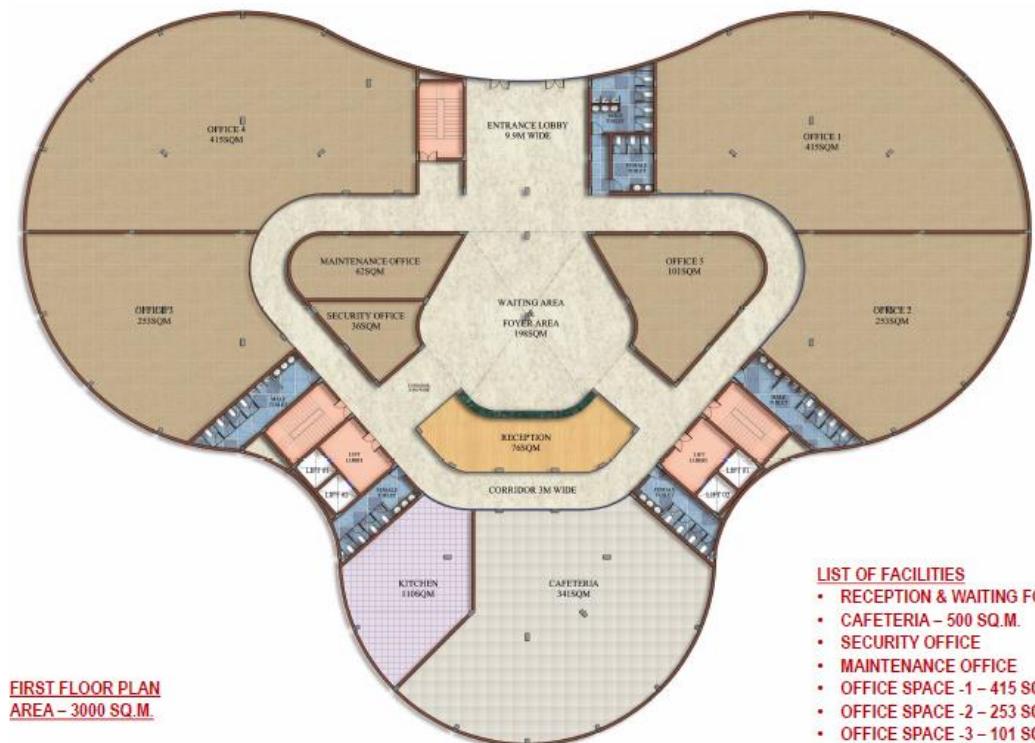
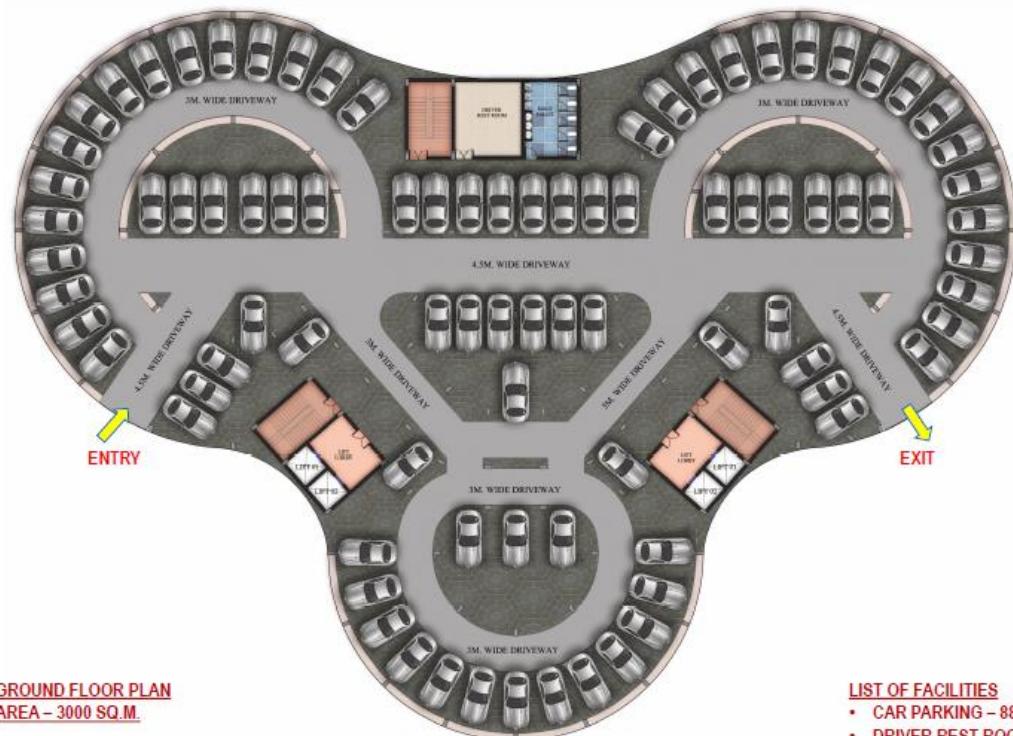
ARTISTIC IMPRESSION

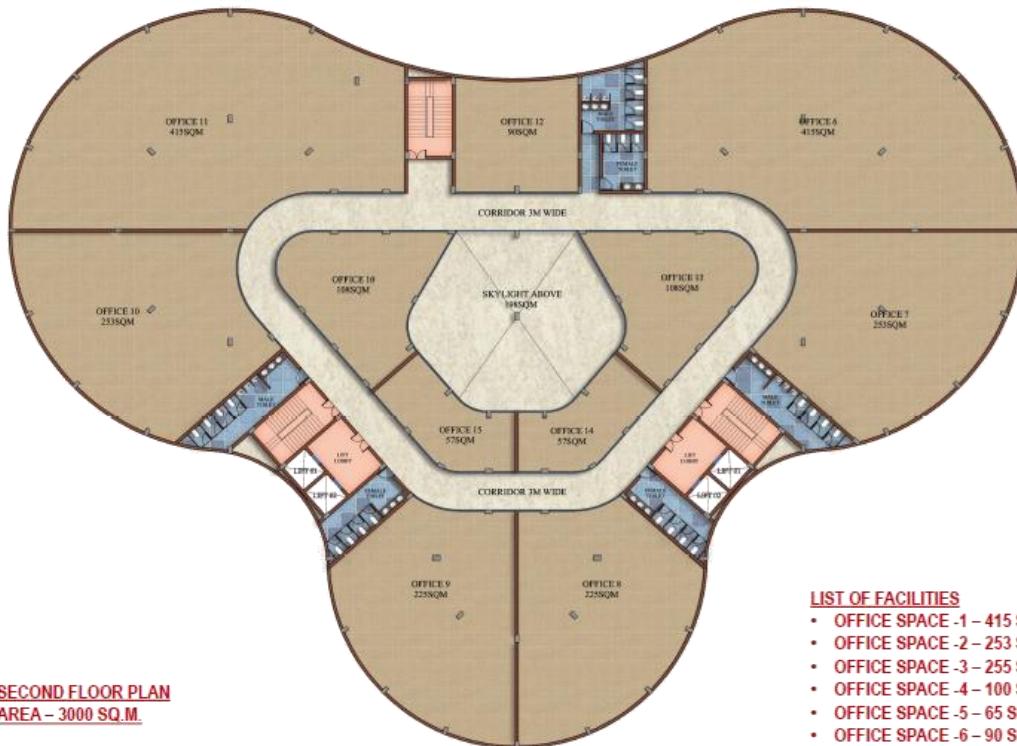






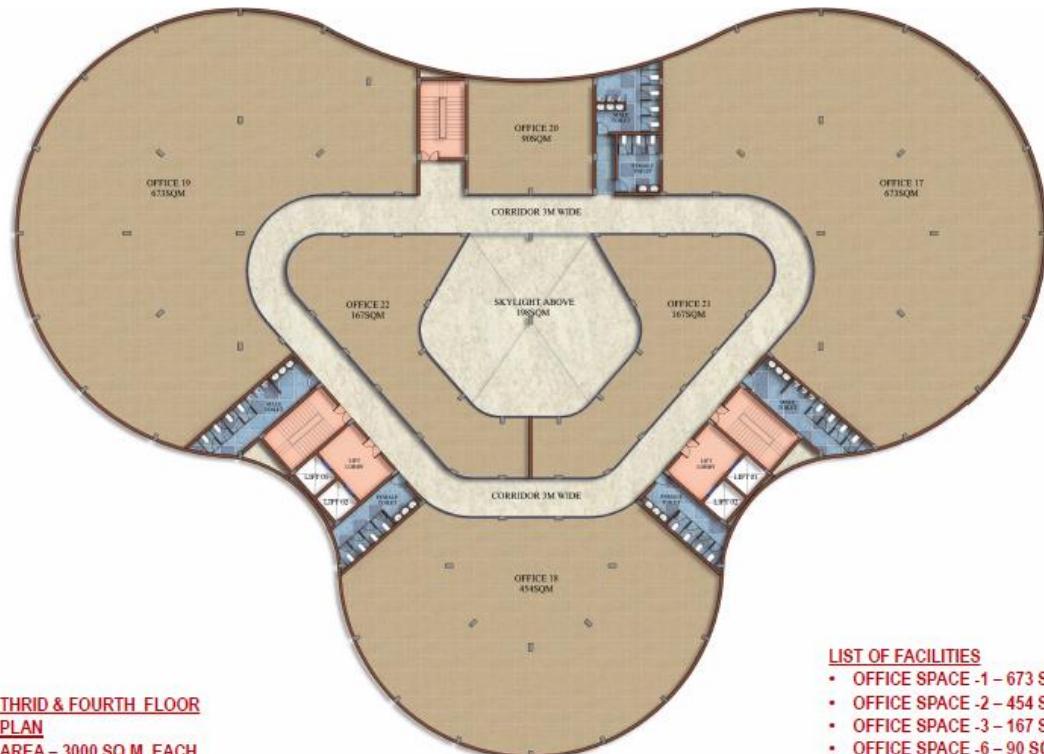
1.6 BUILDING PLANS





LIST OF FACILITIES

- OFFICE SPACE -1 – 415 SQ.M. (2 Nos)
- OFFICE SPACE -2 – 253 SQ.M. (2 Nos)
- OFFICE SPACE -3 – 255 SQ.M. (2 Nos)
- OFFICE SPACE -4 – 100 SQ.M. (2 Nos)
- OFFICE SPACE -5 – 65 SQ.M. (2 Nos)
- OFFICE SPACE -6 – 90 SQ.M. (1 Nos)



LIST OF FACILITIES

- OFFICE SPACE -1 – 673 SQ.M. (2 Nos)
- OFFICE SPACE -2 – 454 SQ.M. (1 Nos)
- OFFICE SPACE -3 – 167 SQ.M. (2 Nos)
- OFFICE SPACE -6 – 90 SQ.M. (1 Nos)

1.7 COMPARATIVE FACILITIES TO EXISTING IT BUILDING

S.NO.	EXISTING IT BUILDING	PROPOSED IT BUILDING
1	ALUMINIUM WINDOW PROVIDED WITH NORMAL GLASS.	UPVC WINDOW WITH DOUBLE GLAZED UNIT PROVISIONED.
2	PLUMBING SYSTEM PROVIDED FOR COMMON TOILETS.	PLUMBING SYSTEM SHALL BE DESIGNED SUCH THAT TOILETS CAN BE CREATED ANYWHERE ON THE FLOOR PLATE.
3	BOILER SYSTEM NOT TAKEN.	WATER HEATING SYSTEM SHALL BE PROVIDED WITH SOLAR AND BOILER SYSTEM.
4	NORMAL FINISHES LIKE VITRIFIED TILE.	SUPERIOR FINISHES EX. GRANITE, VENEER PANELLING, ETC.
5	CENTRALISED UPS SYSTEM ALONE PROVIDED FOR COMMON AREAS.	CENTRALISED UPS SYSTEM WITH STANDBY ONLY FOR COMMON AREAS. INDIVIDUAL UPS BY TENANT.
6	VRV/VRF SYSTEM WITH DUCTING PROVIDED.	VRV/ VRF SYSTEM WITH HEAT PUMPS /HEAT RECOVERY SYSTEMS CONSIDERED FOR BETTER EFFICIENCY & UTILIZATION OF AC SYSTEM.
7	LAN SYSTEM & EPABX SYSTEM PROVIDED. ACCESS CONTROL NOT PROVIDED.	LAN SYSTEM, ACCESS CONTROL, EPABX SYSTEM, CCTV CONSIDERED.
8	NO STP ONLY SEPTIC TANK PROVIDED.	STP CONSIDERED TAKING INTO CONSIDERATION BOTH THE BUILDINGS.
9	NO BMS SYSTEM.	INTEGRATED BUILDING MANAGEMENT SYSTEM SHALL BE INSTALLED.
10	NO GREEN BUILDING FEATURES.	GREEN BUILDING FEATURES SHALL BE INSTALLED.

1.8 ESTIMATED COST

SL.No	Description	Total Amount (In Cr.)
1	CIVIL/INTERIOR WORKS	77.27
2	PLUMBING WORKS	5.26
3	FIRE FIGHTING WORKS	2.37
4	ELECTRICAL WORKS	16.85
5	HVAC WORKS	8.57
6	SUB TOTAL	110.32
7	ADD COST INDEX ON DSR @ 144 OVER BASE 100	2.02
8	DEDUCT FOR GST ON MSOR & DSR@12%	9.72
7	TOTAL PROJECT COST	102.62
8	Add GST @12%	12.31
13	GRAND TOTAL EXCLUDING GST (in Rs.)	114.93

DESIGN BASIS REPORT

PROPOSED CONSTRUCTION OF 2ND IT PARK BUILDING AT SHILLONG TECHNOLOGY PARK, SHILLONG, MEGHALAYA

(STRUCTURE)



B. STRUCTURE

1.1. SCOPE OF STRUCTURAL DESIGN

This criterion covers the structural design basis for concrete Structures for Proposed "**IT PARK, SHILLONG**".

The buildings will be made with RCC framed structure with cast-in-situ columns, beams and slabs to suit the approved/ finalized architectural drawings. The buildings are multi-storey buildings with floors at different levels, as per various architectural drawings.

The buildings shall be as per the Architectural requirement for civil and structural works, standard specifications, relevant I.S. codes and local regulations.

1.2. CODES AND STANDARDS FOR STRUCTURAL DESIGN

All the design shall be based on Indian standard & codes as specified here.

List of Codes and Standards:

- IS-875 (Part 1 To 3)-1987 - Code Of Practice For Design Loads (Other Than Earthquake) For Buildings And Structures
- IS1893-2016 - Criteria For Earthquake Resistant Design Of Structures
- IS-456-2000 - Plain And Reinforced Concrete - Code Of Practice
- IS-13920-2016 - Ductile Detailing Of Reinforced Concrete Structures Subjected To Seismic Forces - Code Of Practice
- IS-800-2007 - Code Of Practice For General Construction, In Steel
- Code IS 1786 -2008 - Specification for high strength deformed steel bars and wires for concrete reinforcement
- SP-34 – Handbook on Concrete reinforcement and Detailing
- SP-16 – Design aids for IS-456

1.3. LOADS AND FORCES

Loads and forces used for design shall be as defined in IS875, and is specified below.

The following type of loads and forces shall be considered.

- Dead load (DL)
- Live load (LL)
- Wind load (WL)
- Earthquake load (EQ)

1.3.1. Dead Load (DL)

Dead load is the load of the structure itself.

Following are the unit weight of major construction materials.

- Reinforced Cement Concrete 25.0 kN/m³
- Plain Cement Concrete 24.0 kN/ m³
- Structural Steel 78.5 kN/ m³

- Saturated soil density 19.5 kN/ m³
- Masonry walls will be with AAC blocks of max density 8 kN/m³ & clay brick of density 19 kN/m³. Walls thickness to be in accordance with Architectural drawings.

1.3.2. Live Load (LL)

Live load for building and structure shall be in accordance with IS875 part 2 unless otherwise specified.

1.3.3. Wind Load (WL)

Wind load to be applied for structures shall be in accordance with IS875 part 3, and noted below.

- Basic wind speed, V_b, Shall be 55m/sec
- Risk coefficient 'K1' shall be equal to 1.0.
- Terrain Height & Structure Height factor 'K2' shall be obtained from table 2 IS 875 part
- Topographic factor K₃ = 1.0

Design wind speed V_z at any height z in m/sec

$$V_z = V_b \times K_1 \times K_2 \times K_3$$

Design wind pressure P_z at any height z in N/m²

$$P_z = 0.6 V_z^2$$

However as either of wind or seismic forces has to be considered at a time, wind loads will not be considered for the design, as they don't govern.

1.3.4. Seismic Load (EQ)

Seismic loads to be applied for structures shall be in accordance with the applicable provision of the IS 1893, 2016 and noted below.

- Seismic Zone Factor, Z, shall be 0.36
- Importance factor I, shall be 1.5
- Soil type=Medium
- Response reduction factor shall be 5 for RCC structures (SMRF).
- Average response acceleration factor

$$A_h = Z/2 \times I/R \times S_a/g$$

$$E = A_h \times W$$

Where 'W' is seismic weight of structure with appropriate live load.

Time period in accordance with IS code of infill wall condition and non-infill condition to be calculated separately. Average of the two values to be considered for design as the frames of the towers are semi infilled.

Ductility provision in detailing of RCC structures shall be considered judiciously based on IS: 13920- 2016 for Lateral force resisting elements of the structure.

1.4. COMBINATION OF LOADS

1.4.1. Load Combination for Concrete Structures

Concrete structural members shall be designed to have, at all sections, a calculated strength necessary to carry the following factored loads and forces as per table 18 of IS 456.

Load Combination	Limit State of Collapse			Limit States of Serviceability		
	DL	IL	WL	DL	IL	WL
(1)	(2)	(3)	(4)	(5)	(6)	(7)
DL + IL		1.5	1.0	1.0	1.0	-
DL + WL	1.5 or	-	1.5	1.0	-	1.0
	0.9⁽¹⁾					
DL + IL + WL		1.2		1.0	0.8	0.8

When the lateral load resisting elements are not oriented along the orthogonal horizontal directions, the structure shall be designed for the effects due to full design earthquake load in one horizontal direction plus 30 percent of the design earthquake load in the other direction.

1.4.2. Load Combination Used

1.4.2.1. Serviceability Combs

LOAD COMB 11 FOOTING (1.0 DL 0.5LL)

3 1.0 4 1.0 5 0.5

* LOAD COMB 12 (1.0 EQX 1.0 DL)

1 1.0 3 1.0 4 1.0

LOAD COMB 13 (1.0 EQZ 1.0 DL)

2 1.0 3 1.0 4 1.0

LOAD COMB 14 (-1.0 EQX 1.0 DL)

1 -1.0 3 1.0 4 1.0

LOAD COMB 15 (-1.0 EQZ 1.0 DL)

2 -1.0 3 1.0 4 1.0

LOAD COMB 16 (0.8 EQX 1.0 DL 0.8 LL)

1 0.8 3 1.0 4 1.0 5 0.8

LOAD COMB 17 (0.8 EQZ 1.0 DL 0.8 LL)

2 0.8 3 1.0 4 1.0 5 0.8

LOAD COMB 18 (-0.8 EQX 1.0 DL 0.8 LL)

1 -0.8 3 1.0 4 1.0 5 0.8

LOAD COMB 19 (-0.8 EQZ 1.0 DL 0.8 LL)

2 -0.8 3 1.0 4 1.0 5 0.8

*****LIMIT STATE OF COLLAPSE*****

1.4.2.2. Column and Beam

LOAD COMB 20 (COL) (1.5 DL 0.75 LL)

3 1.5 4 1.5 5 0.75

LOAD COMB 21 (BEAM)(1.5 DL 1.5 LL)

3 1.5 4 1.5 5 1.5

LOAD COMB 22 (1.5 EQX 1.5 DL)

1 1.5 3 1.5 4 1.5

LOAD COMB 23 (1.5 EQZ 1.5 DL)

2 1.5 3 1.5 4 1.5

LOAD COMB 24 (-1.5 EQX 1.5 DL)

1 -1.5 3 1.5 4 1.5

LOAD COMB 25 (-1.5 EQZ 1.5 DL)

2 -1.5 3 1.5 4 1.5

LOAD COMB 26 (1.5 EQX 0.9 DL)

1 1.5 3 0.9 4 0.9

LOAD COMB 27 (1.5 EQZ 0.9 DL)

2 1.5 3 0.9 4 0.9

LOAD COMB 28 (1.2 EQX 1.2 DL 0.3 LL)

1 1.2 3 1.2 4 1.2 5 0.3

LOAD COMB 29 (1.2 EQZ 1.2 DL 0.3 LL)

2 1.2 3 1.2 4 1.2 5 0.3

LOAD COMB 30 (-1.5 EQX 0.9 DL)

1 -1.5 3 0.9 4 0.9

LOAD COMB 31 (-1.5 EQZ 0.9 DL)

2 -1.5 3 0.9 4 0.9

LOAD COMB 32 (-1.2 EQX 1.2 DL 0.3 LL)

1 -1.2 3 1.2 4 1.2 5 0.3

LOAD COMB 33 (-1.2 EQZ 1.2 DL 0.3 LL)

2 -1.2 3 1.2 4 1.2 5 0.3

1.5. CONCRETE STRUCTURES AND FOUNDATIONS

1.5.1. Design and calculation

All concrete design shall conform to IS456-2000, unless noted otherwise. The detailing of concrete reinforcement shall be in accordance with the requirements given in IS13920-2016.

1.6. DESIGN PARAMETERS

RCC structures shall be designed based on limit state method of design as given in IS: 456-2000 & ductility provision in detailing of RCC structures shall be considered judiciously based on IS: 13920- 2016 for Lateral force resisting elements or the structure. The following parameters shall be used:

RCC GRADE: Minimum M30 for all works, or as per drawings in accordance with clause 6.0 (Table 5)of IS 456-2000 for all.

REINFT STEEL GRADE 500 N/sqmm: High yield strength deformed bars conforming to IS 1786 with minimum yield strength of 500N/sqmm have been considered.

CLEAR COVERS: (clause 26.4 of IS 456:2000 Table 6)

Foundations - 50mm

Columns - 40mm

Beams/Walls - 25mm

Slabs - 20mm

1.7. SEPARATION BETWEEN ADJACENT UNITS

Two adjacent buildings or two adjacent units of the same building with separation joint in between shall be separated by a distance equal to the amount R times the sum of the calculated storey displacements due to earthquake loads, to avoid damaging contact when the two units deflect towards each other.

The force to be considered for calculation of storey displacements shall not be scaled as per Clause 7.8.2, IS 1893:2016. Service load combinations will be used for calculation of the same.

1.8. SOIL PARAMETERS

Allowable bearing capacity in accordance with soil report has to be followed in designing the structures.

TECHNICAL SPECIFICATIONS

PROPOSED CONSTRUCTION OF 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG, MEGHALAYA

(PLUMBING & FIRE FIGHTING)



INDEX

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

28.4	uPVC pipes for SWR system (for soil waste and rain water)	25
28.5	Traps	26
28.5.1	Floor traps.....	26
28.5.2	Urinal traps	26
28.5.3	Floor trap inlet.....	26
28.5.4	Floor Gratings	27
28.5.5	Jointing	27
28.6	Cleanout Plugs (on soil pipes).....	27
28.7	Waste pipe from appliances	27
28.7.1	General.....	27
28.8	Encasing Pipe in Cement Concrete	27
28.9	Testing	27
28.10	Testing Soil, Waste and Rainwater Pipes	27
29	EXCAVATION	28
29.1	Opening out Trenches.....	28
29.2	Obstruction of Roads.....	28
29.3	Removal of Filth.....	28
29.4	Excavation to be taken to Proper Depths.....	28
29.5	Refilling.....	29
29.6	Contractor to Restore Settlement and Damages	29
29.7	Disposal of Surplus Soil	29
29.8	Timbering of Sewer and Trenches	29
29.9	Shoring of Buildings.....	29
29.10	Removal of Water from Sewer, Trench etc.	29
29.11	Width and Depth of Trench	29
30	SCOPE OF WORK.....	30
31	GENERAL REQUIREMENTS	30
32	G.I. PIPES & FITTINGS	31
33	CLAMPS	31
34	UNIONS.....	31
35	FLANGES	31
36	TRENCHES.....	31
37	PAINTING	32
38	PIPE PROTECTION.....	32
38.1	Sand Filling.....	32
39	GUNMETAL VALVES.....	32
40	SLUICE VALVES	32
40.1	Scour Valves:	32
40.2	Air Release Valves	32
41	INSULATION.....	33
41.1	For Chased Internal Pipes.....	33
41.2	For Exposed Piping	33
41.3	Anchor Block	33
42	CPVC PIPES	33
42.1	Joining Pipe & Fittings	33
42.1.1	Cutting	33
42.1.2	Deburing / Beveling	33
42.1.3	Fitting Preparation	33
42.1.4	Solvent Cement Application.....	33
42.1.5	Assembly	33
42.1.6	Set & Cure times:.....	34
42.1.7	Transition of CPVC to Metals	34
42.1.8	Threaded Sealants	34
42.1.9	Hangers & Supports	34
42.2	Concealed Plumbing	34
42.3	Installation procedure	35
43	VALVE CHAMBERS.....	35
44	WATER METERS	35
45	PIPE HANGERS BRACKETS ETC.....	35
46	TESTING	35
47	CONNECTIONS TO WATER TANKS	36

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

48	CONNECTIONS TO MECHANICAL EQUIPMENT SUPPLIED BY OTHER AGENCIES	36
49	DISINFECTION	36
50	PRE COMMISSIONING:	36
51	COMMISSIONING.....	36
52	RESPONSIBILITY.....	37
53	SCOPE OF WORK.....	37
54	GENERAL REQUIREMENTS.....	37
55	FLANGES	38
56	TRENCHES.....	38
57	PIPE PROTECTION.....	38
58	SCOPE OF WORK.....	38
59	GENERAL REQUIREMENTS.....	38
60	ALIGNMENT AND GRADE	39
61	SALT GLAZED STONEWARE PIPES	39
61.1	Laying and Jointing of Stoneware Salt Glazed Pipes	39
61.1.1	Laying of Pipes	39
61.1.2	Jointing of Pipes	40
62	REINFORCED CEMENT CONCRETE PIPES.....	40
62.1	Laying	41
62.1.1	Encasing (all pipes have to be encased)	41
62.2	Jointing	41
62.2.1	Curing	41
63	CEMENT CONCRETE AND MASONRY WORKS FOR MANHOLES AND CHAMBERS ETC.	41
63.1	Materials	41
63.1.1	Water	41
63.1.2	Aggregate for Concrete	41
63.1.3	Sand	41
63.1.4	Cement	41
63.1.5	Mild Steel Reinforcement.....	41
63.1.6	Bricks	42
63.1.7	Other Materials	42
63.2	Cement Concrete (Plain or Reinforced)	42
63.3	Masonry Work	42
63.4	Cement Concrete for Pipe Support	42
64	MANHOLES AND CHAMBERS	42
65	MAKING CONNECTIONS	43
66	COMMISSIONING.....	43
67	DESALTING CHAMBER & RAIN WATER HARVESTING TANK	43
68	DOCUMENTS SUBMISSION	44
69	SCOPE	44
69.1	Work under this Contract consists of.....	44
69.2	The Work Includes.....	45
69.3	Contractor's Experience	45
69.4	Shop Drawings	45
69.5	Other Submittals.....	45
69.6	Execution of Work	46
69.7	Testing & Handing Over	46
69.8	Statutory Permissions	46
69.9	Completion Documents	46
69.10	Performance Guarantee	47
69.11	Defects Liability	47
69.12	Deviations from Tender Specifications.....	47
69.13	Sewage Characteristics.....	47
69.13.1	Design Parameters	47
69.14	Design Consideration	47
69.15	Salient Features	48
69.16	Basis of Design.....	48
69.17	Sewage Treatment Plant.....	48
69.17.1	General	48

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

69.17.2	Description of Process.....	48
69.17.3	Performance Criteria of the Plant	49
69.17.4	Process Description.....	49
69.17.5	Equipment.....	50
69.17.6	Valves	52
70	PIPE SUPPORTS.....	52
70.1	General Support	52
71	INSTALLATION	52
72	TESTING	53
73	ELECTRICAL INSTALLATION	53
74	MOTOR CONTROL CENTRES	53
75	TECHNICAL SPECIFICATION.....	54
76	GENERAL REQUIREMENTS.....	54
77	PIPES	54
78	PIPE FITTINGS.....	54
79	JOINTING.....	55
79.1	Screwed (50 mm dia pipes and below)	55
79.2	Welding (65 mm dia and above)	55
79.3	Flanges	55
79.4	Unions	55
80	PIPE PROTECTION.....	55
81	PIPE SUPPORTS.....	55
82	TESTING	55
83	ANCHOR BLOCK.....	55
84	VALVES	56
84.1	Valves, Gauge and Orifice Plates	56
85	EXTERNAL YARD HYDRANTS.....	56
86	INTERNAL HYDRANTS	56
87	FIRST-AID HOSE REEL EQUIPMENT	56
88	HOSE PIPES, BRANCH PIPES AND NOZZLES.....	56
88.1	Hose Pipes	56
89	BRANCH PIPE.....	57
89.1	Branch Pipes	57
89.2	Nozzle.....	57
90	HOSE CABINET	57
91	FIRE BRIGADE INLET CONNECTIONS.....	57
92	HYDRAULIC SIREN	57
93	VALVE CHAMBERS.....	57
94	PORTABLE FIRE EXTINGUISHER	58
95	SPRINKLER HEADS	58
96	ALARM VALVE & AUTOMATIC WATER MOTOR GONG VALVE	58
97	SHOP DRAWINGS & SPECIFICATIONS	58
98	PUMPS AND WATER TREATMENT EQUIPMENT	59
99	PUMP SET	59
99.1	Water Supply Pumps (Raw Water / Garden Hydrant / Hot Water Recirculation Pump)59	
99.2	Hydro pneumatic Pumps System (Domestic & Flushing Water Supply Pumps)	59
100	SUMP PUMP.....	60
101	FIRE FIGHTING PUMPS	61
101.1	Electrical Operated Main Fire, Sprinkler and Jockey Pumps	61
101.2	Motors for Electric Driven Pumps.....	61
101.3	Air Vessel for Fire Pumps.....	61
101.4	Operating Conditions for the Service Pumps	62
101.5	Diesel Fire Pump	62
101.5.1	Scope.....	62
101.5.2	General	62

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

101.5.3	Drive	62
101.5.4	Fire Pump	62
101.6	Diesel Engine	62
102	CABLES.....	64
103	CABLE TRAYS.....	64
104	EARTHING.....	65
105	CONTROL PANELS / STARTERS.....	65
106	VIBRATION ELIMINATORS.....	65
107	ILLUMINATED FACSIMILE ANNUNCIATOR PANEL	66
107.1	Scope	66
107.2	Illuminated Facsimile Enunciator.....	66
108	WATER FILTER.....	66
108.1	Under Drain System	66
108.2	Face Piping.....	66
108.3	Accessories	66
109	PIPING	67
109.1	Joints	67
109.2	Testing.....	67
110	GUARANTEE.....	67
111	TECHNICAL INFORMATIONS FOR WATER SUPPLY / FIRE FIGHTING PUMPS & EQUIPMENTS AND WATER TREATMENT UNIT ETC.....	68
112	IMPORTANT INSTRUCTION FOR QUALITY OF WATER.....	73
113	EXCLUDED ITEMS FROM THE SCOPE OF PLUMBING & FIRE FIGHTING CONTRACTOR	73
114	REQUIRED QUALITY OF TREATED WATER	73

SPECIAL CONDITION OF CONTRACT

1 SCOPE OF WORK

- Work under this contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely furnish all the Plumbing and other specialized services as described hereinafter and as specified in Plumbing/Fire fighting Drawings.
- Without restricting to the generally of the foregoing shall include the following:-
 - a) Supplying & Fixing of Sanitary Fixtures.
 - b) Soil, Waste, Rain Water and Vent Pipes.
 - c) Water supply including Hot & Cold (Internal & External).
 - d) Pumps, water treatment & allied works.
 - e) External Sewerage system.
 - f) Storm Water Drainage System.
 - g) Sewage Treatment Plant
 - h) Fire Fighting System
- The Contractor must get acquainted with the proposed site for the works and study Specifications and Conditions carefully before Tendering. The work shall be executed as per programme approved by the Engineer-in- Charge. If part of site is not available for any reason or there is some unavoidable delay in supply of materials stipulated by the Owner, the programme of construction shall be modified accordingly and the Contractor shall have no claim for any extras or compensation on this account.
- Works area shall be the area shown in the drawing.

2 SPECIFICATIONS

Work under this contract shall be carried out strictly in accordance with Specifications attached with the Tender & as per C.P.W.D. specifications 1996 Volumes I to VI.

Items not covered under these Specifications due to any ambiguity or misprints, or additional works, the work shall be carried out as per Specifications of the latest Central Public Works Department with latest amendments as applicable in the contract.

Works not covered as mentioned above shall be carried out as per relevant Indian Standards Specifications or Codes of Practice.

The work shall be carried out strictly as specified in Drawings & Technical Specifications. In case of any ambiguity, the details of particular item as given in specification shall supersede the details in Drawings.

3 EXECUTION OF WORK

The work shall be carried out in conformity with the individual services drawings and within the requirements of Architectural, HVAC, Electrical, Structural and Other specialized services drawings.

The Contractor shall cooperate with all trades and agencies working on the site. He shall make provision for hangers, sleeves, structural openings and other requirements well in advance to prevent hold up of progress of the construction programmed.

On award of the work, Contractor shall submit a programmed of construction in the form of a PERT Chart or Bar Chart for approval of the Engineer-in- Charge All dates and time schedule agreed upon should be strictly adhered to, within the stipulated time of completion/commissioning along with the specified phasing, if any.

4 DRAWINGS

All the drawings are diagrammatic but shall be followed as closely as actual construction permits. Any deviations made shall be in conformity with the Architectural and other services drawings.

Architectural drawings shall take precedence over Plumbing or other services drawings as to all dimensions.

Contractor shall verify all dimensions at site and bring to the notice of the Architects or Engineer-in-Charge all discrepancies or deviations noticed. Architects decision shall be final.

Large size details and manufacturers dimensions for materials to be incorporated shall take precedence over small-scale drawings.

All drawings supplied with the Tender shall be returned in good conditions along with the Tender.

All drawings/sketches issued by the Architects/Consultant for the works are the property of the Architects/Consultant and shall not be lent, reproduced or used on any works other than intended without the written permission of the Architects/Consultant.

5 INSPECTION AND TESTING OF MATERIALS

Contractor shall be required, if requested, to produce manufacturers Test Certificate for the particular batch of materials supplied to him. The tests carried out shall be as per the relevant Indian Standards.

For examination and testing of materials and works at the site Contractor shall provide all Testing and Gauging Equipment necessary but not limited to the followings:-

- a) Theodolite
- b) Dumpy level
- c) Steel tapes
- d) Weighing machine
- e) Plumb bobs, Spirit levels, Hammers
- f) Micrometers
- g) Thermometers, Stoves
- h) Hydraulic test machine
- i) Smoke test machine

All such equipment shall be tested for calibration at any approved laboratory, if required by the Engineer-in-Charge.

All Testing Equipment shall be preferably located in special room meant for the purpose.

6 METRIC CONVERSION

All dimensions and sizes of materials and equipment given in the Tender document are commercial metric sizes.

Any weights, or sizes given in the Tender having changed due to metric conversion, the nearest equivalent sizes accepted by Indian Standards shall be acceptable without any additional cost.

7 REFERENCE POINTS

Contractor shall provide permanent Bench Marks, Flag Tops and other reference points for the proper execution of work and these shall be preserved till the end of the work.

All such reference points shall be in relation to the levels and locations given in the Architectural and Plumbing drawings.

8 SHOP DRAWINGS

The Contractor shall submit to the Engineer-in-Charge six copies of the shop drawings.

Shop drawings shall be submitted under following conditions:-

- Contractor shall prepare shop drawings of plumbing / Fire fighting /Sewerage treatment plant etc, for the entire building within four weeks of the award of work. These drawings shall be

submitted to the Engineer-in-Charge for approval and the work shall be executed at site on the basis of these approved drawings.

- Large scale drawings showing typical details for Toilets & Fixtures.
- Equipment layout, piping and wiring diagram.
- Structural supports/hanging/laying and jointing details for all types of pipes as required.
- Layout plans as required and for any changes in the layout of Plumbing / Architectural Drawings.

9 AS BUILT DRAWINGS

The Contractor shall maintain one as built copy of all Drawings, Specifications, Addenda variations, approved submittals, correspondence, and transmittals at the site in good order and readily available to the Owner and the Engineer-in-Charge. The As built Drawings shall be clearly and correctly marked and as built specifications annotated by the Contractor to show all changes made during the construction process at the time the changed Work is installed. No such changes shall be made in the Work unless previously authorized by the change order or by specific approval of deviations or revisions in submittals.

The Contractor shall prepare and furnish to the Architect / services consultant accurate as built drawings. Architect / Services consultant shall approve these drawings after due verification at site. After approval, the contractor shall submit to Engineer-in-Charge, A1 size three (3) black line white paper prints as well as soft copy in form of CD of each drawing as part of close out documents. Project manager shall forward the same to the owner for their records and for maintenance and operation.

The as built drawings must have the following information:

The works as executed complete with:

- Run of all piping & diameters on all floors and vertical stacks.
- Ground and invert levels of all drainage pipes together with location of all manholes and connections up to out fall.
- Run of all water supply lines with diameters, locations, of Control Valves, Access Panels.
- Location of all Mechanical equipment with whole plant layout, piping connections and panels as erected.
- Details of supports left in place and locations of all services encountered.
- Complete schematic diagram of the installation, as installed.
- Complete Schematic flow diagram for Sewage treatment plant.
- Complete layout plan of Sewage treatment Plant.
- Hot water system layout and Schematic of the system

10 CONTRACTORS RATES

Rates quoted in this Tender shall be inclusive of cost of materials, labour, supervision, erection, tools, plant, scaffolding, service connections, transport to site, GST, breakage, wastage and all such expenses as may be necessary and required to completely do all the items of work and put them in a working condition.

Rates quoted are for all heights and depths required for this work.

All rates quoted are inclusive of cutting holes and chases in walls and floors and making good the same with cement mortar/concrete of appropriate mix and strength as directed by Engineer-in-Charge. Contractor shall provide holes, sleeves and recesses in the concrete and masonry work as the work proceeds.

Rates quoted shall be inclusive of cost incurred in testing, commissioning of works and materials.

11 TESTING

Piping and drainage works shall be tested as specified under the relevant clauses of the specifications.

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

Tests shall be performed in the presence of the Engineer-in-Charge / Consultant.

All materials and equipment found defective shall be replaced and whole work tested to meet the requirements of the specifications.

Contractor shall perform all such tests as may be necessary and required by the local authorities to meet Municipal or other bye-laws in force.

Contractor shall provide all labour, equipment and materials for the performance of the tests.

Contractor shall afford all the expenses for the offsite testing of material and equipments.

12 SITE CLEARANCE AND CLEANUP

The Contractor shall, from time to time clear away all debris and excess materials accumulated at the site.

After the Fixtures, equipment and appliances have been installed and commissioned, Contractor shall clean-up the same and remove all plaster, paints stains, stickers and other foreign matter of discolouration leaving the same in a ready to use condition.

On completion of all works, Contractor shall demolish all stores, remove all surplus materials and leave the site in a broom clean condition, failing which the same shall be done at Contractors risk and cost.

13 LICENSE AND PERMITS

Contractor must hold a valid Plumbing license issued by the Municipal Authority or other competent authority under whose jurisdiction the work falls.

Contractor must keep constant liaison with all relevant authorities and shall be responsible for obtaining all approvals relating to water supply, sewerage, drainage and fire fighting system. He shall also be responsible for co-ordination for getting the approval, with other agencies working on the project relating to their scope of work.

Contractor shall obtain No Objection Certificate before commencement of work, from the local authorities all related to his work as required for the building.

Contractor shall obtain, from the local authorities all related completion certificates with respect to his work as required for occupation of the building.

All inspection fees or submission fees paid by the Contractor shall be reimbursed by the Owner on production of valid official receipts.

14 CUTTING & MAKING GOOD

No structural member shall be chased or cut without the written permission of the Engineer-in-Charge.

15 MATERIALS

All materials used in the works shall conform to the Tender specifications.

As far as possible materials bearing I.S. certification marks shall be used with the approval of the Engineer-in-Charge.

Unless otherwise specified and expressly approved in writing by the Engineer- in-charge, materials of makes and specifications mentioned with Tender shall be used.

TECHNICAL CONDITION OF CONTRACT

SECTION – I : SANITARY FIXTURES & FITTINGS

16 SCOPE OF WORK

Work under this section shall consist of furnishing all labor as necessary and required to completely install all Sanitary Fixtures, Brass and Chromium plated fittings and accessories as required by the drawings and specified hereinafter.

Without restricting to the generally of the foregoing the Sanitary Fixtures shall include all Sanitary Fixtures, C.P. fittings and Accessories etc. necessary and required for the Building.

Whether specifically mentioned or not all Fixtures and appliances shall be provided with all fixing devices, nuts, bolts, screws, hangers as required.

Testing of all fixture and fittings shall be done as per Indian standard.

17 GENERAL REQUIREMENTS

All Fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Drawing, Specifications and Drawings.

All Fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per Architectural/Interior designer's requirements. Wherever necessary the fittings shall be centered to dimensions and pattern desired.

Fixing screws shall be half round head Chromium Plated brass with C.P. washers wherever required as per directions of Engineer-in-Charge.

All Fittings and Fixtures shall be fixed in a neat workman like manner true to Levels and Heights shows on the drawings and in accordance with the manufacturer's recommendations. Care shall be taken to fix all Inlet and Outlet Pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling or terrace shall be made good at Contractors cost.

When directed, Contractor shall install Fixtures and accessories in a mock-up room for the approval of the Engineer-in-Charge Sample room Fixtures may be reused on the works if undamaged, but no additional payment for fixing or dismantling shall be admissible.

17.1 Supporting and Fixing Devices

The contractor shall provide all supporting and fixing devices necessary to install the sanitary fixtures and fittings securely in position. The fixing devices shall be rigidly anchored into the building structure. The devices shall be rust resistant and shall be so fixed that they do not present an unsightly look in the final assembly. Where the location demands, the Architects may instruct the contractor to provide chromium plated or other similarly finished fixing devices. In such circumstances the contractor shall arrange to supply fixing devices and install them complete with appropriate vibration isolating pads, washers and gaskets.

17.2 Final Installation

The contractor shall install all sanitary fixtures and fittings in their final position in accordance with approved trial assemblies and as shown on drawings. The installation shall be complete with all supply and waste connections. The connection between building piping system and the sanitary fixtures shall be through proper unions and flanged to facilitate removal/replacement of sanitary fixtures without disturbing the built in piping system. All unions and flanges shall match in appearance with other exposed fittings.

Fixtures shall be mounted rigid, plumb and true to alignment. The outlets of water closet pans and similar appliances shall be examined to ensure that outlet ends are butting on the receiving pipes

before making the joints. It shall be ensured that the receiving pipes are clear of obstruction. When fixtures are being mounted, attention shall be paid to the possibility of movement and settlement by other causes. Overflows shall be arranged as to give visible warning and discharge. A check shall be made to ensure that necessary anchoring devices have been provided for supporting water closets, wash basins, sinks and other appliances.

Joints/gaps between all sanitary appliances/fixtures and the floor/walls shall be caulked with an approved mildew resistant sealant, having antifungal properties, of color and shade to match that of the appliances/fixture and the floor/wall to the extent possible.

17.3 Protection against Damage

The contractor shall take every precaution to protect all sanitary fixtures against damage, misuse, crazing, staining breakage and pilferage by providing proper wrapping and locking arrangement till the completion of the installation. At the time of handing over, the contractor shall clean, disinfect and polish all fixtures and fittings. Any fixtures and fittings found damaged, cracked chipped, stained or scratched shall be removed and new fixtures and fittings free from defects shall be installed at his own cost to complete the work.

18 EUROPEAN W.C.

European W.C. shall be wash down, single or double siphonic type, wall mounted set, flushed by means of exposed cistern, as specified in Drawing. Flush pipe/bend shall be connected to the W.C. by means of suitable rubber adapter. Wall hung W.C. shall be supported by C.I. floor mounted chair.

Each W.C. seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C.

Each W.C. shall be provided with 110mm dia (OD) PVC connector connecting the ceramic outlet of W.C.

19 URINALS

Urinals shall be flat backing large details as per BOQ item.

Flat back Urinals shall be provided with 15 mm dia C.P. spreader, 32 mm dia C.P. domical waste and C.P. cast brass bottle trap with pipe and wall flange, and shall be fixed to wall by one C.I. bracket and two C.I. wall clips as recommended by manufacturers complete and as directed by Engineer-in-Charge.

Flat back urinals shall be fixed with C.P. Brass screws and shall be provided with 32 mm dia Domical Waste leading to Urinal trap.

Urinals shall be flushed by means of sensor operated flush system.

Waste pipes for urinals shall be of the following:

19.1 G.I. Pipes

Waste pipes may be exposed on wall or concealed in chase as directed by the Engineer-in-Charge. Specifications for waste pipes shall be same as given in Sub Section.

20 FLUSHING CISTERN

Flushing cistern shall be concealed or Exposed type design for low volume dual flushes 3 Ltrs & 6 Ltrs as directed by Engineer-in-Charge or mentioned in the drawing.

21 LAVATORY BASIN

Lavatory Basins shall be white glazed vitreous china of size, shape and type as indicated in architectural drawings.

Each Basin shall be provided with MS. or C.I. brackets and clips and the basin securely fixed to wall. Placing of Basins over the brackets without proper securing and fixing shall not be accepted.

Each Basin shall be provided with 32mm dia C.P. waste with overflow, pop-up waste or rubber plug and chain, 32mm dia C.P. Brass Bottle Trap with C.P. pipe to wall and flange.

Each basin shall be provided with CP brass push type self closing pillar tap or Single hole Mixing Fitting as mentioned in the drawing.

Basins shall be fixed at proper heights as shown on architecture drawings. If height is not specified, the rim level shall be 79 cms above the floor or as directed by Engineer-in-Charge.

22 SINKS

Sinks shall be of precast Terrazzo marble or White Glazed fire clay or vitreous china or stainless steel or any other material as specified in the architectural drawing.

Hand Wash Sinks and Process Sinks shall be of stainless steel.

Each sink shall be provided with M.S. or C.I. brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable angle iron clips or brackets as recommended by the manufacturer. Each sink shall be provided with 40 mm dia C.P. waste with chain and plug or P.V.C. waste. Fixing shall be done as directed by Engineer-in-Charge.

Fittings for sinks shall be mixing fittings or as specified in the architectural drawing.

23 ACCESSORIES

Accessories shall be of any of the following types:

- Towel rails

Towel rail shall be C.P brass of size 610mm long and 20mm dia, and fixing with C.P brass brackets fixed to wooden cleats with C.P. brass screws.

- Towel rings

Towel rail shall be C.P brass of size 150mm dia, and fixing with C.P brass brackets fixed to wooden cleats with C.P. brass screws.

- Toilet paper holder

Toilet paper holder shall be of Satin finish stainless steel AISI 316 grade wall mounted type fixed to wooden cleats with C.P. brass screws.

- Hand Dryer

Hand dryer shall be of best quality, to be operated with 230 volts, single phase, with fully hygienic condition, with all accessories and fixing in the wall as mention in the Architectural drawing or as directed by Engineer-in-Charge.

- Coat hooks

Coat hooks shall be of satin finish stainless steel AISI 316 grade wall mounted coat hooks fixed to wooden cleats with C.P. brass screws or as directed by Engineer-in-Charge.

- Soap dispensers

Soap dispensers shall be of satin finish stainless steel AISI 316 grade wall mounted liquid soap dispenser with indicator having bottom trough of soap fixed to wooden cleats with C.P. brass screws or as directed by Engineer-in-Charge.

- Soap dispensers

Soap dispensers shall be of satin finish stainless steel AISI 316 grade wall mounted liquid soap dispenser with indicator having bottom trough of soap fixed to wooden cleats with C.P. brass screws or as directed by Engineer-in-Charge.
Accessories shall be fixed with stainless steel half round head screws and cup washers in wall with rawl plugs or nylon sleeves and shall include cutting and making good.

Porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement : 2 coarse sand) and fixed in relation to the tiling work. The flange of the recessed fixture shall cover the recess in the wall fully.

Contractor shall install all Chromium Plated and porcelain accessories as shown on the drawings or directed by Engineer-in-Charge.

All C.P. Accessories shall be fixed with C.P. brass half round head screws and cup washers in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by Engineer-in-Charge.

Porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work.

24 URINAL PARTITIONS

Urinal partitions shall be Frosted Safety Glass: 8 mm glass urinal partition.

Porcelain partitions shall be fixed at proper heights with C.P. brass bolts, anchor fasteners and M.S. clips as recommended by the manufacturer and directed by Engineer-in-Charge.

25 TOILET FOR THE DISABLED

Where specified, in washroom facilities designed to accommodate physically disabled, accessories shall be provided as per the NBC Norms for Disable Persons architectural drawing or as directed by the Engineer-in-Charge.

Stainless steel grab bars of 600mm long suitable for expose mounting and penned non-slip gripping surface shall be provided in washroom for disabled persons. The flushing cistern shall be provided with chromium plated long handles.

26 TESTING AND ACCEPTANCE

Testing is done as per BS-5572 of **Make & Model of Sanitary fixture & fittings**

SECTION – II INTERNAL DRAINAGE SOIL, WASTE & VENT PIPES

27 SCOPE OF WORK

Work under this section shall consist of furnishing all labor, materials, equipments and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes as required by the drawings, specified hereinafter and as directed by the Engineer-in-Charge.

Without restricting to the generally of the foregoing, the soil, waste, vent and rainwater pipes system shall include the followings:-

- Vertical and horizontal Soil, Waste and Vent Pipes, Rainwater Pipes and Fittings, Joints Clamps and connections to Fixtures.
- Connection of pipes to Gully Traps & Manholes etc.
- Floor and urinal traps, cleanout plugs, inlet fittings and rainwater heads as specified.
- Waste pipes connections from all Fixtures e.g. wash basins, sinks, urinals and kitchen equipments.
- Testing of all pipes.

28 GENERAL REQUIREMENTS

All materials shall be new of the best quality conforming to specifications and subject to the approval of Engineer-in-Charge.

Soil, waste and vent pipes in shafts, ducts and in concealed areas i.e. (false ceiling) shall consist of uPVC, SWR Pipe.

Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified. Pipes shall as far as possible be kept 50mm clear of wall.

Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.

Every waste pipes shall discharge above the grating of properly trapped gully. Contractor will ensure that this requirement is adequately met with. Wherever floor traps are provided it shall be ensured that at-least one washbasin/washing trough is connected to such floor traps to avoid drying of water seal in the trap.

All traps on branch soil and waste pipes shall also be ventilated at a point not less than 75mm or more than 300mm from their highest part and on the side nearest to the soil pipe or waste pipe.

All works shall be executed as directed by Engineer-in-Charge.

28.1 Soil, Waste & Vent Pipes

- a) The Soil & Waste pipe system above ground has been planned as a "two pipe system" as defined in IS: 5329, having separate pipes for waste from kitchen sinks, showers, washbasins, AHU's condensate drains and floor drains . Waste stacks have been provided with a "P" trap at basement ceiling.
- b) All waste water from AHU's, A.C. plant and pump rooms, floor channels in basements will be provided with a deep seal trap before connecting to the main drain or vertical stack.
- c) Vertical soil & waste stacks shall be connected to a common horizontal drain pipe at basement ceiling/ground floor level or to an external manhole directly wherever feasible as shown on the drawings.
- d) All soil and waste from areas below general ground level (Basements) will be collected in sumps and pumped into sewer lines.
- e) Anti-siphonage pipe (ASP) shall be provided for soil fittings on vertical stacks. It may also be provided for waste lines where shown on the drawings.
- f) Vent pipes shall be provided at all sewer lines at the starting manholes.
- g) Soil and Waste pipe used in shall be HCl Pipes. All pipes shall be straight and smooth and inside free from irregular bore, blowholes, cracks and other manufacturing defects. Pipes shall be HCl.
- h) **Connection of pipe:** All HCl Pipe shall be connected with stainless steel coupling with EPDM Rubber.

28.2 Rainwater Pipes

- a) All terraces shall be drained by providing down-takes rainwater pipes.
- b) A separate piped drainage system for sloping roof with leaders shall be provided.
- c) Rainwater pipes are separate and independent connected to the external storm water drainage system as shown on the drawings.
- d) Rainwater in enclosed courtyards shall be collected in catch-basins and connected to storm water drains.

- e) Any dry weather flow from waste appliances, AHU's pump rooms, shall be connected to the sewerage system only.

28.3 Balcony/Planter drainage

Open balconies, terraces, planters and formal landscape areas will be drained by a separate pipe connected to external storm water drainage system.

28.4 uPVC pipes for SWR system (for soil waste and rain water)

Pipes

- All pipes shall be straight and smooth and inside free from cracks and other manufacturing defects. Pipes shall be conforming to I.S. 13952 type A for rain water.
- Pipes shall be joined by approved type of socket and 'O' rubber ring (confirms to I.S. 5382) joints with rubber lubricant.

Fittings

- Fittings shall conform to the Indian Standard recommended for the pipes. Pipes and fittings must be of matching I.S. Specification. Interchange of pipes of one standard with fittings on the other standard will not be permitted.
- Fittings shall be of the required degree of curvature with or without access door.
- Connection from a vertical stack or position to a horizontal line shall be made only by a "Y" junction.
-

Fixing

- All vertical pipes shall be fixed truly vertical to walls with approved type of uPVC saddle clamp. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard). However shaft where more vertical pipes run, the pipes may be fixed to the slotted angle/channel supports fixed to walls at intervals specified here under:-
- Horizontal pipes running along ceiling shall be fixed on **galvanized structural adjustable clamps** (Clevis clamps) of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.
- Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the Engineer-in-charge for making such provisions in the structure as necessary. All damages shall be made good to restore the surfaces at no extra cost.

Clamps

- Holder bat clamps shall be of standard design and fabricated from **galvanized M.S. standard flats** 40x3 mm thick and 12 mm dia M.S. Rod and 6 mm nuts and bolts. Holder bat clamps shall be fixed in cement concrete 1:2:4 mix blocks 10x10x10 cms deep.
- Where holder bat clamps are to be fixed in RCC column or slotted angles, walls or beam they shall be fixed with **galvanized** 40x3 mm flat iron "U" type clamps with anchor fasteners of approved design or 6 mm nuts and bolts.
- For SWR pipes conforming to IS 13592 shall be clamped to wall with approved type of uPVC saddle clamp/ U-clamp or as given in the Bill of quantities.
- Structural clamps shall be fabricated by electro-welding from M.S. structural members e.g. rods, angles, channels flats as per detailed drawing. Contractor shall provide all nuts & bolts, welding material. All fabricated clamps, nuts, bolts and washers shall be not dipped galvanized.
- Galvanized slotted angle/channel supports on walls shall be provided wherever shown on drawings. Angles/channels shall be of sizes shown on drawings or specified in schedule of quantities. Angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with suitable anchor fasteners. The spacing of support bolts horizontally shall not exceed 1 m.
- Wherever M.S. clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement and making good with cement concrete 1:2:4 mix (1 cement :2 coarse sand :4 mm stone aggregate 20 mm nominal size) as directed by the Engineer-in-Charge.
- For sleeves, anchor fasteners and clamp spacing chart shall be as follows:

CLAMP AND PIPE SUPPORT SPACING

S.No.	Type of Pipes & Position	<----- Commercial Pipe Dia.(Spacing in m) ----->						
		15/20	20/25	32/40	50	75/80	100/110	150/160
1	Vertical Pipes							
1.1	GI /MS Pipes	2.4	2.4	3		3.6	4.5	5.4
1.2	uPVC Pipes	x	x		<----- 1 m ----->			
	SWR Pipes							
	IS 13592							
1.3	uPVC /cPVC Pipes	x	x	x		<----- 1 m ----->		
	IS 4985 for Water Supply							
	IS 13585 for SWR	x	x	0.5		0.7	0.9	0.9
2	Horizontal Pipes							
2.1	GI /MS Pipes	<----2.0 m ---->		2.4 m	3	3.6	4	4.5
2.2	uPVC pipes				<----- 1.0 m ----->			
	SWR Pipes							
	IS							
	Water Supply Pipes uPVC							
	IS 4985							
2.3	Fittings	All traps and tees and fittings running below ceiling shall be supported on both sides						

28.5 Traps

28.5.1 Floor traps

Floor traps shall be siphon type full bore P or S type cast iron having a minimum 50 mm deep seal. The trap and main waste pipes in toilets having 150 mm sinking shall run below slab and shall be supported from the ceiling below. The trap and waste pipes in sunken area (where required) shall be set in cement concrete blocks firmly supported on the structural floor. The blocks shall be in 1 : 2 : 4 mix (1 cement :2 coarse sand :4 stone aggregate 20 mm nominal size) and extended to 40 mm below finished floor level. Contractor shall provide all necessary shuttering and centering for the blocks. Size of the block shall be 30x30 cms of the required depth.

28.5.2 Urinal traps

Urinal traps/horn shall be cast iron P or S traps with or without vent shall be fixed as specified for floor traps.

28.5.3 Floor trap inlet

Bath room traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a special type inlet fitting fabricated from uPVC pipe without, with one, two or three inlet sockets fixed on side to connect the waste pipe. Joint between waste and hopper inlet socket of the trap shall be joined with solvent cement recommended by the manufacturer. Inlet shall be connected to a uPVC. P or S trap. Floor trap inlet hoppers and the traps if set in cement concrete blocks as specified in para above without extra charge. uPVC multi-inlet trap can be used where ever possible to be decided by the Engineer-in-Charge.

Trap & Seals

All traps shall be self cleaning design and the seal depth shall be as specified below wherever the traps are not integral with the appliances:

Appliance or ware	Material	Trap Type	Seal depth(mm)
Lavatory /wash basin	C.P. cast brass	32 mm dia Bottle	75 mm
Sink	C.P. cast brass	40 mm dia Bottle	75 mm
Kitchen floor drain of fabricated drain boxes	uPVC/C.I.	75/100 mm dia 'P' or 'S'	50 mm
Urinals	uPVC/C.I.	100 mm dia 'P' or 'S'	50 mm
AHU's	uPVC/C.I.	75 mm dia 'P' or 'S'	50 mm

28.5.4 Floor Gratings

Floor and urinal traps shall be provided with 100-150mm square or round C.P./ Stainless steel grating, with rim of approved design and shape. Minimum thickness shall be 4 mm.

28.5.5 Jointing

Pipe to pipe and pipe to fitting (SWR) joint shall be with 'O' rubber ring as recommended by the manufacturer. Jointing with solvent cement shall be applied to uPVC waste pipes (confirming to I.S. 4985) and fittings or as recommended by the manufacturer's.

28.6 Cleanout Plugs (on soil pipes)

32.6.1 uPVC Clean out pipe for Soil, Waste or Rainwater pipes laid under floors shall be provided near pipe junctions bends, tees, "Ys" and on straight runs at such intervals as required as per site conditions. Cleanout pipe shall terminate flush with the floor levels.

32.6.2 Cleanout on Drainage Pipes

Cleanout pipe shall be provided on starting point of each drain and in between at locations indicated on plans or directed by the Engineer-in-Charge Cleanout pipe shall be of size matching the full bore of the pipe but not exceeding 160 mm OD.

Cleanouts at ceiling level pipe shall be provided with a bend terminating at floor level above. The cap of the cleanout pipe shall have a cap flush with floor.

28.7 Waste pipe from appliances**28.7.1 General**

- a) Waste pipe from appliances e.g. wash basins, sinks and urinals shall be of uPVC pipes 40, 50 or 63 mm OD conforming to IS:4985 class II (6 kg/cm²) shown on the drawings.
- b) All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required pipes may be run at ceiling level in suitable gradient and supported on galvanized structural clamps. Spacing for clamps for such pipes shall be as per the pipe spacing chart given in section 1.

28.8 Encasing Pipe in Cement Concrete

uPVC soil and waste pipes and drainage under floor in sunken slabs and in wall chases (when cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement :2 coarse sand : 4 stone aggregate 12 mm size) 75 mm in bed and all-round. When pipes are running well above the structural slab, the encased pipes shall be supported with suitable cement concrete pillars of required height at intervals of one meter.

28.9 Testing

Testing procedure specified below apply to all soil, waste and vent pipes above ground including pipes laid along basement ceiling.

Entire drainage system shall be tested for water tightness during and after completion of the installation. No portion of the system shall remain untested. Contractor must have adequate number of expandable rubber/bellow plugs, manometers, smoke testing machines, pipe and fitting work test benches and any other equipment necessary and required to conduct the tests. All testing equipment/motors etc. shall be certified for its calibration by an approved laboratory.

All materials obtained and used on site must have manufacturer's Hydraulic Test Certificate for each batch of materials used on the site.

28.10 Testing Soil, Waste and Rainwater Pipes

Apart from factory test all pipes and fittings shall be hydraulically tested for a head of 3 m preferably on a specially set up work bench. After applying pressure, strike the pipe with a wooden pallet and

inspect for blow holes and cracks. Pressure may be applied for about 2 minutes. Reject and remove all defective pipes.

After installation all connections from fixtures, vertical stacks and horizontal drains including pipes along ceiling shall be tested to a hydraulic pressure not exceeding 3 m. Such tests shall be conducted for each floor separately by suitable plugs.

After the installation is fully complete, it should be tested by flushing the toilets, running at least 20% of all taps simultaneously and ensuring that the entire system is self draining, has no leakages, blockages etc. Rectify and replace where required.

Contractor shall maintain a test register identifying date and time of each area. All tests shall be conducted in presence of Engineer-in-Charge and signed by both.

SECTION – III EXCAVATION FOR PIPE LINE

29 EXCAVATION

The excavation for pipe works shall be open cutting unless the permission of the Engineer-in-Charge for the ground to be tunneled is obtained in writing. Where sewers have to be constructed along narrow passages, the Engineer-in-Charge may order the excavation to be made partly in tunnel and in such cases the excavated soil shall be brought back later on for refilling the trenches or tunnel.

29.1 Opening out Trenches

In excavation the trenches, etc. the solid road metal lining, pavement, curbing etc. and turf is to be placed on one side and preserved for reinstatement when the trenches or other excavation shall be filled up. Before any road metal is replaced, it shall be carefully shifted. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the Engineer-in-Charge and of the Owners of the roads or other property traversed and the Contractor shall not cut out or break down any live fence or trees in the line of the proposed works but shall tunnel under them, unless the Engineer-in-Charge shall order to the contrary.

The Contractor shall grub up and clear the surface over the trenches and other excavations of all trees, stumps roots and all other encumbrances affecting execution of the work and shall remove them from the site to the approval of the Engineer-in-Charge.

29.2 Obstruction of Roads

The Contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street and sufficient space shall then be left for public and private transit, he shall remove the materials excavated and bring them back again when the trench is required to be refilled. The Contractor shall obtain the consent of the Engineer-in-Charge in writing before closing any road to vehicular traffic and the foot walks must be clear at all times.

29.3 Removal of Filth

All night soil, filth or any other offensive matter met with during the execution of the works, immediately after it is taken out of any trench, sewer or cess pool, shall not be deposited on to the surface of any street or where it is likely to be a nuisance or passed into any sewer or drain but shall be at once put into the carts and removed to a suitable place to be provided by the Contractor.

29.4 Excavation to be taken to Proper Depths

The trenches shall be excavated to such a depth that the pipes shall rest on concrete or on firm bedding as described in the several clauses relating to these so that the invert may be at the levels given in the sections. In bad ground, the Engineer-in-Charge may order the Contractor to excavate to a greater depth than that shown on the drawings and to fill up the excavation to the level of the sewers with concrete, broken stone, gravel or other materials. For such extra excavation and concrete, broken stone, gravel or other materials, the Contractor shall be paid extra at rates laid down for such works in the schedule, if the extra work was ordered by the Engineer-in-Charge in writing, but if the Contractor should excavate the trench to a greater depth than is required without a specific order to that effect in writing of the Engineer-in-Charge the extra depth shall have to be filled

up with concrete 1:5:10 mix (1 cement: 5 fine sand: 10 stone aggregate 40mm nominal size) at the Contractor's own costs and charges to the requirements and satisfactions of the Engineer-in-Charge.

29.5 Refilling

After the pipes or other work has been laid and proved to be water tight, the trench or other excavations shall be refilled. Utmost care shall be taken in doing this, so that no damage shall be caused to the sewer and other permanent work. The filling in the haunches and upto 75 cms above the crown of the sewer shall consist of the finest selected materials placed carefully in 15 cms layers and flooded and consolidated. After this has been laid, the trench and other excavation shall be refilled carefully in 15 cms layers with materials taken from the excavation, each layer being watered to assist in the consolidation unless the Engineer-in-Charge shall otherwise direct.

29.6 Contractor to Restore Settlement and Damages

The Contractor shall, at his own costs and charges, make good promptly during the whole period the works are in hand, any settlement that may occur in the surfaces of roads, beams, footpaths, gardens, open spaces etc. Whether public or private caused by his trenches or by his other excavations and he shall be liable for any accidents caused thereby. He shall also, at his own expenses and charges, repair and make good and damage done to buildings and other property. If in the opinion of the Engineer-in-Charge he fails to make good such works with all practicable dispatch, the Engineer-in-Charge shall be at liberty to get the work done by the Contractor or deducted from any money that may be or become due to him or recovered from him in any other manner according to the law of the land.

29.7 Disposal of Surplus Soil

The Contractor shall at his own costs and charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled the surplus soil shall be immediately removed, the surface properly restored and roadways and sides left clear.

29.8 Timbering of Sewer and Trenches

The Contractor shall at all times support efficiently and effectively the sides of the sewer trenches and other excavations by suitable timbering, piling and sheeting and they shall be close, timbered in loose or sandy strata and below the surface of the sub soil water level.

All timbering, sheeting and piling with their waling and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse or subsidence of the walls of the trench shall take place.

The Contractor shall be held responsible and will be accountable for the sufficiency of all timbering, branches, sheeting and piling used as also for all damage to persons and property resulting from improper quality, strength, placing, maintaining or removing of the same.

29.9 Shoring of Buildings

The Contractor shall shore up all buildings, walls and other structures, the stability of which is liable to be endangered by the execution of the work and shall be fully responsible for all damages to persons or property resulting from any accident.

29.10 Removal of Water from Sewer, Trench etc.

The Contractor shall at all times during the progress of the work keep the trenches and excavations free from water which shall be disposed off by him in a manner as will neither cause injury to the public health nor to the public or private property nor to the work completed or in progress nor to the surface of any roads or streets, nor cause any interference with the use of the same by the public.

29.11 Width and Depth of Trench

The Engineer-in-Charge shall have power by giving an order in writing to the Contractor to increase the maximum width in respect of which payment will be allowed for excavation in trenches for various classes of sewer, manholes, and other works in certain lengths to be specifically laid down by him, where on account of bad ground or other unusual conditions, he considers that such increased widths are necessary in view of the site conditions.

SECTION – IV WATER SUPPLY SYSTEM (COLD & HOT)

30 SCOPE OF WORK

Work under this section consists of furnishing all labor, materials equipment and appliances necessary and required to completely install the water supply system as required by the drawings & specified hereinafter.

Without restricting to the generality of the foregoing, the water supply system shall include the following:-

- a) Municipal water connection including water meter up to U.G. water tanks.
 - b) Piping from Municipal to raw water tank
 - c) Domestic & Flushing water hydroneumatic pump with connected to OHT.
 - d) Distribution system from overhead tank to single toilet in the building and others are supplied through underground hydroneumatic system.
 - e) Excavation and refilling of pipes trenches.
 - f) Control valves, masonry chambers and other appurtenances.
- All water lines to different parts of building and making connection from source etc.
 - Pipe protection and painting.
 - Providing Hot water supply and return lines and insulation of hot water pipe lines.
 - Control valves, masonry chambers and other appurtenances.
 - Connections to all toilets kitchen equipments, tanks and appliances.
 - Excavation and refilling of pipe trenches, wherever necessary.
 - Trenches for taking pipe lines for these services if required.

31 GENERAL REQUIREMENTS

All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Engineer-in-Charge.

Pipes and Fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

Short or Long bends shall be used on all main pipe lines as far as possible. Use of Elbows shall be restricted for short connections.

As far as possible all Bends shall be formed by means of a hydraulic pipe bending machine for pipes up to 65mm dia.

Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.

As far as possible, all piping inside the buildings shall run either concealed or embedded. Outside the buildings the piping shall be installed at-least 60cms below finished grade. All galvanized steel piping embedded either in trenches or in concrete and masonry work shall be tightly wrapped 1mm thick fiberglass tissue laid in bitumen.

Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

Water Supply System

Contractor should study the site plan and water supply system diagram for an overview of the system.

Source

- a) Water supply will be acquired from Municipal water mains through a service connection
- b) Additional water supply will be obtained from captive tube-wells within the site. The rising mains will be connected to the main fire static tank and then overflow into the main domestic water tank.

Water supply piping for garden hydrant and sprinkler and irrigation system will be separate and independently connected to a different pumping system.

32 G.I. PIPES & FITTINGS

All pipes outside the building and pipes running at basement ceiling level shall be galvanized steel tubes conforming to IS: 1239-1979 of class specified. When class is not specified they shall be medium class.

Fittings shall be malleable iron galvanized fittings, of approved make. All fittings shall have manufacturer's trade mark stamped on it. Fittings for G.I. pipes shall include Couplings, Bends, Tees, Reducers, Nipples, Unions and Bushes. Fittings shall be of IS:1879 - (part I to X) 1975.

Pipes and fittings shall be jointed with threaded fittings. Care shall be taken to remove burr from the end of the pipe after cutting by a round file. All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. G.I. pipes inside toilets shall be fixed in wall chases well above the floor. No pipes shall be run inside

a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other as shown on drawings.

33 CLAMPS

G.I. pipes in shafts and other locations shall be supported by galvanized clamps of design approved by Engineer-in-Charge Pipe in wall chases shall be anchored by iron hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from galvanized structural as described in the sub section. Pipes in typical shafts shall be supported on Slotted Angles/Channels as specified elsewhere.

Pipe hangers shall be provided at the following maximum spacing:

S. No.	Pipe Dia (mm)	Hanger Rod Dia (mm)	Spacing between Supports (Mtr)
1	Upto 25	6	2
2	32 to 50	10	2
3	65 to 100	12	2.4
4	125 to 150	16	3.6
5	200 to 300	19	5.3

34 UNIONS

Contractor shall provide adequate number of unions on all pipes to enable dismantling later. Unions shall be provided near each Gunmetal Valve, Stop Cocks, or Check Valves and on straight runs as necessary at appropriate locations as required and/or directed by Engineer-in-Charge.

35 FLANGES

Flanged connections shall be provided on pipes where shown on the drawings, all equipment connections as necessary and required or as directed by Engineer-in-Charge Connections shall be made by the correct number and size of the bolts and made with 3 mm thick insertion rubber washer. Where hot water or steam connections are made insertion gasket shall be of suitable high temperature grade and quality approved by Engineer-in-Charge Bolt hole dia for flanges shall conform to match the specification for C.I. Sluice Valve to I.S. 780.

36 TRENCHES

The galvanized iron pipes and fittings shall be laid in trenches. The width and depth of the trenches for the different diameters of the pipes shall be as follows:

Dia of Pipe	Width of Trench	Depth of Trench
15mm to 50mm	30 cms	60 cms
65mm to 100mm	45 cms	75 cms

At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earth work in trenches.

When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.

37 PAINTING

All pipes above ground shall be painted with one coat of Red Lead and two coats of Synthetic Enamel paint of approved shade and quality. Pipes shall be painted to standard color code specified by Engineer-in-Charge.

All pipes in chases and below floor shall be provided with Anti-corrosive treatment.

38 PIPE PROTECTION

Where specified in the Drawing all pipes below ground shall be protected against corrosion by wrapping 100mm wide and 2mm thick layer of PYPKOTE/MAKPOLYKOTE over the pipe.

38.1 Sand Filling

All G. I. pipes in trenches shall be protected with fine sand 150 mm all around before filling in the trenches.

39 GUNMETAL VALVES

Valves 65mm dia and below shall be heavy Gunmetal Full way Valves or Globe Valves or Ball valves conforming to IS: 778-1971 of 20 Kg/cm² class. Valves shall be tested at manufacturer's works and the same stamped on it.

All Valves shall be approved by the Engineer-in-Charge before they are allowed to be used on work.

40 SLUICE VALVES

All valves 80mm dia and above shall be C.I. Double Flanged Sluice Valves. Sluice valves shall be Cast Iron double flanged, with rising spindle. Each sluice valve shall be provided with wheel for valves in exposed positions and Cap Top for underground valves. Contractor shall provide suitable operating keys for Sluice Valves with Cap Tops.

Sluice valves shall be of best quality conforming to IS: 780-1969 of class specified.

- Joints for double flanged sluice valves shall be made with suitable tail/socket pieces on the pipeline and flanges joints made with 3 mm thick insertion rubber gasket with appropriate number of bolts, nuts and washers.
- Sluice valves shall be installed at all branches and as shown on the drawings.

40.1 Scour Valves:

Scour valves shall be C.I. sluice valves as specified above. They shall be installed at the lowest level or tail end of the system as shown on drawings and directed by Engineer-in-Charge.

40.2 Air Release Valves

- Air release valves shall be single acting type air valves with Gunmetal body and bronze/gunmetal internal parts and plastic float.
- Each air release valve shall be provided with a cast iron isolating sluice valve of specification given above.

41 INSULATION

41.1 For Chased Internal Pipes

Hot water pipes fixed in chase shall be thermal insulation over hot water pipes with 9mm thick nitrile or approved equivalent thermal insulation tubing, a elastomeric flexible material having hermetic blister closed cell structure of expanded synthetic rubber having a thermal conductivity not exceeding 0.040w/m°k @ 40deg C over pipes.

41.2 For Exposed Piping

Exposed hot water line laid in trenches, exposed in shafts, on terrace and along ceiling level shall be thermal insulation over hot water pipes with 9mm thick nitrile/ polyolefin or approved equivalent thermal insulation tubing, a electrometric flexible material having hermetic blister closed cell structure of expanded synthetic rubber having a thermal conductivity not exceeding 0.040w/m°k @ 40 deg C over pipes. With Aluminum Cladding/ protective coating of resin hardener paint with fiber cloth (FRP)

S.No	Pipe Size (MM)	Thickness of Nitrile Rubber Insulation (MM)
1	15 to 25	9
2	32 to 80	13
3	100 & above	19

41.3 Anchor Block

Suitable anchor blocks shall be provided at all bends and tees to encounter the excessive thrust developed due to water hammer.

42 CPVC PIPES

All pipes inside the buildings and where specified, outside the building shall be CPVC pipes tubes conforming to IS 15778:1996 .Specific Gravity ASTM D 792 at 23°C should be 1.55 as specified. With Tensile Strength as per ASTM D 638 at 23°C should be 55N/mm².

42.1 Joining Pipe & Fittings

42.1.1 Cutting

Pipes shall be cut either with a wheel type plastic pipe cutting or hacksaw blade and care shall be taken to make a square cut which provides optimal bonding area within a joint.

42.1.2 Deburring / Beveling

Burrs and fittings should be removed from the outside and inside of pipe with a pocket knife or file otherwise burrs and fittings may prevent proper contact between pipe and fitting during assembly.

42.1.3 Fitting Preparation

A clean dry rag/cloth should be used to wipe dirt and moisture on the fitting sockets and tubing end. The tubing should make contact with the socket wall 1/3 or 2/3 of the way into the fitting socket.

42.1.4 Solvent Cement Application

Only CPVC solvent cement confirming to ASTM-F493 should be used for joining pipe with fittings. CPVC schedule 40 & 80 heavy bodied CPVC solvent cement only should be used confirming to ASTM-F493.

42.1.5 Assembly

After applying the solvent cement on both pipe and fitting socket, pipes should be inserting into the fitting socket within 30 seconds, and rotating the pipe ¼ to ½ turn while inserting so as to ensure

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

even distribution of solvent cement with the joint. The assembled system should be held for 10 seconds (approx) in order to allow the joint to set up.

An even bead of cement should be evident around the joint and if this bead is not continuous, remake the joint to avoid potential leaks.

42.1.6 Set & Cure times:

Solvent cement set & cure times shall be strictly adhered to as per the below mentioned table:

Minimum Core prior to pressure testing at 150 PSI

S. No.	Ambient Temperature during Core period	Pipe Size	
		1/2" to 1"	1.1/4" to 2"
1	Above 15 deg C	1 Hr	2 Hrs
2	4 – 15 deg C	2 Hrs	4 Hrs
3	Below 4 deg C	4 Hrs	8 Hrs

Once an installation is completed and cored as per above mentioned recommendations, the system should be hydrostatically pressure tested at 150 PSI (10 Bar) for minimum 24hrs. During pressure testing the system should be filled with water and if a leak is found, the joint should be cut out and replacing the same with new one by using coupler.

42.1.7 Transition of CPVC to Metals

When making a transition connection to metal threads, special brass/plastic transition fitting (Male & Female adaptors) should be used. Plastic threaded connection should not be over torque hard tight plugs one half turn should be adequate.

42.1.8 Threaded Sealants

Teflon tapes shall be used to make threaded connection leak proof.

42.1.9 Hangers & Supports

For horizontal runs, support should be given at 3 ft (90 cms) intervals for diameter of 1" and below and at 4 ft (1.20 mtr) intervals for larger size.

Hangers should not have sharp edges which come in contact with the tubing and shall be of GI.

Support should be as per the below mentioned table:

S. No	Size of Pipe Inch	210C Ft	490C Ft	710C Ft	820 C Ft
1	1/2"	5.5	4.5	3.0	2.5
2	3/4"	5.5	5.0	3.0	2.5
3	1"	6.0	5.5	3.5	3.0
4	1 1/4"	6.5	6.0	3.5	3.5
5	1 1/2"	7.0	6.0	3.5	3.5
6	2"	7.0	6.5	4.0	3.5

All special fittings and accessories like internally or externally threaded brass adaptors, ball valves, globe valves, unions, diaphragm valves, butterfly valves, etc shall be made of CPVC by licensee.

The CPVC solvent cement used for installing CPVC piping systems shall conform to ASTM F493. Pipes from 1/2" up to 2" pipes and fittings, single step medium bodied CPVC solvent cement should be used. For CPVC pipes and fittings upwards of 2", a primer shall be used followed by heavy bodied solvent cement conforming to ASTM F493. **PVC solvent cement should not be used.**

42.2 Concealed Plumbing

All internal concealed plumbing for water supply shall be done with CPVC pipes. The pipes & fittings shall conform to CTS (Copper Tube Size) SDR-11 as per ASTM D2846. All pipes and fittings from $\frac{1}{2}$ " up to 2" shall come under this category. Medium body CPVC solvent cement conforming to ASTM F493 should be used for joining pipes to fittings.

42.3 Installation procedure

All parameters pertaining to the installation of CPVC plumbing system such as cutting, joining, support spacing, expansion loops, insulation, type of support, special connections, etc. shall be as per the manufacturer's specifications.

43 VALVE CHAMBERS

Contractor shall provide suitable brick masonry chambers in cement mortar 1:5 (1 cement: 5 coarse sand) on cement concrete foundations 150 mm thick 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) 12 mm thick cement plaster inside and outside finished with a floating coat of neat cement inside with cast iron surface box as approved or as specified in Drawing and in drawings including excavation, back filling complete.

44 WATER METERS

Water meters of approved make and design shall be supplied for installation at locations as shown in drawing. The water meters shall meet with the approval of the local municipal authorities. Suitable valves and chambers to house the meters shall also be provided along-with the meters.

All meters shall conform to Indian Standard IS: 779-1978 (Water meters-domestic type) and IS: 2373-1981 (water meters-bulk type). Where called for water meters shall be located in masonry chambers of appropriated size.

45 PIPE HANGERS BRACKETS ETC.

Sturdy hangers, brackets and saddles of approved design shall be installed to support all pipe lengths which are not embedded over their entire run. The hangers and brackets shall be of adjustable heights and primer coated with red-oxide primer clamps. Collars and saddles to hold pipes shall be provided with suitable gaskets. The brackets and hangers shall be of Mild Steel designed to carry the weight of pipes safely and without excessive deflections.

All pipes and fittings shall be supported near every joint and half-way through every pipe length unless otherwise specified. Where called for, pipe hangers shall also be supplied with proper sound and vibration dampening devices to minimize noise and vibration transmission.

46 TESTING

All pipes, fittings and valves shall be tested by hydrostatic pressure of min. 1.5 times, the working pressure and subject to minimum of 7 kg/cm² in any case and with the consent of Engineer-in-Charge.

Pressure shall be maintained for a period of at least TWELVE hours without appreciable drop in the pressure after fixing at site. (+10 %). A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and Engineer.

In addition to the sectional testing carried out during the construction, Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages, and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes or failure of fittings, to the building, furniture and Fixtures shall be made good during the defects liability period without any extra cost.

After completion of the water supply system, Plumbing Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones at no extra cost and the same shall be tested as above.

47 CONNECTIONS TO WATER TANKS

The contractor shall provide all inlets, outlets, washouts, vents, ball cocks, overflow, control valves and all such other piping connections including level indicator to water storage tanks as called for.

Suitable float controls of an approved make, securely fixed to the tank independent of the inlet pipe and set in a position so that water inlet into the tank is cut off when filled up to the water line. The water level in the tanks shall be adjusted to 25mm below the lip of the overflow pipe. Full way gate/ball valves of approved make shall be provided as near the tank as practicable on every outlet pipe from the storage tank except the overflow pipe.

The overflow pipe shall be so placed as to allow the discharge of water being readily seen. The overflow pipe shall be of size indicated. A stop valve shall also be provided on the inlet water connection to the tank. The outlet pipes shall be fixed approximately 75mm above the bottom of the tank towards which the floor of the tank is sloping to enable the tank to be emptied for cleaning. The ball valves shall conform to Indian Standard IS:1703-1968

48 CONNECTIONS TO MECHANICAL EQUIPMENT SUPPLIED BY OTHER AGENCIES

All inlets, outlets, valves, piping and other incidental work connected with installation of all mechanical equipment supplied by other agencies shall be carried out by the Plumbing contractor in accordance with the drawings, requirements for proper performance of equipment, manufacturer's instructions and the directions of the Engineer-in-Charge. The equipment to be supplied by other agencies consists mainly of Kitchen, Laundry, Air-conditioning, Water Treatment and other similar equipment. The connections to the various equipment shall be effected through proper unions and isolating valves. The work of effecting connections shall be executed in consultation with and according to the requirements of equipment suppliers, under the directions of the Engineer-in-Charge. The various aspects of connection work shall be executed in a manner similar to the work of respective trades mentioned elsewhere in these specifications.

49 DISINFECTION

After completion of the work Contractor shall flush clean the entire system with the city's filtered water after connection has been made.

After the first flushing, commercial bleaching powder is to be added to achieve a dosage of 2 to 3 mg/l of water in the system added and flushed. This operation should be performed twice to ensure that the system is fully disinfected and usable. The Commissioning would not be considered complete without performing the Disinfection.

50 PRE COMMISSIONING:

Ensure that all pipes are free from debris and obstructions.

Check all valves and fire hydrant for effective opening and closing action. Defects should be rectified or valves replaced.

Ensure that all Connections to Branches has been made.

Ensure that mains have been connected to the respective pumps, underground and Overhead tanks.

Water supply should be available at main Underground tank.

All main line Valves should be closed.

51 COMMISSIONING

Fill Underground tank with water. Add 1kg fresh bleaching powder after making a solution to be added near inlet.

Start Water Supply Pump and allow water to fill main Underground tank. Water will first fill the fire tank and then overflow to the Raw Water tanks.

After filling Overhead Reservoir drain the same to its one forth capacity through tank scour valve. (This is to ensure removal of all mud, debris etc. from the tank).

Fill Overhead tank to full.

Release water in the main lines by opening Valves in each circuit. Drain out water in the system through scour valves or fire hydrant in lower regions. Ensure clean water is now coming out of the system.

Open valves for individual clusters. Observe for leakages or malfunctions, check pressure & flow at end of line by opening Hydrants etc. Remove and rectify defects noticed.

Check all outlet points for proper operation by opening each valve and allowing water to flow for a few minutes. Also check for effective closure of valve.

The entire water supply system should be disinfected with bleaching powder and system flush cleaned.

Send four samples of water drawn from four extreme locations for testing for bacteriological test in sterilized bottles obtained from the concerned laboratory. (Laboratory personal may collect the samples themselves).

52 RESPONSIBILITY

Responsibility for various activities in pre-commissioning and commissioning procedures will rest with the Contractor.

SECTION –V : GARDEN HYDRANT SYSTEM

53 SCOPE OF WORK

The scope of this section comprise of the supply, installation testing and commissioning of piping network for garden hydrant & irrigation system.

Work under this section consists of furnishing all labor, materials equipment and appliances necessary and required to completely install the garden irrigation system as required by the drawings, specified hereinafter and given in the Drawing.

Without restricting to the generality of the foregoing, the garden hydrant system shall include the following:-

- All irrigation lines to different parts of site and making connection from source i.e. from STP etc.
- Pipe protection.
- Control valves, masonry chambers and other appurtenances.
- Connections to all hydrant point.
- Excavation and refilling of pipe trenches, wherever necessary.
- Trenches for taking pipe lines for these services if required.

54 GENERAL REQUIREMENTS

All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Engineer-in-Charge.

Pipes and Fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

As far as possible shall be installed at-least 60cms below finished grade.

Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

55 FLANGES

Flanged connections shall be provided on pipes where ever required or as directed by Engineer-in-Charge. Connections shall be made by the correct number and size of the bolts and made with 3 mm thick insertion rubber washer.

56 TRENCHES

The HDPE pipes and fittings shall be laid in trenches. The width and depth of the trenches for the different diameters of the pipes shall be as follows:

Dia of Pipe	Width of Trench	Depth of Trench
15mm to 50mm	30 cms	60 cms
65mm to 100mm	45 cms	75 cms

At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earth work in trenches.

When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.

57 PIPE PROTECTION

Where specified in the Drawing all pipes below ground shall be in trenches and protected with fine sand 150 mm all around before filling in the trenches.

SECTION – VI: SEWERAGE/DRAINAGE SYSTEM**58 SCOPE OF WORK**

Work under this section shall consist of furnishing all Labor, Materials, Equipments and Appliances necessary and required to completely finish Sewerage/Drainage system as specified hereinafter or given in the Drawing.

Without restricting to the generality of the foregoing, the sewerage system shall include:

- Internal/External sewer line.
- Excavations including refilling etc.
- Construction of Collection Chambers, Manholes and Drop Connections.
- Construction of Grease Trap etc.
- Connection to S.T.P and Disposal of treated effluent.
- Storm Water Drainage and Disposal.
- Construction of Desalting chamber & Rain water Harvesting tank
- Testing of pipe lines

59 GENERAL REQUIREMENTS

All materials shall be new of the best quality conforming to specifications and subject to the approval of the Engineer-in-Charge.

Drainage lines shall be laid to the required gradients and profiles.

All piping shall be installed at depth greater than 80cms below finished ground level.

The piping system shall be vented suitably at the starting point of all branch drains, main drains, and the highest/lowest point of drain and at intervals as shown. All venting arrangement shall be unobtrusive and concealed.

All drainage work shall be done in accordance with the local Municipal bye-laws.

Wherever the sewerage pipes run above water supply lines, same shall be completely encased in cement concrete 1:2:4 all round with the prior approval of the Engineer-in-Charge.

Location of all manholes, catch basins etc., shall be got confirmed by the Contractor from the Engineer-in-Charge before the actual execution of work at site.

All works shall be executed as directed by Engineer-in-Charge.

60 ALIGNMENT AND GRADE

The sewer pipes shall be laid to alignment and gradient shown on the drawings but subject to such modifications as shall be ordered by the Engineer-in-Charge from time to time to meet the requirements of the works. No deviations from the lines, depths of cutting or gradients of sewers shown on the plans and sections shall be permitted except by the express direction in writing of the Engineer-in-Charge.

61 SALT GLAZED STONEWARE PIPES

Stoneware pipes shall be of first class quality salt glazed and free from rough texture inside or outside and straight. All pipes shall have the manufacturers name marked on it and shall comply to IS: 651-1971 and shall be of approved makes.

The maximum permissible slope to the various diameters of pipes shall be as follows:

100mm pipe	1 in 40 to 1:50
150mm pipe	1 in 60 to 1:100
200mm pipe	1 in 80 1: 120 to 1: 200
250mm pipe	1 in 90 1: 120 to 1: 250

Where necessary, pipe shall be laid on a bed of plain cement concrete 1:3:6 and minimum 150 mm thick, and shall be projected by providing hunching up to half the diameter of the pipes. The width of the concrete bed for various diameters shall be as follows:

100mm dia pipe	380mm wide
150mm dia pipe	450mm wide
200mm dia pipe	600mm wide
250mm dia pipe	700mm wide

Where the pipes are laid on a soft soil, with the maximum water table level, lying at the invert level of the pipe, the pipe shall be bedded in concrete.

61.1 Laying and Jointing of Stoneware Salt Glazed Pipes

61.1.1 Laying of Pipes

Pipes are liable to be damaged in transit and notwithstanding tests that may have been made before dispatch each pipe shall be examined carefully on arrival at site. Each pipe shall be rung with a wooden hammer or mallet and those that do not ring true and clear shall be rejected. Sound pipes shall be carefully stacked to prevent damage. All defective pipes should be segregated, marked in a conspicuous manner and their use in the works prevented.

The pipes shall be laid with sockets leading uphill and should rest on solid and even foundations for the full length of the barrel. Socket holes shall be formed in the foundation sufficiently deep to allow the pipe jointer room to work right round the pipe and as short as practicable to admit the socket and allow the joint to be made.

Where pipes are not bedded on concrete the trench bottom shall be left slightly high and carefully bottomed up as pipe laying proceeds so that the pipe barrels rest on firm ground. If excavation has

been carried too low it shall be made up with cement concrete 1:5:10 mix at the Contractor's cost and charges.

If the bottom of the trench consists of rock or very hard ground that cannot be easily excavated to a smooth surface, the pipes shall be laid on cement concrete bed of 1:5:10 mix to ensure even bearing.

61.1.2 Jointing of Pipes

Tarred gaskin shall first be wrapped round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid, the pipe shall then be adjusted and fixed in its correct position and the gaskin caulked tightly home so as to fill not more than one quarter of the total length of the socket.

The remainder of the socket shall be filled with stiff mix of cement mortar (1 cement: 1 clear sharp washed sand). When the socket is filled, a fillet should be formed round the joint with a trowel forming an angle of 45 degrees with the barrel of the pipe. The mortar shall be beaten up and used after it has begun to set.

After the joint has been made any extraneous materials shall be removed from inside of the joint with a suitable scraper or "Badger". The newly made joints shall be protected until set from the sun, drying winds, rain or dust. Sacking or other materials, which can be kept damp, shall be used. The joints shall be exposed and space left all rounds the pipes for inspection by the Engineer-in-Charge. The inside of the sewer must be left absolutely clear in bore and free from cement mortar or other obstructions throughout its entire length, and shall efficiently drain and discharge.

- **Gully Traps**

Gully traps shall be of the same quality as described for stoneware pipes in Clause 5.

Gully traps shall be fixed in cement concrete 1:5:10 mix (1 cement: 5 coarse sand: 10 stone aggregate 40mm nominal size) and a brick masonry chamber 30x30 cms inside in cement mortar 1:3 with 10 x 10 cms grating inside and 30x30 cms C.I. sealed cover and frame weighting not less than 7.2 kg to be constructed as per standard drawing. Where necessary, sealed cover shall be replaced with C.I. grating of the same size.

- **Grease Trap**

Grease Trap shall be provided on Kitchen waste lines before discharging the waste into the main sewer line. Grease Trap shall be built in brick masonry and shall be similar in construction to manholes. The grease trap shall be constructed to size as shown at the location on drawings. The grease trap shall be provided with drop inlet, drop outlet, galvanized wrought iron sediment pan and a baffle wall. Grease trap shall be provided with 2 Nos, double seal manhole cover and frame which shall be identified with lettering 'Grease trap" as per the drawing.

- **Testing of Grease Trap**

All rights of the sewer and drain shall be carefully tested for water tightness by mains of water pressure maintained for not less than 30 minutes. Testing shall be carried out for manhole to manhole. All pipes shall be subject to a test pressure of 1.5 meter head of Water. The test pressure will however, not exceed 6mtr head at any point. The pipes shall be plugged preferably with standard design plugs or with rubber plugs on both sides, the upper end shall, however, be connected to a pipe for filling with water and getting the required head poured at one time.

62 REINFORCED CEMENT CONCRETE PIPES

All underground storm water drainage pipes and sewer lines where specified (other than those specified cast iron) shall be centrifugally spun RCC pipes of specified class. Pipes shall be true and straight with uniform bore. Throughout cracked, warped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the Contractor shall produce, when directed a certificate to that effect from the manufacturer.

62.1 Laying

R.C.C. spun pipes shall be laid on cement concrete bed or cradles as specified and shown on the detailed drawings the cradles may be precast and sufficiently cured to prevent cracks and breakage in handling. The invert of the cradles shall be left 12mm below the invert level of the pipe properly placed on the soil to prevent any disturbance. The pipe shall than be placed on the bed concrete or cradles and set for the line and gradient by means of sight rails and bonding rods etc. cradles or concrete bed may be omitted, if directed by the Engineer-in-Charge

62.1.1 Encasing (all pipes have to be encased)

The sewer pipes shall be completely encased or surrounded with concrete where:

- The maximum water table level is likely to rise above the top of the barrel.
- The top (overt) of pipe is less than 200 cms under the road surface.

62.2 Jointing

After setting out the pipes the collars shall be centered over the joint and filled in with tarred gaskin, so that sufficient space is left on either side of the collar to receive the mortar. The space shall then be filled with cement mortar 1:2 (1 cement: 2 fine sand) and caulked by means of proper tools all joints shall be finished at an angle of 45 degree to the longitudinal axis of the pipe on both side of the collars neatly semi flexible type collar joint.

62.2.1 Curing

The joint shall be cured for at least 7 days. Refilling at joints will be permitted only on satisfactory completion of curing period.

63 CEMENT CONCRETE AND MASONRY WORKS FOR MANHOLES AND CHAMBERS ETC.**63.1 Materials****63.1.1 Water**

Water used for all the construction purposes shall be clear and free from Oil, Acid, Alkali, Organic and other harmful matters, which shall deteriorate the strength and/or durability of the structure. In general, the water suitable for drinking purposes shall be considered well enough for construction purpose.

63.1.2 Aggregate for Concrete

The aggregate for concrete shall be in accordance with I S: 383 and I S: 515 in general, these shall be free from all impurities that may cause corrosion of the reinforcement. Before actual use these shall be washed in water, if required as per the direction of Engineer-in-Charge. The size of the coarse aggregate shall be done as per I S: 383.

63.1.3 Sand

Sand for various constructional purposes shall comply in all respects with I S: 650 and I S: 2116. It shall be clean, coarse hard and strong, sharp, durable, uncoated, free from any mixture of clay, dust, vegetable matters, mica, iron impurities soft or flaky and elongated particles, alkali, organic matters, salt, loam and other impurities which may be considered by the Engineer-in-Charge as harmful for the construction.

63.1.4 Cement

The cement used for all the constructional purposes shall be ordinary Portland cement or rapid hardening Portland cement conforming to I S: 269.

63.1.5 Mild Steel Reinforcement

The mild steel for the reinforcement bars shall be in the form of round bars conforming to all requirements of I S: 432 (Grade I).

63.1.6 Bricks

Bricks shall have uniform color, thoroughly burnt but not over burnt, shall have plan rectangular faces with parallel sides and sharp right angled edges. They should give ringing sound when struck. Brick shall not absorb more than 20% to 22% of water, when immersed in water for 24 hours. Bricks to be used shall be approved by the Engineer-in-Charge.

63.1.7 Other Materials

Other materials not fully specified in these specifications and which may be required in the work shall conform to the I S code. All such materials shall be approved by the Engineer-in-Charge before use.

63.2 Cement Concrete (Plain or Reinforced)

Cement concrete pipes bedding, cradles, foundations and RCC slabs for all works shall be mixed by a Mechanical Mixer where quantities of the concrete poured at one time permit. Hand mixing on properly constructed platforms may be allowed for small quantities by the Engineer-in-Charge. Rate for cement concrete shall be inclusive of all shuttering and centering at all depth and heights.

All concrete work shall be cured for a period of at least 7 days. Such work shall be kept moist by means of gunny bass at all times. All pipe trenches and foundations shall be kept dry during the curing period.

63.3 Masonry Work

Masonry work for manholes, chambers, brick masonry pipe trench and such other works as required shall be constructed from 1st class bricks or 2nd class as specified in the Drawing in cement mortar 1:5 mix (1 cement: 5 coarse sand). All joints shall be properly raked to receive plaster.

63.4 Cement Concrete for Pipe Support

Wherever specified or shown on the drawings, all pipes shall be supported in concrete bed all round or in haunches. The thickness and mix of the concrete shall be given in the Drawing. Type of the bedding is as described as follows:

Unless otherwise directed by the Engineer-in-Charge cement concrete for bed, all round or in haunches shall be laid as follows:-

Description	Upto 3 M depth
Pipes in open ground (No sub soil water)	All round (1:4:8)
Pipes (all) in sub soil water condition	All round (1:4:8)
Pipes under the building or at road crossing or under public places	All round (1:3:6)

(1=1 cement, 3-5=coarse sand, 6-10 stone aggregate 40mm nominal size)

R.C.C. pipes or C.I. pipes ,may be supported on brick masonry or precast R.C.C or Cast insitu cradles. Cradles shall be as shown on the drawings.

Pipes in loose soil or above ground shall be supported on brick or RCC anchor blocks as shown on the drawings.

64 MANHOLES AND CHAMBERS

All manholes, chambers and other such works as specified shall be constructed in brick masonry in cement mortar 1:5 (1 cement: 5 coarse sand) or as specified in the Drawing.

All Manholes, Chambers, etc., shall be supported on base of cement concrete of such thickness and mix or shown on the drawings.

Where not specified, Manholes will be constructed as follows:-

<i>(All dimensions internal clear in cms)</i>					
Size of Manhole Type	90x80 Rect.	120x90 Rect.	910 dia Circular	1220 dia Circular	1520 dia Circular
Maximum depth	100	245	170	230	Any depth beyond 230
Average thickness of R.C.C slab	15	15	--	--	--
Size of cover and frame (Internal dia)	61x45.5	50 dia	56 dia	56 dia	56 dia
Weight of cover and frame	38 Kg.	116 Kg.	116 Kg.	116 Kg.	116 Kg.
Type of Cover & Frame	SFRC	SFRC	SFRC	SFRC	SFRC

All manholes shall be provided with cement concrete benching in 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20mm nominal size). The benching shall have a slope of 10cm towards the channel. The depth of the channel shall be full diameter of the pipe. Benching shall be finished with a floating coat of neat cement.

All manholes shall be plastered with 12/15mm thick cement mortar 1:3 (1 cement: 3 coarse sand) and finished with a floating coat of neat cement inside. Manhole shall be plastered outside as above but with rough plaster.

All manholes with depths greater than 1 M. shall be provided with plastic encapsulated 20mm square or 25mm round rods foot rungs set in cement concrete blocks 25 x 10 x 10cms in 1:2:4 mix 30cms vertically and staggered. Foot rests shall be coated with coal tar before embedding.

All manholes shall be provided with cast iron covers and frames and embedded in reinforced cement concrete slab or SFRC precast concrete covers as per instructions of the Engineer-in-Charge. Weight of cover, frame and thickness of slab as given above.

All Rainwater Collection Chamber shall be of the size 50x45x60cm (internal) with horizontal C.I. grating or SFRC precast Gully Grating as per instructions of Engineer-in-Charge. The grating along with frame shall be of size 500x450mm grating having total Wt. of app. 38 Kg and of approved design and quality as per instruction of Engineer-in-Charge. The remaining details of construction shall be same as stated above for the construction of the Manholes etc.

65 MAKING CONNECTIONS

Contractor shall connect the new sewer line to the existing manhole by cutting the walls, benching and restoring them to the original condition. A new channel shall be cut in the benching of the existing manhole for the new connection. Contractor shall remove all sewage and water if encountered in making the connection without additional cost.

66 COMMISSIONING

After successful testing of the different sewerage and drainage pipes in parts, the Contractor shall provide all facilities including necessary piping's, labors, tools and equipments etc. for carrying out testing and commissioning of the entire external sewerage and drainage system complete as per requirement in the presence of Client representative/Consultant, wherever and as may be required. Generally, the following test/inspection has to be carried out:-

- For any Leaks/seepages in the external sewerage and drainage pipes.
- For checking the functioning of the entire external sewerage and drainage system including rainwater harvesting system and to ensure that the waste water is continuously flowing towards outfall without any intermediate stagnation.
- For the functioning of the valves and accessories etc. by putting ON/OFF the controlling valves of the various diversions in the sewerage and drainage and rain water harvesting system.

67 DESALTING CHAMBER & RAIN WATER HARVESTING TANK

All Rainwater Collection Chamber shall be of the size 200x100x60cm (internal) complete as per drawing or as instructions of Engineer-in-Charge.

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

Rain water harvesting pit is constructed preferably 5 to 10m from the permanent structure. The bore will be excavated manually or drilled by reverse direct rotary method up to the water level or as per instruction of Engineer-in-Charge.

The dia of Rain water harvesting pit shall be 3000mm. Pit shall be filled with boulders, gravel and coarse sand.

Bore shall be 250mm dia and pipe shall be 160 OD uPVC 6 kg /cm². The pipe placed in the center of the shaft touching the lowest portion of the pit. The overflow pipe from the desalting chamber is directly connected to the rain water harvesting pit so that the rain water freely enters the pit for recharging. In addition to the inlet pipe from desalting chamber an overflow pipe at the ground level so that any excess water that enters the pit is automatically drained away without damaging the pit.

SECTION – VII: HANDING OVER PROCEDURE

68 DOCUMENTS SUBMISSION

The Contractor shall before finally handing over the completed work in his scope to the Owner, submit the documents as per the Contract and as directed by the Engineer-in-Charge. Given below the checklist for the reference of the Engineer-in-Charge.

Packages/	Sanitary Fixtures	Soil, waste & vent pipes	Water supply system	Sewerage/ drainage system	Water tanks
Final cleaning					
List of inventory					
Training Conducted on					
Operation Manual					
Maint. Manual					
As built P&I Diag/ SLD					
Defects Liability Period/ Warranty					
Commissioning report					
Test reports/ Certificates					
List of essential spares					
Address/ Contact nos. of Vendors					
Remarks					

SECTION – VIII: SEWAGE TREATMENT PLANT (STP)

69 SCOPE

69.1 Work under this Contract consists of

Detailed engineering design of all plan areas, section, Civil, Structural, mechanical, electrical and piping systems according to the current and applicable BIS codes as applicable. The proposed plans of the STP shall be subject to the approval of the Architect / Consultant.

Design, manufacture, assembly, installation, testing and commissioning of the main treatment units in RCC tanks , mechanical equipment for the packaged type Sewage Treatment Plant (STP) of capacity and design parameters given in BOQ & specifications broadly comprising of :-

- Diffused aeration system comprising of non-metallic piping submerged diffusers to be provided in the RCC equalization tank, **SBR unit**, and sludge holding tank
- Twin lobe air blowers with belt drive, electrical motors, piping headers, piping connections to all units.

- Pumping sets from equalization tank to STP, effluent, post filtration and final effluent disposal pumps as per design requirements.
- Final effluent pressure filters, softener pumps for final disposal /reuse.
- Motor control centers, cabling from MCC to all units, all instrumentation, and measuring devices and earthing of equipment. All electrical works to be carried out guidelines as per detailed annexure enclosed.
- Instrumentation and chemical test kit as specified.

Drain channel, sump with a drainage submersible pump (1 working + 1 standby) with pipe work, valves and discharge pipe up to nearest external manhole in plant room shall be provided by others.

Provide PH Meter, Electronic magnetic flow meter in inlet & outlet of filtration system

69.2 The Work Includes

- Civil in Civil BOQ, Mechanical & Electrical works
- Piping as specified.
- Testing, commissioning and operation of plant with water and under load conditions.

Construction of all architectural, civil and structural works related to the construction of the building, its internal lighting, sludge disposal system.

Incoming power connection, electrification of pump house.

Incoming sewer / rising main connection to the plant.

Connection from final effluent tank / pump to point of use for reuse or for disposal in accordance with approval of the State Board for Prevention and Control of Pollution.

69.3 Contractor's Experience

Contractor quoting for the work shall be an experienced specialize contractor engaged in the design, manufacture and execution of STP of similar types and must have completed at least 5 plants of similar or larger size in the last 5 years.

Each offer must accompany a list of plants planned, constructed, executed and are in operation for at least 12 months given: -

- Owner's name, address, telephones and faxes nos.
- Architects/Consultants name, Address, Telephone & fax nos.
- Type of load (Domestic and Industrial)
- Average daily flow, BOD and other information of plant.

69.4 Shop Drawings

The contractor shall submit shop drawings as follows:

- On award of the work, he shall submit GA drawing, PIB diagrams, plant layout with basic dimensions, flow diagram with levels of elements.
- Fabrication and equipment layout piping, valves and all other information required for installation.
- Electrical layouts, detail of all MCC, cable sizing and system diagrams and earthing system.
- Piping layout with pipe dia. slopes, fixing arrangements.
- Three copies of the shop drawings shall be submitted for initial scrutiny. On approval of the same contractor shall submit six copies of the same incorporating corrections etc. Two sets will be stamped "GOOD FOR CONSTRUCTION" by the Consultant and returned to the contractor.

69.5 Other Submittals

Contractor shall furnish four sets of folders giving:

- Catalogues and technical information sheets of equipment to be installed.
- Performance curves, foundation details and fixing arrangements.

Contractors proposal for testing procedures for individual equipment and for overall testing of the plant.

Submittals shall be separate for:

- Mechanical and Piping works
- Electrical Works

All shop drawings and submittals mentioned above shall be approved by Architect and two sets duly stamped shall be returned to the contractor for execution of the works.

69.6 Execution of Work

All work shall be executed only in accordance with the approved shop drawings and other submittals. Contractor shall ensure that all inserts, support plates, puddle flanges and other items required to be incorporated during execution shall be placed in position as per his own requirements during execution of the works.

All special tools and tackle required for erection and assembly of the equipment covered by the contract shall be obtained by the contractor himself. All other materials such as foundation bolt nuts, etc. required for the installation of the plant and equipment shall be supplied by the contractor and are part of the contract.

69.7 Testing & Handing Over

The contractor shall carryout tests on different equipment as required in the presence of the Consultant or his representative in order to enable him to determine whether the plant, equipment and installation comply with the specifications, local codes and in accordance with the letter and intents of the specifications.

The installation shall be handed over to the Engineer-in-Charge only on successful completion, operational tests and acceptance of the effluent quality by the municipal / pollution control and statutory authorities.

69.8 Statutory Permissions

Contractor shall submit a write-up of process of the plant, drawings, design parameters flow and PIB diagrams as necessary and required for submission to the State pollution control authority.

Contractor shall furnish at his own cost, analysis of influent at source (for evaluation) as well as that of influent at the holding tank of the STP and the effluents from the STP for submitting to State Pollution Control Board and any other statutory authority whose approval is required.

Contractor shall perform all testing and operation of the plant in presence of the Pollution Control Board if so stipulated by them.

Contractor to obtain all statutory approval as required for PCB or any other approval. Only official fee will be reimbursed to contractor by the Owner.

69.9 Completion Documents

On successful completion of the entire work, the contractor shall submit 4 sets of following documents to Architect.

A brief write-up of process, day to day operating and maintenance instructions.

List of approved chemicals and procedure for storage and safety norms.

Completion drawing and data, catalogues, performance charts, technical data sheets and equipments installed.

Manufacturer's maintenance and operating instructions for mechanical and electrical equipment.

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

Laminated and framed "As Built" drawings with plans, section, process flow diagrams, pipe runs, levels and final disposal point schedule of equipment installed with all their model Nos. plate data and date of installation.

Test readings of Influent & Effluent parameters taken at final handing over time

NOC (No Objection Certificate) from State Pollution Control Board and any other statutory authority whose approval is required.

69.10 Performance Guarantee

Equipment supplied and installed shall be guaranteed to yield the specified effluent standards which must meet and accepted with the requirements of Pollution Control Board.

The guarantee implicitly includes replacement of the entire plant on failure to meet desired effluent parameters, replacement of individual equipment or repairs as warranted. Decision on each and every aspect on this matter shall rest with the Consultant and shall be final and binding on the contractor.

69.11 Defects Liability

All equipment and the entire installation shall be guaranteed against defective materials and workmanship for a period of 12 months reckoned after taking over of system by Owner along with the documentation. During the defects liability period, the contractor shall replace defective parts and components free of cost. Rectification or repair may be permitted in case the defect is of minor nature.

69.12 Deviations from Tender Specifications

Tendered may indicate their comments only as deviations from the conditions stipulated herein. Wholesale submission of their own conditions and/or printed conditions in disregard of the conditions stipulated herein shall not be binding on this Tender.

No corrections, erasure etc. of this document shall be accepted.

69.13 Sewage Characteristics

69.13.1 Design Parameters

• Project	:	Assembly Building
• Usage	:	Office Staff
• Location	:	Under ground
• Level	:	Ground

69.14 Design Consideration

• Capacity (Max).	:	120m3/day
• Area Available	:	150 Sqm
• Operation	:	Domestic Sewage (round the clock)
• Influent	:	
○ pH	:	7.5 to 8.5
○ BOD 5 days @ 200C.	:	upto 250-350 mg/l
○ Suspended solids (SS)	:	upto 250-400 mg/l
○ Oil & grease	:	50 mg/l
○ COD	:	upto 450-600 mg/l
• Treated Effluent	:	
○ pH	:	6 - 7
○ BOD 5 days @ 200C.	:	less than 10 mg/l
○ Suspended solids (SS)	:	less than 10 mg/l
○ Oil & grease	:	NIL

- COD : less than 50 mg/l

69.15 Salient Features

The plant should be suitable for low/peak flow in line with medical waste usage.

The plant should not create any noise, with no nuisance on fly or mosquito and no foul odors.

The plant should work without the use of in-organic chemical additives

The plant should be provided with tertiary treatment in form of dual media/activated carbon filter /UV system to provide zero bacteriological standards for reuse on:

- Irrigation system
- HVAC cooling tower

69.16 Basis of Design

The capacity/ rating of pumps and equipment etc. shall hold good for the capacity of 60 m³/day and shall be good for meeting the treated parameters requirement as follows:

- Permissible limit as prescribed in IS: 2490 (Part-I)-1974 and environment (Protection) Rules 1986.
- Water (Prevention and Control of Pollution) Act, 1977 & 1978.
- Environment (Protection) Act, 1986.
- Environment (Protection) Rules, 1986.
- Hazardous Wastes (Management & Handling) Rules, 1989.
- Manufacturer, Storage and Import of Hazardous Chemicals Rules, 1989.
- Manufacturer, use import and storage and hazardous Micro-Organizers, Genetically Engineered organizations or Cell Rules, 1989.
- Manual on sewage & sewage treatment - CPHEEO
- The Public Liability Insurance Act, 1991.
- All standards as laid down by Central Pollution Control Board and any other relevant statutory authority.
- 100% recycle of waste water and removal of sludge in cake from, no water to be discharged outside the premises.

69.17 Sewage Treatment Plant

69.17.1 General

The sewage treatment plant (STP) system outlined in this section specifies the system design, manufacture, supply and installation of a standard **Sequential Batch Reactor Technology system (SBR)**.

The Contractor shall submit analytical test reports of effluent water samples after the commissioning or after the system is put into operation or as required by the Consultant.

The report shall contain analysis of all data related to those requirements laid down by the local Authorities.

The effluent from the Sewage Treatment Plant shall be suitably treated and the effluent water recovered shall be used for irrigation purposes/ flushing system/ irrigation/ D.G etc.

69.17.2 Description of Process

The treatment process shall comprise the following stages:

- | | |
|-----------------------------------|---|
| ● Physical treatment: | Fine bar-screening / Oil & Grease Chamber |
| ● Equalization / Collection tank: | Flow equalization with air mixing |
| ● Treatment: | SBR based |

- | | |
|---------------------------|---|
| • Final sedimentation: | Settler tank |
| • Intermediate treatment: | UV System in Intermediate tank |
| • Water reclamation: | tertiary filtration and sterilization (For irrigation purpose, flushing) |
| • Sludge disposal: | In cake form through Filter Press or (Transfer through a screwed type pump to municipal tanker) |

69.17.3 Performance Criteria of the Plant

Raw sewage will be brought into the Sewage Treatment Plant. The Contractor shall receive sewage from this point to the treatment plant for treatment process.

The treatment plant shall be designed to treat the above basic characteristics expected in the raw sewage.

Treated effluent shall be connected to a tertiary filtration plant to treat and shall be used for irrigation purpose and Flushing/CT make up purposes.

69.17.4 Process Description

- Inlet Screen Chamber / Oil & Grease Chamber

Raw sewage shall flow into the inlet screen chamber by gravity. Large solids particles shall be intercepted by a fine screen. Then there shall be Oil & Grease Tank. Sewerage will then flow into Equalization / Collection Tank. The incoming sewage shall be mixed in the EQT and fine bubble aeration shall be maintained.

- Equalization / Collection Tank

The Plant is based on Sequential Batch Reactor Technology popularly known as SBR Technology. Unlike various processes of treatments the raw sewage as obtained for the treatment undergoes Physio-Chemical & Biological Treatments. The first part of Physio-Chemical treatment is the Primary Treatment to the raw sewage, which covers the physical activities like screening, de-gritting, flow measurement, flow distribution etc. The plant is designed in accordance with the characteristics of influent and effluent as provided and according to the guidelines set up by the 'CPHEEO Manual', published by the Govt. of India. The detailed description of individual units & their functions are given below.

The plant comprises of the following components detailed are briefed as follows:

Raw Sewage Pumping Station:

As per the requirement of the plant, the Raw Sewage Pumping Station is designed to handle average, peak and lean flows. The Coarse Screen Chamber is provided ahead of sump. Screens will be provided in the Coarse Screen Chamber to screen the raw influent. Necessary hand operated sluice gate shall be provided to isolate the screen when it is under maintenance. The Screened sewage is then allowed to flow to the Raw Sewage Collection Sump. The detention time stipulated as per the tender is adopted for the hydraulic design of wet well. The necessary pumps will be provided to pump the screened raw sewage for further treatment.

The common rising main is provided to carry the sewage from raw sewage sump to Primary units.

Primary Units:

The first unit of Primary treatment is the Inlet Chamber, in which the discharge from Common rising main through Raw Sewage Pumps is received. The inlet chamber is mainly used to control the velocity of raw influent and also for its smooth distribution of flow to the fine screen channel. The fine screen channel will be equipped with manual screen & mechanical screen as required designed for peak flow velocity. Necessary hand operated sluice gate shall be provided at upstream of the chamber to isolate the screen when it is under maintenance. The screenings is conveyed to the disposal through a belt conveyor and further it is to be disposed off by suitable arrangement.

The screened influent then flows to the Grit chambers where the heavy inorganic matter is separated. The Grit free waste thus obtained will flow to SBR basin. At this stage physical treatment of raw influent known as Primary Treatment completes.

SBR Process:

SBR is a SEQUENTIAL BATCH REACTOR process. It provides highest treatment efficiency possible in a single step biological process.

SBR – System is operated in a batch reactor mode which eliminates all the inefficiencies of the continuous processes. A batch reactor is a perfect reactor, which ensures 100% treatment. Two modules are provided to ensure continuous treatment. The complete process takes place in a single reactor, within which all biological treatment steps take place sequentially.

NO additional settling unit / secondary clarifier is required!

The complete biological operation is divided into cycles. Each cycle is of 3 – 5 hrs duration, during which all treatment steps take place.

Explanation of cyclic operation:

A basic cycle comprises:

Fill-Aeration (F/A)

Settlement (S)

Decanting (D)

A Typical Cycle

During the period of a cycle, the liquid is filled in the SBR Basin up to a set operating water level. Aeration Blowers are started for aeration of the effluent. After the aeration cycle, the biomass settles under perfect settling conditions. Once Settled the supernatant is removed from the top using a DECANTER. Solids are wasted from the tanks during the decanting phase.

These phases in a sequence constitute a cycle, which is then repeated.

Chlorine Contact Tank:

The Effluent from the SBR basins will be collected in Chlorine Contact Tank .The supernatant thus collected will get disinfected in Chlorine Contact Tank by adding suitable dose of chlorine and finally it is discharged in to nearby nallah.

Sludge Handling System:

The sludge as collected from SBR basins is collected into sludge sump and conveyed to centrifuge unit for dewatering the same. The necessary centrifuge feed pumps & Centrifuges will be provided. There will be an arrangement of dosing polyelectrolyte if necessary.

- Intermediate Tank

The effluent shall be retained in the baffle walled cleared water tank for a minimum of 30 minutes for effective disinfection prior to discharge through UV system.

- Sludge Holding Tank

Excessive sludge shall be stored in the sludge holding tank for final dewatering and disposal.

- Then will be Treated Water Tank (TWT)

69.17.5 Equipment

The following give the minimum requirements of the different components of the system.

All equipment and components of the system shall be of top quality construction and shall be corrosion resistant.

- **Fine Screening Equipment**

Bar screen shall be of 304 stainless steel constructions. Drip trays shall be provided for holding and drainage of the screenings. A manual by-pass screen of 30mm opening with stainless steel drip tray shall be provided. An isolation valve shall be provided to divert the flow to the by pass screen when the screen requires service.

- **Air Blowers**

Air blowers shall be provided with standby arrangement. Blowers shall be either of positive displacement or centrifugal with pressure vessel type complete with motor, base-plate, inlet filter, intake silencer and off-load starting system outlet silencer, anti-vibration damper, flexible coupling, filter restriction indicator, non-return valve, pressure relief valve, V-belt system or direct drive coupling. The casing rotor shall be of cast iron construction. Bearings and gears shall be grease lubricated. Motor speed shall be 1500 rpm.

The size and performance of the air blower shall be so selected that it can provide a minimum airflow rate 0.5 l /sec / diffuser to 1l/sec/diffuser maximum, and to maintain a minimum of 2.0mg/ dissolved oxygen in the aeration tanks in operation.

- **Air Diffusers**

Air diffusers shall be made to provide a uniform distribution of fine bubble air release performance in the system. The air diffuser shall be either made of elastomeric rubber membrane or composed of crystalline fused aluminum oxide with a suitable ceramic bonding material.

Membrane endurance shall be more than 180,000 expansion/contraction cycles.

The Contractor shall submit calculation to justify the diffuser selection and air requirement during the detailed design.

- **Sewage Pumps**

Working and standby sewage pumps shall be provided.

Each shall be of submersible type c/w guide base to facilitate ease of removal, lift chain and automatic discharge connection.

- **Settling Tanks**

Settling tanks shall include baffles to prevent short circuiting.

- **Ultra Violet (UV) System**

UV system shall be furnished as a complete package assembly for installation in the plant room. Assembly shall include UV Lamps suitable no. UV dosing system shall perform to achieve a residue not more than 1 mg/l in the treated effluent. feed pump shall have a maximum capacity of 1 l/hr will operate on 50 Hz supply.

- **Tertiary Treatment**

This tertiary treatment shall be provided for the effluent used for irrigation and cooling tower make-up water tank/flushing system.

The tertiary treatment plant shall comprise of the pressure sand filters and activated carbon filters. This shall be sized to accommodate 100% of the effluent discharge flow rate and shall achieve the performance as outlined and described in Design Criteria.

- **Electrical Control**

The operation of the treatment process shall be fully automatic.

A completely assembled and pre-wired control panel consisting of weatherproof cabinet shall be furnished. The control panel shall contain all metering and status indicators, motor starters, program timers, on-off-auto change-over switches and duty selectors for equipment.

- Other Equipment

Any other necessary accessories, such as buffer, riser, scum removal devices, partition, control panel, collection devices, etc. for all the tanks and pumps (where necessary) shall be provided in order to provide a fully working systems.

- Piping Materials

- | | | |
|--------------|---|--|
| ○ SS304 | : | Submerged air piping |
| ○ MS epoxy | : | Air piping and pumped effluent riser (Non submerged) |
| ○ PVC piping | : | Pumped effluent (submerged) & tank overflow pipe line. |

69.17.6 Valves

The Contractor shall supply and install all isolating valves and control valves as indicated on the drawings and as required for the proper and efficient operation and maintenance of the entire systems.

All valves supplied shall be suitable for the working pressure and test pressure of the system as specified elsewhere in this specification.

All valves shall be full line size.

Furnish all valves and accessory materials necessary in the piping whether or not shown on drawings as flows.

Plastic or metal plates (rustles) shall be provided to indicate the open / close status as well as the use of each valve in the pump and tank rooms.

70 PIPE SUPPORTS

70.1 General Support

Tender drawings indicate schematically the size and location of pipes. The Contractor, on the award of the work, shall prepare detailed working drawings, showing the cross-sections, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports. He must keep in view the specific openings in buildings and other structure through which pipes are designed to pass.

Piping shall be properly supported on, or suspended from, on stands, clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchor, clamps and hangers, and be responsible for their structural stability.

Pressure gauges shall be provided as shown on the approved drawings. Care shall be taken to protect pressure gauges during pressure testing.

71 INSTALLATION

The Contractor shall check the associated civil work prior to the installation of any item of machinery and advise the Consultant, in writing, of any deviation of such work from the specified details.

The machinery shall be accurately installed to correct dimensions, alignments, levels, etc., all as indicated on the final drawings. The machinery shall be mounted on flat steel packing pieces of thickness suitable to take up variations in level of the concrete foundations. Suitable packing pieces shall be located adjacent to each holding down bolt and shall be properly bedded by grinding the concrete surface to a smooth, level finish. The machinery shall be aligned and leveled and the nuts of the holding down bolts tightened with

a spanner of normal length. The base plates shall be packed with grout after the machinery has been run and checked by the Consultant for stability and vibration.

Installation shall include the provision and fixing of all necessary holding down bolts, washers, nuts etc.

72 TESTING

The performance of the system shall be demonstrated by taking hourly samples of the raw sewage and final effluent over a twelve hour period. The sample shall be taken at periods approximately the flow rates specified by the plant. The sample shall be combined and a 5-day BOD shall be run, the results of which must verify the capacity of the treatment plant prior to acceptance.

73 ELECTRICAL INSTALLATION**74 MOTOR CONTROL CENTRES**

Switchboard cubicles of approval type shall be fabricated from 2mm thick CRC sheet with dust and vermin proof construction. It shall be painted with powder coating of approved make and shade. It shall be fitted with suitable etched plastic identification plates for each motor. The cubicle shall comprise of the following (Switchgear as given in the schedule of quantities):

- Incoming MCCB of required capacity.
- MCCB / MPCB – one for each motor.
- Fully automatic DOL/Star Delta starters suitable for motor DOL upto 7.5 H.P.; Star / Delta for 10 H.P. and above H.P. with push buttons one for each motor and On / Off indicating neon lamps.
- Single phasing preventer of appropriate rating for each motor.
- Rotary duty selector switch
- Panel type ampere meters one for each motor shall be with rotary selector switch to read line currents.
- Panel type voltmeter on Incoming main with rotary selector switch to read voltage between phase to neutral and phase to phase.
- Neon phase indicating lamps and indicating lamp for each motor and on incoming mains.
- Rotary switch for manual or auto operation for each pump.
- Fully taped separate aluminum bus bar of required capacity for normal and emergency supply where specified.
- Space for liquid level controllers and other equipment specified separately in the contract / given in the schedule of quantities.
- The panel shall be pre-wired with color-coded wiring. All interconnecting wiring from incoming main to switchgear, meters and accessories within the switchboard panel. Wiring shall have suitable copper or aluminum ferrules.

Switchboard cubicle shall be floor or wall mounted type as directed by the Engineer-in-Charge.

SECTION – IX : FIRE FIGHTING SYSTEM

75 TECHNICAL SPECIFICATION

Work under this sub-head consists of furnishing all Labor, Materials, equipment and accessories necessary and required to completely install the Fire Fighting equipment etc., specified hereinafter and given in the

Without restricting to the generality of the foregoing the work of Fire Fighting System shall include the followings:

- Providing M.S. black steel (Class C) pressure pipe line main including Valves, Fire Hydrants, Excavation for Pipe, Laying of pipe, Painting of pipe and Making Connection to supply system.
- Black Steel Pipe, Mains Laterals, Branches, Valves, Hangers and Appurtenances.
- Hose Reels, Rubberized fabric lined hose pipes, Hose cabinets, Sprinkler heads and Landing Valves.
- Portable Fire Extinguishers
- Fire Fighting Pumps, diesel operated pumps, panels and all connected accessories including suction & delivery pipes.
- Testing Commissioning and giving live demonstrations to the various Inspection Authorities and Obtain their "No Objection Certificate" (NOC) for occupation of the building.

76 GENERAL REQUIREMENTS

All materials shall be of the best quality conforming to the Specifications and subject to the approval of the Engineer-in-Charge.

Pipes and Fittings shall be fixed truly Vertical, Horizontal or in slopes as required in a neat workman like manner.

Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause any obstruction in shaft, passage etc.

Pipes shall be securely fixed to walls and ceiling by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceilings.

Valves and other appurtenance shall be so located that they are easily accessible for operation, repairs and maintenance.

77 PIPES

All pipes within and outside the building in exposed locations and shafts including connections buried under floor shall be M.S. Pipes as follows:

- Pipes 150 mm dia and below IS: 1239 (Class C) Heavy Class
- Pipe 200 mm dia and above IS 3589 of thickness specified.

78 PIPE FITTINGS

Pipes and fittings means tees, elbows, couplings, flanges, reducers etc. And all such connecting devices that are needed to complete the piping work in its totality.

Fabricated fittings shall not be permitted for pipe diameters 50 mm and below.

When used, they shall be fabricated, welded and inspected in workshops under supervision of Engineer-in-Charge whose welding procedures have been approved by the TAC as per TAC rule 4102 for sprinkler system and applicable to hydrant and sprinkler system. For "T" connections, pipes shall be drilled and reamed. Cutting by gas or electrical welding will not be accepted.

79 JOINTING

79.1 Screwed (50 mm dia pipes and below)

Joint for black steel pipes and fittings shall be metal-to-metal thread joints. A small amount of red lead may be used for lubrication and rust prevention. Joints shall not be welded or caulked. (With screwed MS forged fittings)

79.2 Welding (65 mm dia and above)

Joints between MS pipes and fittings shall be made with the pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. Buried pipes will be subject to X Ray test from an approved agency as per the TAC norms at the cost of contractor. (With welded M.S. fittings heavy class with V-Groove). The welding machine shall be 3 Phase rectifier of required current and capacity. The vendor for welding will be approved by Engineer-in-Charge.

79.3 Flanges

Flanged joints shall be provided on:

- Straight runs not exceeding 30 m on pipelines 80 mm dia and above.
- Both ends of any fabricated fittings e.g. bends, tees etc. of 65 mm dia or larger diameter.
- For jointing all types of valves, appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and required as good for engineering practice.
- Flanges shall be as per IS 6392-1971, Table 17/18 with appropriate number of G.I. nuts and bolts, half threaded of with 3 mm insertion neoprene gasket complete.

79.4 Unions

Provide Approved type of dismountable unions on pipes lines 65 mm and below in similar places as specified for flanges shall be provided.

80 PIPE PROTECTION

All pipes above ground and in exposed locations shall be painted with one coat of Red Oxide Primer and two or more coats of Synthetic Enamel Paint of approved shade.

All black steel pipes under floors or below ground shall be provided with protection against corrosion by application of 100mm wide and 4mm thick layer of PYPKOTE/ MAKPOLYKOTE over the pipe, as per manufacturers specifications.

81 PIPE SUPPORTS

All pipes shall be adequately supported from ceiling or walls from existing/new inserts by Structural clamps fabricated from M.S. Structural e.g. Rods, Channels, Angles and Flats as per details given in drawings and specifications. All clamps shall be painted with one coat of red lead and two coats of black Enamel paint.

Where inserts are not provided, the Contractor shall provide anchor fasteners. Anchor fastener shall be fixed to walls and ceilings by drilling holes with Electrical drill in an approved manner as recommended by the manufacturer of the fasteners.

82 TESTING

All pipes in the system shall be tested to a hydraulic pressure of 1.5 times of the working pressure or minimum of 15 kg/cm² without drop in the pressure for at least 2 hours.

Rectify all leakages, make adjustment and retest as required.

83 ANCHOR BLOCK

Contractor shall provide suitable cement concrete, anchor blocks of ample dimensions at all bends, tee connection and other places required and necessary for overcoming pressure thrusts in pipes. Anchor blocks shall be of cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size).

84 VALVES**84.1 Valves, Gauge and Orifice Plates**

Sluice Valves above 65 mm shall be of Cast Iron body and Bronze/Gunmetal seat. They shall conform to type PN 1.6 of IS:780-1980, valves up to 65mm shall be of Gunmetal Full way Valve with wheel tested to 20 kg/cm² class-II as per I.S: 778-1971. Valve wheels shall be of right hand type and have an arrow head engraved or cast thereon showing the direction for turning open and closing.

Non-return valves shall be of Cast Iron body and Bronze/Gunmetal seat. They shall conform to class of IS: 5312 and have flanged ends. They shall be swing check type in horizontal runs and lift check type in vertical runs of piping. They shall not be spring-loaded type.

85 EXTERNAL YARD HYDRANTS

The Contractor shall provide External Fire Hydrant in the Ring or on External Fire Line, as per specifications and as shown in drawings. The spacing of the hydrants and the distance from the building shall be maintained as per relevant requirements of latest relevant codes, unless specified herewith.

Each External Fire Hydrant shall be provided with an External Fire Hose Cabinet of M.S of size 76.8 x 61.44 x 25.80 cm, as approved by the Architect to equip 2 nos. of 63 mm dia controlled percolating hose and accessories as required. The cabinet shall be installed near the Hydrant as per details, approved by the Engineer-in-Charge / Architect.

86 INTERNAL HYDRANTS

The Internal Hydrant outlet shall comprise "Single Headed Single Outlet Gunmetal Landing Valve" conforming to type 'A' of IS: 5290-1977. Separate valve on the head shall form part of the landing valve construction.

A cap with chain is provided on one head of the outlet. The hydrant will have an instantaneous pattern female coupling for connecting to Hose Pipe.

The Landing Valve shall be fitted to a Tee connection on the wet riser at the landing.

87 FIRST-AID HOSE REEL EQUIPMENT

First aid hose reel equipment shall comprise reel, hose guide fixing bracket hose tubing globe valve, stopcock and nozzle. This shall conform to IS:884 - 1969. The hose tubing shall conform to IS:1532-1969.

The hose tubing shall be 20 mm dia and 36.5m long. The GM nozzle 5mm and globe valve shall be of 20 mm size.

The fixing bracket shall be of swinging type. Operating instructions shall be engraved on the assembly. This heavy duty mild steel and cast iron brackets shall be conforming to IS: 884 - 1969. The first-aid hose reel shall be connected directly to the MS pipe riser taken independently from ring.

88 HOSE PIPES, BRANCH PIPES AND NOZZLES**88.1 Hose Pipes**

Two numbers Hose Pipes shall be rubber lined woven jacketed and 63mm in dia. 15m long. They shall confirm to type A (Reinforced rubber lined) of IS:636 - 1979. The hose shall be sufficiently flexible and capable of being rolled.

Each run of hose shall be complete with necessary coupling at the ends to match with the landing valve or with another run of hose pipe or with branch pipe. The couplings shall be of instantaneous spring lock type. This shall be conforming to IS: 903.

89 BRANCH PIPE**89.1 Branch Pipes**

Branch pipe shall be of Gunmetal 63 mm dia and be complete with male instantaneous spring lock type coupling for connection to the hose pipe. The branch pipe shall be externally threaded to receive the nozzle.

89.2 Nozzle

The nozzle shall be of Gunmetal 20 mm in (internal) diameter. The screw threads at the inlet connection shall match with the threading on the branch pipe. The inlet end shall have a hexagonal head to facilitate screwing of the nozzle on to the branch pipe with nozzle spanner.

End Couplings, Branch pipe, and Nozzles shall conform to IS:903 - 1985.

Two C.P hoses of 15m length with couplings shall be provided with each External (Yard) Hydrant. Two RRL hoses of 15m length, as specified, with couplings shall be provided with each Internal Hydrant. One nozzle and one branch pipe with coupling shall be provided with each Yard Hydrant and Internal Hydrant.

90 HOSE CABINET

The internal hose cabinet shall accommodate the Hose pipes, branch pipe, Nozzle First aid Hose Reel and Hydrant Outlets and shall be fabricated from 2 mm thick or 14 mm gauge MS/aluminum sheet. The overall size shall be 2100x900x715 mm, or as specified in the Architectural details. This shall have lockable centre opening glazed doors as per the requirement and as per Architectural details. Where the niche for wet riser is provided with shutters, separate hose cabinet as above may be dispensed with.

The hose cabinet shall be painted red and stove enameled and woods FIRE written in front glazed portion.

91 FIRE BRIGADE INLET CONNECTIONS

Fire Brigade Inlet connection shall be provided near the pump house and to the wet riser system as specified, for the following purposes:

- Fire Brigade suction connection for fire static tank with provision of foot valve.
- Fire brigade inlet connection to fire static tank.
- Fire brigade inlet connection to the wet riser system. Each connection shall be provided with similar dia of Sluice valve and Non return valve.

The locations of this Fire brigade connection shall be suitably decided with the approval of Consultant/Landscape Architect and with a view that these are easily accessible to the fire brigade, without any possible Hindrance.

92 HYDRAULIC SIREN

A siren shall be provided in the system, to indicate the flow of water in the wet riser system. Alternative arrangements may also be adopted. This shall be turbine type.

93 VALVE CHAMBERS

Contractor shall provide suitable Brick Masonry Chamber in cement mortar 1:5 (1 cement: 5 coarse sand) on cement concrete foundations 150 mm thick in 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) 15 mm thick plaster inside and outside finished with a floating coat of neat cement inside with cast iron surface box approved by fire brigade including excavation, back filling complete.

Valve chambers shall be of following size:

- For depths 100 cm and beyond 90x90x100 cm

94 PORTABLE FIRE EXTINGUISHER

Portable fire extinguishers shall be provided as per the drawing and shall confirm to IS:2190-1979.

- Two 9 lit. water CO₂ type for every 600 m² area with minimum of 1 extinguishers per floor as per IS:15683
- Dry Chemical powder type of 6 Kg. Capacity as per IS:15683
- CO₂ type of 4.5 kg capacity as per IS: 15683.

95 SPRINKLER HEADS

Sprinkler heads shall be provided at approximate spacing to cover 9 to 12 m² per Sprinkler head. The spacing shall however, be in conformity with the drawings and properly coordinated with Electrical Fixtures, Ventilation Ducts and Grills and other services along the ceiling.

Sprinkler heads shall be chrome finished Brass/Gunmetal with quartz bulb with a temperature rating of 68°C. Sprinkler heads shall be of type and quality approved by the local fire brigade authority. The inlet shall be screwed. Sprinkler heads shall be pendent, recessed or special application side wall Sprinkler types as shown in drawings. All Sprinklers should have the Specifications.

Contractor shall supply spare Sprinkler Heads of each type as per requirement and one Spanner for each type of sprinkler neatly installed in a steel box with glass shutters at locations approved by the Engineer-in-Charge.

96 ALARM VALVE & AUTOMATIC WATER MOTOR GONG VALVE

The alarm valve & water motor gong valve UL approved shall be provided on the Sprinkler main delivery pipe complete in all respects.

97 SHOP DRAWINGS & SPECIFICATIONS

The Contractor shall submit to the Consultant two copies of Shop Drawings for Fire Fighting works as an Advance Copy to the Engineer-in-Charge for approval before start of work. Subsequent to the approval of the shop drawings, the Contractor shall submit six copies of Shop Drawings for execution to the Engineer-in-Charge. Also the Contractor shall submit four copies of the Technical Specifications and Catalogues.

Shop drawings shall be submitted for the following conditions:

- Structural supports/hanging/laying and jointing details for all types of pipes as required.
- Fire Fighting layout plans as required and for any changes in the layout of Fire Fighting/Architectural drawings.

The Contractor can only commence the work after the approval of above documents by Consultant.

SECTION – X: WATER SUPPLY/FIRE FIGHTING PUMPS & EQUIPMENTS AND WATER TREATMENT UNITS ETC.**98 PUMPS AND WATER TREATMENT EQUIPMENT**

Work under this sub-head consists of furnishing all labor, materials, equipment and accessories necessary and required to completely install pumping system for various water supply services and water treatment as per drawings, specified hereinafter.

Without restricting to the generality of the foregoing, the work of pumps and water treatment equipment shall include the followings:

- Raw water pumps.
- Hydro-pneumatic pumps for Domestic and flushing water.
- Garden Hydrant Pumps.
- Hot water recirculation pumps.
- Treated water supply pumps to STP (Emergency supply)
- Sump pumps for disposal of drainage.
- Water treatment unit consisting of filter, and chlorination etc.
- Fire pumps.
- Motor control panels, power and control cabling and allied electrical works.
- Pipes, valves, accessories, hangers, supports, delivery and suction feeders and connection to proposed pipe work.

99 PUMP SET**99.1 Water Supply Pumps (Raw Water / Garden Hydrant / Hot Water Recirculation Pump)**

Water supply pumps shall be suitable for clean water. Pumps shall be multistage, monoblock vertical centrifugal pumps with Cast Iron body and Cast Iron impeller, stainless steel shaft and coupled to a TEFC electric motor by means of a flexible coupling. Each pump should operate a curve 10m below specified head.

Pump and motor shall be mounted on a common M.S. structural base plate or as required as per site conditions.

Each pump shall be provided with a totally enclosed fan cooled induction motor.

Each pumping set shall be provided with a 150mm dia or of suitable size gunmetal "Burden" type pressure gauge with gunmetal isolation cock and connecting piping.

Provide vibration-eliminating pads appropriate for each pump.

Provide rate of flow measuring meter with bypass arrangement with every set of pumps.

All water supply pumps shall be provided with mechanical seals.

99.2 Hydro pneumatic Pumps System (Domestic & Flushing Water Supply Pumps)

Domestic water supply pumps shall be packaged type skid mounted hydro pneumatic system with fixed speed system. Complete system to be mounted on a common base frame.

Pumps shall be multistage, monoblock vertical centrifugal pumps with stainless steel body and stainless steel impeller, stainless steel shaft and coupled to a TEFC electric motor by means of a flexible coupling. Each pump should operate a curve 10m below specified head.

Pressure vessel of non corrosive FRP composite construction lined with NSF and/or FDA listed material, like high density polyethylene with fully replaceable polyurethane. Air cell burst pressure of minimum of 5 times the vessel operating pressure and cycle tested for 2,50,000 cycles. No. and capacity of Pressure Vessel As per manufacturer recommendation.

Pump and motor shall be mounted on a common M.S. structural base plate or as required as per site conditions.

Each pump shall be provided with a totally enclosed fan cooled induction motor.

Each pumping set shall be provided with a 150mm dia or of suitable size gunmetal "Burden" type pressure gauge with gunmetal isolation cock and connecting piping.

Provide vibration-eliminating pads appropriate for each pump.

Provide rate of flow measuring meter with bypass arrangement with every set of pumps.

All water supply pumps shall be provided with mechanical seals.

Pumps shall have Control Panel with programmable logic controller (PLC) for cyclic operation of pumps. Pump working sequence should change after every operation. Contractor overload relays and MCBs should confirm to IEC 898 – 1995/ specifications. Blinking indications for pumps start, trip, low level trip, and health supply should be provided in the panel along with the ammeter & voltmeter. Control panel should also consist of cooling fan.

100 SUMP PUMP

Sump pumps shall be submersible type for lifting domestic sewage or muddy water/drainage. Pump with impeller of approved material shall be mounted on waterproof motor. The impeller shall be suitable for handling solids upto 46-100mm dia.

The pump shall automatically operate with high water level and stop at low water level in the sump by means of "Electronic Level Controller", of the approved make.

The sump pumps shall be complete in all respect and shall be installed as per manufacturer's requirement as shown in the drawing. All accessories shall be In-Built as per manufacturer's specification.

Sump pumps are compact monoblock dry motor submersible pumps for suitable rating, with non-clog free flow open impeller, minimum solid handling capacity up to 100mm for sewer & 40 for storm water . Suitable for operation on 415 volts + 5% -15%, 50 C/s A.C 3 phase supply, speed 960/1440R&M including oil chamber, guide wire for lifting & lowering of pump, M.S. galvanized lifting chain, duck foot bend.

The above pump sets must be supplied complete with following accessories :

- Complete piping 100mm dia common delivery upto 1.5m as shown in the drawing. (The pipe should be preferably heavy duty GI)
- Necessary valve i.e Butterfly valve on delivery/suction side and Non return valves are on delivery side.
- Necessary cable from pumps set to control panel.
- Electrical switch panel having all necessary accessories & safety devices of standard specifications. (Panels with sump pumps near each sump as per site conditions)
- Automatic built-up water level controller with necessary length of cable upto control panel.

101 FIRE FIGHTING PUMPS

101.1 Electrical Operated Main Fire, Sprinkler and Jockey Pumps

Pumping sets shall be single stage horizontal centrifugal single outlet with cast iron body and dynamically balanced bronze impellers. Connecting shaft shall be of stainless steel with bronze sleeve and grease-lubricated bearings.

Pumps shall be connected to the drive by means of spacer type love-joy coupling which shall be individually balanced dynamically and statically.

The coupling joining the prime mover with the pump shall be provided with a sheet metal guard.

Pumps shall be provided with approved type of mechanical seals.

Pumps shall be capable of delivering not less than 150% of the rated discharge at a head of not less than 65% of the rated head. The shut-off head shall not exceed 120% of the rated head.

The System shall meet the requirements of the National building Code 2005 (NBC).

Necessary 'Y' strainer on the suction side and pressure gauge with GM cocks on the delivery side including bypass arrangement (with 50 valve and up to 5M G.I. Medium pipes) for periodical testing of the working of the pumping set shall be provided.

Pump shall be mounted on common base frame fabricated from MS channel as per manufacturer's specification.

Suitable RCC Pump-foundations as per manufacturer's design and 4 nos. Dunlop (cushy foot) heavy duty Ant-vibration mounting pads shall be provided.

101.2 Motors for Electric Driven Pumps

Electrically driven pumps shall be provided with totally enclosed fan cooled induction motors.

Motors for fire protection pumps shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge and shall be designed for continuous full load duty and shall be design proven in similar service.

Motors for fire pumps shall meet all requirements and specifications of the tariff advisory committee.

Motors shall be suitable for 415 volts, 3 Phase, 50 cycles A.C supply and shall be designed for 33°C ambient temperature. Motors shall conform to I.S: 325.

Motors shall be designed for two start system.

Motors shall be capable of handling the required starting torque of the pumps.

Contractor shall provide heating arrangements for the main fire pump motor to ensure that motor windings shall remain dry.

101.3 Air Vessel for Fire Pumps

Provide an air vessel fabricated from 10mm M.S. sheet with dished ends and suitable supporting legs, air vessel shall be provided with a 100mm dia flanged connection from pump, one 25mm dia drain with valve, one gunmetal water level gauge and 25mm sockets for pressure switches. The vessel shall be 450mm in dia and 2000 mm high and tested to 10.0Kg/cm² pressure.

The fire pumps shall operate on drop of 1 Kg/cm² pressure in the mains. The pump operating sequence shall be arranged in a manner to start the pump automatically but should be stopped manually by starter push buttons only.

101.4 Operating Conditions for the Service Pumps

Fire Service Pump	Nos.	Cut in Pressure	Cut Out Pressure	Remarks
Jockey pump	One	8.0 kg/cm ²	6.7 kg/cm ²	To auto start and auto stop on pressure switch on air vessel.
Main pump	One	6.2 kg/cm ²	Push button manual	To auto start on pressure switch on air vessel and manual off.
Diesel Fire Pump	One	5.7 kg/cm ²	Push button manual	To auto start on pressure switch on air vessel and manual off.
Sprinkler Pump	One	6.7 kg/cm ²	Push button manual	To auto start on pressure switch on air vessel and manual off.

101.5 Diesel Fire Pump

101.5.1 Scope

This section covers the details of requirements of the standby fire pump, operated by a diesel engine.

101.5.2 General

The diesel pump set shall be suitable for automatic operation, complete with necessary automatic starting gear, for starting on wet battery system and shall be complete with all accessories. Both engine and pump shall be assembled on a common bed plate, fabricated from mild steel channel.

101.5.3 Drive

The pump shall be only direct driven by means of a flexible coupling. Coupling guard shall also be provided. The speed shall be 1450/1800 rpm.

101.5.4 Fire Pump

The fire pump shall be horizontal split casing centrifugal type. It shall have a capacity to deliver 2280 lpm as specified, developing adequate head so as to ensure a minimum pressure of 3.5 Kg. per cm² at the highest and the farthest outlet. The delivery pressure at the pump outlet shall be not less than 8 Kg. per cm² in any case. The pump may be single stage or multi stage as specified. The pump shall be capable of giving a discharge of not less than 150% of the Rated discharge at a head of not less than 65% of the rated head. The shut off head shall be within 120% of the rated head.

The pump casing shall be of cast iron to grade FG 200 to I.S: 210 and parts like impeller shaft sleeve, wearing-ring etc. shall be of non-corrosive metal like bronze/brass/gunmetal. The shaft shall be of stainless steel. The pump shall be provided with mechanical seal.

The pump casing shall be designed to withstand 1.5 times the working pressure.

Bearings of pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water.

101.6 Diesel Engine

Environmental Conditions - The engine shall be required to operate under the conditions of environment as required as per site conditions.

Engine Rating - The engine shall be cold starting type without the necessity of preliminary heating of the engine cylinders or combustion chamber (for example, by wicks, cartridge, heater plugs etc). The engine shall be multi cylinder/vertical 4 stroke cycle, water cooled diesel engine, developing suitable HP at the operating speed specified to drive the fire pump. Continuous capacity available for the load shall be exclusive of the power requirement of auxiliaries of the diesel engine, and after correction for altitude, ambient temperature and humidity for the specified environmental conditions as mentioned. This shall be at least 20% greater than the maximum HP required to drive the pump at its duty point. It shall also be capable of driving the pump at 150% of the rated discharge at 65% of rated head. The engine shall be capable of continuous non-stop operation for 8 hours and at least 3000 hours of operation before major overhaul. The engine shall have 10% overload capacity for one hour in any period of 12 hours continuous run.

The engine shall accept full load within 15 seconds from the receipt of signal to start. The diesel engine shall conform to B.S: 649/I.S: 1601/I.S: 10002, all amended up to date.

Engine Accessories - The engine shall be complete with the following accessories:-

- Fly sheet dynamically balanced.
- Direct coupling for pump and Coupling Guard.
- Radiator with hoses, fan, water pump, drive arrangement and guard.
- Corrosion Resister
- Air cleaner, oil bath type/dry type
- Fuel service tank support, semi-rotary pump and fuel oil filter with necessary pipe work.
- Pump for lubricating oil and lub. oil filter
- Elect. starting battery (2x12 v)
- Exhaust silencer with necessary pipe work
- Governor
- Instrument panel housing all the gauges, including Tachometer, hour meter and starting switch with key (for manual staring).
- Necessary safety controls
- Winterization arrangement, where specified.

Cooling System - The engine cooling system shall be radiator water cooled system. The radiator assembly shall be mounted on the common bed plate. The radiator fan shall be driven off the engine as its auxiliary with a multiple fan belt. When half the belts are broken, the remaining belts shall be capable of driving the fan. Cooling water shall be circulated by means of an auxiliary pump of suitable capacity driven by the engine in a closed circuit.

Fuel System - The fuel shall be gravity fed from the engine fuel tank to the engine driven fuel pump. The engine fuel tank shall be mounted either over or adjacent to the engine itself or suitably wall mounted on brackets at a height not less than 60 cm above the fuel injection pump. The fuel filter shall be suitably located to permit easy servicing.

All fuel tubing to the engine shall be with copper, with flexible hose connections where required. Plastic tubing shall not be permitted.

The fuel tank shall be of welded steel construction (3mm thick) and of capacity sufficient to allow the engine to run on full load for at least 8 hours. The tank shall be complete with necessary floor mounted supports, level indicator (protected against mechanical injury) inlet, outlet, overflow connections and drain plug and piping to the engine fuel tank. The outlet should be so located as to avoid entry of any sediment into the fuel line to the engine.

A semi rotary hand pump for filling the daily service tank together with hose pipe 5 mtr. long with a foot valve etc. shall also form part of the scope of work.

Lubricating Oil System - Forced feed lub. oil system shall be employed for positive lubrication. Necessary lub. oil filters shall be provided, located suitably for convenient servicing.

Starting System - The starting system shall comprise necessary batteries (2x12 v), 24 volts starter motor of adequate capacity and axle type gear to match with the toothed ring on the fly wheel. By metallic relay protection to protect starting motor from excessively long cranking runs suitably integrated with engine protection system shall be included within the scope of the work.

The battery capacity shall be suitable for meeting the needs of the starting system.

The battery capacity shall be adequate for 10 consecutive starts without recharging with cold engine under full compression.

The scope shall cover all cabling, terminals, initial charging etc.

Exhaust System - The exhaust system shall be complete with silencer suitable for outdoor installation, and silencer piping including bends and accessories needed for a run of 5 meter from the engine manifold. (Adjustment rates for extra length shall also be given). The total back pressure shall not exceed the engine manufacturer's recommendation. The exhaust piping shall be suitably lagged.

Engine Shut Down Mechanism - This shall be manually operated and shall return automatically to the starting position after use.

Governing System - The engine shall be provided with an adjustable governor to control the engine speed within 5% of its rated speed under all conditions of load up to full load. The governor shall be set to maintain rated pump speed at maximum pump load.

Engine Instrumentation - Engine instrumentation shall include the following:-

- Lubricant oil pressure gauge.
- Lubricant oil temperature gauge.
- Water pressure gauge.
- Water temperature gauge.
- Tachometer.
- Hour meter.

The instrumentation panel shall be suitably resilient mounted on the engine.

Engine Protection Devices - Following engine protection and automatic shut down facilities shall be provided: -

- Low lub. oil pressure
- High cooling water temp.
- High lub. oil temperature
- Over speed shut down.

Pipe Work - All pipe line with fittings and accessories required shall be provided for fuel oil, lub. oil and exhaust systems. Copper piping of adequate sizes shall be used for lub. oil and fuel oil. M.S. piping will be permitted for exhaust.

Anti Vibration Mounting - Suitable vibration mounting duly approved by Engineer-in-Charge shall be employed for mounting the unit so as to minimise transmission of vibration to the structure. The isolation efficiency achievable shall be clearly indicated.

Battery Charger - Necessary float and boost charger shall be incorporated in the control section of the power and control panel, to keep the battery under trim condition. Voltmeter to indicate the state of charge of the batteries shall be provided.

102 CABLES

Contractor shall provide all power control cables from the motor control center to various motors, level controllers and other control devices.

Cables shall conform to I.S: 1554 and carry ISI mark.

Wiring cables shall conform to I.S 694.

All power and wiring cables shall be aluminum conductor PVC insulated armored and PVC sheathed of 1100 volts grade.

All control cables shall be copper conductor PVC insulated armored and PVC sheathed 1100 Volt grade.

All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer's name.

All cable joints shall be made in approved manner as per standard practice.

103 CABLE TRAYS

Contractor shall provide M.S slotted cable trays at locations as shown on the drawings.

Cable trays shall be supported from the bottom of the slab at intervals of 60cms at both ends by anchor fasteners.

104 EARTHING

There shall be an independent earthing station. The earthing shall consist of an earth tape connected to an independent plate made of copper or G.I. having a conductivity of not less than 100% international standard. All electrical apparatus, cable boxes and sheath/armor clamps shall be connected to the main bar by means of branch earth connections of appropriate size. All joints in the main bar and between main bar and branch bars shall have the lapping surface properly tinned to prevent oxidation. The joints shall be riveted and sweated.

Earth plates shall be buried in a pit of 1.20x1.20M at minimum depth of 3M below ground. The connections between main bar shall be made by means of three 10mm brass studs and fixed at 100mm centers. The pit shall be filled with coke breeze, rock salt and loose soil. A G.I. pipe of 20mm dia with perforations on the periphery shall be placed vertically over the plate to reach ground level for watering.

A brick masonry manhole 30x30x30cm size shall be provided to surround the pipe for inspection. A bolted removable link connecting main bar outside the pit portion leading to the plates shall be accommodated in this manhole for testing.

105 CONTROL PANELS / STARTERS

Switch board cubicles of approved type shall be fabricated from 16-gauge M.S. sheet with dust and vermin proof construction. It shall be painted with powder-coated finish of approved make and shade. It shall be fitted with suitable etched plastic identification plates for each motor. The cubicle shall comprise of the followings:-

- Incoming main isolation MCCB of required capacity.
- Fully Aluminum taped Bus Bar of required capacity.
- Isolation MCCB one for each motor.
- Fully automatic as specified D.O.L/Star Delta starters suitable for motor H.P. with push buttons one for each motor and on/off indicating neon lamps. (DOL up to 7.5 HP and Star Delta from more than 7.5 H.P)
- Single phase preventer of appropriate rating for each motor.
- Panel type ampere meters one for each motor with selector switch.
- Panel type voltmeter on incoming main with rotary selector switch to read voltage between phase to neutral and phase-to-phase.
- Neon phase indicating lamps for incoming main and on/off indicating lamps for each motor.
- Rotary switch for manual or auto operation for each pump (manual/auto off).
- Fully taped separate aluminum bus bars of required capacity and with required outlets.
- Space for liquid level controllers as specified + 1 extra space.
- The panel shall be pre-wired with color-coded wiring. All interconnecting wiring from incoming main to switch gear, meters and accessories within the switchboard panel.
- Provision of main incoming cables from the top of the panel.

All switch gears and accessories shall be of approved make such as "Siemens, Larsen & Toubro" or equivalent.

Switchboard cubicles shall be floor or wall mounted type as recommended by manufacturers. All floor-mounted switchboards shall rest on minimum 225mm high platform. The contractor shall provide the shop drawings for base and panels.

106 VIBRATION ELIMINATORS

Provide on all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump. Length of the connector shall be as per manufacturer's details.

107 ILLUMINATED FACSIMILE ANNUNCIATOR PANEL**107.1 Scope**

Scope of this section comprises the supply, installation, testing and commissioning of illuminated facsimile annunciation panel.

107.2 Illuminated Facsimile Enunciator

Illuminated facsimile enunciator shall be provided with facsimile of the building, constructed of acrylic panels of suitable dimensions, showing the Basement, Ground floor plans and section showing the location of Zonal Panels on each typical floor, entry points, various facilities shown with enamels in various colors.

Alarm lights to indicate fire location shall be arranged within the acrylic panel and shall be either automatically lighted by operation of any automatic fire detection devices or manual station, or by control of push button incorporated in the control desk.

Indicator of each building or facility shall include two lamps connected in parallel and so arranged that the failure of either of the lamps is readily apparent when a call or test is made.

Power for the Enunciator shall be supplied from the power supply for the control desk.

Representation of the various plans/Drawings on the acrylic of the Enunciator shall be by negative film processing with colored Discrimination of various zones for which the drawings shall be furnished for approval.

108 WATER FILTER

Water filter shall be of dual filter media pressure filter downward or upward flow type suitable for a rate of filtration.

Filter shall be vertical type of required diameter. The shell shall be fabricated from M.S. plate suitable to withstand a working pressure as given below. The minimum thickness of shell will be 8mm and dished ends shall be 10mm. The filter shall have at least one pressure tight manhole cover.

Filter shall be provided with screwed or flanged connections for inlet, outlet, individual drain connections and all other connections necessary and required. Filter shall be painted inside with two or more coats of non-toxic corrosion resistant paint, one coat of red oxide primer outside with two or more coats of synthetic enamel paint of approved shade.

108.1 Under Drain System

Filter shall be provided with an efficient under drain system comprising of collecting pipes, gunmetal/polypropylene nozzles of manufacturer's design. The entire under drain system be provided on M.S. plate or cement concrete supports.

108.2 Face Piping

Filter shall be provided with interconnecting face piping comprising of inlet, outlet, and backwash pipe complete with pipes, valves and accessories, as per requirement. Piping shall be G.I/M.S. piping, medium duty, as per I.S: 1239 and valves shall be cast iron double flanged sluice valves on SOUNDERS pattern with C.I. body and Neoprene rubber diaphragm (Suggested make LABLINE, NKI or equivalent).

108.3 Accessories

Each filter shall be provided with following accessories:-

- Air release valve with connecting piping.
- 150mm dia dial burden type gunmetal pressure gauges with gunmetal isolation cock and connecting piping on inlet and outlet.
- Sampling cocks on raw water inlet and filtered water outlet.
- Individual drain connection with gunmetal full way valve.

- Connection with valve for air scouring.

109 PIPING

Pipes for suction and delivery shall be galvanized/M.S tube (heavy duty) conforming to I.S:1239 up to 150mm dia and as per I.S:3589 for dia 200mm and above. The M.S flanges shall conform to I.S:6392-1971.

Gate valve and check valve above 65mm dia shall be C.I. double flanged conforming to I.S:780 manufactured by the reputed manufacturers or C.I. double flanged butterfly valves.

Full way and check valves 65mm dia and below shall be gunmetal tested to 20Kg/cm² pressure certified and conforming to I.S:778.

Suction strainer or foot valves shall be C.I., confirming to I.S:4038 - 1979.

109.1 Joints

All pipes and fittings shall be provided with flanged joints, with flanges either screwed or welded complete and jointed with 1.5mm thick gasket complete with nuts, bolts and washers etc.

109.2 Testing

All G.I pipes (except fire pipe) shall be tested hydrostatically for a period of 30 minutes to a pressure of 7 Kg/cm² without drop in pressure and all G.I pipes for fire shall be tested hydrostatically for a period of 30 minutes to a pressure of 10 Kg/cm² without drop in pressure.

110 GUARANTEE

The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.

The form of warranty shall be as approved by the Engineer-in-Charge.

The warranty shall be valid for a period of one year from the date of commissioning and handing over.

The warranty shall expressly include replacement of all defective or under capacity equipment, Engineer-in-Charge may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.

The warranty shall include replacement of any equipment found to have capacity lesser than the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Engineer-in-Charge.

**111 TECHNICAL INFORMATIONS FOR WATER SUPPLY / FIRE FIGHTING PUMPS & EQUIPMENTS
AND WATER TREATMENT UNIT ETC.
(TO BE FILLED BY THE TENDERER)**

S.NO	PARTICULARS	Main Fire Pump	Jockey Pump
(I).	ELECTRICAL OPERATED FIRE PUMP		
(A)	PUMP:		
1.	Discharge	:	
2.	Total head at full discharge	:	
3.	Type	:	
4.	Make and Model No.	:	
5.	BHP absorbed	:	
	(a) at rated head and discharge		
	(b) at 150% of rated discharge and 65% of rated head.		
6.	Casing material.	:	
7.	Impeller material.	:	
8.	Shaft material.	:	
9.	No. of stages.	:	
10.	Type of drive.	:	
11.	Type of sealing.	:	
(B)	MOTOR:		
1.	Make.	:	
2.	Type.	:	
3.	Protection type.	:	
4.	Insulation class.	:	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

S.NO	PARTICULARS	Main Fire Pump	Jockey Pump
	5. Electrical particulars (Voltage/No. of phase/frequency).	:	
	6. I.S. conforming to	:	
	7. H.P. (App.)	:	
	8. Speed.	:	
(II).	DIESEL FIRE PUMP		
	<u>Diesel Engine:</u>		
	1. Make & Model No.	:	
	2. Type.	:	
	3. H.P.	:	
	4. Speed.	:	
	5. No. of cylinders.	:	
	6. I.S/BS Standard conforming to	:	
	7. Type of cooling.	:	
	8. Fuel consumption at full load.	:	
	9. Overload capacity.	:	
	10. Isolation efficiency.	:	
(III).	RAW WATER PUMPS		
	1. Discharge	:	
	2. Head	:	
	3. Type	:	
	4. H.P of Motor	:	
	5. Other Details	:	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

S.NO	PARTICULARS	Main Fire Pump	Jockey Pump
(IV).	GARDEN HYDRANT PUMPS		
1.	Discharge	:	
2.	Head	:	
3.	Type	:	
4.	H.P of Motor	:	
5.	Other Details	:	
(V).	HYDRO PUMPS (FOR DOMESTIC WATER)		
(A)	PUMP:		
1.	Discharge.	:	
2.	Total head at full discharge.	:	
3.	Make and Model No.	:	
4.	Type.	:	
5.	Frame size.	:	
6.	BHP absorbed	:	
	(a) at rated head and discharge.	:	
7.	Casing material.	:	
8.	Impeller material.	:	
9.	Shaft material.	:	
10.	No. of stages.	:	
11.	Type of drive.	:	
12.	Type of seal.	:	
(B)	MOTOR:		
1.	Make.	:	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

S.NO	PARTICULARS	Main Fire Pump	Jockey Pump
	2. Frame size.	:	
	3. Type.	:	
	4. Protection type.	:	
	5. Insulation class.	:	
	6. Electrical particulars (Voltage/No. of phase/frequency).	:	
	7. I.S. conforming to	:	
	8. H.P.	:	
	9. Speed.	:	
(VI).	FILTER		
	1. Make	:	
	2. Model	:	
	3. Dia Meter	:	
	4. Height	:	
	5. Type of Flow	:	
	6. Material of Construction	:	
	7. Shell/Dished end thickness	:	
	8. Max. working pressure	:	
	9. Hydro test pressure	:	
	10. Max. Flow rate	:	
	11. Min. flow rate	:	
	12. Filtration Rate	:	
	13. Inlet/outlet pipe Size	:	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

S.NO	PARTICULARS	Main Fire Pump	Jockey Pump
	14. Type of Media	:	
	15. Media Quantity	:	
	16. Type of Valve	:	
	17. Back Wash Frequency	:	
	18. Pressure drop across bed	:	
(VII).	SUMP PUMPS (FOR SEWAGE)		
	1. Discharge	:	
	2. Head	:	
	3. Type	:	
	4. Solid Handling Capacity	:	
	5. H.P of Motor	:	
	6. Other Details	:	
(VIII).	SUMP PUMPS (FOR DRAINAGE)		
	1. Discharge	:	
	2. Head	:	
	3. Type	:	
	4. Solid Handling Capacity	:	
	5. H.P of Motor	:	
	6. Other Details	:	
(IX).	ELECTRIC CONTROL PANEL		
	1. Make	:	
	2. Make of switch fuse unit/breaker used.	:	
	3. Thickness of sheet metal used.	:	

S.NO	PARTICULARS	Main Fire Pump	Jockey Pump
	4. Make of contractors.	:	
	5. Make of cables and size of cables for different motors.	:	
	6. Any other informations.	:	
Note:-			
The Tenderer must give as maximum as possible information. They may add any other relevant information's also, if required.			

112 IMPORTANT INSTRUCTION FOR QUALITY OF WATER

The successful contractor will have to carry out a test of raw water from all the sources of water for the Hospital at their own cost from a reputed lab as approved by the Engineer-in-Charge / Consultant. On the basis of these results the contractor has to submit his shop drawings, design calculations and specifications accordingly.

Please note that it is ultimately the responsibility of the contractor to provide treated water for different use in the hospital as per International Standard as given in the attached guidelines.

113 EXCLUDED ITEMS FROM THE SCOPE OF PLUMBING & FIRE FIGHTING CONTRACTOR

- a. Office of equipments.
- b. Foundations of all equipments.
- c. Main incoming stabilised power supply with double earthing in the Sub Panel / Isolators i.e. $415 \pm 10\%$ volts, 50 Hz $\pm 5\%$ AC supply & single-phase power supply wherever required.
- d. Any kind of masonry work such as openings in walls/slabs and making good thereof.
- e. Civil Water Tanks and Pump Room

114 REQUIRED QUALITY OF TREATED WATER

Sl. No.	Characteristics	Acceptable as per Indian Standard of P.H.E.
1	Turbidity (Units on J.T.U scale)	2.5
2	Colour (Units on Platinum Cobalt scale)	5.0
3	Taste and Odour	Unobjectionable
4	pH	7.0 to 8.5
5	Total dissolved solids (mg/l)	500
6	Total hardness (mg/l) (as CaCO ₃)	200
7	Chlorides (as Cl) (mg/l)	200
8	Sulphates (as SO ₄)	200
9	Fluorides (as F) (mg/l)	1.0
10	Nitrates (as NO ₃) (mg/l)	45
11	Calcium (as Ca) (mg/l)	75
12	Magnesium (as Mg) (mg/l)	> 30
13	Iron (as Fe) (mg/l)	0.1
14	Manganese (as Mn) (mg/l)	0.05
15	Copper (as Cu) (mg/l)	0.05
16	Zinc (as Zn) (mg/l)	5.0
17	Phenolic compounds (as Phenol) (mg/l)	0.001
18	Anionic detergents (mg/l) (as MBAS)	0.2

Sl. No.	Characteristics	Acceptable as per Indian Standard of P.H.E.
19	Mineral Oil (mg/l)	0.01
20	Arsenic (as As) (mg/l)	0.05
21	Cadmium (as Cd) (mg/l)	0.01
22	Chromium (as hexavalent Cr) (mg/l)	0.05
23	Cyanides (as CN) (mg/l)	0.05
24	Lead (as Pb) (mg/l)	0.1
25	Selenium (as Se) (mg/l)	0.01
26	Mercury (total as Hg) (mg/l)	0.001
27	Polynuclear Aromatic Hydrocarbons (PAH)	0.2 ug/l
28	Gross Alpha activity	3p Ci/l
	Gross Beta activity Pci = pico curie	30p Ci/l
29	Bacteriological Quality of piped water supplies	
	Treated water entering the distribution system	
29.1	Faucal coli forms number/100 ml	0
29.2	Coli form organisms number/ 100 ml	0

END OF TECHNICAL SPECIFICATION

TECHNICAL SPECIFICATIONS

PROPOSED CONSTRUCTION OF 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG, MEGHALAYA

(HVAC)



CONTENTS

1	TECHNICAL REQUIREMENTS FOR HVAC WORK	75
1.1	Equipments & Materials of HVAC System.....	75
1.2	General	75
1.3	Tender Drawings	75
1.4	Shop Drawings	76
1.5	As Built Drawings.....	77
1.6	Instruction / Maintenance Manual.....	77
1.7	Discrepancies between Bill of Quantities, Specifications & Drawings	77
1.8	Prices, Unit Rates & Taxes / Duties etc.....	77
1.9	Variation in Quantities & Tender Drawings	78
1.10	Performance Bound Contract	78
1.11	Guarantee.....	78
1.12	Repairs / Replacement of Parts During Guarantee.....	79
1.13	Quiet Operation & Vibration Isolation of AC System.....	79
1.14	Testing.....	79
1.15	System Balancing.....	80
1.16	Operation of Plant	80
1.17	Training of Personal.....	80
1.18	Inspections & Testing	80
2	BASIS OF DESIGN.....	81
2.1	Basis of Design of AC System	81
2.2	Basis of Design of Mechanical Ventilation System	82
2.3	Design Parameters	82
2.4	Noise & Vibration Control.....	82
2.5	Parameters of Air Conditioning &.....	84
2.6	Equipment Selection	84
2.7	Air Conditioning Equipment & Electrical Load	87
2.8	Parameters for Mechanically Ventilated Area with Equipment Selection	90
2.9	Total HVAC Electrical Load	95
2.10	System Description	95
3	TECHNICAL SPECIFICATION OF EQUIPMENTS.....	97
3.1	VRV / VRF Outdoor Unit.....	97
3.1.1	Scope of Work.....	97
3.1.2	Codes & Standard	97
3.1.3	General.....	97
3.1.4	Outdoor Unit	98
3.1.5	Scroll Compressor	98
3.1.6	Heat Exchanger.....	99
3.1.7	Refrigerant Circuit	99
3.1.8	Refrigerant.....	99
3.1.9	Safety Devices.....	99
3.1.10	Oil Recovery System	99
3.1.11	Transit Damage	100
3.1.12	Technical Requirement of VRV / VRF Unit	100
3.2	VRV / VRF Indoor Unit.....	101
3.2.1	Scope of Work	101
3.2.2	General.....	101
3.2.3	Ceiling Mounted Cassette Type Unit (Multi Flow Type)	101
3.2.4	Ceiling Mounted Ductable Type Unit.....	102
3.2.5	Ceiling Suspended Type	102
3.2.6	Hi Wall Mounted Unit.....	102
3.2.7	Floor Standing Type	102
3.2.8	Centralized Type Remote Controller	102
3.2.9	Colour	102
3.3	Double Skinned DX VRV / VRF AHU.....	103
3.3.1	Scope of Work	103
3.3.2	Codes & Standard	103

3.3.3	Air Cooled VRV / VRF Outdoor Unit	103
3.3.4	Double Skinned Air Handling Units	103
3.3.5	Accessories	104
3.4	Ventilation Fans.....	105
3.4.1	Scope of Work.....	105
3.4.2	Type.....	105
3.4.3	Capacity.....	105
3.4.4	Axial Flow Fans	105
3.4.5	Centrifugal Fans	105
3.4.6	Propeller Fans	106
3.4.7	In-Line Fans.....	106
3.4.8	Jet Vent Fan	106
3.4.9	Accessories	106
3.4.10	Performance Data	107
3.4.11	Testing.....	107
3.5	Airwasher	108
3.5.1	Scope of Work.....	108
3.5.2	Type.....	108
3.5.3	Housing	108
3.5.4	Fan	108
3.5.5	Motor	108
3.5.6	Pre Filter Section	108
3.5.7	Air Washer Section	109
3.5.8	Tank & Wet Section	109
3.5.9	Pump, Piping & Valves	109
3.5.10	Efficiency	109
3.5.11	Installation	109
3.5.12	Transit Damage	109
3.5.13	Testing.....	109
3.6	Dry Scrubber.....	110
3.6.1	Scope of Work.....	110
3.6.2	Type.....	110
3.6.3	Principle Of Operation	110
3.6.4	Equipment Specification	110
3.6.5	Housing	110
3.6.6	Finish	110
3.6.7	Pre-filter	111
3.6.8	Electronic Cells	111
3.6.9	Fan	111
3.6.10	Motor	112
3.6.11	Activated Carbon Filter Section	112
3.6.12	Installation	112
3.6.13	Transit Damage	113
3.6.14	Testing.....	113
4	TECHNICAL SPECIFICATION FOR ELECTRICAL ITEMS	114
4.1	Electrical Motors.....	114
4.1.1	Scope of Work.....	114
4.1.2	Motors.....	114
4.1.3	Motor Starters.....	115
4.1.4	Installation of Motors	115
4.2	Motor Control Centre, Ventilation Sub Panel, Power & Control Cabling, Earthing etc.	116
4.2.1	Scope of Work	116
4.2.2	Motor Control Centre / Ventilation Sub-Panel	116
4.2.3	Bus-Bars	117
4.2.4	Air Circuit Breakers	117
4.2.5	Moulded Case Circuit Breakers.....	118
4.2.6	Miniature Circuit Breakers.....	118
4.2.7	Rotary Switch / Selector Switch / Switches / HRC Fuses / Starters / Single Phase Preventers / Toggle Switch	118
4.2.8	Current Transformer	118
4.2.9	Overload Relays	119
4.2.10	Time Delay Relays	119
4.2.11	Indicating Lamps And Metering.....	119

4.2.12	Voltmeter And Ammeters	119
4.2.13	Push Button Stations.....	119
4.2.14	Name Plate.....	119
4.2.15	Conduits	119
4.2.16	Cables	119
4.2.17	Laying Of Cables.....	120
4.2.18	Wire Sizes	120
4.2.19	Drawings.....	120
4.2.20	Testing	120
4.2.21	Painting Of Panels.....	120
4.2.22	Sizes Of Power Cabling	120
4.2.23	Capacity Of Relays And Contacts	121
4.2.24	Earthing	121
5	SERVICES SPECIFICATION	122
5.1	Air Distribution	122
5.1.1	Scope of Works	122
5.1.2	GI Duct (Site Fabricated).....	122
5.1.3	Associated Items For Duct	122
5.1.4	Construction Of Duct	123
5.1.5	Box Type Dampers & Splitters	124
5.1.6	Supply / Return Air Grills & Ceiling Diffusers	124
5.1.7	Fresh Air Intake Louvers With Bird Screen	125
5.1.8	Painting.....	125
5.1.9	Testing	125
5.1.10	Factory Fabricated Ducting	125
5.2	Steel Wire Rope Hangers & Supports	129
5.3	Fire Dampers (UL Listed & Certified)	133
5.3.1	Scope of Work	133
5.3.2	Motorized Combined Smoke & Fire Dampers - Spring Return Type	133
5.4	Refrigerant Piping	134
5.4.1	Scope of Works	134
5.4.2	Refrigerant Piping.....	134
5.5	Insulation / Lining Work.....	136
5.5.1	Scope of Works	136
5.5.2	Material & Process of Acoustic Insulation of Duct / AHU Room	136
5.5.3	Material & Process of Thermal Insulation of CHW / HW Pipes / AC Equipments	137
5.5.4	Material & Process of Thermal Insulation of Ducts	138
5.5.5	Under deck Insulation with Closed Cell Polyethylene FR-XPE.....	139
5.6	Insulated Flexible Duct	140
5.7	Condensate Drain Piping Work.....	140
5.7.1	Scope of Works	140
5.7.2	Drain Water Piping	140
5.7.3	Pipe Fittings.....	141
5.7.4	Flanges.....	141
5.7.5	Installation of Water Piping.....	141
5.7.6	Testing of Pipe System	142
5.7.7	Air-Vents.....	142
6	NOISE & VIBRATION CONTROL	143
6.1	Scope of Work	143
6.2	Standards	143
6.3	General	143
6.4	Sound Attenuators	144
6.5	Anti-vibration Mountings.....	144
6.6	Open Spring Mountings.....	145
6.7	Neoprene-in-Shear Mountings	145
7	MODE OF MEASUREMENT	146
7.1	Sheet Metal Work.....	146
7.1.1	Ducting	146
7.1.2	Grills / Diffusers / Fire Dampers	146
7.1.3	Box Dampers.....	146
7.2	Piping Work.....	146
7.3	Insulation.....	146

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

7.3.1	Insulation of Duct.....	146
7.3.2	Insulation of Chilled Water / Drain Water Pipes.....	147
7.3.3	Insulation of Chiller / Expansion Tank / Suction Line.....	147
7.3.4	Acoustic Lining of Duct & Plenum	147
7.4	Electrical Cabling Work	147
7.5	Structural Supports.....	147
7.6	Flexible Pipe Connector	147
8	EXCLUDED ITEMS FROM THE SCOPE OF HVAC CONTRACTOR	147

END OF CONTENTS

1 TECHNICAL REQUIREMENTS FOR HVAC WORK

Subject: VRF Air-Conditioning & Mechanical Ventilation System for IT Building, Shillong.

Objective: To achieve GRIHA Rating 3 (Green Rating for Integrated Habitat Assessment) as per Green Building rating System in India. The HVAC contractor shall be equally responsible for achieving this certification along with GRIHA Consultant. The HVAC Contractor shall provide complete details & documents as required by the GRIHA Consultant for certification & shall work in consultation with GRIHA Consultant & HVAC Consultant.

1.1 Equipments & Materials of HVAC System

The HVAC System shall comprise of following Equipments & Materials as specified in BOQ.

- A) VRF Outdoor Unit Cool / Heat Pump Type.
- B) VRF Indoor Unit.
- C) Hi-wall Split AC
- D) Fans, Mechanical Vent Unit, Scrubber for Ventilation System.
- E) G.S.S. Ducting, Duct Insulation, Grill / Diffusers etc.
- F) Insulated Copper refrigerant piping.
- G) Drain water piping duly insulated.
- H) Electrical Works Related To HVAC
- I) All other items as detailed in "**Schedule of Quantities.**"

1.2 General

The special conditions of contract given below shall be read in conjunction with the other documents forming part of the contract. In case of any variance, these conditions shall supersede any other conditions mentioned in any contract document.

The materials, design and workmanship shall satisfy the specifications contained herein and codes referred to. Where the technical specifications stipulate the requirement in addition to those contained in the Standard Codes and specifications those additional requirements shall also be satisfied. In the absence of any Standard / Specifications covering any part of the work covered in this tender document, the instructions / directions of engineer-in-charge will be binding on the contractor.

All HVAC installations shall be of high quality, complete and dully operational including all necessary items and accessories whether or not specified herein. All HVAC work shall be completed in accordance with the regulations and standard to the satisfaction of the Engineer-in-charge.

1.3 Tender Drawings

The drawings issued with the tender documents are only for guidance of the tenderer. The actual & final AC drawings shall be prepared by the successful AC Contractor after due co-ordination with

other services & shall be approved by Engineer-in-Charge / AC Consultant / Architect before commencement of site work. The tenderer has to ensure that their proposal will meet with all the current rules & regulations pertaining to the relevant local / national statutory.

1.4 Shop Drawings

On the award of the work, the Contractor shall immediately proceed with the preparation of detailed working drawings showing the detail of each equipment that are to be installed and the ancillary works that are to be carried out. All the works are deemed to be included in various items of bill of quantities as applicable.

Three sets of all such working drawings duly signed by the head of the planning & design department of the tenderer shall be submitted to the Engineer-in-charge for approval to ensure that the works will be carried out in accordance with the specifications and drawings, including such changes as may have been mutually agreed upon. All the drawings shall be received by the Engineer-in-charge for approval within 04 (Four) weeks from the date of award of work. The approval of the drawings by the Consultants / Engineer-in-charge shall in no way relieve the Contractor from his obligations to provide a complete and satisfactory plant installation, testing and commissioning as per intent and purpose as laid down in the specifications. It will be the responsibility of the AC contractor to ensure that laid down inside conditions are maintained at all times.

Any omissions and / or errors shall be made good or rectified whether or not the drawings are approved. Contractor shall obtain written approval for samples (like grills / diffusers) and other materials before placing the order. Contractor shall guarantee the specified inside conditions at specified outside conditions. Prior to the erection of Equipments, the contractor shall furnish to the employer (2) two sets of a comprehensive manual for all equipments etc. describing all components furnishing a list of spare parts and setting forth in details the instructions for the operation and maintenance of the plant.

The Contractor shall also fix in the Operating / Maintenance Room, neatly typed and framed, instructions in details, for the starting and running of the plant.

The AC contractor for approval- shall prepare the following shop drawings

- a) AC Equipment Layout along with sectional drawings of each installed equipment.
- b) Schematic refrigerant piping layout with pipe size.
- c) HVAC layout plans of all floors with sections, support details, position of duct dampers / splitter dampers, insulation, etc.
- d) AC equipments foundation layout plans and load data.
- e) Electrical panel, power & control wiring drawings.
- f) Electrical power requirements on AC Layout Plans along with summary.

- g) Individual equipment drawings from equipment manufacturer along with technical data sheets. (For Engineer-in-Charge / Consultant's Approval)
- h) Any other shop drawings necessary for the project.

1.5 As Built Drawings

The AC Contractor shall submit six sets of paper prints of the as-built drawings & one soft copy, showing accurate record of the work as installed to the Client for his reference. The contractor shall also submit three copies of an Operating Manuals in ring binder describing the brief write up on the system installed, operating instruction for all equipments, catalogues, maintenance of equipments etc

1.6 Instruction / Maintenance Manual

The Contractor shall prepare and produce instruction, operation and maintenance manuals in English for use, operation and the maintenance of the supplied equipment and installations, and submit to the Engineer-in-charge in three copies at the time of handing over. The manual shall generally consist of the following:

- a) Description of the Project.
- b) Operating instructions.
- c) Maintenance instructions including procedures for preventive maintenance.
- d) Manufacturers catalog.
- e) Spare parts list.
- f) Trouble shooting charts.
- g) Drawings.
- h) Type and routine test certificates of major items.
- i) Six sets of as built drawings along with soft copy of drawings in CD.

1.7 Discrepancies between Bill of Quantities, Specifications & Drawings

In case of conflicts between Bill of Quantities, Specification & Drawings the Bill of Quantities shall take precedence over the Specification & Drawings, in keeping with the general intent of the scope of work in the contract document. In all such cases, the Engineer-in-Charge / Consultant will interpret the requirements of the design intent & the Contract Documents & their decision shall be final & binding. The contractor shall not be entitled to any extension of time or any compensation due to such determination.

1.8 Prices, Unit Rates & Taxes / Duties etc.

The prices and unit rates quoted by the bidder in the bid shall be firm and deem to be adequate to cover the entire responsibility involved in the execution and completion of work. The rates shall be complete in all respects including cost of materials, erection, fabrication, labour, supervision, tools and plant, transport, contingencies, breakage, wastage, sundries, scaffoldings, insurance.

Please indicate separately the assessable value & quantum / rate of custom duty, CVD, excise duty on each refrigeration equipment separately in your price bid, if applicable.

The contract price quoted shall remain firm till completion of job and handing over the same in working condition to the client.

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

The rates quoted shall be deemed to allow for all minor extras and constructional details, which are not specifically shown on drawings or given in the specifications but are essential in the opinion of the Engineer-In-charge for the execution of works to con-form to good workmanship and sound engineering practice.

The Engineer-In-charge decision to clarify any item under minor changes, minor extras and constructional details shall be final, conclusive and binding on the Contractor.

The rates quoted by the Contractor shall be net so as to include all the requirements described in the contract agreement and no claim whatsoever due to fluctuations in the price of materials and labour will be entertained.

In case the rates of identical items under different sub-heads / parts are different; the lowest of these will be taken for the purpose of making the payments.

The contractor shall provide all equipments, instruments, labour and such other assistance required by the Engineer-in-charge for measurement of the works, materials etc.

Department reserves the rights to split up the above work between one or more Contractor or award the entire work to one Contractor. Quoted rates should hold good for all such eventualities. No revision in the quoted rates will be entertained at a later date on this account.

1.9 Variation in Quantities & Tender Drawings

The quantities for ancillary works given in the schedule and / or in drawings are for the guidance of the tenderer. The contractor shall be paid on the basis of actual quantities of works carried out. However the contractor shall check these quantities before quoting and will bring to the notice of Consultants / Engineer-In charge for any major variation. HVAC drawings issued with the tender are diagrammatic only and indicate the general arrangement only. The data given in the drawings and specifications is as exact as could be secured, but its accuracy is not guaranteed. Contractor shall carry out his own computations and provide all such equipment, as required to achieve the specified conditions. The contract shall be on works contract basis and the Client reserves the right to add / delete any items of work during the currency of contract.

1.10 Performance Bound Contract

The contract will be a performance bound contract and therefore the Bidder shall make their independent check for Heat Load, selection of equipments etc. The drawings enclosed with the tender documents shall be only tentative layout plans and for guidance purpose only. The detailed shop drawings shall be prepared and submitted for approval to the Department / Engineer-in-Charge / Consultant.

The contractor shall guarantee the specified inside condition at specified outside condition considering the fresh air as detailed in the basis of design of the tender documents.

The contractor shall guarantee that the capacity of various equipments as well as the whole system shall be within ± 3% of the specified capacity.

1.11 Guarantee

The AC contractor shall guarantee the inside design conditions as stipulated in the "Basis of Design" Section - 02. The AC contractor shall be responsible for maintaining the desired inside conditions with the equipments selected & offered by him and shall not deprive him of the responsibility if selection of equipment given in the tender document is not thoroughly checked. In case of shortfall the AC contractor shall replace / modify equipment for achieving desired parameter without any extra

cost to Department / employer. The contractor would be bound to replace the equipment / equipments selected by him if design condition is not achieved by the AC System offered & installed by him. The contractor shall guarantee the complete AC system for a period of 12 months from the date of handing over the plant after successful commissioning. They shall also guarantee that the performance of the various equipments individually / jointly shall not be less than the specified ratings when working under operating conditions for the complete installation.

1.12 Repairs / Replacement of Parts During Guarantee

Any defects or other faults which may appear within defect liability / guarantee period of twelve months from the date of handing over the plant in a satisfactory working conditions to the Department (except for normal wear and tear) arising in the plant from material or workmanship not in accordance with the contract specification will be rectified by the contractors free of cost & nothing shall be paid extra on any account.

1.13 Quiet Operation & Vibration Isolation of AC System

All HVAC equipments shall operate under all varying / part load conditions without any objectionable sound or vibration as specified in the section Noise & Vibration Control or in the opinion of the Department / consultant. In case of rotating machinery sound or vibration noticeable outside / inside the room in which it is installed shall be considered objectionable & shall be rectified by the contractor at his own expense up to the satisfaction of consultant / Department.

1.14 Testing

All testing instruments, velocity meter, digital / electronic electric energy meter, digital thermometer, psychrometer, measuring steel tapes, tools, scaffolding and ladders etc., that may be required for taking measurements shall be arranged by air-conditioning contractor at his own cost.

All types of specified & routine tests of the equipments shall be carried out at the works of the Contractor or the manufacturers of the components. The Department shall be free to witness any or all tests, if they so desired. The Contractor has to inform to the Client before dispatch of any material / equipment.

On the completion of the installation the Contractor shall arrange to carry out various initial tests as detailed below, in the presence of and to the complete satisfaction of the Department / Engineer-in-Charge / Consultants, any defect or short-coming found during the tests shall be speedily rectified or made good by the Contractor at his own expenses. The initial tests shall include, but not be limited to the following:

- a) To operate and check proper functioning of all electrically operated components viz. Compressor motor, pumps, fan of air handling units etc. as well as other electrical motors.
- b) To test and check the proper functioning of electrical gears, safety and other controls to ensure their proper functioning.
- c) To check the air distribution system and to provide designed airflow in all areas by adjusting the grills, diffusers and dampers for air-conditioning.
- d) To check & balance / adjust the refrigerant / water in the circuit for smooth and noiseless flow.
- e) To check the systems against leaks in different circuits, alignment of motor, 'V' belt adjustments, control setting and all such other tests which are essential for smooth functioning of the plant.
- f) Contractor shall have to submit the capacity test of all equipment at site.
- g) On the satisfactory completion of all 'Initial' tests the plant shall be considered 'Virtually Complete' for the purpose of taking over by the Client & balance payment shall be released against BG.
- h) In addition to the 'Initial' test the Contractor shall also give summer, monsoon & winter tests of the plant, each of (3) three days duration, and each one during the full specified outside conditions (when the ambient conditions are close to the specified ambient conditions). The first

running test may be taken on the completion of the initial test, provided the ambient temperature and humidity are near their peak. Inside condition as per the contract, performance of each equipment, Airflow etc. shall be as per the requirement of the contract during these tests.

It is clarified that guarantee period shall start after successful completion of commissioning & handing over.

1.15 System Balancing

The contractor shall leave the system operating in complete balance with air quantities as shown on drawings. Secure all automatic damper and valve linkage in proper positions to provide correct operating ranges. Proper damper positions shall be marked on ducts with permanent indication.

1.16 Operation of Plant

The tenderer shall arrange to operate the AC System for a period of ONE MONTH from the date of commissioning of plant and successful completion of initial test free of cost.

1.17 Training of Personal

The contractor shall impart training to the minimum three technical staffs appointed by the client free of cost during erection and commissioning of the plant.

1.18 Inspections & Testing

All the major equipments may be got inspected & tested before dispatch if desired by the client at the manufacturers work.

The AC Contractor shall intimate the client minimum 21 days in advance about the date of readiness of equipment for inspection & testing at a date to be mutually agreed upon by the client & the AC Contractor.

The manufacturer of these equipments must have a facility of testing the equipments at the test bed on full load at their works. All the test readings mutually taken shall be recorded & evaluated with the technical data furnished by the AC Contractor.

END OF INSTRUCTIONS & SPECIAL CONDITION SECTION

2 BASIS OF DESIGN**2.1 Basis of Design of AC System**

1. Site Location	Shillong, Meghalaya, India
Geographic Location	25.34 N & 91.53 E
Altitude	1525 Meters

2. Introduction

A centralized HVAC system consisting of VRF / VRV equipments shall be designed, installed & commissioned to provide thermally controlled environment for the proposed Building. The HVAC systems shall be designed for automated round the year operation to provide for the Inside environmental conditions as specified below.

3. Outside Design Conditions DBT °C WBT °C

Summer	29.40	21.70
Monsoon	23.30	21.10
Winter	03.30	00.00

4. Inside Design Conditions

Inside conditions in the various areas shall be maintained as per the table given under 'Parameters of Air Conditioning'.

5. Exposed Roof

All exposed roof / terraces shall be insulated with 50 mm thick expanded polystyrene or equivalent material as specified in the BOQ to get an overall heat transmission factor of 0.12 BTU/HR/SFT/°F.

6. Power Supply

Stabilised three phase four wire AC supply i.e. 415 Volts \pm 10 % & 50 Hz \pm 5 % with double earthing shall be made available near outdoor unit / sub panel & Single-phase power supply with earthing near each indoor units & inline fans.

6. Fresh Air / Air Change Per Hour

Fresh Air / Air Change Per Hour in the various Air Conditioned areas shall be maintained as per Table given under 'Parameters of Air Conditioning'.

7. Occupancy

Occupancy in the various areas shall be as per Table given under 'Parameters of Air Conditioning'.

8. Light Power Density

Light Power Density in the various areas shall be as per Table given under 'Parameters of Air Conditioning'.

9. Filtration

Pre filters of efficiency 90% down to 10-micron particle size shall be installed in all the AHU / FCU for AC application.

2.2 Basis of Design of Mechanical Ventilation System

For Mechanical Ventilation designing, NBC 2016 amended up to date (National Building Code of India) guidelines shall be followed & HVAC contractor shall be responsible to comply with latest guidelines of Fire Department at the time of execution. Please refer the 'Parameters of Mechanical Ventilation' table for more details.

2.3 Design Parameters**A) Air-handlers**

a) Maximum Face velocity across cooling coil MPM	:	152.0
b) Maximum face velocity across pre filters MPM	:	152.0
c) Maximum water pressure drop across the coil in Mt.	:	4.6
d) Maximum water velocity through coil in MPS	:	2.5
e) Maximum Fan outlet velocity MPS	:	10.0

C) Ducting Work

a) Method of Duct Design	:	Equal friction Method
b) Maximum air velocity in supply duct (AC) MPM	:	550.0
c) Maximum air velocity in return duct (AC) MPM	:	457.0
d) Friction loss in duct (Maxm.) MM Wg in 100 Mt run.	:	8.33
e) Maximum Velocity at supply air grill outlet (AC) MPM	:	150.00

D) For Air-cooled VRV / VRF Outdoor Unit

a) Temperature of air to inlet of condenser °C	:	45.0
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2.4 Noise & Vibration Control

The air conditioning contractor must take all necessary precautions to have minimum noise generation and its transmission. Minimum vibration as permitted by IS relevant code shall be ensured. A few points for guidance only are given below:

a) VRV / VRF Outdoor Unit

The factory built outdoor unit should be complete with rubber pad of suitable thickness to absorb the vibration generated.

b) VRV / VRF Indoor Unit / Other Equipment

All VRV / VRF indoor unit / other equipment shall have vibration isolation pads of suitable thickness in consultation with manufacturer for isolation of vibration. Double fire retardant flexible connections shall be provided between the outlet of indoor unit & the duct.

c) Duct, Pipes & other accessories

All items suspended from ceiling shall be isolated on separate hangers. In case of ducts, conduits, pipes & tubes the annular space between construction and penetrating element shall be sealed suitably to isolate vibration transmission. The duct lining shall be provided as shown in the tender drawings to reduce the noise level.

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

2.5 Parameters of Air Conditioning & Equipment Selection

S. No.	Floor & Area Name	AC Area, SQFT	Inside Tem. In °C	Relative Humidity %	Light W / SFT	Occupancy	Equip. Load., kW	Fresh Air Qty, CFM	TR Summer	TR Monsoon	kW Winter	Dehum. CFM For Summer	AC Equipment Selection		
													Indoor Equipment Selection	Outdoor Equipment Selection	
	Ground Floor														
1	Office-1	4480	22 ± 1	40~60%	0.90	128	13	909	22.17	19.20	-31.26	10558	5 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/1 - 30 HP	
2	Office-2	2740	22 ± 1	40~60%	0.90	78	8	556	16.12	13.16	-19.57	8422	4 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/2 - 26 HP	
3	Office-3	2740	22 ± 1	40~60%	0.90	78	8	556	12.09	9.82	-19.59	5835	4 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/3 - 26 HP	
4	Office-4	4465	22 ± 1	40~60%	0.90	128	13	906	18.24	15.03	-31.18	8577	5 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/4 - 30 HP	
5	Office-5	1093	22 ± 1	40~60%	0.90	31	3	222	3.67	3.10	-4.76	1586	2 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/5 - 10 HP	
6	Cafeteria	3687	24 ± 1	40~60%	0.90	105	11	748	15.88	11.87	-28.89	6871	4 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/6 - 26 HP	
7	Reception	912	22 ± 1	40~60%	0.90	26	3	185	3.06	2.59	-3.97	1323	2 x 2.0 TR Cassette Unit, 830 CFM Each	VRV ODU/7 & 8 - 2 x 34 HP	
8	Security Office	392	22 ± 1	40~60%	0.90	11	1	80	1.31	1.11	-1.71	569	1 x 2.0 TR Cassette Unit, 830 CFM	From VRV ODU/7 & 8	
9	Maintenance Office	678	22 ± 1	40~60%	0.90	19	2	138	2.27	1.92	-2.95	984	2 x 2.0 TR Cassette Unit, 830 CFM Each	From VRV ODU/7 & 8	
10	Entrance Lobby, Corridor, Waiting Area & Foyer Area	7416	24 ± 1	40~60%	0.90	165	1	1269	28.93	21.52	-43.73	12895	4 x 8.0 TR VRV Ductable Unit, 2825 CFM Each	From VRV ODU/7 & 8	
	First Floor														
1	Office-6	4480	22 ± 1	40~60%	0.90	128	13	909	21.63	20.69	-13.80	10739	5 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/9 - 30 HP	
2	Office-7	2740	22 ± 1	40~60%	0.90	78	8	556	15.78	14.07	-8.89	8210	4 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/10 - 26 HP	
3	Office-8	2435	22 ± 1	40~60%	0.90	70	7	494	13.30	11.84	-8.21	6828	4 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/11 - 26 HP	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

S. No.	Floor & Area Name	AC Area, SQFT	Inside Tem. In °C	Relative Humidity %	Light W / SFT	Occupancy	Equpt. Load., KW	Fresh Air Qty, CFM	TR Summer	TR Monsoon	KW Winter	Dehum. CFM For Summer	AC Equipment Selection	
													Indoor Equipment Selection	Outdoor Equipment Selection
4	Office-9	2435	22 ± 1	40~60%	0.90	70	7	494	8.07	7.16	-7.25	3472	4 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/12 - 26 HP
5	Office-10	2740	22 ± 1	40~60%	0.90	78	8	556	10.13	9.09	-9.14	4580	4 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/13 - 26 HP
6	Office-11	4465	22 ± 1	40~60%	0.90	128	13	906	17.71	16.52	-13.78	8230	5 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/14 - 30 HP
7	Office-12	972	22 ± 1	40~60%	0.90	28	3	197	3.76	3.06	-5.94	1732	2 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/15 - 10 HP
8	Office-13	1093	22 ± 1	40~60%	0.90	31	3	222	3.53	3.46	-0.50	1501	2 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/16 - 10 HP
9	Office-14	630	22 ± 1	40~60%	0.90	18	2	128	2.04	2.00	-0.29	865	1 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/17 - 6 HP
10	Office-15	630	22 ± 1	40~60%	0.90	18	2	128	2.04	2.00	-0.29	865	1 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/18 - 6 HP
11	Office-16	1093	22 ± 1	40~60%	0.90	31	3	222	3.53	3.46	-0.50	1501	2 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/19 - 10 HP
12	Corridor	3350	24 ± 1	40~60%	0.90	74	1	573	6.96	5.77	-8.26	2553	4 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/20 - 20 HP
Second Floor														
1	Office-17	7435	22 ± 1	40~60%	0.90	212	18	1508	37.33	34.64	-22.98	17038	6 x 8.0 TR VRV Ductable Unit, 2825 CFM Each	VRV ODU/ 21 & 22 - 2 x 28 HP
2	Office-18	4915	22 ± 1	40~60%	0.90	140	14	997	22.54	20.12	-16.46	11019	4 x 8.0 TR VRV Ductable Unit, 2825 CFM Each	VRV ODU/ 23 - 36 HP
3	Office-19	7435	22 ± 1	40~60%	0.90	212	21	1508	28.60	26.35	-23.00	13141	6 x 8.0 TR VRV Ductable Unit, 2825 CFM Each	VRV ODU/ 24 & 25 - 2 x 28 HP
4	Office-20	972	22 ± 1	40~60%	0.90	28	3	197	3.76	3.06	-5.94	1732	2 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/ 26 - 10 HP
5	Office-21	1818	22 ± 1	40~60%	0.90	52	5	369	5.88	5.76	-0.83	2496	2 x 4.6 TR VRV Ductable Unit, 1624 CFM Each	VRV ODU/ 27 - 12 HP
6	Office-22	1818	22 ± 1	40~60%	0.90	52	5	369	5.88	5.76	-0.83	2496	2 x 4.6 TR VRV Ductable Unit, 1624 CFM Each	VRV ODU/ 28 - 12 HP

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

S. No.	Floor & Area Name	AC Area, SQFT	Inside Tem. In °C	Relative Humidity %	Light W / SFT	Occupancy	Equpt. Load., KW	Fresh Air Qty, CFM	TR Summer	TR Monsoon	KW Winter	Dehum. CFM For Summer	AC Equipment Selection	
													Indoor Equipment Selection	Outdoor Equipment Selection
7	Corridor	3350	24 ± 1	40~60%	0.90	74	1	573	6.96	5.77	-8.26	2553	4 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/ 29 - 20 HP
Third Floor														
1	Office-17	7435	22 ± 1	40~60%	0.90	212	18	1508	38.56	35.52	-29.16	19531	6 x 8.0 TR VRV Ductable Unit, 2825 CFM Each	VRV ODU/ 30 & 31 - 2 x 28 HP
2	Office-18	4915	22 ± 1	40~60%	0.90	140	14	997	23.35	20.70	-20.55	11541	4 x 8.0 TR VRV Ductable Unit, 2825 CFM Each	VRV ODU/ 32 - 36 HP
3	Office-19	7435	22 ± 1	40~60%	0.90	212	21	1508	29.83	27.23	-29.19	13931	6 x 8.0 TR VRV Ductable Unit, 2825 CFM Each	VRV ODU/ 33 & 34 - 2 x 28 HP
4	Office-20	972	22 ± 1	40~60%	0.90	28	3	197	3.92	3.17	-6.75	1836	2 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/ 35 - 10 HP
5	Office-21	1818	22 ± 1	40~60%	0.90	52	5	369	6.18	5.98	-2.34	2689	2 x 4.6 TR VRV Ductable Unit, 1624 CFM Each	VRV ODU/ 36 - 12 HP
6	Office-22	1818	22 ± 1	40~60%	0.90	52	5	369	6.18	5.98	-2.34	2689	2 x 4.6 TR VRV Ductable Unit, 1624 CFM Each	VRV ODU/ 37 - 12 HP
7	Corridor	3350	24 ± 1	40~60%	0.90	74	1	573	7.52	6.16	-11.04	2909	4 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/ 38 - 20 HP
	Total	111152						458.71	404.65		-444.12			

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

2.6 Air Conditioning Equipment & Electrical Load

SI No.	Floor & Area Name	AC Area, SQFT	AC Equipment Selection		Indoor Installed TR	No. of Points		Kw of Each Point		3/1 Ph		Total KW	
			Indoor Equipment Selection	Outdoor Equipment Selection		Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor
	Ground Floor												
1	Office-1	4480	5 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/1 - 30 HP	27.5	5	1	0.45	33	3	3	2.25	33
2	Office-2	2740	4 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/2 - 26 HP	22.0	4	1	0.45	28.6	3	3	1.80	29
3	Office-3	2740	4 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/3 - 26 HP	22.0	4	1	0.45	28.6	3	3	1.80	29
4	Office-4	4465	5 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/4 - 30 HP	27.5	5	1	0.45	33	3	3	2.25	33
5	Office-5	1093	2 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/5 - 10 HP	8.0	2	1	0.35	11	3	3	0.70	11
6	Cafeteria	3687	4 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/6 - 26 HP	22.0	4	1	0.45	28.6	3	3	1.80	29
7	Reception	912	2 x 2.0 TR Cassette Unit, 830 CFM Each	VRV ODU/ 7 & 8 - 2 x 34 HP	22.0	4	2	0.45	37.4	3	3	1.80	75
8	Security Office	392	1 x 2.0 TR Cassette Unit, 830 CFM	From VRV ODU/7 & 8	4.0	1	NA	0.20	NA	1	NA	0.20	NA
9	Maintenance Office	678	2 x 2.0 TR Cassette Unit, 830 CFM Each	From VRV ODU/7 & 8	4.0	2	NA	0.20	NA	1	NA	0.40	NA
10	Entrance Lobby, Corridor, Waiting Area & Foyer Area	7416	4 x 8.0 TR VRV Ductable Unit, 2825 CFM Each	From VRV ODU/7 & 8	32.0	2	NA	0.20	NA	1	NA	0.40	NA
	First Floor												
1	Office-6	4480	5 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/9 - 30 HP	27.5	5	1	0.45	33	3	3	2.25	33
2	Office-7	2740	4 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/10 - 26 HP	22.0	4	1	0.45	28.6	3	3	1.80	29
3	Office-8	2435	4 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/11 - 26 HP	22.0	4	1	0.45	28.6	3	3	1.80	29

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

SI No.	Floor & Area Name	AC Area, SqFT	AC Equipment Selection		Indoor Installed TR	No. of Points		Kw of Each Point		3/1 Ph		Total KW	
			Indoor Equipment Selection	Outdoor Equipment Selection		Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor
4	Office-9	2435	4 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/12 - 26 HP	22.0	4	1	0.45	28.6	3	3	1.80	29
5	Office-10	2740	4 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/13 - 26 HP	22.0	4	1	0.45	28.6	3	3	1.80	29
6	Office-11	4465	5 x 5.5 TR VRV Ductable Unit, 2047 CFM Each	VRV ODU/14 - 30 HP	27.5	5	1	0.45	33	3	3	2.25	33
7	Office-12	972	2 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/15 - 10 HP	8.0	2	1	0.35	11	3	3	0.70	11
8	Office-13	1093	2 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/16 - 10 HP	8.0	2	1	0.35	11	3	3	0.70	11
9	Office-14	630	1 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/17 - 6 HP	8.0	2	1	0.35	6.6	3	3	0.70	7
10	Office-15	630	1 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/18 - 6 HP	8.0	2	1	0.35	6.6	3	3	0.70	7
11	Office-16	1093	2 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/19 - 10 HP	8.0	2	1	0.35	11	3	3	0.70	11
12	Corridor	3350	4 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/20 - 20 HP	16.0	4	1	0.45	30.8	3	3	1.80	31
Second Floor													
1	Office-17	7435	6 x 8.0 TR VRV Ductable Unit, 2825 CFM Each	VRV ODU/ 21 & 22 - 2 x 28 HP	48.0	5	2	0.45	30.8	3	3	2.25	62
2	Office-18	4915	4 x 8.0 TR VRV Ductable Unit, 2825 CFM Each	VRV ODU/ 23 - 36 HP	32.0	5	1	0.45	33	3	3	2.25	33
3	Office-19	7435	6 x 8.0 TR VRV Ductable Unit, 2825 CFM Each	VRV ODU/ 24 & 25 - 2 x 28 HP	48.0	5	2	0.45	30.8	3	3	2.25	62
4	Office-20	972	2 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/ 26 - 10 HP	8.0	2	1	0.35	11	3	3	0.70	11
5	Office-21	1818	2 x 4.6 TR VRV Ductable Unit, 1624 CFM Each	VRV ODU/ 27 - 12 HP	9.2	2	1	0.35	11	3	3	0.70	11

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

SI No.	Floor & Area Name	AC Area, SqFT	AC Equipment Selection		Indoor Installed TR	No. of Points		Kw of Each Point		3/1 Ph		Total KW	
			Indoor Equipment Selection	Outdoor Equipment Selection		Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor	Indoor	Outdoor
6	Office-22	1818	2 x 4.6 TR VRV Ductable Unit, 1624 CFM Each	VRV ODU/ 28 - 12 HP	9.2	2	1	0.35	11	3	3	0.70	11
7	Corridor	3350	4 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/ 29 - 20 HP	16.0	4	1	0.45	30.8	3	3	1.80	31
Third Floor													
1	Office-17	7435	6 x 8.0 TR VRV Ductable Unit, 2825 CFM Each	VRV ODU/ 30 & 31 - 2 x 28 HP	48.0	5	2	0.45	30.8	3	3	2.25	62
2	Office-18	4915	4 x 8.0 TR VRV Ductable Unit, 2825 CFM Each	VRV ODU/ 32 - 36 HP	32.0	5	1	0.45	35.2	3	3	2.25	35
3	Office-19	7435	6 x 8.0 TR VRV Ductable Unit, 2825 CFM Each	VRV ODU/ 33 & 34 - 2 x 28 HP	48.0	5	2	0.45	30.8	3	3	2.25	62
4	Office-20	972	2 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/ 35 - 10 HP	8.0	2	1	0.35	11	3	3	0.70	11
5	Office-21	1818	2 x 4.6 TR VRV Ductable Unit, 1624 CFM Each	VRV ODU/ 36 - 12 HP	9.2	2	1	0.35	11	3	3	0.70	11
6	Office-22	1818	2 x 4.6 TR VRV Ductable Unit, 1624 CFM Each	VRV ODU/ 37 - 12 HP	9.2	2	1	0.35	11	3	3	0.70	11
7	Corridor	3350	4 x 4.0 TR VRV Ductable Unit, 1377 CFM Each	VRV ODU/ 38 - 20 HP	16.0	4	1	0.45	22	3	3	1.80	22
Total		111152			730.8	123	38					51.70	928

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

2.7 Parameters for Mechanically Ventilated Area with Equipment Selection

S/N	Floor	Area SFT	Effective HT FT	Volume CFT	Air Change Per Hour	Calculated CFM	Installed CFM	Application	Nos. of Fan & Fan Capacity	Type of Fan	Remarks	No. of Point	Kw of Each Point	Phase -1/3	Total Kw, in Normal Mode	Total Kw, Extra in Fire Mode
A	General Areas Ventilation															
	Basement															
1	Male Toilet	285	10	2850	15	713	750	Exhaust	1 x 750	Inline Fan	Normal Mode	1	0.35	1 PH	0.35	0.00
2	Driver Room	365	10	3650	12	730	750	Exhaust	1 x 750	Propeller Fan	Normal Mode	1	0.35	1 PH	0.35	0.00
	Ground Floor															
1	Male & Female Toilet Near Entrance Lobby	450	10	4500	15	1125	1200	Exhaust	1 x 1200	Inline Fan	Normal Mode	1	0.45	1 PH	0.45	0.00
2	Male Toilet Near Office -2	325	10	3250	15	813	1000	Exhaust	1 x 1000	Inline Fan	Normal Mode	1	0.40	1 PH	0.40	0.00
3	Female Toilet Near Cafeteria	245	10	2450	15	613	750	Exhaust	1 x 750	Inline Fan	Normal Mode	1	0.35	1 PH	0.35	0.00
4	Female Toilet Near Kitchen	245	10	2450	15	613	750	Exhaust	1 x 750	Inline Fan	Normal Mode	1	0.35	1 PH	0.35	0.00
5	Male Toilet Near Office -3	322	10	3220	15	805	750	Exhaust	1 x 750	Inline Fan	Normal Mode	1	0.35	1 PH	0.35	0.00
6	3 Nos Toilet in office -1 (65 SFT Each)	195	10	1950	15	488	600	Exhaust	3 x 200	Inline Fan	Normal Mode	3	0.15	1 PH	0.45	0.00
7	3 Nos Toilet in office -2 (65 SFT Each)	195	10	1950	15	488	600	Exhaust	3 x 200	Inline Fan	Normal Mode	3	0.15	1 PH	0.45	0.00
8	3 Nos Toilet in office -3 (65 SFT Each)	195	10	1950	15	488	600	Exhaust	3 x 200	Inline Fan	Normal Mode	3	0.15	1 PH	0.45	0.00
9	3 Nos Toilet in office -1 (65 SFT Each)	195	10	1950	15	488	600	Exhaust	3 x 200	Inline Fan	Normal Mode	3	0.15	1 PH	0.45	0.00
10	Toilet in office -5	65	10	650	15	163	200	Exhaust	1 x 200	Inline Fan	Normal Mode	1	0.15	1 PH	0.15	0.00

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

S/N	Floor	Area SFT	Effective HT FT	Volume CFT	Air Change Per Hour	Calculated CFM	Installed CFM	Application	Nos. of Fan & Fan Capacity	Type of Fan	Remarks	No. of Point	Kw of Each Point	Phase -1/3	Total Kw, in Normal Mode	Total Kw, Extra in Fire Mode
11	Kitchen Exhaust	1180	10	11800	15 CFM/ SFT	17700	18000	Exhaust	1 x 18000	Scrubber	Normal Mode	1	7.30	3 PH	7.30	0.00
12	Kitchen Fresh air	1180	10	11800	12 CFM / SFT	14160	15000	Supply	1 x 15000	MVU	Normal Mode	1	7.30	3 PH	7.30	0.00
First Floor																
1	Male & Female Toilet Near Office-12	450	10	4500	15	1125	1200	Exhaust	1 x 1200	Inline Fan	Normal Mode	1	0.45	1 PH	0.45	0.00
2	Male Toilet Near Office -7	325	10	3250	15	813	1000	Exhaust	1 x 1000	Inline Fan	Normal Mode	1	0.40	1 PH	0.40	0.00
3	Female Toilet Near Office-8	245	10	2450	15	613	750	Exhaust	1 x 750	Inline Fan	Normal Mode	1	0.35	1 PH	0.35	0.00
4	Female Toilet Near Office-9	245	10	2450	15	613	750	Exhaust	1 x 750	Inline Fan	Normal Mode	1	0.35	1 PH	0.35	0.00
5	Male Toilet Near Office -10	322	10	3220	15	805	1000	Exhaust	1 x 1000	Inline Fan	Normal Mode	1	0.40	1 PH	0.40	0.00
6	3 Nos Toilet in office -6 (65 SFT Each)	195	10	1950	15	488	600	Exhaust	3 x 200	Inline Fan	Normal Mode	3	0.15	1 PH	0.45	0.00
7	3 Nos Toilet in office -7 (65 SFT Each)	195	10	1950	15	488	600	Exhaust	3 x 200	Inline Fan	Normal Mode	3	0.15	1 PH	0.45	0.00
8	2 Nos Toilet in office -8 (65 SFT Each)	130	10	1300	15	325	400	Exhaust	2 x 200	Inline Fan	Normal Mode	2	0.15	1 PH	0.30	0.00
9	2 Nos Toilet in office -9 (65 SFT Each)	130	10	1300	15	325	400	Exhaust	2 x 200	Inline Fan	Normal Mode	2	0.15	1 PH	0.30	0.00
10	3 Nos Toilet in office -10 (65 SFT Each)	195	10	1950	15	488	600	Exhaust	3 x 200	Inline Fan	Normal Mode	3	0.15	1 PH	0.45	0.00
11	3 Nos Toilet in office -11 (65 SFT Each)	195	10	1950	15	488	600	Exhaust	3 x 200	Inline Fan	Normal Mode	3	0.15	1 PH	0.45	0.00
Second Floor																
1	Male & Female Toilet Near Office-20	450	10	4500	15	1125	1200	Exhaust	1 x 1200	Inline Fan	Normal Mode	1	0.45	1 PH	0.45	0.00

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

S/N	Floor	Area SFT	Effective HT FT	Volume CFT	Air Change Per Hour	Calculated CFM	Installed CFM	Application	Nos. of Fan & Fan Capacity	Type of Fan	Remarks	No. of Point	Kw of Each Point	Phase -1/3	Total Kw, in Normal Mode	Total Kw, Extra in Fire Mode
2	Male Toilet Near Office -17	325	10	3250	15	813	1000	Exhaust	1 x 1000	Inline Fan	Normal Mode	1	0.40	1 PH	0.40	0.00
3	Female Toilet Near Office-18	245	10	2450	15	613	750	Exhaust	1 x 750	Inline Fan	Normal Mode	1	0.35	1 PH	0.35	0.00
4	Female Toilet Near Office-18	245	10	2450	15	613	750	Exhaust	1 x 750	Inline Fan	Normal Mode	1	0.35	1 PH	0.35	0.00
5	Male Toilet Near Office -19	322	10	3220	15	805	1000	Exhaust	1 x 1000	Inline Fan	Normal Mode	1	0.40	1 PH	0.40	0.00
6	4 Nos Toilet in office - 17 (65 SFT Each)	260	10	2600	15	650	800	Exhaust	4 x 200	Inline Fan	Normal Mode	4	0.15	1 PH	0.60	0.00
7	4 Nos Toilet in office - 18 (65 SFT Each)	260	10	2600	15	650	800	Exhaust	4 x 200	Inline Fan	Normal Mode	4	0.15	1 PH	0.60	0.00
8	4 Nos Toilet in office - 19 (65 SFT Each)	260	10	2600	15	650	800	Exhaust	4 x 200	Inline Fan	Normal Mode	4	0.15	1 PH	0.60	0.00
9	Toilet in office -20	65	10	650	15	163	200	Exhaust	1 x 200	Inline Fan	Normal Mode	1	0.15	1 PH	0.15	0.00
10	Toilet in office -22	65	10	650	15	163	200	Exhaust	1 x 200	Inline Fan	Normal Mode	1	0.15	1 PH	0.15	0.00
11	Toilet in office -21	65	10	650	15	163	200	Exhaust	1 x 200	Inline Fan	Normal Mode	1	0.15	1 PH	0.15	0.00
	Third Floor															
1	Male & Female Toilet Near Office-20	450	10	4500	15	1125	1200	Exhaust	1 x 1200	Inline Fan	Normal Mode	1	0.45	1 PH	0.45	0.00
2	Male Toilet Near Office -17	325	10	3250	15	813	1000	Exhaust	1 x 1000	Inline Fan	Normal Mode	1	0.40	1 PH	0.40	0.00
3	Female Toilet Near Office-18	245	10	2450	15	613	750	Exhaust	1 x 750	Inline Fan	Normal Mode	1	0.35	1 PH	0.35	0.00
4	Female Toilet Near Office-18	245	10	2450	15	613	750	Exhaust	1 x 750	Inline Fan	Normal Mode	1	0.35	1 PH	0.35	0.00
5	Male Toilet Near Office -19	322	10	3220	15	805	1000	Exhaust	1 x 1000	Inline Fan	Normal Mode	1	0.40	1 PH	0.40	0.00

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

S/N	Floor	Area SFT	Effective HT FT	Volume CFT	Air Change Per Hour	Calculated CFM	Installed CFM	Application	Nos. of Fan & Fan Capacity	Type of Fan	Remarks	No. of Point	Kw of Each Point	Phase -1/3	Total Kw, in Normal Mode	Total Kw, Extra in Fire Mode
6	4 Nos Toilet in office - 17 (65 SFT Each)	260	10	2600	15	650	800	Exhaust	4 x 200	Inline Fan	Normal Mode	4	0.15	1 PH	0.60	0.00
7	4 Nos Toilet in office - 18 (65 SFT Each)	260	10	2600	15	650	800	Exhaust	4 x 200	Inline Fan	Normal Mode	4	0.15	1 PH	0.60	0.00
8	4 Nos Toilet in office - 19 (65 SFT Each)	260	10	2600	15	650	800	Exhaust	4 x 200	Inline Fan	Normal Mode	4	0.15	1 PH	0.60	0.00
9	Toilet in office -20	65	10	650	15	163	200	Exhaust	1 x 200	Inline Fan	Normal Mode	1	0.15	1 PH	0.15	0.00
10	Toilet in office -22	65	10	650	15	163	200	Exhaust	1 x 200	Inline Fan	Normal Mode	1	0.15	1 PH	0.15	0.00
11	Toilet in office -21	65	10	650	15	163	200	Exhaust	1 x 200	Inline Fan	Normal Mode	1	0.15	1 PH	0.15	0.00
B	Equipment Room Ventilation															
1	LT Panel Room	1119	15	16517	25	6882	8000	Exhaust	1 x 8000	Axial	Normal Mode	1	1.50	3	1.50	0.00
2	LT Panel Room	1119	15	16517	25	6882	8000	Supply	1 x 8000	Axial	Normal Mode	1	1.50	3	1.50	0.00
3	Pump Room	1883	15	27793.1	25	11580	12000	Exhaust	1 x 12000	Axial	Normal Mode	1	2.2	3	2.20	0.00
4	Pump Room	1883	15	27793.1	25	11580	12000	Supply	1 x 12000	Axial	Normal Mode	1	2.2	3	2.20	0.00
5	STP Room	1345	15	19852.2	30	9926	10000	Exhaust	1 x 10000	Axial	Normal Mode	1	2.2	3	2.20	0.00
6	STP Room	1345	15	19852.2	25	8272	8000	Supply	1 x 8000	Axial	Normal Mode	1	1.5	3	1.50	0.00
C	Smoke Extraction															
1	Corridor (3 Floor Area Considered in case of fire)	10500	10	105000	12	21000	24000	Exhaust	2 x 12000	Axial	In Case Of Fire	1	3.7	3 PH	0	3.7

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

S/N	Floor	Area SFT	Effective HT FT	Volume CFT	Air Change Per Hour	Calculated CFM	Installed CFM	Application	Nos. of Fan & Fan Capacity	Type of Fan	Remarks	No. of Point	Kw of Each Point	Phase -1/3	Total Kw, in Normal Mode	Total Kw, Extra in Fire Mode
2	Corridor (3 Floor Area Considered in case of fire)	10500	10	105000	12	21000	24000	Exhaust	2 x 12000	Axial	In Case Of Fire	1	3.7	3 PH	0	3.7
D	Staircase, Lift & Lobby Pressurization															
1	03 Nos Staircase	NA	NA	NA	NA	NA	24000	Supply	2 x 12000 CFM	Axial	In Case Of Fire	2	2.2	3	0	4.4
2	04 Nos Lift Well	NA	NA	NA	NA	NA	80000	Supply	10 x 8000 CFM	Axial	In Case Of Fire	10	1.5	3	0	15
3	02 Nos Lift Lobby	NA	NA	NA	NA	NA	60000	Supply	6 x 10000 CFM	Axial	In Case Of Fire	6	2.2	3	0	13.2
	TOTAL											79			21	40

2.8 Total HVAC Electrical Load

- | | |
|-------------------------------|------------------|
| a) AC Work | - 980 Kw |
| b) Ventilation Work | - 21 Kw |
| TOTAL Peak Requirement | - 1001 Kw |

2.9 System Description**Air Conditioning System**

Based on the parameters given above, it proposed to install required capacity of VRV / VRF outdoor unit of cool / heat type on terrace in capacity of multiple combination to cater the above air conditioning load. Indoor door unit shall be combination of VRV FCU, Cassette, Ductable etc as shown on the drawings. Indoor and outdoor unit shall be connected with the help of copper refrigerant piping of suitable sizes duly insulated.

Low side work such as ducting, duct lining, duct insulation, grilles / diffusers shall also be planned in coordination with architect, which shall be executed as per the shop drawings made by AC Contractor & approved by Consultant / Architect / Client.

Electrical work shall comprise sub panel, isolators, MCB, power and control cabling, conduit, earthing etc as detailed in Bill of Quantities.

VRV / VRF Outdoor Unit selected above shall not be capable of providing winter heating in Winter Season.

Scheme for Ventilation of Toilets

For all the toilets, inline fan of required capacity shall be installed in the ceiling of individual toilet. Foul smell collected in the duct from the toilet on each floor shall be connected with the inline fan. Foul smell from the toilet shall be trapped with the help of diffusers / grilles and it shall be carried forward to duct.

Scheme for Ventilation of Kitchen

It is proposed to install suitable capacity MVU / Air-washer & scrubber for kitchen ventilation. The air shall be distributed with the help of GSS ducting & diffused through powder coated Aluminium extruded grills. The air shall be exhausted through suitable capacity exhaust air duct terminating into scrubber.

NOTE:

The MVU / Air-washer Fan & Scrubber shall be selected as per final layout & requirements however fan capacity is given in the BOQ for guideline.

Scheme for Lift Well, Fire Escape Staircase & Lobby Pressurisation

It is proposed to install required number of tube axial flow fans of required capacity on the terrace to pressurize lift well / fire escape staircase. In the lift well air shall be directly fed through axial flow fan connected to a small piece of duct. For the fire escape staircase, duct dropper in the shaft shall be taken up to the last basement and individual collar for supply to each level shall be connected with the duct dropper.

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

All lift well and fire escape staircase shall have a positive pressure of 50 Pa compared to the surrounding areas. All pressurization fans shall run in case of fire only. Panel of pressurization fan shall be hooked with the fire alarm panel.

END OF BASIS OF DESIGN SECTION

3 TECHNICAL SPECIFICATION OF EQUIPMENTS

3.1 VRV / VRF Outdoor Unit

3.1.1 Scope of Work

The specification for VRV / VRF Units covers the general design, materials, constructional features, supply, installation, testing, commissioning & carrying out performance test at site.

3.1.2 Codes & Standard

The design, materials, manufacture, inspection, testing & performance of VRV / VRF shall comply with all currently applicable codes, regulation & standards in the locality where the equipment is to be installed.

3.1.3 General

Each VRV / VRF Unit shall be air cooled, split type multi-system air conditioner consisting of outdoor units and number of indoor units, each having capability to cool / heat as per BOQ or the requirements of the individual area to be air-conditioned. The VRV / VRF unit should be capable of connecting minimum ten different type of indoor units to one refrigerant circuit and controlled individually.

Each VRV / VRF unit shall have all inverter scroll / rotary compressors and capable of changing the rotating speed to follow variations in cooling loads. Each indoor unit shall have capability to cool for the requirement of the rooms.

Compressor shall be inverter controlled. Compressor installed in each outdoor module unit shall be equipped with all inverter compressor for higher reliability, improved life, better backup and duty cycling purpose. The system shall be capable of changing the rotating speed of inverter compressor by inverter controller to follow variations in cooling and heating load.

The Outdoor units shall be suitable for mix-match connection of following type.

- Ceiling mounted cassette type (Double flow)
- Ceiling mounted cassette type (Multi flow)
- Ceiling mounted duct type.
- Ceiling suspended type.
- Wall mounted type
- Floor standing type
- Concealed floor standing type.
Or
- VRV DX AHU

Please note that the refrigerant piping shall be capable of extending up to 150m with 50m level difference without any oil traps.

Both indoor and outdoor units shall be factory assembled, tested and filled with first charge of refrigerant. These being very hi-tech in construction with lots of factory checks being conducted, hence no sub assembly should be done at site preferably.

3.1.4 Outdoor Unit

The outdoor unit shall be factory assembled, weather proof casing, constructed from heavy gauge mild steel panels and coated with baked enamel finish. The unit should be completely factory wired, tested with all necessary controls tested prior to dispatch conforming to the following specifications.

- a) All outdoor units shall consist of inverter scroll compressors.
- b) Outdoor units when consisting of more than 1 module (e.g. 22 HP = 10 Hp +12 HP), each should have one separate inverter driven compressors.
- c) In such case, the units shall be provided with duty cycling arrangement for multiple inverter compressors.
- d) The outdoor unit shall be modular in design to facilitate installation one after another close to each other. Preference would be given to compact units having smaller footprint.
- e) Outdoor units should be rugged of anti-corrosion design and should have strong base plate for easy mounting of unit. All interconnecting piping, joints and U bends within the condensing unit shall be painted with two coats of clear transparent polymer coating for protection against corrosion from ambient air pollution.
- f) The outdoor unit shall comprise of sub-cooling feature to effectively use the entire coil surface through proper circuit/bridge in order to prevent flushing of refrigerant owing to large length of piping.
- g) The condensing unit shall be provided with state-of-the-art microprocessor based control panel.
- h) The outdoor unit shall be provided with Aero spiral design fan exhibiting low noise level characteristics complete with aero fitting grille to facilitate spiral discharge of airflow to effect reduction in pressure losses. The fan should be capable to respond to external static pressure of 5mm.
- i) Motor shall be speed controlled to ensure a stable operation for varying ambient, by a factory fitted direct acting head pressure activated variable speed drive for at least 15 steps to give precise discharge pressure and minimum power consumption of condenser fan motor.
- j) The condenser shall be complete with provisions for refrigerant piping connections, shut off valves and any other standard accessories necessary with the equipment supplied.

The condensing unit shall be designed to facilitate fail safe operation when connected to multiple indoor units. If possible, the system should work on standard operating parameters like discharge pressures of not more than 300 PSI as the ref. Piping will be moving around within a residential house, otherwise on any misfortune of any leakage it will act like a bullet on higher pressures. If working on higher operating pressures, vendor to comply with all safety codes of high pressure safety & testing as recommended by Japanese (being Japanese design product) and give 2 sets of special tools to handle such equipment at site. All brazing should be done by only qualified trained person who had training on HIGH PRESSURE brazing, special tools & procedures.

3.1.5 Scroll Compressor

The scroll compressor shall be an industrial quality rugged, cast iron, direct hermetic compressor with scroll plates, suction & discharge service valves. The compressor shall be completely enclosed in a chamber with no leakage path and providing the capability for scroll plates to separate. The compressor shall be provided with industrial solid motor mounts internal motor protection and

vibration isolation pads. Each compressor shall be independently wired and piped to its own circuit for efficient operation & ease of maintenance. The compressor speed shall not exceed 3000 RPM.

The compressor shall be highly efficient inverter control. The inverter compressor shall change the speed in accordance to the variation in cooling or heating load requirement:

- a) All outdoor units shall have multiple steps of capacity control to meet load fluctuation and indoor unit individual control. All parts of compressor shall be sufficiently lubricated stock. Forced lubrication may also be employed.
- b) Oil heater shall be provided in the compressor casing.

3.1.6 Heat Exchanger

The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminum fins to form a cross fin coil.

- a) The aluminum fins shall be covered by anti-corrosion resin film.
- b) The unit should be with heat exchanger to optimize the path of heat exchanger and for better efficiency of condenser.
- c) The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical discharge. Each fan shall have a safety guard.

3.1.7 Refrigerant Circuit

The refrigerant circuit shall include liquid & gas shut-off valves and a solenoid valves at condenser end. The equipment must have inbuilt refrigerant stabilization control for proper refrigerant distribution.

All necessary safety devices shall be provided to ensure the safely operation of the system.

3.1.8 Refrigerant

The VRV / VRF units shall be selected on R410 refrigerant only. The units should be fully factory charged with refrigerant & oil & spare refrigerant & oil must be sent along with the machine for topping up of gas & oil as may be required.

3.1.9 Safety Devices

All necessary safety devices shall be provided to ensure safe operation of the system.

Following safety devices shall be integral part of the outdoor unit:

High pressure switch
Fan drive overload protection switch
Fusible plug
Overload relay including overload protection for inverter driven compressor.

3.1.10 Oil Recovery System

Entire system shall be designed and capable of oil recovery to ensure stable operation with long refrigeration piping lengths.

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

The system should have inbuilt (avoid external) oil balancing circuit to avoid poor lubrication.

3.1.11 Transit Damage

The unit shall be restored to original conditions in case of any transit damages by the contractor at his own cost.

3.1.12 Technical Requirement of VRV / VRF Unit

S/N	Description	Unit	Condition of Service
a)	Type Capacity (cooling)	-- HP (Nominal)	Cool Type As per BOQ
c)	Quantity	Nos.	As per BOQ
d)	Connectable No. of possible indoor unit	Nos.	Refer Drawings
e)	Air entering condenser	Deg. C DB	35.0
f)	Electric Supply	--	415 V/3 Ph/50 Hz
g)	Maximum Refrigerant Piping Length For One Unit	--	150 RMT

3.2 VRV / VRF Indoor Unit

3.2.1 Scope of Work

This section deals with supply, erection, testing and commissioning of Various Type Of Indoor Units confirming to general specification and suitable for the duty selected. The type, capacity and size of indoor units shall be as specified in Schedule of Quantities.

3.2.2 General

Indoor units shall be either ceiling mounted cassette type, or ceiling mounted ductable type or floor standing type or wall mounted type or other as specified in BOQ. Each unit shall have electronic control valve to control refrigerant flow rate respond to load variations of the room.

- a) The address of the indoor unit shall be set automatically in case of individual and group control
- b) In case of centralized control, it shall be set by liquid crystal remote controller

The fan shall be dual suction, aerodynamically designed turbo, multi blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having supported from housing.

The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance with fins. Each coils shall be factory tested at 21kg/sqm air pressure under water.

Unit shall have cleanable type filter fixed to an integrally moulded plastic frame. The filter shall be slide away type and neatly inserted.

Each indoor unit shall have computerized PID control for maintaining design room temperature. Each unit shall be provided with microprocessor thermostat for cooling or heating and cooling.

Each unit shall be with wired LCD type remote controller. The remote controller shall memorize the latest malfunction code for easy maintenance. The controller shall have self-diagnostic features for easy and quick maintenance and service. The controller shall be able to change fan speed and angle of swing flap individually as per requirement.

3.2.3 Ceiling Mounted Cassette Type Unit (Multi Flow Type)

The unit shall be ceiling mounted type. The unit shall include pre-filter, fan section and DX-coil section. The housing of the unit shall be powder coated galvanized steel. The body shall be light in weight and shall be able to suspend from four corners. The fan shall be aerodynamically designed diffuser turbo fan type. Also Units shall have an external attractive panel for supply and return air. Unit shall have four way supply air grilles on sides and return air grille in center.

Each unit shall have high lift drain pump, fresh air intake provision (if specified) and very low operating sound.

All the indoor units regardless of their difference in capacity should have **same decorative panel size** for harmonious aesthetic point of view. It should have provision of connecting branch ducts.

3.2.4 Ceiling Mounted Ductable Type Unit

Unit shall be suitable for ceiling mounted type. The unit shall include pre filter, fan section & DX coil section .The housing of unit shall be light weight powder coated galvanized steel. The unit shall have high static fan for Ductable arrangement.

3.2.5 Ceiling Suspended Type

Unit shall be suitable for ceiling suspended arrangement below false ceiling. The unit include pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.

3.2.6 Hi Wall Mounted Unit

The units shall be wall-mounted type. The unit includes pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.

Unit shall have an attractive external casing for supply and return air.

3.2.7 Floor Standing Type

Unit shall be suitable for floor standing arrangement. The unit include pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.

3.2.8 Centralized Type Remote Controller

A multifunctional compact centralized controller shall be provided with the system.

The controller should be LCD remote controller to act as an advanced air-conditioning management system to give complete control of VRV / VRF air-conditioning Equipment, It should have ease of use for the user and must have a user friendly panel and LCD display.

It shall be able to control up to minimum 64 indoor units with the following functions:-

- a) Starting/stopping of Air-conditioners as a zone or group or individual unit.
- b) Temperature settling for each indoor unit or zone.
- c) Switching between temperature control modes, switching of fan speed and direction of airflow, enabling/disabling of individual remote controller operation.
- d) Monitoring of operation status such as operation mode & temperature setting of individual indoor units, maintenance information, trouble shooting information.
- e) OPTIONAL-Display of air conditioner operation history.
- f) OPERATIONAL-Daily management automation through yearly schedule function with possibility of various schedules.

The controller shall have wide screen user friendly LCD display and can be wired by a non polar 2 wire transmission cable to a distance of 1 km. away from indoor unit.

3.2.9 Colour

The colour of indoor units should be white or to suit interiors as designed by the architects / clients.

3.3 Double Skinned DX VRV / VRF AHU**3.3.1 Scope of Work**

The specification for Double Skinned DX AHU with Air Cooled VRV / VRF Outdoor Unit covers the general design, materials, constructional features, supply, installation, testing, commissioning & carrying out performance test at site.

3.3.2 Codes & Standard

The design, materials, manufacture, inspection, testing & performance of unit shall comply with all currently applicable codes, regulation & standards in the locality where the equipment is to be installed.

3.3.3 Air Cooled VRV / VRF Outdoor Unit**Compressor**

The compressor shall be hermetically sealed scroll compressor. The compressor should be suitable to withstand voltages varying from 340 to 460 volts.

Air Cooled Condenser

The Air cooled condenser should have high efficiency condenser coils having copper tubes & collared aluminium fins with serrated edges & wavy airways to ensure sub cooling. The air cooled condenser should be housed in factory finished cabinet duly enamel painted. The air cooled condenser should have aluminium fins mechanically bonded with copper tubes.

The fan of the air-cooled condenser shall be statically / dynamically balanced and driven by 3 phase motor of suitable horse power.

Note:- For more details about VRV / VRF outdoor unit, please refer the separate specification given with this tender.

3.3.4 Double Skinned Air Handling Units**Scope**

The specification for Double Skin Air Handling Units covers the design requirement, constructional feature, supply, installation, testing & commissioning. The handlers shall be of double skin construction, draw through type comprising of various sections such as pre filter section, DX cooling coil section, fan section etc as per details given in BOQ.

Double Skinned Casing

The casing shall be self supporting type, factory fabricated & assembled made of extruded anodised aluminum hollow sections to make a rigid frame structure. The frame shall be assembled using pressure die cast aluminum joints. The self supporting unit shall consist of sandwiched panel made out of 0.8mm thick pre-plasticide / pre-coated GI sheet outside & 0.8mm GI sheet inside (0.8 mm polished stainless steel in case of AHU for Operation Theatre) duly factory fabricated insulated with 23 / 48 mm thick PU foam insulation in between as specified in Bill of Quantities. The insulated panels shall be bolted to mainframe with neoprene rubber gaskets held captive in the framed extrusion to make it leak proof. Suitable airtight access doors / panels with pressure die cast aluminum hinges & nylon handles and locks shall be provided for access to various sections for maintenance. The Entire housing shall be mounted on Extruded Aluminum channel framework

having pressure die cast aluminum jointers or the framework shall be joined together with corner plates Condensate. Drain Pan shall be constructed of 22 gauge Stainless steel sheet with all corners welded with uniform slope from all sides leading to drain pan ensuring no stagnation of condensate water.

Motor & Drive

The fan motors shall be suitable for $415 \pm 10\%$ volts, $50 \pm 5\%$ HZ, 3 phases TEFC SQ. Cage induction motor. The motor shall be specially designed for quiet operation. Motor shall be suitable to operate with direct driven plug fans and VFD.

Fan

Fans shall be backward curved plug fan with aerofoil design blades so as to give maximum efficiency for given duty condition. The fan shall be AMCA certified and the entire Fan + Motor assembly shall be balanced before dispatch. Fans shall be selected for minimum efficiency of 65%. Multiple fans / single fan shall be used in AHU to suit available AHU Room at site & as per approved shop drawing. The supply air fan shall be as per BOQ. The fan impeller shall be supported to housing with angle iron frame & pillow block heavy duty ball bearing. The fan housing with TEFC Sq. Cage motor shall be mounted on a common adjustable base frame on vibration isolators / rubber turret mounts vibration isolators. The fan motor shall be installed inside the housing of air handling unit to keep low noise level. The fan & motor assembly shall be of aluminum extruded section only.

DX Cooling / Heating Coils

The Cooling coil should be at least 6 row deep or as per BOQ and shall have at least 4.7 fins/cm. The Cooling coil should have aluminium fins and copper tubes mechanically bonded. The unit shall be factory aligned, tested and complete with refrigerant piping connection port, charging valves, thermostatic expansion valve, distributor, liquid strainer, dehydrator, liquid line shut off valve etc.

The cooling coil should be tested for leaks at a hydraulic pressure of at least 10 Kg / sq.cm. for a minimum period of 3 hours at works. The velocity across face should be limited to 152 metre / minute.

Filters

Each unit shall be provided with a factory assembled pre-filter section containing washable synthetic tube air filters having extruded aluminum frame. The filtration efficiency shall be 90 % down to 10 micron particle size. Filters shall fit so as to prevent by pass. Holding frames shall be provided for installing a number of filters cells in banks. These cells shall be held within the frames by sliding the cells between guiding channels. Face velocity across filters shall not exceed 152 MPM.

3.3.5 Accessories

The following accessories shall be provided with each air handlers without any additional cost.

- a) Vibration isolators shall be provided with all air handling units. Vibration isolators shall be cushy foot mountings, springs or approved equal type.

3.4 Ventilation Fans**3.4.1 Scope of Work**

The specification for supplies & exhaust air blowers for mechanical ventilation covers the design requirement, constructional feature, supply, installation, testing & commissioning.

3.4.2 Type

The blower shall be of Tube Axial Flow fans / Centrifugal Fans / Inline fans / Propeller Fans / Jet Fans with or without ducting system & shall be of floor mounted / ceiling hung type.

3.4.3 Capacity

The capacity of Tube Axial Flow fans / Centrifugal Fans / Inline fans / Propeller Fans Jet Fans, diameter, maximum motor H.P & static pressure etc. shall be according to schedule of quantities.

3.4.4 Axial Flow Fans

The exhaust air blower shall be Tube Axial Flow fans connected to the duct & shall be of floor / ceiling / wall mounted type as specified in the Bill of Quantities / GFC Drawings / Shop Drawings. The capacity of tube axial flow fans, diameter, maximum motor H.P & static pressure etc. shall be according to schedule of equipment & Bill of Quantities. The noise level of axial fan shall be less than 80 dBA at a distance of 3.0 mt from the fan.

Axial Flow Fan shall be **AMCA certified** for Air and Sound performance in accordance to **AMCA 210** and **AMCA 300**.

The cylindrical casing shall be made from MS / GI welded carbon steel sheet. The length of casing shall be long to accommodate motor within the casing. Casing thickness shall be minimum 2mm up to 800 mm dia fan, 3 mm thick from 900 to 1250 mm dia & 4 mm thick above 1300 mm dia. The inlet & outlet of the casing shall be fitted with flanges for ductwork connection & other accessories as required. The casing shall be coated with minimum 2 coats of rust proof primer and enamel paint thereafter or to be Powder Coated after phosphating process. The blade of axial flow fan shall be made of die cast aluminium alloy. The blade angle shall be set at manufacturing place & shall be adjustable at site. The hub shall consist of two half-hubs pressed in carbon steel & the centre boss shall be made of die-cast aluminium alloy. The blade feet shall be locked in two half - hubs. The design shall facilitate the alteration of blade angle without disconnecting the hub from the motor shaft. The fan shall be directly driven by TEFC sq. cage induction motor. The fan motors shall be $415 \pm 10\%$ volts $50\text{Hz} \pm 5\%$, 3 phase TEFC SQ. Cage induction motor. The motor shall be specially designed for quiet operation & motor RPM shall be as given in Bill of Quantities.

Complete fan with motor shall withstand 250°C temperature for 2 hours & shall work satisfactorily at this temperature.

Complete Fan assembly for smoke extraction application (Fan Impeller, Fan Casing, Motor base frame along with Motor) shall be tested and approved by UL in accordance with "Power Ventilators for Smoke Control Systems" for (250 degree C) temperature for a 2 hours of operation.

3.4.5 Centrifugal Fans

The Centrifugal blowers shall be double / single inlet, double / single width, forward / backward curved as given in the BOQ & of non-overloading type of suitable construction. The blower performance must be rated in accordance with approved test codes and procedures. The centrifugal fans should confirm to IS – 4894 – 1987 (Revised as on date) The blower housing comprising of

scroll & side plates shall be accurately cut of heavy gauge construction and reinforced with angle bracings. Outlets shall be flanged to assure proper duct connection. Inlet cones shall be spun venturi type, to ensure smooth air entry. The base frame shall be GI / MS channel in bolted / welded construction. Impeller shall be fabricated from sheet steel with backward / forward curved, properly designed blades, with heavy C.I. Hub and shall be both dynamically and statically balanced, to a close tolerance for quiet and vibration free performance. Shaft shall be EN-8., more than 40 mm diameter and shall be accurately ground and polished to a close tolerance. Bearings shall be self aligned, heavy duty ball or tapered roller type with integral dust and grease seals. Fan having wheel diameter of 1220 mm or more, shall be supplied with split, bolted housing for convenience of handling and installation.

Drive assembly for each blower shall consist of blower pulley, motor pulley, and a set of 'V' belts, belt guards, and belt tension adjusting devices. Pulleys shall be selected to provide the required speed. They shall be multi-groove type, with section and grooves selected to transmit 33% more load than the required power and shall be statically balanced. The belt guards shall be of M.S. sheet with angle iron reinforcements and expanded metal screen. The fan motors shall be $415 \pm 10\%$ volts 50HZ $\pm 5\%$, 3 phase TEFC SQ. Cage induction motor. The motor shall be specially designed for quiet operation & motor RPM shall be as given in Bill of Quantities.

3.4.6 Propeller Fans

The Propeller Fan blades shall be pressed steel of aerofoil design for high fan efficiency and static pressure. The blades shall be riveted to a central steel hub. The motor and blades assembly shall be mounted in a cast iron / sheet steel frame with steel brackets. Rubber mounts shall be provided between the mounting frames and brackets. The fan motor shall be totally enclosed type.

3.4.7 In-Line Fans

Inline fans shall be complete with centrifugal impeller, casing, direct driven motor, vibration isolators, direction of discharge and rotation position shall be as per the job requirement and shall be marked on the fan assembly. Housing shall be constructed of hot rolled GSS sheet metal construction. Housing metal parts shall be either spot-welded or screwed or mounted together with rivets. Indication showing rotation arrow and make, model number and duty conditions of the fan shall be available on the housing. Fan wheel shall be forward curved type, statically and dynamically balanced. The fan shall be provided with ball bearings can be used in any mounting position at maximum indicated temperature.

3.4.8 Jet Vent Fan

The fans shall be die-cast aluminium alloy impeller shall be high temperature applications 300 Deg C for 2 hours operation. Fan shall be balanced dynamically and statically. The Casing of Fans shall be made of hot dipped Galvanized steel / powder coated with flanges at both ends. The Motor shall be run on the electrical power suitable for 50Hz. The certification of fans should be in accordance with EN 12101-3 or shall be UL. Fan shall be either EN / UL listed & Stamped for electrical components. The fans shall be protection guards at inlet & outlet side. The Fans shall be silencers manufactured from Galvanized steel length minimum 900 mm to achieve specified noise levels. Fans shall have Inlet cone & out cone made of Galvanized steel. The pre-wired Terminal box is mounted at the outer fan Casing. The unit shall be with mounting brackets for ceiling suspension. Final locations of the jet fans shall be based on the CFD simulation to be submitted by contractor before manufacturing. The Jet Fan Supplier shall include the cost of CFD Analysis & shall select the size and positioning of the fans, giving velocity vectors, static pressure contours, simulations of smoke spreading and other information required for the project.

3.4.9 Accessories

All necessary accessories shall be provided for proper operation and shall also include as part of Unit Price.

- Dunlop cushy foot vibration isolators for the blowers
- Double canvas connections at the outlets of each fan
- Nuts, Bolts, Shims etc. as required for the grouting of the equipment
- Slide rails for mounting the motor and belt adjustments
- Bird Screens in the Inlet
- Detachable and washable fresh air filters at the inlets

3.4.10 Performance Data

All fans shall be selected for the lower operating noise level. Capacity ratings, power consumption, with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the installation. All the fans should be AMCA certified for sound and performance. Complete certified model appearing on AMCA web site shall be accepted.

3.4.11 Testing

Capacity of all fans shall be measured by an anemometer. Measured airflow capacities shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current. Contractor has to carry out the field balancing, if required.

3.5 Airwasher**3.5.1 Scope of Work**

The specification for package type double skin air-washer for mechanical ventilation covers the design requirement, constructional feature, supply, installation, testing & commissioning.

3.5.2 Type

The Air-washer system shall be Draw through type having 90% saturation efficiency with cellulose paper pads. The air washer shall be designed for maintaining inside temperature 5 - 7 °C higher than the outside wet bulb temperature.

3.5.3 Housing

Double skinned panels shall be 25 mm thick made of galvanized steel, pressure injected with foam insulation (density 40 Kg / m³) shall be fixed to 1.5 mm thick aluminium alloy twin box section structural framework with stainless steel screws. Outer sheet of panels shall be made of galvanized pre-plasticized sheet of 24 gauge thick and inner sheet of 24 gauge plain GI sheet. The entire framework shall be mounted on an aluminium alloy or galvanized steel (depending on size) channel base as per manufacturer's recommendation. The panels shall be sealed to the framework by heavy duty 'O' rings gaskets held captive in the framed extrusion. All panels shall be detachable or hinged. Hinges shall be made of die cast aluminium with stainless steel pivots, handles shall be made of hard nylon and be operational from both inside and outside of the unit. Units supplied with various sections shall be suitable for on site assembly with continuous foam gasket. All fixing and gaskets shall be concealed. Units shall have hinged, quick opening access door in the fan section and also in filter section where filters are not accessible from outside. Access doors shall be double skin type. Recirculation tank shall be fabricated from 18-gauge stainless steel sheet duly reinforced with all corners welded. The tank shall be complete with double brass strainers, make-up connection with float, drain and overflow connections.

3.5.4 Fan

The blower shall be Centrifugal Forward / Backward Curved DIDW fan wheel of totally GI Construction with Inlet Cones and shall be complete with individual motor and drive and shall be mounted on C Channel frame and Cushy Foot or Spring Mounts. Each Air-washer system shall comprise of one / two no. fans to handle air quantities as stipulated in BOQ. Each fan shall be driven by suitable HP TEFC motor. The fan wheel will be of the multiblade type and mounted on two self-aligning pillow block bearings of the requisite size. The fan shall be run with the help of "V" Groove drives as per the recommendation of the drive supplier.

3.5.5 Motor

The TEFC motor shall be suitable for 415 ± 10% volts, 3 phase, 50 Hz ± 5%, A.C supply. The motor shall be with class B/E insulation confirming to IS 325. The motor speed shall be 1440 RPM maximum designed and guaranteed for continuous operation at the nameplate rating. It should confirm to IP 55.

3.5.6 Pre Filter Section

The filter section shall incorporate cleanable aluminum filters of size 610 x 610 x 50 mm thick made out of 18 G with aluminum fill only. The velocity across the filters should be limited to 152 MPM. The filter bank should be mounted in 16 G aluminum frame with provisions of removal of filter for cleaning. The filtration capacity of the filter shall be down to 10 micron particle size with the minimum efficiency of 90%.

3.5.7 Air Washer Section

The air-washer section shall consist of cellulose paper pads of intersecting angle of 45/15 OR 60/30 Deg. The fill shall be cross fluted configuration assembled in self supporting pads in light weight construction. The pads shall be able to redistribute the water & shall be impregnated with insoluble antifreeze salts rigidifying saturates & wetting agents with built in eliminators.

The velocity across the fill shall not exceed 152 MPM & shall not allow carryover water. A FRP distributor should evenly distribute water on the fill. Eliminator plates shall be four bend made from 24 gauge galvanized sheet steel or PVC.

The efficiency of fill should be able to perform with an efficiency of 90% minimum & thickness of fill should be 200 mm minimum.

3.5.8 Tank & Wet Section

The tank & wet section shall be made out of 18G stainless steel only.

3.5.9 Pump, Piping & Valves

The air-washer shall be provided with monoblock pump set as specified in Bill of Quantities. It will be complete with inter connecting GI medium class piping, GM gate valves, check valves, Y-Strainers, suction screen etc. The accessories shall include make up, drain, over flow, quick fill & brass float valve, canvass connections at each blower outlet.

3.5.10 Efficiency

The overall efficiency of air washer system shall be at least 90% and factory test certificate shall be submitted along with the equipment.

3.5.11 Installation

The fans, pumps, air-washer / scrubber etc. shall be provided with necessary vibration isolation cushion foot mounts. The contractor shall arrange all necessary accessories such as nut bolts etc.. The contractor shall arrange his own labour with material for completion of assembly.

The contractor, if specifically specified in bill of quantities, shall cast the RCC foundations for equipments. Anti-vibration pads of adequate efficiency shall be provided.

3.5.12 Transit Damage

The contractor at his own cost shall restore the unit to original conditions in case of any damages.

3.5.13 Testing

The AC contractor shall compute the unit air quantity with the help of velocity meter. The computed results shall be tallied with specified capacities and power consumption shall be tallied with the indicated figures in the technical data furnished with the bid by the contractor.

All necessary instruments of proper accuracy and services needed for the tests required for the computation of capacities and power consumption as required by the Consultant shall be provided by the contractor at his own cost.

H.15 It shall also be the responsibility of the Contractor to supply the motors and starters to satisfy the local regulations pertaining to the limitation of starting current and indemnify the owner from all liabilities arising out of any objections raised by the local authorities in this regard.

3.6 Dry Scrubber

3.6.1 Scope of Work

The specification for package type dry scrubber for kitchen exhaust covers the design requirement, constructional feature, supply, installation, testing & commissioning. It shall have electrostatic air cleaner, Activated Carbon Filter Bank Unit as Odor Absorber Section, Automatic Wash Unit & Detergent Tank as specified in the BOQ. Odor Absorber Section & Automatic Wash Unit with Detergent Tank shall be if specified in the BOQ. The Air Cleaner shall handle the contaminated air from kitchen exhaust hoods containing grease, smoke (aerosols) etc.

3.6.2 Type

The unit shall be modular in construction and shall have individual sections of inlet, pre-filter, ionization collector section. Unit shall be supplied with control panel and one point wiring.

3.6.3 Principle Of Operation

The pre-filter shall remove of large grease particles. The electronic filter shall remove the smaller grease and smoke particles. The principle of operation shall be based on electrostatic deposition. The particle shall pass by an ionizing wire, which will induce a positive charge on the particle. The particle then shall pass between closely spaced aluminum plates, which are held at a positive charge and a ground. As the charged particle travels between the two aluminum plates it shall be forced away from the plate held at the identical polarity and drawn towards the grounded plate. Once attached the particle shall remain on the plate until cleaned off during washing.

3.6.4 Equipment Specification

The air filtration system shall be a modular system. Multiple units can be joined together for increased volume. The system shall be a single pass. Particulate filtration efficiency shall be evaluated on the basis of ASHRAE 52-72 & DOP Test Method. The specified unit shall have demonstrated a removal efficiency of at least 90%. Ozone Generation concentration shall not exceed 0.05 PPM.

3.6.5 Housing

Housing shall be 16 gauge (1.6mm) Electro galvanized steel with powder coat / PU paint finish construction. Each section shall include single door access, located on one side of the unit. The access door shall be mounted on hinges and secured with appropriate arrangement allowing for component access and removal. All doors shall be gasketed to prevent air and water leakage. High voltage contacts on the housing shall be made of appropriate material like phosphor/bronze etc. Enclosure for electrical components shall be included to prevent leaks to the power supply. Unit shall have flanges / collar on the inlet and outlet for connecting ductwork. Unit shall be provided with appropriate drainage arrangement. Electrical contacts shall be in the door for ease of maintenance. Each unit shall have track guides for proper alignment of cell, making it possible to change the direction of airflow by reversing the orientation of electronic collector cell(s).

3.6.6 Finish

The external casing finish shall be a durable industrial grade semi gloss Baked on epoxy ester / PVC / Nylon, not less than 3-mil minimum thickness or PU paint finish with same thickness. The pre-filter shall be Washable type 2 layers of Aluminum mesh are used to optimally remove larger particles of grease and dust before the main filter and shall be secured in stainless steel frame. Face of each prefilter shall be min 2.75 square feet.

3.6.7 Pre-filter

Access to the prefilter shall be from the side through the same hinged door to gain access to the electronic cells. Separator section shall be designed for an equal airflow across the entire Air cleaning unit.

3.6.8 Electronic Cells

Electronic cells described in this section refer to a full size cell. Half size shall not be acceptable. Ionizing-Collecting cell shall be of one-piece construction min 254 mm deep in direction of airflow. Face area of each cell shall be min 0.24 square meters and the effective collecting area min 44 square feet (4.1 square meters). Frame- All support framing, end plates and ionizer ground electrodes shall be 0.080-inch (2.03-mm) thick aluminum. Handle shall be located on the side of the cell for removal of the cell from the air cleaner. The handle shall be grounded to the frame of the cell. Contacts shall be made of any suitable material like phosphor bronze or eq. on the front of the cell. They shall make contact with the ionizing, collector and ground sections of the cell.

Ionizer Section

Ionizing wires shall be minimum of 8 per electronic cell, with a length of min 15.35 inches (390 mm) each. Ionizing wires shall be constructed of 0.010 inches diameter (0.25 mm) Tungsten for prevention of corroding or breaking. Wires shall be fixed at one end and spring mounted on the other for ease of maintenance. There shall be min7 grounding plates between the wires stabilize the ionization field for better performance. Grounding plates shall be no greater than 1.89 inches (48 mm) apart, and 0.07 inches (1.8 mm) thick. Insulators for the ionizer shall be made of Teflon.

Collector Section

Grounding plates shall be a minimum of 0.02 inches (0.5 mm) thick aluminum. The plates shall be 9.65 inches (245 mm) deep in the direction of airflow. Grounding plates shall be a minimum of 23 quantities per cell. Spacing between grounding plates shall be at 0.67 inches (17 mm). Spacing between the grounding plates and the charged plates shall be at 0.3346 inches (8.5 mm). Charged plates shall be a minimum of 0.02 inches (0.5 mm) thick aluminum. The plates shall be 7.68 inches (195 mm) deep in the direction of airflow. Charged plates shall be a minimum of 22 quantities per cell. Spacing between charged plates shall be at 0.67 inches (17 mm). Separator rods shall be made of aluminum with notches to hold the ground and charged plates apart at given lengths. Rods shall be 0.47 inches (12 mm) in diameter. The separator rods shall run the length of the cell to the frame of the cell. There shall be at least 12 rods total per cell. Insulators for the collector shall be made of PTFE (Teflon). Markings shall be on the cell to inform indicating direction of the airflow.

Power Supply

Power supply shall be of a 100% solid state type. Power supply shall be mounted within the air cleaner out of the air stream. Input voltage shall be 220 Vac, 50 HZ, 1 phase. Output High frequency with built in short circuit and arc protection, providing a dual high voltage output of (+)12 KVDC for the ionizer and (+) 6 KVDC for the collector. The Power Supply shall be of capable of min 120 watts and 10 mA. The power supply shall operate over a temperature range of -20 to 140 degrees F (-38 to 85 degrees C).

3.6.9 Fan

The blower shall be Centrifugal Backward Curved DIDW fan wheel of totally GI Construction with Inlet Cones and shall be complete with individual motor and drive and shall be mounted on C Channel frame and Cushy Foot or Spring Mounts. Each Scrubber shall comprise of one / two no. fans to handle air quantities as stipulated in BOQ. Each fan shall be driven by suitable HP TEFC motor. The fan wheel will be of the multiblade type and mounted on two self-aligning pillow block

bearings of the requisite size. The fan shall be run with the help of "V" Groove drives as per the recommendation of the drive supplier.

3.6.10 Motor

The TEFC motor shall be suitable for $415 \pm 10\%$ volts, 3 phase, 50 Hz $\pm 5\%$, A.C supply. The motor shall be with class B/E insulation confirming to IS 325. The motor speed shall be 1440 RPM maximum designed and guaranteed for continuous operation at the nameplate rating. It should confirm to IP 55.

3.6.11 Activated Carbon Filter Section

Equipment Description

The Activated Carbon Bank shall be supplied as a one-piece factory joined assembly of individual section(s) selected to remove and control gas & vapor contaminants from kitchen exhaust. To lengthen the life span of the activated carbon, it should be used in conjunction with an Industrial grade electrostatic air cleaning system or other proven filtration system which has a filtration efficiency above 90%.

Unit Housing

Housing shall be constructed with 16/20 gauge steel sheet and powder coated to protect against rust and corrosion. It shall have a door for replacing filters located at one side of the unit. The door shall be gasketed to prevent air leakage. As a precaution, there shall be a post filter to trap blown away carbon pallets.

Unit Internal Frame & Activated Carbon trays

Housing shall have sufficient slots for the required number of Activated carbon trays. These trays shall be installed in a Vee Manner with side access door. Each tray shall hold approximately 3.00 kilogram of activated carbon. The contact time required is at least 0.1 second or a minimum of 40kg per cms (cubic meters per sec) of air. Tray Thickness shall not be exceeding to 22 mm, so that can operate at minimum pressure drop possible keeping the contact time as specified.

Activated Carbon pellets:

Activated carbon pellets used should be high activity quality impregnated carbon. It should be manufactured from specific grades of bituminous coal to produce a high quality carbon that can meet the demands of kitchen exhaust treatment.

The carbon shall have a minimum carbon tetrachloride activity of 50% to 60%. The typical properties of the activated carbon pellets are :

Surface Area ($m^2 g^{-1}$)	950-1100
Bulk density ($g cm^{-3}$) base	0.48 – 0.52
Loose filled density ($g cm^{-3}$)	0.43 – 0.47
Moisture Content (%w/w)	<15
Hardness (%)	93-99
pH	7-8
Pellet	3 - 4 mm

3.6.12 Installation

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

The fans, scrubber etc. shall be provided with necessary vibration isolation cushy foot mounts. All necessary accessories such as nut bolts etc. shall be arranged by the contractor. The contractor shall arrange his own labour with material for completion of assembly.

The contractor, if specifically specified in bill of quantities, shall cast the RCC foundations for equipments. Anti-vibration pads of adequate efficiency shall be provided.

3.6.13 Transit Damage

The contractor at his own cost shall restore the unit to original conditions in case of any damages.

3.6.14 Testing

The AC contractor shall compute the unit air quantity with the help of velocity meter. The computed results shall be tallied with specified capacities and power consumption shall be tallied with the indicated figures in the technical data furnished with the bid by the contractor.

All necessary instruments of proper accuracy and services needed for the tests required for the computation of capacities and power consumption as required by the Consultant shall be provided by the contractor at his own cost.

It shall also be the responsibility of the Contractor to supply the motors and starters to satisfy the local regulations pertaining to the limitation of starting current and indemnify the Department from all liabilities arising out of any objections raised by the local authorities in this regard.

4 TECHNICAL SPECIFICATION FOR ELECTRICAL ITEMS

4.1 Electrical Motors

4.1.1 Scope of Work

The scope of this section comprises the supply, installation, testing & commissioning of all types of motors used for HVAC Units conforming to these specifications and in accordance with Schedule of Quantities. The motor installation, wiring & its control shall be carried out in accordance with the specifications as detailed below.

4.1.2 Motors

The motor shall be of the following design and should run at all loads without any appreciable noise or hum.

Totally enclosed fan cooled Sq. Cage.

Enclosure and type of motor shall depend upon duty and usage unless otherwise specified.

- a) The winding of motors shall be class 'B' insulation and suitable for local conditions. The insulation of motors shall confirm to IS:325/1978.
- b) All motors shall comply with IS:325, IEC-34.1 or BS – 2313, IEC-72.1 for foot mounted motors.
- c) The rating of the motor shall be as indicated in the Schedule of Quantities. The motors shall be selected on the basis of ambient temperatures and allowable maximum temperature rise.
- d) Motor above 1HP shall be three phase unless otherwise specified.
- e) All motors shall be rated for continuous duty as per IS:325. Motor shall be suitable for operation on 415 volts \pm 10% volts, 50 \pm 5% Hz three phase AC supply (or 230 \pm 10% volts, 50 \pm 5% Hz for single phase AC supply).
- f) Motors shall be provided with cable box to receive Aluminum conductors, PVC insulated, PVC sheathed and armored cables.
- g) All motors shall be provided with combination of 'Ball and Roller Bearing'. Suitable grease nipples for regreasing the bearing shall be provided.
- h) Motors above 0.25 HP shall be provided with overload protection. Motors above 100 HP shall be provided with thermal protection and thermistor detector in the stator winding.
- i) The starter current and the type of starter to be used shall be as follows (unless otherwise specified)

	Type of motor	Starting Current	Starting method
a)	Sq. Cage motor up to 7.5 HP	600% of full load current	D.O.L
b)	Above 7.5 HP up to 60 hp	250% of full load current	Star / Delta
c)	75 HP & above	200% of full load current	Closed transition Star / Delta or Double Star

4.1.3 Motor Starters

- a) All starter shall confirm to IS: 13947. The starter shall be enclosed in sheet metal enclosure, which would be dust vermin proof.
- b) All starter should have suitable range of voltage and frequency.
- c) All starter shall have integral stop/start push button of international colour code.
- d) Contactor shall have number of poles as required for appropriate duty. Contacts should be made of solid silver faced & shall be suitable for at least 40 contacts per hours.
- e) In event of power failure, the starter should automatically disconnect.
- f) All starters shall be provided with thermal over load relay.
- g) All star delta starters shall have adjustable timers.
- h) Terminal blocks with integral insulating barrier shall be provided for each starter.
- i) All starters shall be provided as specified in Schedule of Quantities. All starter shall be compatible to the drive and driven equipment.
- j) Extra contact for interlocking purpose shall be provided in the starter.
- k) All starter shall be compatible for Auto / Manual operation (BMS Compatible)
- l) All starter shall have separate single phasing preventer.

4.1.4 Installation of Motors

- a) The motor and drive machine shall be fixed on slide rails to facilitate belt and other adjustments.
- b) Vibration isolation arrangement shall be provided.
- c) The installation of motor shall be carried out as per IS:900.
- d) The motor with driving equipment shall be mounted on foundation and connected to each other with flexible coupling with guard in condenser & chilled water pumps.
- e) All motor shall be wired as per specifications. Earthing of motor frame shall be done with GI strips as specified in 'Schedule of Quantities'.
- f) All motors shall be tested at manufacturer's works as per I.S. standard and test certificates shall be furnished.
- g) All motors after AC contractor shall test installation at site for vibrations, heating and electrical insulation resistance.

4.2 Motor Control Centre, Ventilation Sub Panel, Power & Control Cabling, Earthing etc.**4.2.1 Scope of Work**

The scope of this section comprises the supply, installation, testing & commissioning of Motor Control Centre, Ventilation Panels, AHU Sub Panel, power / control cabling & earthing work shall be carried out as per the specification given below and in accordance with Schedule of Quantities. All work shall conform to Indian Electricity Act (amended up to date), I.S. code of practices, local rules and regulations etc. The codes & standard to be followed shall be as given below:-

- BIS 13947 (Part 4) - AC contactors up to 1000V
- BIS 13947 - AC Circuit Breakers
- BIS 2705 - Current Transformers
- BIS 3156 & 4146 - Potential Transformers
- BIS 4064 - Air break switches for voltage not exceeding 1000V
- BIS 13947 - Control switches
- BIS 1822 - Motor duty Switches
- BIS 12021 - Specification for control transformer
- BIS 8623 - Factory built assembly of switchgear & control gear
- BIS 13947 (Part I) - Degree of protection for enclosure
- BIS 3842 - Specification for electrical relays for AC system
- BIS 13707 - Specification for HRC fuses
- BIS 5082 - Wrought Al. and Aluminium alloys, bars, rods, tube and sections for electrical purposes
- BIS 13947 (Part 1) - General requirement for switchgear & control gear for voltage not exceeding 1000V
- BIS 3231 - Electrical relays for power system protection

4.2.2 Motor Control Centre / Ventilation Sub-Panel

Motor control centre shall be floor mounted extendable type & Ventilation sub-panel shall be wall mounted type. The sheet steel (CRCA) used for fabrication shall be of 2.0mm for load bearing members and 1.6mm for non-load bearing members. The panels shall be supplied with required base channels. These panels shall be cubical sectionalized type, totally enclosed dust & vermin proof. Gaskets shall be provided in all joints to prevent dust to reach the internals of the panels to make it completely dust proof. The degree of protections for panels shall be IP 52 for indoor applications and IP 65 for outdoor applications as per IS:2147.

These panel (MV) shall be suitable for voltages up to 500 volts, three phase 50 Hz, 4 wire supply capable of functioning satisfactorily in temperature ranging up to 45 to 50 degree centigrade and rupturing capacity suitable for connected load & design should be type tested for 42 KA fault level. All joints of panels shall be welded and braced as necessary to provide a rigid support for all components. The base channel provided in the floor mounted MV panel shall be 100mm x 50mm x 6mm & a clear space of 200mm between the floor and the bottom most part of the unit shall be provided. The panel shall be correctly positioned. Self-threading screws shall not be used in the construction of control panels. Appropriate knock-out holes of proper sizes shall be provided for incoming and outgoing cables. The facility for bottom or top entry of cables in the panels shall be provided. Necessary cables clamps shall be provided for holding the cables in position.

All power/control wiring inside the panel shall be colour coded and control wiring ferruled for identification purpose. All labeling shall be provided in engraved anodized aluminum strips on the front face of the panel.

Each circuit breaker shall be housed in separate compartments. It shall have steel sheets on top and bottom of compartment. The steel sheet hinged door shall be interlocked with the circuit breaker on

the “ON” position. When the breaker is on the “ON” position, suitable preventive measures shall be provided, such as interlocks, to prevent the breaker from being drawn out. When the breaker is in “ON” position steel sheet shall be provided between the tiers in the vertical section. The door of this compartment shall not form part of the draw out arrangements.

4.2.3 Bus-Bars

The bus-bar and its connections shall be aluminum Electrolytic grade E-91 as per IS: 5082 and shall be of rectangular section. These should be suitable for full load current for phase bus-bar and neutral bus-bar shall be of half rated current capacity. The bus-bar should have provision on either side for extension. The bus-bar should be sleeved with colour coded heat shrinkable PVC sleeve. Bus-bar supports shall be of fibre glass reinforced thermosetting polyester having in built and tracking barriers to break the path of conducting dust through moulded ribs.

In panels bus-bar connections shall be done by drilling holes with cadmium coated bolts and nuts. Extra cross section shall be provided to compensate drilling of the holes. Insulated aluminum strips of suitable size of full rated current capacity shall be used for interconnecting bus-bar and breaker.

A horizontal / vertical wire way shall be provided for interconnecting control wiring between different vertical sections.

The terminal blocks shall be used for outgoing terminals and neutral link at a suitable located place in the control panel. Separate compartments for outgoing and incoming cable shall be provided. The current transformers of all instruments shall be mounted with terminal blocks.

All live parts including incoming and outgoing link / terminals should be totally shrouded by means of non hygroscopic and fire retardant material.

4.2.4 Air Circuit Breakers

The circuit breaker shall be capable of making and breaking the specified fault currents without straining or damaging any part of the switchgear. The breakers shall be air break, motorized / manually operated as specified in BOQ and draw out type. All feeders of rating 800A and above shall be ACB and of fully draw out type. The circuit breaker shall be stored energy closing type, manual/electrically operated with tripping mechanism. The circuit breaker shall be provided with 4 NO + 4 NC of auxiliary potential free contacts required for indication, control, interlocking and other purposes. All contacts shall be wired to a terminal block. Circuit breakers with stored energy closing mechanism shall be capable of making the rated short-circuit current, when the stored energy is suitably charged by a spring. It shall also be capable of closing on no-load without suffering undue mechanical deterioration. The maximum make- time shall also not be exceeded.

The direction of motion of the handle, for manual spring charging shall be marked. A device indicating when the spring is charged fully shall also be provided. Motors and their electrically operated auxiliary equipment for charging a spring shall operate satisfactorily between 85% and 110% of the rated supply voltage. The breaker operating mechanism should store energy for O-C-O operation and shall not, in any case, get stuck in closed position during this cycle. After failure of power supply to the motor, at least one open-close-open operation of the circuit breaker shall be possible. The breaker operating mechanism shall be electrically and mechanically trip-free in all positions.

All ACBs shall be provided with microprocessor based trip unit for protection against overload, short circuit and earth faults. The releases shall be communicable to other systems on an open communication protocol. The Communication Port shall be provided in front/back. The circuit breakers shall be suitable for locking in fully isolated condition.

Following interlocks and features shall be provided so that

- a) Truck can be moved within panel only when CB is off.
- b) CB can be closed only when the test (or) service limit switches permits.
- c) Breaker compartment door cannot be opened when the CB is in Service/test position.
- d) Breaker cannot be put in to service position with compartment door open.
- e) Earth slide beyond the test position till trolley is drawn out.

Closing and tripping coil shall operate satisfactorily under the following conditions of supply voltage variation:

- a) Closing coils – 85% to 110% of rated voltage..
- b) Trip coils – 70% to 110% of rated voltage.

4.2.5 Moulded Case Circuit Breakers

The MCCBs shall confirm to the latest applicable standards. MCCBs in AC circuits shall be of four pole construction arranged for simultaneous four pole manual closing and opening. Operating mechanism shall be quick-make, quick-break and trip free type. The ON, OFF and TRIP positions of the MCCB shall be clearly indicated and visible to the operator. Operating handle for operating MCCBs from door of board shall be provided. MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit ratings. MCCBs shall incorporate time delay devices to ensure that it will tolerate harmless transient overload unless this is well in excess of 25% of its rated value for a sustained period. The circuit breaker shall be provided with 2 NO + 2 NC of auxiliary potential free contacts required for indication, control, interlocking and other purposes. All contacts shall be wired to a terminal block. The breaking capacity of MCCB's shall be as per the design requirements.

4.2.6 Miniature Circuit Breakers

Miniature Circuit Breaker shall comply with IS-8828-1996/IEC898-1995. Miniature circuit breakers shall be quick make and break type for 230/415 VAC 50 Hz applications with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting be type (Class-3). MCBs shall be classified (B,C,D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values. The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP and TPN miniature circuit breakers shall have a common trip bar.

4.2.7 Rotary Switch / Selector Switch / Switches / HRC Fuses / Starters / Single Phase Preventers / Toggle Switch

These shall be of approved make and conforming to relevant ISI standard. The rupturing capacity of HRC fuses should not less than 80 KA and in case of switches it should be 60 Amps maximum.

4.2.8 Current Transformer

The current transformers shall have accuracy of class I and 5P10 / 10P10 and suitable VA burden for operation of the connected meters and relays.

4.2.9 Overload Relays

All the motors shall have overload relay protections conforming to relevant IS.

4.2.10 Time Delay Relays

These shall be adjustable type with time delay adjustments of 0-180 or as per manufacturer's standards.

4.2.11 Indicating Lamps And Metering

These shall confirm to BS37 & BS39. All meters shall be flush mounted and draw-out type. The indicating lamp shall be filament type and with very low burden & economy resistor.

4.2.12 Voltmeter And Ammeters

Motor Control Centre (MV Panel) shall have flush type voltmeter & ammeter of size 96 x 96 mm.

4.2.13 Push Button Stations

These shall be suitable for panel mounting and accessible from front without opening. These shall be provided for manual starting and stopping of motors/equipments as per normal practices. The contacts shall be suitable for 6AMP current capacity.

4.2.14 Name Plate

Suitable anodized Aluminium name plate of 1.2 mm thick shall be provided on all the Switchboards and individual compartments.

4.2.15 Conduits

These shall be preferable made of mild steel, stove enameled from inside and outside with minimum wall thickness of 1.6 mm for conduits up to dia of 25mm and 2 mm for conduits above 25 mm diameter.

4.2.16 Cables

Cable shall be supplied inspected, laid, tested and commissioned in accordance with drawings, specifications, relevant Indian Standards Specifications and cable manufacturer's instructions. The cable shall be delivered at site in original drums with manufacturer's name clearly written on the drum.

The cables shall comply with the latest edition of the following standards

- BIS: 7098 (PART-I) - XLPE Cables - LT
- BIS: 8130 - Conductors for insulated electric cables & flexible cords.
- BIS: 3975 - Mild steel wires, strips & tapes for armouring of cables.
- BIS: 10418 - Wooden drums for electric cables.
- BIS: 10810 (PART 58) - Oxygen Index test

The material of cable shall be as follows:-

- a) The MV power cable of 660/1100 V. grade shall be XLPE insulated Aluminium conductor armoured cable.
- b) The MV control cables shall be PVC insulated copper conductor armoured stranded cable.

- c) The HT power cable of 11 KV grade shall be XLPE insulated Aluminium conductor armoured cable.

4.2.17 Laying Of Cables

These shall be laid as Indian Standard code of practice. All cables shall be laid on 16G GI Perforated U shaped Channel 40mm x 20mm cable trays. In case more than one cable is running, then proper space in between the two cables shall be provided to avoid loss of current carrying capacity. While cables are running on walls, proper saddles must be provided.

4.2.18 Wire Sizes

Single stand PVC-copper conductor wires shall be used inside the control panel for interconnecting different components. All wires shall be neatly dressed and coloured beads shall be provided for easy identification in control wiring. The minimum size of control wiring shall be 1.5sq.mm. Testing of panels as per code of practice shall be done at works by Employer / Architect before inspection & dispatch to site.

4.2.19 Drawings

Necessary drawings of all control panels and wiring of equipment etc., shall be submitted by the contractor for approval of the Engineer in Charge. On final completion of job and before handing over of AC System As Built Drawings shall be submitted to the Department.

4.2.20 Testing

All equipment and components supplied may be subjected to inspection and tests by the client / consultant or his authorized representatives during manufacture, erection / installation and after completion. No tolerances shall be allowed other than the tolerances specified or permitted in the relevant approved Standards, unless otherwise stated. If the guaranteed performance of any item of equipment is not met and / or if any item fails to comply with the specification requirement in any respect whatsoever at any stage of manufacture, test or erection, the client / consultant may reject the item, or defective component thereof, whichever he considers necessary.

The complete electrical installation shall be tested in accordance with relevant IS codes in presence of Electrical Supervisor of the client before commissioning of plant.

4.2.21 Painting Of Panels

All sheet metal enclosures shall be powder coated only after de-rusting & hot-dip phosphating degreasing etc. at works only.

NOTE: Rubber mats of 1100 volts shall be laid in front of all switch boards.

4.2.22 Sizes Of Power Cabling

The following size of power cabling shall be used only :

HP of Motors	Cable size
a) Up to 5 HP	3c x 4sq.mm aluminium conductor armoured cable.
b) 5 to 7.5 HP	3c x 6sq.mm aluminium conductor armoured cable.
c) 10 to 15 HP	2no. 3c x 6sq.mm aluminum conductor armoured cable.
d) 20 to 25 HP	2 nos. 3 x 16sq.mm aluminum conductor armoured cable.
e) 30 to 35 HP	2 nos. 3c x 25sq.mm aluminum conductor armoured cable.

f)	40 to 50 HP	2 nos. 3c x 35sq.mm aluminum conductor armoured cable.
g)	60 HP	2 nos. 3c x 50sq.mm aluminum conductor armoured cable.
h)	75 HP	2 nos. 3cx 70sq.mm aluminum conductor armoured cable.
i)	100 HP	2 nos. 3cx 95sq.mm aluminum conductor armoured cable.
j)	125 HP	2 nos. 3cx 120sq.mm aluminum conductor armoured cable.

4.2.23 Capacity Of Relays And Contacts

The following capacity relays and contacts shall be used for various rating of motors:

Type of Starter Contactor Overload Relay

			Contactor	Phase Relay Range
a)	50/60 HP Motor	Star Delta Starter	70 Amp.	30 - 50 Amp.
b)	40 HP Motor	Star Delta Starter	45 Amp.	20-33 Amp.
c)	30 HP Motor	Star Delta Starter	45 Amp.	20-33 Amp.
d)	25 HP Motor	Star Delta Starter	32 Amp.	14-23 Amp.
e)	20 HP Motor	Star Delta Starter	32 Amp.	14-23 Amp.
f)	15 HP Motor	Star Delta Starter	25 Amp.	9-15 Amp.
g)	10 HP Motor	Star Delta Starter	16 Amp.	6-10 Amp.
h)	7.5 HP Motor	D.O.L. Starter	16 Amp.	9-15 Amp.
i)	5 HP Motor	D.O.L. Starter	16 Amp	6-10 Amp.

4.2.24 Earthing

The earthing of all equipments shall be carried out by Copper strips / wires as mentioned in Bill of Quantities. All panels / three phase motors shall be earthed with two number distinct and independent Copper strips / wires of the following sizes:

1. Motor upto 5.5 KW	3 sq. mm Copper Wire	8 SWG GI Wire
2. Motor 7.5 to 18.75 KW	4 sq. mm Copper Wire	6 SWG GI Wire
3. Motor 22.5 to 50 KW	25x3 mm Copper Strip	25x6 mm GI Strip
4. Motor 51 to 89 KW	25x6 mm Copper Strip	32x6 mm GI Strip

The earthing connections shall be connected to main earth station or main earth grid. The earth connections shall be connected to equipments after removal of paint, grease etc.

5 SERVICES SPECIFICATION

5.1 Air Distribution**5.1.1 Scope of Works**

The scope of this section comprises supply, fabrication, installation & testing of all sheet metal GI ducts as well as supply, installation, testing & balancing of all grills, diffusers & other accessories in accordance with these specification & Schedule of Quantities.

5.1.2 GI Duct (Site Fabricated)

- a) All ducts shall be fabricated either from Galvanized Sheet Steel (GSS) conforming to IS: 277 or aluminum sheets conforming to IS:737. The steel sheets shall be hot dip galvanized with coating of minimum 120 grams per square meter (GSM) of Zinc.
- b) The thickness of sheets for fabrication of rectangular ductwork shall be as under. The thickness required corresponding to the longest side of the rectangular section shall be applicable for all the four sides of the ductwork.

Longest side (mm)	Minimum sheet thickness	
	For GSS	For Aluminum
750 mm and below	0.63	0.80
751 mm to 1500 mm	0.80	1.00
1501 mm to 2250 mm	1.00	1.50
2251 mm & above	1.25	1.80

- c) All sheet metal connections, partitions and plenums required for flow of air through the filters, fans etc. shall be at least 1.25 mm thick galvanized steel sheets, in case of G.I. sheet ducting or 1.8 mm thick aluminium sheet, in case of aluminium sheet ducting and shall be stiffened with 25 mm × 25 mm × 3 mm angle iron braces.
- d) Circular ducts, where provided shall be of thickness as specified in IS: 655 as amended up to date.
- e) Aluminium ducting shall normally be used for clean room applications, hospitals works and wherever high cleanliness standards are functional requirements.

5.1.3 Associated Items For Duct

- a) Jet nozzles/Eye ball suitable for long throw distance with optimum acoustic properties, preferably used for heating and cooling in critical areas. The adjustment facilities – manual or automatic. The adjustment can be rotated through 360°. The material of eye ball is aluminium and mounting for the eyeball is with two plastic rings colour white. The connection element and saddle connection are in galvanized sheet steel. The surface can be pre-treated and powder coated.
- b) Supply/return air outlets F.A. grilles and accessories shall be constructed from extruded aluminium sections.
- c) Flanges for matching duct sections, stiffening angels (braces) and supporting angles shall be of rolled steel sections, and shall be of the following sizes.

Application	Duct Width	Angle Size
Flanges	Up to 1000 mm	35mm × 35mm × 3mm
-do-	1001 mm to 2250 mm	40mm × 40mm × 3mm

-do-	More than 2250 mm	50mm x 50mm x 3mm
Bracings	Up to 1000 mm	25mm x 25mm x 3mm
-do-	More than 1000 mm	40mm x 40mm x 3mm
Support angels	Up to 1000 mm	40mm x 40mm x 3mm
-do-	1001 mm to 2250 mm	40mm x 40mm x 3mm
-do-	More than 2250 mm	Size and type of RS section shall be decided in individual cases

- d) Hanger rods shall be of mild steel and of at least 10 mm dia for ducts up to 2250 mm size, and 12 mm dia for larger sizes. All ducts shall be supported from the ceiling / slab by means of MS rods of dia (10-12) mm fully threaded with MS angle at the bottom with neoprene pad in between the duct & MS angle. The ducts shall be suspended from the ceiling with the help of dash fasteners. The contractor shall arrange provision for necessary ancillary materials required for hanging the ducts. **Alternatively Steel Wire Rope Hangers & Supports system can be used in place of MS Rod & MS Angle.**
- e) All nuts, bolts and washers shall be zinc plated steel. All rivets shall be galvanized or shall be made of magnesium – aluminium alloy. Self tapping screws shall not be used.
- f) The vanes shall be provided wherever required and shall be securely fastened to prevent noise & vibration.
- g) The rubber gasket shall be installed between duct flanges in all connections and joints.
- h) All flanges and supports should be primer coated.
- i) The flexible joints shall be fitted to the delivery side of AHU fans with Fire Retardant Double canvass. The length of flexible joints should not be less than 150 mm and not more than 300 mm between faces.
- j) The ducting work can be modified if deemed necessary in consultation with the Engineer in Charge to suit actual site conditions in the building.

5.1.4 Construction Of Duct

- a) Ducts shall be fabricated at site or factory fabricated and shall be generally as per IS: 655 "Specifications for metal air ducts". Unless otherwise deviated in these General Specifications.
- b) The interior surfaces of the ducting shall be smooth.
- c) All the ducts up to 600 mm longest side shall be cross broken between flanges by a single continuous breaking. Ducts of size 600 mm and above shall be cross broken by single continuous breaking between flanges and bracings. Alternatively, beading at 300 mm centres for ducts upto 600 longest side, and 100 mm centres for ducts above 600 mm size shall be provided for stiffening.
- d) As far as possible, long radius elbows and gradual changes in shape shall be used to maintain uniform velocity accompanied by decreased turbulence, lower resistance and minimum noise. The ratio of the size of the duct to the radius of the elbow shall be normally not less than 1:1.5.
- e) Flanged joints shall be used at intervals not exceeding 2500mm. Flanged shall be welded at corners first and then riveted to the duct.

- f) Stiffening angels shall be fixed to the sides of the ducts by riveting at 1.25 meters from joints for ducts of size 600 mm to 1500 mm, and 0.6 mm form joints for ducts of size larger than 1500mm. Bracings for ducts larger than 1500mm can alternatively be by diagonal angels.
- g) Plenums for filters shall be complete with suitable access door of size 450mm x 450mm.

5.1.5 Box Type Dampers & Splitters

These dampers shall be provided in the ducting work for proper control and balancing of air distribution. All dampers shall be louver type robust construction. These dampers shall be fitted with easily accessible operating mechanism, complete with links, levers, quadrant for proper control and setting in a desired position. The position of the handle of the damper operating mechanism shall be clearly visible and shall indicate the position of the damper in the duct. All dampers, splitters shall be fabricated out of G.S. sheet of two gauges higher than the duct piece having these fittings. Dampers shall be installed in duct at all required locations. No extra payment shall be made separately since these form part of Air Circulation System.

NOTE: In case angle iron supports are not feasible to be installed for supporting the ducts due to height constraint then the contractor shall support the ducts with M.S flats of at least double the thickness of the angle iron supports.

5.1.6 Supply / Return Air Grills & Ceiling Diffusers

Grilles and diffuser constructed of extruded aluminium sections shall have grille bars set straight, or deflected as required. These shall be assembled by mechanical interlocking of components to prevent distortion. These grills and diffusers shall have a rear set of adjustable blades, perpendicular to the face blades for deflection purpose.

All grills / diffusers shall have soft continuous rubber / foam gasket between the periphery of the grills / diffusers and surface on which it has to be mounted. The colour of grills / diffuser shall be as per the approval of the Engineer in Charge.

a) Rectangular / Square / Linear Supply And Return Grills

Square and rectangular wall outlets shall have a flanged frame with the outside edges retuned or curved 5 to 7 mm and fited with a suitable flexible gasket between the concealed face of the flanges and the finished wall face. The core of supply air register shall have adjustable front louvers parallel to the longer side to give upto 22.5 degrees vertical deflection and adjustable back louvers parallel to the shooter side to achieve horizontal spread air pattern to at least 45 degrees. Fixed bar linear air grills shall have only front louvers. The outer framework to the grills shall be made of not less than 1.6 mm thick aluminium sheet. The louvers shall be of aerofoil design of extruded aluminium section with minimum thickness of 0.8 mm at front and shall be made of 0.8 mm thick aluminium sheet. Louvers may be spaced 18 mm apart.

b) Square / Rectangular Ceiling Diffusers

Square and rectangular ceiling air diffusers shall have a flanged flush with the ceiling into which it is fitted or shall be of anti smudge type the outlets shall comprise and outer shell with duct collar and removable diffusing assembly. These shall be suitable for discharge in one or more directions as required. The outer shell shall not be less than 1.6mm thick extruded section aluminium sheet. The diffuser assembly shall not be less than 0.80 mm thick extruded aluminium section.

c) Circular Ceiling Diffusers

Circular ceiling diffusers shall have either flush or anti smudge outer cone as specified in the tender specifications. Flush outer cones shall have the lower edge of the cone not more than 5 mm below

the underside of the finished ceiling into which it is fitted. Anti smudge cones shall have the outer cone profile designed to reduce dirt deposit on the ceiling adjacent to the air outlet. The metal sheet used for construction of these shall be minimum 1.6 mm thick extruded aluminium sheet.

d) Linear Slot Diffusers

Linear diffuser shall have a flanged frame with the outside edges returned 3.5 mm and shall have one to four slots as required. The air quantity through each slot shall be adjustable. The metal sheet used for the construction of these shall be minimum 1.6 mm thick extruded aluminium sheet.

e) Laminar Supply Air Diffusers

Laminar supply air diffusers shall be made of 2 mm thick powder coated aluminum sheet duly insulated with 5 mm thick closed cell polyethylene foam insulation having factory laminated aluminium foil and joints covered with self adhesive aluminium taps and having holes 2/3 mm dia including frame work.

f) Volume Control Device

All supply air outlets shall be fitted with a volume control device, made of extruded aluminium gate section. The blades of the device shall be mill finish/block shade pivoted on nylon brushes to avoid rusting & rattling noise, which shall be located immediately behind the outlet and shall be fully adjustable from within the occupied spaces without removing any access panel. The volume control device for circular outlets shall be opposed blade radial/shutter type dampers, or two or more butterfly dampers in conjunction with equalizing grid. Opposed blade dampers shall be used for square and rectangular ceiling/wall outlets and intakes.

5.1.7 Fresh Air Intake Louvers With Bird Screen

The fresh air intake louvers at least 50mm deep will be made of powder coated extruded aluminum construction. A bird wire screen made of 12 mm mesh in 1.6 mm steel wire held in angle or channel frame shall be fixed to the rear face of the louver frame by screens. The blades shall be inclined at 45 degree on a 40mm blade pitch to minimize water ingress. The lowest blade of the assembly shall be extended out slightly to facilitate disposal of rain water without falling on door / wall on which it is mounted. Additional intermediate equally spaced supports and stiffeners shall be provided to prevent sagging/vibrating of the louvers, at not more than 750mm centres where the louver's length is longer than 750mm.

The intake louvers shall be provided with factory fitted volume control dampers in black finish.

5.1.8 Painting

All ducts collar / shoot behind the grills / diffuser shall be given at least two coats oil black enamel paints.

5.1.9 Testing

The complete duct system shall be tested for air leakage & complete air distribution system shall be balanced in accordance with air quantities indicated on the approved drawing.

5.1.10 Factory Fabricated Ducting

5.1.10.1 General

Ducting work shall mean all ducts, casing, dampers, access doors, joints, stiffeners and hangers.

5.1.10.2 Governing Standards

Unless otherwise specified here, the construction, erection, testing and performance of the ducting system shall conform to the SMACNA – 1995 standards (“HVAC Duct Construction Standards – Metal and Flexible – Second Edition – 1995” – SMACNA).

5.1.10.3 Duct Materials

The duct shall be fabricated from Lock Forming Quality (LFO) grade galvanized steel sheets with 120 gms / sq.m galvanizing (total coating on both sides) on the sheets.

All ducts wherever specified, shall be factory fabricated in box sections from G.I. continuous coils with all suitable joints, supports, sealing arrangements etc.

The thickness of galvanized sheet and type of flange class at 1200 mm spacing shall be as follows:-

Size of Duct	Sheet Thickness	Type of Flange
Up to 450 mm	0.50 mm	C&S cleats
450 mm to 750 mm	0.50 mm	Type E
Size of Duct	Sheet Thickness	Type of Flange
751 mm to 1000 mm	0.63 mm	Type E
1001 mm to 1500 mm	0.63 mm	Type H
1501 mm to 1800 mm	0.80 mm	Type H
1801 mm to 2100 mm	1.00 mm	Type J
2101 mm and above	1.00 mm	Type J

The gauges, joints and bracings for sheet metal ducting work shall further conform to the provision as shown on the drawings.

Ducts larger than 600 mm shall be cross broken or straight beaded. Duct sections upto 1200 mm length may be used with bracing angles omitted.

Changes in section of duct work shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 DEG. Angle from the axis of the main duct unless otherwise approved by the engineer – In – Charge.

All ducts shall be supported from the ceiling / slab by means of fully threaded GI rods of 8 mm – 12 mm dia, with M.S. slotted double – C channel of 3.0 mm thickness at the bottom. The rods shall be anchored to R.C. slab using metallic expansion fasteners.

5.1.10.4 Installation

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

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

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

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

All air turns of 45 degrees 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 of vibration.

The ducting work shall be varied in shape and position to fit actual conditions at building site. All changes shall be subjected to the approval of the engineer – In – Charge. The contractor shall verify all measurements at site and shall notify the engineer – In – Charge. The contractor shall verify all measurements at site and shall notify the engineer – In – Charge of any difficulty in carrying out his work before fabrication.

Self adhesive sponge rubber / PVC gaskets of 6 mm maximum thickness shall be installed between duct flanges as well as between all connection of sheet metal ducts to walls, floor column, heater casing and filter casings. Sheet metal connections shall be made to walls and floor by means of wooden member anchored to the building structure with anchor bolts and with the sheet screwed to them.

Flanges, bracing and supports shall be galvanized steel. The connection shall be 4 bolts slip on type flange system with sealant injected within the flanges. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.

Joints, seams, sleeves, splitter, branches, takeoffs and supports are to be as per duct details as specified, or as decided by Engineers –in –Charge.

Hexagon nuts and bolts, stove bolts or buck bolts, rivets, or closed center top rivets, or spot welding may fix joints requiring bolting or riveting. Self tapping screws must not be used .All jointing materials must have a finish such as cadmium plating or galvanized as appropriate.

Fire retarding non- porous, vermin proof flexible joints are to be fitted to the suction and delivery of fans. The material is to be normally double heavy canvas or as directed by Engineer-in-Charge .On all circular spigots the flexible materials are to be screws or clip band with adjacent screws 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.

The flexible joints are to not less than 75 MM and not more than 250 MM between faces.

The duct work should be carried out in a manner and at such times as not to hinder or delay the work of the other agencies especially the boxing or false ceiling contractors.

Duct passing through brick or masonry, wooden frames work shall be provided within the opening. Crossing duct shall have heavy flanges, collars on each side of wooden frame to make the duct leak proof.

5.1.10.5 Dampers

Splitter Dampers

At the junction of each branch duct with main duct and split of main duct, volume dampers must be provided. Dampers shall be two gauges heavier than the gauge of the large duct and shall be rigid in construction.

The dampers shall be of an approved type, lever operated and complete with locking devices, which will permit the dampers to be adjusted and locked in any positions, and clearly indicating the damper position.

The dampers shall be of splitter, butterfly or louver type. The damper blade shall not be less than 1.25 mm (18) Gauge, reinforced with 25 mm angles 3 mm thick along any unsupported side longer than 250 mm. Angle shall not interfere with the operation of dampers, nor cause any turbulence.

5.1.10.6 Opposed Blade Dampers

Automatic and manual volume opposed blade dampers shall be complete with frames and nylon bush as per drawings. Dampers and frames shall be constructed of 1.6 mm steel sheets and blades shall be of extruded aluminium of aerofoil design. The dampers for fresh air inlet shall additionally be provided with fly mesh screen, on the outside, of 0.8 mm thickness with the mesh.

Wherever required for system balancing, a balancing opposed blade damper with quadrant and thumb screw lock shall be provided.

After completion of the duct work, dampers are to be adjusted and set to deliver air flow as specified on the drawings.

5.1.10.7 Access panel

A hinged and gasketed double skin, factory fabricated access panel measuring at least 450 mm x 450 mm shall be provided on duct work before each fire damper and at each control device that may be located inside the duct work.

5.1.10.8 Miscellaneous

All duct work joints are to be true right angle and with all sharp edges removed.

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

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

Diverting vanes must be provided at the bends exceeding 600 mm 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 and to avoid vibrations. Additional supports are to be provided where required for rigidity or as directed by engineer – In – Charge.

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

All edges shall be machine treated using lock formers, flanges and rollers.

All the flanges shall be connected to the GSS ducts by rivets at 100 mm centres.

The ducts should be supported by approved type supports at a distance not exceeding 2.0 meters

5.2 Steel Wire Rope Hangers & Supports

Wire Hangers shall be used to suspend all static HVAC & Mechanical services.

Wire Hangers should consist of a pre-formed wire rope sling with a range of end fixings to fit various substrates and service fixings, these include a ferruled loop, permanently fixed threaded M6 (or M8, M10) stud, permanently fixed nipple end with toggle, at one end or hook or eyelet, cladding hook, barrel, wedge anchor, eyebolt anchor or any other end fixture type or size as per manufacturers recommendation and design. The end fixings and the wire

must be of the same manufacturer with several options available. The system should be secured and tensioned with a Hanger self-locking lock at the other end comprising of a single piece housing; the wedge inside the lock housing should be having serrated teeth & made up of sintered steel and springs used, if any, should be made up of stainless-steel. Once the grip is locked for safety purpose unlocking should only be done by using a separate setting key and should not be an integral part of the self-locking grip for safety purpose. Only wire and/or supports supplied and/or approved, shall be used with the system.

Wire Hangers should have been independently tested by Lloyds Register, APAVE, TUV, CSA, Chiltern International fire, ADCAS, Intertek, ECA, and SMACNA, approved by ULC and CSA and comply with the requirements of DW/144 and BSRIA – wire Rope Suspension systems.

Wire rope should be manufactured to BSEN 12385: 2002

The contractor shall select the correct specification of wire hanger to use for supporting each particular service from table 1 below. Each size is designated with a maximum safe working load limit (which incorporates a 5:1 safety factor).

The correct specification of wire hanger required is determined using the following formula.

Weight per meter of object suspended (kg) X distance between suspension points (m) = weight loading per Hanger suspension point (kg).

Where the installed wire rope is not vertical then the working load limit shall be reduced in accordance with the recommendations give in the manufacturer's handbook.

The contractor shall select the correct length of wire rope required to support the service. Lengths from 1-10m lengths. Specials can be made, check with manufacturer. No in-line joints should be made in the rope.

Table. 1

Wire Hanger Safe Working Load		
Hanger No.	minimum breaking load of Wire Rope	working load limit (kg/lbs)
No. 1	80kg/176 lbs	0-10 kg / 0-22 lbs
No. 2	260kg/572 lbs	10-45 kg / 23-100 lbs
No. 3	580kg/1276 lbs	45-90 kg / 101-200 lbs
No. 4	1500kg/3300 lbs	90-225 kg / 210-495 lbs
No. 5	2160kg/4752 lbs	225-325 kg / 496-715 lbs
No. 6	2500kg/5500 lbs	325-500 kg / 715-1100 lbs

The standard range of Hanger Kits should contain galvanized high tensile steel wire rope or stainless steel wire rope as per the application, the minimum specification is as above and should be

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

manufactured to BS 302 (1987), BSEN12385. Comply with manufacturer's load ratings and recommended installation procedures. Note the testing is done to the minimum breaking load of the wire thus giving a minimum safety factor of 5:1.

Mechanical Supports – Wire Hanger Supports are suitable for: Water Pipes, Drainage Pipes, Gas Pipes, Refrigeration Pipes, Condensation Water Pipes.

Piping Supports: Rigid supports may be used in conjunction with wire hangers to assist with alignment of services as per the Schedule. These can be at 30m intervals or so depending on the run of the service. Rigid support must also be used in conjunction with wire hangers with pipe work at each change of direction or connection. For insulated pipe, provide protective sleeve to protect the entire circumference of the pipe insulation. Stainless Steel Supports should be available for food, chemical and High Corrosion areas near coastlines.

Any other wire hanging arrangement solution can be used based on manufacturer's recommendation on site conditions after prior approval. Support piping in accordance with Schedule at the end of this Section.

Refer to manufacturers catalogue and installation guide for further technical information. Comply with manufacturer's load ratings and recommended installation procedures. All supporting system shall be provided by same manufacturer.

Pipe Hanger Schedule

Pipe Size	Weight of pipe + fluid	Weight of pipe + fluid per Rmt	Spacings (pipe + fluid + insulation)	Spacings (pipe + fluid + laster)	Total Weight of pipe + fluid	Total Weight of pipe + fluid	Wire Hanger (SWL kgs)	Wire Hanger (SWL kgs)
(mm)	with insulation (kgs / rmnts)	with sand cement plaster (kgs / rmnts)	between supports (mts)	between supports (mts)	with insulation (kgs / rmnts)	with sand cement plaster (kgs / rmnts)	for pipe with insulation (kgs / rmnts)	for pipe with sand cement plaster (kgs/rmnts)
12-32	11.73	14	1.5	1.5	18	21	45	45
40-65	11.73	14	2	2	23	28	45	45
80-125	34.73	41.67	2	2	69	83.34	90	90
150-200	112	134	2	1.5	224	201	225	225
250-above	as per the manufacturer recommendation and with prior approval.							

Rigid Supports for pipes to be used in conjunction with wire supports:

Pipe Size(mm)	Rod Size (mm)
Dia.	
Up to 12 mm	10
15-25 mm	10
25-65 mm	10
80-100 mm	12

Pipe Size (mm)	Pipe Supports
UP TO 50 Ø	40x40x6 M.S ANGLE
80Ø TO 100Ø	50x50x6 M.S ANGLE

Pipe Size (mm)	Horizontal Supports	Vertical Supports
125Ø TO 200Ø	75x40 M.S CHANNEL	50x50x6 M.S ANGLE
250Ø TO 300Ø	100x50 M.S CHANNEL	75x40 M.S CHANNEL
300Ø TO 400Ø	150x75 M.S CHANNEL	100x50 M.S CHANNEL
450Ø TO 600Ø	200x75 M.S CHANNEL	200x75 M.S CHANNEL

Testing

- a. During construction, the contractor shall properly cap all lines, so as to prevent the entrance of sand, dirt, etc. Each system of piping shall be flushed thoroughly after completion (for the purpose of removing dirt, grit, sand etc. from the piping and fittings) for as long a time as is required to thoroughly clean the system.
- b. All piping shall be tested to hydrostatic test pressure of at least two times the maximum operating pressure, but not less than 10 kg per sq. cm gage for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified, retested and gotten approved
- c. Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.
- d. Piping may be tested in sections and such sections shall be securely capped, then retested for the entire system.
- e. The Contractor shall give sufficient notice to all other agencies at site, of his intention to test a section or sections of piping and all testing shall be witnessed and recorded by Owner's site representative.
- f. The contractors shall provide temporary pipe connections to initially by-pass condenser / chiller and circulate water through condenser/ chilled water pipe lines for minimum 8 hours. Water should be drained out from the lowest point. The temporary lines shall be removed and blanked with dead flanges. Pot strainers and Y strainers shall be cleaned and fresh water filled in the circuits.
- g. After regular flushing, as per 'f' above, all systems shall be chemically cleaned. Chemical cleaning shall be carried out in 3 stages. In first stage biological cleaning shall be done to remove algae, bacteria, SRB etc which produces slimes. Second stage is pre-cleaning in which loose rust, oil, and debris are removed. Chemical addition and hold up time shall be as per chemical supply agencies recommendations. Third stage is passivation, in which chemicals will be added and passivation film will be formed over inside surfaces of piping system. Type of chemical used and quantity of the same along with detailed method statement shall be submitted by contractor for consultants' approval before starting this activity.

Before handover Owner's site representative shall be provided with certificate of cleaning of pipe systems, signed by the contractor.

- h. After the piping has been installed, tested and run for atleast three days of eight hours each, all insulated exposed piping in plant room shall be given two finish coats, 3 mils each of approved colour, conforming to relevant BIS Codes.

The direction of flow of fluid in the pipes shall be visibly marked with identifying arrows. For painting of insulated and clad pipes refer to Insulation section.

- i. The Contractor shall make sure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipment in the system concerned. If proper circulation is not achieved due to air bound connection, the Contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and re-finishing of floors and walls if required.
- j. The Contractor shall provide all materials, tools, equipment, instruments, services and labour required to perform the test and to remove water resulting from cleaning and after testing.

5.3 Fire Dampers (UL Listed & Certified)

5.3.1 Scope of Work

The scope of this section comprises the supply, installation, testing & commissioning of fire dampers conforming to these specifications and in accordance with Schedule of Quantities.

5.3.2 Motorized Combined Smoke & Fire Dampers - Spring Return Type

- a) All supply air Ducts in AHU room crossing shall be provided with approved make fire and smoke dampers of at least 90 minutes fire rating & shall be UL certified as per UL555.
- b) The fire damper blades & outer frame shall be formed of 1.6 mm galvanized steel sheet. The damper blade shall be pivoted on both ends using chrome-plated spindles in self-lubricating bushes. Stop seals shall be provided on top & bottom of the damper housing made of 16G Galvanized steel sheet. For preventing smoke leakage side seals will be provided.

In normal operating conditions damper blade shall be held in open position with the help of a 24 V operated electric actuators thereby providing maximum air passage without creating any noise or chatter.

- c) The damper shall be actuated through electric actuator. The actuator shall be energized with the help of a signal from smoke detector installed in AHU Room / R. A. Duct. The fire damper shall close due to temperature rise in S. A. Ducts through the electric temperature sensor, which is factory set at 165 °F.
- d) Each motorized smoke cum fire damper shall have its own panel which will incorporate necessary circuit required to step down voltage available from UPS or emergency power supply to show status of the damper (open or close), to allow remote testing of damper, indication in event of damper closure due to signal from smoke sensor / temp. sensor & reset button. Additional terminal will be provided to have audio cum video signal in Central Control Room.
- e) Damper actuator shall be such that it should close the damper in the event of power failure automatically and open in the same in case of Power being restored.
- f) The fire Damper shall be mounted in fire rated wall with a duct sleeve 600 MM long. The sleeve shall be factory fitted on fire damper. The joints at sleeve end shall be slip on type. Minimum thickness of GI Sheet shall be 18G.
- g) The damper shall be installed in accordance with the installation method recommended by the manufacturer.
- h) Hinged access doors of suitable size complete with airtight gaskets shall be provided in all fire dampers & plenums.

5.4 Refrigerant Piping

5.4.1 Scope of Works

The scope of this section comprises supply, installation, testing & commissioning of refrigerant piping as detailed below in specifications.

5.4.2 Refrigerant Piping

All refrigerant piping for the air conditioning system shall be constructed from soft seamless up to 19.1mm and hard drawn copper refrigerant pipes for above 19.1mm with copper fittings and silver-soldered joints. The refrigerant piping arrangements shall be in accordance with good practice within the air conditioning industry, and are to include charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits.

All joints in copper piping shall be sweat joints using low temperature brazing and or silver solder. Before joining any copper pipe or fittings, its interiors shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently, it shall be thoroughly blown out using nitrogen.

After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using nitrogen at pressure of 20Kg per sq.cm and 10 Kg per sq.cm (low side). Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum if 700mm hg and held for 24 hours.

The air-conditioning system supplier shall be design sizes and erect proper interconnections of the complete refrigerant circuit.

The thickness of copper piping shall not be less than 20gauge for pipes up to 19.1mm and 18 gauge for bigger sizes

The suction line pipe size and the liquid line pipe size shall be selected according to the manufacturers specified outside diameter. All refrigerant pipes shall be properly supported and anchored to the building structure using steel hangers, anchors, brackets and supports which shall be fixed to the building structure by means of inserts or expansion shields of adequate size and number to support the load imposed thereon.

The OD & wall thickness size of copper refrigerant piping shall be as per VRV / VRF manufacturer standard. **The pipe thicknesses given below are minimum.**

Outside Diameter (mm)	Wall Thickness (MM)
a) 50.8	1.64
b) 44.5	1.64
c) 41.3	1.43
d) 34.9	1.21
e) 28.6	1.0
f) 25.3	0.8
g) 22.2	0.8
h) 19.1	0.8
i) 15.9	0.8
j) 12.7	0.8
k) 9.5	0.8
l) 6.4	0.8

5.5 Insulation / Lining Work

5.5.1 Scope of Works

The scope of this section comprises supply & fixing of thermal / acoustic insulation of ducts, pipes etc. as per the specification given below & in accordance with Schedule of Quantities.

5.5.2 Material & Process of Acoustic Insulation of Duct / AHU Room

a) Resin Bonded Fibre Glass Wool

The Thermal conductivity values in W/m.K of fibre glass shall confirm to following:

Mean Temperature P⁰C	Density In Kg / Cmt.	Thermal Conductivity W/m.k
25P ⁰ C	32/48	0.030

Acoustic Lining of Duct

The material to be used for duct lining shall be 12 / 25 mm thick resin bonded fibre glass rigid board having a density of 48 Kg/m³ & covered with 0.5 mm thick perforated aluminum sheet. The lining of initial length of the duct shall be done as shown in the tender layout drawings & shall be carried out as follows.

- a) Clean the duct piece thoroughly,
- b) Fix the board of suitable thickness inside the duct & cover with fibre glass tissue paper.
- c) Cover the insulation board with 0.5mm thick perforated aluminum sheet with atleast 20% perforation.
- d) Secure the insulation board & aluminum sheet with cadmium coated bolts nuts & cup washers / steel screws.
- f) Finally seal the ends completely, so that no lining material is exposed.

Acoustic Lining of AHU Room

The four walls and ceiling of AHU Rooms shall be provided with acoustic lining of thermal insulation as per following specifications & as specified in the Schedule of Quantities.

- a) Clean the surface.
- b) A 610 x 610 mm frame work of 25 x 50 x 50 x 50 x 50 x 25 mm 'U' shape channel made of 0.6 mm. thick G.S.S. shall be fixed on to walls by means of rawl plug in walls & dash fasteners in ceiling. Before fixing channel shall be filled with fibre glass.
- c) Fix the resin bonded glass wool having density of 32 Kg/cmt.in the frame.
- d) Finally, finish it by covering the surface with 0.5 mm thick perforated aluminium sheet with brass screws. Before fixing aluminium sheet, fibre glass tissue paper must be sandwitched.
- e) All horizontal and vertical joints shall be covered with at least 25 mm. wide, 1mm aluminium strips held in position by steel or brass screws.

5.5.3 Material & Process of Thermal Insulation of CHW / HW Pipes / AC Equipments**Material**

- Insulation material shall be Closed Cell Elastomeric Nitrile Rubber.
- Density of Material shall be between 50+/-10% Kg/mP³P.
- Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/mP⁰K at an average temperature of 0P⁰C.
- The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990.
- Water vapour permeability shall not exceed 0.017 Perm inch (2.48×10^{-14} Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor or 'μ' value should be minimum 7000.
- Complete pipe insulation shall have 200 g/m² factory laminated, treated woven Glass Cloth coating for mechanical and UV protection.

Thickness of the insulation shall be as specified for the individual application.

Pipe Insulation

All chilled water, refrigerant and condensate drain pipe shall be insulated in the manner specified herein. An air gap of 25 mm shall be present between adjacent insulation surfaces carrying chilled water or refrigerant. Before applying insulation, all pipes shall be brushed and cleaned. All Pipe surfaces shall be free from dirt, dust, mortar, grease, oil, etc. Nitrile Rubber insulation shall be applied as follows:

- Insulating material in tube form shall be sleeved on the pipes.
- On existing piping, pre slit, self adhesive tube with factory laminated woven glass cloth coating shall be placed. Remove the release paper and make a seam joint. Cover the joint with integral glass cloth flap. Butt joints shall be sealed with adhesive and shall be covered with same glass cloth (slit opened tube of the insulating material (slit with a very sharp knife in a straight line) shall be placed over the pipe and) adhesive shall be applied as suggested by the manufacturer.
- Adhesive must be allowed to tack dry and then press surface firmly together starting from butt ends and working towards centre.
- Wherever flat sheets shall be used, Factory cut sheets shall be used (it shall be cut out in correct dimension.) All longitudinal and transverse joints shall be sealed as per manufacturer recommendations.
- The insulation shall be continuous over the entire run of piping, fittings and valves.
- All valves, fittings, joints, strainers, etc. in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced.

The detailed application specifications are as mentioned separately. The manufacturer's trained installer should only be used for installation.

Recommended Adhesive

In all cases, the manufacturer's recommended Adhesive (SR-998) should be used for the specified purpose.

Pump Insulation

Chilled water pump shall be insulated to the same thickness as the pipe to which they are connected and application shall be same as above. Care shall be taken to apply insulation in a manner as to allow the dismantling of pumps without damaging the insulation.

Shell Insulation

The chiller shells shall be factory insulated in accordance with the manufacturer's standards.

Cold Water & Expansion Tank Insulation

Cold water tank, and chilled water expansion tank shall be insulated as per manufacturer's standard.

Parameters for Selection of Thickness

- a) Design Basis: Condensation Control
- b) Region: Non Costal Area
- c) Application: Outdoor & Indoor
- d) Design Conditions: 30 Deg. C & 90 % RH

Thickness of Insulation

- a) Chilled Water Pipe Line Temperature 7.0 Deg. C

Indoor Application (Conditioned / Semi Conditioned Space)

Up To 150 mm Pipe Size	- 25 mm Thick Insulation
Above 150 mm & Up To 600 mm Pipe Size	- 32 mm Thick Insulation
Above 600 mm Pipe Size	- 38 mm Thick Insulation
Chilled Water Tank	- 32 mm Thick Insulation

Outdoor Application / Non Conditioned Space

Up To 100 mm Pipe Size	- 32 mm Thick Insulation
Above 100 mm & Up To 200 mm Pipe Size	- 38 mm Thick Insulation
Above 200 mm & Up To 600 mm Pipe Size	- 44 mm Thick Insulation
Chilled Water Tank	- 44 mm Thick Insulation

- b) Drain Water Pipe Line Temperature 15.0 Deg. C

Up To 50 mm Pipe Size	- 19 mm Thick Insulation
-----------------------	--------------------------

- c) Refrigerant Pipe Line Temperature 3.0 Deg. C

Up To 9.5 mm Pipe Size	- 19 mm Thick Insulation
Above 9.5 mm to 22.2 mm Pipe Size	- 25 mm Thick Insulation
Above 22.2 mm & Up To 50.8 mm Pipe Size	- 32 mm Thick Insulation

5.5.4 Material & Process of Thermal Insulation of Ducts

Duct insulation: Chemically Cross Linked Closed Cell Polyethylene FR-XPE (Or Nitrile Rubber) Fire Retardant grade in roll form density not less than 33±3kg/cum and thermal conductivity 0.0319w/mk at

mean temperature of 0°C. Supply and Return air ducts shall be insulated as shown in the drawing/as specified in the bill of quantities

- | | |
|--------|---|
| CASE-1 | Supply Air (SA) Duct. (When Return Air is being taken through the False-Ceiling)
Supply Air - 6 mm thick |
| CASE-2 | Supply Air (SA) & Return Air (RA) Duct (When both are in the Non-Conditioned area)
Supply Air – 12 mm thick
Return Air – 6 mm thick |
| CASE-3 | Supply Air (SA) & Return Air (RA) Duct (When both the Ducts are above False Ceiling of Air-conditioned Area)
Supply Air – 10 mm thick
Return Air – 6 mm thick |

Insulation for duct shall be applied as follows:

UNEXPOSED DUCT

NORMAL TYPE: (For zones over false-ceiling with plain sheet)

- a) Clean the duct surface to be insulated and apply a thin film of adhesive (Pidilite SR 998) and leave it for 2-3 min. for drying. Once the adhesive is dry but tacky to touch, place the insulation sheet in designed position.
- b) Press the sheets in position and butt the joints well together.
- c) Apply 50mm wide self adhesive tape on both longitudinal and transverse joints.

5.5.5 Under deck Insulation with Closed Cell Polyethylene FR-XPE

Ceiling of exposed roof shall be provided with under deck insulation as per following specifications & as specified in the Schedule of Quantities.

- a) Clean the surface & apply the adhesive on it.
- b) Fix Closed Cell Polyethylene FR-XPE with Overlap Edge of density 33±3kg/cum with the help of adhesive.
- c) Apply adhesive between all longitudinal and transverse joints of insulation material.
- d) Fix the insulation material finally with the help of rawl plug & dash fasteners in ceiling.

5.6 Insulated Flexible Duct

Flexible ductwork shall be as described in the SMACNA Low Pressure Duct Standards (5th Edition).

- a. Where flexible connections are indicated or required between rigid ductwork and particular components or items of equipment, the internal diameter of the flexible duct shall be equal to the external diameter of the rigid ductwork and of the spigot served. The use of flexible duct between rigid sections of sheet metal ductwork to change direction or planes will not be permitted except where indicated or expressly authorised by the Owner.
- b. The flexible duct shall have a liner and a cover of tough tear-resistant fabric equal in durability and flexibility to glass fibre and shall be impregnated and coated with plastics. It shall be reinforced with a bonded galvanised spring steel wire helix between the liner and the cover and an outer helix of glass fibre cord or equal shall be bonded to the cover to ensure regular convolutions.
- c. Alternatively the flexible duct shall consist of flexible corrugated metal tubing of stainless steel, aluminium, tinplated steel or aluminium coated steel. The metal may be lined on the inside or the outside or both with plastics material.
- d. The joints of rigid spigots shall be sealed with a brush coat of pipe jointing paste or mastic compound. Ducts up to 150mm diameter shall be secured with a worm drive type hose slip. Ducts over 150mm diameter shall be secured with a band clip.
- e. The frictional resistance to air flow per unit length of the flexible duct shall not exceed 50% more than the frictional resistance per unit length of galvanised steel ducts of equivalent diameter. The radius ratio R/D for bends shall not be less than 2, where R is the centre line radius and D is the diameter of the flexible duct.
- f. Flexible ductwork shall not pass through fire/smoke resistant building construction nor be used at extract points where deposits of flammable substances are likely to occur in high fire risk areas.
- g. The leakage from any section of flexible duct shall not exceed 1% of the design air flow rate at the static operating pressure.
- h. Flexible ducts shall be suitable for an operating temperature range of -18°C to 120°C and shall comply with BS 476 Part 1, Section 2, Clause 7 (Class 1: Surface of very low flame spread).

5.7 Condensate Drain Piping Work

5.7.1 Scope of Works

The scope of this section comprises supply, installation, testing & commissioning of drain water pipes, pipe fittings and valves etc. as detailed below in specifications. All pipes, fittings and valves etc. shall conform to relevant Indian standards.

5.7.2 Drain Water Piping

The pipes, fittings and valves shall be of approved make given in the tender.

Drain water / make up water pipes shall be "B" Class GI Pipe & shall Conform to IS: 4736.

The pipes shall be sized for individual liquid flow & shall ensure smooth noiseless balanced circulation of fluid.

All piping and their steel supports shall be thoroughly cleaned and primer coated before installation.

5.7.3 Pipe Fittings

The pipe fittings for screwed piping shall be malleable iron and for piping with welded joints shall of weldable quality. Also the fittings shall be suitable for same pressure ratings as for the piping system.

All bends up to sizes 150 mm dia shall be ready made of heavy duty wrought steel of appropriate class.

All bends in sizes 200 mm and above shall be fabricated from the same dia and thickness of pipe in at least four sections and having a center in radius of at least 1.5 times diameter of pipes. Fittings such as tees, reducers etc. shall be fabricated from the same pipe and its length shall be at least twice the diameter of the pipe.

The dead ends shall be formed with flanged joints & shall have 6mm thick blank between flange pair for 150 mm and over.

5.7.4 Flanges

All flanges shall be of mild steel as per IS : 6392 / 71 (with latest amendments) & shall be slip on type welded to the pipes. Flanged thickness shall be to suit Class II pressure. 3 mm thick gasket shall be used in between the flanges.

Flanged pair shall be used on all such equipments which are required to be isolated or removed for service for example condenser / chilled water pumps, chilling m/c, AHU etc.

5.7.5 Installation of Water Piping

- a) All pipes shall be securely supported or suspended on stands, hangers, clamps etc. as required. The Air-conditioning contractor shall design all brackets, saddles, anchors, clamps etc. & shall be responsible for structural adequacy.
- b) All pipe supports shall be of steel, coated with two coats of anti-corrosive paint and finally finished with paint.
- c) The pipe spacing shall be as follows :

Dia of Pipe	Spacing between supports
Up to 25mm	1.5 mt
30 mm to 50 mm	2.0 mt
65 mm to 75 mm	2.5 mt
100 mm to 125 mm	3.0 mt
150 mm	3.5 mt
200 mm & above	4.0 mt

- d) The vertical rises shall run parallel to walls and should be straight to wall duly checked with plumb line.

- e) In case pipes with/ without insulation while passing through the wall / slab, shall be provided with sleeve 50mm higher in size than the pipe with / without insulation.
- f) Wherever insulated pipes are running, it should be supported in such a way that no undue pressure is exerted on the insulated pipe.
- g) The expansion-joints or expansion-loops shall be provided to take care of the expansion and contraction in pipes due to temperature rises.

5.7.6 Testing of Pipe System

- a) All tools, tackles, labours etc. shall be arranged by A/C Contractor.
- b) All pipes shall be tested hydraulically at 1.5 times the maximum operating pressure for a period of 24 hours. All leaks occurring during testing shall be rectified to the satisfaction of the Engineer in Charge. After repairs of leak it shall be tested again at the same pressure.
- c) In case piping is tested in parts, these sections shall be securely sealed and capped during testing.
- d) The A/C Contractor should ensure that there should be minimum vibration / noise in the chilled water / condenser water circuit due to water turbulence.

5.7.7 Air-Vents

Air vents for purging of air trapped in piping system shall be provided at the highest point. Globe valves of the size as indicated below shall be provided & **no additional price shall be paid**.

Pipe Size	Valve Size
Upto 100mm	25mm dia
Above 100mm to 300mm	40mm dia

6.1 Scope of Work

This section deals with design, supply, installation, testing and commissioning of noise and vibration control equipment and accessories.

6.2 Standards

The testing of all noise control equipment and the methods used in measuring the noise rating of air conditioning plant and equipment shall be in accordance with the relevant sections of the following British Standards, unless otherwise stated:

BS 4718: 1971	Methods of Test of Silencers for Air Distribution Systems
BS 2750: Parts 1-9:1980	Laboratory and Field Measurement of Airborne Sound Insulation of Various Building Elements Recommendations for Field Laboratory Measurement of Airborne and Impact Sound Transmission in Buildings
BS 3638: 1987	Methods of Measurement of Sound Adsorption in a Reverberation Room
BS 4773: Part 2: 1976	Acoustic Testing.
BS 4856: Part 2: 1976	Acoustic performance without additional ducting of forced fan convection equipment.
Part 5: 1976	Acoustic performance with additional ducting of forced fan convection equipment
BS 4857: Par 2:1978 (1983)	Acoustic Testing and Rating of High Pressure Terminal Reheat Units.
BS 4954: Par 2:1978 (1987)	Acoustic Testing and Rating of Induction Units.
BS 5643:	1984 Glossary of Refrigeration, Heating, Ventilating and Air Conditioning Terms

6.3 General

The air conditioning contractor must take all necessary precautions to have minimum noise generation and its transmission generated by moving plant and equipment to achieve acceptable limits for occupied areas. In addition to the noise level criteria particular attention must be given to the following details at time of ordering plant and equipment and their installation :-

All moving plant / equipment shall be statically and dynamically balanced at manufacturers works and certificates issued.

The isolation of moving plant, machinery and apparatus including lines equipment from the building structure.

Where duct work and pipe work services pass through walls, floors and ceilings, or wherever supported shall be surrounded with a resilient acoustic absorbing material to prevent contact with the structure and minimise the outbreak of noise from plant rooms.

The reduction of noise breakout from plant rooms and the selection of externally mounted equipment and plant to meet ambient noise level requirements of the Specifications.

Electrical conduits and connections to all moving plant and equipment shall be carried out in flexible conduit and cables to prevent the transmission of vibration to the structure and nullify the provisions of anti-vibration mountings.

All duct connections to fans shall incorporate flexible connections, except in cases where these are fitted integral within air handling units.

All resilient acoustic absorbing materials shall be non flammable, vermin and rot proof and shall not tend to break up or compress sufficiently to transmit vibration or noise from the equipment to the structure.

Where practicable, attenuators shall be built into walls and floors to prevent the flanking of noise the duct work systems and their penetrations sealed in the manner previously described. Where this is not feasible, the exposed surface of the duct work between the attenuators and the wall subjected to noise infiltration shall be acoustically clad as specified.

Ambient noise from cooling tower also shall be assessed to determine the suitable attenuators that can reduce the noise so as not affecting the adjoining public area.

6.4 Sound Attenuators

Attenuators shall be provided in ducts in accordance with acceptable noise level criteria & if specified in BOQ. Attenuators shall be constructed from high quality pre-galvanised steel sheet casings with lock formed joints along the casing length. Angle iron cross jointing flanges shall be fitted to silencer casings, drilled as required and finished with red oxide primer paint. Acoustic splitters shall be formed by channel section pre-galvanised sheet steel framework retaining acoustic fill of a density to attain the required performance. Splitters shall have round nose ends to give smooth entry and exit conditions to minimise air pressure drops. The acoustic fill shall be protected from the air flow by 22 swg minimum perforated galvanized sheet steel. All attenuators shall be selected against a maximum allowable air pressure drop of 100 Pa.

It will be the responsibility of the AC Contractor at the time of placing orders for fan equipment to obtain from the manufacturers, certified sound power levels to enable the selected duct silencers to be checked against the original design information, prior to orders being placed.

6.5 Anti-vibration Mountings

All items of rotating and reciprocating plant and equipment shall be isolated from the structure by the use of anti-vibration materials, mountings or spring loaded supports fixed to either concrete bases, inertia blocks or support steels.

Centrifugal fans and motors within air handling units shall be isolated from the frame of the air handling unit by suitable anti-vibration mountings. Fan discharge air connections shall be fitted with approved flexible connections.

Axial flow fans shall be mounted on steel legs as diaphragm plates supported on neoprene in shear anti-vibration mountings, or suspended using spring loaded hangers to suite the application.

Centrifugal pumps shall be mounted on inertia bases consisting of reinforced concrete sub-base, anti-vibration mountings and concrete filled steel upper plinth. The AC Contractor shall be responsible for providing the steel upper plinth and mountings.

Pipe work connections to circulating pumps, chillers, cooler coils and other heat exchanger equipment shall be made with flexible connections as per piping Specifications.

The construction of the anti-vibration mountings shall generally comply with the following: -

Enclosed Spring Mounting (Caged or Restrained Springs)

Each mounting shall consist of cast or fabricated telescopic top and bottom housing enclosing one or more helical steel springs as the principle isolation elements, and shall incorporate a built-in leveling device.

The springs shall have an outside diameter of not less than 75% of the operating height, and be selected to have at least 50% overload capacity before becoming coil bound.

The bottom plate of each mounting shall have bonded to it a neoprene pad designed to attenuate any high frequency energy transmitted by the springs.

Mountings incorporating snobbery of restraining devices shall be designed so that the snubbing damping or restraining mechanism, is capable of being adjusted to have no significant effect during the normal running of the isolated machine.

The manufacturers shall provide restrained isolator on chillers subject to approval.

6.6 Open Spring Mountings

Each mounting shall consist of one or more helical steel springs as the principal isolation elements, and shall incorporate a built-in leveling device. The spring shall be fixed or otherwise securely located to cast or fabricated top and bottom plates, and shall have an outside diameter of not less than 75% of the operating height, and shall be selected to have at least 50% overload capacity before becoming coil-bound.

The bottom plate shall have bonded to it a neoprene pad designed to attenuate any high frequency energy transmitted by the springs.

6.7 Neoprene-in-Shear Mountings

Each mounting shall consist of a steel top plate and base plate completely embedded in oil resistant neoprene. Each mounting shall be capable of being fitted with a leveling device, and bolt holes in the base plate and tapped holes in the top plate so that they may be bolted to the floor and equipment where required.

7 MODE OF MEASUREMENT

The following measurement code shall apply to the Contract:

7.1 Sheet Metal Work

7.1.1 Ducting

- a) The final finished sheet area in sq. mt shall be measured only.
- b) Vanes, splitters, flanges, access doors etc. shall not be separately measured. These shall be treated as part of duct work.
- c) Bends, Elbows, Transformation, pieces etc. shall be measured along the centre line and measured as per duct work.
- d) Canvas connections, Duct Supports, Stiffening members, frames etc. shall not be measured separately and shall form part of duct work / equipment.

7.1.2 Grills / Diffusers / Fire Dampers

All Grills / Diffusers / Fire Damper areas will be measured in terms of effective area (Neck Area). Any Extruded aluminum grill / diffusers having an area less than 0.1 sq.mt shall be accounted as 0.1 sq.mt.

7.1.3 Box Dampers

- a) Duct dampers shall be measured in Sq. Mt. in terms of effective area.
- b) Fresh air dampers shall be measured as effective areas only. No separate measurements for bird screen inlet / outlet louvers shall be done.

7.2 Piping Work

- a) The length of piping accessories & fittings shall be measured along its centre line in meters and no measurements for bends, elbows, tees etc. shall be made. All such fittings / accessories shall be treated as part of the piping work.
- b) Flanges shall not be measured, as they form part of piping work.
- c) For thermometer wells & pressure gauge sockets no measurement shall be done separately.
- d) All kinds of supports, hangers etc shall be part of piping work & no extra measurements shall be done.
- e) No additional price for installation of purge & de-scaling valves as required at site shall be paid.

7.3 Insulation

7.3.1 Insulation of Duct

This shall be measured on the basis of bare duct surface area i.e. the area of duct insulation & area of duct shall be same.

7.3.2 Insulation of Chilled Water / Drain Water Pipes.

- i) Insulation of pipes shall be measured in terms of linear length of pipe for each size.
- ii) For insulation of bends, elbows, tees etc. it shall be measured along with the center line of insulation and shall be measured in meters.
- iii) Insulation of valves shall be separately accounted as per bill of quantities.

7.3.3 Insulation of Chiller / Expansion Tank / Suction Line

The insulation of the above equipments shall be deemed to form part of equipment and no separate measurements for insulation of such items will be accounted for.

7.3.4 Acoustic Lining of Duct & Plenum

This shall be measured on the basis of bare duct surface area i.e. the area of duct lining & area of duct shall be same.

7.4 Electrical Cabling Work

- a) All power cables / controls cables shall be measured on linear basis in meters.
- b) No extra price shall be paid on account of end termination of cables which includes thimble, gland etc.

7.5 Structural Supports

No extra price shall be paid on account of structural supports required for piping, ducting & cabling work.

Note:- The items not specified above or not specified in BOQ & Specification but technically required shall be part of that particular equipment / material.

7.6 Flexible Pipe Connector

Flexible pipe connector wherever required are part of the equipment & are specified in BOQ with the equipment. No extra price shall be paid on account of this.

8 EXCLUDED ITEMS FROM THE SCOPE OF HVAC CONTRACTOR

- a. Housing of equipments.
- b. Foundations of all equipments.
- c. Main incoming stabilised power supply with double earthing in the Sub Panel / Isolators i.e. $415 \pm 10\%$ volts, $50 \text{ Hz} \pm 5\%$ AC supply & single-phase power supply wherever required.
- d. Any kind of masonry work such as openings in walls/slabs and making good thereof.
- e. Any kind of exposed roof insulation work.

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

- f. Any kind of false ceiling work, return air boxing, wooden / aluminium frames for fixing grills / diffuser.
- g. Water softening plant if required.
- h. Drain points in near each indoor unit.
- i. Power and water for erection, testing and commissioning of the HVAC System.
- j. Any kind of masonry shafts & trenches for laying pipes / cables / ducts etc.

DETAILED PROJECT REPORT

PROPOSED CONSTRUCTION OF 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG, MEGHALAYA

(ELECTRICAL)



CONTENTS

1	ELECTRICAL SYSTEM	149
1.1	Basis of Design.....	149
1.1.1	Equipments & Materials of Electrical & Low Voltage System	149
1.1.2	Objective.....	150
1.1.3	Legal & Statutory Compliances	150
1.1.4	Source of Power.....	150
1.1.5	SEB Power Supply Voltage.....	150
1.1.6	Electrical Substation.....	150
1.2	Scope, Codes & Standards	150
1.2.1	General.....	150
1.2.2	Codes & Standards	150
1.3	D.G. Set.....	152
1.3.1	Intent of Specification	152
1.3.2	Codes and Standards.....	152
1.3.3	Engine	153
1.3.4	Alternator	154
1.3.5	Other Accessories	154
1.3.6	Erection, Testing & Commissioning	156
1.3.7	Commissioning Check Tests / Performance and Guarantee Test.....	157
1.4	Cable Work.....	157
1.4.1	Description of Work	157
1.4.2	Applicable Codes & Standards.....	157
1.4.3	Submittals.....	157
1.4.4	Test reports	158
1.4.5	Specifications	158
1.4.6	Installation	158
1.4.7	Proximity to Communication Cables	158
1.4.8	Cable Laying Direct in Ground	158
1.4.9	Laying on Cable Tray	161
1.4.10	Testing & Commissioning.....	162
1.4.11	Completion Plan and Completion Certificate	162
1.4.12	Testing of Cables	162
1.4.13	Cable Tags	162
1.5	Cable Tray	163
1.5.1	Perforated Cable Tray	163
1.5.2	Ladder Type Cable Tray.....	163
1.6	Safety Materials	163
1.6.1	Description of Work	163
1.6.2	Applicable Codes & Standards.....	164
1.6.3	Submittals.....	164
1.6.4	Specification	164
1.7	Piping Work (D.G. Flue Gas Exhaust System)	165
1.7.1	Scope of Work.....	165
1.7.2	D.G. Flue Gas Exhaust Piping	165
1.7.3	Pipe Insulation (D.G. Flue Gas Exhaust Piping System)	165
1.8	11 KV VCB Panel (Indoor Type)	165
1.8.1	General.....	165
1.8.2	Codes and Standards.....	165
1.8.3	Rating	166
1.8.4	Accessories	166
1.8.5	Submittals.....	166
1.8.6	Type and Construction	166
1.8.7	Bus Bar and Insulators	167
1.8.8	Earthing and Protective Earthing.....	167
1.8.9	Metering and Protection	167
1.8.10	Interlocking, Safety and Operating Mechanism	168
1.8.11	Additional Accessories	168
1.8.12	Control Supply	168
1.8.13	Installation	168

1.8.14	Tests.....	168
1.9	11KV/0.433KV Oil Type Distribution Transformer.....	169
1.10	Main LT panel Cum DG Synchronizing Panel	169
1.10.1	General.....	169
1.10.2	Submittals, Shop Drawing and Technical Data.....	170
1.10.3	Construction	170
1.10.4	Metal Treatment and Finish.....	171
1.10.5	Bus Bar	172
1.10.6	Medium Voltage Air Circuit Breaker	172
1.10.7	Moulded Case Circuit Breaker	174
1.10.8	Measuring instrument for metering.....	175
1.10.9	Control Switches	176
1.10.10	Cable Termination	176
1.10.11	Control Wiring.....	176
1.10.12	Terminal Block.....	176
1.10.13	Labels	176
1.10.14	Miscellaneous.....	176
1.10.15	Battery and Battery Charger.....	176
1.11	Capacitor Bank Panel	176
1.11.1	Codes and Standards.....	177
1.11.2	Submittals.....	177
1.11.3	Control Panel.....	177
1.11.4	Painting.....	177
1.12	Sandwich Bus Duct & Rising Main.....	177
1.12.1	Scope	177
1.12.2	Codes and Standards.....	177
1.12.3	Application data.....	177
1.12.4	Enclosure.....	178
1.12.5	Earthing	178
1.12.6	Bus Conductor.....	178
1.12.7	Jointing Coupler.....	178
1.12.8	Insulating Material of the Bus bars.....	179
1.12.9	Temperature Monitoring at Joints.....	179
1.12.10	Type Test Reports	179
1.12.11	Routine Test Reports by Manufacturer	179
1.12.12	Routine Tests during Installation at Site.....	180
1.12.13	Tap off box.....	180
1.13	Sub Distribution Panel.....	180
1.13.1	General.....	180
1.13.2	Standards	180
1.13.3	Submittals.....	181
1.13.4	Constructions.....	181
1.13.5	Metal Treatment and Finish.....	182
1.13.6	Bus Bars	182
1.13.7	MOULDED CASE CIRCUIT BREAKERS	182
1.13.8	Measuring Instruments for Metering.....	183
1.13.9	Control switches	184
1.13.10	Cable Terminations	184
1.13.11	Control Wiring.....	185
1.13.12	Terminal Block.....	185
1.13.13	Labels	185
1.13.14	Testing at Manufacturing Work	185
1.13.15	Testing and Commissioning	185
1.13.16	Automatic transfer switch	185
1.14	Distribution Boards	188
1.15	Conduit and Wiring System	189
1.15.1	M.S. Conduit.....	189
1.15.2	Conduit Joints.....	189
1.15.3	Protection against Condensation	189
1.15.4	Protection of Conduit against Rust.....	189
1.15.5	Painting of Conduit and Accessories	190
1.15.6	Fixing of conduits	190
1.15.7	Outlet Boxes	190
1.15.8	Fan Box	190

1.16	Light & power accessories	191
1.16.1	General.....	191
1.16.2	Light Switches Modular Type	191
1.16.3	6/16 Amp Switch Socket Outlet Modular Type.....	191
1.16.4	Wiring	191
1.16.5	Joints	192
1.16.6	Sub Mains.....	192
1.16.7	Load Balancing.....	192
1.17	Conduiting and Wiring for SAMTV System	192
1.17.1	Conduiting	192
1.17.2	Outlets	192
1.17.3	Junction Box.....	192
1.17.4	Coaxial Cables	192
1.17.5	Tap Off.....	192
1.17.6	Splitters.....	192
1.18	Fire Alarm with DVC and FFT System.....	193
1.18.1	General Scope of Works	193
1.18.2	Reference for Installation	193
1.18.3	Submittals and Shop Drawing	193
1.18.4	Operation Manual.....	193
1.18.5	Basic System.....	194
1.18.6	Specification	194
1.19	UPS System	194
1.19.1	System Components	194
1.19.2	Product Certification / Testing	194
1.19.3	Operating Temperature	194
1.19.4	Humidity.....	194
1.19.5	Output Frequency.....	194
1.19.6	Wave Form	194
1.19.7	Transient Response	194
1.19.8	Load Power Factor	195
1.19.9	Crest Factor.....	195
1.19.10	Switch Over Time	195
1.19.11	Overload Rating.....	195
1.19.12	Switching speed	195
1.19.13	Indication	195
1.19.14	Protection	195
1.19.15	Control Circuitry.....	195
1.19.16	Metering.....	195
1.19.17	Communication Port.....	195
1.19.18	Diagnosis & Configuration Software	195
1.19.19	Out Look	195
1.19.20	Ups Failure	196
1.19.21	Harmonic Distortion of Wave Form	196
1.19.22	Maintenance by Pass Switch	196
1.19.23	Battery Disconnect Switch.....	196
1.19.24	Static Transformer Switch	196
1.19.25	Retransfer to Inverter	196
1.19.26	Quality Assurance	196
1.19.27	Installation Drawing	196
1.19.28	Product Documentation.....	196
1.19.29	Training.....	196
1.19.30	Spare Parts.....	196
1.19.31	Material and Workmanship.....	197
1.19.32	Storage Battery.....	197
1.19.33	Service Report.....	197
1.19.34	Maintenance.....	197
1.19.35	Inverter efficiency	197
1.19.36	Protection class	197
1.20	Boom Barrier System.....	197
1.21	Elevators	198
1.21.1	General.....	198
1.21.2	Function of the building	198
1.21.3	Quality of service.....	198

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

1.21.4	Introduction.....	198
1.21.5	General.....	199
1.21.6	Approvals.....	199
1.21.7	Testing.....	199
1.21.1	Lift Schedule-.....	199
1.21.2	Lift Equipments Specification	199
1.21.3	Electrical Equipment and Wiring	204
1.21.4	Features Requirements for Passenger Lift	204
1.21.5	Electric Power Supply	206
1.22	Fire Survival Cable	206
1.23	Low Voltage Works	206
1.23.1	ITAM	206
1.23.2	Access Control System:	207
1.23.3	Structured Cabling.....	207
1.23.4	IP-PBX System.....	210
1.23.5	Core Switch	221
1.23.6	Technical Specification of Distribution Switch.....	224
1.23.7	Technical Specification of Access PoE Switch	226
1.23.8	Technical Specification of ITAM	227
1.23.9	Technical Specification of Indore Access Point/Outdoor	228
1.23.10	Technical Specification of Wireless Controller (Wi-Fi Controller)	229
1.23.11	Firewall /UTM	230
1.23.12	IP CCTV System Technical Specification	231
1.23.13	Technical Specification of Dome Camera	231
1.23.14	Technical Specification of Bullet Camera.....	232
1.23.15	Technical Specification of 64 Channel NVR	233
1.23.16	Technical Specification of 8 Port Industrial PoE Switch.....	234
1.23.17	Access Control System Technical Specification	236

END OF CONTENTS

1 ELECTRICAL SYSTEM

1.1 Basis of Design

1.1.1 Equipments & Materials of Electrical & Low Voltage System

The Electrical & Low Voltage System shall comprise of following Equipments & Materials.

- a) SITC of D.G. Set
- b) SIT&C of 11KV/0.415KV Substation
- c) Bus Duct / Rising Main
- d) Earthing System.
- e) D.G. Set Exhaust Piping
- f) Safety Equipment
- g) Main L.T. Panels / Synchronizing Panels
- h) Floor Distribution Panel
- i) Distribution Boards
- j) Main & Sub main Cables
- k) Point Wiring
- l) Occupancy & Day light Sensor
- m) Light Fixtures
- n) External Lighting
- o) Lightning Protection System
- p) UPS System
- q) Telephone System & IP Based EPABX
- r) Data cabling Network
- s) Data Networking
- t) Addressable Fire Detection System
- u) Public Address System
- v) CCTV System
- w) Access Control System
- x) PV Solar System with Grid Tie invertors
- y) Boom barrier
- z) Flap Barrier
- aa) Lift System
- bb) All other item as detailed in Specification.

1.1.2 Objective

The Electrical design objective is to achieve a sustainable building that are energy and resource efficient and promote a healthier environment for building occupants & also to achieve GRIHA-3 Rating India Certification.

1.1.3 Legal & Statutory Compliances

Our Electrical system design shall be based on compliance with the local and national codes, standards, bye-laws & regulations such as NBC 2016, ECBC 2017, GRIHA, Latest CPWD Specification, NEC, BIS, NFPA, NFC and IEC etc. Further details are given under each services head in this report.

1.1.4 Source of Power

The electrical system design shall be based on receipt of Bulk Supply Connection from SEB (State of Meghalaya).

1.1.5 SEB Power Supply Voltage

The incoming supply voltage shall be as per State Electricity Regulation based on electrical demand load & availability of H.T. Line network. Before bidding, the contractor shall check and coordinate the entire requirement with department.

1.1.6 Electrical Substation

The transformer rating are 3x1250 KVA & DG Set rating are 3x1010 KVA.

1.2 Scope, Codes & Standards

1.2.1 General

To provide a complete electrical system for the distribution of electric power from the point of Supply (SEB), D.G.s to the utilization equipment, and described in these specifications. It will be the bidder's responsibility to work out the exact quantities with drawings as per area program & from work site, which trade provides said equipments, materials, tools and labor.

1.2.2 Codes & Standards

The design engineering manufacturing and the installation shall be in accordance with established codes, sound engineering, practices, and specifications and shall conform to the statutory regulations applicable in the country. Contractor shall obtain all approvals from statutory authorities' e.g. Electrical inspector, pollution control boards, SEB as applicable before commissioning of electrical/DGs, Indian Electricity Act, Indian Electricity Rules, Factory Act, Pollution Control Act.

IS-732:	Code of practice for electrical wiring installation system voltage not exceeding 650V.
IS-3043:	Earthing.
IS-7689:	Guide for control of undesirable static electricity.
IS-3716:	Insulation co-ordination application guide.
IS-8130:	Conductors for insulated electrical cables and flexible cords.
IS-5831:	PVC insulation and sheath of electric cables.
IS-3975:	Mild steel wire, strips & tapes for armouring cable.
IS-3961:	Current rating of cables
IS-694:	PVC insulated (heavy duty) electric cables for working Voltage up to and including 1100 volts.
IS-424- 1475 (F-3):	Power cable flexibility test.
IEC-439/IS-7098:	Specification for cross linked polyethylene insulated PVC sheathed cable for working voltage up to 1.1 KV.
IS-1554:	PVC insulated cables up to 1100 volts.
IS-10810:	Test procedures for cables.
IS-6121:	Cable glands.
IS-10418:	Cable drums.
IEC-754(1):	FRLS PVC insulated cable.
ASTM-D-2863:	Standard method for measuring minimum oxygen concentration to support candle like combustion of plastic (oxygen index).

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

ASTM-D-2843:	Standard test method for measuring the density of smoke from burning or decomposition.
IS/IEC-62305	Code of practice for the protection of buildings and allied structure against Lightning\
IEEE-383:	Standard for type test class-IE, electric cables, field splicers and connections for power generation station.
IS 13947/IEC 947:	Air circuit breaker/moulded case circuit breaker.
IS-8623:	Specification for factory built assemblies of switch gear and control gear for voltage upto and including 1000vac/1200vdc
IS 1018:	Switchgear and control gear selection/installation and maintenance
IS-1248:	Direct acting indicating analogue electrical measuring instruments and testing accessories.
IS-13779:	Digital measuring instruments and testing accessories.
IS-3156:	Voltage transformer
IS-2705:	Current transformer for metering and protection with classification burden and insulation.
IS -2147:	Degree of protection provided by enclosures for low voltage. PART 1,11,111 Switchgear and control gear
IS-3427:	Metal enclosed switchgear and control gear
BS-162:	Safety clearance
IS-3202:	Code of practice for climate proofing of electrical equipment.
IS-375:	Marking and arrangement for switchgear, bus bars, main connections and auxiliary wiring.
IS-722:	Ac electric meters
IS-3231:	Electrical relays for power system protection.
IEC-255:	Electrical Relays
IS-5082:	Electrolytic copper/aluminium bus bars
IS-2834:	Capacitors
IS-2713:	Steel tubular pole
IS-335:	Specification for insulating oil
IS-3837:	Specifications for accessories for rigid steel conduit for electrical wiring.
IS-2026&335:	Distribution transformer

(PART I,I4I,III)GI/STEEL/PVC conduit pipe for electrical wiring.

IS-2274:	Code of practice for electrical wiring installation system voltages exceeding 650 volts.
IS-6665:	Code of practice for industrial lighting
IS-3646:	Interior insulation part 1&2 a) Supply Voltage 11 KV or 6 KV as applicable b) Neutral Earthing Solid Earthing c) Voltage Regulation + 10% d) Frequency Regulations + 3%
IS-1944:	Code of practice for lighting of public through fares.
IS-7752:	Guide for improvement of power factor consumers installation.
IS-13346:	General requirement for electrical for explosive gas atmosphere.
IS-13408:	Code of practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres
IS-12360:	Voltage and frequency for ac transmission & distribution system.
IS-5572:	Classification of hazardous area for electrical installations.
IS-5571:	Guide for selection of electrical equipment for hazardous area.
IS-4201:	Application guide for Current Transformer
IS-4146:	Application guide for Voltage Transformer
IS-10028:	Code of practice for installation and maintenance of transformer
IS-8478:	Application guide for on load tap changer
IS-10561:	Application guide for power transformer
IS-1646:	Code of practice for fire safety of buildings electrical installation
IS-3034:	Code of practice for fire safety of industrial building-electrical generating and distribution station
IP-30:	National electrical code (NEC) BIS publication.
IS-4722:	Rotating electrical machines.
IS-4889:	Method of determination of efficiency of rotating electrical machines.
IS-325:	Three phase induction motors.
IS-4729:	Measurement and evaluation of vibration of rotating electrical machines.

IS-900:	Installation and maintenance of induction motors.
IS-4029:	Air break switches.
IS-2208-9224:	HRC cartridge fuses.
IS-2959:	Contactors.
IS-9537:	Rigid steel conduit.
IS-1030-1982:	Specification for carbon steel castings for general engineering purpose.
IS-1601/ BS-649:	Performance & testing of Internal Combustion (IC) engines for general purpose.
AIEE-606(1959):	Recommended specification for speed governing of I.C.engine generator units.

BS-5514/IS-3046 8528(Part-2): Reciprocating IC engine driven A.C. generators. Any other standard may be followed provided it is equivalent or more stringent than the standards specified above. In case of any deviation /conflict of this specification with the codes & standards, the following order of precedence shall govern. Specification, particular specification if any, and drawings. Indian regulations/codes and standards.

1.3 D.G. Set

1.3.1 Intent of Specification

This specification covers the design, manufacture, assembly, shop testing, packing, dispatch, transportation supply, erection, testing, commissioning, performance and guarantee testing of **Diesel Gen-Sets**, complete in all respects with all equipment, fitting and accessories for efficient and trouble free operation as specified here under.

1.3.2 Codes and Standards

The equipment furnish under this specification shall conform to the following latest standard, except where modified or supplemented by this specification:

BS:5514	:	Specification for reciprocating internal combustion engine.
BS:5000	:	Rotating electrical machines of particular type or for particular applications.
IS:1239 (Part - I&II):	:	Mild steel tubes and fittings.
IS:1651	:	Stationary cells and batteries lead acid type (with tubular positive plates).
IS:9224	:	Specification of low voltage fuses, General Purpose.
IS:4540	:	Mono-crystalline semi-conductor rectifier assemblies and equipment.
IS:5	:	Colours for ready mixed paints.
IS:4722	:	Rotating electrical machines
IS:1248	:	Specification for electrical indicating instruments.
IS:10000	:	Methods of tests for internal combustion engines.
IS:10002	:	Specifications for performance requirements for constant speed compression ignition (Diesel) engine for general purposes (above 20 KW).
IS:2147 control gear.	:	Degree of protection provided by enclosure for low voltage switchgear and
IS:1600	:	Code for type testing of constant speed IC engines for general purposes.
IS:1601	:	Performance of constant speed IC engines for general purposes.
ASME Power : Test Code PTC-17	:	Internal combustion engines.

1.3.3 Engine

Diesel Engine shall be stationary, compression, ignition, totally enclosed, water cooled, stroke cycle, cold battery starting, turbo charged and after cooled heat exchanger cooled 1500 RPM in accordance to BS and IS specification complete with all accessories.

Cooling System

Cooling system shall have radiator, Thermostat & engine built pumps, Corrosion Resister, Self contained piping for secondary circuit, By pass thermostat.

Fuel System

Fuel System shall have PT Fuel Pump, Injectors, Fuel filters, Self contained piping & houses, Complete piping.

Lubricating System

Lubricating system shall have Oil pump, Strainer, Lube oil cooler, Oil filter, Bypass filter, Self contained piping, Lube oil priming pump if required.

Air Intake System

Air intake system shall have dry type filter, Air intake manifold with necessary connections, Turbocharger with after cooler.

Exhaust System

Exhaust system shall have Exhaust Manifold, Flexible piping, Hospital silencer to limit the noise level and extending silencer outside the canopy.

Starting System

Starting system shall have Starter 24V with suitable ampere capacity, Charging Alternator with inbuilt regulator 24 V minimum 30 AMP DC or as per battery capacity, Connecting links between battery & alternator. The engine shall be suitable for black start.

Main and Big End Bearing

The main and big end bearing shall be detachable shells of high grade bearing material, and shall be pre finished. The dimensions of big end bearings shall be such that the connecting rods can be withdrawn through the cylinder liners.

Coupling Arrangement

Coupling arrangement shall have Flexible coupling, Flywheel, Flywheel Housing, Coupling Guard

Instrument Panel

Instrument Panel shall have-

- Lube oil pressure gauge
- Water temperature gauge
- RMP Indicator & Hour Meter.
- Battery charger ammeter.
- Starting switch with key

Safety Control Trip

- Low Lube oil pressure
- High Water temperature
- Engine over speed.
- Lub oil temperature.

1.3.4 Alternator

Manufacturer : Stamford / Leroy Somer IS: 4722/BS 2613

Output : 1010 KVA self excited, self regulated foot mounted fitted with ball and roller bearings and having PMG, droop CT for paralleling. This shall give full output of 1010 KVA at 40 deg. C.

Power factor : 0.8

Rated Generating Voltage : 415 Volts, 3 phase 4 wire systems

Voltage regulation: +/- 1.0% all load between no load to full load & power factor 0.8 to unity AVR shall be mounted in alternator.

Frequency : 50 HZ

Speed : 1500 RPM

Overload Capacity : 10% for one hour in any 12 hours of operation without exceeding temperature rise limits specified in BS: 2613 when corrected to ambient temperature at site

Class of Insulation : H and temp. Rise limited to class H

Space Heater : To be provided if required.

Winding connection: Star connection (all six leads will be brought out of stator frame).

Termination : Termination box shall be amended to connect the bus duct/LT XLPE Cable.

The alternator shall be self-excited, self regulated, self ventilated in brush less for suitable automatic voltage regulator and shall conform to BS: 2613 or equivalent standard and shall give rated output at NTP conditions. The alternator shall have space heater which shall be connected with breaker NO/NC contacts and this should be able to cut off with thermostat.

1.3.5 Other Accessories

Fuel Tank

Day service fuel tank shall be made of 2mm thick MS sheet of 990 litres capacity for each set with all accessories such as oil level indicator, inlet pipe connection, outlet pipe connection, trough to collect split oil, air vent pipe with air filter, manhole with cover, low level and full level float valve arrangements with all fittings interconnections between tanks. The tank shall be provided with suitable calibration scale.

Base Frame:

M.S. Fabricated adequately machined base frame complete with lifting, facilities pre-drilled foundation holes suitable for permanent installation on foundation shall also be supplied. The base frame shall be manufactured with steel and shall be stress relieved. Manufacturer shall specify what measures are taken to reduce the stresses.

Batteries

For electrical control ckt of 24V D.C. of suitable ampere hour complete with battery charger, leads and wooden base plate and shall be placed inside canopy.

Fuel system

The engine shall be capable of running on High Speed Diesel fuel oil. The fuel consumption of the engine at full, three quarters and half of its rated power output shall be indicated by the Contractor in

the bid. A fuel service buffer tank, common for two DG set with 990 litres capacity shall be provided on a suitably fabricated steel platform. The tank shall be complete with level indicator marked in litres, filling inlet with removable screen, an outlet, a drain plug, an air vent and necessary piping. The fuel tank shall be painted with oil resistant paint. Service tank level switches (2 Nos. per tank) for alarm & trip shall also be provided by the bidder. All pipe joints should be brazed/welded. A hand pump for pumping the fuel into the fuel service tank together with necessary pipes or tubing shall be provided.

Silencer

Exhaust silencer shall be residential type to reduce the noise level.

Cooling

The diesel engine shall be radiator cooled type if installed on site plan and heat exchanger cooled if installed in basement.

Engine Governor

The governor shall be Electronic type suitable for class A-1. This shall control the generator frequency, and shall be suitable for operation as per the selected battery voltage (24 V DC.). The governor shall be provided with a manually adjustable over speed trip mechanism to automatically shut-off the engine or the fuel supply if the set reached 120 % of rated speed. Governor shall be capable to maintain zero speed rate or regulation and shall be AI type as per BS:5514 in order to take care of heavy motor starting. It shall have necessary characteristics to maintain the speed substantially constant even with sudden variation in load. However, a tripping shall be provided if speed exceeds maximum permissible limit.

Turbo Charger

It shall be of a robust construction, suitable of being driven by engine exhaust having a common shaft for the turbine and blower. It shall draw air from filter of adequate capacity to suit the requirements of the engine.

Starter Battery

The battery shall conform to the requirement of IS: 1651. Starting battery sets of 24 V, heavy duty high performance approved make/quality shall be provided to enable crank & start the engine even in cold/winter morning conditions. Type/voltage/AH capacity of same on 20 hour rated discharge period shall be indicated in the offer. The battery shall be capable of performing at least (6) six normal starts without recharging.

The battery shall be provided with 2 Nos. cables, minimum 1.5m long heavy duty PVC insulated cabling with brazed tinned lug at one end and with brazed tinned brass terminal lug at battery end - for connecting batteries to cranking system - with 0.25 m long inter battery connecting cable.

The lugs shall be clearly stamped (+) or (-) and positive cable also red sleeved for easy identification.

Engine Safeguard

Safeguards shall be provided and arranged when necessary to stop the engine automatically by the following:

Energising a solenoid coupled to the stop lever on the fuel injection pump rack.

De-energizing the "fuel on" solenoid

Energizing the "fuel - cut off" solenoid.

If any of the door opens.

The operation of the safeguard shall at the same time give individual warning of the failure by illuminating an appropriate local visual indicator and remote alarm at generator panel.

The contactors, relays and other devices necessary for signal and control, for above purposes shall be provided at Generator panel.

At the set at a easily accessible place an “EMERGENCY STOP” mushroom head stay put type P.B shall provided to stop the set in emergency mode.

The safe guard to “STOP THE SET” shall stop the set irrespective of mode selection of the set viz Auto, Manual or test for following cases, with simultaneous isolation of alternator ckt.

Emergency stop P.B's operation

Over speed.

Low lube oil pressure.

Sound Attenuating Acoustic Enclosure

Sound Attenuating Acoustic Enclosure should have pleasant and aesthetical looks and should be able to bring down the noise to 75 decibels when measured at a distance of 1 meter away from the set.

The DG set should be supported on a base frame in an MS Sheet enclosure with suitable ducting for air inlet and outlet. The door and enclosure should be given corrosion resistant treatment and painted to be weatherproof and long lasting. Resin bonded Glass / Mineral / Rock wool of high density with perforated MS Sheet should be provided and covered with tissue paper. Enclosures should be provided with durable locking system with doors duly gasketed with neoprene rubber.

Exhaust gases should be taken out from the DG Set by means of MS Pipe and a noise suppressor. Proper care should be taken for engine heat rejection in order to have safe working temperature inside the enclosure by provision of fans etc, as required. The design aspect should ensure free and uninterrupted flow of suction and exhaust air in order that the temperature rise of the enclosure with respect to the ambient is less than 7°C.

Radiator hot air shall be throughout on top instead of front. The arrangement to be made accordingly in acoustic enclosure.

1.3.6 Erection, Testing & Commissioning

The entire work of erection, testing and commissioning of equipment supplied under this package shall be carried out by contractor and performance and guarantee tests to be conducted at site are also included under the scope of this specification. For this purpose the contractor shall depute suitable qualified technical supervisor to site on advance intimation to the Owner along with all special testing equipment required for testing and performance and guarantee tests. The supervisor(s) shall be responsible for the installation, testing, commissioning checks and performance & guarantee tests mentioned in relevant clauses of this volume and the checks recommend by the contractor.

The successful contractor shall submit sufficiently in advance the bio-data of the supervisor giving details of his experience for Owner's approval.

The contractor shall ensure that the equipment supplied by him are installed in a neat workman like manner such that they are leveled, properly aligned and well oriented. The tolerances shall be established in Contractors drawings and/or as stipulated by the Owner.

All special tools and tackles and spares required for erection, testing and commissioning of equipment shall be supplied by the contractor. The bid shall include a list of these special tools, tackles and spares along with their item wise prices. The total cost for these tools, tackles and spares shall be included in the bid price.

Erection, testing and commissioning manuals and procedures shall be supplied, prior to dispatch of the equipment.

The contractor shall ensure that the drawings, instruction and recommendations are correctly followed while handling, setting, testing and commissioning the equipment.

1.3.7 Commissioning Check Tests / Performance and Guarantee Test

In addition to the checks and test recommended by the manufacturer, the contractor shall supervise the following acceptance tests to be carried out on each test.

Load test

The engine shall be given test run for a period of at least 2 hours depending upon the actual power factor of the load and set shall be subjected to the maximum achievable load without exceeding the engine or alternator capacity.

This full load test is to be followed immediately by a 10% overload run for one hour. The performance of the engine, alternator and exciter shall be satisfactory at the end of this overload run.

At the end of the full-load run, and again at the end of the over-load run, tests for temperature rise and insulation resistance of the alternator as specified shall be taken.

Full load test can be performed at site or at manufacturer's works before dispatch and shall be monitored by the Client/Consultants/Representative.

Regulation Test

The automatic and manual regulation of the alternator load at half and full rated load shall be tested for a nominal volts of 240 Volts, between phase to neutral and at 0.8 p. f. to verify the requirements of voltage and frequency variation as per IS:4722.

Speed and Governing

The speed of the engine shall be verified to ensure that it conforms to the requirement of BS: 5514.

1.4 Cable Work

1.4.1 Description of Work

Supply, laying, testing and commissioning of cables as per specifications, schedule of quantities and drawings.

1.4.2 Applicable Codes & Standards

IS: 10242 (Part-3, Section-12)	:	Installation of cables for low voltage system
IS: 7098 (Part-1&2)/IS: 5831/ IEC: 60502/BS: 6746/BS:5467	:	Cross linked polyethylene insulated PVC sheathed cables.
Part-I	:	For working voltages up to & including 1100 Volts.
Part-II:	:	For working voltage from 3.3 KV up to & including 33 KV.
IS: 10810	:	Method of test for cables
IS: 1255	:	Code of practice for installation & maintenance of power cables up to & including 33 KV rating.
IS: 8130/IEC: 60228	:	Conductors for cables
IS: 10418	:	Drums for electric cables.
IS: 2062, IS: 800, IS: 816	:	Structural welding steel

1.4.3 Submittals

Cable schedule as per site conditions & good for construction drawings.

Layout of various cables on cable tray / trench along with sections showing no. of cables, distance between cables etc, size of cable trays etc.

Cable tray layout, as per site condition, duly coordinated with other services.

1.4.4 Test reports

Routine test certificates for each drum of cable brought to site.

1.4.5 Specifications

General

Cable shall be supplied inspected, laid, tested and commissioned in accordance with drawings, specifications, relevant Indian Standards Specifications and cable manufacturer's instructions. The cable shall be delivered at site in original drums with manufacturer's name clearly written on the drum.

Material

The MV power cable of 1100 V and upto 16 sq.mm shall be XLPE insulated & PVC sheathed copper conductor armoured cable as per relevant IS.

The MV power cable of 1100 V and above 16 sq.mm shall be XLPE insulated & PVC sheathed Aluminium conductor armoured cable as per relevant IS.

The MV control cables shall be PVC insulated copper conductor armoured cable.

The HT power cable of 11KV KV grade shall be XLPE insulated Aluminium conductor armoured earthed cable.

For Fire Fighting, Ventilation System, Fire Detection System, PA System – Fire survival cable shall be used.

1.4.6 Installation

General

The cable installation including necessary joints shall be carried out in accordance with the specifications given herein. For details not covered in these specifications, I.S. 1255 shall be followed. No straight through joint shall be permitted in the system. The cables shall be supplied as per cable schedule submitted by the contractor & approved by Engineer-in-Charge.

1.4.7 Proximity to Communication Cables

Power and communication cables shall as far as possible cross at right angles. Where power cables are laid in proximity to communication cables the horizontal and vertical clearances shall not normally be less than 30 cm.

1.4.8 Cable Laying Direct in Ground

General

This method shall be adopted where the cable route is through open country along roads/lanes etc. and where no frequent excavation are encountered and where excavation is easily possible without affecting other services.

Trenching

Width of Trench: - The width of trench shall be determined on the following basis:

- a) The minimum width of trench for laying single cable shall be 35 cm.

- b) Where more than one cable is to be laid in the same trench in horizontal formation, the width of trench shall be increased such that the inter-axial spacing between the cables, except where otherwise specified shall be at least 20 cm.
- c) There shall be a clearance of at least 15 cm between axis of the end cables and the sides of the trench.

Depth of Trench:- The depth of trench shall be determined on the following basis:

- a) Where cables are laid in single tier formation, the total depth of trench shall not be less than 75 cm. for cables up to 1.1 KV and 1.20 m for cables upto 33 KV.
- b) When more than one tier of cables is unavoidable and vertical formation of laying is adopted, depth of trench in a (i) above shall be increased by 30 cm. for each additional tier to be formed.

Excavation of Trenches

- a) The trenches shall be excavated in reasonably straight lines. Wherever there is a change in direction, suitable curvature shall be provided complying with the requirements.
- b) Where gradients and changes in depth are unavoidable, these shall be gradual.
- c) Excavation shall be done by any suitable means-manual or mechanical. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench.
- d) Adequate precautions shall be taken not to damage any existing cables, pipes or other such installations in the proposed route during excavation. Wherever bricks, tiles or protective covers or bare cables are encountered, further excavation shall not be carried without the approval of the Engineer-in-Charge.
- e) Existing property exposed during trenching shall be temporarily supported or propped adequately as directed by the Engineer in charge. The trenching in such cases shall be done in short lengths, necessary pipes laid for passing cables therein and the trench refilled.
- f) If there is any danger of a trench collapsing and endangering adjacent structures, the sides should be well shored up with timbering and/or sheeting as the excavation proceeds. Where necessary, these may even be left in places when back filling the trench.
- g) Excavation through lawns shall be done in consultation with the staff of the department/Owner concerned.
- h) The bottom of the trench shall be level and free from stone, brick bats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 8 cm. in depth.

Laying of Cable in Trench

- a) At the time of issue of cable for laying, the cores shall be tested for continuity and insulation resistance.
- b) The cable drum shall be properly mounted on jacks or on a cable wheel, at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum without failure and that the spindle is horizontal in the bearings so as to prevent the drum creeping to one side while rotating.
- c) The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire cable length shall as far as possible be pulled off in one stretch. However, where this is not possible the remainder of the cable may be removed by 'Flaking' i.e. by making one long loop in the reverse direction.
- d) i) After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted slightly over the rollers beginning from one end by helpers standing about 10 m apart and drawn straight. The cable should then be taken off the rollers by additional helpers lifting the cable and then laid in a reasonably straight line.

- ii) For short runs and sizes up to 50 Sq. mm of cables up to 1.1 KV grade, any other suitable method of direct handling and laying can be adopted with the prior approval of the Engineer-in-Charge.
- e) When the cable has been properly straightened, the cores shall be tested for continuity and insulation resistance. In case of PVC cables, suitable moisture seal tape shall be used for this purpose.
- f) i) Cable laid in trenches in a single tier formation shall have a covering of clean, dry sand of not less than 17 cm above the base cushion of sand before the protective cover is laid.
- ii) In the case of vertical multi-tier formation after the first cable has been laid, a sand cushion of 30 cm shall be provided over the initial bed before the second tier is laid. If additional tiers are formed, each of the subsequent tiers also shall have a sand cushion of 30 cm. as stated above. The top most cable shall have a final sand covering not less than 17 cm. before the protective cover is laid.
- g) At the time of original installation, approximately 3 m of surplus cable shall be left on each end the cable and on each side of underground joints (Straight through/Tee/Termination) and at entries and places as may be decided by the Engineer-in-Charge. The surplus cable shall be left in the form of a loop. Where there are long runs of cable length loose cable may be left at suitable intervals as specified by the Engineer-in-Charge.
- h) A final protection to cables shall be laid in accordance with Clause j to provide warning to future excavators of the presence of the cable and also to protect the cable against accidental mechanical damage by pick-axe blows etc.
- i) Unless otherwise specified, the cables shall be protected by second class bricks of not less than 20 cm x 10 cm x 10 cm (nominal size) as per CPWD Building Specification or protection covers placed on top of the sand, (bricks to be laid breadth wise) for the full length of the cable to the satisfaction of the Engineer-in-Charge. Where more than one cable is to be laid in the same trench, this protective covering shall cover all the cables and project at least 5 cm. over the sides of the end cables.

Back Filling

- a) The trenches shall be back-filled with excavated earth free from stones or other sharp edged debris and shall be rammed and watered, if necessary, in successive layers not exceeding 30 cm. Unless otherwise specified, a crown of earth not less than 50 mm. in the centre and tapering towards the sides of the trench shall be left to allow for subsidence. The crown of earth however should not exceed 10 cm. so as not to be a hazard to vehicular traffic. The temporary re-instatements of roadways should be inspected at regular intervals, particularly during the wet weather, and any settlement should be made good. Further trenches cut through roadways or other paved areas shall be restored to the same density and material as the surrounding area and repaved in accordance with the relevant Specifications to the satisfaction of the Engineer-in-Charge.
- a) Where road berm or lawns have been cut or kerb stones displaced, the same shall be repaired and made good except turfing/asphalting to the satisfaction of the Engineer-in-Charge and all surplus earth or rock removed to places as specified.

Route Markers

- a) Route markers shall be provided along straight runs of the cables at locations approved by the Engineer-in-Charge and generally at intervals not exceeding 100 m. Markers shall also be provided to identify change in the direction of the cable route and also for location of every underground joint.
- b) Route markers shall be made out of 100 mm x 100 mm x 5 mm GI/Aluminium plate, welded or bolted on to 35 mm x 35 mm x 6 mm angle iron 60 cm. long. Such plate markers shall be mounted parallel to and 0.5 m or so away from the edge of the trench.

Alternatively cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate of 20 mm nominal size) marker 60 cm x 60 cm 10 cm in size shall be laid flat and centred over

the cable. The concrete markers unless otherwise instructed by the Engineer-in-Charge shall project over the surrounding surface so as to make the cable route easily identifiable.

- c) The work 'cable' and other details such as voltage grading, size etc. as furnished by the Engineer-in-Charge shall be inscribed on the marker.

Laying in Pipes / Closed Ducts

In location such as road crossing, entry to building, on poles, in paved areas etc. cables shall be laid in pipes or closed ducts.

GI or Hume Pipes (spun reinforced concrete pipes) shall be used for such purposes. In the case of new construction, pipes as required shall be laid along with the Civil works and jointed according to the instructions of the Engineer-in-Charge as the case may be. The size of pipe shall be as indicated in the electrical drawings. GI pipe shall be laid directly in ground without any special bed. Hume pipe (Spun reinforced concrete pipe) shall be laid over 10 cm. thick cement concrete 1:5:10 (1 cement: 5 coarse sand: 10 graded stone aggregate of 40mm nominal size) bed, after which it shall be completely embedded in concrete. No sand cushioning or tiles need be used in such situations. Unless otherwise specified, the top surface of pipes shall be at a minimum depth of 1mtr. from the ground level when laid under roads, pavement etc.

Where steel pipes are employed for protection of single core cables feeding AC load, the pipe should be large enough to contain both cables in the case of single phase system and all cables in the case of poly phase system.

The pipes on road crossing shall preferably be on the skew to reduce the angle of bends as the cable enters and leaves the crossings. This is particularly important for high voltage cables.

Manholes of adequate size as decided by the Engineer-in-Charge shall be provided to facilitate feeding/drawing in of cables and to provide working space for persons. They shall be covered by suitable manhole covers with frame of proper design. The construction of manholes and providing the cover is not in the scope of this Contract and shall be got executed and paid for by the Engineer-in-Charge through another agency.

Pipes shall be continuous and clear of debris or concrete before cable is drawn. Sharp edges at ends shall be smoothened to prevent injury to cable insulation or sheathing.

Pipes for cable entries to the building shall slope downwards from the building and suitably sealed to prevent entry of water inside the building. Further the mouth of the pipes at the building end shall be suitably sealed to avoid entry of water. This seal in addition to being waterproof shall also be fireproof.

All chases and passages necessary for laying of service cable connections to buildings shall be cut as required and made good to the original finish and to the satisfaction of the Engineer-in-Charge. Cable grips/draw wires and winches etc. may be employed for drawing cables through pipes/closed ducts etc.

1.4.9 Laying on Cable Tray

Cables, where indicated in approved shop drawings, shall be laid on overhead cable trays which are suspended from ceiling or supported from wall, by anchor fasteners as required.

The Contractor shall provide for all accessories for the installation of the cable trays, such as bends, tees, reducers coupler plates, and structural steel members (comprising of channels, angles, flats, rods) for structural supports for cable trays etc.

Cable Tray Mounting

Unless otherwise specifically noted on the relevant layout drawing, all cable tray mounting works to be carried out ensuring the following:

- a) Cable tray mounting arrangement type to be as marked on layout drawing.
- b) Assembly of tray mounting structure shall be supplied, fabricated, erected & painted by the contractor.

c) Cable tray running along the wall should be supported at intervals not exceeding 1.5 m. In case of branching, there should be a support on all branches at a distance of 30 cm from the point of branching. Support should not be less than 40 mm x 40 mm x 5 mm MS angle-secured in an approved manner where runs are along the walls. In case of ceiling suspended cable tray horizontal supports made of 40 mm x 40 mm 5 mm MS angle iron shall be provided. The horizontal interval between two such supports shall be 1.0 meter. These supports shall be suspended from C.I. boxes or suitable approved suspension devices such as dash fastener of suitable sizes in the ceiling by means of 10 mm diameter GI threaded rods. All above mounting accessories form part of installation of cable trays.

1.4.10 Testing & Commissioning

Inspection

All cables shall be inspected upon receipt at site and checked by the Engineer-in-Charge for any damage during transit.

Testing

- i. All 650/1100 Volt grade cables before laying shall be tested with a 500 V megger or with a 2,500/5,000 V megger for cables of higher voltages. The cable cores shall be tested for continuity, absence of cross phasing, insulation resistance to earth/sheath/armour and insulation resistance between conductors.
- ii. All cables shall be subject to above mentioned tests during laying, before covering the cables by protective covers and back filling and also before the jointing operations.

1.4.11 Completion Plan and Completion Certificate

- a) After completion of the work the Contractor shall draw completion plans to a suitable scale and shall submit to the Engineer-in-Charge. The completion plans shall, inter-alia, give the following details
 - i) Layout of cable work
 - ii) Length, size, type and grade of cables.
 - iii) Method of laying i.e. direct in ground, in pipes etc.
 - iv) Location of each joint with jointing method followed.
 - v) Route marker and joint maker with respect to permanent land marks available at site.
 - vi) Wherever the previously laid cable is cut and additional joints are introduced etc., the cable records shall suitably be amended.

1.4.12 Testing of Cables

The cables shall be tested before and after laying. The Megger value in normal dry weather shall be 50 Mega ohm for 1.1 KV grade cable. This value shall be 100 Mega ohm for 11 KV grade cable.

1.4.13 Cable Tags

Cable tags shall be made out of 2mm thick aluminium sheets. Each tag shall be 2" in dia or 3" x 3" square with one hole of 2.5mm dia, 6 mm below the periphery, or as approved by Consultant. Cable designations are to be punched with letters / number punches and the tags are to be tied to cables with piano wires of approve quality & size. Tags shall be tied inside the panels beyond the glanding as well as above the glands at cable entries. Along trays tags are to be tied at all bends. On straight lengths, tags shall be provided at every 5 meters.

Cables shall be secured to cable trays with 3mm thick x 25mm wide aluminium strips/suitable GI clamp, or as approved by Consultant, at 1000 mm intervals and screwed by means of rust proof screws and washers, of adequate but not excessive lengths. Cable trays for horizontal runs

suspended from the ceiling will be supported with mild steel straps or brackets, at 1000 mm intervals and the overall tray arrangement shall be of a rigid construction. External cabling route marker with C.I. plate marked with "DANGER 1.1 KV CABLE" with 0.6 meter long GI angle iron grouting bracket including 1:3:6 ratio cement concrete base block of minimum size 200 x 200 x 350 mm to be provided or as approved by Elect. Supply Company.

1.5 Cable Tray

All cables trays shall be made of G.I. sheet.

Cable trays shall be complete with bends, joints, coupler plates and accessories as may be required for joining the cable trays. The bends, Tee joint, Cross joint for all sizes of cable tray shall be factory fabricated.

Cable trays shall be either perforated or ladder type as called for in the schedule of quantities.

1.5.1 Perforated Cable Tray

Standard dimensions of perforated cable trays shall be as follows:

- | | | | |
|----|---------------|---|---|
| 1. | Width | : | 100 mm to 1200 mm |
| 2. | Length | : | 2500 mm |
| 3. | Thickness | : | 2mm up to 750 mm width and
3mm from 900mm to 1200 mm |
| 4. | Collar height | : | 50 mm up to 600 mm and 75 mm from 750 mm to 1200mm |

1.5.2 Ladder Type Cable Tray

Standard dimensions of ladder type cable trays shall be as follows:

Size of tray	size of main channel	size of rung /spacing between rungs
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900mm to 1200mm	25 x100 x 25 x 3mm	20 x 50 x 20 x 2 @ 200C/C
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Up to 750mm	25 x 75 x 25 x 2mm	20 x 50 x 20 x 2 @ 200C/C
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Sizes of angle for cable tray supports shall be minimum 40 x 40 x 5 mm up to 600mm & 50 x 50 x 5mm minimum as specified in the drawings/schedule of quantities for sizes above 600 mm. Hangers shall be of minimum 10 mm dia steel round bars up to 600 mm & 12 mm dia steel from 750 mm to 1200 mm as specified in the drawings/schedule of quantities. All the support shall be G.I.

Fixing arrangement shall be as approved by the Consultant.

Hardware to be used in cable tray system shall be galvanized or zinc passivated.

The testing on galvanized material if required shall be carried out as per IS: 2633, amended to date.

1.6 Safety Materials

1.6.1 Description of Work

- A. Insulation Mats
- B. First Aid charts and First Aid Box
- C. Danger Plate
- D. Fire Extinguishers
- E. Fire Buckets
- F. Tool Box

G. Caution Board

H. Key Board

1.6.2 Applicable Codes & Standards

- A. IS : 15652 Insulation mats
- B. IS : 2878 Portable CO₂ Fire Extinguisher
- C. IS : 2546 : Fire Buckets
- D. ANSI/NFPA 70 - National Electrical Code.

1.6.3 Submittals

- A. Product Catalogues.

1.6.4 Specification

Insulation Mats

A. Insulation mats conforming to IS: 15652 shall be provided in front of main switch boards and other control equipment as specified.

First Aid Chart and First Aid Box

A. Charts (one in English, one in Hindi, one in Regional Language), displaying methods of giving artificial respiration to a recipient of electrical shock shall be prominently provided at appropriate places. Standard First Aid Boxes containing materials as prescribed by St. John Ambulance brigade or Indian Red Cross should be provided in sub-station.

Danger Plate

A. Danger plates shall be provided on HV and LV equipments. LV danger notice plate shall be 200 mm x 200 mm made of mild steel atleast 2 mm thick vitreous enamelled white on both sides and with inscriptions in signal red colour on front side as required.

B. Size of the HV Danger Notice plate shall be 250 mm x 200 mm and 2 mm thick.

Fire Extinguishers

A. Portable CO₂ conforming to IS: 2878-1976 dry chemical (conforming to IS 2171-1976) extinguishers shall be installed in the sub-station at suitable places (like HT/LT panel rooms) as specified.

B. Foam type fire extinguisher shall be installed in Transformer Room.

Fire Buckets

A. Fire buckets conforming to IS: 2546-1974 shall be installed with the suitable stand for storage of water and sand.

Tool Box

A. A standard tool box containing necessary tools required for operation and maintenance shall be provided in sub-station.

Caution Board

A. Necessary number of caution boards such as "Man on Line" "Don't switch on" etc. shall be available in the sub-station.

B. The Caution Board shall be of size 300 mm x 200mm made of mild steel, 2mm thick, vitreous enamelled white on both sides and with inscriptions in original red colour on front side as required.

Key Board

A. A key board of required size shall be provided at a proper place containing castel keys, and all other keys of sub-station and allied areas.

B. The Key board shall be made of 12mm thick first class teak wood shall be of size 400 mm x 300m and with adequate depth to hold the keys. It shall be provided with a lockable type hinged glass door made of 12 mm. thick first class teakwood frame with 3 mm thick sheet glass fixed with piano hinges. The key board shall enough number of hooks for hanging the castle keys and all other keys of the sub-station and allied areas. It shall be painted with one coat of wood primer and two coats of white enamel paint.

1.7 Piping Work (D.G. Flue Gas Exhaust System)

1.7.1 Scope of Work

The scope of this section comprises supply, installation, testing & commissioning of D.G. Flue Gas Exhaust System pipes & pipe fittings etc. as detailed below in specifications. All pipes and fittings etc. shall conform to relevant Indian standards.

1.7.2 D.G. Flue Gas Exhaust Piping

D.G. Exhaust pipes shall be M.S. Black pipes (B Class / 5.0 mm thick) up to 150 mm and MS ERW Black Pipes above 150 mm and it shall conform to IS:1239 (Part 1) -1991 & IS:3589 – 1991 Grade 330 with latest amendments.

All piping and their steel supports shall be thoroughly cleaned and primer coated before installation.

1.7.3 Pipe Insulation (D.G. Flue Gas Exhaust Piping System)

The scope of this section comprises supply, installation, testing & commissioning of D.G. Flue Gas Exhaust Pipe Insulation and Aluminium Cladding. All insulation material and aluminium cladding shall conform to relevant Indian standards.

1.8 11 KV VCB Panel (Indoor Type)

1.8.1 General

Vacuum Circuit Breaker shall be incorporated in H.T. Panel wherever specified. VCB's shall be suitable for operation on 11KV, 3 phase, 50Hz, AC supply.

1.8.2 Codes and Standards

The 11 KV VCB Panel shall comply with the following standards as amended up to date.

IS: 2516 (Part I – Set 3)	: Indian Electricity Supply and regulations.
IEC 60298& IEC 60694	
IS: 3427 & IS 12729	: Vacuum Circuit Breakers
IEC: 298 (1987) (Annex. AA)	: Testing for Internal Arc
IEC: 529	: Degree of Protection – IP 55
IS: 2544	: Bus Bar Supports
IS: 2705 / IEC – 185	: Current Transformer
IS: 3516 / IEC – 186	: Potential Transformer

1.8.3 Rating

The rating of the vacuum circuit breaker shall be as per the drawings and schedule of quantities. The rated/breaking capacity of the breaker shall be 350 MVA at 11 KV. The rated making capacity shall be as per the relevant standards.

1.8.4 Accessories

Circuit Breakers shall be provided with the following accessories.

- i. Auxiliary Switch with minimum 6 NO+ 6 NC auxiliary contacts.
- ii. Shunt Trip Coil
- iii. Mechanical Operation Counter
- iv. Spring Charging motor and handle for manual charging.

1.8.5 Submittals**Shop Drawing and Technical Data**

The tenderer shall furnish relevant technical data on breakers and associated equipment along with the offer.

The Contractor shall furnish relevant descriptive and illustrative literature on breakers and associated equipment and the following for approval before manufacture of the panel.

- a) Complete assembly drawings of the panel showing plan, elevation and typical section views and locations of cable boxes, bus bar chamber, metering and relay compartment and terminal blocks for external wiring connections.
- b) Typical and recommended schematic diagrams for control and supervision of circuit breakers.
- c) Foundation plan showing location of foundation channels, anchor bolts and anchors, floor plans and openings for cables etc.
- d) Type test certificates along with oscillograms for breakers of identical design.
- e) All drawings and data shall be in English.

1.8.6 Type and Construction

The metal clad panel shall be made out of 2.0 mm thick CRCA sheet steel. The steel work should have undergone a rigorous rust proofing process comprising alkaline degreasing, descaling in dilute sulphuric acid and recognized phosphating process and shall then be given powder coating (Electrostatic) paint of manufacturer's standard shade. The Switch Board Shall be fully extensible with following compartment.

- a. Circuit Breaker Compartment
- b. Bus bar Compartment
- c. CT and Cable Termination Compartment

The compartments shall be dust & vermin proof and safe to touch. A separate metering chamber for fixing the necessary instrumentation metering and protective equipment shall be mounted on the top / bottom of the panel at the front. The VCB shall consist of three air insulated poles incorporating mechanism of interrupters and suitable clearance between phases. The body of interrupters shall be made of nickel chromium steel supported on insulators made out of metalized aluminium oxide. The contacts shall be of chromium copper and butt shaped. Vacuum circuit breaker shall be mounted on truck or a carriage mechanism. The drawout carriage shall have two position for the circuit breaker viz isolated/test & service position. Bus bars shall be insulated type made of high conductivity copper

supported on cast epoxy mono block designed to withstand full short circuit currents and shall be provided all along the length of the H.T. board.

It shall be horizontal draw out & isolation type, fully interlocked, with dust and vermin proof construction, suitable for indoor installation. The panel shall be supplied with the manufacturer's test certificates. Certificates with date of manufacture and shall be complete in all respects as per details given in the bill of quantities. The switchgear constructions shall be such that the operating personnel are not endangered by breaker operation and internal explosions, and the front of the panel shall be specially designed to withstand these. Pressure relief flaps shall be provided for safely venting out gases produced inside the high voltage compartment, bus bar compartment and termination compartment. These flaps shall be vented upwards and cannot be opened from outside. These relief flaps shall be of such construction as not to permit ingress of dust/water in harmful quantities under normal working conditions. Enclosure shall be constructed with sheet steel of at least 2.0mm thickness. It shall have a rigid, smooth, leveled, flawless finish.

Total height of the H.T. Panel board shall be 2750mm approximately and width 600mm (approx.). On the incoming breaker panel, a 100VA burden and Class I accuracy potential transformer $11\text{KV}/\sqrt{3}$ / $110\text{V}/\sqrt{3}$ with LT fuses shall be provided. These shall be three single phase PTs cast resin insulated type. Adequate space at the rear of the panel shall be provided for termination of power & control cables. The panel shall be provided with suitable terminating arrangement for termination of cables. The making contact arms (upper & lower) of the circuit breaker shall be encased in polypropylene tubes. Penetration type bushings shall be provided in the bus bars & cable compartment for the fixed contacts. Safety shutters shall be provided to cover up the fixed high voltage contacts on bus bar and cable sides when the carriage is moved to Isolated/Disconnected position. The shutters shall move automatically with the movement of the draw out carriage. It shall, however, be possible to open the shutters of bus bars side and cable side individually.

Mechanically operated circuit breaker auxiliary switches of minimum 6 NO + 6 NC ways, shall be provided for control and indication purposes. Control wiring shall be done by using 1.5 sq. mm, 1.1KV grade stranded copper PVC insulated cable. All control fuses shall be HRC link type.

L.T. Terminal blocks for control wiring shall be clamp type suitable for connection of only 2 wires per terminal and shall be 650 V grade. The L.T. control circuit shall be routine tested to withstand 2.0KV for one minute. Bus bar compartment shall be provided at the rear. Electrolytic copper bus bars shall be of rectangular cross section and insulated. Bus bars shall be supported properly by cast epoxy resin insulators so as to withstand thermal and dynamic stresses during system short circuits. Bus bars shall be provided with necessary colour coding for phases indication. The bus bars shall be designed to withstand a temperature rise of 60 deg. C above and ambient temperature of 50 deg. C. The standard clearance between phase bus bars to be maintained.

1.8.7 Bus Bar and Insulators

Bus bars and connections shall be of high conductivity electrolytic copper conforming to relevant IS standards. They shall be adequately supported on epoxy insulators to withstand electrical and mechanical stresses due to specified short circuit currents. Bus bar cross section shall be uniform throughout the length of switch board. Contact surface at all joints shall be properly cleaned and No-oxide grease applied to ensure an efficient and trouble free connections. All bolted joints shall have necessary washers for maintaining adequate contact pressure. All connection hardware shall have high corrosion resistance. Bus bar insulators shall be of track-resistance, high strength, non-hygroscopic, non-combustible type & shall be suitable to withstand stresses due to over voltages and short circuit current. Bus bar shall be supported on the insulator such that the conductor expansion and contraction are allowed without straining the insulators. The temperatures of the bus bars and all other equipments, when carrying the rated of relevant Indian Standards, duly considering the specified ambient temperature.

1.8.8 Earthing and Protective Earthing

Copper earthing bus shall be provided. It shall be bolted/ welded to the frame work of each panel. The earth bus shall have sufficient cross time fault currents to earth without exceeding the allowable temperature rise. Suitable arrangement shall be provided at each end of the earth for bolting. Owner's earthing conductors and earth bus shall run inside at the back of the panel for entire length. Facilities shall be provided for integral earthing of bus bars & feeder circuit.

1.8.9 Metering and Protection

The VCB Panel Board shall be provided with cast resin current transformers for metering and protection. The CT's shall conform in all respects to IS 2705-1964 Part-I, II and III. These shall have accuracy class of 1.0 for metering of 5P10 for protection. Potential transformers shall be epoxy cast resin type & conform to specifications of IS: 3156-1965 Part-I, II & III and shall be class-1. Electronic digital type Ammeter and voltmeter to be installed on panel. Electronic type digital energy analyzer having parameter of KW, KWH power factor, frequency etc. with 30 days memory shall be provided. All meters shall be tested for 2000V for 1 minute and shall be 96mm square pattern, flush mounting type with necessary selector switches. Necessary indicating lamps of low voltage type with built in resistors shall be provided (maximum wattage 2.5W). The electronic digital types IDMT relay (2 O/C + 1 E/F) to be provided as per B.O.Q. description.

1.8.10 Interlocking, Safety and Operating Mechanism

Vacuum Circuit Breaker shall have electrically operated mechanism for spring charging. These operating mechanisms shall be of the stored energy type. In the closed state of the breaker, the energy stored in the springs shall be suitable for O-C-O duty. The draw out carriage cannot be moved from either test/disconnected to service position or vice versa, when the circuit breaker is 'On'. The circuit breaker cannot be switched 'ON' when the carriage is in any position between test & service position. The front door of the panel cannot be opened when the breaker is in service position or in an intermediate position. The low voltage plug & socket cannot be disconnected in any position except test/isolated position. The door cannot be closed unless the LV plug has been fitted. It shall be possible to mechanically close and trip the circuit breaker through push buttons with the circuit breaker in service position and the door closed. Individual explosion vents shall be provided for breaker, bus bar, cable chambers on the top of the panel to let out the gases under pressure generated during an unlikely event of a fault inside the panel. Circuit Breaker & sheet metal enclosure shall be fully earthed. Self locking shutters shall be provided which close automatically and shall be interlocked with the movement of the draw out carriage mechanism.

1.8.11 Additional Accessories

The loose items to be supplied with the 11KV VCB Panel Board shall comprise of the following:

- a. Maintenance Manual.
- b. Racking in/out handle.
- c. Foundation bolts.
- d. One number Earthing Trolley for cable side.

1.8.12 Control Supply

- a. The tripping circuit shall be at 24 Volt D.C. through a power pack unit.
- b. A 11KV/230Volt control transformer shall be provided.

1.8.13 Installation

- a. 11 KV switch board shall be installed and levelled on the foundation as per manufacturer's drawing. Bus bar connections shall be checked after installation. Cable end boxes shall be sealed after the cable work is completed to prevent absorption of moisture.

1.8.14 Tests

Factory tests

The circuit breakers panel shall be subjected to routine tests at manufacturers works in accordance with the details specified in the relevant IS specifications.

The vendor shall submit the type test certificate for following along with the offer.

- a. Temperature rise test.
- b. Impulse & power frequency voltage test
- c. Short time current test on circuit breaker.

Site test

1. Verification for completion of equipment, physical damage/ deformities.
2. Alignment of panel, interconnection of bus bars & tightness of bolts & connection etc.
3. Interconnection of panel earth bus bar with plant earthing grid.
4. Inter panel wiring between transport sections.
5. Cleanliness of insulators and general Cleanliness of panel to remove traces of dust, water etc.
6. Control wiring verification after interconnecting of panel.
7. Check for free movement of circuit breaker, lubrication of moving part & other Parts as per manufacturers manual.
8. Manual/Electrical operations of the breaker and Functional test as per drawings.
9. Meggar before the Hi Pot test.
10. Meggar after the Hi Pot test.
11. CT/PT ratio/polarity primary injection test.
12. Secondary injection test on relays to practical characteristics.

These tests as per the clauses above will be witnessed by the owner/consultant at the works for which necessary information has to be given in advance to the owner/ consultant.

1.9 11KV/0.433KV Oil Type Distribution Transformer-

As per CPWD specification / ECBC regulation and relevant IS code.

1.10 Main LT panel Cum DG Synchronizing Panel

1.10.1 General

This section covers the detail requirements for Design, Manufacturing, Testing at works. Main L.T. Panel shall be made out of CRCA sheet steel indoor type, floor mounted, free standing, totally enclosed, extensible type, air insulated type for use on 415 Volts, 3 phase with neutral, 50 cycles/sec system. D.G. Panel shall have PLC and required Hardware and Software to achieve the AMF, Synchronizing and Interlocking.

The equipment shall be designed to conform to the requirements of:

- i. IS: 8623- Factory Built Assemblies of switchgear and control gear.
- ii. IS: 4237- General requirements for switchgear and control gear for voltages not exceeding 1000 volts.
- iii. IS: 2147- Degree of protection.
- iv. IS: 375- Marking and arrangement of bus bar.

Individual equipment housed in the Main L.T. Panels shall conform to the following IS Specification.

- i. Air circuit breakers/ moulded case circuit breaker IS: 60947 (Part-II) & IEC 60947(2)
- ii. Fuse switch and switch fuse units - IS: 13947 (Part-3) & IEC 947 (3).
- iii. HRC fuse links - IS: 13703

- iv. Current Transformers - IS :2705
- v. Voltage Transformers - IS :3156
- vi. Indicating Instruments - IS: 1248
- vii. Integrating Instruments - IS : 722
- viii. Control Switches & Push Buttons - IS : 6875
- ix. Auxiliary Contactors - IS : 13947 (Part-4/Sec.-I) & IEC 947 (4/1)
- x. Relays - IS: 3231

1.10.2 Submittals, Shop Drawing and Technical Data

The Contractor shall furnish relevant descriptive and illustrative literature on breakers and associated equipment and the following for approval before manufacture of the panel.

- a) Complete assembly drawings of the panel showing plan, elevation and typical section views and locations of cable boxes, bus bar chamber, metering and relay compartment and terminal blocks for external wiring connections.
- b) Typical and recommended schematic diagrams for control and supervision of circuit breakers.
- c) Foundation plan showing location of foundation channels, anchor bolts and anchors, floor plans and openings for cables etc.
- a) Type test certificates.

1.10.3 Construction

- 1. Made out of the requisite vertical sections, which when coupled together shall form continuous dead front switchboards.
- 2. The degree of protection being not less than IP 52 to IS: 2147.
- 3. Suitable for extensible on both sides by the addition of vertical sections after removal of the end covers.
- 4. Shall be suitable for cable entry from top / bottom both except wherever indicated through removable cable gland plate of 3 mm thick. Compression gland shall be staggered in alleys so as to maintain necessary clearance between cables.
- 5. Fire retardant polycarbonate sheet shall be provided for viewing panels housing MCB's at eye level. Cable channels are to be used wherever possible for aesthetic look.

Lifting hooks / angles to be provided on the panel. Panel shall have 20% free space for future use.

Panel shall be provided with louvers having wire mesh inside for ventilation.

Each vertical section shall comprise of:

- i. A minimum 2 mm thickness front framed structure of rolled/folded sheet steel channel section rigidly bolted together. This structure shall house the components contributing to the major weight of the equipment, such as circuit breaker cassettes, fuse switch units, main horizontal bus bars, vertical risers and other front mounted accessories. The structure shall be mounted on a rigid base frame of folded sheet steel of minimum 3 mm thickness and 100 mm height. The design shall ensure that the weight of the components is adequately supported without deformation or loss of alignment during transit or during operation.

- ii. Cable chamber housing (In rear of panel) the cable end connections, and power/control cable terminations. The design shall ensure generous availability of space for ease of installation and maintenance of cabling, and adequate safety for working in one vertical section without coming into accidental contact with live parts in an adjacent section.
- iii. Front and rear doors fitted with dust including neoprene gaskets with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be assured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust. All door shall be lockable mounted lock.

The height of the panels should not be more than 2400 mm. The total depth of the panel should be adequate to cater to proper cabling space and should not be more than 1500mm. Operating handle not higher than 1800mm. The minimum height for operating handle shall be 300 mm from floor level.

Doors and covers shall be of minimum 2mm thick sheet steel. Sheet steel shrouds and partitions shall be of minimum 2mm thickness. All sheet panels shall be smoothly finished, levelled and free from flaws. The corners should be rounded.

The apparatus and circuits in the power control centres shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety.

Apparatus forming part of the Main L.T. Panel shall have the following minimum clearances.

- i. Between phases - 26mm
- ii. Between phases and neutral - 19mm
- iii. Between phases and earth - 19mm
- iv. Between neutral and earth - 19mm

For any reason, the above clearances are not available, suitable insulation shall be provided. Clearances shall be maintained during normal service conditions. Creepage distances shall comply to those specified in relevant standards. All insulating material used in the construction of the equipment shall be of non-hygroscopic material, duly treated to withstand the effects of the high humidity, high temperature tropical ambient service conditions.

Circuit breakers and fuse switches shall be arranged in multi-tier formation, except that not more than two air circuit breakers shall be housed in a single vertical section. Cable entry for various feeders shall be from the rear. Panel shall be suitable for termination of bus duct for incoming breakers.

Metallic/insulated barriers shall be provided within vertical sections and between adjacent sections to ensure prevention of accidental contact with:

- i. Main bus bars and vertical risers during operation, inspection or maintenance of functional units and front mounted accessories.
- ii. Cable termination of one functional unit, when working on those of adjacent unit/units.

All doors/covers providing access to live power equipment/ circuits shall be provided with tool operated fasteners to prevent unauthorized access.

Provision shall also be made for permanently earthing the frames and other metal parts of the switchgear by two independent connections.

1.10.4 Metal Treatment and Finish

All steel work used in the construction of the L.T. cubicle panels should have undergone a rigorous metal treatment process as follows:

- i. Effective cleaning by hot alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution.
- ii. Pickling in dilute sulphuric acid to remove oxide scales & rust formation, if any, followed by cold water rinsing to remove traces of acidic solution.

- iii. A recognized phosphating process to facilitate durable coating of the paint on the metal surfaces and also to prevent the spread of rusting in the event of the paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution.
- iv. Passivating in de-oxalite solution to retain and augment the effects of phosphating.
- v. Drying with compressed air in a dust free atmosphere.
- vi. Powder Coating paint of colour approved by Architect/Consultant/ Engineer-in-charge.

1.10.5 Bus Bar

The bus bars shall made of high conductivity, high strength aluminium alloy complying with the requirement of grade E-9IE of IS-5082 and air insulated. The bus bars shall be suitable braced with non-hygroscopic SMC supports to provide a through fault withstand capacity of required rating of fault level as per actual calculation for one second. The neutral as well as the earth bar should be capable of withstanding the above level. Ridges shall be provided on the SMC supports to prevent tracking between adjacent bus bars. Large clearances and creepage distances shall be provided on the bus bar system to minimize possibilities of fault.

The Panel shall be designed that the cables are not directly terminated on the terminals of breaker/switch fuse/fuse switch etc. but on cable termination links. Capacity of aluminium bus bars shall be considered as 0.8 Amp/sq.mm of cross section area of the bus bar. The main bus bars shall have continuous current rating throughout the length of L.T. Panel. The bus bar system shall consists of main horizontal bus bar and auxiliary vertical bus bars run in bus bar alley/chamber on either side in which the circuit could be arranged/connected with front access. The minimum size of vertical bus bar shall be as per fault level of panel i.e 50 KA.

In case of copper bus bars, high conductivity electrolytic grade copper with current density not less than 1.4 Amp/ sq. mm shall be used. Bus Bar shall be tinned.

Connections from the main bus bars to functional circuit shall be arranged and supported to withstand without any damage or deformation the thermal and dynamic stresses due to short circuit currents. Bus bars to be colour coded with PVC sleeves.

Cadmium plated G.I. nuts and bolts shall be used for making bus bar to bus bar connections in aluminium bus bars.

Whenever copper bus bar and aluminium bus bar are connected to each other, bimetallic strip shall be used. In case of copper bus bar, tinning shall be done.

Bus bar calculation shall be submitted along with manufacturing drawing of panel for approval with bus bar manufacturer data sheet.

1.10.6 Medium Voltage Air Circuit Breaker

TYPE AND CONSTRUCTION

The ACB shall confirm to the requirements of IS 13947-2 and shall be type tested & certified for compliance to standards from-CPRI. The circuit breaker shall be suitable for 415 V \pm 10%, 50 Hz supply system. Air Circuit Breakers shall be with moulded housing / sheet metal housing flush front, draw out type and shall be provided with a trip free manual operating mechanism or as indicated in drawings and bill of quantities with mechanical "ON" "OFF" "TRIP" indications.

The ACB shall be 3/ 4 pole with modular construction, draw out, manually or electrically operated version as specified. The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity (Ics) shall be as specified on the single line diagram and should be equal to the Ultimate breaking capacity (Icu) and short circuit withstand values (Icw) for 1 sec.

Icu = Ics = Icw = shall be based on actual calculation.

Circuit breakers shall be designed to 'close' and 'trip' without opening the circuit breaker compartment door. The operating handle and the mechanical trip push button shall be at the front of the breakers panel. Inspection of main contacts should be possible without using any tools. The

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

ACB shall be provided with a door interlock. i.e. door should not be open when circuit breaker is closed and breaker should not be closed when door is open.

All current carrying parts shall be silver plated and suitable arcing contacts with proper arc chutes shall be provided to protect the main contacts. The ACB shall have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhanced safety and in accessibility to live parts. All electrical closing breaker shall be with electrical motor wound stored energy spring closing mechanism with mechanical indicator to provide ON/OFF status of the ACB.

The auxiliary contacts blocks shall be so located as to be accessible from the front. The auxiliary contacts in the trip circuits shall close before the main contacts have closed. All other contacts shall close simultaneously with the main contacts. The auxiliary contacts in the trip circuits shall open after the main contacts open. It should be possible to change settings on load.

Minimum 4 NO and 4 NC auxiliary contacts shall be provided on each breaker. Break time of ACB shall not be more than 70 milli second in case of short circuit.

Rated insulation voltage shall be 1000 volts AC.

CRADLE

The cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. The movements shall be free from jerks, easy to operate and shall be on steel balls/rollers and not on flat surfaces.

There shall be 4 distinct and separate position of the circuit breaker on the cradle.

Racking Interlock in Connected/Test/Disconnected Position.

Service Position : Main Isolating contacts and control contacts of the breaker are engaged.

Test Position : Main Isolating contacts are isolated but control contacts are still engaged.

Isolated Position : Both main isolating and control contacts are isolated.

There shall be provision for locking the breaker in any or all of the first three positions mechanically.

The following safety features shall be incorporated:

- a. Withdrawal or engagement of Circuit breaker shall not be possible unless it is in open condition.
- b. Operation of Circuit breaker shall not be possible unless it is fully in service, test or drawn out position.
- c. All modules shall be provided with safety shutters operated automatically by movement of the carriage to cover exposed live parts when the module is withdrawn.
- d. All Switchgear module front covers shall have provision for locking.
- e. Switchgear operating handles shall be provided with arrangement for locking in 'OFF' position.

PROTECTION

All breaker (ACB's) should be equipped with static release to offer accurate and versatile protection with complete flexibility and shall offer complete over current protection to the electrical system in the following four zones:

- Long time protection.
- Short time protection with intentional delay.
- Instantaneous protection.
- Ground fault protection.

SAFETY FEATURES

- (i) The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.
- (ii) It shall not be possible to interchange two circuit breakers of two different thermal ratings. For Draw-out breakers, an arrangement shall be provided to prevent rating mismatch between breaker and cradle.
- (iii) There shall be provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism. Farthing bolts shall be provided on the cradle or body of fixed ACB.
- (iv) The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, digital voltmeter and ammeter of size not less than 96 mm x 96 mm, selector switches, MCB for protection circuit and measuring instrument circuits.
- (v) It shall be possible to bolt the draw out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.
- (vi) Draw out breakers should not close unless in distinct Service/Test/Isolated positions.
- (vii) The insulation material used shall conform to Glow wire test as per IEC60695.
- (viii) The ACB shall provide in built electrical and mechanical anti-pumping.

TESTING

Testing of each circuit breaker shall be carried out at the works as per relevant IS Code of Practice and the original test certificate shall be furnished in triplicate. The tests shall incorporate at least the following.

- i. Impulse withstand test.
- ii. Power frequency withstand test.
- iii. Short circuit test.
- iv. Temperature - rise test under rated conditions.

1.10.7 Molded Case Circuit Breaker

GENERAL

Moulded Case Circuit Breakers shall be incorporated in sub distribution boards wherever specified. MCCB's shall conform to IS 13947-2 and / or IEC 947-2 in all respects. MCCB's shall be suitable either for single phase AC 230 volts or three phase 415 volts.

FRAME SIZES

The MCCB's shall have the following frame sizes subject to meeting the fault level specified elsewhere.

- i) Up to 100A rating 100Amp frame.
- ii) Above 100A to 200A 200Amp frame.
- iii) Above 200A to 250A 250Amp frame.
- iv) Above 250A to 400A 400Amp frame.
- v) Above 400A to 630A 630Amp frame.

CONSTRUCTIONS

The MCCB cover and case shall be made of high strength heat treatment and flame retardant thermo-setting insulating material. Operating handle shall be of rotary type quick make/quick

break, trip-free type. The operating handle for simultaneous operation and tripping of all the three phases.

Suitable fire extinguishing device shall be provided for each contact. Tripping unit shall be of thermo magnetic type up to 250 A for adjustable overload & short circuit protection and shall be microprocessor type above 250 A for adjustable overload, short circuit & earth fault protection. MCCB shall be line load reversible type. Device shall have IDMT characteristics for sustained overload, and short circuits. MCCB shall be current limiting type.

Contacts trips shall be made of suitable are resistant, silver alloy for long electrical life. Terminals shall be of liberal design with adequate clearance.

RUPTURING CAPACITY

The Moulded Case Circuit Breaker service breaking capacity (Ics) shall be based on actual calculation.

TESTING

Test certificate of the MCCB as per relevant Indian Standards (IS) shall be furnished. Pre-commissioning tests on the sub distribution boards incorporating the MCCB shall be done as per standard.

1.10.8 Measuring instrument for metering

GENERAL

The specifications herein-after laid down shall also cover all the meters, instrument and protective devices required for the electrical works. The ratings, type and quantity of meters, instruments and protective devices shall be as per the bill of quantities.

DIGITAL AMMETERS

Digital Ammeters shall be confirmed to IS: 13875. It shall be digital type 7 segment LED display. Ammeter shall be suitable for accuracy class 1.0 and burden 0.2 VA approx. The ammeters shall be capable of carrying sustained overloads during fault conditions without damage or loss of accuracy. The meter shall be suitable for working in ambient temp 0 degree to 50 degree and 95% humidity condition.

DIGITAL VOLTMETERS

Digital Voltmeters shall be confirmed to IS: 13875. It shall be digital type 7 segment LED display. Voltmeter shall be suitable for accuracy class 1.0 and burden 0.2 VA approx. The range for 3 phase voltmeters shall be 0 to 500 volts. The meter shall be suitable for working in ambient temp 0 degree to 50 degree and 95% humidity condition. The voltmeter shall be provided with protection MCB of suitable capacity.

CURRENT TRANSFORMERS

Current transformers shall be in conformity with IS: 2705 (Part I, II & III) in all respects. All current transformers used for medium voltage applications shall be rated for 1KV Current transformers shall have rated primary current, rated burden and class of accuracy as required. However, the rated secondary current shall be 15A unless otherwise specified. The acceptable minimum class of various applications shall be as given below.

Measuring	: Class 1.0
Protection	: Class 5 P10

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault on medium voltage system. The fault level of CT shall be same as fault level of panel. Terminals of the current transformer shall be marked permanently for easy identification of poles. Separate CT shall be provided for measuring instruments and protection relays. Each C.T. shall be provided with rating plate.

Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT's shall be copper conductor, PVC insulated wires

with proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.

1.10.9 Control Switches

Control switches shall be of the heavy duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting.

Indicating lamps shall be of the LED type, and with translucent lamps covers. Bulbs & lenses shall be easily replaced from the front.

Push buttons shall be on the momentary contact, push to actuate type fitted with self reset contacts & provided with integral escutcheon plates marked with its functions.

1.10.10 Cable Termination

Cable entries and terminals shall be provided in the sub distribution boards to suit the number, type and size of aluminium conductor power cable and copper conductor control cable specified.

Provision shall be made for top or bottom entry of cables as required. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated. Cable glands shall be brass compression type, barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

1.10.11 Control Wiring

All control wirings shall be carried out with 1100V grade single core PVC cable conforming to IS 694/IS 8130 having stranded copper conductors of minimum 1.5 sq. mm for potential circuits and 2.5 sq. mm for current transformer circuits. Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance. Wiring shall be identified by numbering ferrules at each end. All control fuses shall be mounted in front of the panel and shall be easily accessible.

1.10.12 Terminal Block

Terminal blocks shall be 500 Volts grade of the stud type. Insulating barriers shall be provided between adjacent terminals. Terminals block shall have a minimum current rating of 10 Amps and shall be shrouded. Provisions shall be made for label inscriptions.

1.10.13 Labels

Labels shall be of anodized aluminium, with white engraving on black background. They shall be properly secured with fasteners.

1.10.14 Miscellaneous

Push buttons shall be of the momentary contact, push to actuate type fitted with self reset contacts & provided with integral escutcheon plates marked with its functions.

1.10.15 Battery and Battery Charger

A set of 24V DC power supply shall be provided for indication, relay operation etc. for Main L.T. Panel. DC Power supply shall be sealed maintenance free batteries of suitable capacity. Suitable battery chargers shall also be provided to charge the battery to perform during mains failure.

1.11 Capacitor Bank Panel

Medium Voltage Capacitors and Control Panel to be used for improvement of power factor of the electrical system and shall be connected to Main L.T. Panels through L.T. Cable / L.T. Bus ducts.

Automatic Power Factor Correction Panel shall function to improve power factor of the system in which it is connected. It shall improve power factor up to 0.99 from existing value.

1.11.1 Codes and Standards

Unless otherwise specified the capacitor and control panel shall conform to following.

- a. IS: 2834 - Shunt capacitors for power systems.
- b. IS: 2147 - Degree of protection provided by enclosures for low voltage switchgear and control gear.
- c. IS: 4237 - General requirements for switchgear and control gear for voltages not exceeding 1000V.
- d. IS: 8623 - Specification for factory built assemblies of switchgear and control gear (Up to 1000 volts).
- e. IS: 2208 - HRC cartridge fuse links up to 650 volts.
- f. IS: 4064 - Specification for Fuse Switch & Switch Fuse switchgear and control gear.
- g. IS: 2959 - AC contactors for voltage not exceeding 1000 volts.

1.11.2 Submittals

Shop drawing and technical data

Complete technical data sheet including guarantee details giving the temperature rise, capacitor losses etc, Capacitor panel GA drawing, indicating mounting of capacitor units shall be furnished with the shop drawing.

1.11.3 Control Panel

The panel shall be provided with necessary MCCB's, contactors, automatic required steps relays with associated CT's and power factor meter, indicating lamps, push buttons etc. Capacitors shall also be housed in the same panel. The panel shall be free standing type, dead front cubicle and shall be constructed from 2 mm thick sheet steel. The degree of protection shall be IP 54. This panel shall be integrated with the main L.T. panel unless specified otherwise.

1.11.4 Painting

As the capacitor panel is integrated with Main LT panel, it shall be painted as per specification in relevant Clause above.

1.12 Sandwich Bus Duct & Rising Main

1.12.1 Scope

This specification covers Design, manufacturing, Supply, Installation, testing and commissioning of Sandwich type metal enclosed bus duct suitable for 415V, 50Hz and having Ampere rating as per requirement.

1.12.2 Codes and Standards

The design, material used, construction, manufacture and testing for Sandwich type Bus duct shall conform to IS 8623 Part 1 &2 and IEC 60439 Part 1 & 2 standards and IEC 61439.

In case of conflict between the standards and the specifications, specifications shall hold good.

1.12.3 Application data

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

Sandwich bus trunking system shall be compact & maintenance free design with low impedance construction & low voltage drop.

Rated operational voltage shall be 1000V AC,

Rated insulation voltage shall be 1000V AC,

Rated dielectric voltage shall be 3.5 KV rms for 60 seconds.

Ingress protection shall be IP 54/55 for indoor application & IP 65 for outdoor application.

The maximum permitted temperature rise for the system shall be max 55°C over an ambient of 40°C.

1.12.4 Enclosure

The enclosure shall be Fabricated out of 1.6mm thick GI in such a way that it gives very good short circuit withstand capacity & shall conform to latest IS standards applicable.

The enclosure design shall be totally dust and vermin proof, weather proof and shall conform to High degree of protection IP-55 as per IS 13947 for feeder application and IP 54 for rising mains (plug in bus trunking).

The Bus duct shall be painted with Textured finished powder coated from Outside.

The color of the enclosure shall be RAL 7032 of minimum thickness of 70 microns & max upto 100 microns.

The enclosure shall be tested for SALT SPRAY test for minimum 1000 Hours from an independent testing Laboratory.

1.12.5 Earthing

Two separate runs of earthing shall be provided which should run along with the entire Length of the Busduct.

The size for the total earth bus bar shall be capable to withstand the earth fault current (earthing bus bar material shall be GI).

1.12.6 Bus Conductor

The material of the bus bars shall be electrolytic grade Aluminum with min 98% purity & minimum conductivity of 57% IACS & copper conductors shall be OFC ETP grade with 99.9% purity & conductivity upto 100% IACS .

Copper shall be TIN plated throughout the length and for Aluminum bus bars ends shall have tin/silver plating

The specifications and the system should be suitable for 100% loading for Horizontal and vertical installation at an ambient temperature of 40 degree C and temperature rise of bus bars shall not exceed 55 Degree C.

1.12.7 Jointing Coupler

Each Bus duct section shall be joined to the adjacent section by UNIBLOCK coupler operated by one/two HTS bolts. The joint assembly shall be such that, it can be installed or removed at any time to isolate / join two adjacent sections of the bus duct in installed conditions.

The Uniblock joint shall have disc spring washers for uniform distribution of pressure.

The joint shall have shear nut with default torque for 100% tightness. The disc spring washers shall accommodate the thermal expansions of the bus bars and housing at joint area.

The insulation material at joint shall be of CLASS 'F' temperature grade.

Serrated aluminum fin type pressure plates for improved heat dissipation at every joints shall be provided

For multiple tire / stack Busduct, multiple busbar runs for each phase shall be shorted at every joint itself.

1.12.8 Insulating Material of the Bus bars

The Insulating material of the bus bars shall be Multilayer Class 'F' insulation with high class P.E.T. insulation having superior thermal characteristics. In case the manufacturer is offering Epoxy Insulation is not allowed.

Insulation BDV shall be min 20kV per layer.

The rated Insulation voltage shall be 1000V and rated Impulse withstands voltage Uimp shall be 12KV. Manufacturer shall submit the Impulse voltage test report.

1.12.9 Temperature Monitoring at Joints

Thermal Stickers shall be provided at each joint pack for regular monitoring of temperature raise after the Bus duct has been put into operation.

1.12.10 Type Test Reports

Manufacturer shall submit following type test reports as per IEC 61439,

Verification of Temperature Rise Limits

Short Circuit Withstand Test.

Verification of dielectric strength.

Verification of Clearances and creep age distance.

Verification test for abnormal heat.

Verification of 12 Kv impulse voltage test.

Verification of Resistance and Reactance

Degree of Ingress Protection

1.12.11 Routine Test Reports by Manufacturer

The following tests shall be conducted at manufacturers works prior to dispatch of the Busduct assembly.

One minute power frequency withstand voltage test of 3.5KV.

Insulation resistance test. Insulation resistance shall be greater than 100 Mega Ohms at 500 V between Phase to Neutral and greater than 200 Mega Ohms at 500 V between Phases to Phase.

Temperature Rise test at Factory.

Physical verification of all components.

1.12.12 Routine Tests during Installation at Site

The following routine tests shall be carried out during Installation at site:

A general visual check shall be carried out. This shall cover measurement of overall dimension, number and type of devices, terminal boxes, connection of terminals and phase sequence etc.

Dry insulation test with power frequency voltage shall be conducted.

Insulation resistance shall be checked after high voltage test is conducted. Insulation resistance shall be greater than 100 Mega Ohms at 500 V between Phase to Neutral and greater than 200 Mega Ohms at 500 V between Phase to Phase.

Electrical Operational Test and Relay / Release Setting.

1.12.13 Tap off box

Shall be fabricated with 1.6mm Electro galvanized steel.

Plug in contacts shall be silver coated & spring loaded construction to ensure adequate and firm contact area.

Shall contain adequate Clamps such that the entire load / weight / mass of Tap off Boxes should not rest on the spring loaded plug in contacts.

Earthing in the plug-in contacts shall make first contact when inserting plug in contacts and break last while removing tap off boxes.

Safe interlocking mechanism shall be provided to prevent accidental opening of the door & also it should not be possible to plug-out or plug-in to the bus trunking, when the Switching device is in 'ON' position.

Suitable external earthing shall be provided in the tap off box to maintain the earth continuity.

The live parts inside the tap off box shall be safe guarded by transparent insulator plate which will allow visible inspection but prevents physical touch.

The tap off box shall be designed in such a way to accommodate different reputed isolating / tripping devices.

1.13 Sub Distribution Panel

1.13.1 General

Sub Distribution Board shall be metal clad totally enclosed, rigid, floor mounting, air insulated, cubicle type for use on 415 volts, 3 phase, 50 cycle system. Equipment shall be designed for operation in high ambient temperature and high humidity tropical atmospheric conditions.

1.13.2 Standards

The equipment shall be designed to conform to the requirements of:

IS 8623 – Factory Built Assemblies of switchgear and control gear.

IS 4237 – General requirements for switchgear and control gear for voltages not exceeding 1000 volts.

IS 2147 – Degrees of protection provided by enclosures for low voltage switchgear and control gear.

IS 375 – Marking and arrangement of bus bars.

Individual equipment housed in the sub distribution boards shall conform to the following IS specifications:

a) Moulded Case Circuit Breakers - IS: 13947-2/IEC 947-2

b)	Miniature Circuit Breaker	-	IEC - 60898
c)	Contractors	-	IEC – 947-4-1, IS 13947-4-1
d)	Current Transformers	-	IS: 2705
e)	Indicating Instruments (Analogue)	-	IS: 1248,
f)	Indicating Instruments (Digital)	-	IS: 13875
g)	Integrating Instruments (Analogue)	-	IS: 722, IS: 13779-1999
h)	Integrating Instruments (Digital)	-	IS: 13779- 1999, IS: 14697
i)	HRC fuse links	-	IS: 13703 / IEC 269

1.13.3 Submittals

Shop Drawings And Technical Data

The tenderer shall furnish relevant technical data of switchgears and associated equipment along with the offer.

The Contractor shall furnish relevant descriptive and illustrative literature on switchgears and associated equipment and the following for approval before manufacture of the panel.

- a) Complete assembly drawings of the panel showing plan, elevation and typical section views and locations of cable boxes, bus bar chamber, metering compartment and terminal blocks for external wiring connections.
- b) Typical and recommended schematic diagrams and control wiring.
- c) Foundation plan showing location of foundation channels, anchor bolts and anchors, floor plans and openings for cables etc.
- d) All drawings and data shall be in English.

1.13.4 Constructions

Sub Distribution boards shall be metal enclosed, indoor, floor mounted free standing and/or wall mounted type made up of the required vertical section, which when coupled together shall form continuous dead front. Sub distribution boards shall be dust and damp protected, the degree of protection being no less than IP: 54 to IS:2147. Sub distribution boards shall be fabricated with a framed structure with rolled/folded sheet steel channel section of Sheet steel shroud and partitions shall be of minimum 2mm thickness, doors and covers shall also be of 2mm thickness. All panel doors shall be pad lockable type. All sheet steel work forming the exterior of sub distribution boards shall be smoothly finished, leveled and free from flaws. The corners to be rounded. Front and rear doors to be fitted with dust proof including neoprene gasket with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be ensured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.

Following minimum clearance to be maintained after taking into account connecting bolts, clamps etc.

i)	Between Phases	-	32mm
ii)	Between Phases and neutral	-	26mm
iii)	Between Phases and earth	-	26mm
iv)	Between Neutral & earth	-	26mm

All insulating, materials used in the construction of the equipment shall be of non hygroscopic materials, duly treated to withstand the effect of high humidity, high temperatures, tropical ambient service conditions. SMC (Sheet Moulded Compound) supports & shrouds shall be used.

Functional units such as moulded case circuit breakers shall be arranged in multi-tier formation. The design of the sub distribution boards shall be such that each MCCB unit shall be fully compartmentalized.

Insulated barriers shall be provided with vertical section and between adjacent section to ensure prevention of accidental contact with main bus bars and vertical risers during operation, inspection or

maintenance of functional units. All doors/covers providing access to live power equipment/circuits shall be provided with tool operated fastness to prevent unauthorized access. Sub distribution boards shall be so constructed that the cable alley shall be sufficient enough to accommodate all the outgoing and incoming cables.

For each cable alley, there shall be separate cable gland plate of detachable type at the bottom and/or top of the panel as required. Gland plate shall be 3 mm thick.

A base frame made out of 75mm x 40mm x 5.0mm M.S. Channel to be provided.

1.13.5 Metal Treatment and Finish

All metal work used in the construction of the sub distribution boards should have undergone a rigorous metal treatment process as follows:

- a) Effective cleaning by hot non alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution
- b) Picking in dilute sulphuric acid to remove oxide scales & rust formation, if any, followed by cold water rinsing to remove traces of acidic solution.
- c) A recognized phosphating process to facilitate durable coating of the paint on the metal surfaces and also to prevent the spread of rusting in the event of the paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution.
- d) Passivating in de-oxalite solution to retain and augment the effects of phosphating.
- e) Drying with compressed air in a dust free atmosphere.
- f) A finishing coat of powder coating of Siemens grey colour and thickness of powder coating shall not be less than 50 micron.

1.13.6 Bus Bars

The bus bars shall be air insulated and made of high conductivity, high strength Aluminium complying with the requirement of grade E-91E.

The bus bars shall be suitably braced with non-hygroscopic SMC supports to provide a through fault withstand capacity shall be as per actual calculation.

The neutral as well as the earth bar should be capable of withstanding the above level. Ridges shall be provided on the SMC supports to prevent tracking between adjacent bus bars. Large clearances and creep age distance shall be provided on the bus bar system to minimize the possibility of fault. The main phase bus bars shall have continuous current rating throughout the length of the panel. The cross section of neutral bus bars shall be same as that of the phase bus bar for bus bars of capacity up to 250 Amp; for higher capacities, the neutral bus bar shall not be less than half (50%) the cross section of that of the phase bus bars. Connections from the main bus bars to functional circuits shall be so arranged and supported to withstand without any damage or deformation the thermal and dynamic stresses due to short circuit currents. Bus bars shall be colour coded with PVC heat shrinkable sleeves.

The sub distribution boards shall be designed that the cables are not directly terminated on the terminals of MCCB etc. but are terminated on cable termination links. Capacity of aluminium bus bars shall be considered as 1.0 Amp per sq. mm of cross section area of the bus bars.

1.13.7 MOULDED CASE CIRCUIT BREAKERS

GENERAL

Moulded Case Circuit Breakers shall be incorporated in sub distribution boards wherever specified. MCCB's shall conform to IS 13947-2 and / or IEC 947-2 in all respects. MCCB's shall be suitable either for single phase AC 230 volts or three phase 415 volts.

FRAME SIZES

The MCCB's shall have the following frame sizes subject to meeting the fault level specified elsewhere.

i)	Up to 100A rating	100Amp frame.
ii)	Above 100A to 200A	200Amp frame.
iii)	Above 200A to 250A	250Amp frame.
iv)	Above 250A to 400A	400Amp frame.
v)	Above 400A to 630A	630Amp frame.

CONSTRUCTIONS

The MCCB cover and case shall be made of high strength heat treatment and flame retardant thermo-setting insulating material. Operating handle shall be of rotary type quick make/quick break, trip-free type. The operating handle for simultaneous operation and tripping of all the three phases.

Suitable fire extinguishing device shall be provided for each contact. Tripping unit shall be of thermo magnetic type up to 250 A for adjustable overload & short circuit protection and shall be microprocessor type above 250 A for adjustable overload, short circuit & earth fault protection. MCCB shall be line load reversible type. Device shall have IDMT characteristics for sustained overload, and short circuits. MCCB shall be current limiting type.

Contacts trips shall be made of suitable are resistant, silver alloy for long electrical life. Terminals shall be of liberal design with adequate clearance.

RUPTURING CAPACITY

The Moulded Case Circuit Breaker service breaking capacity (Ics) shall be based on actual calculation.

TESTING

Test certificate of the MCCB as per relevant Indian Standards (IS) shall be furnished. Pre-commissioning tests on the sub distribution boards incorporating the MCCB shall be done as per standard.

1.13.8 Measuring Instruments for Metering

GENERAL

Direct reading electrical instruments shall be in conforming to IS 1248. The accuracy of direct reading shall be 1.0 for voltmeter and 1.5 for ammeters. Other type of instruments direct reading shall be 1.0 for voltmeter and 1.5 for ammeters. Other type of instruments shall have accuracy of 1.5. The errors due to variations in temperature shall be limited to a minimum. The meter shall be of flush mounting type of 96mm square pattern. The meter shall be enclosed in a dust tight housing. The housing shall be of steel or phenolic mould. The design and manufacture of the meters shall ensure the prevention of fogging of instruments glass. Instruments meters shall be sealed in such a way that access to the measuring element and to the accessories with in the case shall not be possible without removal of the seal. The meters shall be provided with white dials and black scale markings.

The pointer shall be black in colour and shall have zero position adjustment device which could be operated from outside. The direction of deflection shall be from left to right.

Suitable selector switches shall be provided for all ammeters and voltmeters intended to be used on three phase supply.

The specifications herein-after laid down shall also cover all the meters, instrument and protective devices required for the electrical works. The ratings, type and quantity of meters, instruments and protective devices shall be as per the bill of quantities.

DIGITAL AMMETERS

Digital Ammeters shall be confirmed to IS: 13875. It shall be digital type 7 segment LED display. Ammeter shall be suitable for accuracy class 1.0 and burden 0.2 VA approx. The ammeters shall be capable of carrying sustained overloads during fault conditions without damage or loss of accuracy. The meter shall be suitable for working in ambient temp 0 degree to 50 degree and 95% humidity condition.

DIGITAL VOLTMETERS

Digital Voltmeters shall be confirmed to IS: 13875. It shall be digital type 7 segment LED display. Voltmeter shall be suitable for accuracy class 1.0 and burden 0.2 VA approx. The range for 3 phase voltmeters shall be 0 to 500 volts. The meter shall be suitable for working in ambient temp 0 degree to 50 degree and 95% humidity condition. The voltmeter shall be provided with protection MCB of suitable capacity.

CURRENT TRANSFORMERS

Current transformers shall be in conformity with IS: 2705 (Part I, II & III) in all respects. All current transformers used for medium voltage applications shall be rated for 1KV Current transformers shall have rated primary current, rated burden and class of accuracy as required. However, the rated secondary current shall be 15A unless otherwise specified. The acceptable minimum class of various applications shall be as given below.

Measuring	: Class 1.0
Protection	: Class 5 P10

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault on medium voltage system. Terminals of the current transformer shall be marked permanently for easy identification of poles. Separate CT shall be provided for measuring instruments and protection relays. Each C.T. shall be provided with rating plate.

Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT's shall be copper conductor, PVC insulated wires with proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.

1.13.9 Control switches

Control switches shall be of the heavy duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting.

Indicating lamps shall be of the LED type, and with translucent lamps covers. Bulbs & lenses shall be easily replaced from the front.

Push buttons shall be on the momentary contact, push to actuate type fitted with self reset contacts & provided with integral escutcheon plates marked with its functions.

1.13.10 Cable Terminations

Cable entries and terminals shall be provided in the sub distribution boards to suit the number, type and size of aluminium conductor power cable and copper conductor control cable specified.

Provision shall be made for top or bottom entry of cables as required. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated. Cable glands shall be brass compression type, barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

1.13.11 Control Wiring

All control wirings shall be carried out with 1100V grade single core ZHFR cable conforming to IS 694/IS 8130 having stranded copper conductors of minimum 1.5 sq. mm for potential circuits and 2.5 sq. mm for current transformer circuits. Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance. Wiring shall be identified by numbering ferrules at each end. All control fuses shall be mounted in front of the panel and shall be easily accessible.

1.13.12 Terminal Block

Terminal blocks shall be 500 Volts grade of the stud type. Insulating barriers shall be provided between adjacent terminals. Terminals block shall have a minimum current rating of 10 Amps and shall be shrouded. Provisions shall be made for label inscriptions.

1.13.13 Labels

Labels shall be of anodized aluminium, with white engraving on black background. They shall be properly secured with fasteners.

1.13.14 Testing at Manufacturing Work

All routine tests specified in IS: 8623-1977 shall be carried out and test certificates submitted to the Engineer – in –Charge.

1.13.15 Testing and Commissioning

Commissioning checks and tests shall be included all wiring checks and checking up of connections. Primary/secondary injection tests for the relays adjustment/setting shall be done before commissioning in addition to routine megger test. Checks and tests shall include the following:

- a) Operation checks and lubrication of all moving parts.
- b) Interlocking function check
- c) Insulation test: When measured with 500 V megger, the insulation resistance shall not be less than 100 mega ohms.
- d) Trip tests & protection gear test.

1.13.16 Automatic transfer switch

General requirements

The following covers the Automatic Transfer Switch Equipment (ATSE) and its By-Pass equipment. The ATSE shall be composed of

- two separate Load Break Switches,
- a mechanism to operate and mechanically interlock the switches,
- an actuator made of a motorized unit or a double solenoid mechanism (both momentarily energized)
- a 3 phases monitoring device and control module (MDCM) for monitoring supply circuits and for transferring the load circuit from one supply to another.

The ATSE shall be fully integrated in one device. No additional wiring other than the power connection shall be allowed to facilitate the proper functioning of the ATSE with the MDCM.

All the elements of the transfer switch equipment and control module shall be of the same manufacturer.

The ATSE shall be of the PC type.

The ATSE shall have 3 stable positions: Normal, Isolated and Emergency.

The ATSE shall be of a Disconnector type with fully visualized breaking.

The ATSE shall be able to do On Load Manual switching.

The ATSE must be proposed in 3 and 4 poles versions.

Design requirements

The transfer switch unit shall be electrically operated and mechanically held.

It shall be no power consumption while in a stable position other than the one required for the control unit.

The electrical actuator shall be a motorized unit or a double solenoid mechanism, which is momentarily energized.

The switches shall be inherently mechanically interlocked to ensure at any moment only one out of the three stable positions.

The system shall incorporate a position indicator for the 3 stable positions.

To prevent source overlapping the transfer is operated through distinct isolated positions. The sensing and logic shall be built-in microprocessor for maximum reliability and with option of serial communications feature. To facilitate flexibility of installation there shall be provision of Line/ Load reversibility.

The switching contact shall be silver plated and maintenance free in various environments. It shall be of self cleaning capability to optimize the quality of the contact during operation

The Neutral pole of ATS shall be fully rated (100% rating as that of all 4 poles).

The 4 poles shall switch simultaneously.

Standards & Codes

The ATSE shall conform to the requirements of the IEC Standard 60947-6-1 for the source transfer function and 60947-3 for Disconnection and manual on load switching.

The MDCM shall comply with the following standards:.

Emission General standard

- EN 55022 Conductor Emission
- EN 55022 Radiated Emission

Immunity General standard

- EN 61000-4-2 Electrostatic Discharge (ESD)
- EN 61000-4-3 Radiated electromagnetic field
- EN 61000-4-4 Electrical fast transient (EFT)
- EN 61000-4-5 Surges
- EN 61000-4-6 Conducted radio frequency field
- EN 61000-4-8 Power frequency magnetic field
- EN 61000-4-11 Voltage dips, short interruptions and variations
- EN 61000-4-13 Harmonics and inter harmonics
- IEC 61010-1 Electromagnetic compatibility

Safety requirements & features

The ATS shall be of Disconnector type as per IEC 947-3

It shall not be possible to mix the two supplies (Normal supply and Emergency supply) in case of any failure of the equipment. This characteristic must be guaranteed by a proper design of the mechanism.

Opening and Closing operations of the contacts must be independent from the driving mechanism. The speed of the contacts shall be independent of the speed of motor or manual operation to ensure the safety of the operator.

In case of contacts welding, the ATSE must remain in its actual position, in Manual or Automatic operation, according to IEC 60947-3. Neither the manual nor the automatic operation can lead to a failure of the mechanism or of the interlocking. The mechanical indicator shall show the actual position in contact welded situation.

The ATSE shall have a Manual and Automatic mode: the swap between both modes shall be possible only with a key or selector on the front face. Manual operation shall be prohibited in automatic and Automatic operation shall be inhibited in Manual mode.

The ATSE shall have a built-in provision for padlocking in the Isolation position for the safety of the operators. A provision for a padlocking in Normal or Emergency positions shall also be provided.

Automatic commands shall be inhibited when the product is padlocked

The padlocking shall be possible only in Manual position.

The ATSE shall be able to accommodate up to three padlocks at the same time.

A handle for manual operation shall be provided for emergency transfer purposes.

The handle shall be located on the ATSE itself to ensure a safe and quick operation during power outages. The handle shall be easily removable for automatic operation.

Manual transfer shall be possible on load, without any upstream disconnection, with respect to the safety of the operator. This feature is essential in case of emergency and panic.

It shall be possible to block the re-transfer process via programming. When selected, retransferring to the Main source must be validated locally or remotely via keypad or external contact.

The replacement of the motor operated actuator shall be possible under live condition with respect to the operator safety (isolation distances, easy access to the fixing elements).

Operations

The ATSE shall be supplied by any present source. It shall allow the ATSE to be controlled in the 3 positions with only one source present.

The ATSE shall have high short time current withstand capability (Icw 1 second in accordance to IEC 60947-3).

Manual retransfer function can be inhibited and must be possible either locally or from remote.

The ATSE shall have the possibility to be electrically controlled in any of the 3 positions by mean of dry contacts. It overrides the automatic sequence. Once back in Auto mode, the ATSE shall come back to the proper position.

Automatic operation via the MDCM

The monitoring device and control module (MDCM) must be integrated within the ATSE.

Electrical Control of the product position must be possible and controlled locally or remotely. Any automatic command must be inhibited during control operation (takeover).

Parameters sensing & setting

The MDCM shall include 3 phases sensing for monitoring of voltage and frequency to detect the presence and loss of the power supply for activation of the automatic transfer. The settings are as following:

PARAMETER	SOURCES	THRESHOLD	HYSSTERESIS
Under voltage	Mains and Backup, 3 phases	80 to 98%	81 to 99%
Over voltage	Mains and Backup, 3 phases	102 to 120%	101 to 119%
Under frequency	Mains and Backup	80 to 99%	80.5 to 99.5%
Over frequency	Mains and Backup	101 to 120 %	100.5 to 119.5%
			100.6

Voltage settings shall be field adjustable in 1% increments either locally with the display and keypad, or remotely through serial communication. Frequency settings shall be adjustable in 0.1% increments either locally with the display and keypad, or remotely through serial communication. All settings shall be adjustable directly from the front face, opening of the MDCM is strictly forbidden for obvious reasons of safety and possible damages. The MDCM shall have a phase sequence detection to ensure the proper voltage vectors sequence on both power supplies. The MDCM shall have programming for selection of network type 4NBL/41NBL/42NBL/3NBL/2NBL/2BL/1BL and capability to monitor the minimum and maximum voltages and frequencies threshold and hysteresis. The MDCM shall allow the setting of the sources priority. The MDCM shall be equipped with the activation of manual re-transfer mode. The MDCM must be equipped with a permutation counter to enable to record the life span of the ATSE represented by the number of transfer operations. Resetting of this counter shall be conditioned by 4 digits numerical password with 2 levels of security. Interface with the MDCM The MDCM must be easily configurable via a HMI dialogue interface complete with a 2 levels security 4 digits numerical Password for programming access right. The MDCM shall be equipped with local visualization of three phase currents, powers (P, Q, S), frequency and power factor through 3 current transformers measurement from the 2 sources. Source status shall be clearly visible on the front of the unit for both normal & emergency, stated in a clear schematics diagram. The controller shall provide digital readout of voltage on all 3 phases, frequency and phase rotation. Inputs/outputs, communication.

The MDCM shall be able to provide up to four Inputs (Programmable NO or NC) and four Outputs (NO Type) for interfacing with control system. The inputs and outputs functions shall be versatile (no unique function), the assignment being done by the HMI or the communication. The MDCM can be equipped with an option to enable communication via RS485 module MODBUS protocol with a transmission speed up to 38400 bps. The link shall be capable of reading the voltages, timers and inputs values, setting all parameters values and inputs/outputs functions.

Timers settings

An adjustable timer of 0 to 60 seconds shall be provided to detect the priority network failure, to override any transient outages of the normal supply. (Main Failure Timer, MFT). A timer of 0 to 60 seconds shall be provided to validate the stability of emergency network before transfer, once the Generator Set supply is available. (Delay To Transfer, DTT). While transferring to emergency, a possibility to stay in position 0 shall be provided from 0 to 20 seconds (O Main Failure timer, OMFT). An adjustable timer of 0 to 30 minutes shall be provided to detect priority network return to normal, to override any false availability of the normal supply. (Main Return Timer, MRT). While transferring back to primary source, a possibility to stay in position 0 shall be provided from 0 to 20 seconds (O Main Return timer, OMR). An adjustable timer of 0 to 30 minutes shall be provided to allow the generator cooling down after load retransfer from standby source to Mains source (Cool Down Timer, CDT). The controller shall provide the ability to prevent retransfer to Mains from happening, except if the user validates manually the retransfer. (Manual Re-Transfer).

Maintenance & testing

The MDCM shall provide the possibility to run a test ON load and OFF load.

It shall be possible to actuate these sequences from the front face HMI or via the Modbus link.

Maintenance of the electrical parts (Controller or Motorization unit) shall be possible without disconnection of the power conductors.

It shall be possible to change any actuator unit based on a motor technology in less than 10 minutes without disconnection of the power conductors. During this operation, it shall still be possible to operate manually the switch with the MDCM and motorization removed.

Both Local and Remote control of test sequences shall be possible on the Switch.

Inspection at factory

The inspection / testing of all the ATS / STS shall be done at manufacturer works before dispatch by client & consultant.

Factory testing and certification

The complete ATSE shall be factory tested to ensure proper operation of the individual components together and correct overall sequence of operations. The test must also ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

The manufacturer shall be certified ISO 9001 : 2003 International Quality Standard and the manufacturer shall have third party certification verifying its quality assurance in design / development, production, installation and servicing in accordance with ISO 9001.

Training

The manufacturer / supplier shall ensure the training for Operating staff in the local national language, by means of fully configured Training kits to impart hands-on training to simulate various parameters and for trouble shooting exercise.

1.14 Distribution Boards

General

a) Distribution Board shall be double door type with extended loose wire box & M.S. Junction Box at the top and suitable for flush installation. All distribution boards shall be of three phases (415 Volts) or single phase (240 Volts) type with incoming isolator or MCB and/or RCCB as in Bill of Quantities. Distribution boards shall contain plug in type miniature circuit breaker mounted on bus bars. Miniature circuit breakers shall be quick make & quick break type with trip free mechanism. MCB shall have thermal & magnetic short circuit protection. MCB shall conform with IS 8828-1978 & IS 8828 - 1996. Bus bars shall be of electrolytic copper. Neutral bus bars shall be provided with the same number of terminals as there are single ways on the board, in addition to the terminals for incoming mains. An earth bar of similar size as the neutral bar shall also be provided. Separate neutral & earth bus bar link to be provided for each phase. Phase barrier shall be fitted and all live parts shall be screened from the front. Ample clearance shall be provided between all live metal and the earth case and adequate space for all incoming and outgoing cables. All distribution board enclosures shall have an etched zinc base stove painted followed by synthetic stove enamel, colour

light gray. A circuit identification card in clear plastic cover shall be provided for each distribution board. IK (Mechanical Stress) rating of distribution board enclosure shall not be less than IK –07/ 08 / 09.

b) Distribution Board with single phase outgoings requirement shall be Horizontal type. Distribution Board with three phase outgoings requirement shall be Vertical/ Horizontal type. Distribution Board installed in indoor dry locations shall conform to IP-42. Distribution Board installed in outdoor & wet locations shall conform to IP- 65.

c) Miniature Circuit Breakers for lighting circuits shall be of "B" series where as the circuits feeding discharge lamps (HPMV or HPSV) halogen lamps, all power outlet points, equipment/ machinery shall be of "C/D" series (Motor circuit) types. All miniature circuit breakers shall be of not less than 10KA rated rupturing capacity. All miniature circuit breaker terminals shall have safety shutter.

d) Distribution board shall be provided with isolator or MCB and/or earth leakage circuit breaker. Earth leakage circuit breaker shall be current operated type and of 30mA sensitivity unless otherwise stated. RCCB shall be mounted within distribution board box for single phase distribution board while in three phase distribution board RCCB shall be either mounted within distribution board box or in a separate MS box below distribution board. Width and depth of RCCB box shall be same as that of distribution board box and of same finish. Height of RCCB box shall be sufficient to accommodate RCCB & termination of incoming & outgoing wires. Distribution board box, isolator, MCB'S used shall be of one/same manufacturer. Standard size manufactured by approved manufacturer shall be used. In case size required is not standard size of manufacturer, in that case next standard size distribution board box shall be used with incoming & outgoing MCB. Additional cutout/space for outgoing MCB shall be plugged with blank plates. No extra cost shall be paid for using bigger/higher size distribution board box and blank plates.

1.15 Conduit and Wiring System

1.15.1 M.S. Conduit

All conduit pipes shall be of approved gauge (not less than 16 SWG for conduits of sizes up to 32mm diameter and not less than 14 SWG for conduit of size above 32mm diameter) solid drawn or reamed by welding finished with stove enameled surface. All conduit accessories shall be of threaded type and under no circumstances pin grip type accessories shall be used. The maximum number of PVC insulated 650/1100 volts grade copper conductor cable that can be drawn in conduit of various sizes shall be as per IS code. No steel conduit less than 20mm in diameter shall be used unless otherwise stated.

1.15.2 Conduit Joints

Conduit pipes shall be joined by means of threaded couplers, and threaded accessories only. In long distance straight run of conduits, inspection type couplers at reasonable intervals shall be provided or running threads with couplers and jam nuts shall be provided. In the later case the bare threaded portion shall be treated with anti-corrosive preservative. Threads on conduit pipes in all cases shall be between 13mm to 19mm long sufficient to accommodate pipes to full threaded portion of couplers or accessories. Cut ends of conduit pipe shall have no sharp edges nor any burrs left to avoid damage to the insulation of conductor while pulling them through such pipes.

Wherever conduit passes a building expansion joint, galvanized flexible metallic conduit shall be provided for connecting rigid M.S. Conduit in either slab.

1.15.3 Protection against Condensation

The layout of conduit should be such that any condensation or sweating inside the conduit is drained out. Suitable precaution should also be taken to prevent entry of insects inside the conduit.

1.15.4 Protection of Conduit against Rust

The outer surface of conduit including all bends, unions, tees, junction boxes etc forming part of conduit system shall be adequately protected against rust when such system is exposed to weather by being painted with two coats of oxide paint applied before they are fixed. In all cases, no bare threaded portion of conduit pipe shall be allowed. Unless such bare thread portion of conduit is treated with anticorrosive preservative or covered with approved plastic compound.

1.15.5 Painting of Conduit and Accessories

After installation, all accessible surface of conduit pipes, fittings, switch and regulator boxes etc. shall be painted with two coats of approved enameled paint or aluminium paint as required to match the finish of surrounding wall, trusses etc.

1.15.6 Fixing of conduits

Surface Conduit

Conduit pipes shall be fixed by heavy gauge saddles, secured to suitable wood plugs or other approved plugs with screws in an approved manner at an interval of not more than one meter but on either side of the couplers or bends or similar fittings, saddles shall be fixed at a distance of 30cm from the centre of such fittings. The saddles should not be less than 24 gauges for conduits up to 25mm dia and not less than 20 gauge for larger diameter conduits. The corresponding widths shall be 19mm & 25mm. Where conduit pipes are to be laid along the trusses, steel joint etc. the same shall be secured by means of special clamps made of MS. Where as it is not possible to drill holes in the trusses members suitable clamps with bolts and nuts shall be used. All fixing arrangement like saddles, special purpose clamps, nuts, bolts etc. shall deemed to be included in quoted rates of conduit.

For 25mm diameter conduit width of clip shall be 19mm and of 20 SWG. For conduit of 32mm and above, width of clip shall be 25mm and of 18 SWG.

Where conduit pipes are to be laid above false ceiling, either conduit pipes shall be clamp to false ceiling frame work or suspended with suitable supports from the soffit of slab. For conduit pipe run along with wall, the conduit pipe shall be clamped to wall above false ceiling in uniform pattern with special clamps if required to be approved by the Engineer-In-Charge at site.

Recess / Concealed Conduit

The chase in the wall shall be neatly made and of ample dimensions to permit the conduit to be fixed in the manner desired. In the case of building under construction, conduit shall be buried in the wall before plastering and shall be finished neatly after erection of conduit. In case of exposed brick/rubble masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work. Entire work of chasing the wall, fixing the conduit in chases, and during the conduit in mortar before plastering shall form part of point wiring work. (For chase cutting-chase cutting machine shall be used and no manual cutting shall be allowed).

The conduit pipe shall be fixed by means of stapples or by means of saddles not more than 60cm apart or by any other approved means of fixing. Fixing of standard bends and elbows shall be avoided as far as practicable and all curves maintained by bending the conduit pipe itself with the long radius which shall permit easy drawing in of conductors. All threaded joint of conduit pipe shall treat with some approved preservative compound to secure protection against rust. Suitable inspection boxes to the barest minimum requirements shall be provided to permit periodical inspection and to facilitate replacement of wires, if necessary. These shall be mounted flush with the wall. Suitable ventilating holes shall be provided in the inspection box covers. Wherever the length of conduit run is more than 10 metres, then circular junction box shall be provided to facilitate pulling of wires. The chicken wire mesh shall be provided by civil agency.

1.15.7 Outlet Boxes

Switch/outlet boxes shall be made of metal on all sides except on the front. Boxes shall be G.I. Up to 10cmx20cm size Box shall have wall thickness of 18 SWG and above 10cmx20cm shall have 16 SWG. The metallic boxes shall be painted with anticorrosive paint before erection. Clear depth of the box shall not be less than 50mm all fitting shall be fitted in flush pattern. Switch/outlet boxes shall be suitable to house modular type light and power accessories. Earthing stud to be provided for connection of earthing wire in side of box at near any corner.

1.15.8 Fan Box

Fan Box shall be made out of 14 gauge M.S. sheet in hexagonal shape. The dia of box shall be 150 mm and depth of box shall be 80 mm. A M.S. covers plate size 160 mm x 160mm x 16 gauges to be provided in the back of fan box. 12 mm dia M.S.Rod to be provided for fan hanging arrangement in

the box. A 28 mm dia knockout To be made in all six hexagonal vertical part for conduit entry in the box. The box shall be painted with 2 coat of primer. A 180 mm dia, 2 mm thick hylem sheet Cover to be provided. (The sample to be approved before procurement / execution by owner / consultant)

1.16 Light & power accessories

1.16.1 General

All light & power accessories shall be of modular range of plate switch type and shall be of one manufacturer (brand) and type.

1.16.2 Light Switches Modular Type

All switches for control of light shall be of 6/10 Amp unless otherwise stated. All switches shall be modular range of plate switch type. The switches shall be rocker mechanism type with silver contact. All switches shall be of white finish or as sample approved by owner/consultant.

1.16.3 6/16 Amp Switch Socket Outlet Modular Type

Switch socket outlet shall be of 3 pin 6Amp outlet shall have safety shutters. The switch shall be of rocker mechanism type with silver contact. Socket outlet shall be shutter type and of modular range of plate type and having white finish or as approved by owner / consultant.

1.16.4 Wiring

All FRLS insulated copper conductor multi-stranded wires shall conform to relevant IS codes. Cable conductor size and material shall be as required.

All internal wiring shall be carried out with FRLS insulated wires of 1100 volts grade. The circuit wiring for points shall be carried out in looping in system and no joint shall be allowed in the length of the conductors. Circuit wiring shall be laid in separate conduit originating from distribution board to switch board for light/fan. A light/fan switch board may have more than one circuit but shall have to be of same phase. Looping circuit wiring shall be drawn in same conduit as for point wiring. Each circuit shall have a separate neutral wire. Neutral looping shall be carried out from point to point or in light/fan switch boards. A separate earth wire shall be provided along with circuit wiring for each circuit. For point wiring red or yellow or blue colour wire shall be used for phase and black colour wire for neutral. Circuit wiring shall be carried out with red, yellow or blue colour FRLS insulated wire for RYB phase wire respectively and black colour FRLS insulated wire for the neutral wires. FRLS insulated green colour wire shall be used as earth continuity conductor and shall be drawn along with other wires. No wire shall be drawn into any conduit until all work of any nature, that may cause injury to wire is completed. Care shall be taken in pulling the wires so that no damage occurs to the insulation of the wire.

Before the wires are drawn into the conduit, the conduits shall be thoroughly cleaned of moisture, dust and dirt. Drawing & jointing of copper conductor wires & cables shall be as per CPWD specifications.

All the wire & cables shall be copper up to 16 sq.mm and above 16 sq.mm shall be aluminum except UPS cables. For UPS Incoming & outgoing, only copper cable/ wire shall be used.

Nominal Cross-sectional Area of conductor in Sq. mm	20mm		25mm		32mm		38mm		51mm		64mm	
	S	B	S	B	S	B	S	B	S	B	S	B
1.50	5	4	1	8	18	12	-	-	-	-	-	-
2.50	5	3	8	6	12	10	-	-	-	-	-	-
4	3	2	6	5	10	8	-	-	-	-	-	-
6	2	-	5	4	8	7	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-

16	-	-	2	2	3	3	6	5	10	7	12	8
25	-	-	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	-		3	2	6	5	8	6
50	-	-	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	-	-	4	3	5	4

1.16.5 Joints

All joints shall be made at main switches, distribution board socket and switch boxes only. No joint shall be made in conduits & junction boxes. Conductors shall be continuous from outlet to outlet.

1.16.6 Sub Mains

Sub-main wiring shall be carried out with FRLS Insulated Copper multi-stranded wires/cables.

Sub-main cable where called for shall be of the rated capacity and approved make. Every sub-main shall be drawn into an independent adequate size conduit. Adequate size draw boxes shall be provided at convenient locations to facilitate easy drawings of the sub-main cables. Cost of junction box/drawn box is deemed to be included in the rates of sub-main wiring. An independent FRLS insulated copper earth wire of proper rating shall be provided for every sub-main. Single phase sub-main shall have single earth wire whereas three phase sub-main shall be provided with two earth wire.

Where sub-mains cables are connected to the switchgear, sufficient extra lengths of sub-main and mains cable shall be provided to facilitate easy connections and maintenance. For termination of cables crimping type cable socket/lugs shall be provided. Same colour code as for circuit wiring shall be followed.

1.16.7 Load Balancing

Balancing of circuits in three phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

1.17 Conduiting and Wiring for SAMTV System

1.17.1 Conduiting

Conduiting for SMATV system shall be carried out in M.S. Conduit Conduiting shall be carried out as specified in point wiring head.

1.17.2 Outlets

All SMATV outlets shall be provided with modular range of cover plate, box and coaxial outlet. Cover plate shall match in shape & finish with other light and power accessories.

1.17.3 Junction Box

Suitable size of metallic junction box shall be provided for termination of conduit for SAMTV system. Box shall be made of 16 SWG G.I. sheet and shall be treated before galvanizing. Front of the junction box shall be provided with 3mm thick phenolic laminated sheet cover.

1.17.4 Coaxial Cables

The coaxial cable shall be of wideband type coaxial cables.

1.17.5 Tap Off

These shall be of ultra wide bandwidth and of hybrid type. These shall have a flat frequency response over the entire operating range. These shall have aluminium cast housing for high frequency radiation resistance.

The Tap offs shall be in one way, two way and four way configurations.

1.17.6 Splitters

These shall be of ultra wide band width and of hybrid type. These shall have a flat frequency response over the entire operating range. These shall have an aluminium cast housing for high frequency radiation resistance.

The splitters shall be in 2 way, 3 way & 4 way configurations.

1.18 Fire Alarm with DVC and FFT System

1.18.1 General Scope of Works

This section of the specification includes the furnishing, installation, and connection of a microprocessor controlled, addressable fire alarm equipment required to form a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panels, auxiliary control devices, annunciator, power supplies, and wiring as per shop drawings and specified herein.

The system shall be designed such that each loop shall be limited to only 80% of its total capacity at initial installation.

All equipment/components shall be new & the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation. Refer to the riser/connection diagram for all specific system installation/termination/wiring data.

All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

1.18.2 Reference for Installation

UL / EN Approved

1.18.3 Submittals and Shop Drawing

Sufficient information shall be clearly presented and shall include manufacturer's name, model numbers, power requirements, equipment layout, device arrangement and complete wiring.

Sequence and description of operation.

Product Data for each type of equipment, initiating device, signal device, peripheral device and cable provided on the project.

Shop drawings shall include battery calculations, floor plans and wiring diagrams.

1.18.4 Operation Manual

Operation manual shall include:

Installation instructions for use by installing contractor.

Operational instructions or manual for use by building personnel, including Name and phone number of service representative.

Maintenance instructions as required for use by building personnel.

Copy of approved shop drawings.

1.18.5 Basic System

The system shall be a complete, electrically supervised fire detection and evacuation system using fire fighter telephone with microprocessor based operating system having the following; capabilities, features and capacities:

Communication between network nodes, each supporting an interactive, self-standing, intelligent local control panel, with system wide displays. Any network node shall be capable of supporting a local system in excess of 4000 input/output points.

The local system shall provide status indicators and control switches for all of the following functions:

Audible and visual notification alarm circuit zone control.

Status indicators for sprinkling system water-flow and valve supervisory devices. (if any)
Any additional status or control functions as indicated on the drawings, including but not limited to; emergency generator functions, fire pump functions, door unlocking and security with bypass capabilities.

Each intelligent addressable device or conventional zone on the system shall be displayed at the fire alarm control panel by a unique alphanumeric label identifying its location.

1.18.6 Specification

All the equipment shall be UL approved and compliance to NBC/CPWD spec.

1.19 UPS System

1.19.1 System Components

IGBT Technology.

1.19.2 Product Certification / Testing

The product shall have certification from any one of the following -

- a) ERTL
- b) ETDC
- c) Sameer
- d) STQC
- e) IEC
- f) ISO 9001

1.19.3 Operating Temperature

0-40 degree Centigrade

1.19.4 Humidity

Upto 90%

1.19.5 Output Frequency

50 Hz +/- 0.01% Hz

1.19.6 Wave Form

Pure Sine Wave

1.19.7 Transient Response

+/- 1% maximum under following conditions:

- a) Loss or Return of Input AC supply
- b) 100% step load

1.19.8 Load Power Factor

0.9 lag to unity.

1.19.9 Crest Factor

Greater than 3:1

1.19.10 Switch Over Time

Zero

1.19.11 Overload Rating

110% for 30 minutes

125% for 01 minutes

1.19.12 Switching speed

Minimum 2 KHZ

1.19.13 Indication

Mains ON/OFF, /Battery HIGH/LOW, Battery ON, Invertor ON/TRIP, O/P HIGH/LOW, Battery HIGH/LOW, Alarm for Battery Discharge.

1.19.14 Protection

Input - Over/Under voltage, Over Current.

Battery - Over/Under Voltage, Over Current, Battery Low Alarm/Trip.

Output - Over/Under Voltage, Over Current.

Output - Short Circuit Over Temperature DC Over Current

1.19.15 Control Circuitry

Microprocessor based control circuitry be provided and all indications will be digitally displayed using microprocessor based software.

1.19.16 Metering

Digital display with multifunctional key panel indicate.

Output Voltage/Current

DC Voltage/Current

Output Frequency

1.19.17 Communication Port

RS 232

1.19.18 Diagnosis & Configuration Software

Compatible with Unix/Windows.

1.19.19 Out Look

Compact size with aesthetically good look (specify the size and weight)

1.19.20 Ups Failure

During failure in the UPS equipment the static switch automatically transfer the A.C. load directly to the AC. line in less than 1/4 cycle so that transfer does not affect critical equipment operation.

1.19.21 Harmonic Distortion of Wave Form

Total harmonic distortion (THD) should be below 3% for linear load and below 5% for nonlinear load.

1.19.22 Maintenance by Pass Switch

The portion of UPS module used to connect the alternator supply to critical load while electrically isolating static switch and inverter for maintenance purpose.

1.19.23 Battery Disconnect Switch

The switch used to electrically isolate the storage batteries from UPS module.

1.19.24 Static Transformer Switch

The switch senses an inverter shutdown signal or degradation of inverter output item. It shall automatically transfer the loads from one inverter to the alternative AC power without interruption.

1.19.25 Retransfer to Inverter

The static transfer switch shall be capable of automatically retransferring the load back to inverter after the inverter has returned to normal voltage and stabilized for period of time.

1.19.26 Quality Assurance

The manufacturer shall have quality assurance program with check on incoming parts and final products. A final test procedure for product shall include a check of all performance specifications and a minimum 24 hour running.

1.19.27 Installation Drawing

After the receipt of order a minimum two sets of installation drawings showing outline dimension, weights and connections and a one line drawing of the UPS shall be sent to the purchaser to be used in planning the installation of the system.

1.19.28 Product Documentation

Manufacturer shall supply a comprehensive set of product documentation for:

1. Installation
2. Operation
3. Maintenance

This should include complete outline and external connection drawings and schematic and physical wiring diagrams as well as parts list and parts layout down to the smallest components level. It should include startup and service manuals with complete privation and remedial maintenance and trouble showing instructions. This should include all ancillary equipment and accessories.

1.19.29 Training

It is important that at least -2 personnel who are to be responsible for operation and maintenance of UPS be trained at the manufacturer site.

1.19.30 Spare Parts

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

The recommended spare parts for 5 years of maintenance are to be listed and should be quoted along with main modules.

1.19.31 Material and Workmanship

- 1) Workmanship shall be first class in every respect.
- 2) All material shall be new and of best commercial grade.
- 3) Brackets and securing hardware shall be electroplated with corrosion resistance material.
- 4) Internal wiring conductors shall be combined into cable or bundles and shall be tied securely together and numbered or coded to correspond with documentation.

1.19.32 Storage Battery

The storage battery shall be furnished with racks connecting hardware and standard service resistance material accessories. The battery shall be delivered charged and filled ready for service.

1.19.33 Service Report

Assigned field service report describing start-up and on site testing shall be furnished.

1.19.34 Maintenance

If the battery is taken out of service for maintenance by manually opening battery disconnect switch the UPS shall continue to function and meet all the performance criteria specified except.

1.19.35 Inverter efficiency

94% minimum

1.19.36 Protection class

IP – 20

1.20 Boom Barrier System

E	Boom Barrier (6m)			
	Minimum Specifications			
1	Application: Outdoor IP Rating: 54			
2	Barrier Housing Unit: Powder Coated; Boom: Powder Coated White RAL 9010 with Red reflective strips.			
3	Housing Material Of Construction: All Aluminium Housing with Base frame in SS-304 for high protection against corrosion.			
4	Protection: All Housing and internal parts will be rust & corrosion free metals or alloys of high strength with suitable Epoxy coating as applicable.			
5	Boom Specifications: The Booms shall be extruded aluminum with octagonal profile (straight/articulated) 100mm. X 55mm. X 1.6 mm. shall be the structure of the profile/ Alternatively the boom may also be offered as extruded aluminum with round profile of dia 74 mm X 1.4 mm.			
6	Intelligence: The barrier shall use a blockable DC High Torque Drive in combination with CAN bus communication standard interfaced Controller. It shall offer LCD Display & Graphic User Interface for easy control setting. Possibility for			

	Integration via standard user interfaces.			
7	Digital Inputs: Minimum 8 Digital Outputs: Minimum 4 Relay Outputs: At least 6			
8	Compliance & Safety: Compliance to CE. Adherence to Safety Requirements of the EMC Directive 2004/108/EC, Low Voltage Directive 2006/95/EC and the basic requirements of the Machinery Directive 2006/42/EC			
9	Power Supply: 230+/- 10% VAC, 50 Hz.			
10	Maximum Power Consumption: Not More than 120 watts for Barrier Length up to 6 Meters.			
11	Opening & Closing Time: 4 seconds for Boom Length between 3.5 to 6 Meters			
12	Operating Temperature: 30 Degree Celsius to + 50 Degree Celsius			
13	Safety : Software for Detection of Presence of Vehicle in Loop or in the path of Infrared Safety Sensors available. Loops or sensors to be used to prevent barriers from closing on the vehicle.			
14	Duty Cycle: 100%			
15	Integration: Shall function in integration with Smart cards, proximity reader based access control systems etc.			
16	Performance Requirement: MCBF- 10 Mil Cycles, MTBF- 50,000 Hours, MTTR- 30 Minutes			
17	Certificates Required: TUV For Opening & Closing time, ISO Certificate of the Company from the country of Origin, UL Certification for the product, Certification for Ingress Protection (IP), EMC Test report			

1.21 Elevators

1.21.1 General

Good elevator system design shall be critical to a multi-storey building. Planning of elevator systems must therefore feature very early in overall building design programmes. The quality of Vertical Transportation is vital to circulation and therefore shall have a profound effect on human response towards efficiency in overall performance.

Elevator System shall be confirmed to match the expected traffic requirements, both present and future. This shall mean that accuracy in predicting expected building population and how and when it shall move is critical for it is on this principle that fundamental elevator system design shall be based.

Vertical transportation system shall be designed on three basic considerations, namely,

1.21.2 Function of the building

Function of the building i.e. Cultural Building.

1.21.3 Quality of service

Quality of service which is measured in terms of waiting time of passengers / persons at various floors for boarding of elevator.

1.21.4 Introduction

It is proposed to Supply, Installation, Testing and Commissioning of Lift with all accessories etc.

1.21.5 General

This specification covers manufacturer, testing as may be necessary before dispatch, delivery at site, all preparatory work, assembly and installation, final testing, commissioning, putting into operation. The lift shall be supplied as per relevant latest IS code, Latest CPWD Specification & NBC-2016.

1.21.6 Approvals

Statutory approvals shall be in contractor scope etc.

1.21.7 Testing

Tests for the various items of equipments shall be performed at the contractor's cost and test certificate to be furnished by the contractor (for Motor, Machine Break-tests Controller & Steel wire Ropes). If required by the Engineer-in-Charge, the Contractor shall permit the Owner's authorized representative to be present during any of the tests. After notification to the Owner that the installation has been completed the contractor shall make under the direction and in the presence of the Engineer-in-Charge such test and inspections as have been specified or as the Engineer-In-Charge shall consider necessary to determine whether or not the full intent of the requirements of the plans and specifications have been fulfilled. In case the work does not meet the full intent of the specifications and further tests shall be considered necessary the contractor shall bear all the expenses thereof.

1.21.1 Lift Schedule-

As per architectural drawing.

1.21.2 Lift Equipments SpecificationGeneral

The lifts shall be A.C. variable voltage variable frequency micro processor controlled Machine Room & Machine Room Less as per actual/site requirement.

Stops & Openings

Lifts shall be required to serve the floors as shown in attached drawing of Lift plan and sections.

Travel

The travel of lifts shall be as per actual requirement.

Tenderer shall note that all dimensions are as indicated in the enclosed drawings and his design shall be based on the same .These specifications have been based on Indian standard and equipments available locally as per Indian codes and rules. Equipment from other countries will be acceptable if it is of better quality and competitive in price and conforms to International Standards .The size of hoist way and car enclosure will, however be the same as specified namely.

Controls

Operation of Lifts shall be full collective as Simplex / Duplex / Triplex as per actual / site requirement.

Driving Mechanism

The lift shall be provided with A.C, variable voltage, variable frequency, microprocessor controlled motion and drive control system. The tenderer shall indicate the model No. name of manufacturer and country of origin being provided, and the cable size required.

Operation

Each car shall be arranged so that momentary pressure of one or more of its buttons shall cause that car to start.

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

A car cannot be started unless the car door is in the closed position and all hoist way doors for that car are locked in the closed position.

All the lifts shall be provided with fireman switch.

Operation with Attendant

When the key switch is in position of "without Attendant" the elevator shall operate as described above.

With the key switch in the position of "with Attendant" the direction lights and buzzer shall be operative and "up" direction and the "down" direction buttons in the regular car operating panel shall be effective for the attendant operation.

When on attendant operation, the car and hoist way doors shall open automatically at each stop but the closing of the above shall be subject to the "up" or "down" direction buttons.

As a visual signal to the attendant, the "up" or "down" direction-jewel shall illuminate upon registration either car or landing calls to indicate the travel direction of the car. The attendant shall operate the lift normally in the direction indicated by the direction -jewel. Travel may be realised by the pressure of a car button for a landing in that direction from the car and the direction button in the car operating panel for that direction.

When the key-operated independent service switch is "on" the corresponding car shall operate only from its car button and shall be entirely independent of the other car. The other car shall then operate as a Simplex Collective Elevator responding to its own car calls and all landing calls.

The pressure of direction button shall cause the doors to close and start the car in the direction desired, provided a car on landing call is registered for the direction. If pressure of the direction button is released before the car starts, the doors shall reopen. After the car has started, the direction button can be released and the car shall answer car and landing button calls.

Continuous pressure of the non-stop button shall cause the car to by-pass all landing calls and respond only to registered car calls.

In order to have a car available at the main floor while both lifts are in operation "with Attendant" a "down" light signal shall be registered. Automatically in the first car which clears all its calls. This signal shall indicate to the attendant that this car should be started "down" and pressure of the "down" direction button shall move the car automatically to the main floor.

The car shall also have emergency stop and alarm push buttons. In the machine room manual Cranking device shall be provided.

Machine, MR

The lift machine shall be placed directly above the hoistway upon machine room slab and steel beam and directly above the Car for MRL/MR Lift Suitable material like rubber pads of required thickness shall be used below the lift machine to reduce noise and vibrations. The machine shall be of gearless type. It shall include a motor, electro mechanical brake, sheave shaft and sheave all completely mounted on a common bed plate. The hard alloy cast iron or steel sheave shall have rope grooves to ensure proper traction and minimize rope wear. Suitable means of lubrication shall be provided for all the bearing. Means for manual operation of the lift car shall be made by providing wiring wheel suitably marked to indicate the direction of the movement of car to enable the lift car to be brought to the nearest landing manually in the event of stoppage of lift due to any reason with a warning display for switching off the electrical supply before operating manually.

Motor

The motor shall be particularly designed for elevator service with high starting torque at low speed and low running current.

Brake

The drive machinery shall be provided with an electromagnetic brake. It shall be spring applied and electrically released type.

The brake shall be capable of operating automatically by the various safety devices, current failure, the failure of any of the several units of the equipment to function in a proper manner and by normal stopping of the car. It shall be so designed that it is capable of stopping and holding the car with load. The operation of brake shall be smooth, gradual and noiseless.

Details of brake installation should be given along with bid.

Control

The control shall be variable voltage variable frequency.

Controller

Electro magnetic controller shall be provided with microprocessor with fully computerized control system in machine room to control starting, stopping and to automatically apply the brake in the event of power failure or on operation of safety device. The electrical contacts shall be suitable materials for long life and reliable operation without excessive wear.

Car Frame Safety Gear and Governor

The car frame which supports the car platform and enclosure shall be made of structural steel and equipped with suitable guides and car safety device mounted underneath the car platform. The safety gear shall be of instantaneous type. Car safety, to stop the car whenever excessive descending speed is attained, shall be operated by a centrifugal speed governor located at the top of the hoist way and connected to the governor through a continuous steel rope. Suitable means shall be provided to cut off power from the motor and apply the brake on application of safety. Indicate when the safety gear to stop the car shall become instantaneously operative.

Relays

Overload relays to protect the driving motor against overloads shall be provided.

Terminal and Final Limits

Terminal switches shall be provided to stop the car at the terminal landings. These terminals switches shall act independently of the operating device or final limit switches. Ultimate or final limit switches shall also be provided to automatically cut off the power and apply brake in case the car travel beyond terminal landings.

Terminal Buffer

Suitable spring buffers shall be installed to stop the car and counter weight at the extreme limits of travel. Buffer must be suitable for installation in the space available.

Hoist Ropes

Round stranded steel wire ropes shall be used for lift suspension. The number and sizes of the hoisting rope shall be so selected to ensure proper factor of safety and proper operation of the elevator. The suspension ropes shall correspond to relevant Indian Standard. Governor ropes shall also be of steel.

Car Platform

The car platform shall be framed construction and designed on the basis of rated load evenly distributed. Car platform shall be suitably designed to cater for specific designed stone floors.

Car and Landing Door Operator

An electric door operator for opening and closing the car door and the landing door shall be provided. It shall consist of a machine on the elevator car, operating the door when the car is stopping at a landing. The car door and the landing door shall be mechanically connected and shall move simultaneously in opening and closing. Every landing door shall be provided with a locking device which shall comply with the following requirements:-

- a) It shall not be possible to open the landing door from the landing side until the lift car is within that particular landing zone. However, provision shall be made for opening the door by means of special key for use in case of an emergency.

- b) it shall not be possible for the car to be started or kept in motion unless all the landing doors and car door are closed and locked except when the car is coming to a stop at that landing within the leveling.
- c) The electrical and mechanical parts of all locking devices shall be substantial design and construction.
- d) An electric contact for the car door shall be provided which shall prevent car movement away from the landing unless the door is in closed position.

The car door and landing door shall open automatically as the car is stopping at a landing. The closing of car door and landing door must occur before the car is set in motion. A device shall be provided to stop and reverse the doors during their closing motion.

Door Hangers and Tracks

The car and the landing door shall be provided with two point suspension sheave type hangers complete with tracks. Sheaves and rollers shall be of steel with moulded nylon cellar and shall include shielded ball bearing. Tracks shall be suitable steel section with smooth surface. The landing doors shall also consist of heaters, sills, frames, etc. as required.

Car Door Safety

Infra Red Electronic Door Detectors shall be provided for all the elevators.

Car Operating Panel in the Car

The car operating panel in each car shall be stainless steel sheet of suitable thickness flush mounted. The panel shall contain the following:-

- a) A series of push buttons numbered to correspond to the landings served.
- b) An emergency stop button.
- c) An emergency call button connected to a bell to serve as an emergency signal.
- d) A two position key operated switch marked to indicate with attendant and without attendance.
- e) A buzzer.
- f) Up and down (visual) direction light jewels.
- g) A nonstop button.
- h) A door open button.
- i) A fan switch.
- j) All fixtures to be in stainless steel.

Car Direction Indicator

Signal indication in the car shall be provided by the appropriate arrow being illuminated to indicate the direction in which the car shall next travel.

Car position Indicator

Suitable signal indication in the car shall be provided by the appropriate numeral being illuminated when the car is passing the corresponding door. This indicator shall remain illuminated when the car is stopped at a floor. The cover of the indicator unit will be stainless steel sheet of suitable thickness:-

Emergency Light in Car

A battery operated emergency light point with incandescent lamp shall be provided in the car which shall operate automatically in case of power failure.

Alarm Bell

An emergency alarm bell should be provided. The alarm bell shall be located in the ground floor landing and push for the same shall be in the car operating panel. The system shall be operated by batteries with trickle charger and the bell / siren should work the moment the alarm button in the car is pressed.

Call Button in Landings

An up push button and a down push button at each intermediate landing and a single push button at each terminal landing shall be provided to call the lift car in a particular landing for travelling in a direction desired. The push buttons shall have call registration lights and shall illuminate when a button is momentarily pressed to indicate that the call is registered and the direction of the call. The button shall remain illuminated until the call is answered. The top covers of landing push button boards shall be of stainless steel sheet of suitable thickness.

Floor Position Indicator

Suitable signal indication at all landing shall be provided by the appropriate numeral being illuminated when the car is pressing the corresponding floor. The indicator shall remain illuminated when the car is stopped at a floor. The top cover of the floor position indicator units shall be stainless steel sheet of suitable thickness.

Detailed Instructions

Inside the lift car suitable instructions for passenger on metallic plate shall be displayed. Such plates in lift car shall indicate capacity, nos. of persons, No smoking and such other instructions as are suitable for proper and safe operation of the lifts.

Fireman Switch

Each lift will have fireman switch with glass front break for access of fireman. The operation of this switch shall cancel all calls to this lift and lift will stop at the next nearest landing if travelling upward. The doors will not open at this landing and the lift will start travelling to ground floor. In case of its travel in the downward direction when the fireman's switch is operated, it will go straight to ground floor direct without stopping enroute. The emergency stop button inside the car will become inoperative during the journey. Once the car has reached the ground floor, it shall be solely under the command of fireman by car buttons, landing calls being isolated. The lift can be put to normal use by putting the fireman switch in its original position.

Emergency Stop Switch

On top of the lift car an emergency stop switch shall be provided for use by maintenance personnel. Similar switches shall also be provided in the car operation of these switches shall render the car and landing buttons in-operative and cancel all registered calls.

Micro Self-Leveling

The lifts shall be provided with a Micro Self-Levelling feature that shall automatically bring the car to the floor landings. This Micro Levelling shall within its zone, be entirely automatic and independent of the operating device and shall correct for over-travel or under-travel and rope stretch.

Painting

All lift metal work shall be given one shop coat of rust inhibiting paint in the factory and painted with finishing coats on site. Factory finished powder coated paint to desired shade is acceptable. Any damage caused during erection of the equipment shall be repaired to restore it to required finish.

Automatic Rescue Device (ARD)

All the lifts shall be programmed for ARD (Automatic Rescue Device) which shall enable the lifts to stop at the nearest floor in the event of power failure/ shutdown/ breakdown and the doors to be opened, so that any passengers in the lift would not be trapped inside the lift cars in such eventuality.

Weight for Car Interior

Car interior work weight should not exceed 300 kg.

1.21.3 Electrical Equipment and Wiring

Scope

The scope of this section comprises supply, installation and wiring of all electrical equipment including control wiring. Power supply at 415 V, 3 phase, 50 Hz, 4 wire with double earthing will be supplied by the Owner in the machine room with a MCCB in sheet steel enclosure for each lift . All further wiring to motors and controllers, hall buttons, alarm bell, car position indicators etc. shall be provided by the lift Contractor.

A separate DB shall also be provided in the lift machine room for lighting, socket outlets, drilling machine, etc. by the Electrical Contractor.

Wiring

All wires and cables shall be insulated with polyvinyl chloride base insulation rendered flame retardant armored and rated for 1100 volt service and suitable for use in dry and wet locations. Makes of wires and cables shall be subject to the approval of the Consultant before delivery.

All control wiring shall be of copper.

Wires and cables subject to movement and abrasion shall be protected by flexible galvanized steel conduit.

Traveling cables shall be of best grade for the service and shall originate at steel junction boxes in hoist way and at steel junction boxes on the car, hung so that the proper size loop may be obtained. they shall have a fire and moisture resistant outer covering and contain a steel supporting strand. Traveling cables shall be suitably suspended to relieve strains in individual conductors. Traveling cables shall be provided for telephone, signals, controls, lights, fans, alarm bell, emergency circuit, music and communication with control room etc.

Earthing of all equipment is in the scope of the lift contractor.

1.21.4 Features Requirements for Passenger Lift

1.0	Car Operating Panel	
i)	No.	1
ii)	Material	SS
2.0	FINISHES	
2.1	Car	
i)	Enclosure	SS Hairline Polish sides and full ht mirror in rear
ii)	Floor	Suitable for 20 thick Granite
iii)	Ceiling	As per Architect's selection
iv)	illumination	CFL
v)	ventilation	Sweep twin blower
2.2	Door	
i)	Car door	SS 304 Hairline Finish
ii)	Hoistway Door	SS 304 Hairline Finish

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

2.3	Hand rail	SS Hand rail
2.4	Signal Fittings	
	i) Hall buttons	Micro push – Self Illuminating with up/ down arrows / touch screen
	ii) Car Position Indicator	
	a) Type	Digital with scrolling up/ down arrows
	b) Arrival gong	Yes
3.0	TRACTION & CONTROL	
3.1	Traction	Gearless induction motor
3.2	Speed Control	AC VV +VF
3.3	Operation	Simplex / Duplex / Triplex full collective
3.4	Alarm Bell	Yes
3.5	Buffers	Spring/ Hydraulic
3.6	Automatic Rescue Device	Yes
3.7	Fire Man's Switch	Yes
3.8	Elevator Management System	Yes
3.9	Emergency Car Lighting	Yes
3.10	Overload Protective Device	Yes
3.11	Pre-recorded voice announcement	Yes
	NOTES-	Battery operated automatic rescue device shall bring the elevator to the next landing and open the door
		Fire Man's switch shall be at the home landing and shall be provided with each elevator.
		All elevators shall be hard wired to the control room at ground floor and should be connected to the monitoring system proposed.
		Emergency lighting shall be through a maintenance free battery complete with rectifier / charger.
3.12	Additional Featured	Intercom link & parallel signals with BMS Room/ Control Room at

	<p>Ground Floor level and one at Reception Lobby Emergency alarm bell to Control Room/ BMS Room Hook up lifts on BMS which shall include potential free contacts for elevators for</p> <ul style="list-style-type: none"> a) Lift Direction b) Lift Position c) Lift not working/ under maintenance d) Parking of lift at desired floor
	<p>Contractor shall provide diagrammatical representation of interface provision for BMS & provision mode in the controller. Braille button shall be provided as per GRIHA requirement.</p>

1.21.5 Electric Power Supply

All the equipments shall be suitable for operating within a range of $\pm 10\%$. Any equipment which cannot be operated with the above mentioned power supply shall be provided with necessary Transformer / Rectifier / Stabilizer at bidder's own cost. The power shall be provided at one point in each machine room at the location indicated by the contractor. Further power distribution shall be in the scope of the contractor.

1.22 Fire Survival Cable

A] Control Cables :(For Fire Alarm /Detection Systems, Public Address Systems, Fire Fighter's Talk Back Systems)

2 C X 1.5 Sq.mm. Fire Survival Armored Cable , 600/1000 V, Annealed Copper Conductor Class 2, having Glass Mica Fire barrier tape, covered by an extruded layer of Cross Linkable Ethylene Propylene Rubber (EPR) insulation, steel wire armored, Inner & Outer LSZH sheathed. Basic Design as per BS 7846:2009. Circuit/Fire Integrity as per BS 8434-2:2009 (930+40 Deg. C for 2 Hours).

B] Power Cables: (For Power Supply to: Elevators, Smoke Extraction Axial Flow Fans, Fire Pumps, Emergency Lighting System, Lift Well/Staircase Pressurization Axial Flow Fans)

Fire Survival Armoured Cable , 600/1000 V, Annealed Copper Conductor Class 2, having Glass Mica Fire barrier tape, covered by an extruded layer of Cross Linkable Ethylene Propylene Rubber (EPR) insulation, steel wire armoured, Inner & Outer LSZH sheathed. Basic Design as per BS 7846:2009

Circuit/Fire Integrity as per BS 8491: 2008 (830+40 Deg. C for 2 Hours)

1.23 Low Voltage Works

1.23.1 ITAM

S.No	Specifications	Compliance
1	Web Appliance Hardware	Rack based Intel Core i7 or better, 3.20GHz w/ HD Graphics
		Memory 32GB 4x8GB DDR4 2666MHz
		Minimum 1 TB SATA/SSD Drive
		Integrated NIC
		COTS Compliant
2	Web Appliance Software	
	Items	Capture specifications, warranties, Serial Numbers, MAC Addresses, IP info, what other H/W relates/connects to this H/W, item status, event logs, assignees
	Software	Specifications, License information
	Assignment Relationships	and Where each software is installed, license qty, component relations, contract relations to software/hardware/invoices

	Commercial Data	Purchase proofs depicting date, vendor, prices, attached documents	
	Agents	Vendors, H/W & S/W Manufacturers, Buyers (for different Dpt), Contractors	
	Locations	Location of each asset building, floor, room, rack, rack row, row depth	
	Contracts	Define custom contract types, like support& maintenance, SLA, etc. Track contract events.	
	Tags	Multiple tags for items and software. You may use tags for grouping according to usage, budget, owner, importance, etc.	
	Files	Attach documents to every main object entity (Items, Software, Invoices, Contracts)	
	Users	Who has what or who is responsible for what.	
	Racks	Display rack layout with items assigned to each rack row. (Supports multiple items/rack row).	
	Print labels	Print label stickers for tag all your assets, with or without barcode, from phones and laptops to cooling units and UPS. Easily define new label paper layouts through the GUI.	
	Backup	Get a full backup of the installation and data. Ability to restore	
	Page Print Support	All screen pages/lists/reports print-outs possible without menus, scrollbars and other clutter.	
	Interface Translations	Translation file support	
	LDAP support	Pull user list for item assignment from an LDAP URL	

System Architecture and Indicative Layout

Bidder shall calculate the camera quantity as per the scope of work and full coverage requirement. All the backend system must be designed as per the min specification given here. For Camera Monitoring and Control minimum 55inch Full HD Monitor shall be considered. All the cameras shall be live on using multiple monitors. One monitor shall not have more than 36 camera 6x6 Grid. Two Monitors can be used in one workstation in Dual Monitor Mode. Min 05 concurrent workstation license shall be offered and no of Workstation and Monitors shall be decided by the bidder as per the design and specs written here in this document.

1.23.2 Access Control System:

Access Control system will be magnetic door type controlled through Card readers and biometrically. All sensitive areas like OT's/ICUs Corridor, Laboratory, Stores, OPD Departments in Main Administrative& etc. shall be provided with Access Control System. IP based door controllers shall be provided as required. Existing LAN infrastructure shall be used for network connectivity of IP based door controllers. Each Controller will control four No. of Magnetic locks which can be for single or double leaf door. The centralized control will be managed through a server to be installed in main Security Control/ Server Room. For Overriding purpose Push Button will be provided inside the rooms.

The system will be capable to record the biometric attendance of the authorized personnel and the records will be stored in server.

1.23.3 Structured Cabling

Technical Specification for Structured Cable and Components:		Compliance
1	Cat 6A UTP Cable	
4 Pair Cable with integral cross -member pair separator for uniform characteristic impedance.		
Category 6A Unscreened Twisted 4 Pair 100 Ω cable shall be compliant with ANSI/TIA/EIA-568-C.2; ISO/IEC 11801 Ed. 2.0; 10BASE-T, IEEE 802.3 af (PoE), 100BASE-T, IEEE 802.3at (PoE+) & 1000BASE-T		

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

	Category 6A UFTP cables shall extend between the work area location and its associated telecommunications closet and consist of 4 pair. ISO/IEC 60332-1-2; IEC 60754-1 & 2; IEC 61034-2	
	Conductor: Solid Copper	
	Conductor Diameter: 0.56mm (23 AWG)	
	Insulator HD Polyethylene solid	
	Jacket: FR LSZH RoHS complied	
	Outer Diameter: 7.4± 0.4mm	
	Max Temperature: -20°C to +75°C	
	Mechanical Test	
	Should have Pulling force of 100N.	
	Bend Radius: Installation: <4 X Cable Diameter,	
	Electrical Test	
	D.C. resistance conductor : <9.38Ω /100m	
	Resistance Unbalance 5% Max	
	Mutual Capacitance : < 5.6nF/100m	
	Capacitance Unbalance : < 330/100m at 1Khz	
	NVP : 76%	
	Operating Temperature: -35Deg C ~ +65 Deg C	
	ETL 4 port channel Test report should be submitted with 800 Mhz	
	Should be ETL Certified	
2	Cat 6A STP RJ 45 Keystone Jack	
	RJ45 Jack of Category 6A, for the establishing of transmission channels of class EA with up to 4 plugged connections, complies with Category 6A requirements of the standards ISO/IEC 11801:2.1 edition, EN 50173-1 (200X), ANSI/TIA/EIA 568-C.2, backwards compatible with Cat6, Cat.5e and Cat.5.	
	Suitable for 10GBase-T applications in acc. with IEEE 802.3an more than or equal to 800 MHz (ETL test report to be submitted)	
	Compatible with RJ standard plugs (RJ11, RJ12, RJ45), PCB- and tool free based connection of installation cables AWG 24 – 22 (0.5 mm – 0.65 mm) and flexible cables AWG 26/7 – AWG 22/7.	
	IDC termination should feature nil crossover in acc. with EIA/TIA 568-A/B, Tin phosphor bronze contacts for complying IEC 60603-7	
	Housing material: Polycarbonate (UL-94-V0)	
	Jack Contacts: Phosphor bronze, 50 micro-inch gold plating over nickel	
	Contact Force: 99.2g (3.5oz) FCC Plug	
	Dielectric Withstand Volt: 100VAC RMS 60Hz	
	Contact Resistance: <= 20 mΩ	
	Current Rating: 1.5A at 68°F	
	Plug insertion Life: >=750 times plug in	
	Plug Retention Force:30lb (133n/13.3Kg)	
	Temperature Test: -10°C to 60°C (14°F to 140°F)	
	Keystone should feature with Tool free termination technology	
	Material: RoHS complied	
	Should be be 3P Certified for 4 pair Poser over Ethernet under electrical load of up to 2A per conductor	
3	Patch Cord, STP/UTP 4P, Cat.6A, length 1.0/ 2.0 m	
	Standardization: Compliant with Cat.6A, Class EA requirements: ISO/IEC 11801 2.1 Edition Compliant with Cat.6A component	
	Cable shield: STP/UTP	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

	Number of conductors : 8	
	Stranding: 7 x 0.16 mm (26 AWG)	
	Cable jacket characteristics: cable, metal-free	
	Cable overall diameter: 6.0±0.2 mm	
	Tube / Wire type: stranded conductor	
	Insulation: foam skin, polyolefin, 0.98±0.02mm OD.	
	Plug: Feature cable retention, with enhanced pull strength.	
	Cat 6A patch cord plug to have round cable holder and strain relief boot to avoid bending.	
	plug should have high repeatability cross talk performance	
	Plug design should be patented with unique feature	
	Should be ETL certified	
4	19" 1U 24 port shielded Patch Panel	
	Patch panel should be modular design, populates up to 24 UTP/STP keystone-type jacks in 1U	
	Patch panel should be Enhanced with cable strain relief with retention tray; It should be single metal both front panel and rear tray	
	Material: sub-rack made of Aluminum with dimension 44.4 mm : 482.6 mm : 105 mm (h:w:d) tray	
	Information Outlet or connectin module should comply with the specification mentioned above in 2	
	Panel should be supplied with earthing wire and earther lug for STP	
	Standard : Conforms to IEC-60603-7 (603-7) for keystone-type, snap-on apertures	
	Should be RoHS complied	
5	Faceplate	
	Should be UK style Keystone-type Faceplates are available in 1, 2 & 4 port configurations	
	Should be featured with shutter options	
	Should support Work with both Flush and Wall mount box	
	Should support Operating Temperature: -10~+60; Storage Temperature: -40~+68; Humidity: 10%~90% RH	
	Material: ABS, UL 94V-0; Spring: SUS304; Surface Finish: Polished	
6	Cat6A Shielded Field Termination Plug	
	Standardization: Compliant with Cat.6A, Class EA requirements: ISO/IEC 11801 2nd Edition backward Compliant with Cat.6 component standards IEC 60603-7-4 and 60603-7-5	
	Cable: UTP/STP	
	Number of conductors : 8	
	Termination: IDC type Tool less	
	RJ45 Plug Metal covers: Zinc die-casting with nickel plated	
	RJ45 Plug contacts: Phosphor bronze with nickel plated	
	Plastic Wire Organizer: PC, Color: White, UL 94V-0	
	IDC Durability: ≥20 Termination cycles	
	RJ45 Jack Durability: ≥750 Plug-Jack mating cycles per IEC 60603-7-81	
	Operating Temperature: -10 degree C to +60 degree C	
	Patch Cord retention strength: 7.7 Kg Max. according to IEC 60603-7-5	
	Rj45 Plug Insertion force: 3.1 Kg Max according to IEC 60603-7-81	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

7	Slim Patch Cord, STP 4P, 30 AWG, Cat.6A, length 1.0/ 2.0 m	
	Standardization: ANSI/TIA-568-2.D Conform to ANSI/TIA-568-C.2, ISO/IEC 11801 2.1 edition and CENELEC EN50173 (2007) for Category 6A/CLASS EA standards	
	Cable shield: STP/UTP	
	Number of conductors : 8	
	Polyester Aluminum foil on each pair along with Braid shield	
	Gold-Plated Copper Contacts Provide Corrosion Resistance and Signal Conductivity	
	Basic Wires: Conductor: Eight wires stranded bare copper, 7 x 0.10mm (30 AWG). Insulation: foam skin, polyolefin, 0.68±0.02mm OD.	
	Shield: Overall Braid Shield	
	Overall Diameter: 4.5 ± 0.2 mm max..	
	Outer Sheath: LSZH – IEC-60332-1	
	Electrical: DC Resistance: Max. 376 Ω/km at 20°C Resistance Unbalance: 2% max. at 20°C Mutual Capacitance: 43 pF/m nominal at 1 KHz Voltage Rating: 30 V rms Dielectric Strength: 500 VAC/one minute mean (wire to wire) Dielectric Withstanding: 1000 volts RMS, 1 min. (60Hz) Insulation Resistance: 500 mega-Ohms Current/Voltage Rating: 1.5 Amps, 30 VAC / 56 VDC	
	Storage & Operating Temperature: -20°C to 60°C & -10°C to 50°C	
	Plug Housing: PC Resin UL-94V2	
	Contacts: High grade copper alloy	
	Plating: 50 micro-inch (1.27 micro-meter) gold	
	ETL Verified Certificate for 2 port Channel	

1.23.4 IP-PBX System

S.No.	Description	Compliance
1	IP Telephony System Architecture	
	The IP telephony system must be based on a pure IP technology that is a software-only solution.	
	The IP telephony system must support unified communication (UC) server & gateways architecture for SIP, Digital and Analog trunks connectivity.	
	The System must be TEC Approved with GR Number.	
	The system must be capable of supporting Analog, Digital, IP Telephones, and SIP based video desk phones.	
	The communication servers must work in an Active/Active redundancy mode. It should be possible to define servers load balancing mode.	
	All servers must be provided in a cluster mode. If one cluster server fails, one of the other cluster servers in the network must be able to take the complete load of the calls automatically (without any manual intervention) and without dropping any existing calls (IP,TDM & PRI) or data (CDR, CTI). Management of all servers in cluster should be from same web page. All servers should have same database.	
	The telephony system must be able to register SIP phones/SIP video phones and MGCP phones directly to it	
	System should have Distributed Architecture	
	It should be possible to install Telephony system in VMware EXSi 5.5 or higher.	
	All Data (Numbers, COS, Routing, Applications) should reside in all the Servers	
	Database replication in All servers should be automatic and real time	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

Should support N+1 Redundancy Architecture as well as 1+1 redundancy Architecture	
Should support Remote Survival Nodes	
In case of failure of one server, the SIP Phones, SIP Gateways, MGCP Phones should register with second Server automatically	
System Diagnostics should be done in Server	
Hot Standby for SIP Phones and Gateways i.e SIP Phones and Gateways should register automatically to next available telephony server.	
COTS - commercial off-the-shelf Servers should be used for telephony system	
Telephony system should use Linux Operating System	
system should support CSTA phase III Protocol	
Full continuation for call signalling and media must be supported	
Calls must not be disconnected and control must remain throughout the swap to an alternate server including full call control (transfer, conference actions, continuation of CDR data for the existing call).	
Load Balancing of end points must be possible by the administrator	
There must be no restriction on the number of endpoints being backed up in case of one server failure.	
UC platform servers must provide full failover and redundancy	
System should support the following SIP RFCs:	
RFC 3261 (SIP: Session Initiation Protocol)	
RFC 3262 (Reliability of Provisional Responses in Session Initiation Protocol)	
RFC 3263 (Locating SIP Servers)	
RFC 3264 (An Offer/Answer Model with Session Description Protocol (SDP))	
RFC 3265 (Specific Event Notification)	
RFC 2327 (SDP- Session Description Protocol)	
RFC 1889 and 1890 (RTP/RTCP)	
RFC 3515 (REFER)	
RFC 2833 (DTMF over IP)	
Scalability	
It should be possible to add more sites and users without the need to change the software and existing configuration.	
The system must be scalable to at least 2,000 endpoints in a single cluster architecture.	
Each server must support a minimum of 1000 endpoints	
The call signalling server must handle traffic at a minimum of 100K BHCC.	
The system must be modular, scalable and distributable	
System Survivability	
The UC platform must consist of one or many servers where each server in the cluster provides complete 100% application functionality.	
In case of a failed server, all endpoints registered with that server need to register instantly with a different server in the cluster with no interruption to on-going calls.	
Media Gateways must have survival mechanisms that allow them to maintain 100% of the telephony services for their users in case of failure in the WAN links when the signalling with the call server drops.	
The life cycle of the entire system being provided must be at least Ten (10) years.	
The system gateway must be able to restart automatically without human intervention when the external AC power supply is resumed after complete power failure (even after the batteries are discharged).	
The telephony system must be capable of providing 99.999% availability.	
Distributed Architecture	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

	The UC platform must have distributed architecture and centralized control for all the sites in the network.	
	The proposed solution must support Hybrid cloud solution in order to guarantee business continuity with overall survivability regardless of a failure at any single location.	
	The proposed solution must enable part of the cluster to be hosted in a Cloud Service Provider (CSP) to run all applications.	
	The proposed solution must have built in redundancy using a cloud solution to provide automatic disaster recovery option.	
	The proposed solution should have provision to be installed using an image of the application an easily implemented on the Cloud Service Provider servers.	
	Quality of Service (QoS)	
	The voice and signaling frames must be marked [tagged] in order to be recognized.	
	Server – Physical Attributes	
	COTS – Commercial Off-the-Shelf servers must be used.	
	The redundant server must have separate hardware, not sharing elements like hard drives and RAM etc., to avoid a single point of failure.	
	The server should have AC power supply.	
	The system must be based on server gateway architecture with external appliance servers	
	No card based processor systems / soft switch should be quoted.	
	The call processor must run on Linux OS.	
	Minimum Server Specifications:	
	The CPU must be from the Intel® Xeon® processor E3-1220v5 or latest	
	The server must have at least 8GB RAM	
	The server must have Hard Drives (300GB each) of storage	
	The server must have a Dual 1GB network interface.	
	Form Factor for physical server (Not Virtual Machine) should be 1 U	
	Gateways	
	The media gateways shall be capable of being centrally managed via the telephony management application. The system should support multiple gateways.	
	The system gateway should be able to restart automatically without human intervention when the external ac power supply is resumed after complete power failure	
	The system gateways should support the following type of extensions:	
	Analog	
	Digital	
	Cordless (DECT) Extension	
	SIP	
	MGCP	
	The system gateway should support the following type of trunks :	
	Analog: E&M (2W), E&M (4W), DC loop signaling, decadic, DTMF	
	Digital: 2Mb stream with the following signaling protocols (Digital CEPT, R2MFC)	
	Standard ISDN BRI, PRI	
	SIP and MGCP on VOIP	
	ISDN (30B+D / 23B+D / 2B+D)	
	SS7	
	ISDN QSIG (30B+D / 2B+D)	
	Q-sig over IP	

Security	
Administration of the system should be using HTTPS	
It should support the Interop with leading SBC	
System should use TLS (Transport Layer protocol) to encrypt SIP, HTTP, FTP and SRTP (Secure Real-time Transport Protocol) and SRTCP to encrypt RTP and RTCP	
System should have auto Provisioning profiles contain pre-configured sets of features that must automatically polls and updates registered phones with the latest phone firmware and configuration files.	
Mobility	
The system should have Call Back feature. If the user dials his own extension from predefined number (mobile/landline) then system should disconnect the call and then system should call the user to provide the dial tone so that user can make intercom or PSTN calls.	
The system should have Call Through feature. If the user dials his own extension from predefined number then system should provide dialtone to make intercom or o/g calls.	
The system should have Flexi Call (Forking, reach-me-anywhere) feature. Users should be able to receive calls on any of their phones, from almost anywhere. An incoming call rings on all or specific phones until the user answers the call. The user can transfer the call, establish a conference, and so on, whether the answering device is an internal device, an external phone, or a cellular handset. If the answering phone is an external device, the call automatically becomes an authorized mobility call.	
The system should support SIP Client on smart phone.	
SIP Endpoints	
All SIP phones must support the standard SIP protocol. No proprietary protocols are allowed to be used.	
SIP phones must support the configuration of programmable buttons with functions such as Break-in, Conference call, Deflect, silent monitoring and more.	
SIP phones must work in conjugation with the following applications:	
1. Contact Centre (Agents Phones)	
2. Attendant Console	
3. Managed Audio Conferencing	
4. Managed Video Conferencing	
5. UC clients	
ACD	
System should have built in Automatic Call Distribution (ACD) with following features:	
Busy ACD Group announcement	
Hunt Group Release	
IVR-ACD	
Log In / Log Out	
Multiple Announcements:	
1. Mandatory announcement - All incoming callers to an ACD/HUNT group must be able to hear an introductory announcement in its entirety usually explaining about the company, product, or campaign.	
2. First announcement - If all agents are busy, callers must be able to hear this announcement once usually informing them that their call has been placed in queue. (The system must be able to cut short this announcement if an agent becomes available to attend to the caller.)	
3. Music - If no agents are available after the first announcement (or no First and Periodic announcers have been configured), the caller must be able to hear background music while in queue.	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

	4. Periodic announcement - Alternating with background music, these announcements can also be played to callers in queue according to the Periodic Announcement Interval (see above) until the ACD/HUNT call is answered.	
	Release / Resume	
	Wait Queue	
	Wrap-Up Time	
	Automatic Release of ACD Agent	
	Automatic Call Distribution (ACD) Extended Overflow	
	Zone Page	
	A phone user must be able to simultaneously broadcast a message over all types of endpoints.	
	The maximum quantity of endpoints in one zone should not be less than 100.	
	System Administration	
	System administration should be web based.	
	All programming of system should be done through a web-based GUI interface.	
	The administrator should have Dynamic Profiles.	
	The system should allow for complete multi-level administration. The administrator must be able to define at least five (5) different administration level profiles that can be applied to allow subsets of users to access and manage particular pages in the systems Web Portal	
	Certification Requirements	
	1. The OEM must comply with ISO 9001 certification in all the company's activities.	
	2. The products must comply with Safety and EMC standards, including FCC, UL/TUV, CE, and the RoHS directive.	
	System Features	
	ANI (Caller ID) Restriction	
	ARS (Automatic Route Selection)	
	Auto Attendant	
	Call Forward at Night/Holiday	
	Call Forward Destinations	
	Call Forward for Undefined Stations	
	Call Forward on Busy	
	Call Forward on DND (Do Not Disturb)	
	Call Forward on Logout	
	Call Forward on No Answer	
	Caller id based routing for individual extension	
	Deflect (Divert) Call	
	Digit Train Conversion	
	Direct-In-Dial	
	Direct-In-Line (DIL)	
	Hot Line	
	Interactive Voice Response (IVR)	
	Least Cost Routing	
	Look Ahead Routing (LAR)	
	Numbering Plan	
	Personal Routing Rules based on caller id and DNIS	
	Predetermined Night Answer	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

Toll Restriction – Digit Analysis	
Toll Restriction – Trunk Groups	
Trunk to Trunk Connection	
Trunk Transfer Restriction	
Classes of Service	
Night Answer Central Bell / UNA Pickup	
Page Queue	
Recall	
Recall / Incomplete Destination	
Second Ring back Tone	
Speed Dial Public (System) and Private	
Virtual Numbers	
Music On Hold	
Voice Page	
Silent Monitor	
Zone Page	
Barge In	
Wake up	
Extension Features	
Answer Call Waiting by Transfer	
Auto Set Relocate	
Auto-Answer	
Automatic Disconnect	
Automatic Number Identification (ANI) Display	
Browse Personal Directory	
Busy Lamp Field	
Call Forward All	
Call Hold	
Call Log	
Call Parking and Call Pickup	
Call Waiting	
Caller ID Control	
Caller-ID Screening	
Caller id based routing for individual extension	
Calling Number and Name	
Camp-on Idle	
Configurable DSS Buttons	
Direct Dial without Off Hook (Hands Free)	
Directed Call Pickup	
Display Automatic Number Identification (ANI)	
Display Dialed Number and Name	
Display Dynamic Call Divert Information	
Display Select Hold Display	
Display Time/Date Function	
Do Not Disturb (DND)	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

	DSS/BLF	
	Elapsed Time Display	
	Group Call Pickup	
	Hands Free	
	Hands-Free Announce and Reply (Idle State)	
	Last Number Redial	
	Login and Logout	
	Message Waiting Indication	
	Multi Appearance (Call Waiting)	
	Multiple Line Appearance	
	On-Hook Dialing	
	Placing Multiple Calls on Hold	
	Privacy – ANI Restriction	
	Reminder/wake up Call	
	Restrictions – Station	
	System Non-Exclusive Hold	
	Transfer with Consultation	
	Transfer without Consultation (Blind)	
	Voice Page	
	Emergency Preemption	
	Listen to Paging while in a call (Busy Condition)	
	ULA - User Line Appearance (ULA)	
2	Emergency communication	
	The Emergency communication resource should be from the same telephony server and have the facility to automatic dial out to connect up to 100 participants in a single conference. System should also have 100 party managed meet me conference. It should be possible to further divide 100 party conference bridge into any combination like 10 X 10 party, 5 x 20 party etc. if required. The meet me conference should be secured means to enter to the conference bridge, the user should enter the password.	
	The emergency communication management should be from Web Browser/HTML5 based GUI based interface from Windows PC and Touchscreen Devices.	
	The emergency communication must be controlled by a user defined as Group Operator from the web based GUI.	
	The Group Operator should have following features as below:	
1.	The Group Operator must be able to add / remove members	
2.	The Group Operator must be able to add other conference members	
3.	The Group Operator must be able to mute / unmute (User, None, All)	
4.	The Group Operator must be able to lock / unlock the conference	
5.	The Group Operator must be able to close the conference	
6.	It must be possible to dial out a pre-defined group (or multi-groups) of participants/numbers by simply pressing the pre-assigned virtual key on PC.	
7.	Each pre-set conference must have its own unique dial number such that when this group number is dialled; all the number stations will ring simultaneously.	
8.	Any combination of stations and external numbers must be able to be defined as members of the Group Call.	
9.	Participants may join a conference in the audible or in the mute mode, if in mute mode, the right to speak must be selectively offered to attendees per their request by a special signal sent to the Group Operator by the attendees.	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

	10. Attendees must be able to be added or excluded at any time by the Group Operator	
	11. The conference must be terminated when the Group Operator leaves (auto terminate if all members left are muted).	
	12. The Group Operator must be able to barge into an existing user call based on pre-emption predefined rules.	
	13. Group operator must have two SIP phones so that if one phone is busy in conference, the second phone can be used to add participants.	
	14. Both group operator SIP phones should be controlled by web based conference management GUI for telephony feature like answer, hold, transfer etc.	
	15. The same Group operator should also function as operator console	
3	Specification of Type -1 IP phone	
	SIP phone should be from the same OEM of IP telephony system	
	132 x 64-pixel graphical LCD	
	1 VoIP accounts	
	XML remote phonebook	
	Auto provision via FTP/TFTP/HTTP/HTTPS for mass deployment	
	Anonymous call, anonymous call rejection	
	PoE, Headset, Wall-Mountable	
	Volume adjustment, ring tone selection	
	Voicemail, MWI	
	Call park, call pickup	
	DTMF: In-band, out-of-band (RFC 2833) and SIP INFO	
	VAD, CNG, AEC, PLC, AJB, AGC	
	Full-duplex hands-free speakerphone	
	SIP v1 (RFC2543), v2 (RFC3261)	
	NAT Traversal: STUN mode or 3rd party SBC	
	DTMF: In-Band, RFC2833, SIP Info	
	IP Assignment: Static/DHCP/PPPoE	
	1xRJ9 handset port	
	1xRJ9 headset port	
	Transport Layer Security (TLS)	
	LED for call and message waiting indication	
	2xRJ45 10/100M Ethernet ports	
	Power over Ethernet (IEEE 802.3af)	
4	Specification of Type -2 IP phone	
	SIP phone should be from the same OEM of IP telephony system	
	132 x 64 -pixel graphical LCD with backlight	
	2 VoIP accounts	
	Local phonebook up to 100 entries	
	Auto provision via FTP/TFTP/HTTP/HTTPS for mass deployment	
	SRTP/ HTTPS/ TLS, 802.1x	
	PoE, Headset, Wall-Mountable	
	Volume adjustment, ring tone selection	
	Voicemail, MWI	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

	Call park, call pickup	
	Narrowband codec: G.711, G.723.1, G.726, G.729AB	
	VAD, CNG, AEC, PLC, AJB, AGC	
	Full-duplex hands-free speakerphone	
	SIP v1 (RFC2543), v2 (RFC3261)	
	NAT Traversal: STUN mode or 3rd party SBC	
	DTMF: In-Band, RFC2833, SIP Info	
	IP Assignment: Static/DHCP/PPPoE	
	1xRJ9 handset port	
	1xRJ9 headset port	
	Transport Layer Security (TLS)	
	LED for call and message waiting indication	
	2xRJ45 10/100M Ethernet ports	
	Power over Ethernet (IEEE 802.3af)	
5	Specification of IP Video phone	
	SIP phone should be from the same OEM of IP telephony system	
	7 inch (124 x 600) adjustable touch screen	
	720p30 HD Video	
	Runs Android 5.1.1	
	Built in Bluetooth 4.0 + EDR for headsets and pairing mobile devices	
	Dual Port Gigabit Ethernet with PoE	
	Built in WiFi(802.11b/g/n)	
	Call recording, hotline, one touch dial	
	Redial, call waiting, emergency call	
	Data import/export via Bluetooth	
	Ring tone selection/import/delete	
	Local phonebook up to 1000 entries	
	XML/LDAP remote phonebook	
	Intelligent search method	
	Phonebook search/import/export	
	Black list	
	HD voice, HD Handset, HD Speaker	
	Audio Codec: Opus, G.722, G.722.1, G.722.1C, G.711, G.723, G.726, G.729AB, iLBC	
	Video Coded: H.264 High Profile, H.264, VP8	
	Self View (local video preview)	
	27 one-touch DSS keys	
	Illuminated mute/headset/handsfreespeakerphone key	
	SIP v1 (RFC2543), v2 (RFC3261)	
	Call server redundancy supported	
	IPv4/IPv6	
	NAT transverse: STUN mode	
	Proxy mode and peer-to-peer SIP link mode	
	Time and date synchronization using SNTP	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

	UDP/TCP/DNS-SRV(RFC 3263)	
	QoS: 802.1p/Q tagging (VLAN), Layer 3 ToS, DSCP	
	SRTP for voice encryption	
	Transport Layer Security (TLS)	
	HTTPS certificate manager	
	AES encryption for configuration file	
	Digest authentication using MD5/MD5-sess	
	OpenVPN, IEEE802.1X	
	Auto provision via FTP/TFTP/HTTP/HTTPS for mass deploy	
	Auto-provision with PnP, Zero-sp-touch, TR-069, SNMP	
	Package tracing export, system log	
	Setup assistant wizard	
6	Help desk specification	
1.1	General capabilities	
1.1.1	The proposed solution must be embedded within the platform, not installed on a separate server and should be from the same OEM of the telephony system.	
1.1.2	The system must be an All in one solution that provides a one server solution for UC&C and 5 agent license for help desk.	
1.1.3	Single server deployment with intuitive and central management capabilities should support true multimedia.	
1.1.4	Help desk managers must be able to easily prioritize customers and incoming contacts regardless of the media used.	
1.1.5	The same set of business and routing rules can be applied to voice / chat calls, emails, and faxes if required.	
1.1.6	The help desk must support multi-layer routing including Priority, Skill Based, Statistical, Business Rules, and Customer Defined Values.	
1.1.7	Help desk must have embedded IVR, enabling managers to design routing plans and accurately assess help desk activity trends.	
1.1.8	The IVR application must be a GUI application that can be managed by the customer.	
1.1.9	The customer must have the ability to build new self-services applications like new IVR flow for new service.	
1.1.10	Customer must have the ability to define/change routing rules by himself based on customer's profile.	
1.1.11	The help desk must support Outbound, Call-back and Campaigns – including preview, progressive and automated outbound dialling.	
1.1.12	The supervisor must be able to see the status of help desk agents in real-time in his PC like logout, busy, free, release, non ACD etc. in graphical form in pie chart / bar chart.	
1.2	Help desk facilities	
1.2.1	Real-time Monitoring – must provide supervisors with statistical information about the current status of the help desk with on line refresh (1sec). The application must include pre-defined list of reports and the customer (end user) should be able to choose reports as needed.	
1.2.2	The Real Time application must provide the ability to build/change the workspace for each user and by user (not vendor or distributor).	
1.2.3	The RT must provide the ability to move agents to/from different groups/queues for current login only.	
1.2.4	Historical Reports – must be able to collect all information from call entry to call termination. Call profile details for internal investigation purposes should be part of the contact center solution.	

	1.2.5 The help desk solution must have an embedded Management Information System (MIS) suite that monitors all help desk activities, generating reports that summarize the past performance of the system over a given time period, and providing statistical analysis of the help desk within a specified period. Real-time and historical reports provide:	
	Help desk agent should be able to do following activities from agent application installed on PC:	
	Login/Logout from group	
	Release/Resume	
	Ready	
	Wrap-up Code	
	Release for Break	
	Release for Meeting	
	Control Wrap Up	
	Supervisor Help	
	Agent Board	
	Answer	
	Hold	
	Retrieve	
	Hang Up	
7	Specifications for Self Survivable Gateway:	
	Gateway should have minimum 96 analog/CO ports. Gateway should be from the same OEM of IP telephony system	
	Voice Processing – voice codecs: G.711, G.729A, G.723.1,etc. and echo cancellation: G.168 with 64ms echo tail; dynamic jitter buffer; voice activity detector (VAD)	
	Call Handling – configurable dialing plan	
	Fax Processing – T.30, T.38 fax relay	
	User Features – caller ID, call forward, call transfer, hotline, CRBT, do not disturb, speed dialing	
	Protocol – SIP (RFC3261, MGCP etc)	
	Standards – caller ID detection (FSK)	
	Primary and Backup – the gateway can be configured and controlled in server clusters	
	LED indicators– power, system status, network status, line status	
	Ethernet Connector – Dual Gigabit ethernet. The Gateway should function as a Self-Survivable unit when the Ethernet connectivity at gateway end breaks.	
	Power Input – -48 VDC, should have dual DC power supply or dual AC power supply	
	Operation Humidity – 10% to 90% (non-condensing)	
	Operation Temperature – 0 to 40°C	
8	PRI Gateway specification	
	PRI gateway should have Configuration – 1 PRI (30 Channels) or 2 PRI (60 Channels) and should be from the same OEM of telephony system.	
	Voice Processing – G.711, G.729A, G.723.1, GSM, iLBC;echo cancellation: G.168 with 64ms echo tail; dynamic jitter buffer; VAD and CNG	
	Calling Control – called/calling party number translation; second stage dialing; voice detection; auto dialing with DTMF; ring back tone generation and detection; voice announcement	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

	Voice Proxy – RTP voice proxy function for NAT/firewall traversal	
	Fax Relay – T.30 transparent mode, T.38 fax relay	
	Call Handling – configurable dialing plan, up to 500 routing rules	
	Configuration Interface – Web Utility	
	Remote Management – Telnet, HTTP, TR069	
	PSTN – ISDN PRI standard: ANSI, NI-2, DMS, 5ESS	
	SIP – RFC3261, RFC2976, RFC3515, RFC3581	
	DTMF – tone detection generation and detection; DTMF relay: RFC2833, INFO (SIP)	
	DTMF detection and progress tone detection	
	Play ring-back tone	
	T.30 and T.38	
	RTP proxy for NAT traversal	
	Ethernet – RJ-45, 10/100 Base-T	
	Trunking Interface – RJ-45	
	System Memory – 128MB or higher	
	System Flash – 16MB or higher	
	Power Input – 220V AC or - 48 VDC , should have dual AC/DC power supply	
	Operation Humidity – 10% to 90% (non-condensing)	
	Operation Temperature – 0 to 40°C	
9	Specification of Soft client	
	The soft client should be from the same OEM of IP telephony system. Wifi facility for smart phone to be provided by the customer.	
	Soft client should be available for Windows PC, Android Phone and IOS phone	
	It should support Windows 7, Windows 8, Windows 10	
	it should be freely downloadable from Google Play / Apple store	
	it should support following features:	
	Make a call	
	Hold	
	Retrieve	
	transfer	
	"Presences (User Select) -	
	Change status: Available, Busy No Answer, Busy call waiting, DND, Logoff, Forward to VM "	
	Dial users number - Internal, External, Mobile	
	"Instant messaging - IM with another soft client User, IM with a Multi Destination, Search on IM sessions, Save IM sessions, IM to groups"	
	3 way audio conference	
	call divert	
	camp on	
	view missed call	
	Contacts synchronized with the PBX directory	

1.23.5 Core Switch

Item	Technical Specifications	Compliance
Type	Modular Switch with atleast 6 service slots other than control card slots	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

Ports	40 ports (SFP+) with 10 Gbps speed provided on the dedicated card populated with 20 nos. of 10G singlemode SFP modules.	
	40 x 10/100/1000 BaseT RJ 45 ports provided on the dedicated card(separate from 10G card).	
	12 x 40G SFP ports distributed across the cards to have redundancy populated with 10 nos. of 40G singlemode QSFP modules.	
Switching capacity	Aggregate capacity of 6 Tbps or more and performance of minimum of 4 Bpps	
Per slot bandwidth	480 Gbps full duplex	
Architecture	The Switch should have a Truly Distributed Architecture. All Interface Modules should have all the resources for switching and Routing and should offer True Local Processing.	
	The chassis should be ready with all fabric cards (max supported) to provide full throughput of the System from day 1.	
	Redundant CPU, Redundant Switch Fabric and Redundant Power Supplies from Day 1	
	Fully decoupled control plane and data plane	
	Support for 40G and 100G ports from Day 1	
High Availability features	There should not be any single point of failure in the switch. All the main components like CPU module, switching fabric, power supplies and fans etc should be in redundant configuration. Components, like modules/power supplies/fan tray should be Hot Swappable	
	Support for Hot Swap of all redundant components: Line Cards, Fabric, power supply, and fan trays	
	Should Support software upgrades with minimal traffic disruption during the upgrade	
	Switch should support processes to be run in protected memory space and independent of each other and the kernel, providing fault containment and enabling modular patching and upgrading and rapid restarting. Individual processes should be restarted independently without loss of state information and without affecting data forwarding.	
Memory	16 GB DRAM	
Layer 2 features	Should support Industry Standard Port/Link Aggregation for All Ports. Also Cross Module Link aggregation should be supported	
	Jumbo Frames support up to 9K Bytes	
	Should support port, subnet based 802.1Q VLANs. The switch should support 4,000 vlans	
	The switch should support 512K MAC addresses.	
	The switch should support IEEE 802.1w RSTP and IEEE 802.1s MSTP	
Routing Protocols	Should support RIP v1/v2, OSPF v1/v2 from Day 1	
	Should support BGPv4, IS-IS	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

	Should support IPv6 packet switching and routing using OSPFv3, RIPng in hardware from day 1.	
	Should support minimum 512K Route entries for IPv4 and 512k for IPv6	
Security features	Should support Access Control Lists	
	Should support various type of ACLs like port based/vlan based.	
	Should support integrated security features like DHCP relay with option-82, Dynamic Arp Inspection	
	Should Support MAC Address Filtering based on source and destination address	
	Should have support for RADIUS and TACACS+	
	The switch should support Port-security.	
Network protocols	Should Support VRRP Protocol or equivalent from Day 1	
	Should support MPLS. In case these features are nor supported in the chassis, vendor need to propose the equivalent functionality on separate device to ensure compliance and interoperability	
	The Switch should support GRE tunneling protocol	
Traffic policing	Should support Ingress/Egress Queuing	
	Should be able to filter, mark and limit traffic flows	
	Should support minimum 8 queues per port	
	Should support policy based traffic classification based on Type of Service (ToS), IP Precedence mapping, Layer 2/3/4 defined traffic flows, MAC address, VLANs	
Multicast	Should support H/W based IPv4 and IPv6 Multicasting	
	Should Support IGMP v1, v2 , v3, IGMP Snooping	
	Should support 128K IPv4/IPv6 multicast routes	
	Should support Protocol Independent Multicast - Sparse Mode and PIM - SSM, MSDP	
Network monitoring /management	Switch should be manageable through NMS on per port/switch basis with common interface for all manageable devices on the network. Should Support SNMP, RMON/RMON-II, SSH, telnet, web management through network management software.	
	Should support port mirroring feature for monitoring network traffic.	
	The switch should support role based access control to limit access to switch operations.	
	Should have modular OS and should support configuration roll back to recover mis-configured switch to last known good configuration	
IEEE Standards	IEEE 802.1AB	
	IEEE 802.1D	
	IEEE 802.1p	
	IEEE 802.1Q	
	IEEE 802.1s	
	IEEE 802.1w	

	IEEE 802.3ae	
	IEEE 802.3ba	
	IEEE 802.3ah	
	IEEE 802.3ad	
Certification	EAL3/ NDPP or above Certified	

1.23.6 Technical Specification of Distribution Switch

+ S. No.	Detailed Technical Specifications	Compliance (Yes / No)
A	Solution Requirement	
	The Switch should support non-blocking Layer 2 switching and Layer 3 routing	
	There switch should not have any single point of failure like power supplies and fans etc. should have 1:1/N+1 inbuilt level of redundancy	
B	Hardware and Interface Requirement	
	Switch should have the 32 x 40G/100G QSFP+/QSP28 ports	
	Switch should have 16GB DRAM and 64GB Flash/Storage	
	Switch should support Configuration roll-back and check point	
	Switch should support for different logical interface types like loopback, VLAN, SVI/RVI, Port Channel, multi chassis port channel/LAG etc.	
	1 U Rack mountable and should have Virtual chassis feature	
	The switch should support for 96,000 IPv4 unicast routes and 48,000 IPv6 unicast routes entries in the routing table with including 96,000 IPv4 multicast routes and 48000 IPv6 Multicast Routes,	
	The switch should support hardware based load sharing at wire speed using LACP and multi chassis etherchannel/LAG	
	Switch should support minimum 6.4Tbps of switching capacity and 2Bpps	
C	Layer2 Features	
	Spanning Tree Protocol (IEEE 8201.D, 802.1W, 802.1S)	
	Switch should support minimum 256,000 no. of MAC addresses	
	Switch should support 64 Nos. of link or more per Port channel (using LACP) and support 64 number of ports per Link Aggregation Group	
	Support for broadcast, multicast and unknown unicast storm control to prevent degradation of switch performance from storm due to network attacks and vulnerabilities	
D	Layer3 Features	
	Switch should support all physical ports to use either in Layer2 or Layer 3 mode and also should support layer 3 VLAN Interface and Loopback port Interface	
	Switch should support static and dynamic routing like Static, OSPF and BGP	
	Switch should provide multicast traffic reachable using PIM-SM and SSM	
E	Availability	
	Switch should provide gateway level of redundancy in IPv4 and IPv6 using HSRP/ VRRP	
	Switch should support for BFD For Fast Failure Detection	
F	Quality of Service	
	Switch system should support 802.1P classification and marking of packet CoS, DSCP etc.	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

	Switch should support for different type of QoS features for real time traffic differential treatment using WRED and SP Queuing	
	Switch should support Flow control of Ethernet ports to control traffic rates during congestion by allowing congested nodes to pause link operation at the other end for receiving traffic as per IEEE 802.3x	
G	Security	
	Switch should support for deploying different security for each logical and physical interface using Port Based access control lists of Layer-2 to Layer-4 in IP V4 and IP V6 and logging for fault finding and audit trail	
	Switch should support control plane i.e. processor and memory Protection from unnecessary or DoS traffic by control plane protection policy	
	Switch should support for AAA using TACACS+ / Radius	
	Switch should support to restrict end hosts in the network. Secures the access to an access or trunk port based on MAC address. It limits the number of learned MAC addresses to deny MAC address flooding	
	Switch should support for Role Based access control (RBAC) for restricting host level network access as per policy defined	
	Switch should support to prevent edge devices in the network not administrator's controlled from becoming Spanning Tree Protocol root nodes	
	Switch should support unicast and/or multicast blocking on a switch port to suppress the flooding of frames destined for an unknown unicast or multicast MAC address out of that port	
H	Manageability	
	Switch should support for RMON I / II . Should also support for central NMS management and monitoring	
	Switch should provide remote login for administration Telnet, SSHv2	
	Switch should support for management and monitoring status using different type of Industry standard NMS using SNMP V2 and V3	
	Switch should support for basic administrative tools like Ping and traceroute	
	Switch should support central time server synchronization using Network Time Protocol NTP V4	
I	IPv6 features	
	Switch should support for IPv6 connectivity and routing required for network reachability using different routing protocols such as OSPFv3, BGP+ etc.	
	Should support route redistribution between these protocols	
J	Safety and Compliances	
	Switch should be IPv6 Ready Logo Certified	
	Switch Should be Common Criteria/NDPP/NDcPP certified	

	<p>Switch should be CAN/CSA-C22.2 No. 62368-1-14 Information Technology Equipment – Safety UL 62368-1 Information Technology Equipment – Safety. EN 62368-1 Information Technology Equipment—Safety, IEC 62368-1 Information Technology Equipment —Safety, EN 55024:2010 (CISPR 24:2010) Information technology equipment—Immunity characteristics—Limits and methods of measurement. FCC 47 CFR Part 15 USA Radiated and Conducted Emissions ICES-003 Canada Radiated and Conducted Emissions VCCI-CISPR 32:2016 Japanese Radiated and Conducted Emissions BSMI CNS 13438 Taiwan Radiated and Conducted Emissions (at 10 meters) KN32/KN35 Korea Radiated Emission and Immunity Characteristics (at 10 meters) KN61000 Korea Immunity Test TEC/SD/DD/EMC-221/05/OCT-16 India EMC standard</p>	
	Environmental Compliance	
	Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Waste Electronics and Electrical Equipment (WEEE)	

1.23.7 Technical Specification of Access PoE Switch

S. No.	Detailed Technical Specifications	Compliance (Yes / No)
1	Minimum 24 x 10/100/1000 Base-T PoE+ and 4 x 1/10G ports. (with required transceiver modules)	
2	1 U Rack mountable and should provide stacking of minimum 10 switches with 128Gbps of dedicated stacking/ equivalent bandwidth (All the stacking accessories should be included from day 1).	
3	The Switch should have 2GB DRAM and 2GB internal Flash	
4	256 Gbps or higher Backplane capacity and minimum 190 Mpps of forwarding rate	
5	Should support Non-blocking hardware architecture	
6	All interfaces should provide wire speed forwarding for both Fiber and copper modules	
7	Support for at least 1000 VLANs & 32k MAC address	
8	It should support IGMP snooping v1,v2 & v3	
9	It should have static IP routing from Day 1 and should be upgradable to support OSPF and PIM	
10	Switch should support 8 hardware queues per port	
11	Dynamic Host Configuration Protocol (DHCP) snooping	
12	Switch should support LLDP capabilities	
13	Should support IP Source Guard , DAI and IPv6 Security feature like IPv6 RA Guard and IPv6 Neighbor Discovery Inspection	
14	Should support Secure Shell (SSH) Protocol and Simple Network Management Protocol Version 3 (SNMPv3).	
15	Switch needs to have console port for administration & management	
16	Management using CLI, GUI using Web interface should be supported	
17	FTP/TFTP for upgrading the operating System	
18	The Switch should support MACSec	
19	Should support Energy Efficient Ethernet	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

20	IEEE 802.1x support	
21	IEEE 802.1D Spanning-Tree Protocol	
22	IEEE 802.1p class-of-service (CoS) prioritization	
23	IEEE 802.1Q VLAN	
24	IEEE 802.3 10BASE-T specification	
25	IEEE 802.3u 100BASE-TX specification	
26	Switch should have internal redundant power supply and Hotswappable fans	
27	Switch should able to support management via CLI, Web interface	
28	SNMP v1,v2,v3	
29	Switch should be manageable through both IPv4 & IPv6.	
30	Switch should be UL-UL60950-1,FCC Part 15, VCCI Class A, EN 55022, EN 55024, EN 300386, CAN/CSA 22.2 No.60950-1, Reduction of Hazardous Substances (ROHS) certified	
31	Switch should be IPv6 Logo Certified	
32	Switch Should be Common Criteria NDPP/NDcPP certified	

1.23.8 Technical Specification of ITAM

S.No	Specifications	Compliance
1	Web Appliance Hardware	Rack based Intel Core i7 or better, 3.20GHz w/ HD Graphics
		Memory 32GB 4x8GB DDR4 2666MHz
		Minimum 1 TB SATA/SSD Drive
		Integrated NIC
		COTS Compliant
2	Web Appliance Software	
	Items	Capture specifications, warranties, Serial Numbers, MAC Addresses, IP info, what other H/W relates/connects to this H/W, item status, event logs, assignees
	Software	Specifications, License information
	Assignment Relationships	and Where each software is installed, license qty, component relations, contract relations to software/hardware/invoices
	Commercial Data	Purchase proofs depicting date, vendor, prices, attached documents
	Agents	Vendors, H/W & S/W Manufacturers, Buyers (for different Dpt), Contractors
	Locations	Location of each asset building, floor, room, rack, rack row, row depth
	Contracts	Define custom contract types, like support& maintenance, SLA, etc. Track contract events.
	Tags	Multiple tags for items and software. You may use tags for grouping according to usage, budget, owner, importance, etc.
	Files	Attach documents to every main object entity (Items, Software, Invoices, Contracts)
	Users	Who has what or who is responsible for what.
	Racks	Display rack layout with items assigned to each rack row. (Supports multiple items/rack row).
	Print labels	Print label stickers for tag all your assets, with or without barcode, from phones and laptops to cooling units and UPS. Easily define new label paper layouts through the GUI.

	Backup	Get a full backup of the installation and data. Ability to restore	
	PagePrint Support	All screen pages/lists/reports print-outs possible without menus, scrollbars and other clutter.	
	Interface Translations	Translation file support	
	LDAP support	Pull userlist for item assignment from an LDAP URL	
	ITAM Appliance	Approved Make: Nexus/ Siemens/ Torque	

1.23.9 Technical Specification of Indore Access Point/Outdoor

SN	Specification	Compliance (Yes/No)
1	The Access Point proposed must have radios to support 2.4Ghz and 5 Ghz channels with 802.11ac Wave-2, 4X4:4 MU-MIMO with a throughput of upto 2.5 Gbps.	
2	Should come with standard Mounting Brackets	
3	Access point should have a Gigabit link that can support atleast 1 Gbps of throughput.	
4	Should be capable of Band Steering	
5	Should support Way finding within covered areas to start with.	
6	Should not require any calibration for configuration of BLE location based messaging	
7	AP should support encrypted data transmission between user and also to cloud management platform	
8	Should support virtual BLE technology	
9	Should support automatic RF optimization	
10	WIPS/WIDS detection of rogue and honeypot Access Point detection,	
11	Should be able to limit per SSID or per user based, uplink or downlink bandwidth	
12	Should be based on the platform of Artificial Intelligence	
13	Should have following compliances:- UL 60950-1 CAN/CSAC22.2 No. 60950-1 FCC Part 15.247, 15.407, 15.107, and 15.109 RSS247 ICES003	
14	Artificial Intelligence Support from wireless access point to Switching end.	
	Access Point -Outdoor AP (4X4:4)	
SN	Detailed Specifications	Compliance (Yes/No)
1	Should be Outdoor Access Point 4 X 4 MU - MIMO , SU MIMO	
2	Should have Data Rate Support - 2.3 Gbps	
3	Should At 2.4Ghz - 4x4:4 802.11b/g/n/ac up to 800 Mbps data rate. 802.11ac for VHT capable Proprietary clients..	
4	Should At 5 Ghz - 4x4:4 802.11a/n/ac Wave 2 up to 1,733 Mbps data rate.	
5	Should have Antenna Options - Internal and External	
6	Should have Bluetooth - 16 directional antenna + 1 omni antenna	
7	Should have Transmit Beamforming and Maximal Ratio Combining	
8	Should have 10/100/1000 BaseT RJ45 interface that supports 802.3at PoE	
9	Should have Operating Temp. - -20° to 65° C; no solar loading -20° to 55° C; with solar loading	

10	Should have Enclosure - IP67 / NEMA 4 compliant	
11	Should have 10% to 90% maximum relative humidity, non-condensing	
12	Should have 1 - 10/100/1000BASE-T auto-sensing RJ-45 with PoE 1 – 10/100/1000BASE-T auto-sensing RJ-45	
13	Should support Artificial Intelligence (AI) Driven and Dynamic debugging with automatic RF Optimization feature	
14	Should have Multi-color status LED	
15	Compliance Standards - UL 60950-1 CAN/CSAC22.2	
	No. 60950-1 FCC Part 15.247, 15.407, 15.107, and 15.109 RSS247 ICES003 (Canada)	

1.23.10 Technical Specification of Wireless Controller (Wi-Fi Controller)

SN	Specification	Compliance (Yes/No)
1	Should have a Artificial Intelligence (AI) driven, Cloud based Controller	
2	The Solution should support 802.11ac primarily and should be backward compatible to 802.11n/a/b/g. The solution should also support 802.11ax as per requirement.	
3	The solution should support Location Based services via Bluetooth low energy and should also support Asset Tracking.	
4	The solution should support Guest Portal	
5	The solution should support WIPS, Rouge AP detection and Honeypot AP detection	
6	Should be able to provide insights based on Time to connect, successful connect, coverage, capacity, AP Uptime, Roaming and throughput.	
7	should be able to integrate with varous authentication mechanism including the RADIUS servers, etc.	
8	Should support Dynamic Packet capture to enhance troubleshooting.	
9	Should support upto 16 SSIDs per AP and the cloud controller should be scalable to handle around 5000 APs or more in future	
10	Should have a virtual assistant to troubleshoot deeper and facilitate investigation of existing or future issues in the Wi-Fi network	
11	Must be able to limit per SSID based uplink or downlink Bandwidth	
12	Must be able to limit per user based uplink or downlink bandwidth	
13	Must be able to provide per application bandwidth limit as well	
14	The per application based Bandwidth limit should be applicable on Home Grown or Organization specific applications as well	
15	Pre-staging of APs should be possible to have zero touch provisioning	
16	Should support bulk configuration based on templates	
17	Should be able to handle interference and shift the communication on another channel automatically if, needed	
18	Should be able to create access policies based on various groups/labels/subnets	
19	Should be able to extend API to integrate with other systems as well.	
20	Network Switching should also Artificial Intelligence (AI) driven,	

S. No	Detailed Technical Specifications	Compliance (Yes / No)
	Architecture:	
1	The appliance based security platform shall be capable of providing firewall, IPS and VPN (IPSec) functionality simultaneously.	
2	The Firewall should have Application visibility and control/ AVC from Day 1.	
3	The Firewall should have Advanced Threat Protection like malware and zero-day threats	
4	The platform should be based on real time, secure, embedded operating system.	
5	Should provide Stateful failover.	
6	HA configuration that uses dedicated HA-control interfaces apart from the mentioned traffic interfaces	
7	Should provide active/active and active/standby failover	
	Sessions	
8	Should support upto 50 Million Concurrent sessions and at least 500,000 sessions per second	
	System Throughput	
9	Should provide 90 Gbps Firewall Throughput and 60Gbps IMIX throughput	
10	Should provide 30 Gbps IPSec throughput	
11	Should provide 40 Gbps IPS throughput	
12	Should provide 20 Gbps NextGen firewall throughput including Firewall, Application security/ AVC, IPS and URL Filtering	
13	Memory - atleast 256GB or higher and 900GB storage	
14	Support: - IKEv1 and v2, IPSec VPN standards, 56-bit DES, 168-bit 3DES, 256-bit AES encryption	
15	Authentication, Authorization and Accounting (AAA) support: RADIUS, TACACS or TACACS+	
16	Support for: Network and application level attacks ranging from malformed packet attacks to DoS attacks, Support RSA and Diffie-Hellman, MD-5, SHA-1, SHA-128, SHA-256	
17	Provides:	
18	Rich dynamic NAT and PAT services	
19	Static NAT and PAT services	
20	Stateful and stateless and Zone-based firewall	
21	Denial of service (DDoS) protection	
22	Traffic anomaly protection	
	Management	
23	Web based management to support for remote monitoring	
24	Accessible through variety of methods including: Telnet, Console Port, SSH	
25	Dedicated Out-of-Management interface	
26	Support SNMPv1, v2, v3 & Support for syslog	
27	Should have the ability to create customizable administrative roles/profiles (monitoring only, read-only access to configuration).	
	Software features	
28	support for IPv4, RIPv2, OSPF, BGP, VLAN, DHCP, Support for IPv6 RIPng, OSPFv3.	
	Power Supply	
29	Internal Redundant Power supply and redundant hotswappable fans	

Minimum Interfaces Required		
30	8 x 1/10Gig, 2 x 40Gig, 2 x 100G Ports loaded with required optics	
31	Firewall Should be EAL4/ NDPP/NDcPP certified	

1.23.12 IP CCTV System Technical Specification

1.23.13 Technical Specification of Dome Camera

S.No	Features	Specifications	Compliance
1	Form Factor	DOME	
2	Certification	UL,CE,FCC	
3	Housing	IP67 and IK10 or better	
4	System Compatibility	ONVIF profile S ,G & T	
5	Max Resolution	5MP(2592 X 1944)	
6	lens	2.7mm to 12 mm motorized varifocal length	
7	Focus	Auto focus	
8	Image sensor	1/2.8" or larger	
9	H-FOV	99 ~ 30°	
10	Min illumination	0.01 Lux @ (F1.2,AGC ON), 0 Lux with IR	
11	Shutter speed	1/5 s ~ 1 / 100,000 s	
12	Video compression	H.265+ ,H.265 ,H.264+ H.264	
13	Video bit rate	256 Kbps to 8 Mbps	
14	Noise reduction	2D / 3D DNR	
15	Video Streams	Quad stream , Each stream should support H.265+ compression	
16	IP filter	Should support IP filter for security purpose	
17	Frame rate	Main stream upto 5MP@25fps , sub stream upto 2MP@25fps , third and fourth stream upto VGA@25fps	
18	ROI	Should Support ROI for Better bandwidth consumption	
19	BLC	Support	
20	Day & Night	IR cut filter with auto switch	
21	Day / Night Switch	Auto / Schedule / Triggered by Alarm In	
22	Edge analytics	Motion Detection, Perimeter Intrusion, Line Crossing, Stationary Object, Pedestrian detection, Face detection (deep learning) ,Cross counting	
23	Image setting	Flip, Rotation, Corridor mode, Saturation, Brightness, Contrast, Hue, Sharpness adjustable	
24	Rotate Mode	Yes	
25	WDR	120 dB WDR	
26	Alarm	1 input, 1 output	
27	Audio	1 input, 1 output	
28	SD Card support	upto 128 GB	
29	Protocols	TCP/IP,HTTP,DHCP,DNS,DDNS,RTP/RTSP,PPPoE,SMTP ,NTP,UPnP,SNMP,HTTPS,FTP,	
30	Video output	1 X BNC	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

31	Reset button	Available	
32	Security	Flash-prevention, dual stream, heartbeat, password protection, privacy mask, IP address filtering	
33	Digital Zoom	Should have the capability to digitally zoomed in web browser by selecting the area using mouse	
34	Factory Default	Should have the option of setting the configuration to factory default except network settings.	
35	Privacy Zones	Min 4 Nos of selectable privacy Zones	
36	User accounts	Should support 1 admin and 6 user accounts	
37	Firmware upgrade	Firmware upgrade shall be done through web browser	
38	Remote Update	Camera IP and firmware should be upgradable through the device search tool/Software without directly logging in to the camera. Firmware should also be upgradable through web browser	
39	Defog	Should support Defog mode	
40	IR Distance	Min IR distance 40 meters	
41	Vandal resistant	IK10	
42	Operating Temperature	-30°C ~ 60°C Humidity 95% or less (non-condensing)	
43	General	OEM should not be blacklisted nationally or internationally	

1.23.14 Technical Specification of Bullet Camera

S.No	Features	Specifications	Compliance
1	Form Factor	Bullet	
2	Certification	UL,CE,FCC	
3	Housing	IP 67 and IK 10 or better	
4	System Compatibility	ONVIF profile S , G & T	
5	Max Resolution	5MP(2592 X 1944)	
6	lens	2.7mm to 12 mm motorized varifocal length	
7	Focus	Auto focus	
8	Image sensor	1/2.8" or larger	
9	H-FOV	99 ~ 30°	
10	Min illumination	0.01 Lux @ (F1.2,AGC ON), 0 Lux with IR	
11	Shutter speed	1/5 s ~ 1 / 100,000 s	
12	Video compression	H.265+ ,H.265 ,H.264+ H.264	
13	Video bit rate	256 Kbps to 8 Mbps	
14	Noise reduction	2D / 3D DNR	
15	Video Streams	Quad stream , Each stream should support H.265+ compression	
16	IP filter	Should support IP filter for security purpose	
17	Frame rate	Main stream upto 5MP@25fps , sub stream upto 2MP@25fps , third and fourth stream upto VGA@25fps	
18	ROI	Should Support ROI for Better bandwidth consumption	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

19	BLC	Support	
20	Day & Night	IR cut filter with auto switch	
21	Day / Night Switch	Auto / Schedule / Triggered by Alarm In	
22	Edge analytics	Motion Detection, Perimeter Intrusion, Line Crossing, Stationary Object, Pedestrian detection, Face detection (deep learning) ,Cross counting	
23	Image setting	Flip, Rotation, Corridor mode, Saturation, Brightness, Contrast, Hue, Sharpness adjustable	
24	Rotate Mode	Yes	
25	WDR	120 dB WDR	
26	Alarm	1 input, 1 output	
27	Audio	1 input, 1 output	
28	SD Card support	upto 128 GB	
29	Protocols	TCP/IP,HTTP,DHCP,DNS,DDNS,RTP/RTSP,PPPoE,SMTP ,NTP,UPnP,SNMP,HTTPS,FTP,	
30	Video output	1 X BNC	
31	Reset button	Available	
32	Security	Flash-prevention, dual stream, heartbeat, password protection, privacy mask, IP address filtering	
33	Digital Zoom	Should have the capability to digitally zoomed in web browser by selecting the area using mouse	
34	Factory Default	Should have the option of setting the configuration to factory default except network settings.	
35	Privacy Zones	Min 4 Nos of selectable privacy Zones	
36	User accounts	Should support 1 admin and 6 user accounts	
37	Firmware upgrade	Firmware upgrade shall be done through web browser	
38	Remote Update	Camera IP and firmware should be upgradable through the device search tool/Software without directly logging in to the camera. Firmware should also be upgradable through web browser	
39	Defog	Should support Defog mode	
40	IR Distance	Min IR distance 50 meters	
41	Operating Temperature	-30°C ~ 60°C Humidity 95% or less (non-condensing)	

1.23.15 Technical Specification of 64 Channel NVR

S.No	Features	Specifications	Compliance
1	NVR	64 Channel NVR	
2	Recording bandwidth	Max 640Mbps	
3	Recording Resolution	8MP (4K), 5MP, 3MP ,2MP(1080P),1.3MP(960P),1.0MP(720P)	
4	Display Split	1/4/6/8/9/10/13/14/16/17/19/22/25/32/36/64	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

5	live/Playback performance	4K: 4ch realtime , 4MP: 8ch realtime , 3MP: 10ch realtime , 2MP: 16ch realtime	
6	Playback	Max 8ch playback	
7	Output Interface	1 HDMI (up to 4K), 1 VGA	
8	Display Resolution	1024*768, 1280*720, 1280*1024, 1440*900, 1920*1080, 2560*1440, 3840*2160	
9	Alarm Input/out	16ch in / 4ch out	
10	Ethernet	RJ-45 port (1000M)	
11	Smart Phone	iOS, Android	
12	Internal HDD	8 SATA HDDs, each HDD up to 8TB support RAID 0/1/3/5/10/JBOD/CLONE	
13	RS485	1 X RS485	
14	e-SATA	1 X e-SATA	
15	Line in	1 X Line in	
16	USB	1x3.0 USB for backup/upgrade , 2x 2.0 USB for mouse	
17	Support AI with deep learning supported cameras.AI- Registered quantity	10000 AI-Registered quantity	
18	AI-Maximum captured quantity with deep learning supported cameras	200,000 faces	
19	ONVIF	ONVIF Compliant	
20	Power Supply	AC 110~240V	
21	Certification	UL,CE,FCC	

1.23.16 Technical Specification of 8 Port Industrial PoE Switch

S.NO	Parameters	Specifications	Comply
1	Interface	8 x 10/100/1000Base-T Ports POE + 2 x Gigabit SFP Slots + 1 Console Port	
2	Network Protocols	IEEE802.3 10BASE-T; IEEE802.3i 10Base-T; IEEE802.3u; 100Base-TX/FX; IEEE802.3ab 1000Base-T; IEEE802.3z 1000Base-X; IEEE802.3x; IEEE802.3af, IEEE802.3at	
3	PoE Specification	PoE Standard: IEEE802.3af/ IEEE802.3at , PoE ports: 1-8 ports support PoE+ , Available PoE Power 240 W	
4	Performance Specification	Bandwidth: 20Gbps , Jumbo Frames: 9216 Bytes , Packet Forwarding Rate: 14.88Mpps , MAC Address Table: 8K	
5	Forwarding Mode	Store-and-Forward	
6	Protection	Lightning protection, IP30 protection	
7	Power Supply	Dual DC Input - 48 ~ 57 VDC	
8	Ring Management	Rapid Ring , Self recover time in < 20ms	
9	Spanning Tree	IEEE802.1D (STP) , IEEE802.1W (RSTP) , IEEE802.1S (MSTP)	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

10	VLAN	802.1Q VLAN , Port-Based , VLAN Entries - 4K , Private VLAN Edge , Voice VLAN , Guest VLAN , Q-in-Q , 802.1v Protocol VLAN , MAC-Based VLAN , IP Subnet-Based VLAN	
11	IGMP snooping v1/v2	Supports IGMP Snooping,MLD Snooping,Multicast VLAN Registration (MVR),Supports GARP/GVRP	
12	IEEE 802.3ad LACP	Dynamic Trunk , Static Trunk	
13	LLDP	supports LLDP link discovery protocol	
14	System management	User add / delete user; User login, operation, status, event log , Device reset, configuration save/restore, upgrade management, time setting	
15	Layer 3 Switching	Static Route , DHCP Server	
16	Class of Service	Port Based , 802.1p , DSCP , TCP/UDP	
17	Rate Limiting	Ingress , Egress	
18	Priority Queue Scheduling	WRR , Strict Priority	
19	Harware Queues	8 Hardware Queues	
20	ACLs	L2/L3/L4 , IPv6 Support	
21	Security	Port Security (MAC-based) , IP Source Guard , Storm Control ,RADIUS Authentication 802.1x , TACACS+ Authentication , HTTPs and SSL (Secured Web) , BPDU Guard , STP Root Guard , DHCP Snooping , Loop Protection	
22	DHCP	Client , Relay , Option 66 , Option 67 , Option 82	
23	Event/Error Log	Syslog , SMTP (RFC821)	
24	Management Access Filtering	SNMP , Web , Telnet , SSH	
25	PoE Management	Scheduling , Auto-Checking , Power Delay	
26	Switch Management	SNMP (v1, v2c, v3) , RMON (1,2,3 & 9 Groups) , Software Upgrade , Configuration Export/Import , Port Mirroring , LLDP (IEEE802.1AB) , LLDP-MED (IEEE802.1AB) , CDP Aware , sFlow , IPv6 Management , NTP	
27	Device Management	Topology View , Floor View , Map View , Dashboard , Traffic Monitoring , Cable Diagnostics	
28	Fanless	Fan Less	
29	Environmental	Operating Temperature -40°C to 75°C , Storage Temperature -40°C to 85°C , Humidity 5 to 95% RH	
30	Industry Standard / Certifications	CE/FCC/UL	
31	Shell	IP30 protect grade, metal shell	
32	Installation	DIN-Rail or Wall mounts	
33	Certifications	IEC 60068-2-6 ,IEC 60068-2-27 ,IEC 60068-2-32 ,EN61000-4-2 ESD, EN61000-4-3 RS, EN61000-4-4 EFT, EN61000-4-5 Surge, EN61000-4-6 CS, EN61000-4-8 PFMF ,FCC Part 15 Class A, (EN61000-3-2, EN61000-3-3,EN61000-6-4, EN61000-6-2, EN55022	

1.23.17 Access Control System Technical Specification

Technical Specification of 2 Door 2 Reader Controller

S. No.	Specification	Compliance
1	Applications	Access Control System
2	CPU	ARM 32 Bit RISC Processor
3	Memory	Up to 4GB (8 MB Flash)
4	No. of Doors	2
5	No. of Readers	2
6	Events/Transactions	Up to 2,50,000
7	No. Users	Up to 100000
8	Web Server	Available
9	Door Interlocking/Man Trap	Available
10	Global APB	Available
11	SNMP Alerts	Available
12	MODBUS Protocol Support	Available
13	AC Fail/Low Battery Alert	Available
14	Reader Interface	Weigand (26 bit to 56 bit)
15	Input	06 inputs (2- Door Status, 2- Egress, 1- Fire & 1-intrusion)
16	Output	04 outputs (2 - DOTL, 2 – Lock)
17	Communications Port	TCP/IP,RS485
18	Fire Integration	Yes
19	Intrusion Integration	Yes
20	LCD	16X2 LCD Display
21	Keypad	4X3 Key with soft keypad
22	Baud Rate	9600bps (Default)
23	Controller ID	Up to 10,000
24	Language	English
25	Power Supply	12 V DC/ 5A
26	Enclosure	Industry Standard Metal Enclosure
27	Mounting	Din Rail (Without Metal Enclosure)
28		Wall mount (With Metal Enclosure)
29	Facility Code	Available
30	Time Zone / Access Levels	63 + 1 (Free Time Zone)/Unlimited
31	Time Zone Slots	4 slots per Day
32	Anti-Passback	Hard, Soft, Escort (Reader Wise),Global
33	Holiday Settings	42

Technical Specification of Smart Card Reader

S.No.	Specification	Compliance
1	Read Range	4 -9 cms
2	Data Read	CSN/Sector
3	Type	Smart Card (Mifare Classic)
4	Transmit Frequency	13.56 MHz

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

5	Card (Transponder)	Mifare® Series (ISO14443-A)	
6	Card Read Time	0.1 sec	
7	Output Interface	Wiegand Format(32 bits)	
8	LED Indicator	Bi color LED	
9	Power supply	12 V DC @ 100mA	
10	Dimensions	80W X 83 H X 21 D	
11	Material	ABS Plastic	
12	Color	Black	
13	Cable Specs (Recommended)	5 core, 7/36 shielded cable	
14	Cable Distance from Controller:	80m (Wiegand)	
15	Card should be read in	1 sec	
16	A Wiegand output that easily interfaces with most existing Wiegand protocol access control panels.		
17	Compact and Elegant. Easily installed on walls and doors.		

END OF ELECTRICAL SYSTEM SECTION

LIST OF APPROVED MAKES OF MATERIALS						
1. CIVIL & PLUMBING WORKS						
S. No.	Details of Equipment / Material	Make / Manufacturer				
1	Adhesive for Door Work	Fevicol	Vamicol	Dunlop	Araldite	Century
2	Air Release Valve	Azud	AIP	Bermad	Bird	Kirloskar
		Venus	Zoloto			
3	Aluminium Accessories and Hardware	Classic	Argent	Oxford	Newlite	Crown
		EBCO				
4	Aluminium Cladding Sheets	Aludecor	Alstrong	Alucobond	Alupan	Alstone
		Alshine	Durabuild			
5	Aluminium Die-Cast handles & two point locking kit	Giesse	Securistyle	Alu – alpha		
6	Aluminium Extrusion	Indal	Mahavir	Hindalco	Jindal	Bhoruka
7	Aluminium Fabricators	M/s. International Glass House	M/s. AGV Alfa Lab Ltd.	M/s. Consolidated Engg. Company	M/s. Ajit (India) Pvt. Ltd.	Calco
		Alkarma				
8	Anchor Fastner	Hilti	Fischer	Bosch		
9	Anti – Termite Treatment	Pest Control India Ltd.	Bayer India	Any permanent members of IPCA as approved by Engr-in-Charge.		
10	Automatic variable temperature control / fixed temperature control faucets	Jaquar	AOS-Robo-U-Tec	Parry	Angash	Euronics
11	Ball Cock	Zoloto	L&T	Audco	Advance	
12	Ball valves with floats	Zoloto	Leader	Sant	Jayco	GPA
		Audco	AIP			
13	Batch Mix Concrete (BMC) / Ready Mix Concrete (RMC)	The contractor to install his own computerized batching plant of suitable capacity and arrange for Transit Mixers, pumps etc. as per approval of Engineer – In-Charge.				
		OR				
		ACC	Nuvoco	JK Cement	Unitech	Ultra tech
14	Brass stop & Bib Cock	Zoloto	Sant	Jaguar	AIP	
15	Butterfly valves	Zoloto	Audco	AIP	Sant	Advance
16	C. I Fitting	RKS	AVR	UNIK	Electrostee I	Kesoram
		ISSCO	Neco	RIF	SKF	
17	C.I Sluice Valve & Non Return Valve	Kirloskar	IVC	Leader	Zoloto	L&T
		Audco	Advance	AIP		

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

18	C.I Valves (Full way, Check and Globe Valves	Leader Upadhyay	Kirloskar Castle	SKF Kartar	Zoloto	Sant
19	C.I. Manhole Covers	Neco Kajeco	R.I.F. Grohe	B.I.C. Gem	Hepco Parry	SKF Kohler
20	C.P. Fittings Mixer / Pillar taps/ C.P brass angle valve/ Valves Washers, C.P. brass accessories	Parko Roca	Jaguar Aquplus	Marc	Dripless Kerovit	Soma
21	C.P. Waste, Spreaders, Urinal	Jaguar	Parko	Kingston	Gem	Kerovit
22	Calcium Silicate False Ceiling	India Gypsum Saint Gobain (Gyproc)	Armstrong	Decosonic	Daiken	Aerolite
23	Calcium Silicate Boards	Hilux	Aerolite	Saint Gobain (Gyproc)		
24	Calcium Silicate Tiles	Hilux	Aerolite	Saint Gobain (Gyproc)		
25	Carpet Flooring (Tiles & Rolls)	Modulyss	Forbo	Corus	Shanhua	Heritage
26	Cement	ACC Jaypee-Rewa Bangur	L&T Shree Nuvoco	Ultra tech Lafarge Ambuja	Birla Gold Prism	JK Cement India Cement
27	Cement: White	Birla White	JK	Travancore Cements Ltd		
28	Central Control	Rain Bird, USA	Toro	Nelson		
29	Centrifugally cast C.I Rainwater fitting / Bronze gratings etc.	Sages Metals Neco	GMGR BIC	Electro Steel Neer	Kesoram	IISCO
30	Centrifugal Pump	Crompton	Kirloskar	KSB	Willo	Lobara
31	Centrifugally C.I Rainwater Intel fitting , Bronze gratings	Sages Metals Neco	GMGR BIC	Electro Steel Neer	Kesoram	IISCO
32	Centrifugally casted C.I. Pipes	Neco	Hepco	SKF	Kapilash	Kesoram
33	Ceramic tiles	Johnson Spartek	Somany Bellissimo	Kajaria	Nitco Ceramics	RAK
34	Ceramic tiles Adhesive	Basf Swastik	Sika	Cico	Pidilite	Bal Endura
35	Chlorinator	Thermax Ltd Techcon	Watcon Jesco	Ion exchange Prominent	Sigma DH Combine Inc.	Siemens
36	Chlorine Dosing System	Toshcon	Chloromax	Thermax		
37	Clear Glass / Clear Float Glass / Toughened Glass	ModiGUARD	Saint Gobain (SG)	Asahi India Ltd	GSC	Tata
38	Cockroach Trap	Chilly	GMGR	Camry		

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

39	Compressed Chequered tiles	Johnson Bellissimo	Somany	Kajaria	Spartek	Nitco
40	Concrete Additive	Sika	STP	Cico	Pidilite	Fosroc
		Fairmate	MC Bauchemie	Chokesy	Basf	
41	Copper Fittings (Capillary)	Yorkshire Imperial, U.K.	Mexflow	Rajco Metal Works Mumbai	Conex - Benninger	
42	Copper Pipes	Mexflow	Rajco Metal Works Mumbai	Conex - Benninger		
43	CPVC Pipes & Fittings	Prakash Surya	Flowguard	Astral	Ashrivad	Oriplast
		AKG	Supreme	Kishan		
44	Curtain Rod/Drapery Rod	Vista	Mac Décor	Hunter Douglas		
45	Dash Fasteners	Hilti	Fischer	Bosch		
46	Disc Filter	Azud	Spain	Amaid	Arkal	
47	Door closer / Floor spring	Ozone	Godrej	Everite	Hardwyn	Master
		Dorset	Dorma	Doorking		
48	Door Locks	Godrej	Harrison	Link	Dorset	
49	Door Seal – Woolpile Weather Strip	Anand Reddiplex	Enviroseal			
50	Doors & Windows Fixtures / Fitting.	Everite	Argent	Classic	Crown	Earl Bihari
		Dorset	Dorma	Haffele	Hettich	Godrej
51	Drainage Pumps	Grundfos	KSB	Salmson	Kirloskar	
52	Ductile Iron Fittings (IS:9523)	Electrosteel	Kesoram	Tisco	Jindal	
53	Ductile Iron Pipes (IS:8329)	Electrosteel	Kesoram	Tisco	Jindal	
54	E.P.D.M Gaskets	Anand Reddiplex	Enviro Seals			
55	Extruded Polystyrene Board	Styrofoam by DOW Chemicals	Insuboard by Supreme Industries			
56	Filtration Plant / Softening Plant	Bikon water	Ion exchange	Thermax	Pentair	Eureka Forbes
		Doshi Ion	Fontus			
57	Fire rated Doors & Frames	Navair	Shaktimet	GMP	Promat	Godrej
		Hormann				
58	Fire Rated Glass	Saint Gobin	Torch	Gaberwal		
59	Fire Retardant Paint	Viper FRS 881	Nullifire	Berger		
60	Fire Seal	Sealz	Alstroflam	Abacus		
61	Fire: Door Closures, Mortice Dead locks	Becker Fire Solution	Ingersoll Rand LCN Series	Dormakaba TH Series	Dorset	Hormann
62	Fire: D-Type Pull Handles	Becker Fire Solution	Dormakaba	Hardwin	Dorset	Hormann
63	Fire: Hinges,	Becker Fire Solution	Ingersoll Rand	Dormakaba	Dorset	Hormann
64	Fire: Panic Exit Device	Dorma	D-line	Dorset	Hormann	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

65	Fire: Panic Exit Devices	Becker Fire Solution	Ingersoll Rand LCN Series	Dormakaba PHA Series	Dorset	Hormann
66	Fire: Tower Bolts	Suzu	Nulite	Dorset	Hormann	
67	Flush Door Shutters	Archidply	Duro	Greenpanel	Century	Merino
		Kitply				
68	Flush Valves	Gem	Jaguar	Parko	Kingston	Plumber
		Marc				
69	Forged Steel Fittings & Flanges (For Welded joints)	Rohini	Kanwal	Vijay Cycle & Steel		
70	G.I. Fittings	R	Unik	S.S.	Sun	Swastik
71	G.I. Pipes	Jindal Hissar	Tata	Prakash Surya	SAIL	Swastik
72	Geyser	AO Smith	Racold	Venus	Volta	Usha Lexus
		Almonard	Bajaj	Havells		
73	Glass : Mirror	Modiguard	Atul	Saint Gobain	Asahi India	Pilkington
74	Glass Wool	Owens Corning	UP Twiga	KIMMCO		
75	Insulation	Roxul rockwool	Knauff	NISCHIAS		
76	Glass / Glass for Aluminum Doors/ Windows	Glaverbel	Asahi India Safety Glass Ltd.	Atul	Saint Gobain	Modi Float glass (India)
		Pilkington				
77	Grab bars and Disabled Hardware	Dorma	Ozone	D-line		
78	Gunmetal Valves / C.P brass angle valve	Zoloto	Leader	Kilburn	Sant	Kartar
		AIP	Audco	Jaquar	Kerovit	
79	Gypsum Board	Beral Gypsum	India Gypsum	USG Boral	Saint Gobain (Gyproc)	
80	Chairs	Godrej	Wipro	Featherlite	Herman Miller	Geeken
		HNI				
81	Hand Drier	Kopal	Utech Systems	Blue Circle (India) Pvt. Ltd.	Euronics Automat	CMR
82	HDPE Pipes / Moulded Fittings	Emco	Polyefins	Pioneer Plyfab	Supreme	Jain Irrigation
		Oriplast				
83	HDPE Solution tank	Watcon	Ion Exchange	Water Supply Specialist Pvt. Ltd.		
84	Heat Resistant Terrace Tiles	Thermatek	Thermatek	Thermatek	Thermatek	Thermatek
85	Horizontal Centrifugal / Monoblock Pumps	Kirloskar	DP Holland	Willo	Grundfoss	CRI Pumps
		Salmson	Ebara			
86	Hydro-pneumatic System	Willo	Grundfoss	Salmson	Nocchi	Xyllum
87	Inbuilt Drip Line	Azud	Rainbrid-USA	Netafim		

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

88	Insulation of Hot water pipes	Vidoflex insulation	Superion insulation Kaiflex – Kaimann	Armoflex	Thermaflex	Armacell
89	Laminates	Ventura	Archidlam	Century	Greenlam	Formica
		Amulya	Merino			
90	Liquid Level Controllers / Indicators	Advance Auto	Minilec	Radar	Femac	Switzer
91	Liquid Soap Dispenser	Chilly	Euronics	Camry	Utec	Kopal
92	M.S. Pipe	Jindal Hissar	Prakash – Surya	BST	Kalinga	TATA
		TT Swastik				
93	Mainline Isolation Valve	Sant	Leader	Zoloto	Audco	Advance
94	Metal False Ceiling	Hunter Douglas	Armstrong	Durlum	Lindner	Chicago Metals
		USG Boral	Dexune	RK Ceilings		
95	Mineral fibre ceiling	Armstrong	AMF	USG Boral	Anutone	Dexune
96	Modular SS Railing System	Metallica India	Stark Steel Fabricators	Het creators	D – Line International Denmark	Mobel Hardware
97	MS Saddle with G.I. Riser	Harvel	Alprene	Rain Bird, USA		
98	Night Latch	Godrej	Harrison	Link	Dorset	Dorma
99	Non Return Valve	Sant	Leader	Zoloto	Audco	Advance
100	P.R.S. Dials	Rain Bird, USA	Toro, USA	Nelson		
101	P.T.M.T. Fitting	Prince India	Symet			
102	MDF	Archidply	Greenpanel	Action Tesa	Valbopan	
103	Pre-Laminate MDF	Merino	Greenpanel	Jaitra	Action Tesa	
104	Metalic Laminates	Metlam	Homapal	Dekodur		
105	Glass Fibre Acoustical Ceiling Tile	Decosonic	Ecophone	Armstrong	Anutone	
106	Acoustic Wooden Perfonated Slat	Decosonic	Armstrong	Saint Gobain		
107	Acoustical Fabric (With Glasswood) Wall Panels	Anutone	Ecophone	Saint Gobain		
108	R.C.C Pipes	Indian Hume Pipe	Pragati Concrete Udyog	Daya	KK	JSP
109	Paint- Cement Paint	ICI	Berger	Asian	Dulux	Goodlas
		Nerolac	J&N			
110	Paint - Dry Distemper	ICI	Berger	Asian	Dulux	Goodlas
		Nerolac	J&N			
111	Paint - Oil Bound Distemper / Acrylic Washable Distemper	ICI	Berger	Asian	Dulux	Goodlas
		Nerolac	J&N			
112	Paints - Cement Based	ICI	Berger	Asian	Dulux	Goodlas
		Nerolac	J&N	Snowcem plus	Tatacem	
113	Paints - External Emulsion	ICI	Berger	Asian	Dulux	Goodlas

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

	Paint	Nerolac	J&N			
114	Paints - Other Paints / Primer	ICI	Berger	Asian	Dulux	Goodlas
		Nerolac	J&N			
115	Paints - Plastic Emulsion Paint	ICI	Berger	Asian	Dulux	Goodlas
		Nerolac	J&N			
116	Paints - Resin Based Paints	ICI	Berger	Asian	Dulux	Goodlas
		Nerolac	J&N			
117	Paints - Synthetic Enamel Paints	ICI	Berger	Asian	Dulux	Goodlas
		Nerolac	J&N			
118	Paint Epoxy paint	Nerolac	Shalimar	Cico	Fairmate	Sika
		Basf	Berger	Asian	Pidilite	
119	Paints - Texture paint	Berger	J&N	Spectrum	Unilite heritage	Asian
		Dulux	ICI			
120	Paver blocks (All Types)	KK Manholes	Uni Stone Products (India) Pvt. Ltd	Hindustan Tiles		
121	PE-AL-PE Pipe and Accessories	Kitec	Jindal	Kissan	Vista	
122	Pipe coat material (pipe protection)	RPG Raychem	Pypkote	Makphalt		
123	Plastic seat cover of W.C	Commander	Hindware	Johnson	Poddar	Parryware
		Bestolite	Capri			
124	Plywood/Block board/Ply board	Archidply	Duro	Greenpanel	Century	
125	Polycarbonate Sheets	Danpalon	Tuflite Polymers	DPI Daylighting	Macrolux	GE Plastic
		Vergola	Midori	Zesta		
126	Poly-sulphide Sealant	Pidilite	Fosroc	Chokesy	ChematalR ai	Cico
		Sika	MC Bouchemie	Basf		
127	Pop up Connecting Assembly	Rain Bird	Dura	Lasco		
128	Popup Spray Head	Rain Bird	Toro, USA	Nelson		
129	Powder Coating Material pure Polyester	Jotun	Berger	Goodlass Nerolac		
130	PP-R Pipes (PN – 16)	Amitex Polymers Pvt. Ltd.	Prince	Supreme	Vector	
131	Pre-coated Galvanised Steel Sheet	Tata BlueScope	Llyod Insulations India Ltd	S.R.Metals		
132	Pre-Laminated Particle Board	Century	Jaitra	Action TESA	Merino	
133	Pressed Steel Doors Frame	West Wind Concepts Pvt. Ltd., Gurgaon	Shiva Steel Pvt. Ltd., Noida	AGEW Steel Manufacturing, Ahmedabad	Sukri	Godrej
		Gurdian	Navair			
134	Pressure Relief Valve	Omega	Sant	Leader	Zoloto	Audco

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

135	Pumps	DP Holland	Willo	Grund foss	Xyllum	Lobara
136	PVC continuous fillet for periphery packing of glazings / Structural/Glazing	Roop	Anand	Forex Plastic	Nagalia	Trading Company
137	PVC Flooring	Forbo	Tarkett	Gerflor	Armstrong	Polyfloor
138	PVC flushing cistern	Commander	Johnson Pedder	Parryware	Duralite	Geberit
		Viega	Hindware			
139	PVC Pipes & fitting SWR Soil, Waste & Vent Pipes and fittings, Type B PVC Casing & Screen Pipes	Prince	Supreme	Finolex	AKG	Oriplast
		Kasta	Vector	Prakash Surya		
140	PVC Water Stops	Prince	Supreme	Finolex	Oriplast	Basf
141	Polyethylene Storage Tank	Sintex	Polycon	Fusion	Plasto	Oriplast
142	R.O. System	Ion Exchange	Sterling India Ltd.	Pentair water	Eureka Fobes	
143	Reinforcement Steel (Primary Producer)	SAIL	RINL	TISCO	IISCO	JSW
144	RQRC Hydrant	Harvel	Alprene	Rain Bird, USA		
145	RQRC Key	Harvel	Aqua	Drip& Drip		
145	Sensor Operated Auto Flushing System Urinals	Jaquar	AOS-Robo	U-tec	Angash	Euronics
		CMR	Roca			
146	SFRC / RCC Manhole Covers/ Perfect RCC Grating	KK Manholes	SK Precast Concrete	Advent concreteo vision		
147	Silicon sealants /Weather Sealant / Structural Glazing Sealant	GE- Silicon	Pidilite	Chokesy	Wacker	Forsoc
		Cico	Dow Corning	Sika		
148	Sluice valve / NRV	Kirloskar	IVC	Kilburn	Zoloto	Castle
		Leader	L&T	Audco		
149	Solar Hot water system	Emmvee Solar	Racold	Solahart (India)	Venus	Honeywell
149	Solenoid valve	Rain Bird, USA	Toro	Nelson		
150	SS Gratings, Soap Dish Towel Rail etc.	Camry	Glacier	Gem		
151	Stainless Steel	Salem Steel	As approved E-in-Charge			
152	Stainless Steel bolts, Washers and Nuts	Kundan	Puja	Atul		
153	Stainless Steel Clamps	Hilti	Intellotech	Koncept		
154	Stainless steel CP Grating	Chilly	Camry	Viega	Neer	GMGR
155	Stainless Steel D-handles	D-line	Giesse	Dorma	Dorset	
156	Stainless Steel Friction Stay	Earl Bihari	Securistyle	EBCO		
157	Stainless Steel Pressure Plate Screws	Kundan	Puja	Atul		

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

158	Stainless Steel Screw for Fabrication and fixing of Windows	Kundan	Puja	Atul		
159	Stainless Steel Sink	Hindware	Jayna	Neelkanth	Nirali	Kingston
		AMC	Orient	Commander		
160	Stone ware pipes & Gully Traps	Perfect	R.K	Hind	Anand	
161	Submersible Drainage pump	Jyoti	Crompton	Kirloskar	KSB	Grundfos
		Mather & Platt	JS	Wilo	Xyllum	
162	Sunken Portion Treatment	Choksey	Sika	Cico	MC Bouchemie	Basf
163	Super plasticizer	Cico	MC Bauchemie (India) Pvt Ltd	Roffes Construction Chemicals	Pidilite Industries	Berger
		Fosroc	Sika	Basf	Ultracon	
163	Tiles: Glass Mosaic Tiles	Mridul	Italias	Bisazza	Pace India	
164	Tiles: Glazed tiles	Bell	Somany	Johnson	Kajaria	Spartek
		Bellissimo	Nitco	RAK		
165	Tiles: Vitrified Tiles	Somany	H.R.Johnson	Kajaria	Nitco	RAK
		Restile	Bell	Bellissimo	Spartek	
166	UPVC Pipes & fittings	Prakash surya	Finolex	Oriplast	Supreme	AKG
		Kasta	Vector	Astral	Prince	
167	Vacuum Dewatered Flooring	Tremix	Sun Build	Avcon technics		
168	Valve Box	Rain Bird, USA	Carson Brook, USA	Dura		
169	Veneer	Duro	Greenpanel	Century		
169	VFD Pump	Jyoti	Crompton	Kirloskar	KSB	Grundfos
		Mather & Platt	Ebara			
170	Vibration Eliminator Resisto-flex Pads & Connections	Relay Corpn.	Kanwal			
171	Vitreous China/ Sanitary ware	Parryware	Neycer	Cera	Hindware	Kohler
		Grohe	Kerovit	Jaguar	Aquaviva	
172	Water Cooler	Blue Star	Volta	Usha	Godrej	Eureka fobes
173	Water Meter	Capstan	Kranti	Anand	Kant	
174	Water Proofing Agencies	Shalimar Tar products	IWL (India) Ltd.	M/S Llyod Insulations India Ltd.	Chemisol Adhesive Pvt. Ltd. Mumbai	Indian Water proofing
		Overseas Water proofing	(Chemistik) Texas Ltd.	Fosroc	Sika	Cico
		MC Boucheme	Chyrs			
175	Water Proofing Materials	Shalimar Tar products	IWL (India) Ltd.	M/S Llyod Insulations India Ltd.	M/S Chemisol Adhesive Pvt. Ltd. Mumbai	Grace

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

		Sika	Cico	MC Boucheme	Fosroc	Chyrso
176	Water supply pumps	KSB	Grunfos	Kirloskar	Crompton	Mather & Platt
		Ebara				
177	White Glazed Fire Clay Sink	Sanfire	Cera	Neycer	Hindware	
178	WC Pan Connector	Supreme	Prince	Mc Alpine		
179	Wooden Laminated Flooring	Berryfloor	Krono	Egger	Haro	Pergo
		Armstrong	Kaindl	Greenpanel		
180	P U Water Proofing	Fosroc	Pidilite	Basf	Sika	Mapei
		Chyrso	Berger			
181	T.P.O Laxer W.P.	Basf	Fosroc	Sika	Firestone	Chyrso
182	Modular Furniture	Godrej	BP Ergo	Wipro	Featherlite	HNI
183	Fabric Blinds	Hunter Douglas	Mac Décor	Vista		
184	Aluminium Louvers / Facades.	Harsons Green	Hunter Douglas	Lindner	Faveton	Chicago Metals
185	Copper Louvers / Facades.	Harsons Green	Hunter Douglas	Lindner		
186	Tensile Fabric	Mehler	Verseidag	Heytex		
187	Facade Tiles	Clayton	Faveton	Terreal	Hunter Douglas	Tempio
188	Zinc Panels	Elzinc/VM Zinc	Halcor	Leqsa	Cinkarna	
189	Expanded Metal Mesh Panels	Fils & Italfim	Expanded Metal Mesh company	Harsons Green		
190	WTP	BS Enviro	Pentair	Doshion	Thermax	
191	STP/ETP	BS Enviro	C-Tech	Doshion	Premiertech	Thermax
		Brizanzia Technologies				
192	AAC Block	Aerocon	Ballarpur	JindalBlock	JK Laxmi	Finecrete
193	AAC Blocks adhesive	Saint Gobain Weber	Sastha buildtech	Ultratech		
194	Adhesive for Stone/ Tile Fixing Solution	Saint Gobain Weber	Kerakoll	Dunlop		
195	Epoxy Grout for Stone/ Tile	Saint Gobain Weber	Kerakoll	Norcros		
196	Stone Sealer	Saint Gobain Weber	AKEMI	MMC		
197	Water Proofing Polymer based	Saint Gobain Weber	Kerakoll	Mapei	Chyrso	
198	Water Proofing Cementitious membrane	Saint Gobain Weber	Kerakoll	Mapei		
199	Polymer Modified Cementitious Grout	Saint Gobain Weber	Kerakoll	Norcros		

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

200	Pre-Cast GRC Jali	Unistone	Grand GRC Prefab pvt. Ltd.	Ecovision		
201	Hdpe Grass Pavers & Hdpe Drain Board	Ovilite	Aceturf	Virendra Textiles		
202	Ornate Pots(Removable Planters)	Smart Exteriors	Yuccabe	Raunaq Sales		
203	Sculptures	Kalanishtha Enterprises	Art View Studio	Us India Art & Culture Exchange		
204	Stone	R.K.Marble	ArasiEmpexs	Mangla Group	DBS	Stonex
205	Water Body Vendors/Fountain	Ripple Engineering	Premium Pools	Watcon Water Specialist		
206	Irrigation Products	StitchwellQuali tex	Irrigation Products International	Jain Irrigation Systems		

2. FIRE FIGHTING WORKS						
S. No.	Details of Equipment / Material	Make / Manufacturer				
207	Diesel engine driven pump	Kirloskar	Ashok Leyland	Mather & Platt	Wilo	
208	Air Break Contractors	Seimens	L&T	ABB		
209	Air Release Valve	Rb	Tbs	Cimbrio	Zoloto	
210	Alarm valve & Hydraulic (Alarm motor with coupling)	HD fire protect	Mather&Platt			
211	Alternator	Stamford	Lorey Somer	Kirloskar	Toyo denki	AVK
212	Ammeter, Voltmeter, PF, kW, Hz, meter (Analogue), Energy Meter	AE	Enercon	Conzerve		
213	Ball Valve	Rb	Zoloto	Leader	Danfoss	Sant
		Rapid	Castel	Emerald Audco		
214	Battery	Exide	Amco	Amaraja	Chabbi	Statcon
215	Butt welded fitting (UL Listed	V.S.Forge	True Forge	DRP-M		
216	Butterfly valves / C.I. Double flanged sluice Valves & check valves	Interval	Leader	Audco	Kirloskar	Advance
217	Cable lugs and glands	Comet	Dowell	Lotus	Jainson	
218	Cables	Universal	CCI	Gloster	Elektron	Polycab
		Finolex				
219	Control / Potential / Current Transformer	Precise	Gillbert & Maxwel	AE	Kappa	
220	Deluge valve	Eversafe	HD	Tyco		
221	ELCB	MG	MDS Legrand – Lexic	L&T Hager	Siemens	
222	Electrical Motors	Kirloskar	Seimens	Crompton	Wilo	Mather & Platt
223	Epoxy Paint	ICI	Berger	Asian	Nerolac	
224	Fire Aid / Fire Hose Reels, GM short branch pipe, 2/3/4 FB inlet/draw off connection	Ceasefire	Newage	Safeguard	Minimax	Usha fire
225	Fire Buckets	Safex	Minimax	Peter Autokit		
226	Fire Extinguisher	Safex	Minimax	Peterautokit	Omaxe	Padmini Fire
		Ceasefire	Newage	Exflame		
227	Fire Hose Pipes	Ceasefire	Newage	Safex	Jayshee	Ushafire
228	Fire Hydrant Valves	Ceasefire	Newage	Safeguard	Minimax	Peterautokit
229	Fire Man's Axe	Ceasefire	Newage	Safeguard		
230	Flexible trailing cable for lifts	Lapp Kabel	Approved equivalent			
231	Flow switch	Potter	System sensors	Rapid flow		
232	Foot Valve (Cast iron/ Gunmetal)	Kirloskar	Neta	Leader	Zoloto	

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

233	Forged steel fitting	V.S.Forge	True Forge	DRP-M		
234	Forged Steel Fittings & Flanges (For Welded joints)	Rohini	Kanwal			
235	GI clamps	Chilly	Hilti	GMGR		
236	GI , MS Pipes	Tata	Jindal Hissar	Praksh Surya	BST	
237	Gunmetal Branch Pipe	Newage	Ushafire	Safeguard		
238	Gunmetal Valves (fullway Check and Globe Valves)	Audco	Interval	Advance		
239	Hose Reel	Minimax	Usha Fire	Omaxe	Padmini Fire	Newage
		Ceasefire	Safeguard			
240	Hydrant Valves	Newage	Minimax	Peterautokit	Safeguard	Ceasefire
241	Indicating Lamps & Push Buttons	L&T	Technico	Led Type		
242	Non-Return Valve – Swing	Intervalve	Audco (Cast Iron)	Zoloto	Sant	
243	Nozzle	Newage	Safeguard	Usha Fire	Minimax	
244	Over Load Relays	GE	L&T	Siemens		
245	Pipe coat material (pipe protection)	Pypcoat	Makphalt	Safex		
246	Pipe External Protection	Pipe Kote (4mm thick)	Equivalent or other approved makes			
247	Pipe Hangers	Chilly	GMGR			
248	Power/auxiliary Contactors	MG	Siemens	ABB	GE	L&T
249	Pressure guage	Fiebig	H.GURU			
250	Pressure Switch	Danfoss	Indfoss	Switzer		
251	Push Buttons, Indicating lamps LED	MG	L&T	Schneider		
252	RRL Hose	Jayshee	Newage	Ushafire	Padmini Fire	Ceasefire
		Safeguard	Superek	Jyoti		
253	Single Phase Preventer	L&T	Minilac	Grinnel	Tyco	Viking
		Eversafe				
254	Sluice Valves	Kirloskar	Audco	Unik	Leader	Zoloto
		Sant				
255	Solenoid valve, Spray nozzle	Parker	HD	Tyco	Emersion	
256	Sprinkler (ICV)	HD	Tyco	Reliable	Wormald	Viking
257	Sprinkler Heads /Water Curtain Nozzle	Grinnel	Tyco	Viking	Eversafe	Reliable
		HD	Firesafe			
258	Steel flexible extension	Eversafe	Safex	Tyco		
259	Suction "Y" Type Strainer	Kirloskar	Leader	Zoloto	Sant	
260	Vibration Eliminator	Resistoflex	D waren	Kanwal		
261	Weld Electrodes	Advani	ESAB	L&T		
262	Deluge valve	Tyco	Viking	HD		

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

263	Fire Hydrants (Landing Valves)	Padmini	Safegaurd	Newage		
264	Hose Reel Drum & Tube	Padmini	Safegaurd	Newage		
265	Hose Pipes	Padmini	Safegaurd	Newage		
266	Branch Pipes	Padmini	Safegaurd	Newage		
267	Fire Brigade Inlet & Draw Off Connections	Padmini	Safegaurd	Newage		
268	Fire Men,s Axe	Padmini	Safegaurd	Newage		
269	Fire Extinguishers	Padmini	Safegaurd	Newage		
270	Flexible Pipe for Sprinkle	Padmini	Safegaurd	Newage		
271	Sprinkler Head	HD	Tyco	Newage		
272	Fire Pumps	Kirloskar	M&P			
273	Installation Control Valve/ Fire alarm Valve	HD	Viking			
274	Flow Switch	System Sensor	Rapid Control	Potter		
275	Stainless Steel Railing, Accessories etc in Grade SS 316	Dorma	D-line	Geze	Ozone	Q-railing
		Koncept				

3. HVAC WORKS						
S. No.	Details of Equipment / Material	Make / Manufacturer				
	Chillers					
276	Water Cooled Centrifugal Chillers With VSD (AHRI Certified)	Carrier	Daikin	Trane	Dunhumbu sh	Jhonson
277	Rotary Screw Water-cooled Water Chilling Machine (AHRI Certified – 200 TR & Above)	Carrier	Daikin	Trane	Dunhumbu sh	Jhonson
278	Rotary Screw Water-cooled Water Chilling Machine (Below 200 TR)	Carrier	Daikin	Trane	Dunhumbu sh	Jhonson
		Blue Star	Voltas	Hitachi		
279	Rotary Screw Air-cooled Water Chilling Machine (AHRI Certified - 100 TR & Above)	Carrier	Daikin	Trane	Dunhumbu sh	Jhonson
280	Rotary Screw Air-cooled Water Chilling Machine (Below 100 TR)	Carrier	Daikin	Trane	Dunhumbu sh	Jhonson
		Blue Star	Voltas	Hitachi		
281	Magnetic Bearing Water Chilling Machine	Daikin	Trane	Dunhumbus h	Jhonson	
282	Scroll Air-cooled / Water Cooled Water Chilling Machine	Carrier	Blue Star	Voltas		
283	VRV / VRF System (Outdoor / Indoor Units, Copper Y Joints and Fittings, Central & Remote Controller)	Daikin	Toshiba	Mitsubishi	LG	Samsung
		Hitachi	O General	Panasonic	Blue Star	
284	Air-cooled Ductable Split Unit	Voltas	Blue Star	Daikin	Hitachi	LG
		Carrier				
285	Air-cooled Packaged Unit	Voltas	Blue Star	Daikin	Hitachi	LG
		Carrier				
286	Air Cooled Hi-wall / Cassette Unit	Voltas	Blue Star	Daikin	Hitachi	Carrier
		ETA-O-General				
287	Air Cooled Precision AC Unit	Emerson	APC	Stulz	Blue Box	
288	Horizontal Split Casing / Vertical Inline / End Suction / Monoblock Pump Sets (For Primary CHW Pumps & Condenser Water Pumps & Hot Water Pumps)	ITT Xylem	Armstrong	Grundfoss	Wilo	Kirloskar
289	Variable Speed Pumping System (For Secondary Chilled Water Pumps Motors)	ITT Xylem	Armstrong	Grundfoss		

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

290	Variable Frequency Drive (For Pumps, Cooling Tower & AHU)	Danfoss (FC 102)	ABB (ACH 550)	Siemens (Sinamics G120P)		
291	Air Separator & Expansion Tank	Emerald	K D Agency	Spirotech		
292	Cooling Tower (CTI Approved & Certified)	Paharpur	Delta	Advance	Bell	
293	Air & Dirt Separator, Automatic Air Vent, Vacuum Degasser	Spirotech	Comfort	Spirotherm		
294	Hot Water Generator & Pan Humidifier	KEPL	Emerald	Rapid Cool		
295	Electrochemical Water Treatment & Disinfection System (For AC Plant)	Elgressy	Terragon	ENPAR Technologies		
296	Air Handlers Unit	Zeco	Edgetech	Waves	Flakt	System Air
297	Fan Coil Unit	Zeco	Edgetech	Waves	Flakt	System Air
298	ARI certified Cooling / Heating Coil (AHU & FCU)	Zeco	Edgetech	Waves	Flakt	System Air
299	AHU Fans (AMCA Certified for Sound & Performance)	Comferi	Krugger	Wolter	Nikotra	
300	Heat / Energy Recovery Wheel	DRI	Novelair-Sevcon	Greenheck	Enventus	
301	Air-washer & Wet Scrubber	Zeco	Edgetech	Waves	Airflow	
302	Dry Scrubber	Espair	Trion	Waves		
303	Scrubber & Air-washer Fans (AMCA Certified for Sound & Performance)	Comferi	Krugger	Wolter	Nikotra	
304	Acoustically Insulated Box Type Inline Fans	Greenshank	Kruger	Wolter	Airflow	Pineair-Ostberg
		Caryaire				
305	Axial Fan / Centrifugal Fan (AMCA Certified for Sound & Performance)	Greenshank	Airflow	Krugger	Wolter	Comefri
306	Propeller Fan	GE	Usha	Bajaj		
307	Three phase motors	ABB	CG	Siemens	Marathon	
308	Three phase motors (250°C for 2 Hours)	Marathon	Havells-Lafert	Baldor		
309	Water Piping	Tata	SAIL	Jindal Hissar	Prakash Surya	
310	Y-strainer / Pot – strainer	Emerald	Betaflo	Rapid Cool		
311	Butterfly Valve (Manual & Motorized)	Advance	Audco			
312	Actuator for Motorised Butterfly Valve	Belimo	Siemens	Danfoss	Honeywell	
313	Manual Balancing Valve	Advance	Audco			
314	Dual Plate Check Valve	Advance	Larsen Toubro	Audco		

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

315	Automatic Balancing Valves	Danfoss	Flowcon	TA	Siemens	
316	Pressure Independent Balancing Cum 2-way Control Valve (Single Body)	Danfoss	Flowcon	TA	Siemens	
317	Three Way / Two Motorized Valves, Thermostat / Humidistat	Siemens	Johnson	Honeywell	Danfoss	
318	Globe / Ball Valve (With or Without Strainer)	Giacomini	Betaflo	Leader	Rapid Cool	Sant
319	Auto Air Vent Valve	Giacomini	Spirotech	Airtech		
320	Pressure Gauges	Feibig	Emerald	H Guru	Taylor	
321	Industrial Type Thermometer (Alcohol filled V form)	Feibig	Emerald	H Guru	Taylor	
322	GSS Sheet	Sail	Tata	Jindal		
323	Factory Fabricated Duct	Rolastar	Zeco	Ductofab	Waves	
324	Aluminium Sheet	Hindalco	Nalco	Balco		
325	Vibration Isolation Spring & Flexible Pipe Connector	Easyflex	Resistoflex	Dunlop	Kanwal	
326	VAV Boxes	Titus	Conaire	York	Johnson	
327	CAV	Conaire	Trox	Airflow		
328	Fire & Smoke Damper Spring Type	Caryaire	Mapro	System Air		
329	Fire Damper Actuator	Belimo	Siemens	Danfoss	Honeywell	
330	Extruded aluminum grills / Diffusers	Caryaire	Mapro	System Air	Tristar	
331	Pre Filters, Fine Filters & Hepa Filters	Thermodyne	Klenzoid	Purolator	Spectrum	Mechmark
332	Closed Cell Fire Retardant XPE (For Duct Insulation)	Paramount	Supreme	Trocylleene		
333	Nitrile Rubber For Pipe / Duct Insulation (With Mechanical & UV Protection)	Armaflex	Vidoflex	Eurobatex	K Flex	
334	Expanded Polystyrene (For Underdeck / Overdeck Insulation)	Mettur Beardsell	Styrene Packing	Toshiba	Indian Packaging	
335	Fibre Glass Rigid Board	U.P.Twiga	Owen corning	Kimco		
336	Paints	ICI	Asian	Berger	Nerolac	
337	Tar felt / CPRX compound	Shalimar tar product				
338	Dash Fasteners	Fisher	Hilti	Bosch		
339	Welding Rods	Advani	L&T	Esab		
340	Insulated Flexible Duct	Pineair	Atco	Caryaire		
341	Duct / Pipe Support	Easyflex	Gripple	Resistoflex		
342	Copper Refrigerant Piping	Mandev	Rajco	Shree Shyam	Mexflow	Mehta tube

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

343	Copper Refrigerant Pipe Insulation	Armaflex	Aeroflex	Kflex	Aflex	
344	Imported Duct Mounted Ozone System	Ruks	Trimed			
345	Imported AHU UVC / CoiloTron / UVGI	Ruks	Trimed			
346	Electrical Panel, Console Panel & Sub-Panels	KEPL	Tricolite	SPC Electrotech	System Power Control	
347	Air-Circuit Breaker	L&T	Siemens	Schenider		
348	M.C.C.B.	L&T	Siemens	Schenider		
349	MCB	L&T	Siemens	MDS		
350	Starters, Contactors, Push Buttons, Overload Relay	L&T	Siemens	Schenider		
351	Single Phase Preventer	L&T	Siemens	Minilec		
352	Current Transformer	G & M	Kappa	Precise	C & S	
353	Rotary Switches	L&T	Siemens	BCH		
354	Selector & Toggle Switch	Kaycee	L&T			
355	Change Over Switch	Elecon	L&T			
356	HRC Fuse and Fittings	L&T	Siemens	C & S		
357	Voltmeter / Ammeter	A.E.	IMP	Elmeasure		
358	Indicating Lamps	Siemens	L&T			
359	Time Delay Device	Siemens	L&T	BCH.		
360	Power Cable & Accessories	Worldcab	Gemscab	Finolex	KEI	
361	Control Cable & Accessories	Worldcab	Gemscab	Finolex	KEI	
362	MS Conduits ISI Approved	BEC	Steelcraft	AKG		
363	TDRs	LT-LK	BCH			
364	GI Cable Tray (Factory Fabricated)	CTM Engg	KEPL	MEM	Rico	
365	Vacuum Degasser	Spirotech	Comfort	Spirotherm		
366	BMS System					
a)	Software	Honeywell	ALC	Siemens		
b)	Network Area Controller	Honeywell Trend	ALC	Siemens		
c)	Third Party Integrator	Honeywell Trend	ALC	Siemens		
d)	Central and DDC Controllers	Honeywell Trend	ALC	Siemens		
e)	Ultrasonic BTU / Flow Meters	Forbes Marshall	Landis & Gyr	Siemens	Fuji	
f)	Immersion Temperature Sensor	Honeywell	ALC	Siemens	Elektron	
g)	Return Air Temperature Sensor	Honeywell	ALC	Siemens	Elektron	
h)	Network / Remote Operator Terminal	Honeywell	ALC	Siemens		

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

i)	Smoke Sensor	Honeywell	MSR	MSA	Elektron	
j)	Temperature plus RH Sensor	Honeywell	ALC	Siemens		
k)	Differential Pressure Switch-Air	Honeywell	Siemens	Beck		
l)	Differential Pressure Switch-Water	Honeywell	ALC	Siemens	Danfoss	
m)	Computer	IBM	Compaq	HP	Dell	
n)	Laser Printer	HP	Sharp	Canon		
o)	Communication Cable	Molex	Fusion Polymer	Belden	R&M	
p)	Signal Cable	Delton	Fusion Polymer	Skytone		
q)	CO2 Sensor	MSR	Siemens	Honeywell	Elektron	
r)	CO Sensor (Electro Chemical Gel Based)	MSR	MSA	Honeywell	Elektron	
s)	Level Switch	Dwyer	Radix	Veksler		
t)	Current Relay	ABB	Minilac	Seto		
u)	DC Voltage Transducer	ABB	Siemens	Seto	Mosibus	
v)	Multifunction Meter with Communication Port	Conzerve	L&T			
w)	Lux Level Sensor	Honeywell	Schneider	Siemens	Hager	
x)	Differential Pressure Transmitter-Air	Honeywell	Siemens	Beck		
y)	Pressure Transmitter-Water	Honeywell	Siemens	Schnider		
367	Digital Thermostat / Humidistat	Siemens	Honeywell	Carrier Race		
368	Any Missing Item	Prior Permission is required from HVAC Consultant				

4. ELECTRICAL WORKS						
S. No.	Details of Equipment / Material	Make / Manufacturer				
369	Air Circuit Breaker (Model shall be as per Tender Specification & BOQ)	L&T	Schneider	Siemens	ABB	Mitsubishi
		Legrand	C&S			
370	MCCBS Breaker (Model shall be as per Tender Specification & BOQ)	L&T	Schneider	Siemens	ABB	Mitsubishi
		Legrand	C&S			
371	SFU / FSU	L&T	Schneider	Siemens	ABB	C&S
372	HRC/ HBC Fuses & Bases	L&T	Schneider	Siemens	ABB	
373	MCB/ MCB Isolators	L&T	Schneider	Siemens	ABB	Legrand
		C&S				
374	RCCBS/ RCBOS	L&T	Schneider	Siemens	ABB	Legrand
		C&S				
375	MCB Distribution Boards	L&T	Schneider	Siemens	ABB	Legrand
		C&S				
376	Change Over Switch (Off Load/ On Load)	L&T	HPL	Socomec	C&S	
377	Metal Clad Sheet Steel Enclosure Socket/ Plug Box	L&T	Schneider	Siemens	ABB	Legrand
378	Automatic Transfer Switches	Asco	Russel	Socomec		
379	Load Break Switches	L&T	Schneider	Siemens		
380	FR/ FRLS/ Fire Survival PVC Insulated Copper Wires/ Cables (Armoured or otherwise)	KEI	Polycab	Finolex	CCI	Batra Henlay
		Havells	National Cables			
381	Modular Plate Switches & Sockets	Wipro (North-West)	Schneider	Crab Tree	MK	Legrand
		Philips	Simon	C&S		
382	Trivector Meter	L&T	Secure	Conzerv	HPL Socomec	Enersol
		Pulse Equipment				
383	Light Fixtures (LED)	Wipro	Insta Power	Philips	Regent	Legero
		Panasonic				
384	Façade & External Lighting	Bajaj	Philips	Trilux	Regent	Legero
385	Luminaries	Wipro	Crompton	GE	Philips	Osram
		Bajaj	Keselec	Insta Power	HPL	Lustre
		Twinkle Luminaire	Nova	Havells		
386	Telecommunication / TV Cable	Polycab	National Cables	Fusion Polymer Industries	Lapp Cable	Finolex
		Havells	Skytone	Batra Henlay		

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

		Tricolite	Advance Panel & Switchgear	Adlec	Ambit Switchgear	SPC Electrotech
387	LT Panel/ PCC/ MCC/ MCBS/ DG Synchronizing Panels/ APFC/ Panels/ Control Panels/ Feeder Pillars/ Service Pillars / H.T. Panel	Or any other Panel manufacturer complying the following conditions:				
		1) CPRI certificate not older than 5 years.				
		2) Form of Separation-3B				
		3) Panel manufacturer make approval shall be taken by Architect / Consultant before ordering the panel.				
		4) Fabrication facility up to IP 54/55.				
		5) 7 tank pre treatment facility for sheet.				
		6) Equipped with latest CNC bending, powder coating, Bus Bar bending & punching machine and compressor etc.				
388	a) Conventional Bustrunking & Rising Mains	Tricolite	Advance Panel & Switchgear	Adlec	SPC Electrotech	Same make as that of the LT Panels.
	b) Sandwitch Busduct	Schneider	Legrand	GE		
389	PVC Conduit (ISI Marked)	BEC	AKG	Polypack	Atul	
390	Steel Conduit (ERW) (ISI Marked)	BEC	AKG	RMCON	Atul	
391	Flexible Conduit	Lapp	Hensel	Jainsons		
392	Bakelite Sheet	Hylam	Formica	Greenpanel		
393	Computer/ Data Cable	Systimax	Shyam	Lucent	Avaya	Lapp
394	Voltage Transformers	Siemens	L&T	Kappa	Anand Power Tech	PEPL
395	Current Transformers	Siemens	L&T	Kappa	Anand Power Tech	PEPL
396	AMP Meter/ Voltmeter / Energy Meter/ MFM	Conzerv HPL	Socomec	L&T	Trinity	Enersol
397	Ceiling Fan	Crompton	Bajaj	Usha	Havells	
398	Exhaust Fan	Crompton	Bajaj	Usha	Polar	Havells
399	Tag Block	Krone	Ericson	TVAR&M		
400	Transformers	Voltamp	Kotsun	Universal	Kirloskar	Essenar
		Rectifier & Control				
401	Automation Power Factor Control Relay	L&T	Schneider	Siemens	ABB	
402	Capacitors & Reactors	L&T	Schneider	Siemens	ABB	
403	Cable Glands (Double Compression with Earthing Links)	Dowells	Comet	Brasco	HMI	Gripwell
		Lapp	Multi	Comex	Baliga	
404	Bi-Metallic Cables Lugs/ PVC Glands	Dowells	Action	Jainsons	Kabel	
405	Cable Jointing Kits	Raychem	Jainsons	3M	Densons	Safeiki
406	Cable Trays (Factory Fabricated) / Raceways	Pilco	Slottco	Patney System Ltd.	Storack	Indiana
		Steelways	CTM Engineers	Profab	MEM	Bharti
407	Battery (Sealed)	Yuasa	Powersafe	HBL Nife	Amco	Exide

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

	Maintenance Free)	Amara Raja	Standara	Batteries	Standard-Furukawa	
408	Battery Charger	BCH	Lobotek	HBL Nife	Amara Raja	Chabi
		Caldyne	Crompton Greaves			
409	DG Set	Caterpillar	Cummins	Penta	Mitsubishi	MTU
		Volvo Penta (Up to 600 KVA only)	Perkins			
410	DG Set Alternator	Stamford	Lerroy Sommer			
411	Control Gear (Contractors etc.)	L&T	Schneider	Siemens	ABB	
412	Protection Relays Microprocessor Based	L&T	Schneider	Siemens	ABB	Areva
413	Earth Leakage Relay	L&T	PIC	Minilec	Eaton	
414	Single Phasing Device	L&T	Siemens	Minilec		
415	Push Buttons	L&T	Schneider	Siemens	ABB	
416	Time Relay Device	L&T	Schneider	Siemens	ABB	
417	Selector Switches & Rotary Switches	L&T	Schneider	Siemens	ABB	
418	Indicating Lights	L&T	Schneider	Siemens	ABB	
419	Terminals	Elmex	Essen	Deinki	Wago	
420	MS Swaged Tubular Pole Street Light Poles	ASPL	Advance Steel Tubes	Klite	Philips	Orients
		Laasma	Keselec	Bajaj	Lustre	Wipro
421	Telephone Outlets					As per Switch / Socket Make.
422	Motors	ABB	Crompton	Siemens	Kirloskar	Bharat Bijli
		Jyoti	NGEF			
423	EPBAX & Telephone System	Siemens	Ericsson	Tadiron	Mytel	
424	Multi-Meter & Meggars	Escrop	Motwani			
425	Programmable Logic Controller	Siemens	Woodward	Allen Bradley		
426	Lighting Protection Unit	ABB	Erico	Schneider	LPI	OBO Betterman
427	UPS	APC Schneider	Emerson	Tata Libert	Socomec	GE Power
		Auto Meter Alliance	Eaton Power	Siemens		
428	Package Sub-Station (With Off Load Tap Changer)	Schneider	ABB	L&T	Siemens	Universal
429	United Sub-Station (With On Load Tap Changer)	Ambit Switchgear	Sudhir Engineering	Universal		
430	Pumps	Kirloskar	Crompton	Grundfoss	KSB	Mather & Platt
		Beacon	Worthington			
431	Aviation Obstruction Light	Bajaj	Wipro	Philips	GE	Crompton
		Insta Power				

DETAILED PROJECT REPORT: 2ND IT PARK BUILDING IN SHILLONG TECHNOLOGY PARK CAMPUS, SHILLONG

432	High Mast Lighting System	Philips	Bajaj	Crompton	Thron	Keselec
		Insta Power				
433	LT Servo Automatic Voltage Stabilizer	AE	Logicstat	LD Power Transformer s Ltd.	Stabline	Recon
		Icon	Globe			
434	D.G. Set Acoustic Enclosure	As per DG supplier and approved by EIC and Consultant/Architect.				
435	M.S. Pipe	Tata	Jindal	SAIL		
436	Butterfly / Balancing Valve	Advance	Audco			
437	Cooling Tower	Bell	Paharpur	Delta		
438	Pot Strainer / Y Strainer	Rapid Cool	Emerald	Sant		
439	CCTV Camera / Dvr / Nvr	Mobotix	Impulse	Axis	Pelco	
440	Access Control	Syris	ESSL	Matrix	Impulse	Infianis
441	CAT 6A	Belden	Molex	R&M		
442	Lifts / Elevators	Otis	Kone	Mitsubishi	Johnson Lifts	Schindler
FIRE ALARM SYSTEM						
443	Fire Alarm System	Honeywell Notifier	Honeywell Esser	Siemens	Shrack	Edward
444	Response Indicator	Reputed Brand as approved by Architect/ Consultant.				
445	PA System	Honeywell	Aties	Bose Prasedio	Ahuja	Ravel