OIL INDIA LIMITED
(A Government of India Enterprise)
CONTRACTS & PURCAHSE DEPARTMENT
PLOT NO. 19, SECTOR 16A, NOIDA- 201301

ADDENDUM NO.-1

Tender No. CLI9636P22 dated 14.02.2022

This Addendum No. 1 dated 17.02.2022 to Tender No. CLI9636P22 dated 14.02.2022 for - "CONSTRUCTION OF TRAINING CENTER CUM HOLIDAY HOME AT BRITONIA, PORVORIM, GOA INCLUDING ALL AMENITIES, OTHER ANCILLARY SERVICES COMPLETE IN ALL RESPECT." is issued to notify the amendment to tender document as below:

1. Appendixes to the Section-V "Scope of Work and Special Terms & Conditions" of the Tender Document is issued as under:

    a) APPENDIX –XXVIII "Technical Specifications Electrical Works"
    b) APPENDIX-XXIX "Technical Specifications HVAC Services"
    c) APPENDIX-XXX "Technical Specifications Plumbing and Fire Fighting Services"

    Copy of the Appendixes is enclosed with this addendum.

All others terms and conditions of the Bid Document remain unchanged. Details can be viewed at www.oil-india.com.

MANAGER – C&P

PROJECT: PROPOSED TRAINING CENTRE CUM HOLIDAY HOME AT BRITONIA PROVORIM, GOA

TECHNICAL SPECIFICATIONS

ELECTRICAL WORKS

Contents

END OF CONTENTS

1 INSTRUCTION & SPECIAL CONDITIONS FOR SUBMISSION OF TENDER

SUBJECT: Proposed Electrical System for Hotel Holiday Home at Goa.

INTRODUCTION: It is proposed to Supply, Installation, Testing and Commissioning Electrical Work D.G. Set, Exhaust Piping, Exhaust Piping Insulation, D.G. Set neutral & body earthing, Cabling, Synchronizing Panel, 11KV/0.415KV Substation, Main L.T. Panel, Floor Distribution Panel & Distribution Board, Main & Sub main Cables, Point Wiring, Light Fixture, Telephone System, Data Cabling Network, Addressable Fire Detection System, Public Address System, Lightning Protection System, Inverter, Earthing & External Lighting System etc. as per Schedule of Quantities given in the tender. The Electrical Work shall comprise of following.

a) Supply of D.G. Set

b) Installation of D.G. Set.

c) Cabling

d) D.G. Set Aux. Panel.

e) Earthing System.

f) D.G. Set Exhaust Piping

g) Safety Equipment

h) SIT&C of 11KV/0.415KV Substation

i) Main L.T. Panels

j) Floor Distribution Panel

k) Distribution Boards

l) Main & Sub main Cables

m) Point Wiring

n) Light Fixtures

o) Telephone System

p) Data cabling Network

q) Addressable Fire Detection System

r) Public Address System

s) CCTV System

t) Lightning Protection System

u) UPS System

v) All other item as detailed in Schedule of Quantities.

1.1 GENERAL:

A) 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 including one year guarantee period for the following Work.

B) Name of Work: Proposed Construction of Hotel Holiday Home at Goa. (S.H: Electrical Work)

C) The work shall be executed as per CPWD General Specifications for Electrical Works-2013, CPWD General Specifications for Electrical Works Part I, II, III & IV as amended up to date, relevant IE rules, relevant IS and as per directions of Engineer-in-Charge. These additional specifications & conditions are to be read in conjunction with above and in case of variations; specifications given in the Additional Specifications & Conditions shall apply. However, nothing extra shall be paid on account of these as the same are to be read along with schedule of quantities for the work.

END OF SECTION – 01

2 TECHNICAL SPECIFICATION OF EQUIPMENTS

3 ELECTRICAL LOAD CALCULATION

PROJECT - PROPOSED HOTEL HOLIDAY HOME AT GOA						
S. NO.	**DESCRIPTION**	**NO. OF POINT**	**LOAD PER POINT**	**CONNECTED LOAD**	**DIVERSITY**	**DEMAND LOAD (KW)**
(I)	**LIGHT & POWER LOAD**					
(a)	**BASEMANT FLOOR**					
1	1x12w LED Surface Light	18	12	216	0.8	0.2
2	1X15w LED Recess Light	2	15	30	0.8	0.0
3	1x10w LED Mirror Light	1	10	10	0.8	0.0
4	1X28w Ceiling Light	25	28	700	0.8	0.6
5	1X36w LED Recess Light	2	36	72	0.8	0.1
6	1x10w Bulk Head Light	8	10	80	0.8	0.1
7	Ceiling Fan	10	60	600	0.8	0.5
8	Exhaust Fan	1	100	100	0.8	0.1
9	6A Raw Power socket	6	100	600	0.6	0.4
10	6/16A Raw Power Socket for Geyser	1	1500	1500	0.5	0.75
11	6/16A Raw Power Socket for Lift	2	1000	2000	0.3	0.6
12	6/16A Raw Power Socket	13	1000	13000	0.3	3.9
(b)	**GROUND FLOOR**					
13	1x12w LED Surface Light	35	12	420	0.8	0.3
14	1X12w LED Recess Light	28	12	336	0.8	0.3
15	1X15w LED Recess Light	52	15	780	0.8	0.6
16	1x10w LED Mirror Light	14	10	140	0.8	0.1
17	1X28w Ceiling Light for Kitchen	4	28	112	0.8	0.1

18	1X36w LED Recess Light	21	36	756	0.8	0.6
19	1x10w Bulk Head Light	2	10	20	0.8	0.0
20	Ceiling Fan	27	60	1620	0.8	1.3
21	Exhaust Fan	10	100	1000	0.8	0.8
22	6A Raw Power socket	113	100	11300	0.6	6.8
23	6/16A Raw Power Socket for Geyser	10	1500	15000	0.5	7.5
24	6/16A Raw Power Socket for Lift	2	1000	2000	0.3	0.6
25	6/16A Raw Power Socket	36	1000	36000	0.3	10.8
26	HVAC Indoor Unit (Single Phase)	10	552	5520	1.0	5.5
(c)	**FIRST FLOOR**					
27	1x12w LED Surface Light	35	12	420	0.8	0.3
28	1X12w LED Recess Light	28	12	336	0.8	0.3
29	1X15w LED Recess Light	54	15	810	0.8	0.6
30	1x10w LED Mirror Light	14	10	140	0.8	0.1
31	1X36w LED Recess Light	17	36	612	0.8	0.5
32	1X24w LED Recess Light	6	25	150	0.8	0.1
33	1x10w Bulk Head Light	2	10	20	0.8	0.0
34	Ceiling Fan	21	60	1260	0.8	1.0
35	Exhaust Fan	10	100	1000	0.8	0.8
36	6A Raw Power socket	122	100	12200	0.6	7.3
37	6/16A Raw Power Socket for Geyser	10	1500	15000	0.5	7.5
38	6/16A Raw Power Socket for Lift	2	1000	2000	0.3	0.6
39	6/16A Raw Power Socket	37	1000	37000	0.3	11.1
40	HVAC Indoor Unit (Single Phase)	9	461	4149	1.0	4.1
(d)	**SECOND FLOOR**					
41	1x12w LED Surface Light	22	12	264	0.8	0.2
42	1X12w LED Recess Light	20	12	240	0.8	0.2

43	1X15w LED Recess Light	54	15	810	0.8	0.6
44	1x10w LED Mirror Light	10	10	100	0.8	0.1
45	1x10w Bulk Head Light	2	10	20	0.8	0.0
46	Ceiling Fan	10	60	600	0.8	0.5
47	Exhaust Fan	10	100	1000	0.8	0.8
48	6A Raw Power socket	80	100	8000	0.6	4.8
49	6/16A Raw Power Socket for Geyser	10	1500	15000	0.5	7.5
50	6/16A Raw Power Socket for Lift	2	1000	2000	0.3	0.6
51	6/16A Raw Power Socket	13	1000	13000	0.3	3.9
52	HVAC Indoor Unit (Single Phase)	4	630	2520	1.0	2.5
(e)	**THIRD FLOOR**					
53	1x12w LED Surface Light	22	12	264	0.8	0.2
54	1X12w LED Recess Light	10	12	120	0.8	0.1
55	1X15w LED Recess Light	71	15	1065	0.8	0.9
56	1x10w LED Mirror Light	5	10	50	0.8	0.0
57	1x10w Bulk Head Light	2	10	20	0.8	0.0
58	Ceiling Fan	10	60	600	0.8	0.5
59	Exhaust Fan	10	100	1000	0.8	0.8
60	6A Raw Power socket	75	100	7500	0.6	4.5
61	6/16A Raw Power Socket for Geyser	5	1500	7500	0.5	3.75
62	6/16A Raw Power Socket for Lift	2	1000	2000	0.3	0.6
63	6/16A Raw Power Socket	13	1000	13000	0.3	3.9
64	HVAC Indoor Unit (Single Phase)	4	515	2060	1.0	2.1
(f)	**TERRACE FLOOR**					
65	1x18w LED Surface Light	22	18	396	0.8	0.3
66	1x9w Bulk Head Light	2	9	18	0.8	0.0
67	Exhaust Fan	10	100	1000	0.8	0.8

68	6A Raw Power socket	5	100	500	0.6	0.3
69	6/16A Raw Power Socket for Geyser	5	1000	5000	0.3	1.5
70	32 HP Outdoor Unit (Three Phase)	1	28800	28800	1.0	28.8
71	28 HP Outdoor Unit (Three Phase)	2	25200	50400	1.0	50.4
72	26 HP Outdoor Unit (Three Phase)	2	23400	46800	1.0	46.8
73	20 HP Outdoor Unit (Three Phase)	1	18000	18000	1.0	18.0
	TOTAL FOR UPS LOAD					**263**
(II)	**UPS LOAD**					
(a)	**BASEMENT FLOOR**					
74	1x12w LED Surface Light	9	12	108	1.0	0.1
75	1X28w Ceiling Light	5	28	140	1.0	0.1
76	1X36w LED Recess Light	1	36	36	1.0	0.0
77	6A UPS Socket	9	100	900	1.0	0.9
78	2X6A Socket for work Station	5	120	600	1.0	0.6
79	6/16A UPS Socket	1	500	500	0.8	0.4
(b)	**GROUND FLOOR**					
80	1x18w LED Surface Light	12	18	216	1.0	0.2
81	1X12w LED Recess Light	4	12	48	1.0	0.0
82	1X15w LED Recess Light	2	15	30	1.0	0.0
83	1X28w Ceiling Light for Kitchen	2	28	56	1.0	0.1
84	1X36w LED Recess Light	6	36	216	1.0	0.2
85	6A UPS Socket	9	100	900	1.0	0.9
86	2X6A Socket for work Station	5	120	600	1.0	0.6
87	6/16A UPS Socket	1	500	500	0.8	0.4
(c)	**FIRST FLOOR**					
88	1x12w LED Surface Light	12	12	144	1.0	0.1
89	1X12w LED Recess Light	4	12	48	1.0	0.0

90	1X15w LED Recess Light	2	15	30	1.0	0.0
91	1X36w LED Recess Light	6	36	216	1.0	0.2
92	6A UPS Socket	9	100	900	1.0	0.9
93	2X6A Socket for work Station	11	120	1320	1.0	1.3
94	6/16A UPS Socket	1	500	500	0.8	0.4
(d)	**SECOND FLOOR**					
95	1x12w LED Surface Light	9	12	108	1.0	0.1
96	1X12w LED Recess Light	4	12	48	1.0	0.0
97	6A UPS Socket	5	100	500	1.0	0.5
98	6/16A UPS Socket	1	500	500	0.8	0.4
(d)	**THIRD FLOOR**					
99	1x18w LED Surface Light	9	18	162	1.0	0.2
100	1X12w LED Recess Light	4	12	48	1.0	0.0
101	6A UPS Socket	3	100	300	1.0	0.3
102	6/16A UPS Socket	1	500	500	0.8	0.4
	TOTAL FOR UPS LOAD					**9**
(III)	**COMMON SERVICES LOAD**					
103	Ventilation Load					10
104	Fire Fighting Load					10
105	Plumbing Load					10
106	STP Load					10
107	External Lighting					5
108	Lift 2 Nos @ 10 KW					20
	TOTAL FOR COMMON SERVICES LOAD					**65**
	TOTAL FOR (I+II+III)					**337**
	OVERALL DIVERSITY					**0.80**

	TOTAL DEMAND AFTER OVERALL DIVERSITY	KW				**270**
	RATING OF TRANSFORMER					
	POWER FACTOR					0.90
	KVA RATING					300
	LOADING FACTOR					0.85
	400 KVA, 11KV/0.415KV, OIL TYPE CSS WITH ON LOAD TAP CHANGER					**353**
	POWER FACTOR					0.80
	KVA RATING					337
	LOADING FACTOR					0.90
	1NOS 250 & 1NOS 125 KVA, 415 VOLT, RADIATOR COOLED D.G. SET					**375**

4 11KV COMPACT SUBSTATION

CODE & STANDARDS

All equipment and material shall be designed manufactured and tested in accordance with the latest applicable Indian Standard / IEC standard.

Equipment and material confirming to any other standard which ensures equal or better quality may be accepted. In such case copies of English version of the standard adopted shall be submitted.

The electrical installation shall met the requirement of Indian Electricity Rules as amended upto date relevant IS code of practice and Indian electricity act.

The Unitized Sub-station offered shall in general comply with the latest issues including amendments of the following standards but not restricted to it.

Title	**Indian Standards**
High Voltage Low Voltage Pre-Fabricated Substation	IEC:61330
11 kV Switchgear cubicles	IS:13118, IS:3427, IEC:60694. IEC:60298
Ring main unit 11 kv grade	IS:9920, IEC:60265
Code of practice for selection, installation and maintenance of Switchgear	IS:10118

Distribution Transformer	IS: 2026 IS : 1180 (Part I) 2014
Dry Type Power Transformer	IS:11171
Colour for ready mix paints	IS:5
Enamel synthetic, exterior a)Undercoating b) finishing	IS:2932
L.T. Fuseboard Panel	IS:5039
Indian Electricity Rules	
Indian Electricity Act	

4.1 DESIGN CRITERIA

Compact Sub-station shall consist of **11KV SF6 Insulated compact switchgear with Circuit Breaker as protection to transformer + Transformer + L.T. Switchgear** with all connection accessories, fitting & auxiliary equipment in an pre-fabricated Enclosure to supply Low-voltage energy from high-voltage system as detailed in this specification. The complete unit shall be installed on a substation plinth (base) as **Outdoor substation**. 11KV Load Break Cable Switches controls incoming-outgoing feeder cables of the 11KV ring/radial distribution system. The Circuit Breaker shall be used to control and isolate the 11kV/433V Distribution transformer. The transformer's L.T. side shall be connected to L.T. switchgear. The connection cables to consumer shall be taken out from the L.T. switchgear.

The pre-fabricated unitized substation shall be designed for

a) Compactness and aesthetics,
b) Fast installation,
c) Maintenance free operation,
d) Safety for worker/operator & public.

The Switchgear and component thereof shall be capable of withstanding the mechanical and thermal stresses of short circuit listed in ratings and requirements clause without any damage or deterioration of the materials. For continues operation at specified ratings temperature rise of the various switchgear components shall be limited to permissible values stipulated in the relevant standard and / or this specification.

Service Conditions

The equipment offered shall be suitable for continuous satisfactory operation in tropical area of Installation.

The Enclosure consisting of High Voltage switchgear-control gear, Low Voltage switchgear-control gear & Transformer of the Unitized substation shall be designed to be used under **normal outdoor service condition**. Ambient temperature shall be taken as 50 deg. C for the purpose of designing the electrical equipment. The enclosure should take minimum space for the installation including the space required for approaching various doors & equipment inside. The enclosure construction shall be such that it fully protects ingress of rain water & rusting .For this purpose ,construction without welded joint is preferred.

4.2 SPECIFIC REQUIREMENT

The main components of a prefabricated-unitized substation are Transformer, High-voltage switchgear-control gear, Low-voltage switchgear-control gear, corresponding interconnections (cable, flexible , busbars) & auxiliary equipment. The components shall be enclosed, by either common enclosure or by an assembly of enclosure. All the components shall comply with their relevant IS/IEC standards.

Ratings

Description	**Unit**	**Value**
Rated Voltage / Operating Voltage	kV rms	11
.**Rated frequency & Number of phases**	Hz & nos.	50 & 3
.**Rated maximum power of substation**	kVA	As per B O Q
.**Rated Ingress protection class of Enclosure**	IP:	IP:54 for LT Switchgear & HT Switchgear compartments and IP-23 for Transformer compartment.
.HV Insulation Level		
Rated withstand voltage at power frequency of 50 Hz	kV rms	28
Rated Impulse withstand Voltage	kV peak	75
.HV Network & Busbar		
Rated current	Amp	630A
Rated short time withstand current	kA rms / 1sec	18.3
Making capacity for switch-disconnector & earthing switches	kA peak	52.5kA
Breaking capacity of Isolators (rated full load)	A	630A
.LV Network		As per the Bill of quantities

4.3 OUTDOOR ENCLOSURE

The enclosure shall be made of Galvanised Sheet Steel tropicalised to meet Indian weather conditions.

The base of the enclosure shall ensure rigidity for easy transport & installation.

The structure of the substation shall be capable of supporting the gross weight of all the equipment & the roof of the substation compartment shall be designed to support adequate loads.

There shall be proper / adequate ventilation inside the enclosure so that hot air inside enclosure are directed out by help of duct. Louvers apertures shall be provided so that there is circulation of natural air inside the enclosure.

The complete design shall be preferably modular in design i.e small sheets shall be joined together to make a big sheet. This helps in avoiding skewing, bending of the single sheets on doors and sides due to its own load under service. The doors shall be provided with proper interlocking arrangement for safety of operator.

Public Nuisance Protection: There shall be preferably no bolting arrangement on the doors and sides (periphery) so that there is no access of water, dust inside. This also ensures that the unit is well protected from outside from public nuisance owing to its being located in a crowded and compact places. Hinges and locks on the door shall be so designed that they are either not accessible to public from outside or can not be tampered with.

Interconnection: The connection of HT switchgear to Transformer shall be with the help of suitable size of cables from Transformer to LT switchgear with the help of suitable size of Aluminium busbars. The interconnections inside the unit shall be the responsibility of the supplier.

Internal Fault : Failure within the unitized substation due either to a defect, an exceptional service condition or mal-operation may initiate an internal arc. Such an event may lead to the risk of injury, if persons are present. It is desirable that the unit shall be tested for Internal Arc fault test as per latest IEC 61330.

Covers & Doors: Covers & doors are part of the enclosure. When they are closed, they shall provide the degree of protection specified for the enclosure. Additional wire mesh may be used with proper Danger board for safety of the operator. All covers, doors or roof shall be provided with locking facility or it shall not be possible to open or remove them before doors used for normal operation have been opened. The doors shall open outward at an angle of at least 90 deg & be equipped with a device able to maintain them in an open position. The top cover shall be slightly inclined so that there is no accumulation of water during rainy season or otherwise. Proper padlocking facility shall be provided for doors of each compartment.

Earthing : All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequate terminal intended for connection to the earth system of the installation, by way of flexible jumpers/strips & Lug arrangement. The continuity of the earth system shall be ensured taking into account the thermal & mechanical stresses caused by the current it may have to carry. The components to be connected to the earth system shall include :

a) The enclosure of Unitized / prefabricated substation,
b) The enclosure of High voltage switchgear & control gear from the terminal provided for the purpose,
c) The metal screen & the high voltage cable earth conductor,
d) The transformer tank or metal frame of transformer,
e) The frame &/or enclosure of low voltage switchgear,

Inetrnal Illumination: Their shall be arrangement for internal lighting activated by associated switch on doors for HV , Transformer & LV compartments separately.

Labels : Labels for warning , manufacturer's operating instructions etc. & those according to local standards & regulations shall be pasted / provided inside and shall be durable & clearly legible.

Painting and Fabrication process :

a) The paints shall be carefully selected to withstand tropical heat rain. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling. For this purpose two component poly-urethane paint shall be used.

b) Special care shall be taken by the manufacturer to ensure against rusting of nuts, bolts and fittings during operation. All bushings and current carrying parts shall be cleaned properly after final painting.

c) The fabrication process shall ensure that there are no sharp edges on the GI sheets used. For modular structure the two smaller units shall be joined together by Clinching Technology so that there is no piercing of the material being joined. This type of joint shall ensure robust mechanical strength to the complete structure so made.

4.4 11KV Switchgear

Non-extensible SF6 Insulated Compact Switchgear as required shall consist of following items:

Load Break Cable Switch with integral earth switch both having full making capacity shall be used for Incoming and Outgoing cables if used in a ring or as mentioned in the bill of quantities. The combination of load break switches and circuit breakers shall be as per the bill of quantities. Suitable arc proof tested cable covers shall be provided for each cable switch. The cable covers accessible from front shall be mechanically interlocked to its corresponding earth switch and the earth switch shall be mechanically interlocked to its corresponding cable switch for safety of the operator.

VCB / SF6 Circuit Breaker shall be used for distribution network of HT switchgear. Circuit Breaker complete with operating mechanism, self powered microprocessor based O/C, S/C, E/F protection relay with associated Current Transformers shall be used for control and protection of Transformer. The Circuit Breaker being fixed type shall be provided with a Isolator in series for isolation purpose for maintenance. An integral cable earthing switch with full making capacity shall be provided. The arc proof cable covers accessible from front shall be mechanically interlocked to the earthing switch, which in turn shall be interlocked to the isolator for safety of the operator.

The above Load Break Cable Switches , circuit breakers , Busbars should be mounted inside a robotically welded sealed for life , stainless steel tank of 3 mm thick sheet metal. The operating mechanism of the switches and breakers shall be outside the SF6 tank and accessible from front. The tank should be filled with SF6 gas at adequate pressure. The degree of protection for gas tank should be IP67**.** There shall be provision for filling the SF6 gas at site. Moreover the Stainless Steel Gas Tank shall confirm to the sealed pressure system as per IEC and ensure the gas leakage to 0.1 % per year as per IEC.

The Circuit Breaker is required to control 11 kV/433 volts distribution Transformer of required rating and relay settings and Current Transformers shall be selected accordingly.

General Finish: Totally enclosed, metal enclosed, vermin and dust proof suitable for tropical climate use as detailed in the specification.

Ratings: The busbars shall have continuous rating of 630 Amps. The isolator shall have a continuous rating of 630 Amps. CIRCUIT BREAKER shall have a continuous rating of 630 Amps. in accordance with relevant IS / IEC standard

Breaking & Making Capacity: The Load Break Cable Switches shall be capable for breaking rated full load current. The same along with its earthing switch shall also be suitable for full making capacity of the system as specified. The complete switchgear shall be suitable for breaking capacity of 18.3 kA symmetrical at 11000 volts three phase.

Busbar: Switchgear shall be complete with all connection, bus-bars etc. Copper busbars continuous rating shall be 630 Amps. The busbars should be fully encapsulated by SF6 gas inside the steel tank.

Remote Operation: Provision shall be there for remote operation of the switchgear's Isolators & Breaker CB shall be possible using Motors fitted to the operating mechanism. It shall be possible to fit the motors either directly in manufacturing plant or on site as & when required. Installation on site shall be possible

Protection : The CB shall be fitted with microprocessor based self powered relay inside the front cover to avoid any tampering. The same shall be used in conjunction with suitable Current Transformer and Tripping Coil for fault tripping of the Circuit Breakers.

Cable Termination: Each Cable compartment shall be provided with three bushings of adequate sizes to terminate the incoming outgoing 11kV 3 Core cables. There shall be enough height (Minimum 450mm) from the base of the mounted switchgear so that the cables can be bent and taken vertically up to the bushings. The Cable termination shall be done by Heat shrinkable Termination method so that adequate clearances shall be maintained between phases for Termination. Access to all the cables should be possible form the front of RMU. Cable Termination boots shall be supplied by the switchgear manufacturer.

Locking Arrangement : Suitable padlocking arrangements shall be provided as stated below…

a) CB manual operating handle in the "OFF" position.

b) Each feeder Panel operating handle in 'Closed' 'Open" or 'Earth' position.

c) Each isolator operating handle in 'Closed', ' Open', or 'Earth' position.

4.5 Ratings

		Non-Extensible radial compact switchgear with Circuit Breaker
3.5.1	Switchgear Data	
a)	Service	Outdoor but inside Enclosure
b)	Type	Metal clad
c)	Number of phases	3
d)	Voltage	11000V
e)	Rated Frequency	50 Hz
f)	Rated Current	630 Amp (isolator)
g)	Short Circuit rating	
	i) Breaking	18.4 kA rms for Breaker
	ii) Short time withstand for 3 Sec.	18.4 kA rms
	iii) Rated S/c making	52.5 kA peak for Breaker
h)	Short duration power freq.	28 kV
i)	Insulation Level	75 KV peak
j)	System earthing	Solidly earthed at substation
3.5.2	4.5.1.1.1 Breaker	
a)	Type	VCB/SF6 in SF6 tank
b)	Rated voltage	11kV
c)	Breaking current	
	i) Load breaking	18.4 KArms.
d)	Making current	52.5 KA peak
e)	Rated current	630 Amps.
f)	No. of poles	3
g)	Operating mechanism.	Trip free & free handle type with mechanically operated indication & pad locking.

3.5.3	Isolators	
a)	Type	**load breaking and fault making in SF6 tank**
b)	**Rated current**	630 Amps.
d)	Rated breaking capacity	630 Amps.
e)	**Fault making capacity**	52.5 KA peak
f)	**No. of poles**	3
g)	**Operating mechanism**	Operating handle with ON, OFF, Earth positions with arrangement for padlocking in each position.
3.5.4	**Busbars: (If any)**	
a)	Material	Copper
b)	Type	SF6 insulated
c)	Rated Current	630 Amps

4.6 Isolator

The Isolators offered shall conform to IS:4710/9920 as amended to date. The isolator shall be triple pole, spring assisted, hand operated, non-automatic type with quick break contacts. The operating handle shall have three positions 'ON', 'OFF' and 'EARTH' which shall be clearly marked with suitable arrangement to padlock in any position. A safety arrangement for locking shall be provided by which the isolator operation shall be prevented from 'ON' position to 'EARTH' position or vice versa.

4.7 Switchgear

Sealed for life, the enclosure shall meet the "sealed pressure system" criteria in accordance with IEC:298 (a system for which no handling of gas is required through out service life of approximate 20 years.) There shall be no requirement to 'top up' the SF6 gas. In addition, manufacturer shall confirm that maximum leakage rate is lower than 0.1% per year. It shall provide full insulation, making the switchgear insensitive to the environment. Thus assembled, the active parts of the switchgear unit shall be maintenance free.

The switchgear & switchboard shall be designed so that the position of different devices is visible to the operator on the front of the switchboard & operation are visible as well. The switchboard shall be designed so as to prevent access to all live parts during operation without the use of tools.

RMU should be tested for internal arc fault test .

4.8 Circuit Breaker

The Unit shall consist 630A Tee-off spring assisted, three pole VCB/SF6 circuit breaker, with integral fault making / dead breaking earth switch. The function shall be naturally interlocked to prevent the main & earth switch from being switched 'ON' at the same time & the CB not allowed to trip in 'Earth On' position. The selection of the main/earth switch lever on the panel, which is allowed to move only if the main or earth switches in the off position. The lever shall be able to pad locked in either the main or earth position.

The manual operation of the circuit breaker shall not have an effect on the trip spring. This should only be discharged under a fault (electrical) trip condition, the following manual reset operation should recharge the trip spring & reset the CB mechanism in 'main off' position.

4.9 Protection

Protection Relays: The CB shall be fitted with microprocessor based self powered relay inside the front cover to avoid any tampering.

Tests For RMU Each type of 11kV Switchgear shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards i.e. IS:9920, IS:3427, IS:13118, IEC:265, IEC:298 and during manufacturing and on completion

Routine Tests : The tests shall include but not necessarily limited to the following….

a) Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme and proper functioning of the equipment.

b) All wiring and current carrying part shall be given appropriate High Voltage test.

DISTRIBUTION TRANSFORMER

4.10 OIL FILLED TRANSFORMER

Requirement: 11000/415 Volt Oil immersed, ONAN cooled suitable for installation at outdoor in Enclosure for ground mounting. The transformer should be hermitically sealed & should be with corrugated wall design

Voltage Ratio: No load voltage 11000/433 volts within tolerance as stipulated in Iis 1180 Part 1 (2014) / IS:2026 .

Rating: The transformer shall have a continuous rating as specified at any of the specified tapping position and with the maximum temperature rise specified.

Temperature Rise: The maximum temperature rise at the specified maximum continuous output shall not exceed 40°C by thermometer in the hottest portion of the oil or 45°C measured by resistance of winding above ambient temperature, not exceeding 40°C daily average or 50°C maximum.

Type of Load: The transformer shall be suitable for carrying load within temperature rise indicated in the Indian Standard specification IS:6600 'Guide for loading of oil immersed Transformer'.

Overloads: The transformers shall be suitable for carrying overload within temperature rise indicated in IS:6600 'Guide for Loading of oil immersed Transformer'.

Connections: H.V. Delta and L.V Star connected with neutral brought out on the secondary side for connection to earth; Vector group DYn11 of IS:2026.

Tapping :

a) Each transformer shall be provided with **Rotary type tap switch** so as to provided for a voltage adjustment on H.V. from , +5% to -10% in 2.5% equal steps with on load tap changer to obtain rated voltage of 415 volts on LV side. The tapping shall be provided for following voltage ratios at no load.

b) Each transformer shall be provided with adjustable **tapping Links** such as to provided for a voltage adjustment on H.V. from , +5% to -10% in 2.5% equal steps with on load tap changer to obtain rated voltage of 415 volts on LV side. The tapping shall be suitable to change on H.V. side by links provided for this purpose.

Cleaning & Painting

a) All steel surfaces shall be thoroughly cleaned by sand blasting or chemical agents, as required to produce a smooth surface free of scales, grease and rust.

b) The internal surfaces in contact with insulating oil shall be painted with heat resistant insulation paint which shall not react & be soluble in the insulating liquid used.

c) The external Surfaces, after cleaning, shall be given two coats of high quality epoxy based rust resisting primer as per IS:2074 followed by filler coats.

d) The transformer shall be furnished with coats of weather resisting battleship gray epoxy based enamel paint as per IS:2932 specially recommended for transformer use.

e) The paints shall be carefully selected to withstand tropical heat rain, effect of proximity to the sea etc. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

f) Special care shall be taken by the manufacturer to ensure against rusting of nuts, bolts and fittings during operation. All bushings and current carrying parts shall be cleaned properly after final painting.

Both H.V. and L.V. bushings shall have creepage corresponding to **very heavily polluted atmosphere**.

Oil: New transformer oil used shall be according to IS:335.

Phase Marking & Danger Plate: Phase markings in fluorescent paint on small non-corrodible metallic tags shall be permanently fixed for H.V. and L.V sides. Phase markings tags shall be properly fixed with proper alignment. Danger plates shall be provided on the H.V & LV sides, mentioning the Corresponding Voltages.

4.11 Core and Coil :

Core : The core shall be constructed from high grade, cold rolled, non-ageing, low loss, high permeability, grain oriented, cold-rolled grain oriented silicon steel laminations. The transformer shall be so designed as to have minimum humming noise. The percentage harmonic potentials with the maximum flux density under any conditions shall be such that capacitors connected in the system shall not be overloaded.

The core and coil assembly shall be securely fixed in position so that no shifting or deformation occurs during movement of transformer. The core and coil assembly shall be capable of withstanding without injury, the thermal and mechanical effects of short circuit at the terminals of any winding as per IS:2026.

Impedance Volts: The Percentage impedance value at 75 Deg. C at any tap shall be 5% subject to tolerance as specified in IS:2026. The value of the impedance volts at each tapping over the specified range shall be specified in the bid.

Regulation: The regulation at 75° C at full load at unity and 0.8 power factor subject to the usual tolerance as per IS:2026 shall be specified in the bid.

Power Freq. High Voltage & Insulation Level (Impulse voltage): The distribution transformer shall be designed so that they are capable of withstanding high voltage & impulse voltages as per IS:2026 and as given below:

a) Impulse Voltage for 11kV winding: 75 kV (1.2/50 Microsecond wave shape).

b) High Voltage : 28kV rms.

4.12 Fittings & Accessories For Corrugated Tank Transformer

The following accessories conforming to IS:3639 shall be provided for 11 kV/0.415 kV distribution transformer.

Two earthing terminals with copper lugs. The lugs shall be provided in such a way that they shall not obstruct the movements of rollers. The earthing continuity for all the connected equipments shall be properly done.

Two lifting lugs for complete transformer as well as enclosure.

Off circuit tapping switch shall be rotary type, 3 pole gang operated, top mounting draw out type only. Tap switch shall be suitable for rated current considering 20% overloading & operating voltage. Switch shall be provided with externally operating hand wheel handle with indicator and locking device, with direction changing facility and locking arrangement.

Rating plate and diagram plate of durable non-corroding metal giving information as required under IS:1180. Rating plate shall also include Transformer **Actual %Z, Load Loss at 50% & 100% (Full-Load) at 75°C** along with details like Purchase Order Number, date. The name plate marking shall be done with fluorescent colour. Each equipment shall carry individual name-plate with proper instructions & affixed with screws.

NOTE - The supplier shall give sufficient advance information about the test schedule to enable the owner to appoint his representative.

5 D. G. SET

5.1 D.G. SET (250 & 125 KVA)

5.1.1 INTENT OF SPECIFICATION:

This specification covers the design, manufacture, assembly, shop testing, packing, dispatch, transportation supply, 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.

5.1.2 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	:	Degree of protection provided by enclosure for low voltage switchgear and control gear.
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.

5.1.3 ENGINE:

Diesel Engine shall be stationary, compression, ignition, totally enclosed, radiator cooled, stroke cycle, cold battery starting, turbo charged and after cooled 1500 RPM in accordance to BS and IS specification complete with all accessories.

5.1.4 COOLING SYSTEM:

Radiator Cooled with Acoustic Enclosure Outdoor Type.

5.1.5 FUEL SYSTEM:

Fuel System shall have PT Fuel Pump, Injectors, Fuel filters, Self contained piping & houses, complete piping.

5.1.6 LUBRICATING SYSTEM:

Lubricating system shall have engine mounted lube oil pump, strainer, lube oil cooler, oil filter, By-pass filter, self contained piping.

5.1.7 AIR INTAKE SYSTEM:

Air intake system shall have dry type filter, Air intake manifold with necessary connections, Turbocharger with after cooler.

5.1.8 EXHAUST SYSTEM:

Exhaust system shall have Exhaust Manifold, Flexible piping, Hospital silencer to limit the noise level and extending silencer outside the canopy.

5.1.9 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.

5.1.10 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.

5.1.11 COUPLING ARRANGEMENT:

Coupling arrangement shall have Flexible coupling, Flywheel, Flywheel Housing, Coupling Guard.

5.1.12 INSTRUMENT PANEL:

Instrument Panel shall be compatible for remote connectivity and shall have-

- Lube oil pressure gauge
- Water temperature gauge
- RPM Indicator & Hour Meter
- Battery charger ammeter
- Starting switch with key

5.1.13 SAFETY CONTROL TRIP:

- Low Lube oil pressure
- High Water temperature
- Engine over speed.

5.1.14 ALTERNATOR:

Standard : IS: 4722/BS 2613

Output	:	250 & 125 KVA self excited, self regulated foot mounted fitted with ball and roller bearings. This shall give full output of 250 & 125 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 temperature rise limited to class H
Winding connection	:	Star connection (all six leads will be brought out of stator frame).
Termination	:	Termination box shall be amended to match bus duct termination arrangement.

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 and shall be directly coupled with engine mounted on common rigid fabricated steel base frame with suitable ant vibration isolation system.

5.1.15 OTHER ACCESSORIES:

FUEL TANK:

Day service fuel tank shall be made of 3mm thick MS sheet of 990 litres capacity for each set with all accessories such as inlet pipe connection, outlet pipe connection, through to collect split oil, air vent pipe with air filter, and manhole with cover with all fittings interconnections between tanks. The tank shall be provided with suitable calibration scale. Socket for level controller for automation purpose to be provided with dead plug.

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 etc with M.S. Base & stand 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.

SILENCER:

Exhaust silencer shall be residential type to reduce the noise level.

5.1.16 COOLING:

The diesel engine shall be radiator cooled.

5.1.17 ENGINE GOVERNER:

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). Governor shall be capable to maintain zero speed rate or regulation and shall be A-1 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.

5.1.18 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.

5.1.19 STARTER BATTERY:

The battery shall be maintenance free type.

5.1.20 ENGINE SAFEGAURD:

Safeguards shall be provided and arranged when necessary to stop the engine automatically by the following:

Energizing 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.

MANDATORY SPARE PARTS:

The list of mandatory spares to be submitted by the contractor to owner along with bid.

5.2 PIPING WORK (D.G. FLUE GAS EXHAUST SYSTEM)

5.2.1 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.

5.2.2 D.G. FLUE GAS EXHAUST PIPING

D.G. Flue Gas Exhaust Pipe shall be "Medium" Class “B” M.S. Black pipes 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.

5.2.3 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.

5.2.4 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.

Flanged pair shall be used on all such equipments which are required to be isolated or removed for service.

5.2.5 PIPING INSTALLATION

The drawings attached with this tender indicate schematically the sizes, location of pipes & vertical shafts. The contractor, on award of the work, shall prepare detailed shop drawings based on tender drawings, showing the cross-section, longitudinal sections, details of fittings and all pipe supports.

Piping shall be properly supported on, or suspended from, stands, clamps, springs, hangers as specified and as required at site. The contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers and shall be responsible for their structural sufficiency. A set of piping support calculations shall be submitted for structural engineer review and approval before site installation wherever critical & required.

Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint and finish coated black. Where pipe and clamps are of dissimilar materials, a gasket shall be provided in between. Spacing of pipe supports shall not exceed the following:

Pipe Sizes	**Spacing Between Supports**	**Rod Size**
Up to 12 mm	1.2 Meter	8 mm
15 to 25 mm	1.8 Meter	8 mm
32 to 150 mm	2.4 Meter	10 mm
Above 150 mm	---------As Per Approved Shop Drawing------	

Vertical pipes passing through floors shall be plumb and parallel to wall. Pipes shall be supported on all floors. MS cleats shall be welded on pipes and rest on MS channel placed on the floor with 15 mm thick resistoflex pads between the cleat and channel. U clamps with resistoflex sheet shall be provided to keep the pipe in position.

T heading in exhaust piping shall be avoided.

Pipe sleeves at least 3 mm thick, 50 mm / 100 mm larger in diameter than exhaust pipes respectively shall be provided wherever pipes pass through retaining wall and slab. Annular space shall be filled with fibre glass and finished with retainer rings welded on the ends of the sleeve. All pipes passing through the retaining wall shall be provided with suitable water proofing compound.

Wherever pipes pass through the brick or masonry / slab openings, the gaps shall be sealed with fire sealant.

The Contractor shall make sure that the clamps, brackets, clamp saddles and hangers provided for pipe supports are adequate. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.

All pipes shall be accurately cut to the required size in accordance with relevant BIS Codes, edges beveled and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reducers shall be used for the piping to drain freely. In other locations, concentric reducers may be used.

5.3 MAIN L.T. PANEL-

5.3.1 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 (as per the BOQ) 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)

a. Relays - IS: 3231

5.3.2 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.

5.3.3 CONSTRUCTION

D. G. Panel shall be

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 42 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	-	32mm
ii.	Between phases and neutral	-	26mm
iii.	Between phases and earth	-	26mm
iv.	Between neutral and earth	-	26mm

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.

5.3.3.1 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.

5.3.3.2 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 50KA RMS symmetrical for one second and a peak short circuit withstand capacity of 105KA. 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 cross section of neutral bus bars shall be same as that of phase bus bar for bus bars of capacity up to 200Amp; for higher capacity the neutral bus bar shall not be less than half (50%)the cross section of that the phase bus bars. 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.

5.3.3.3 MEDIUM VOLTAGE AIR CIRCUIT BREAKER

TYPE AND CONSTRUCTION

The ACB shall confirm to the requirements of IEC 60947-2 / IS 60947-2 and shall be type tested & certified for compliance to standards from–CPRI, ERDA / any accredited international lab. The circuit breaker shall be suitable for 415 V $\pm$ 10%, 50 Hz supply system. Air Circuit Breakers shall be with moulded 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.

Air circuit breakers shall have a rated operational voltage of 415V AC (50Hz) & impulse voltage of 12 kV.

The construction of circuit breakers shall be as per pollution degree 4 requirements to sustain harsh environments

The tests shall be carried out with a breaking performance during operation (Ics) and admissible short time withstand (Icw) equal to the ultimate breaking capacity (Icu). i.e. Icu = Ics = Icw = 50KA for 1 Sec.

The Circuit Breaker shall have minimum mechanical life of 10000 operations without maintenance.

The breakers shall deliver an electrical life of 6000 operations up to 2000A & 5000 operations for ratings 2500A and above under rated voltage of 440V AC, without maintenance.

All 4 Pole ACBs shall have fully rated neutral equal to rating of the breaker & shall be protected against over-load & short-circuit with provisions for settings at:

- 4P 3d - neutral unprotected,
- 4P 3d + N/2 - neutral protection at 0.5In,
- 4P 4d - neutral protection at In to ensure precise neutral protection.

Shunt trip and closing coil shall be of continuous rated design and both should be accessible from the front of ACB after opening the cover, without disturbing any other part/release.

The Circuit Breaker shall have minimum 4 changeover auxiliary contacts rated at 10 A 240/380V volts 50 Hz. There should exist, facility to add one more set of 4 contacts as required.

Ready-to-close contact shall exist for indicating that all safety parameters are checked & enabling closure of breaker, ensuring at-most safety for the user.

The withdrawable circuit breaker shall have the following three distinct and separate positions, which shall be indicated on the face of the panel.

- "Service" -- Both main and auxiliary circuits are connected.
- "Test" – All auxiliary circuits are connected & main circuits are disconnected.
- "Isolated" -- Both main and auxiliary circuits are disconnected.

There should be a positive locking at these positions while racking out or racking in for clear & confirmative indications as the position is reached. A release push button shall be available to release the lock.

A door interlock shall be provided so that it shall not be possible to open the door until the air circuit breaker moving part is in the disconnected position.

The racking handle shall be stored on the air circuit breaker in such a manner as to be accessible without defeating the door interlocking.

The Circuit breaker protection shall be through intelligent ET range of electronic trip system suitable to protect the distribution network, against LI (Over load, Instantaneous), LSI (Overload, Short-Circuit & Instantaneous) & LSIG (Overload, Short-Circuit, Instantaneous & Ground fault).

The circuit breaker control unit shall be with display. The trip units with display shall be suitable to measure current and voltage parameters.

Control unit shall have fault history data & store last 10 trip causes.

The trip unit shall have following protection settings, based on the type of trip unit.

- Adjustable over load current (Ir) settings from 40% to 100% of rating of ACB (In).
- Over load time setting (tr) from 0.5s, 1s, 2s, 4s…….24s as field selectable curves
- Short circuit setting (Isd) from 1.5 to 10 times of Ir setting
- Short circuit time delay adjustable from 0 to 400 msec.
- Instantaneous (Ii) protection with an adjustable pick-up and an OFF position.
- Earth fault setting adjustable in absolute Ampere with time delay settings from 0 to 400 ms.

PROTECTION

The protection release shall have following features and settings:

(i) TRUE RMS SENSING

The release shall sample the current at the rate of 16 times per cycle to monitor the actual load current waveform flowing in the system and shall monitor the true RMS value of the load current. It shall take into account the effect of harmonics also.

(ii) THERMAL MEMORY

When the breaker shall reclose after tripping on overload, then the thermal stresses caused by the overload if not dissipated completely, shall get stored in the memory of the release and this thermal memory shall ensure reduced tripping time in case of subsequent overloads. Realistic Hot/Cold curves shall take into account the integrated heating effects to offer closer protection to the system.

(iii) DEFINED TIME – CURRENT CHARACTERISTIC

A variety of pick-up and time delay settings shall be available to define the current thresholds and the delays to be set independently for different protection zones thereby achieving a close-to-ideal protection curve.

(iv) TRIP INDICATION

Individual fault indication for each type of fault should be provided by LEDs for faster fault diagnosis.

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. Earthing 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.

5.3.3.4 MOULDED 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. All MCCB shall be provided with rotary operating mechanism.

All MCCBs shall be suitable for 3 Phase 415 Volts AC 50 HZ supply.

All MCCBs shall have rated service breaking capacity (Ics) equal to the ultimate breaking capacity (Icu) at defined operational voltage.

All MCCBs shall clearly indicate the suitability for isolation in the name plate identified by the symbol  .

All MCCBs shall offer class –II front face i.e. main current path of the circuit breaker should be isolated from auxiliary section

All MCCBs shall have cross bolted termination.

All MCCBs above 250A shall have the following features

- Single frame size with common accessories to reduce inventory
- Microprocessor trip unit
- Adjustable overload settings – 0.5-1 In
- Adjustable Short circuit – 2-10 Ir
- Adjustable neutral for 4P MCCBs – 0-0.5Ir-1Ir
- Thermal memory
- Test connector to check the healthiness of trip unit
- 4000 electrical operations
- ON/OFF/Trip/Push to trip indication contacts

All MCCBs up to 250A shall have following features

- Single frame size with common accessories to reduce inventory
- Thermal magnetic trip unit
- Adjustable overload settings – 0.7-1 In
- Fixed short circuit settings
- Fully rated neutral for 4P MCCB
- 10000 electrical operations
- ON/OFF/Trip/Push to trip indication contacts

Individual fault trip LED indications shall be available on all types of trip units for easy & faster identifying the cause of fault.

I^2t ON / I^2t OFF options shall be available for short-circuit & earth fault protections to enhance discrimination with downstream devices.

The trip unit shall have integral test facility to verify the healthiness and to avoid external calibration.

The release shall be self diagnostic type with clear LED indication in case of mal functioning.

It shall be possible to change the **protection settings on line** and the circuit breaker need not be switched of while adjusting the setting.

Circuit breakers shall conform to Electromagnetic compatibility tests (EMC) as specified in IEC 60947-2, Appendix F.

Manufacturer shall submit the test certificates for the same.

The control unit shall have **thermal memory** throughout the range to store temperature rise data in case of repetitive overload or earth fault for protecting the cables and loads.

RUPTURING CAPACITY

The Moulded Case Circuit Breaker shall have a minimum fault breaking capacity (Ics) of not less than 50KA RMS at 415 volts or as specified in BOQ./ Drawing.

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.

5.3.3.5 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 confirm 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 confirm 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 of 50KA 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.

5.3.3.6 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.

5.3.3.7 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.

5.3.3.8 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.

5.3.3.9 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.

5.3.3.10 LABELS

Labels shall be of anodized aluminium, with white engraving on black background. They shall be properly secured with fasteners.

5.3.3.11 MISCELANEOUS

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.

5.3.3.12 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**.**

5.4 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.

5.4.1 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 controlgear 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.

5.4.2 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.

5.4.3 SPECIFICATION

CAPACITORS

i. The capacitor shall be 3 phase heavy duty box type capacitor 480 Volt, 50 Hz, with 14% detuned reactor.

ii. The temperature rise above the specified ambient (50ºC) of any part of the capacitor and polyurethane resins associated equipment shall not exceed the permissible temperature as per IS: 2834.

iii. 100/50/25/10/5 KVAR capacitor units shall be used to form a bank of capacitors of desired capacity. All these units shall be connected in a parallel by means of solid bus bars of adequate current carrying capacity. The combination of capacitor unit shall be such as not to exceed permissible over voltage across the healthy capacitor units in case of failure of one or more units. Capacitor banks shall be suitable for operation at 110% of rated RMS voltage and 150% of rates RMS current. Each unit shall satisfactorily operate at 135% of rated KVAR.

iv. Construction-

The Capacitor banks shall be floor mounting type using minimum floor space. The container of capacitors shall be hermetically sealed in sturdy containers made out of 2 mm thick M.S. sheet steel. Dry type or synthetic non-inflammable oil shall be used for insulation. Each standard unit shall be provided with a built in silvered fuse.

v. Discharge Resistance

Each capacitor unit shall be individually protected by MCCB with indication to show when it is in operation. The capacitors shall be provided with permanently connected discharge resistors so that residual voltage of the capacitors shall be reduced to 50 Volts or less within one minute after the capacitor is disconnected from the sources of supply.

vi. Earthing

Two separate earthing terminals shall be provided for earth connection for each bank. All components and frame shall be properly earthed.

5.4.4 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 42. This panel shall be integrated with the main L.T. panel unless specified otherwise.

5.4.5 PAINTING

As the capacitor panel is integrated with Main LT panel, it shall be painted as per specification in relevant Clause above.

5.5 SUB DISTRIBUTION PANEL

5.5.1 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.

5.5.2 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

5.5.3 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.

5.5.4 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.

5.5.5 METAL TREATMENT AND FINISH

All metal work used in the construction of the sub distribution boards should have under gone 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.

5.5.6 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 of 35KA RMS symmetrical for one second or as specified in BOQ/Drawing and a peak short circuit with stand capacity of 105 KA.

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 distance shall be provided on the bus bar system to minimize the possibility of fault. The main phase bus bars shall have continues 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 0.8 Amp per sq. mm of cross section area of the bus bars.

5.5.7 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. All MCCB shall be provided with rotary operating mechanism.

All MCCBs shall be suitable for 3 Phase 415 Volts AC 50 HZ supply.

All MCCBs shall have rated service breaking capacity (Ics) equal to the ultimate breaking capacity (Icu) at defined operational voltage.

All MCCBs shall clearly indicate the suitability for isolation in the name plate identified by the symbol  .

All MCCBs shall offer class –II front face i.e. main current path of the circuit breaker should be isolated from auxiliary section

All MCCBs shall have cross bolted termination.

All MCCBs above 250A shall have the following features

- Single frame size with common accessories to reduce inventory
- Microprocessor trip unit
- Adjustable overload settings – 0.5-1 In
- Adjustable Short circuit – 2-10 Ir
- Adjustable neutral for 4P MCCBs – 0-0.5Ir-1Ir
- Thermal memory
- Test connector to check the healthiness of trip unit
- 4000 electrical operations
- ON/OFF/Trip/Push to trip indication contacts

All MCCBs up to 250A shall have following features

- Single frame size with common accessories to reduce inventory
- Thermal magnetic trip unit
- Adjustable overload settings – 0.7-1 In
- Fixed short circuit settings
- Fully rated neutral for 4P MCCB
- 10000 electrical operations
- ON/OFF/Trip/Push to trip indication contacts

Individual fault trip LED indications shall be available on all types of trip units for easy & faster identifying the cause of fault.

I^2t ON / I^2t OFF options shall be available for short-circuit & earth fault protections to enhance discrimination with downstream devices.

The trip unit shall have integral test facility to verify the healthiness and to avoid external calibration.

The release shall be self diagnostic type with clear LED indication in case of mal functioning.

It shall be possible to change the **protection settings on line** and the circuit breaker need not be switched of while adjusting the setting.

Circuit breakers shall conform to Electromagnetic compatibility tests (EMC) as specified in IEC 60947-2, Appendix F.

Manufacturer shall submit the test certificates for the same.

The control unit shall have **thermal memory** throughout the range to store temperature rise data in case of repetitive overload or earth fault for protecting the cables and loads.

RUPTURING CAPACITY

The Moulded Case Circuit Breaker shall have a minimum fault breaking capacity (Ics) of not less than 35 KA RMS at 415 volts or as specified in BOQ./ Drawing.

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.

5.5.8 MEASURING INSTRUMENTS, FOR METERING:-

GENERAL

Direct reading electrical instruments shall be in conform 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 confirm 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 confirm 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 5A 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 of 50KA 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.

5.5.9 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.

5.5.10 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.

5.5.11 CONTROL WIRING-

All control wirings shall be carried out with 1100V grade single core FRLS 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.

5.5.12 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.

5.5.13 LABELS-

Labels shall be of anodized aluminium, with white engraving on black background. They shall be properly secured with fasteners.

5.5.14 TESTING AT MANUFACTURING WORK-

All routine tests specified is IS: 8623-1977 shall be carried out and test certificates submitted to the Engineer – in –Charge.

5.5.15 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 meggar 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 meggar, the insulation resistance shall not be less than 100 mega ohms.

d) Trip tests & protection gear test.

6 UPS

6.1.1 SYSTEM COMPONENTS

IGBT technology (IGBT Rectifier & IGBT Invertor) with galvanic isolation transformer.

6.1.2 POWER

On-Line UPS

6.1.3 PRODUCT CERTIFICATION/TESTING

The product shall have certification from any one of the following -

a) ERTL

b) ETDC

c) STQC

d) I E C

e) ISO 9001

6.1.4 OPERATING TEMPERATURE

0 - 40 degree Centigrade

6.1.5 HUMIDITY

Up to 95%

6.1.6 OUTPUT FREQUENCY

50 Hz +/- 0.01% Hz

6.1.7 WAVE FORM

Pure Sine Wave

6.1.8 TRANSIENT RESPONSE

+/- 1% maximum under following conditions:

a) Loss or Return of Input AC supply

b) 100% step load

6.1.9 RECOVERY TIME

To nominal voltage in less than 10 milli second.

6.1.10 EFFICIENCY (OVER ALL)

Minimum 90% at full load.

6.1.11 LOAD POWER FACTOR

0.9 lag to unity.

6.1.12 CREST FACTOR

Greater than 3:1

6.1.13 MTBF

Minimum 100000 hrs.

6.1.14 SWITCH OVER TIME

Zero

6.1.15 OVERLOAD RATING

110% for 30 minutes

125% for 10 minutes

150% for 1 minutes

6.1.16 NOISE

Less than 65 dB at 1 mtr.

6.1.17 SWITCHING SPEED

Minimum 2 KHZ

6.1.18 INDICATION

Mains ON/OFF, /Battery HIGH/LOW, Battery ON, Invertor ON/TRIP, O/P HIGH/LOW, Battery HIGH/LOW, Alarm for Battery Discharge.

6.1.19 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

6.1.20 CONTROL CIRCUITORY

Microprocessor based control circuitory be provided and all indications will be digitally displayed using microprocessor based software.

6.1.21 METERING

Digital display with multifunctional key panel indicate.

Output Voltage/Current

DC Voltage/Current

Output Frequency

6.1.22 COMMUNICATION PORT

RS 232

6.1.23 DIAGNOSIS & CONFIGURATION SOFTWARE

Compatible with Unix/Windows.

6.1.24 OUT LOOK

Compact size with aesthetically good look (specify the size and weight)

6.1.25 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.

6.1.26 HARMONIC DISTORTION OF WAVE FORM

Total harmonic distortion (THD) should be below 2% for linear load and below 3% for nonlinear load.

6.1.27 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.

6.1.28 BATTERY DISCONNECT SWITCH

The switch used to electrically isolate the storage batteries from UPS module.

6.1.29 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.

6.1.30 RETRANSFER TO INVERTOR

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.

6.1.31 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.

6.1.32 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.

6.1.33 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.

6.1.34 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.

6.1.35 SPARE PARTS

The recommended spare parts for 5 years of maintenance are to be listed and should be quoted along with main modules.

6.1.36 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.

6.1.37 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. The battery shall be maintenance free type.

6.1.38 SERVICE REPORT

Assigned field service report describing start-up and on site testing shall be furnished.

6.1.39 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.

6.1.40 INVERTOR EFFICIENCY

96% minimum

6.1.41 PROTECTION CLASS

IP – 20

6.1.42 PARALLEL – CONNECTION

Up to 4 module

7 CABLE WORK

7.1.1 DESCRIPTION OF WORK

Supply, laying, testing and commissioning of cables as per specifications, schedule of quantities and drawings.

7.1.2 APPLICABLE CODES & STANDARDS

IS: 1554 (Part-I)	:	1.1KV Grade PVC insulated Cables.
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 11 KV.
IS: 10810	:	Method of test for cables
IS: 1255	:	Code of practice for installation & maintenance of power cables up to & including 11 KV rating.
IS: 8130/IEC: 60228	:	Conductors for cables
IS: 10418	:	Drums for electric cables.
IS: 2062, IS: 800, IS: 816	:	Structural wedding steel

7.1.3 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.

7.1.4 TEST REPORTS

Routine test certificates for each drum of cable brought to site.

7.1.5 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. grade shall be FRLS XLPE insulated Aluminium conductor armoured cable.

The MV control cables shall be FRLS insulated copper conductor armoured cable.

The HT power cable of 11 KV grade shall be XLPE insulated Aluminium conductor armoured cable.

7.1.6 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.

7.1.7 PROXIMITY TO COMUNICATION 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.

7.1.8 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.

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/amour 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.

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.

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.

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.

7.2 RACEWAY

All raceway shall be of 1.6mm/2.0mm/2.5mm thick G.P. sheet as specified in BOQ. The raceway shall have Z- section, hole with thread for cover screw, coupler plate, cover, junction box, fly cover etc as required. The screw for cover fixing shall be counter sunk type. The size of raceway shall be as follow.

WIDTH (mm)	HEIGHT (mm)	THICKNESS (mm)	COVER THICKNESS (mm)
50	40	1.6	2.0
75	40	1.6	2.0
100	40	1.6	2.0
150	40	1.6	2.0
200	40	1.6	2.0
300	40	2.0	2.0

7.3 DISTRIBUTION BOARDS

7.3.1 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 phase (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 stoved 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 – 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 "C" 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 terminal shall have safety shutter.

d) Distribution board shall be provided with isolator or MCB and/or earth leakage circuit breaker as mentioned in drawings and BOQ. 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 specified in BOQ is not standard size of manufacturer, in that case next standard size distribution board box shall be used with incoming & outgoing MCB as specified in BOQ. 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.

7.4 CONDUIT AND WIRING SYSTEM

7.4.1 PVC CONDUIT

Conduits shall be heavy gauge rigid PVC of minimum thickness of 2mm. Conduits shall be ISI marked confirming to IS: 9537 (Part-3)-1983. All conduit and conduit accessories shall be of PVC. Conduit shall be jointed together by a vinyle type cement/solvents. Minimum size of conduit shall be 25mm unless otherwise mentioned in BOQ or drawing. Conduit shall be fixed on ceiling or wall. All conduits shall be concealed in wall/ceiling etc. or fixed on surface of wall with clamps at regular interval as called for elsewhere. For termination of PVC conduits into switch outlet box, PVC female adopters shall be used. Wherever conduit run exceeds 10 metre, circular junction boxes shall be provided to facilitate pulling & inspection of wires. Inspection boxes shall be suitably located in co-ordination with the Engineer-in-charge. Conduits shall be bend using suitable size springs. Long radius bends shall be provided. Heating shall not be used to bend the conduits. Size of conduit shall depend upon number and size of wires to be drawn.

7.4.2 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.

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.

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.

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.

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.

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 gauge 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 treated 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.

OUTLET BOXES:-

Switch/outlet boxes shall be made of metal on all sides except on the front. Boxes shall be hot dip galvanized mild steel. Up to 20 x 30cm size M.S. Box shall have wall thickness of 16 SWG and MS boxes above 20x30cm size shall be of 14 SWG. The metallic boxes shall be painted with anticorrosive paint before erection. Clear depth of the box shall not be less than 60mm. 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 provoded for connection of earthing wire in side of box at near any corner. Nakka shall be 3 mm thick.

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. cover plate size 160 mm x 160mm x 16 gauge 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.)

DEEP TEE:-

The tee shall be made out of C.I. material. The dia of tee shall be 60 mm and the Depth of tee shall be 70 mm. The thickness of deep tee wall shall be 1.3mm to 1.5mm. (The sample to be approved before procurement/execution by owner / consultant.)

ERECTION AND EARTHING OF CONDUITS:-

The conduit of each circuit or section shall be completed before conductors are drawn in. The entire system of conduit after erection shall be tested for mechanical and electrical continuity throughout and permanently connected to earth conforming to the requirement by means of special approved type of

earthing clamp effectively fastened to conduit pipe in a workmen like manner for a perfect continuity between the earth and conduit. Gas, water pipe shall not be used as earth medium.

7.4.3 LIGHT & POWER ACCESSORIES:-

GENERAL

All light & power accessories shall be of modular range of plate switch type and shall be of one manufacturer (brand) and type.

LIGHT SWITCHES

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 contract. All switches shall be of white finish or as sample approved by owner/consultant.

6/16 AMP SWITCH SOCKET OUTLET.

Switch socket outlet on lighting circuit 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. Switch and socket outlet shall be mounted on a suitable size GI box with suitable size modular cover plate.

Switch socket outlet on power circuit shall be of 6 pin 16/6 Amp outlet (Universal Socket) shall have safety shutters. The switch shall be of rocker mechanism type with silver contacts. Socket outlet shall be shutter type and of modular range of plate type and having white finish. Switch and socket outlet shall be mounted on a suitable size G I box with suitable size modular cover plate.

TELEPHONE OUTLET

Each Telephone outlet location shall be provided with 1 No. telephone Jack type outlet (RJ11). The telephone outlet shall be of modular range of plate switch type and shall be mounted on a suitable size G I Box with modular range cover plate.

WIRING

All PVC insulated copper conductor multi-stranded wires shall conform to relevant IS codes. Cable conductor size and material shall be as specified in BOQ.

All internal wiring shall be carried out with PVC 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 PVC insulated wire for RYB phase wire respectively and black colour PVC insulated wire for the neutral wires. PVC 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.

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.

SUB MAINS

Sub-main wiring shall be carried out with PVC Insulated Copper multi-stranded wires/cables in suitable PVC / M.S. Conduit unless otherwise called for.

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 PVC 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.

LOAD BALANCING

Balancing of circuits in three phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

COLOUR CODE FOR CIRCUIT & SUB-MAIN WIRING

Colour code for circuit & sub-main wiring installation shall be Red, Yellow, Blue for three phases. Black for neutral and green for earth in case of insulated earth wire.

7.4.4 CLASSIFICATION OF POINTS:-

General

Classification and measurement of Point wiring shall be as follows:

Conduiting & wiring from switch to first point including circuit wiring along with conduits, shall be classified as “One point (First point) controlled by one number 6Amp one way/two way switch”.

Conduiting & wiring from first point to next point to be controlled by same switch in same circuit shall be classified as “Looping Points”.

CONDUCTOR SIZE

Wiring shall be carried out with following sizes of PVC insulated multi-stranded single core copper conductor wire/cable.

Light point	-	1.5 Sq.mm
Ceiling/Cabin/Exhaust Fan Point	-	1.5 Sq.mm

Plug Point (5 A SS outlet)	-	1.5 Sq.mm
Light Circuit Wiring	-	1.5 Sq.mm
6A Circuit Wiring	-	2.5 Sq.mm
MCB Control Light Point	-	2.5 Sq.mm
General Power Point (15A S.S. outlet)-Second Point	-	4.0 Sq.mm
Power Point for Geyser / A.C. Unit	-	4.0 Sq.mm

7.4.5 TELEPHONE WIRE/CABLES:-

Separate conduits shall be provided for internal telephone wiring of telephone system commencing from tag block. Each telephone outlet shall be wired with 2 pair telephone cable from the tag block. All telephone wires shall be of 0.61mm dia annealed tinned high conductivity copper conductor PVC insulated & PVC sheathed grey conforming to ITD specification SWS 113 B&C. Multipair PVC insulated cables laid in conduit shall be provided for connecting various tag blocks. Telephone cables used for external connections shall be armored. These cable shall be laid directly in ground or in pipe etc. as call for elsewhere.

Following number of 2 pair wires/cables shall be drawn in various sizes of conduits as listed below.

25mm conduit - Up to 6 Cables

All telephone cables used in the building shall be PVC insulated PVC sheathed.

7.4.6 TELEPHONE DISTRIBUTION BOARDS (TAG BLOCK):-

Tag block shall be mounted in M.S. box fabricated from 1.63 mm thick sheet steel. Box shall undergo a rigorous metal treatment process i.e. degreasing, pickling, phospating, pasivating in de oxalate solution, dry with compressed air in dust free atmospheric facility and disconnection module shall be in multiple of 10 pairs. Disconnection unit shall be mounted on back mounting frame.

Maximum number of PVC insulated 650/1100 V grade aluminium / copper conductor cable conforming to IS: 694 – 1990, that can be drawn into rigid PVC/MS conduit.

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	2	3	4	5	6	7	8	9	10	11	12	13
1.50	5	4	10	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

NOTE:

The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.

The columns headed 'S' apply to runs of conduits which have distance not exceeding 4.25m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns headed 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.

Conduit sizes are the nominal external diameters.

7.4.7 CONDUITING AND WIRING FOR SAMTV SYSTEM:-

CONDUITING

Conduiting for SMATV system shall be carried out in M.S. Conduit. Conduiting shall be carried out as per Clause No. 3.7.2 of this specification.

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.

JUNCTION BOX

Suitable size of metallic junction box shall be provided for termination of conduit for SAMTV system. Box shall be made of 1.6mm thick MS sheet and shall be treated before painting. Front of the junction box shall be provided with 3mm thick phenolic laminated sheet cover.

CATV LINE AMPLIFIERS

The CATV Amplifier shall be housed in a high frequency resistant Aluminium housing. The CATV Amplifier shall have an in built variable equalizer and Alternator for site signal condition adjustments.

COAXIAL CABLES

The coaxial cable shall be of wideband type (RG-11 for Riser & RG-6 for distribution)

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 a aluminium cast housing for high frequency radiation resistance.

The Tap offs shall be in one way, two way and four way configurations.

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 a aluminium cast housing for high frequency radiation resistance.

The splitters shall be in 2 way, 3 way & 4 way configurations

7.5 ADDRASSABLE FIRE ALARM SYSTEM

7.5.1 SCOPE OF WORK

7.5.1.1 The scope of work under this heading shall include designing supplying and installing of Analogue Addressable Fire Detection and Alarm System. The work under this system shall consist of furnishing all materials, equipment, appliances and labour necessary to install the complete Fire Detection and Alarm System, complete with Main Fire Alarm Control Panel, Sensors, Sounders, Strobes, Manual Call Stations, Relays etc. for interfacing with other systems.

7.5.1.2 It shall include laying of cabling duct, conduits and power supply etc., necessary for installation of the system with supply of sensors and devices as appropriate and as indicated in the Specification and Bill of Quantities. Any openings/chasing in the wall/ceiling required for the installation shall be made good in appropriate manner.

7.5.1.3 The Bidder shall also undertake to control and monitor the ventilation and other systems from the Fire Alarm Panel through the use of Addressable Output / Input Modules.

7.5.1.4 The Building should be designated as multiple fire zones with each area forming one or more software programmed zones. All wiring shall be done using 2 x 1.5 mm^2 twisted pair shielded PVC insulated copper cable while exposed and in PVC/MS Conduits in concealed in concrete.

7.5.2 GLOSSARY OF TERMS

7.5.2.1 FIRE ALARM PANEL (FACP)

This refers to the microprocessor-based panel that shall be connected to the various sensors/devices by means of 2 wire loops. The FACP shall be able to supervise individual detectors for proper performance as well as to give pinpoint location of Fire or Fault Alarm and initiate Alarms as well as facility for cutting off of AHU's and Electrical Power is also

to be included. The panel shall also have the provision through volt-free contact to activate an Auto-Dialer to dial selected phone numbers in case of fire.

7.5.2.2 LOOP

A loop shall mean a 2-wire circuit connecting 198 Addressable Devices, which shall include 99 Sensors and 99 Modules. The loop card shall have built-in short circuit isolators to accommodate Class A wiring.

7.5.2.3 ADDRESSABLE DEVICES

This term indicates the complete group of addressable devices such as Sensors or Detectors, Manual Call Stations, Addressable Output / Input Modules etc.

7.5.2.4 SENSORS OR DETECTORS

The Sensors or Detectors shall be Analogue Addressable type. The chamber should be easily removable for the purpose of easy maintenance. The address programming shall be done through the decade switch in the Detector. The Detectors shall have a common base to allow easy interchange of various types of Detectors. Address setting by DIL Switch shall not be acceptable or through Hand Held Programmer.

7.5.2.5 MANUAL CALL STATION

The Manual Call Station shall be addressable type with Input Modules to define the address for each station. The function shall be similar to that of conventional Manual Call Point and should be resetable without replacing the glass.

7.5.2.6 OUTPUT MODULE

Output module shall mean Addressable points from the FACP with potential free contacts for tripping of AHUs, power supply etc. as required. Any module shall operate two relay outputs powered from the loop and preferably consuming single address on the loop. The system shall also be able to handle separate modules to interface the speakers of the Public Address System.

7.5.2.7 INPUT MODULE

The input modules shall be of dual/single channel type. The dual channel module shall be selectable for Normally Open or Normally Close by a 2 bit DIL switch.

7.5.2.8 FAULT ISOLATOR

This unit shall be placed on the loop preferably after every 20–30 devices and shall be able to isolate electrical short circuit in the wiring. All the other detectors shall remain functional because of the Class A wiring of the loop. The isolator shall not utilize an address and shall be built into the detector base wherever required.

7.5.2.9 SOUNDERS/HOOTERS

Each sounder shall be of addressable type. The sounders shall derive power either from Loop itself or from external 24VDC Source. It shall be capable of being directly mounted on the wall/ceiling or along with the detector. The sounder shall have an output of at least 90db at 1 mtr. The sounder shall be programmed to activate in event of an alarm from a single detector/device or a group of detectors/ devices.

7.5.3 SPECIFICATION

7.5.3.1 The design, supply and installation and testing of the entire fire alarm system shall conform to EN 54 / BS: 5839 or NFPA 71 and 72. The detectors shall conform to relevant codes for Fire Alarm Systems.

7.5.3.2 A general line diagram showing the circuit and spacing of detectors is to be enclosed. The quantity mentioned in the Price Schedule shall be quoted for. Unit rates shall apply in the event of any variance.

7.5.4 FIRE ALARM SYSTEM

7.5.4.1 The Fire Alarm System shall confirm to EN54, BS: 5839 or NFPA 71/72 in respect of design and installation, and it shall give Audio/Visual Alarm Signals when there is rise in temperature in case of Heat Detector or while measuring Smoke Density in case of Smoke Detector, while it exceeds the pre-set limit. The system shall give pinpoint location of fire with warning system and voice communication for commands and instruction if required.

7.5.4.2 The system shall have a microprocessor-based control and monitoring facility. The basic function of the system shall be able to achieve pinpoint location of alarm indication.

7.5.4.3 It shall be possible to program each loop with up to 99 Detectors & 99 Modules in a circuit.

7.5.4.4 Annunciation facility shall also be inbuilt into the FACP, the panel being able to initiate alarm signal for any particular zone.

7.5.4.5 The system shall be fully supervised for all fault conditions with distinctive alarm operated for fault and fire conditions. Test buttons and software features shall be provided to test the electronic circuits and Detector health.

7.5.4.6 The FACP shall be so programmed that when a particular Detector or group of detectors gives a fire signal the FACP should be able to trip an individual AHU automatically. In case of Fire in an area handled by an AHU the FACP shall be able to trigger a Relay that shall shut off the AHU through an additional contact provided in the AHU panel by the AC contractor.

7.5.4.7 The FACP shall have facility to connect addressable Input / Output Devices in the peripheral RS 485 bus. These may be 8 way input card, 4 way relay card, 4 way sounder card, passive/active repeater panels and mimic driver cards.

7.5.4.8 The system shall be based on an “Open Protocol” to ensure flexibility of using Sensors / Detectors of an alternate manufacturer, in case the user requires such an option at a later date.

7.5.5 FIRE ALARM CONTROL PANEL (FACP)

7.5.5.1 The Fire Alarm Control Panel shall be micro processor based fully Analogue Addressable, Analogue Control Unit which shall control all Analogue Addressable Detectors, Manual Call Stations and Switching Systems (for disconnecting AHU and power supply) connected to it.

7.5.5.2 All addressable units shall be connected to the FACP through the Loop Cards and shall be addressed through individual numbers. The FACP shall be able to obtain analogue value for all detectors in the circuit through a pulsed digitalized current data. The FACP shall be able to analyze all analogue inputs from all addressable units, and through its own software and

ambient level screening the FACP shall be able to identify fire, possible fire or fault conditions. The unit supervision shall be dynamic and continuous.

7.5.5.3 The FACP shall itself have one loop card built in. The loop shall be able to address 198 Detector/Devices per Loop. At least 99 FACP units may be networked to enhance system capacity as and when required. All the networked panels shall display all the events occurring anywhere in the system. Each FACP on the network shall effectively function as a repeater panel as well.

7.5.5.4 The FACP shall also give adequate warning signal whenever there is dust accumulation in detectors, and up to the point of its replacement it should be possible to change the level of ambient alarm calibration condition either by the use of software program operable by the owner or by resetting the detector.

7.5.5.5 Short / Open circuit units shall also be reported at the FACP In such cases, the system through the use of fault isolators shall be able to isolate that segment between the two fault isolators. The missing Detectors/Devices shall also be reported at the FACP with identification of the location.

7.5.5.6 The FACP shall have the facility to set sensitivity of each smoke sensor remotely. It shall also be possible to set the sensitivity to a global high or global low based on night or daytime.

7.5.5.7 When an alarm condition is sensed at the FACP from a smoke or heat detector, a delay time/alarm verification period shall be started. If the sensor is still in alarm after the delay time expires, an alarm condition is reported. The delay time shall be adjustable from 0 to 990 sec's.

7.5.5.8 The FACP shall have the facility to perform walk test such that an operation can be periodically checked out for all initiating devices. As each device is placed into alarm the FACP shall print the condition and automatically rest the device. Audible devices shall be initiated, if required at a preprogrammed time. If a zone is inadvertently left in walk test mode, it shall automatically reset to normal after the idle time is exceeded. During the walk test the zones other than the programmed zones shall be under continuos supervision (normal mode). In case of any alarm initiated by detector/devices the walk test shall get terminated automatically.

7.5.5.9 Programming functions shall include alarm/trouble type assignment, point descriptor assignment, alarm message assignment, etc.

7.5.5.10 Programming may be carried out from the FACP keyboard or utilizing the approved PC setup software via laptop/desktop computer.

7.5.5.11 The FACP shall have a Liquid Crystal Display of Alphanumeric type to indicate immediately all conditions. The display should be high resolution, backlit 2 (lines) x 40 character. In case of testing of the system from the FACP the Display shall be able to give readouts of analogue value of all detectors being tested. The FACP shall also be able to carry out continuous self-monitoring when in normal condition.

7.5.5.12 The FACP shall have facility for in-built or external printer coupled to the FACP, which shall log all events with time. The printout shall clearly indicate the event - Fire/Pre Alarm/Fault etc. With the unit address and time.

7.5.5.13 The FACP shall also be able to discriminate between false alarms and fire conditions, as well as priority selection of alarm in case alarm activates in two or more remotely located units simultaneously. In such cases, the Manual Call stations shall have the highest priority.

7.5.5.14 The FACP also is able to actuate switches automatically in case of Fire condition that of AHU's and power supply or other systems such as Gas Extinguishing Systems.

7.5.5.15 In this respect the bidder is required to take note of clause relating to cutting off of AHU's given above. The bidder shall note that the Client shall provide no additional facilities for completion of this mechanism other than that specified in clause 1.4.6.

7.5.5.16 The System shall be fail safe and adequate safe guards should be under taken that in the event of a failure of a part of the System it shall not handicap the complete System. The Loop Cards shall be of Modular Construction.

7.5.5.17 The Bidder shall undertake the responsibility of the complete installation, commissioning, user trials, training and maintenance of the System as required. The Bidder shall take all responsibility for preparation and installation of System Software into the FACP. The Software shall be such so as to be easily operated by the Client's Personnel and secured against Software errors, ability to be upgraded so as to incorporate more features at a later date.

7.5.5.18 The FACP shall have its own Battery Backup of a minimum of 48 hours in normal condition and then half an hour in alarm condition. The back up time calculation shall be done as per IS 2189 standards. The Battery shall be 2*12V (24V) DC and of sealed lead acid rechargeable maintenance free type, housed inside the FACP.

7.5.5.19 It shall be able to withstand temperature variations from 0^0 centigrade to 55^0 centigrade. Further, Relative Humidity (non-condensing type) up to 95% shall not hamper its performance. The voltage rating shall be from 15V DC to 32V DC, though the voltage may be change depending upon the working voltages of a proprietary FACP.

7.5.5.20 The FACP shall be totally enclosed dust and vermin proof type made of minimum 16 gauge dust inhibited sheet with even baked finish. The FACP shall be of completely solid stage design.

7.5.5.21 The logic circuitry shall be based on high noise immunity solid state hardware employing modular construction. Logic cards shall be of epoxy fibber glass construction.

7.5.5.22 The FACP shall have any one of these approvals: EN 54:LPCB, UL and FM.

7.5.5.23 The system shall be designed such that it shall be possible to add at least 20% of the Detectors for future expansion without extra cost on the panel.

7.5.5.24 The FACP shall be capable of being networked (future expansion) with other similar FACPs located at different part of the premises through a single RS485 bus.

7.5.5.25 The FACP shall have provision for interfacing with the Public Address System.

7.5.5.26 The Panel should have a minimum of 20 zones and each zone shall have an LED to indicate independently fire and fault conditions on the panel fascia.

7.5.5.27 The panel should have the facility to interface with an automatic two-channel programmable speech dialer for verbal reporting of fire. It shall be able to call four telephone numbers per channel. The programmable speech dialer shall have two alarm inputs and shall provide listen-in capabilities through the built-in microphone. The dialer shall have a built-in keypad for easy operation, programming and voice recording.

7.5.6 ADDRESSABLE DETECTORS

7.5.7 Smoke detector

7.5.7.1 All detectors are fitted with plug-in system type connections, from the maintenance and compatibility point of views. An alarm release will not effect a detector's good functioning. After resetting the alarm, the detector will resume operations without readjustment of any kind.

7.5.7.2 The detector shall be high performance optical type. Detectors using radioactive elements shall have BARC approval.

7.5.7.3 The detector shall be able to sense incipient fire by detecting the presence of visible and invisible products of combustion. The detector shall be suitable for low voltage (15 to 32 V DC) two wires supply. The detector shall be provided with Twin LED indication and the sensitivity of the detector shall not vary with change in ambient temperature, humidity, pressure or voltage variation.

7.5.7.4 Neither its performance shall be affected by air current up to 1.52mtr per second. The detector shall be suitably protected against dust accumulation/ ingress and it shall be free from maintenance and functionally tested at intervals. All detectors shall be identical in construction design and characteristic to facilitate easy replacement.

7.5.7.5 The coverage per smoke detector shall strictly follow IS 2189 standards. It shall be possible to connect Smoke Detector with Heat Detector or Manual Push Button in the same circuit. The sensitivity of detector shall be set from the FACP to suit the site requirement.

7.5.7.6 It shall have in-built locking mechanism to check the removal and pilferage of the detector. The quiescent current flow must not exceed 250 micro amps and alarm condition current shall be maximum 10 milliamps.

7.5.7.7 The Photoelectric type Smoke Detector shall be Analogue Addressable type and be able to send analogue output to the FACP regarding its condition. It shall be able to communicate with the FACP by the pulses emitted from the FACP. The detector should be programmed using a decade or rotary switch.

7.5.7.8 The base of the Detector shall be electronics free and interchangeable with other smoke or heat detectors. The enclosure shall meet IP 42 protection grade.

7.5.7.9 It shall be able to withstand temperature variations from - 10 degree centigrade to 50 degree centigrade. Further, Relative Humidity (non-condensing type) up to 80% shall not hamper its performance. The voltage rating shall be from 15V -32V DC though the voltage may be changed depending upon the working voltages of a proprietary FACP.

7.5.7.10 The Detector shall have LPCB or UL/FM approval. It shall be possible to test the Detectors working both from the FACP as well as locally by means of a magnet to simulate a Functional Test Condition.

7.5.7.11 It shall be possible to mount the detectors in Duct Casting Unit for sampling of Supplying Air from the AHUs.

Secondary response indicators shall be provided for all the Above False Ceiling Detectors.

7.5.7.12 The detector shall have twin LED's for 360 degree viewing angle. LED on the detector shall blink each time the sensor is scanned by the FACP. If the FACP determines that the sensor is in alarm, the FACP will command the sensor LED to remain on to indicate the same. Each sensor will be capable of being tested for alarm via command from the FACP. Each sensor shall respond to FACP scan with the information about its type for identification.

7.5.7.13 it shall be possible to connect loop powered base sounders on the detector loop. The sounder shall have a sound output of at least 85db and will not require a separate cable for power supply.

7.5.8 HEAT DETECTOR

7.5.8.1 14 Heat detector shall provide temperature measurement when it reaches pre-alarm in normal course. However the operator shall have the option of calling up the temperature measured by the specific detector as and when required.

7.5.8.2 It shall have in-built locking mechanism to check the removal and pilferage of the detector. The quiescent current flow must not exceed 200 microamps and alarm condition current shall be maximum 10 milliamps.

7.5.8.3 The heat detector shall be Analogue Addressable type and be able to send analogue output to the FACP regarding its condition. It shall be able to communicate with the FACP by the pulses emitted from the FACP. The detector should be programmed using a decade or rotary switch.

7.5.8.4 The base of the Detector shall be electronics free and interchangeable with other smoke or heat detectors. The enclosure shall meet IP 30 protection grade.

7.5.8.5 It shall be able to withstand temperature variations from - 10 degree centigrade to 60 degree centigrade. Further, Relative Humidity (non-condensing type) up to 80% shall not hamper its

performance. The voltage rating shall be from 15V -32V DC though the voltage may be changed depending upon the working voltages of a proprietary FACP.

7.5.8.6 The Detector shall have LPCB or UL/FM approval. It shall be possible to test the Detectors working both from the FACP as well as locally by means of magnet to do a Functional Test.

7.5.8.7 The detector shall have twin LED's for 360 degree viewing angle. LED on the detector shall blink each time the sensor is scanned by the FACP. If the FACP determines that the sensor is in alarm, the FACP will command the sensor LED to remain on to indicate the same. Each sensor will be capable of being tested for alarm via command from the FACP. Each sensor shall respond to FACP scan with the information about its type for identification.

7.5.8.8 It shall be possible to connect loop powered base sounders on the detector loop. The sounder shall have a sound output of at least 85db and will not require a separate cable for power supply.

7.5.9 Multicriteria/Multisensor (Smoke + Heat Detector)

Detector combines optical smoke detection, heat detection, and microprocessor control with analogue addressable Communications

Detector shall have two auto learn Sensitivity settings, three fixed Sensitivity photo thermal, settings and thermal only detection mode.

It shall be possible to connect loop powered base sounders on the Detector loop. The sounder shall have a sound output of at least 85db and will not require a separate cable for power supply.

Detector shall have twin LED's for 360 degree viewing angle. LED on the detector shall blink each time the sensor is scanned by the FACP.

If the FACP determines that the sensor is in alarm, the FACP will Command the sensor LED to remain on to indicate the same. Each Sensor will be capable of being tested for alarm via command from The FACP.

Each sensor shall respond to FACP scan with the Information about its type for identification.

7.5.10 High Sensitivity Laser Smoke Detectors.

Laser Smoke detector will provide and extremely high Sensitivity to fire conditions, by detecting earliest particle of Combustion.

Detector should detect both fast flaming and slow smoldering fires

The detector should have 9 different sensitivity levels from (0.07- 6.56% /m).

Detector shall have twin LED's for 360 degree viewing angle.

LED on The detector shall blink each time the sensor is scanned by the FACP.

If the FACP determines that the sensor is in alarm, the FACP will Command the sensor LED to remain on to indicate the same.

Each Sensor will be capable of being tested for alarm via command from The FACP.

Each sensor shall respond to FACP scan with the Information about its type for identification.

It shall be possible to connect loop powered base sounders on the Detector loop. The sounder shall have a sound output of at least 85db and will not require a separate cable for power supply.

The Detector should be 100% times more sensitive than normal Smoke Detector.

7.5.11 MANUAL CALL STATIONS

The manual station shall be a press to break type. The device shall be red in color and suitable for surface or flush mounting. Manual stations shall be interfacable to an addressable input module that can be accommodated within the device. The manual station shall have normally open fire alarm and annunciator contacts and these contacts shall close on activation. Contacts shall remain closed until station is manually reset.

The Manual Call Station shall be fully addressable with its own addressable module and operated by digitized signals from the FACP. The voltage range shall be from 15V to 32V. It shall have protection as per IP33. The operating temperature range shall be from -10 degree C to 60 degree C. Relative Humidity (non condensing) range of performance parameters shall be between 10 to 93%.

7.5.12 FIRE ALARM REPEATER / ANNUNCIATOR PANEL

The Alarm Repeater/Annunciator Panel shall display fire/fault messages simultaneously with the FACP. It shall be capable of interfacing with the FACP on a single RS 485 Bus. The panel shall be capable of operating on 24 V DC supply.

The panel shall have a 2 x 40 character backlit alphanumeric LCD display, which shall display date, time & description of alarm/trouble events that are displayed in the FACP with an inbuilt buzzer to indicate fault/fire alarm.

The panel shall be powered from the FACP.

It shall have control keys for Sound, Silence, Mute and to reset the FACP from the repeater station.

The repeater panel shall have the following LED‘s indications

a. Supply

b. Fault

c. Mute

d. Silent

e. Disabled

f. Fire

7.5.13 SOUNDER/HOOTERS CUM STROBES

The sounder shall be electronic type and shall give discontinuous/ intermittent audible alarm whenever any detector or MCP operates.

The sound output from the Hooter should not be less than 85 decibels at the source point.

The sounder/Hooter shall be powered from either 2 wire detector loop or separate power supply 24 VDC can be used or additional cable shall be used in case of external power supply.

At 24 volts, 15, 15/75, 30, 75, 95, 110, 115, 135, 150, 177, or 185 candela by way of a rear-mounted slide switch and front

Viewing window

The horn/strobe shall be listed to UL 1971/ UL 464/LPCB and shall be

Approved for fire protective service. The horn/strobe shall be wired as a primary-signaling notification appliance and comply with the Americans with Disabilities Act requirements for visible signaling appliances, flashing at 1 Hz over the strobe's entire operating voltage range. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. The horn shall have three audibility options and an option to switch between a Temporal 3 pattern and a Non-Temporal (continuous) pattern. These options are set by a multiple position switch. On four-wire products, the strobe shall be powered independently of the sounder. The horn on horn/strobe models shall operate on a coded or non-coded power supply.

7.5.14 DUCT CASTING UNIT

The Duct Casting Units are to be directly installed in the return air conditioning ducts for detecting any hazardous quantity of products of combustion be carried through the ducts.

The complete unit shall consist of Polycarbonate housing to accommodate Photo Electric Detector with plug - in facility and sampling tubes, one for Air inlet and other as the air outlet.

The Inlet tube shall extend into and across the duct width (from 0.5 meter to 3.0 meter); the outlet tube shall be of fixed length of 7.5-cm length.

When the AHU blower fans shall operate a continuous cross sectional Sampling of air from the duct shall flow through the housing containing the Detector. The outlet tube shall return the sampled air into the duct.

The functional requirements of the Duct Casting Unit shall be:

i) Uniform Sensitivity - irrespective of air velocity - up to 1200 meters per minute.

ii) It shall function on the Venturi principle, with Aluminum Venturi tubes.

iii) The Duct Casting Unit shall be compact, easy to install and with the facility to dism the cover or Detector for maintenance purposes.

iv) The housing shall be mounted outside the duct; the probe tubes shall be inserted th the duct by cutting precision sized holes into the duct and sealed with rubber gask

v) The Duct Casting Unit shall be LPCB/UL Approved.

7.5.15 ADDRESSABLE MONITOR MODULE

The monitor module shall provide an addressable input for N.O. or N.C. Contact devices such as manual stations, Water flow switches, sprinkler Supervisory devices, etc.

It shall provide a supervised initiating circuit. An open-circuit fault shall be Annunciated at the Fire Alarm panel (Subsequent alarm shall be reported.)

The device shall contain an LED, which blinks upon being scanned by the Fire alarm panel. Upon determination of an alarm condition of an alarm condition, the LED shall be latched on.

The device shall have a selectable inbuilt fault isolator.

7.5.16 ADDRESSABLE CONTROL MODULE

Addressable Control Module shall be provided to operate dry contacts for switching ON OFF pressurization fans, AHU' s etc. in case of fire etc. It shall have a built in type identification to automatically identify this device to the control panel. It shall have internal circuitry & relay powered directly by two-wire loop. It shall have a selectable inbuilt fault isolator.

7.5.17 FAULT ISOLATOR MODULE

The Fault Isolator Device shall detect and isolate a short-circuited segment of a Fault-tolerant loop. The device shall automatically determine a return to normal condition of the Loop and restore the isolated segment. The fault isolator device shall be placed at least every [20] devices to limit the Number lost in the event of a short-circuit/wiring fault.

7.5.18 GRAPHIC MONITORING SOFTWARE

The Graphic Software shall Provide both Alarm Management and system maintenance tool.

All the information is available on a single screen allowing quick Assessment, whilst any actions can be taken by accessing the Built-in menus. Building Evacuation, Alarm Silencing and Reset are available to any users with suitable security clearance.

System maintenance can be performed on any device or zone whether the workstation is connected to a single panel or a series of networked panels. From a single location simple checks can be performed to assess the status of individual devices, whilst devices and zones can easily be temporarily isolated for on-site works to be performed. Advanced functionality is available to users with level 3 access permitting the maintenance of PC

software security passwords, Time & Date setting and control of the workstation functionality.

The schematic view offers users the site plan. It can be configured to provide a number of levels representing the overall site, individual floor plans, small sections of the floor plans or even individual rooms. Each plan is independently named and can be configured to show all devices as installed on the site. The event log details a complete history of the activity of the fire system.

All major control actions are recorded with date, time, user and an Optional comment field. Entries are colour coded to help easy Identification of specific types of events.

7.5.19 FIRE ALARM SYSTEM TESTING

7.5.19.1 FACP

a. The FACP shall be checked for basic tests such as visually checking input voltage and amperage. All zones one by one shall be de wired to check for fault signal indication in the FACP.

b. The Power Source shall be cut off and checked for stand by Supply from the Batteries. After six hours the FACP Source shall be switched on to check for auto switch over to the Mains mode.

c. Tests shall be conducted for AC fail, charger fail, DC fail, Battery Disconnect or Battery fail. In all such cases the relevant L E D should glow and the piezo sound shall also give sound output.

7.5.19.2 SMOKE DETECTOR

a. The testing shall be carried out for each loop / zone, initially one detector in a zone and subsequently 2 or more disassociated detectors in each zone with time lapse between the detectors to test for Alarm Priority, Alarm Queuing and Call Logging.

b. An identified detector will be subjected to smoke aspiration from burning paper/cigarette puffs, rubber and other materials which give dense smoke held at 0.3 M distance from the detector. The FACP should indicate increased analogue output for that address and after the programmed delay time, a fire alarm signal shall be indicated. This delay shall be utilized for alarm verification.

c. The same test shall be carried out for two detectors in the same Loop but in different rooms. The FACP shall indicate Pre Alarm higher analogue levels for both detectors in its display with separate identification for both fires. One of the detectors in question is subjected too higher and longer levels of smoke aspiration. The FACP should give priority alarm for this address. The printout shall indicate individual addresses of the detectors with achieved analogue values and the time of event.

d. This test shall be carried out for different Loops as well as for 2 Loops simultaneously.

7.5.19.3 **HEAT DETECTOR**

a. The same tests in the same sequence shall be carried out for this Detector but with the application of hot air from a hair dryer held at approximately 60 cm distance.

7.5.19.4 **COMBINED TEST**

a. The next test will be in combination of Photoelectric / Heat Detectors simultaneously with time lapse between application of smoke or heat or as required by the Client.

7.5.19.5 **ADDITIONAL TEST**

a. One detector of each type will be disconnected and subjected to slow dust build - up by means as desired by the Bidder and again connected in the circuit.

b. The FACP shall indicate the changed ambient levels and automatically adjust the analogue values for the same. These Detectors are to be replaced by new Detectors of identical type and the FACP shall then be programmed accordingly and checked. The Bidder will take custody of the removed detectors without additional cost to the Owner.

c. Any part of the Loop shall be short-circuited. The FACP shall indicate the communication failure of all the devices connected in the short-circuited segment. After the short circuit is corrected, the Fault Isolator shall return to its normal status automatically, this being reflected in the FACP. The Loop shall then be in normal operation again. Any part of the Loop shall be de wired and tested as given above.

7.5.20 All other tests as required by the client at the time of handing over.

FIRE ALARM CONTROL PANEL

Type		: Analog Addressable
Type of display		: LCD
Display of	:	ALL EVENTS
Addressable capability	:	198 Detector/Devices per loop
Intelligent capability	:	Yes
Fault-isolation capability	:	Yes
Alarm delay capability	:	Yes
Sensor-self-test capability		Yes
LCD display type	:	Minimum 2 Lines, 40 character on each line
BAS integration capability		Yes through Modbus
Stand-by battery with charger	:	Yes

Voltage requirement	:	230 V 50 HZ - Ac
No. of Zones		20
No. of Loops	:	As required to handle the devices in the Bill of Quantities with 20% spare capacity

MULTICRITERIA/MULTISENSOR DETECTOR

Type	:	Analog Addressable
Twin LED indication	:	Yes
Blinking LED facility	:	Yes
Addressable capability	:	Yes
Intelligent capability	:	Yes
Remote / Local test capability	:	Yes
Sensor Coverage		Spot Detection
Programming of detector	:	By Decade or Rotary Switch
Operating Temperature Deg C	:	-10° C to 60° C
Operating RH at 40° C	:	10% - 93% RH
Operating Voltage	:	15 - 32 V DC
Power Consumption	:	< 300 Micro Amps
Sensors	:	Optical and thermal type
Sensitivity settings	:	minimum 2 Nos.
Photo thermal sensitivity settings:		minimum 3 Nos.
Detection Mode	:	Combines or Thermal Only.

LAZER SMOKE DETECTOR

Type	:	Analog Addressable
Twin LED indication	:	Yes
Blinking LED facility	:	Yes
Addressable capability	:	Yes
Intelligent capability	:	Yes
Remote / Local test capability	:	Yes
Sensor Coverage	:	Spot Detection
Programming of detector	:	By Decade or Rotary Switch

Operating Temperature Deg C	:	-10° C to 60° C
Operating RH at 40° C	:	10% - 93% RH
Operating Voltage	:	15 - 32 V DC
Power Consumption	:	< 300 Micro Amps
Sensitivity settings	:	9 Levels (0.07 – 6.56%/m).

OPTICAL SMOKE DETECTOR

Type	:	Analog Addressable
Twin LED indication	:	Yes
Blinking LED facility	:	Yes
Addressable capability	:	Yes
Intelligent capability	:	Yes
Remote / Local test capability	:	Yes
Sensor Coverage	:	Spot Detection
Programming of detector	:	By Decade or Rotary Switch
Operating Temperature Deg C	:	-10° C to 60° C
Operating RH at 40° C	:	10% - 93% RH
Operating Voltage	:	15 - 32 V DC
Power Consumption	:	< 300 Micro Amps

FIXED/ ROR TYPE HEAT DETECTOR

Type	:	Analog Addressable
Dual Thermistor	:	Yes
Twin LED indication	:	Yes
Blinking LED facility	:	Yes
Addressable capability	:	Yes
Intelligent capability	:	Yes
Remote / Local test capability	:	Yes
Sensor Coverage	:	Spot Detection
Programming of detector	:	By Decade or Rotary Switch
Operating Temperature Deg C	:	-10° C to 60° C

Operating RH at 40° C	:	10% - 93% RH
Operating Voltage	:	15 - 32 V DC
Power Consumption	:	< 300 Micro Amps

MANUAL CALL POINT

Type	:	Analog Addressable, Resettable type
LED indication	:	Yes
Operating Voltage	:	15V - 32 V
Power consumption	:	< 250 Micro Amps
Dimensions	:	Semi-flush mounting: 89 x 93 x 27.5 (WxHxD)/
Surface mounting	:	89 x 93 x 59.5 (WxHxD)
Weight	:	Semi Flush: 110g/Surface: 160g
IP Rating	:	IP24D
Operating Temperature	:	-30°C to +70°C
Relative Humidity	:	0% - 95% non-condensing
Operating Voltage	:	15V to 30Vdc max
Current Consumption	:	Quiescent (without isolator) 260µA
		Quiescent (with isolator) 360µA
Alarm Current	:	6mA (both

REPEATER ALARM PENAL

Type	:	Active Type
Controls	:	System Reset, Accept, Mute, Silence & Self Test
LCD Display	:	80 Characters
Power Supply	:	External Type 24 VDC
Operating Current	:	90MA

ADDRESSABLE MONITOR MODULE

Mounting Option	:	DIN Rail or Surface Mount
Status Indication	:	Tri Colour LED

Address Setting	:	Through Selector Switch
Operating Temperature	:	-20 deg c- +60 deg c
Humidity	:	0 – 95 % Maximum Non Condensing
Operating Voltage	:	15-30 VDC
Current Consumption	:	Maximum 600 MicroA
Type	:	Single Channel

ADDRESSABLE CONTROL/OURPUT MODULE

Mounting Option	:	DIN Rail or Surface Mount
Status Indication	:	Tri Colour LED
Address Setting	:	Through Selector Switch
Operating Temperature	:	-20 deg c- +60 deg c
Humidity	:	0 – 95 % Maximum Non Condensing
Operating Voltage	:	15-30 VDC
Current Consumption	:	Maximum 510 MicroA
Type	:	Single Channel
Relay Type	:	Form C

FAULT ISOLATOR MODULE

Mounting Option	:	DIN Rail or Surface Mount
Status Indication	:	Tri Colour LED
Address Setting	:	Through Selector Switch
Operating Temperature	:	-20 deg c- +60 deg c
Humidity	:	0 – 95 % Maximum Non Condensing
Operating Voltage	:	15-30 VDC
Current Consumption	:	200 MicroA
Fault detection Delay	:	100 to 400 ms

8 PUBLIC ADDRESS SYSTEM

The system shall provide new and unique features for the market. Each component in the system shall be designed to suit the system needs as required.

The system shall have the following features:

- Easy configuration, but without losing the ability to solve complex requests. A basic mode configuration wizard and an expert mode program interface shall be provided. Fast and correct installation shall be possible, but it shall also be possible to handle complex and specific application requirements. A free programmable Task Engine shall be available via the expert mode program interface. The basic mode wizard shall be able to provide a step-by-step configuration guide that creates a complete IRIS-Net basic system configuration file. It shall be possible to create basic system with just 30 minutes.

- Due to its flexibility, the system shall eliminate the project risk right from the start. The matrix structure shall be evident throughout the system. Dynamic routing and intelligent audio power distribution shall make the system suitable for almost any application. The system shall be designed to ensure a system-wide intelligent power management architecture. The system shall raise the bar and creates a PA/EVAC system that uses the lowest power consumption for the application without losing functionality. It shall save batteries and maintenance costs!

- The system shall be built by professional sound engineers, and shall add pro-sound audio quality level to the PA/EVAC system. This high-quality level shall enable combined use of Fire/EVAC with applications that requires high-quality audio, such as presentation rooms, school stages, etc. The excellent sound quality shall ensure excellent intelligibility in all kind of situations.

- The new Call station shall be designed as a modern device. The new call station shall provide a green LED on the Microphone in to show that a call is going across from the call station.The system shall be able to handle up to 16 call stations

- The system shall be capable to address up to 492 zones with a total speaker load up to 40.000 Watt. It shall be able to handle 4 system sources and up to 16 music sources including local source inputs.

- It shall be possible to have just one spare amplifier in the system to take over from a duty amplifier in case one fails.

8.1.1 System controller

The system controller shall be an EN54-16 compliant and certified device in a 2 RU, 19”-cabinet. The TCP/IP capable network device shall contain all controlling and monitoring functions of a voice evacuation system.

The controller shall manage the supervision of its own operation and that of the connected devices. It shall control and activate the connected amplifiers and spare amplifier and shall replace the amplifier routing and channel that has reported a fault. A failsafe mode shall ensure that emergency calls are passed through to the amplifiers even if the controller itself fails.

The controller shall support single line switching or redundant group A/B switching.

Network connectivity status and fault conditions shall be displayed via LEDs on the front panel.

>1000 fault, warning and event conditions shall be logged internally and it shall be reported with the possibility to look real-time into the logging and save the log with logging tools. Four 100V audio inputs shall be routed to 12 speaker line outputs. Each block of 6 loudspeaker zones shall allow separate two-channel operation to

ensure continuous business music or it shall allow to be configured to double the amount of power in a 6 zone 1 channel block. It also shall have an option to have multiple calls in parallel in a 2 channel operation mode.

In case of too much amplifier power, it shall be possible to also transfer overrun amplifier power to additional system routers.

The controller shall provide an internal 16x 4 Audio matrix with full DSP functionally on each of the 4 outputs. The controller shall operate as a four channel output matrix.

It shall be possible to adjust channel delays up to 10s per channel.

A single system controller shall be able to manage up to 20 routers, 16 call stations and up to 492 loudspeaker circuits.

It shall allow up to 12 controllable local audio inputs.

A built in message manager shall be able to store up to 100 emergency- or business-calls, with a total storage time up to 85 minutes.

It shall be possible to send two different messages simultaneously to individual destinations.

In combination with license free spoken word evac sound files shall be provided in 7 languages.

A separate included tool shall provide on the fly replacing non-evac messages at any time without system interruption or system restart; So called hot swappable messages.

Loudspeaker supervision shall be fully controlled by the controller and executed from the router. The user shall be able to choose between impedance measurement, simple EOL boards with pilot tone supervision (requires return wires) or via advanced addressable EOL supervision boards, which requires a ground connection but no additional return wires.

Zones outputs shall be able to handle a load from 2-500 Watt.

Max 500 Watt per 6 zones shall be provided, if required.

The controller shall be able to handle up to 2000 Watt load.

It shall be possible to use connect to a FPA5000 via Ethernet

The controller shall have the following specifications:

- 16x4 DSP matrix mixing
- Priority mixing with ducking, attack and release
- 3 band parametric PEQ in the inputs
- 5 band parametric PEQ in the outputs
- up to 10s delay per output
- Gain adjustment in the in- and outputs
- Compressor on the inputs
- Limiters on the inputs
- Cross point matrix level adjustment with ducking level, fade in and fade out time
- 2 mic/line inputs (System s/n >= 106dB) – 2x Euro Style - 2x cinch
- 4 separate call station RJ45 input busses, each can be daisy chained up to 4 call stations
- 4 output channels for daisy chaining amplifiers via RJ45
- 12 input contacts; 6x voltage free (isolated) + 6x Supervised, to ensure compliancy to all different standards (like VDE0833 & NEN2575)
- 12 output contacts; 1x Relay + 12 Open Collector

- 6 High power output contacts (1A)
- 8 Analog input contacts with 256 steps resolution
- Four input channels (100V, 70V) + 2 spare channel inputs (100V, 70V)
- Real time clock with summertime and wintertime switching
- DCF77 receiver sync input
- Event scheduler
- 12 zone outputs (100/70V)
- 12 zone status LED (active – green, fault – yellow, alarm – red)
- 6 system status LED (general fault, system fault, alarm mode, power indicator, standby mode, network connection status)
- Internal router pcb: 2x 2ch x 6zone (2 separate channels can be provided on each 6 zones. Blocks can be daisy chained)
- Controller shall be configurable as 6 A/B zones or 12 single zones
- Internal sounder
- System access shall have password protection
- CAN bus between system components
- Based on a fully digital platform
- Network prepared (remote system racks)
- 24V DC Input

Audio:	16 (internal) audio Channels
	4 Aux input channels
	4 Callstation input channels
	4 audio output channels
Safety:	Internal supervision, system monitoring, watchdog, fault output
Software:	Basic mode (Wizard) & expert Mode (IRISNet; Intelligent Remote & Integrated Supervision Net)
	Integration of controller, amplifiers, call stations and peripheral control
	Configuration, control and supervision for complete audio systems
	Message swapper
	Programmable user control,
	GUI and access levels
Audio input specifications:	+6dBu/ 1,55V
Audio output specifications:	+6dBu/ 1,55V
Frequency response:	20Hz to 20kHz (-0,5dB)
Signal-to-noise ratio (A-weighted):	analog in to analog out: >106 dB typical
THD+N:	0.01%

Crosstalk:	>100dB @ 1 kHz
Samplerate:	48 kHz; 24bit
DSP Processing:	3 DSPs (480 MIPS) internal
Ethernet:	10/100 MB, RJ-45 (PC control)
CAN:	10 to 500 kbit/s, 2x RJ-45
	(remote and control)
Networking:	Module slot for optional Network / OMNEO interface
Control Port:	1 slave clock output (max. 1 A)
	1 time sync input (DCF-77 standard)
	12 control inputs (logic control)
	12 control outputs
	6 analog inputs 0-10V
Power supply:	+24 V DC (wide range tolerance:
	18 V to 58 V DC)
Operating temperature:	-5 C to +45 C
Product dimensions (W x H x D):	19", 2 HU, 483 x 88 x 376 mm
Colour:	Black / Silver
Weight:	3.5 kg

8.1.2 Amplifier

The 2x 500W Class D, high efficiency amplifier shall be an EN54-16 compliant and certified system device in a 2 RU, 19"cabinet. It shall provide 70/100V loudspeaker output voltages that are galvanically separated. The amplifier shall be permanently monitored by the system controller.

A special standby mode shall be provided for saving energy during the time the amplifier is not is use with respect to all economical and supervision aspects.

System control and audio interconnections shall be done via RJ45 connectors.

The amplifier shall be used as a system amplifier, but it shall also be possible to use the amplifier standalone.

As a system amplifier, four automatic selectable audio inputs via RJ45 shall be available. It shall also be possible to use a local input, and as such shall provide local (non-system controlled) sources without losing system and line supervision.

It shall be a requirement that local input is used in case of standalone mode.

The local input shall be configurable in a way that it can be used in as source input for in an installed system, for example for an external PA or local source input.
The amplifier shall have the following specifications:

- 2x 500 Watt Class D amplifier
- 4 channel input on RJ45 connector, amp link in and out
  (4 channel dynamic input channel switching for each amplifier)
- Local input on amplifier:
  Enabled via software configuration or automatically selected when amplifier address is set to address "0",
  System channel 4 will be used as supervision channel in case local inputs are used.
- Loop through on RJ45 connector (4 channels)
- Amplifier efficiency >= 78%
- Limiter prevents audible distortion
- AC Power switch on rear side
- 24V DC Input
- Front to rear air ventilation

Max amplifier load:	2x 500Watt
Signal to noise ratio, A-weighted:	>104 dB
Power requirements:	100 – 240 VAC in, IEC non locking socket,
	50 to 60 Hz or 24 VDC in (20 - 28 VDC)
Product dimensions (Width by Height by Depth): 19”,	
	2RU, 483 by 88.1 by 374.8 mm
Color:	Black/Sliver

8.1.3 Router

The system Router shall be an EN54-16 certified device in a 2 RU, 19”cabinet. The device shall extend the number of zones in a system and shall contain all the necessary controlling and monitoring functions.

The internal supervision system shall monitor the functions and operation of both itself and the connected devices. It shall be capable of rerouting a spare amplifier channel and shall replace an amplifier channel that has reported a fault.

Fault conditions shall also be reported to the connected system controller for operational control and logging purposes. A failsafe mode shall ensure that emergency calls are passed to the loudspeakers, even if the unit itself fails.

The controller shall support single line assignment or redundant group A/B switching.

Connectivity status and fault conditions shall be displayed via LEDs on the front panel, including a zone status LED.

It shall be possible to route up to 4 channels into eight 100V audio inputs to 24 speaker line outputs. The router loudspeaker outputs shall be divided in blocks of 6 loudspeaker line outputs. Each block of 6 zones shall allow

the same or a different two-channel operation mode to ensure continuous and/or different business music into different zone blocks.

The router shall operate as a four in two out matrix (4 channel input matrix to 2-channel zone block output).

Zone outputs shall be able to handle a load from 2-500 Watt.

Max. 500 Watt per 6 zones shall be provided.

The Router shall be able to handle up to a 4000 Watt load.

Integrated loudspeaker supervision shall eliminate the need of amplifier power for supervision, which shall result in very low power consumption.

The router shall have the following specifications:

- 24 input contacts; 12x voltage free (isolated) + 12x Supervised
- 24 output contacts; 24 Open Collector outputs
- 2 Relay switched outputs
- Eight 100V input channels + 4 spare 100V channel inputs
- 24 zone status LED (active – green, fault – yellow, alarm – red)
- 4 system status LED (general fault, power indicator, standby mode, network connection status)
- Internal router pcb: 4x 2ch x 6zone, were each block can be daisy chained
- 12 A/B zones or 24 single zones
- CAN bus between system components
- Max 1000 meter distance
- 24V DC Input

Safety:	Internal supervision, system monitoring,watchdog, fault output
CAN:	10 to 500 kbit/s, 2x RJ-45
	(remote and control)
Control Port:	1 x 8-pin RJ connector
	24 control inputs (analog 0-10 V/logic control)
	24 input contacts;
	12x voltage free (isolated) + 12x supervised, to ensure compliancy to all different standards (like VDE0833 & NEN2575)
Power supply:	+24 VDC
	(Range tolerance: 18VDC to 58VDC)
Operating temperature:	-5 C to +45 C
Product dimensions (W x H x D)	19”, 2 HU, 483 x 88 x 376 mm
Color:	Black/Silver

8.1.4 Call Station

The call station shall be an EN54-16 compliant and certified user interface.

It shall be designed in a modern and robust chassis with a graphical display.

As standard, the call station shall have a gooseneck microphone with pop shield and permanent monitoring, an illuminated LC-display and an integrated loudspeaker to be used for system sounds.

The operation status shall be permanently supervised by the system controller.

It shall be possible to modify the call station to suit the user's requirements by connecting up to five remote call station extensions, each with 20 free customizable functions and selection buttons.

It shall be possible to extend the call station extension at the right and at the left side. Is shall be possible to mount a maximum of 3 additional emergency buttons on the Call station. Optionally it shall be possible to mount a key switch to lock or enable call station functions with a key switch or to give access to a second access level.

The Call station shall have a built-in numerical keypad; it shall be possible to enable or disable the keypad during configuration.

The call station shall have the following specifications:

- Five menu/function keys (pre-programmed) – four buttons shall provide each 1 LED (two LED's shall be 2 green and 2 LED's shall be yellow).
- Green led on the microphone which is active during a call
- 15 function and speed dial buttons (customizable), two LEDs (green/red) per button.
- Button functions shall be programmable such as:
    - Zone select, source select, level control, emergency on/off, message on/off, failure acknowledge/reset.
    - switching output trigger on/off or 0 to 10V, select scheduled events, scheduled event on/off.
- Fascia cover with transparent areas for customizable labels.
- Multilanguage LCD display informs about system status, system faults, selected zones, source select, clock, different kind of additional (failure) messages shall be free configurable.
- Supervised electret microphone, with limiter and a speech filter for excellent speech intelligibility.
- CAT5 cable for data and audio connection to controller (can bus, up to 1000 meter).
- It shall be possible to daisy chain 4 call stations.
- It shall receive audio and operational control signals from the controller and report its status to the system controller.
- Internal monitoring with error logging– complying with all relevant national and international standards.

Supply voltage:	15–58 V DC
Maximum supply current (without extensions):	< 80 mA / 24 V
	< 110 mA / 18 V
Maximum supply current (with 5 extensions):	< 180 mA / 24 V
	< 250 mA / 18 V
Maximum mic input level:	-21 dBu
Maximum line input level:	+4 dBu

Maximum NF output level:	+12 dBu
LC-Display:	Lighted (122 x 32 pixel)
External Connectors:	1PCA BUS connector (Control data + Audio + Power supply, RJ-45) 1Audio Source (Line level, phone jack) 1 Microphone input (phone jack) 1 EXT connector (call station extension, RJ-12)
Operating temperature:	-5° to 45° C
Product dimensions (Width by Height by Depth):	200 by 167 by 65 mm (without microphone)
Color:	black
Net weight:	0.6 kg

8.1.5 Keypad

The call station extension shall be EN54-16 compliant. It shall be designed in a robust and modern chassis. It shall expand the call station by 20 customizable functions keys.

It shall be possible to install a maximum of five call station extensions on one call station, which shall expand the call station by up to 100 function keys (115 in total).

It shall be possible to mount the extension on the left or right-side of the call station.

The call station extension shall have the following specifications:

- 20 free customable functions keys, and two LEDs per button (green/red).
- It shall be possible to program button functions as:
    - Zone select, source select, level control, emergency on/off, message on/off, failure acknowledge/reset.
    - switching output trigger on/off or 0 to 10V, select scheduled events, scheduled event on/off.
- An LED shall also be programmable for own indication functionality.
- Fascia cover with transparent areas for customizable labels.
- RJ12 cable for data connection to call station.
- Max. 5 extensions per call station.
- Sents & Receives operational control to and from the call station.
- Internal monitoring with error logging– complying with all relevant national and international standards.

Connectors:	RJ12
Operating temperature:	-5° to 45° C

Product dimensions (Width by Height by Depth): 140 by 167 by 65 mm

Color:	black
Net weight:	0.29 kg

8.1.6 Loudspeakers

Ceiling Type Loudspeaker

A flush-mounting ceiling loudspeaker is available for general application. These full range loudspeakers are suitable for both speech and music reproduction. The speaker assembly consists of a single piece, 6 W loudspeaker and frame with a 100 V matching transformer mounted on the back.

Technical Specifications are as follows:

Maximum power	9 W
Rated power	6W
Sound pressure level at 6 W / 1 W (1 kHz, 1 m)	108 dB / 90 dB (SPL)
Effective frequency range (-10 dB)	150 Hz to 15 kHz
Rated voltage	100 V
Rated impedance	1667 Ω

Cabinet (Wall Mount) Loudspeaker

A wall-mounting loudspeaker is available for general application. These full range loudspeakers are suitable for both speech and music reproduction. The speaker assembly consists of a single piece, 6 W loudspeaker and frame with a 100 V matching transformer mounted on the back.

Technical Specifications are as follows:

Maximum power	9 W
Rated power	6W (6 – 3 – 1.5W)
Sound pressure level at 6 W / 1 W (1 kHz, 1 m)	96 dB / 90 dB (SPL)
Effective frequency range (-10 dB)	200Hz to 15 kHz
Rated voltage	100 V
Rated impedance	1667 Ω
Opening angle at 1 kHz/4 kHz (-6 dB)	150° / 70°

9 Objective of CCTV System

The objective of CCTV system is to provide video surveillance and recording function for the

Hospital operators to monitor strategic area to secure the safety and security of the public and staff.

General Requirements for CCTV System

The CCTV system shall be used for observation of public movement for security, disaster measures. According to them, the basic requirements for CCTV system shall be as follows

Monitoring Patients and Public Movement

The CCTV camera shall be installed at a different location like entry exit ,waiting area etc for the purpose of monitoring of public services, including patients .

NETWORK VIDEO RECORDER (NVR)

The Contractor shall provide NVR in consideration of the following specifications

General

1. The NVR should support recording of MPEG-2 and MPEG-4 source simultaneously. It

Should support recording of video and audio. The NVR should support applications, recording, re-play and backup simultaneously.

2. System should ensure that once recorded, the video cannot be altered ensuring the audit trail is intact for evidential purposes.

3. System to have facility of additional camera installation beyond the originally planned capacity up to 25% at each station without impacting on the performance of the system in any manner

4. The recording resolution and frame rate for each camera should be user programmable.

5. System must provide built-in facility of watermarking or Digital certificate to ensure tamperproof recording so that these can be used as evidence at a later date, if so desired. The recording should support audit trail feature.

6. The software should have user access authority configurable on per device or per device group basis. The user should have the facility to request the access of any camera and can control the camera for a reservation period. Control of camera is released after the reservation period.

7. In order to optimize the memory, while recording, video should be compressed using MPEG-4 or better standard and streamed over the IP network. Once on the network, video can be viewed on a Control room workstation or on analog monitor using a hardware decoder (MPEG-4/compatible standard Receiver) and should be recorded on NVR SERVER and should be backed up on NAS/RAID Backup device. The decoder should be capable of forward integration with the future editions of MPEG standards likely to be evolved at least up to the end of the DLP.

8. Video stream from individual cameras should be recorded on respective NVR &, subsequently, archived to NAS box/RAID backup device. System should have provision to automatically over-write the new information after the period of 7 days & necessary script/algorithm must be available in the Application.

9. The software should Support flexible 1/2/4 Windows Split screen display mode or scroll mode on the PC monitor or on preview monitor as per site requirement.

10. NVR Should have below specification

APPENDIX-XXVIII

Processor	Dual-core embedded processor
Operating System -	Embedded LINUX
IP Camera Input	32 channel Analog or 64 Channel IP
Two-way Talk	1 channel Input, 1 channel Output, RCA
User Interface	GUI
Video Output	1 HDMI, 1 VGA
Compression	H.264+/H.264/MJPEG
Video Resolution	2560 × 1920, 2048 × 1536, 1920 x 1080, 1280 x 1024, 1280 x 720, 1024 x 768
MD Zones	396 (22 × 18)
Video Loss	Supports
Camera Blank	Supports
Alarm Input	4 channel
Alarm Output	2 channel
Hard Disk	4 SATA Ports, up to 8TB
Smart Phone	Smart Phone - iPhone, iPad, Android Phone
Trigger Events	Recording, PTZ, Tour, Alarm, Video Push, Email, FTP, Spot, Buzzer & Screen tips
Recording Mode	Manual, Schedule (Regular, Continuous), MD (Video detection: Motion Detection, Camera Blank, Video Loss), Alarm, Stop
Search Mode	Time/Date, Alarm, MD & Exact search (accurate to second), Smart search
Playback	Play, Pause, Stop, Rewind, Fast play, Slow play, Next file, Previous file, Next camera, Previous camera, Full screen, Repeat, Shuffle, Backup selection, Digital zoom
Backup Mode	USB Device /Network
Interface Ports	1 HDMI, 1 VGA, 2 USB(1 USB 2.0 , 1 USB 3.0), 1 RS485, 1 RS232, 1 RJ45
Record Interval	1~120 min (default: 60 min), Pre-record: 1~30 sec, Post-record: 10~300 sec
Max User Account	128 users
Ethernet	1 RJ-45 port (10/100M/1000M)

Protocols	HTTP, TCP/IP, IPv4/IPv6, UPNP, RTSP, UDP, SMTP, NTP, DHCP, DNS, IP Filter,PPPOE, DDNS, FTP, Alarm Server,ONVIF Version 2.4
Power Supply	DC12V/4A
Power Consumption	20W(without HDD)
Working Temp	. -10 ~+55°C / 10~90%RH / 86~106kpa

High Resolution IP Fixed Box type Camera (Day/Night)

Image Sensor:	1/2.8" Progressive Scan CMOS
Signal System:	PAL/NTSC
Min. Illumination:	Color: 0.005 lux @(F1.2, AGC ON), 0 lux with IR
Shutter time:	1/3 s to 1/100,000 s
Slow shutter:	Support
Lens:	2.8 mm, horizontal field of view: 108° 4 mm, horizontal field of view: 86.4° 6 mm, horizontal field of view: 52° 8 mm, horizontal field of view: 40° 12 mm, horizontal field of view: 25°
Lens Mount:	M12
Adjustment Range:	Pan: 0° to 360°, tilt: 0° to 90°, rotate: 0° to 360°
Day& Night:	IR cut filter with auto switch
Wide Dynamic Range:	120 dB
Digital noise reduction:	3D DNR
Compression Standard	
Video Compression:	H.265+/H.265/H.264+/H.264/MJPEG
Video bit rate:	32Kbps~16Mbps
Triple Streams:	Yes
Image	

Max. Image Resolution:	1920 x 1080
Frame Rate:	50Hz: 25fps (1920 × 1080, 1280 × 960, 1280×720) 60Hz: 30fps (1920 × 1080, 1280 × 960, 1280×720)
Sub Stream:	50Hz: 25fps (640 × 360, 352 × 288) 60Hz: 30fps (640 × 360, 352 × 240)
Third Stream:	50Hz: 25fps (1920 × 1080, 1280×720, 640 × 360, 352 × 288) 60Hz: 30fps (1920 × 1080, 1280×720, 640 × 360, 352 × 240)
Image Enhancement:	BLC/3D DNR
Image Settings:	Rotate Mode, Saturation, Brightness, Contrast, Sharpness adjustable by client software or web browser
Target Cropping:	Support
ROI:	Support 1 fixed region for each stream, and face dynamic tracking
Day/Night Switch:	Auto/Scheduled
Network	
Protocols:	TCP/IP, UDP, ICMP, HTTP, HTTPS, FTP, DHCP, DNS, DDNS, RTP, RTSP, RTCP, PPPoE, NTP, UPnP, SMTP, SNMP, IGMP, 802.1X, QoS, IPv6
General Function:	One-key reset, Anti-Flicker, heartbeat, mirror, password protection, privacy mask, Watermark, IP address filtering
System Compatibility:	ONVIF (Profile S, Profile G), PSIA, CGI, ISAPI
Interface	
Communication Interface:	1 RJ45 10M / 100M Ethernet interface
On-board storage:	Built-in Micro SD/SDHC/SDXC slot, up to 128 GB
Smart Feature-set	
Behavior Analysis:	Line crossing detection, Intrusion detection, Unattended baggage detection, Object removal detection
Line Crossing Detection:	Cross a pre-defined virtual line
Intrusion Detection:	Enter and loiter in a pre-defined virtual region
Unattended Baggage:	Objects left over in the pre-defined region such as the baggage, purse, dangerous materials
Object Removal:	Objects removed from the pre-defined region, such as the exhibits on display.

Recognition:	Face Detection

High Resolution IP Fixed Dome type Camera

Image Sensor:	1/3" Progressive Scan CMOS
Signal System:	PAL/NTSC
Min. Illumination:	Color: 0.005 lux @(F1.2, AGC ON), 0 lux with IR
Shutter time:	1/3 s to 1/100,000 s
Slow shutter:	Support
Lens:	2.8 mm, horizontal field of view: 108° 4 mm, horizontal field of view: 86.4° 6 mm, horizontal field of view: 52° 8 mm, horizontal field of view: 40° 12 mm, horizontal field of view: 25°
Lens Mount:	M12
Adjustment Range:	Pan: 0° to 360°, tilt: 0° to 90°, rotate: 0° to 360°
Day& Night:	IR cut filter with auto switch with 36IR LED
Wide Dynamic Range:	120 dB
Digital noise reduction:	3D DNR
Compression Standard	
Video Compression:	H.265+/H.265/H.264+/H.264/MJPEG
Video bit rate:	32Kbps~16Mbps
Triple Streams:	Yes
Image	
Max. Image Resolution:	1920 x 1080
Frame Rate:	50Hz: 25fps (1920 × 1080, 1280 × 960, 1280×720) 60Hz: 30fps (1920 × 1080, 1280 × 960, 1280×720)
Sub Stream:	50Hz: 25fps (640 × 360, 352 × 288) 60Hz: 30fps (640 × 360, 352 × 240)
Third Stream:	50Hz: 25fps (1920 × 1080, 1280×720, 640 × 360, 352 × 288) 60Hz: 30fps (1920 × 1080, 1280×720, 640 × 360, 352 × 240)

Image Enhancement:	BLC/3D DNR
Image Settings:	Rotate Mode, Saturation, Brightness, Contrast, Sharpness adjustable by client software or web browser
Target Cropping:	Support
ROI:	Support 1 fixed region for each stream, and face dynamic tracking
Day/Night Switch:	Auto/Scheduled
Network	
Protocols:	TCP/IP, UDP, ICMP, HTTP, HTTPS, FTP, DHCP, DNS, DDNS, RTP, RTSP, RTCP, PPPoE, NTP, UPnP, SMTP, SNMP, IGMP, 802.1X, QoS, IPv6
General Function:	One-key reset, Anti-Flicker, heartbeat, mirror, password protection, privacy mask, Watermark, IP address filtering
System Compatibility:	ONVIF (Profile S, Profile G), PSIA, CGI, ISAPI
Interface	
Communication Interface:	1 RJ45 10M / 100M Ethernet interface
On-board storage:	Built-in Micro SD/SDHC/SDXC slot, up to 128 GB

10 MODE OF MEASUREMENT

The following measurement code shall apply to the Contract:

10.1 Power and Controls Cables / Wires

1. All power cables / controls cables shall be measured on linear basis in meters.

10.2 Cable Tray Work

a) The cable trays shall be measured on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross joints, etc, and paid for accordingly.

APPENDIX-XXVIII

11 LIST OF APPROVED MAKES FOR ELECTRICAL WORKS:

Make indicated in the under mentioned list of Approved Makes is for general guidance of contractor. Final choice of make & model out of List of Approved Makes shall be of Architect/ Consultant/Owner.

S.NO.	DESCRIPTION	MANUFACTURER'S NAME
1	AIR CIRCUIT BREAKER	ABB (E MAX) / L & T (U POWER) / SCHNEIDER (MASTERPACT MVS) / SIEMENS (3WT) / LEGRAND (DMX^3)
2	MCCB (MICROPROCESSOR)	ABB (Tmax) / L & T (D sine) / Schneider (Compact NXS / NS) / Siemens (3VL) / Legrand (DPX)
3	MCCB (THERMO-MAGNETIC)	ABB (TMAX) / L & T (D SINE) / SCHNEIDER (EASYPACT CVS / COMPACT) / SIEMENS (3VT / 3VL) / LEGRAND (DPX)
4	MPCB (MICROPROCESSOR)	ABB / L & T / SCHNEIDER / SIEMENS / LEGRAND
5	MCB / RCCB / RCBO	LEGRAND (LEXIC) / SCHNEIDER (ACTI 9) / HAGER / L&T / ABB
6	SWITCH DISCONNECTOR FUSE UNIT	L & T / SIEMENS / ABB / SCHNEIDER
7	SWITCH FUSE UNIT WITH HRC FUSES	L & T / SIEMENS / ABB / SCHNEIDER
8	CONTACTORS / RELAYS / TIMERS	L & T / SIEMENS / ABB / SCHNEIDER / LEGRAND
9	CAPACITOR	DUCATI / EPCOS / ABB / L&T / SCHNEIDER
10	AMMETERS / VOLTMETERS & METERING EQUIPMENTS	L & T / NEPTUNE / CONZERVE / ENERSOL / SECURE / ELMEASURE
11	SELECTOR SWITCHS	KAYCEE / SALZAR / L&T
12	CT / PT	KAPPA / AE / ECS / KALPA / L&T
13	INDICATING LAMP	L&T / VAISHNO / SIEMENS
14	APFC RELAY	L &T / DUCATI / SEIMENS / EPCOS / ABB / SCHNEIDER
15	BATTERIES	EXIDE / AMCO / STANDARD FOURKA / PRESTOIITE
16	BATTERY CHARGING PANEL	UPTRON / VOLSTAT ELECTRONICS / KELTRON / NELCO / VOLT STAT

17	PVC / XLPE INSULATED 11 KV CABLES	UNIVERSAL (SATNA) / CCI / NICCO / FINOLEX / POLYCAB / SKYTONE / RR KABLE
18	PVC / XLPE INSULATED 1.1 KV CABLES	UNIVERSAL (SATNA) / CCI / NICCO / FINOLEX / POLYCAB / SKYTONE / RR KABLE
19	DC MINIATURE CIRCUIT BREAKER	SCHNEIDER / SIEMENS / L&T / ABB
20	LUGS	DOWELLS / MULTI / CAPITAL / 3D / C.C.I. / 3 M / COMET / HEX
21	CABLE GLANDS	SIEMENS / COMET / GRIPPWEL / PEECO / POWER
22	Main L.T. PANEL / CAPACITOR PANEL / DISTRIBUTION PANEL / SYNC. PANEL	DYNAMIC / APPLICATION CONTROL / SHIVALIC / SUPERTECH CONTROL SYSTEM
23	BUS DUCT / RISING MAINS (SANDWITCH TYPE)	LEGRAND -ZUCCHINI / SCHNEIDER / L&T-HENIKWON / C&S / SIEMENS / GE / GODREJ
24	CABLE TRAY / RACEWAY	INDIANA / BHARTI / SLOTCO / PILCO / PROFAB / BEC / MEM
25	INDUSTRIAL OUTLET	LEGRAND (LEXIC) / SCHNEIDER (ACTI 9) / HAGER / L&T / ABB
26	FIRE EXTINGUISHERS	ZENITH / MINIMAX / NEWAGE
27	ENERGY ANALYSER (WITH RS 485 PORT)	SCHNEIDER / CONZERV / ENERSOL / ELMEASURE
28	DISTRIBUTION BOARDS	HAGER / LEGRAND / L & T / SCHNEIDER / C & S / POLYCAB
29	PVC INSULATED COPPER CONDUCTOR WIRES	FINOLEX / RR KABLE / POLYCAB / SKYTONE / KEI / HAVELLS / BONTON
30	CHANGE OVER SWITCHS	L&T / ABB / SCHNEIDER
31	TELEPHONE TAG BLOCK	KRONE / TVS R&M
32	MS CONDUITS AND ACCESSORIES	B.E.C. / AKG / PPECISION / RERMCON
33	PVC FRLS CONDUITS AND ACCESSORIES	AKG / BEC / PPECISION / POLYCAB
34	PVC CONDUITS AND ACCESSORIES	AKG / BEC / PPECISION / ATUL / POLYCAB
35	SWITCHS & SOCKETS OUTLETS (MODULAR TYPE)	LEGRAND (MYRIUS) / CLIPSAL (C VIVACE / ZENCELO) / ABB (CLASSIC LUMINA) / WIPRO NORTH WEST

		(STYLUS) / MK (WRAPAROUND PLUS / SIEMENS (DELTA VEGA)
36	AVIIATION OBSTRUCTION LIGHT	BAJAJ / WIPRO / PHILIPS
37	CAT-5 / CAT-6 WIRE	AMP / SYSTEMAX / LUCENT / LEGRAND / POLYCAB
38	CAT-6A WIRE	AMP / SYSTEMAX / LUCENT / LEGRAND / POLYCAB
39	TELEPHONE WIRES AND CABLES	FINOLEX / RR KABLE / SKYTONE / POLYCAB / DELTON / HAVELLS
40	TELEVISION COXIAL CABLE	FINOLEX / RR KABLE / SKYTONE / POLYCAB / DELTON / HAVELLS
41	TELEPHONE / DATA OUTLET	LEGRAND / SCHNEIDER / SIEMENS / SYSTEMAX / LUCENT
42	DATA Rack	LEGRAND / APW / SIEMENS
43	LIGHT FIXTURE	REGANT / PHILIPS / AXL / TRILUX
44	LAMPS	OSRAM / PHILIPS
45	CEILING / WALL FAN	HAVELLS / CROMPTON GREAVES / USHA / BAJAJ
46	EXHAUST FAN	HAVELLS / CROMPTON GREAVES / USHA / BAJAJ
47	PA SYSTEM	Honneywell / Bosch / Asquare / Toa
48	FIRE ALARM SYSTEM	Notifier By Honeywell / Bosch / Edwards
49	PRESENCE DETECTOR	Hagger / Legrand / Philips / Wipro
50	CCTV CAMERA	HONEYWELL / TYCO / BOSCH / UNIVIEW
51	NVR / DVR	HONEYWELL / TYCO / BOSCH / UNIVIEW
52	LIGHTNING PROTECTION	ERICO / CAPE ELECTRIC / JMV / OBO
53	EARTHING	ERICO / CAPE ELECTRIC / JMV / OBO
54	RCC HUME PIPE	DAYA SPUN PIPE / J K SPUN PIPE / K K SPUN PIPE

55	UPS	NUMERIC / SOCOMEC / APC SCHNEIDER / AAL
56	STREET LIGHT POLE	BAJAJ / PHILIPS / SHAKTIV / LM INDIA / LOKOZO
57	DESK TOP	HP / DELL / IBM
58	MAGNETIC LOCK	CAPTURE / TRIMEC / ALGATEC
59	BOOM BARRIER	MAGNETIC CONTROL / BFT / DELTA SCIENTIFIC
60	AUTOMATIC TRANSFER SWITCH	ASCO / SOCOMEC / CUMMINS
61	SYNCHRONIZING RELAY	WOOD WORD / DIEF
62	PROFESSIONAL LED PANEL	PANASONIC / SHARP / NEC
63	PLC	SIEMENS / ALLEN BRADLEY / MITSUBISHI / ABB
64	DUAL MEETRING SYSTEM WITH SOFTWARES	SECURE / CRYSTAL
65	SERVO STABLIZER	MARVELL / TSI
66	D G SETS	OEM - Jakson Ltd (Cummins) / Sudhir / Jakson Bros / Sterling / TIL / Kohler {Engine - Cummins, MTU, Mitsubishi-Japan and Caterpillar (Full range), Volvo Penta / Kirlosker
67	D.G. SET (ALTERNATOR)	STAMFORD / LEROY SOMER / GREAVES / MARATHON
68	M.S. PIPE	TATA / JINDAL HISSAR / MSL / SAIL
69	BUTTERFLY VALVES	AUDCO / ADVANCE
70	Y - STRAINER	EMERALD / RAPID COOLED
71	FUEL METER	KENT / AQUA METRO
72	D.G. ACCOUSTIC ENCLOSURE	CUMMINS / STERLING / CATTER PILLER
73	EXHAUST SILENCER	RUSK POWER / NELSON / ACCOUSTIC INDIA

74	EXHAUST FLEXIBLE BELLOW	ALFA FLEXITUBE / KANWAL / PRECISE
75	EXHAUST PIPE INSULATION	LIOYD INSULATION / ROCKWOOL INDIA / UP TWIGA
76	ANCHOR FASTNER	FISHER / HILTI
77	GATE VALVE	SANT / LEADER
78	HEAT RESISTANCE PAINT	ICI / BERGER / NATIONAL
79	LEVEL CONTROLLER	VEKSLER
80	BULK OIL HSD TANK	ENGINEER SYNDICATE / STERLING GENERATOR/ VEEAIR FABRICATOR
81	M.S. ANGLE / CHANNEL	CAPITAL / CAPTAIN
82	OIL TRANSFER PUMP	ROTODEL
83	BALL VALVE	ZOLOTO / AUDCO
84	NON RETURN VALVE	ADVANCE / AUDCO / INTERVALVE
85	FOOT VALVE	GURCO
86	11 KV RMU PANEL	ABB / SCHNEIDER
87	11 KV AND 33 KV CIRCUIT BREAKER	ABB / SIEMENS / SCHNEIDER
88	11 KV AND 33 KV PANEL	ABB / SIEMENS / SCHNEIDER / TRICOLITE / AMBIT / ADLEC / ADVANCE / CONQUERENT
89	11 KV AND 33 KV ISOLATOR	PENTAGON / ABOND / PANICKER / ESHWARI
90	11 KV / 0.415 KV - COMPACT SUBSTATION	ABB / SCHNEIDER / RHINE / C & S
91	TRANSFORMERS	CROMPTON / KIRLOSKER / ABB / SCHNEIDER / VOLTAMP / SUDHIR INTRA / ESENNAR / KOTSONS
92	H.V. CABLE TERMINAL JOINTS	RAYCHEM / 3 M / M-SEAL / ISOTECH / DENSON
93	ALUMINIUM BUS BAR	ELECTROLYTIC GRADE - HINDALCO / CENTURY / JINDAL

94	COPPER BUS BARS	ELECTROLYTIC GRADE - RACHNA METAL / LIBU METAL
95	11 KV ISOLATOR AND D O FUSES	AMEI / ELPRO / STERLING
96	FIRE SEALANT	BIRLA 3M / HILTI / NU GREEN
97	ANY OTHER ITEMS	ON APPROVAL OF CONSULTANT OR ENGG IN CHARGE

12 EXCLUDED ITEM FROM THE SCOPE OF ELECTRICAL CONTRACTOR

a) Housing of equipments.

b) Foundations of all equipments, supporting structure etc.

c) Any kind of masonry work such as making of masonry trench, opening in wall / slab etc.

d) Power and water for erection, testing and commissioning of the Electrical System.

e) Any deposit to government.

END OF APPENDIX-XXVIII

PROJECT: PROPOSED TRAINING CENTRE CUM HOLIDAY HOME AT BRITONIA PROVORIM, GOA

TECHNICAL SPECIFICATIONS
HVAC SERVICES

Contents

APPENDIX-XXIX

END OF CONTENTS

TECHNICAL SPECIFICATION OF EQUIPMENT

SCOPE

The scope of this Section comprises the supply, erection testing and commissioning of the air-conditioning system confirming to these specifications and in accordance with the requirements given in Schedule of Equipments.

1.1 VARIABLE REFRIGERANT FLOW SYSTEM

General

- The scope of this section comprises the design, supply erection, testing and commissioning of Inverter Scroll technology / Digital Vapor Injection based VRF type system of air conditioning conforming to these specification/ Explanatory Note and in accordance with the requirements of Drawing and Schedule of Quantities. The prices quoted shall include all the equipment ancillary material as specified and all such items whatsoever and which may be required to fulfill the intent and purpose as laid down in the specification and the approved drawings. The contractor shall calculate equipment capacity based upon design parameters specified for the system design & verify all the quantities and sizes of refrigerant pipe, fitting, cables, control cable, pipes, insulation, indoor units, and outdoor units etc. before installation to avoid any shortfall or surplus. The tenderer shall also include all necessary civil work MS frame work for installation of outdoor and indoor units in VRF based air condition system. The cost quoted by tendered shall also include the refrigerant gas R-410A & its charging for proper & specified functioning of air conditioning system and discharge cowl.

- The scope in the tender schedule also covers detailed designing of complete air-conditioning system Inverter Scroll technology / Digital Vapor Injection based VRF air conditioner with air cooled outdoor units system capable of cooling and heating (reverse cycle) as per individual or season requirement suitable for operation on 415 V, 3 Phase, 50 Hz AC electric supply.

- The outdoor units shall have both cooling & heat pump mode, consisting of one / multiple compressor. It should have single circuit of refrigerant piping and multiple in door units of various types. Each indoor unit should have capability to cool or heat as per seasonal weather changes and as per Bill of Quantity.

- The tendered shall quote only makes for which he has satisfactorily executed the job and shall also furnish certificate to the effect that the such equipment has performed satisfactorily under Indian weather conditions at least for a period of one year from its commissioning. The performance certificate from the end user shall also be enclosed with the tender documents.

- The firm should comply with the parameters as specified in the terms & conditions.

- The project of air-conditioning is required to be executed in time bound and professional manner. The equipments involved in air-conditioning are complex in nature comprising of instrumentation, control and central management system. The job, therefore calls for highest order of technical expertise and also requirement of experience of air-

conditioning installation with proven performance. This consent shall also covers aspects of desired assistance in the field of design, development, testing, execution, completion & maintenance/ maintenance spares of the air-conditioning system.

- Notwithstanding the technical details as specified in the tender, the manufacturers may offer/ indicate systems and necessary design & features applicable for the offered products at the tendering stage.

1.2 OUTDOOR UNIT

i. The outdoor unit shall be factory assembled, weather proof casing (Material of construction of casing shall be vendor's standard design), constructed from heavy gauge GI sheets steel panels and coated with baked enamel finish. The outdoor unit shall be completely factory wired, tested with all necessary controls, acoustic jackets for compressors, hydrophilic & anticorrosive coating on condenser fins & filled with first charge of refrigerant before delivering at site The Unit should have a minimum of 3.8 COP at AHRI Condition with 100% load (The same shall be after accounting inverter loss, switching loss and oil return loss). All the vendors shall provide an O.E.M letter from the manufacturer for the C.O.P mentioning the COP is after the losses mentioned above. The Outdoor unit shall be capable of operating at an ambient temperature of 48 Deg C & each bidder should provide a copy of the rating chart as appearing in the technical data book of the OEM, clearly showing the operating performance at 43 Deg C ambient temperatures.
   Cowl arrangement for directing the air in case of top discharge unit shall be a part of outdoor unit..

ii. The VRF equipment should be capable so that refrigerant piping between indoor units and outdoor unit shall be capable of proving 1000 m total piping length and longest equivalent piping length as 200m.

iii. The outdoor unit shall be factory tested and filled with first charge of refrigerant R-410A before delivering at site.

iv. It should also be provided with duty cycling for variable compressors delivering the capacity / power consumption from 10-100% to follow variation in cooling & heating loads & switching starting sequence for better stability and prolonging equipment life.

v. The unit shall be provided with its own microprocessor control panel with provision for integration with the building management system for Air-conditioning system.

vi. The machine must have a sub cool feature to use coil surface more effectively through proper circuit/ bridge so that it prevents the flushing of refrigerant from long piping due to this effect thereby achieving energy savings.

vii. The outdoor unit should be fitted with low noise level and should not be more than 60db (A) at normal operation when measured horizontally 1m away and 1.5m above ground.

viii. The outdoor unit should be fitted with low noise aero spiral design fan with aero fitting grill for spiral discharge airflow to reduce pressure loss and should be fixed with DC fan motor for better efficiency.

ix. In case of trouble occurs in an indoor units (s), the continuous operation of system should be possible.

x. The unit shall be designed in such as way that cleaning of drain Pan should be easy & inspection/ replacement of compressor should be easy.

xi. The condensing unit shall be designed to operate safely whey connected to multiple fan coil units.

Specification- Home Automation Interface with Air-Conditioning Unit

- All OEM/Vendor/SI should provide all API to interface with smart home controller. This could means providing detailed message formats over the physical link (RS-485/Serial RS232/Ethernet) in terms of bits. Also, the various messages and commands with full parameters, syntax and documents needs to be provided.
- All available control and monitoring parameters should be shared with client to interface with Smart Home Automation system.
- In case of any issue regarding the interface with smart home automation system then OEM should take responsibility to support in term of customization of the APIs to integrate with smart home automation system.
- Vendor also supports in case of any revision of the product or software driver for interfacing without any cost escalation within product warranty period.
- Vendor should supply the product compatible with industry standard open communication protocol.
- Scope of the controls/home control or open protocol (herein after referred the work in this specification) means design, procurement, execution and the completion of smart home control for Air Conditioning.
- The product should have output RS-485/Serial RS-232/Ethernet
- The system should be complete in all respect in term of supply, installation, testing and commissioning of the all necessary hardware and associated software.

1.1.1 Compressor

i. The highly efficient hermetic Inverter Scroll technology / Digital Vapor Injection

based compressor shall be highly efficient. The system should response efficiently in accordance to the variation in cooling or heating load requirement.

II. 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.

1.1.2 Oil Recovery system

Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigeration piping lengths.

The system must be provided with oil balancing circuit to avoid poor lubrication.

1.1.3 Refrigerant Circuit

The refrigerant circuit shall include liquid and 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 safe operation of the system.

1.1.4 Heat Exchange

The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminum fins to form a cross fin coil. The aluminum fins shall be covered by anti-corrosion resin / hydrophilic film.

The System must have sub-cooling heat exchanger further to Condenser to increase refrigerating effect in Indoor units. The Condenser fins must be coated with Anti- corrosive treatment.

The condensing unit fan motors to have at least two speed operations to maintain constant head pressure control at all ambient temperatures and modes of operation.

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.

1.1.5 Safety Devices

All necessary safety devices shall be provided to ensure safe operation of the system.
Following safety devices shall be part of outdoor unit: - high pressure switch, fuse, fan drive overload protector, fusible plug, crankcase heater, over load relay, overload protection for inverter.

1.2. INDOOR UNITS

All indoor units as specified shall have; in general, noise levels should be low. For critical applications noise levels below these limits may, however, be specified during design stage.

- Each unit shall have electronic control valve to control refrigerant flow rate respond to load variation of the room.

- The address of the indoor unit shall be set automatically in case of individual and group control.

- In case of centralized control system, it shall be possible to set the address of individual indoor unit through a 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 support from housing.

- Indoor unit shall have cleanable type filter fixed to an integrally moulded/ moulded plastic frame. The filter shall be slide in and neatly insertable type. It shall be possible to clean the filters either with compressed air or water. Resin net (Washable) MERV Rating 6 / 80% down to 20% Micron.

- Each unit shall have Electronic control expansion valve for variable refrigerant Flow Effect.

- Each indoor high wall unit shall be with cordless remote controller as standard features. The remote controller shall memorize the latest malfunction code for easy maintenance. The controller shall have self diagnostic features for each and quick maintenance and service. The controller shall be able to change fan speed and angle of swing flap (for high wall) individually as per requirement.
- The address of the indoor unit shall be set automatically in case of individual and group control. In case of centralized control, liquid crystal remote controller shall set it.
- Cooling Coil Shall is direct expansion, constructed from copper tubes expanded into aluminum fins to form a rigid mechanical bond.

High Wall Indoor Type Unit

The unit shall be high wall mounted type. The unit shall include pre-filters, fan section and DX-coil section. The housing of the unit shall be powder coated/ heat treated 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. Unit shall have an external attractive panel for supply and return air.

Ceiling Mounted Duct Type Unit

Ceiling Mounted Duct Type Unit Shall is direct driven of the DIDW multi-blade type, statically and dynamically balanced to ensure low noise and vibration free operation. The noise level shall not exceed 42 dbA for non ductable type unit & shall not exceed 49 dbA for ductable type unit. Each unit shall have an individual corded remote controller for local control of the indor unit.

1.3 Electronic Expansion Valve

Each indoor unit shall be fitted with an electronic expansion valve to control the refrigerant flow in response to the load variations in the room. The electronic expansion valve is to be controlled via a computerized control sensing the return air temperature, refrigerant inlet and outlet temperatures.
During the cooling operation the electronic expansion valve shall control the refrigerant

superheat degree at the evaporator.

1.4 Y-Joint/Ref net séparation

Supply & installation of the Y-Joint/ Ref-net separation refrigeration pipe joints and headers in the appropriate orientation to enable correct distribution of refrigerant. The Distribution Joints should be factory insulated with pre-formed sections of Expanded Polystyrene/Equivalent.

1.5 Centralized system touch screen remote controller (As applicable)

- A multifunctional compact Touch Screen centralized controller shall be provided with the system.
- The System Controller shall act as an advanced air conditioning management system to give complete control of VRV / VRF air conditioning equipment. It shall have ease of use for the user
- It shall be able to control up to 256 64 (128 units) groups of indoor units with the following functions :-
    a. Starting/stopping of Air conditioners as a zone or group or individual unit.
    b. Temperature setting for each indoor unit or zone.
    c. Switching between temperature control modes, switching of fan speed and direction of
    d. Airflow, enabling/disabling of individual remote controller operation.
- Monitoring of operation status such as operation mode & temperature setting of individual indoor units, maintenance information, trouble-shooting information.
- The controller shall have wide screen user friendly color LCD Touch screen display and can be wired by a non-polar 2 wire transmission cable to a distance of 1 km away from indoor unit.
- Scheduling of both indoor and outdoor units as per requirements.

1.6 Cabling bewteen indoor and outdoor units

- The cable between indoor and outdoor units shall run in suitable containments or cable tray.

1.7 REFRIGERANT COPPER PIPING:

1.7.1 **Refrigerant Piping**

- Scope of Refrigerant Piping work shall include Supply, installation, testing and commissioning of all interconnecting pipe-work between the condensing unit & indoor units. Refrigerant quality seamless copper tubes with brazed connections and the appropriate Distribution joints and headers shall be used.
- The piping should be routed at site in such a manner, that brazed joints in the Refrigeration Piping are kept to a minimum.
- All interconnecting piping, joints and U bends within the condensing unit shall be painted with two coats of clear transparent coating of suitable material for protection against corrosion from ambient air pollution.

- Each coat shall have dry film thickness of 35 micron or more. The coating shall be strong, flexible and durable. It shall have good adhesive and abrasion resistance.
- It shall be resistant to moisture, UV, acid alkali and other chemicals and capable of functioning between -250º C upto 1500º C
- The polymer shall be obtained by the mixing of base / monomer with a hardener / polymerisor. It may be brush applied or with the use of a suitable gun.
- Refrigerant piping for the air-conditioning system shall be upto 19.1 mm dia of soft seamless copper tubes & for above 19.1 mm dia the pipe material shall be of hard seamless copper tubes with pipes material being hard drawn copper pipe.
- Forged copper fittings shall be used for the refrigerant piping.
- The refrigerant piping arrangements shall be in accordance with good engineering practices as applicable to the air-conditioning industry, and shall include charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits except Y joint/separation tubes.

1.7.2 Joint Orientation

- Proprietary Distribution refrigeration pipe joints and headers shall be installed in an appropriate orientation to enable correct distribution of refrigerant. The Distribution joints shall be factory insulated with pre-formed sections of expanded Polystyrene/ equivalent.

1.7.3 Cleanliness of Piping

- All pipe-work must be kept clean and free from contamination to prevent breakdown of the system. All pipe ends shall be kept sealed until immediately prior to make a joint.
- Before jointing any copper pipe or fittings, its internals 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 gas.

1.7.4 Pressure Testing

- After complete installation of refrigerant piping, it shall be pre-pressure tested and repaired if necessary and further pressure tested to 3,800 Pa, to hold for a minimum 48 hours with dry nitrogen prior to insulating the joints. After satisfactory testing, the refrigerant pipe shall be evacuated and dehydrated to (- 755 MM HG) and held for 12 hours.

1.7.5 Refrigerant Charge

- Refrigerant charge must be calculated based on the actual length of the refrigerant pipe work. The refrigerant charging process must be carried out with an appropriate charging station and under supervision of Consultancy.

1.7.6 Piping Insulation

- All suction & liquid lines of the Refrigerant pipe work shall be insulated with closed cell expanded polythene tubular insulation pipe sections as specified to avoid condensation. Moulded Tee joints of thermal insulating material shall be used at bends.
- Closed cell expanded polythene tubular fire retardant pipe insulation having a wall thickness of not less than 13 mm for soft pipe / 19mm for hard pipe.
- The thermal conductivity of the insulation material shall not exceed 0.032 W/m K at 0 deg C. mean temperature. The density of the insulation material shall not be less than 33+/- Kg/

cum.

- All joints of the insulation shall be sealed with 100 mm width x 3 mm thick self-adhesive tapes of the same material as insulation and shall be of the same make as the basis insulation material
- To protect nitrile rubber insulation of exposed copper piping from degrading due to ultra violet rays & atmospheric condition, it shall be covered polished coating with at least two coats of resin and hardener above nitrile rubber insulation. Fiber glass tape shall be helically wound & coated with painted two coats of resin with hardener to give smooth & plain finish.

1.7.7 Fixing Pipe Work& Electrical Conduit:

- The insulated refrigerant piping and electrical conduit shall run on GI tray properly supported by GI rods. The exposed tray on terrace shall be covered by open able GI covers.
- Refrigerant copper piping shall be as per ASTM : B280. OD & wall thickness of copper refrigerant piping shall be as follows:

Size	Thickness	Specification
6.35mm (1/4 in)	0.8 mm	C12200T-O (ANNEALED)
9.52mm (3/8 in)	0.8 mm	C12200T-O (ANNEALED)
12.70mm (1/2 in)	0.8 mm	C12200T-O (ANNEALED)
15.88mm (5/8 in)	0.99 mm	C12200T-O (ANNEALED)
19.05mm (3/4 in)	0.8 mm	C12200T-1/2 H (HALF-HARD)
22.23mm (7/8 in)	.8 mm	C12200T-1/2 H (HALF-HARD)
28.58mm (1 1/8 in)	.99 mm	C12200T-1/2 H (HALF-HARD)
31.75mm (1 1/4 in)	1.1mm	C12200T-1/2 H (HALF-HARD)
34.9mm (1 3/8 in)	1.21 mm	C12200T-1/2 H (HALF-HARD)
41.3mm (1 5/8 in)	1.43 mm	C12200T-1/2 H (HALF-HARD)

1.8 DRAIN PIPING:

- The indoor units shall be connected to drain of UPVC pipe.
- The pipes shall be laid in proper slope for efficient drainage of condensate water. U trap shall be provided in the dain piping(wherever required)
- Drain Pipe Insulation
  a) Drain pipes carrying condensate water shall be insulated with 6 mm Nitrile rubber having a ‗K' value of 0.037 W/mk at a mean temperature of 20°C and a minimum density of 55 Kg/ Sqm.
  b) The joints shall be properly sealed with synthetic glue to ensure proper bonding of the ends.

1.9 Installation

The VRV type air conditioning units shall be mounted on vibration isolators and installed in accordance with the manufacturer's recommendation such that no disturbing vibration or

noise is being transmitted to the nearby structure.
Refrigerant pipes that exposed to outdoor shall be covered with UV coating to protect insulation from direct UV exposure.
All galvanized support beams, galvanized legs, galvanized hangers, anchor bolts, vibration isolators, ductworks shall be provided for the installation of the units.

1.10 Testing

The units shall be tested for capacity and COP as per ARI-1230 conditions at manufactures premises as well as at site before delivery by the consultant in presence of the Owners / their representative; they reserve the right to witness the tests.

1.11 TECHNICAL DATA SHEET OF VARIABLE REFRIGERANT VOLUME AIR COOLED UNITS

It is mandatory to fill given below data sheet at the time of tender quoting and at the time of proposal.

Outdoor Unit

Outdoor Units Make and Model

a) Type (Cooling or heat pump)
b) Dimension of unit (Overall)
c) Actual capacity (TR) at specified conditions
d) Permissible length of refrigerant piping
e) Type of compressor
f) No. of compressor (each unit)
g) No. of digital compressor Electrical characteristics
h) Power consumption at ARI conditions for each capacity 100%
   75%
   50%
   25%

Indoor Unit

a) Manufacturer Type
b) Nominal capacity (TR)
c) Airflow Min/Max (CFM) Sound level (Hi/Lo)
d) Overall dimensions (L x W x H)
e) Unit weight (Kg)
f) Remote controller for each indoor unit (Yes/No)

Centralized Controller

a) No. of controllers
b) Features
c) Power consumption
d) Technical brochures to be attached.

END OF VRV SPECIFICATION

2.1 SPLIT TYPE AIR CONDITIONERS UNITS:

The contractor shall supply and install split system air conditioner with 5 star rating wherever indicated. The system shall be complete in all respects and comply with the specifications as given. All split units shall be eco friendly type.

Air cooled split unit shall be provided with High energy efficient (EER) hermetically sealed Invertor scroll compressor complete with vibration isolators & factory installed controls like single phase prevent or HP, LP & overload cutouts, inter locking of fan & compressor, thermostat with selector switch, wiring etc. Efficient cooling coil shall be selected for low velocity with maximum 3/8" OD copper tubing having extended aluminum fins with rigid bonding between tubes & fins for high heat transfer. Tubes shall be arranged in a staggered design for best air contact thus giving low bypass. The cooling coil circuits shall be fed with liquid refrigerant through the expansion valve and a distributor. Blower of an evaporating unit shall be statically and dynamically balanced and shall be selected to give required airflow as identified in the drawings. Filters shall be synthetic type of Nylon mesh with plastic/metal frame. Drain pan shall be of SS/powder coated MS duly insulated. Casing shall be heavy gauge factory painted to provide better protection against rusting.

2.2 Condensing Units

Remote air cooled condensing unit shall be provided with efficient condenser coils made out of copper tubing with extended aluminum fins. Tubes shall be arranged in a staggered design for better efficiency. Condenser fans shall be selected to operate quietly for required CFM to keep condensing temperature low. The compressor shall be in the outdoor unit capable of operating continuously even at high ambient of 46 deg C (115 deg F). The condensing unit shall be installed with M.S. base frame, along with cushy foot mounting vibration isolation pads, bolted and clamped to terrace or wall. The compressor for 1.5 & 2 TR units shall be hermetically sealed Rotary/Reciprocating type.

Interconnected refrigerant piping between outdoor unit & indoor unit shall be of heavy gauge copper complete with expansion valve, liquid line strainer, drier, shut off valves, including insulated suction line. Expansion valve or termination of capillary tube shall be provided within indoor unit. 25mm thick neoprene rubber pads shall be supplied for each indoor/outdoor units. The units shall be tested in accordance with IS:1391. The power supply shall be provided at outdoor/indoor unit as per manufacturer's requirement.

2.3 REFRIGERANT PIPING:

2.3.1 All refrigerant pipes and fittings shall be type `L' hard drawn copper tubes for large units & soft copper tubes for low capacity units with wrought copper fitting suitable for connection with silver brazing or as per Manufacturers recommendations.

2.3.2 All joints in copper piping shall be sweat joints using low temperature brazing. Before jointing any copper pipe or fittings, its interior shall be thoroughly cleaned be passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while construction the joints. Subsequently, it shall be thoroughly blown out using carbon dioxide/nitrogen.

2.3.3 Refrigerant lines shall be sized to limit pressure drop between evaporator and condensing unit to less than 0.2 kg per Sqcm.

2.3.4 Removable type combination drier and filter shall be installed in liquid line of the refrigeration system incorporating a three way valve bypass. After ninety days of

commissioning, liquid line drier and filter cartridges must be replaced by contractor at actual cost to be borne by owner.

2.3.5 After the refrigerant piping installation has been completed the refrigerant piping system shall be pressure tested using, Freon mixed with nitrogen at a pressure of 20 Kg per Sq. cm.

(High side) and 10 Kg per Sq. cm (Low side) pressure shall be maintained on the system for a minimum of 12 hours. The system shall then be evacuated to a minimum vacuum of 70 cm. of mercury and held for 24 hours, during which time, change in vacuum shall not exceed 12 cm of mercury. Vacuum shall be checked with vacuum gage.

2.3.6 All refrigerant piping shall be installed strictly as per the instructions and recommendations of air conditioning equipment manufacturers. Oil traps shall be provided where required.

2.3.7 All the refrigerant tube shall be thoroughly tested and checked for leaks, washed with carbon tetra chloride once, followed by two flushing with nitrogen and one flushing with refrigerant. All safety controls shall be suitably set and a record of all setting shall be furnished to the Engineer in charge.

2.3.8 All copper tubes shall be coated with transparent anti corrosive primer before insulation.

2.3.9 The suction and liquid line shall be insulated with 13 mm thick expanded polyethylene/ Nitrile rubber insulation and the discharge/gas line shall be insulated with 19mm thick insulation.

2.3.10 Necessary chases and holes in walls and floor etc for laying the piping work shall be done by contractor, after completion of work necessary repair work shall be done by contractor and brought to its original finish

2.4 PAINTING:

Shop coats of paint that have become marred during transportation or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with two coats of enamel paint to match the finish over the adjoining shop- painted surfaces.

2.6 MISCELLANEOUS:

- The unit shall have control panel, housing the starting switches, contactor, relays etc. Isolation pads shall be provided under the units.
- Insulated drain line shall be provided from indoor unit upto drain trap. (to be priced separately).
- Suitable M.S. channel supporting frame shall be provided for the condensing unit and supporting arrangement for the indoor units.
- Interconnecting power and control cabling shall be provided between condensing unit and evaporator unit.
- PVC flexible sleeves shall be provided to cover the insulated refrigerant piping and electrical cabling from indoor to outdoor units.
- Compressor current should not flow through indoor unit.

- Inbuilt protection in indoor unit against electric fault to be provided.

2.2 INSTALLATION:

The Indoor Units shall be Ceiling/Wall/Floor Mounted on suitable vibration isolators & frame work. The indoor units shall be mounted on ribbed rubber pads for vibration isolation. The outdoor unit shall be installed with a steel base frame along with cushy foot mounting vibration isolation pads. The refrigerant pipes & interconnecting cables & wires shall be neatly & firmly installed on 25 mm wide brackets fixed to masonry. Care shall be taken to avoid possibility of damage to cable/wires insulation due to hot refrigerant pipes. The contractor shall supply the required charge of refrigerant, lubricant and other consumables, for commissioning and testing of the equipment.

2.3 TESTING & COMMISSIONING:

After installations are completed, all air-conditioning system shall undergo test run.
Unit capacity in tons refrigeration shall be computed from the temperature readings and air-flow measurements. Flow measurements shall be preferably by a hot-wire anemometer or a velometer. Computed results shall conform to the specified capacities and the power consumption shall conform to the figures furnished by the manufacturer.
Any adjustments that are needed shall be made to assure that all air-conditioning system will operate either the required performance. Report forms to contain following minimum data listings shall include design and actual conditions for each Item mentioned below:

a) Date and time of test.
b) Air-conditioning unit make, type, name and serial number.
c) Fan rpm.
d) Fan motor amperage
e) Rated motor amperage, starter number and ampere rating.
f) Fan CFM
g) Fresh air CFM in case of ductable units
h) Outside conditions (DB and WB)
i) Entering coil conditions (mixing) (DB and WB)
j) Leaving coil conditions (DB and WB)

END OF SPLIT UNIT SPECIFICATION

3.0 VENTILATION FANS

3.1 Scope of Work

The specification for supplies & exhaust air blowers for mechanical ventilation covers the design requirement, constructional feature, supply, installation, testing & commissioning.

- This Section specifies the manufacture and installation of all ventilation fans as shown on Drawings.
- The fan external total pressure resistance figures specified on the Equipment Schedules and/or Drawings is for guidance and information only and are calculated based on assumed resistance figures of equipment. The exact fan total pressure based on the duct run and the offered equipment shall be carefully checked and re-calculated for each fan before ordering the equipment. Calculation shall be submitted for Approval. No modification to the ductwork system shall be allowed without prior Approval. Any additional cost for the modification of the system (fans, motors, switchgears, cables, panel boards, switchboards, etc.) necessary to meet the specified duties, spatial conditions and the offered equipment shall be provided at no extra cost to the Employer.
- Allowance shall be made for the effects on fan performance of all installation conditions including coils, eliminators, sound attenuator, plenums, enclosures, inlet and discharge arrangements so that actual installed fan performance equals that specified.
- Proprietary bell mouth and wire guard shall be provided for fans without ductwork connection. Bell mouth is not required for propeller fans.

3.2 QUALITY CONTROL

a. Reference Codes and Standards
   i. AMCA Standard 210: Laboratory Methods of Testing Fans for Rating
   ii. BS 848: Fans for General Purposes
   iii. IS / IS / IEC 60034 for design, performance and efficiency of motors
   iv. ISO 5801: Industrial Fans – Performance Testing using Standardized Airways
b. Codes and regulations of the jurisdictional authorities.
c. All fans, drives and accessories shall be designed, constructed, rated and tested in accordance with the recommendations and standards of AMCA / ISO.
d. Fan tests shall conform to the requirements of AMCA Standard 210 or ISO 5801 or to an Approved equal standard.
e. Sound ratings shall conform to AMCA standard test code for sound rating of air moving devices or BS 848: Part 2.

3.2 Type

The blower shall be of Tube Axial Flow fans / Centrifugal Fans / Inline fans / Propeller Fans with or without ducting system & shall be of floor mounted / ceiling hung type.

3.3 Capacity

The capacity of Tube Axial Flow fans / Centrifugal Fans / Inline fans / Propeller Fans, diameter, maximum motor H.P & static pressure etc. shall be according to schedule of quantities.

3.4 Technical and installation requirements

A. Fans shall have non-overloading characteristic, except for forward curved centrifugal, over their entire operating range. The characteristic curves shall be such that the fan operating point falls between the no flow static pressure and the maximum mechanical efficiency. The fan characteristic shall also be such that for a 15 % increase in total pressure over the specified value, the fan shall deliver not less than 85 % of the specified air volume flow rate. The stability of fan operation shall not be affected under such situation.

B. All axial flow fans with nominal rating above 7.5 kW shall have a minimum efficiency of 70%. The manufacturer‘s best efficient fans shall be selected through manufacturer‘ software by engineer in charge during approval.

C. Each fan unit including motor and drive shall be supplied from the manufacturer as a completely factory-assembled package and all guarantees and test certificates shall be deemed to apply to the entire assembly.

D. All fans shall be capable of withstanding the pressures and stresses developed during continuous operation at the selected duty. Additionally, all belt driven fans shall be capable of running continuously at 15% in excess of the selected fan Capacity.

E. Lifting eye/Flanges shall be provided on all centrifugal and axial fans.

F. All fans shall be statically and dynamically balanced.

G. All centrifugal fan shafts shall have the ends drilled to receive a tachometer.

H. Motor speed shall not exceed 1495 rpm unless otherwise specified.

I. Nominal motor nameplate rating shall be higher than the peak operating power of the selected fan curve for non-overloading characteristic. The motor rating shall be a minimum of 15% higher than the motor operating point at design conditions unless otherwise specified.

J. All fans and motors offered shall be of minimum vibration and noise level during operation. Should the vibration and noise level be excessive and not within acceptable standards, additional vibration isolation and sound attenuation shall be provided at no extra cost to the Employer to the satisfaction of the Engineer.

K. All fans are required to be hot dip galvanized.

3.5 Axial Flow (Vane/Tube Axial) Fans

The Exhaust/Supply air blower shall be Direct Driven Areo-foil shaped Vane/Tube Axial Flow fans connected to the duct & shall be of floor / ceiling / wall mounted type as specified in the Bill of Quantities. The capacity of Vane/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 78 dba at a distance of 3.0 meter from the fan.

FAN CASING:

The cylindrical casing should be made from welded carbon steel sheet. The inlet & outlet of the casing shall be fitted with matching flanges for ductwork connection & other accessories as required. The surface finish shall be epoxy coated.

- Inspection doors or sight ports to enable direction of rotation to be established and shall be provided on the cones.
- Terminal boxes welded to the casing shall be provided for electrical connection using metallic flexible conduits to fan motor complying with BS 4999: Part 20 for dust and weatherproof conditions.
- Grease nipples if required, shall be brought to the outside of the casing in the most accessible position and fitted with lubrication tube made of copper or other Approved material.
- Gasketed access doors shall be provided in each fan housing or connecting ductwork, suitable for access to adjust or replace blades. For smoke extraction fans, the gaskets shall be suitable for continuous operation in an air stream temperature of 250 °C for not less than two hours.

IMPELLER:

The blade of axial flow fan shall be made of die cast aluminium alloy. The blade angle shall be set at manufacturing place & shall also have facility to modify latter. 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 impeller assembly shall be fixed on the shaft by means of a double cone type expansion bush. The design shall facilitate the alteration of blade angle without disconnecting the hub from the motor shaft.

- For hub size of 315mm (dia.) and above, blades shall be manual adjustable without removing the wheel.
- Positive locking shall be provided for securing the impeller blades into the hub. Spun aluminium hub caps shall be fitted.
- The blades shall be counter-balanced and mounted on a thrust bearing for vertically installed fans.

MOTOR:

The fan shall be directly driven by TEFC sq. cage induction motor. The fan motors shall be 415±10% volts 50HZ ± 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. After assembling the impeller shall be statically & dynamically balanced. Fan RPM shall be 960 for normal working & 1450 RPM for working in case of fire.

The mounting ring shall be of CRCA / sheet steel with brackets to connect the frame, with the Fan / Motor assembly. Rubber mounts shall be provided between the mounting frame and the mounting brackets.

MISCELLANEOUS:

- Smoke Extraction fans have driven motors shall be of class H insulation. Except smoke extraction fans and unless otherwise specified, drive motors shall be of class F insulation (BS 4999 and BS 2757) totally enclosed type and rated for continuous operation in ambient temperature of 50 °C. Performance and rating shall comply with BS 5000 and IEC 34- 1 with protection to IP55. All motors shall be of efficiency class IE-2.
- Factory bell mouth shall be provided where no duct connection is required. Fans shall be fitted with bell mouth inlets. Flow cores and bell mouth inlets shall be fabricated in steel and provided with flanges drilled and rigidly bolted to the fans.
- Provide wire guards on fan outlet/inlet not connected to ductwork and shall be made freely accessible for maintenance.
- Fans shall be provided with mounting feet and spring isolators.
- The bearing life of the fan motor assembly shall be of 40,000 hours (L-10 life).
- Stationary, curved guide vanes shall be located on the outlet side of the fan to straighten the motion of the air leaving the blades to improve operating efficiency if required.
- For smoke extraction fan, adequate clearance shall be provided between blade tips and housing at all points to allow for expansion and contraction over a continuous operation in an air stream temperature range from 0°C to 250 °C without developing interference to the specified flow capacity.

  The fabrication/shop drawings shall show the clearance at over a continuous operation in an air stream temperature range from 0 °C to 250 °C as well as any point of minimum clearance in between. The motors in case of smoke extraction fans shall be fire rated for 250°C, 2 hours.

3.6 Centrifugal Fans

The Centrifugal blowers shall be forward/backward curved double / single inlet, double / single width, 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).

FAN CASING:

Fan casing shall be of sheet steel construction adequately stiffened and braced and shall be entirely free from vibration or drumming during normal operation. The steel required to be galvanised / hot dip galvanised.

The blower housing comprising of scroll & side plates shall be accurately cut of heavy gauge all welded sectional 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 angle iron in bolted / welded construction.

All fans with an inlet eye diameter exceeding 300mm shall have a bolted access door on the scroll for access purposes. The size of access panels shall be such as to facilitate cleaning and maintenance of the impeller.

Drain sockets or holes with drain pipe brought out to an accessible point, valved and plugged, shall be provided.

Fan casings shall be fitted with flanges on the outlet connection suitable for connection of discharge ductwork and flexible connections as shown on the Drawings.

Where the inlet side of the fan is connected to ductwork, matching flanges for connection of flexible connections shall be provided

Inspection doors or sight ports to enable direction of rotation to be established shall be provided

IMPELLER:

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 hot rolled steel or forged steel, sized adequately, but in no case or less 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. After assembly, the complete fan shall be painted with rust proof and two coats of synthetic enamel paint. Fan having wheel diameter of 1220 mm or more, shall be supplied with split, bolted housing for convenience of handling and installation.

- Impellers shall be double inlet, double width or single inlet, single width as shown on the Equipment Schedule and/or Drawings and shall be mounted on substantial hubs.
- Fan impellers shall be backward/forward sloping blades as specified on the

Equipment Schedule and/or Drawings.

- Impellers shall be rigidly fixed to solid bright steel shafts adequately sized and proportioned to ensure that the maximum operating speed is not more than 60% of the first critical speed. The shaft shall be protected by reliable anti-rust coating.
- Impellers shall be of steel, electro-galvanized after fabrication (or aluminium where indicated), of riveted or welded construction, with spiders or hubs, of robust design and shall be capable of running continuously at 15% in excess of normal speed.
- All forward curved fans shall be selected for use with speed not exceeding 1200rpm and backward curved fans shall be selected not to exceed 2000rpm, unless otherwise specified.

MOTOR:

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±10% volts 50HZ ± 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.

Centrifugal fans consuming more than 7.5kW at the fan shaft shall be of the backward bladed type having a fan total efficiency not less than 80%. Centrifugal fans with shaft power exceeding 15kW shall be of the aerofoil backward curve type.

MISCELLANEOUS:

- Unless otherwise specified, drive motors to Class F insulation shall be totally enclosed and rated for continuous operation in an ambient temperature of 50°C. Performance and rating shall comply with IEC 60034. All motors shall be of efficiency class IE-2.
- The fan and motor shall be mounted on rigid galvanized steel channel base. Provide slide rails for adjustable mounting of motors.
- The driven V-belt shall be rated at 150% of the operating motor power input. Provide adjustable sheaves on the motor, capable of 20% adjustment in fan speed, with the design fan capacity settling at approximately the midpoint of the adjustment. Belt speed shall not exceed 25m/s.
- Type of V-belt shall be in accordance with the "Standards for Light-duty or Fractional-Horsepower V-Belts" of Rubber Manufacturers Association.
- Belt guards shall be of heavy gauge steel framing with expended mesh

screen.

- All belt guards shall have access openings at the shaft ends to enable tachometer readings to be taken.
- Vibration isolators shall be provided in accordance with "Acoustic Treatment and Vibration Control" sectionof this M&W Specification.
- The shafts shall be carried in ring lubricated self-aligning sleeve bearings for shafts of 150mm diameter and larger. Each bearing shall have large oil storage capacity to ensure efficient lubrication. On shafts of sizes smaller than 150mm diameter, grease lubricated self-aligning ball bearings resiliently mounted to reduce noise transmission shall be used.
- The shafts shall be extended beyond the drive-side bearing and keyed for overhung pulley in all cases.
- The bearing life of the fan motor assembly shall be of 40,000 hours (L-10 life).

3.7 SMOKE EXTRACTION AND PRESSURIZATION FANS

- In addition to the aforesaid requirements stipulated in this M&W Specification, all fans used for smoke extraction and pressurization shall comply with additional requirements specified in this Clause.
- Smoke extraction fans shall be rated to deliver the designed flow rate and pressure for continuous operation in an air stream temperature of 250° C for not less than 2 hour.
- All finishes shall be factory-applied and certified by the respective manufacturer that the finishing materials are capable of withstanding exposure continuously to an air stream temperature of 250 °C for not less than 2 hours without producing smoke or any toxic fumes.
- Motor winding of smoke extraction fans shall be insulated to permit motor operation at design conditions for continuous operation in an air stream temperature of 250 °C for not less than 2 hour. The smoke extraction fans shall be performance tested at factory for the performance and operating condition before delivery. Type test certificates shall be submitted to the Engineer for Approval.

3.8 Propeller Fan

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.

- The impeller shall be designed to give maximum volume with minimum noise level and minimum power consumption and shall be made of steel or aluminum alloy. The hub shall be steel with grey stove epoxy finish or aluminum alloy. The fan shall be complete with anti-vibration mount.

- The motor shall be dust and moisture protected to IP54 and of a totally enclosed construction with permanently lubricated ball bearings suitable for running in ambient temperatures of up to 50°C and relative humidity of up to 100%.
- Wire guards made of heavy gauge steel wire or rod with all joints and crossings welded and shall be fitted to impeller side or motor side or both where appropriate.
- Propeller fans shall be diaphragm mounted on not less than 3mm thick steel mounting plate with stove epoxy grey finishes.
- Provided with seal permanently lubricated bearings.
- With tip speed not exceeding 17.5m/s

3.9 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.

3.10 Installation

- All belts, pulleys, chains, gears, couplings, projecting set screws, keys and other rotating parts shall be adequately guarded so that any person can safely come in close proximity thereto.
- Fit fans and appurtenances to the space provided and make readily serviceable.
- Provide support beams, support legs, platforms, hangers and anchor bolts required for the proper installation of equipment as shown on the Drawings or as recommended by the manufacturer and Approved by the Engineer.
- Provide permanently attached lifting eyes of sufficient number for on Site installation and future dismounting of fan units.
- Provide factory inlet bells and other accessories for fan units as shown on the Drawings or otherwise required for a complete and efficient installation.
- Where corrosion can occur, appropriate corrosion resistance materials and installation methods shall be used including isolation of dissimilar

metals against galvanic interaction.

- Thoroughly clean the entire system before installing filters or operating the fans.
- For systems containing filters, install filters and permanently seal the filter frame air-tight before operating the fans. Replace all dirty filters and filter media before handing over the system to the Employer.
- Means of protection against overcurrent in the motor shall be incorporated in the control equipment when the motor rating exceeds 0.37 kW.
- A hole in the blanking off plate shall be provided for the cables leading to the fans. The hole shall be sealed around the cables with material suitable for sealing the hole effectively and continuously exposed to an air stream

temperature of 250 °C for not less than 2 hours rating if the fans are used for smoke extraction.

DATA SHEET FOR AXIAL FLOW FANS	
Type	Vane/Tube Axial (Long Casing Type)
Reference Code / Standard	AMCA 210, ISO5801, BS848
Capacity	As per BOQ
Flow	Unidirectional
Noise	78 dBA at 3.0 meter
Total Pressure	As per BOQ
FAN	
Blade	Aerofoil Construction, Dynamically Balanced
Material	Aluminum alloy
Bearings	Totally sealed type Ball Bearing
Hub	Cast Aluminium Alloy
Casing	Rolled Steel Sheet, Heavy Gauge
Shaft	Solid Steel
Mounting	Shaft Key And Positive Locking Device
Drive Arrangement	Direct Drive
Motor	
Type	TEFC, IE-2, Induction Motor, Continuous Duty
Design	As Per IEC 60034
Power Supply	Three Phase, 415 V, 50 Hz, AC Power Supply IP 55 Protected
Mounting Arrangement	Suitable Bracket For Ceiling Suspension

APPENDIX-XXIX

Lifting Arrangement	Lifting Eye At Suitable Location And Number or as per manufacturer standard.
Paint	Synthetic Paint (Not required in case of 275 GSM or above, as per standard)

1. Lifting eyes / Flanges shall be provided for the lifting of fans.
2. Should be provided for spring isolators & to install fans as per manufacturer standard.
3. Flanges on the fans have sufficient strength to lift the fans.
4. Fans shall be provided with Flexible connections(Fire Rated in case of Fire Rated) with spring washers on both the side.

END OF FAN SPECIFICATION

4.0 CO SENSORS

4.1 Scope of Work

The scope of this section comprises the supply, installation, testing & commissioning of CO Sensor for basement Car Park Ventilation in auto mode conforming to these specifications and in accordance with Bill of Quantities.

4.2 Carbon monoxide

CO sensors shall be installed to monitor air quality in the Car parking area during operational hours. CO sensors shall be connected with various Fans through in built PLC controller and Fire alarm Panel/BMS, which synchronies the air flow as per the requirement guided by CO sensors.

- On the basis of the CO level detected. Each zone shall be provided with various independent CO sensors, the numbers of CO sensors depends upon area of zone.
- The sensor, PLC controller and all components shall be mounted in one neat and compact case, suitable for wall mounting. The indication light shall be mounted on the cover of the case, if surface mounted. All components shall be factory mounted.
- The sensors shall be mounted on walls or columns at 1600 to 1800 mm above FFL. The sensors shall be evenly spaced throughout the zones so that the minimum numbers of sensors per zone are utilized.
- Sensors shall not be installed directly in front of air inlets. Each sensor shall be wired directly to the control panel housing the PLC controller
- The controller shall provide 4 to 20 mA or 0 to 10 volts DC output signal.
- The controller shall be capable of interfacing with BMS/Fire alarm panel as available.
- Sensor should not be cross-sensitive or respond to other ambient gases, including gases like SO2, acetone, ammonia, Nitrogen dioxide, Hydrogen Sulphide.
- Sensor must have reverse polarity and short circuit protection along with over-flooding protection.
- It should have auto recovery to zero point with replaceable sensor cell.

4.3 CONTROL PHILOSOPHY AND LOGIC

To monitor Carbon Monoxide (CO) levels and control ventilation inside the basement area.

The basement is divided in various zones and each zone is having various ventilation fans. Each zone will have 5 nos. CO sensors to monitor the CO levels. In normal CO levels, below the defined threshold, normal Ventilation fans will remain in stop condition. As soon as the CO levels monitored by any of these CO sensors in a zone exceed the defined threshold, PLC will give the Start command to the both normal ventilation fans of that zone. Fan Run status will be monitored by electrical panel output to ensure the correct condition and proper operation of ventilation fans.

4.4 SPECIFICATIONS

The CO sensors shall be suitable for wall mounting include the following features:

- Sensor Range 0 to 300 ppm
- Analog output 4 to 20 mA / 0-1OVDC
- Low Voltage operation 24 VAC / VDC
- Sensor Type Electro-chemical with no cross sensitivity
- Sensor life Min. 5 years (with replaceable sensor cell)
- Stability & resolution ± 5 ppm
- Sensor Coverage Minimum 500 sqm (field conditions)
- Working temperature -10°C to + 50°C
- Sensor should have enclosure flammability in accordance to UL746C 5V & should have minimum IP54 protected housing with provision of dust and moisture protection.

4.5 SCHEDULE OF TECHNICAL DATA

A. CO Sensor

i. Make and Model
ii. Type
iii. Range
iv. Accuracy:
v. Output signal:
vi. Power supply:
vii. Sensor life expectancy
viii. Coverage area:
ix. Response time:
x. Warm-up time
xi. Protection class:
xii. Operating temperature
xiii. Operating Humidity.
xiv. Storage temperature
xv. Storage Humidity

END OF CO SENSORS 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.

- All ductwork and distribution accessories delivered to Site shall be new and indelibly stamped to identify different grades, materials and manufacturers.
- Provide all ductwork, diffusers, registers, dampers and grilles generally in accordance with the Drawings to be performed during final design stage.
- Diffusers, registers and grilles shall be selected to meet the requirements of noise control as described elsewhere in this Specification.

5.1.2 Quality control

- Relevant Codes and Standards
- HVCA, DW/144: Specification for Sheet Metal Ductwork, Low, Medium and High Pressure/Velocity Air Systems
- IS 277 : Galvanized steel sheets (plain and corrugated) - Specification
- BS 476: Fire Tests on Building Materials and Structures
- BS 729: Hot Dip Galvanized Coatings on Iron and Steel Articles
- UL 555: Fire Dampers
- UL 555S: Leakage Rated Dampers for Use in Smoke Control Systems
- SMACNA: HVAC Duct Construction Standards, metal and Flexible and Rectangular Industrial Dust Construction Standards (Note: SMACNA standards shall be applied only if any part of the duct installation standards is not covered by DW/144).

5.1.3 SHEET MATEL DUCT (FACTORY FABRICATED DUCT)

5.1.3.1 RAW Materials

The duct shall be fabricated from Lock Forming Quality (LFO) grade galvanized steel sheets with 275 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.

In addition, if deemed necessary, samples of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

The G.I. raw material should be used in coil-form (instead of sheets) so as to limit the longitudinal joints at the edges only irrespective of cross-section dimensions.

5.1.3.2 Duct Connectors and Accessories

All transverse duct connectors (flanges/cleats) and accessories/related hardware are such as support systems shall be zinc-coated (galvanized). The bolts for fixing of slip-on flange corners should be of SS.

5.1.3.3 FABRICATION STANDARDS

All ductwork including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and other transformation pieces must be factory-fabricated or by equivalent technology. Equivalency will require fabrication by utilizing the following machines and processes to provide the requisite quality of ducts and speed of supply:

Coil lines to ensure location of longitudinal seams at corners/folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct.

All ducts, transformation pieces and fittings to be made on CNC profile cutters for required accuracy of dimensions, location and dimensions of notches at the folding lines.

All edges to be machine treated using lock formers, flangers and roller for turning up edge.

Sealant dispensing equipment for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints are specified.

5.1.3.4 SELECTION OF G.I. GAUGE AND TRANSVERSE CONNECTORS

Duct Construction shall be in compliance with **2" (500 Pa) w.g. static norms as per DW144/SMACNA.**

All transverse connectors shall be the 4-bolt slip – on flanges system or equivalent imported makes of similar 4-bolt systems with built-in sealant.

Non-toxic, AC-applications grade P.E. or PVC Gasketing is required between all mating flanged joints. Gasket sizes should conform to flange manufacturer's specification. The sealant used at corner of the slip-on flanges & that sealant should withstand 100 ^{0}C & same should be nontoxic.

5.1.3.5 DUCT CONSTRUCTION

The fabricated duct dimensions should be as per approved drawings and all connecting sections are dimensionally matched to avoid any gaps.

Dimensional Tolerances: All fabricated dimensions will be within +/- 1.0mm of

specified dimension. To obtain required perpendicularity, permissible diagonal tolerances shall be +/-
mm per metre.

Each and every duct pieces should be identified by color coded sticker which shows specific part numbers, job name, drawing number, duct sizes and gauge

Ducts shall be straight and smooth on the inside. Longitudinal seams shall be airtight and at corners only, which shall be either Pittsburgh or Snap Button Punch as per DW144/SMACNA practice, to ensure air tightness

Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Turning vanes or air splitters shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence

Plenums shall be shop/factory fabricated panel type and assembled at site.

The deflection of transverse joints should be within specified limit for rectangular duct deflection as per DW144/SMACNA Standards.

Reinforcement of ducts shall be achieved by either cross breaking or straight beading depending on length of ducts.

5.1.3.6 SUPPORT SYSTEM

A completely galvanized system consisting of fully threaded rods, slotted angles or double-L bottom brackets (made out of 3.0 mm M.S. sheet) nuts, washers and anchor bolts as supplied by supplier or generally conforming to SMACNA standards should be used. GI angle support system of adequate sizes shall also be provided at the bends, joints in vertical laying and wherever required as per site conditions or as directed by Engineer-in-charge.

NORMAL DUCT SUPPORT SYSTEM			
Sr. No.	Maximum Duct Size(mm)	Hanger Rod Diameter	Interval (mm)
1	Up to-700	6mm	2400
2	701-1200	8mm	2400
3	1201-2000	10mm	2400
4	Above 2000	12mm	2400

As an alternative, slotted galvanized brackets attached to the top two bolts of the support system may also be used as appropriate for the site condition.

To provide the required thermal brake effect, Neoprene or equivalent material of suitable thickness shall be used between duct supports and duct profiles in all supply air ducts not enclosed by return air plenums.

Fire rated duct works shall be fabricated with 18 G and supporting distance shall not exceed 1.2 Mtr with 6mm thick fire retardant gasket suitable for 250 deg C 2 hr shall be used in duct joints along with fire sealants.

All fire rated ducts shall be supported from the ceiling / slab/Wall by means of fully threaded GI rods with M.S. slotted double – C channel at the bottom. The rods shall be anchored to R.C. slab using metallic expansion fasteners.

Fire rated duct support system shall be as per the fire rated manufacture recommendation suitable to with stand 250 Deg C for 2 Hours.

Support details shall be approved by Engineer In charge before installation.

5.1.3.7 Installation

The duct installation shall conform to DW144/SMACNA norms. For duct assembly and installation the use of suitable tools and tackles should be used to give the required duct quality and speed of installation including (but not restricted to)

Electric Pittsburgh Seamer–used for closing Pittsburgh joints

- Electric Slitting shear – to make cut-outs
- Drilling machine with drill bits – for drilling holes in sheet metal work
- Hammer drill machine with drill bits – for drilling holes in building structures for anchors
- Hoisting system – for lifting the duct assembly upto mounting heights

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.

Fires 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 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 masonary, 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.
with the Engineer in Charge to suit actual site conditions in the building.

5.1.3.8 MISCELLANEOUS

- All sheet metal and stainless steel ducting shall be constructed to the recommendations of DW144/ SMACNA. The pressure class rating shall also be in accordance with DW144 /SMACNA.
- Ductwork shall be constructed of galvanized steel sheets complying to DW144/SMACNA for sheet thickness and IS277 for galvanization requirements. The galvanization requirements as per IS277 are as follows:

Thickness of sheet (mm)	Galvanization (GSM)
0.63 to 1.2 (both inclusive)	275

- Provide volume control dampers, complete with adjusting handle or similar device to all branches of the supply air ducts to regulate air flows along the main duct and the branch ducts. Provide opposed blade type volume control dampers to all branch.
- Provide flexible connectors of not less than 100 mm long between primary air handling units/air handling units/fans and related ductwork to prevent transmission of vibration to adjacent elements. Flexible connectors shall also be provided at building expansion and movement joints.
- The material used for the flexible connections shall withstand the specified conditions of temperature and air pressure, and shall comply with the standards of air-tightness. The material shall be fire resistant.
- Provide flanged joints to plant and elsewhere as necessary to facilitate maintenance.
- All flanged joints in ductworks shall be made up with rubber gaskets or suitable mastic material. These joints should also be connected with suitable material for earthing. Proper sized electrical continuity jumpers (min. 2 per joint) are required to be provided for making the duct work continuous. The gaskets provided should be fire retardent and should not emit toxic gases in case of fire.
- Apply sealant, adhesives, tapes to joints for sealing. All such material shall comply with the requirements of DW144 /SMACNA.
- Balancing dampers of appropriate types shall be provided for air balancing.
- Short radius rectangular and square elbows in air ducts shall be equipped with double thickness turning vanes. Long radius elbows shall be used wherever possible.
- The transition ductwork between silencers and fans shall be constructed of not less than 1.2mm thick galvanised steel sheet. The transition shall be aligned with the fans and shall be connected with angle flanges.

- The ducts and supports in the building must be adequate for minimum 100mm wg static pressure or the system pressure whichever is higher.
- Duct crossing for duct strength at 450mm or as per DW144/SMACNA.

5.1.3.9 DOCUMENTATION & MEASUREMENT FOR DUCTING

All ducts fabricated and installed should be accompanied and supported by following documentation:

- For each drawing, all supply of ductwork must be accompanied by computer-generated detailed bill of materials indicating all relevant duct sizes, dimensions and quantities. In addition, summary sheets are also to be provided showing duct area by gauge and duct size range as applicable.
- Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise.
- All duct pieces to have a part number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement, verification and approvals.

5.1.3.10 TESTING

- **After Duct installation** a part of duct section (5% of total duct) may be selected at random and tested for leakage of class12 as per SMACNA standards. The procedure for leak testing should be followed as per SMACNA – "HVAC Air Duct Leakage Test Manual " (First Edition)
- All Ducting must be fabricated at factory with DW144/SMACNA standard only, no site fabrication of ducts allowed except termination/connecting pieces.

DATA SHEET FOR NON FIRE RATED DUCT MATERIAL AND DUCT WORK	
Duct Material	Galvanized Quality Sheet Steel Of Lock Forming
Zinc Coating	As per IS277
Reference codes /Standards	Duct Construction DW 144 / SMACNA(only for parts not covered in DW144), IS277
Duct	All Duct Sections Will Be Cross Broken
Guide Vanes	At All the Bends To Be Made From The Same Material As The Duct
Thickness Of Sheet and Type Of Joint for Rectangular Duct	As per DW144/SMACNA
Traverse Joint	
Large side upto 1000mm	TDF type Flange
Large side 1000mm and above	Slip On Flange
Bracing/Support	Indicative support arrangement is given in tender drawing, final drawing shall be approved by engineer in charge
Duct Accessories	
For Joints	Hexagonal Nuts – Bolts / Washers Zinc Coated
Rivets	Galvanized Iron / Magnesium Aluminum Alloy
Gaskets	Fire retardant– size as per flange requirement
Screws	Self Tapping Screws Will Not Be Used
Support Arrangement	As Per SMACNA/DW144
Support From Wall / Ceiling	Anchor Fastener Of Required Rating Not Less Than 2.5 Times the Load of the Duct
Paint	Flanges And Supports Treated For Corrosion And Painted With Zinc Rich Paint Of Approved Quality
Flexible Connection circular Spigots	Fire Proof Material To Be Screwed Or Clip Band With Adjustable Screw Or Toggle Fitting
Flexible Connection Rectangular Ducts	Fire Proof Material To Be Flanged And Bolted With Backing Flat Or Bolted To Mating Flange With Backing Flat
Flexible Connection	150 mm Length Between Two Faces (Minimum)

5.1.3.11 Flexible Ducts

- Flexible ducts shall be neatly fixed and adequately supported.
- Flexible ducting used to connect the air distribution accessories and main ductworks shall comply with Part 7 of DW144/SMACNA.

- Flexible duct length shall not exceed 3.7m in length. Sheet metal duct branch off shall be provided in case the maximum length of flexible duct permitted is not long enough to reach the air terminal.
- Bending radius shall be sufficient to prevent undue tensioning of the outside of the bend and restriction of the throat likely to cause deformation and/or leakage. The ratio between the bending radius and the duct diameter shall be less than 2. In no case shall flexible ductwork be used to connect misaligned ducts.
- Flexible duct shall consist of flexible corrugated metal tubing of stainless steel, aluminium, tin plated or aluminium coated steel and suitable for an operating temperature range of –5 to 9°C.
- The frictional resistance to air flow per unit length of flexible duct shall not exceed 150% of the frictional resistance per unit length of galvanised steel duct of similar diameter.
- Flexible duct shall be insulated and wrapped with a minimum 25mm thick 24kg/m3 density fibre glass blanket.
- Flexible duct shall not be used for any system which is designed for handling smoke or being part of a smoke control system.

5.1.3.12 Paint/Covering for Fire Rated Ductwork (As applicable)

- Where shown on the Drawings, fire rated ductwork or equipment enclosure shall be fabricated from fire rated material to the requirements of BS 476 Part 24 or ISO 6944.
- The construction of the ductwork or enclosure shall take into account the structural strength, noise isolation as required and the requirements of Class C duct in accordance with DW144/SMACNA.
- All necessary supports, and other accessories required for the complete installation of fire rated ductwork, Sealant, Gasket, including additional material for fire stopping at wall/ceiling penetration, shall be supplied by the same manufacturer as the fire rated duct material and shall be assembled in accordance with all the manufacturer‘s recommendation regarding all aspects of construction and installation shall be certified by the manufacturer.
- The applicable smoke temperature shall be 250 deg C. The ductwork system shall be fire-rated for two hours and shall maintain mechanical stability, fire resistant integrity, and thermal insulation criteria to BS 476: Part 24 as per the ISO Cellulosic Fire Curve at temperature of 1029^0C, for both vertical and horizontal duct arrangements, for both inside and outside fire exposures. Restriction of the duct due to twisting or buckling after the fire test shall not cause 25 % or more reduction in cross-sectional duct area.
- The performance shall not be affected by moisture absorption. Mechanical strength shall be maintained and the fire resistance material shall not de-laminate or the fire resisting properties shall not deteriorate even under

water saturation. The material shall also be "Class-One" surface spread of flame as defined in BS 476: Part 7. Additional insulation, if required, shall be used as per the manufacturer's recommendation.

- The fire resistant material shall not attract pests and shall not rot or support the growth of mould.
- All fire resistant ductwork or enclosure, apart from its fire resisting quality, shall be capable of resisting accidental damage and shall require to pass the hard body impact test section of BS 5669: Part 1 / BS EN 1128 with the weight being dropped through not less than 1m.
- Smoke extraction system ductwork shall be made from suitable material with adequate thickness. Rivets or self sealing screws used shall not be of aluminium. Where ductwork (including sealant, flexible connection, gasket and accessories) for smoke extraction / purge systems penetrate the fire compartment walls or floors of the room which they serve, the portion of the ductwork that traverses outside of the compartment wall or floor shall have a fire rating equal to the fire rating of the compartment wall or floor which it traverses through or of not less than two hours whichever is the higher.
- Fire resistant and acoustically sealed access panels shall be provided in the above-mentioned enclosures for the access and maintenance of equipment and fire dampers.

DATA SHEET FOR FIRE RATED DUCT MATERIAL AND DUCT WORK	
Duct Material	Galvanized Sheet Steel Of Lock Forming Quality
Fire Rating	Two Hour @ 250^0 C
Zinc Coating	As per IS277
Duct	All Duct Sections Will Be Cross Broken
Guide Vanes	At All the Bends To Be Made From The Same Material As The Duct
Thickness Of Sheet And Type Of Joint for Rectangular Duct **Traverse Joint**	As per DW144/SMACNA
Large Side upto 1000 mm	TDF Type
Large Side 1001 – 2250 mm	Slip on flange
Bracing	Indicative support arrangement is given in tender drawing, final drawing shall be approved by engineer in charge
Duct Accessories	
For Joints	Hexagonal Nuts – Bolts / Washers Zinc Coated
Gask ets	Material- Fire Rated For 250^0 C 2 hours
	Thickness- As per flange requirements
Screws	Self Tapping Screws Will Not Be Used

Joint Strength	Should With Stand 1.5 Times the Operating Pressure With Out Deformation Or Failure
Support Arrangement	As Per SMACNA/DW144
Joint Strength	Should With Stand 1.5 Times the Operating Pressure With Out Deformation Or Failure
Support From Wall / Ceiling	Anchor Fastener Of Required Rating Not Less Than 2.5 Times the Load of the Duct
Paint	Flanges And Supports Treated For Corrosion And Painted With Zinc Rich Paint Of Approved Quality
Flexible Connection circular Spigots	Fire Proof Material To Be Screwed Or Clip Band With Adjustable Screw Or Toggle Fitting
Flexible Connection Rectangular Ducts	Fire Proof Material To Be Flanged And Bolted With Backing Flat Or Bolted To Mating Flange With Backing Flat
Flexible Connection	150 mm Length Between Two Faces (Minimum)
Duct Material	Fire Rated To Comply With BS – 476 Part 24 And ISO – 6944
Reference Standard	BS 476 Part 24, ISO – 6944
Flame And Fire Spread	Class O (BS 476 Part 6 & 7)
Fire Duct Work	Manufactured to HVCA Standard DW-144/ SMACNA
Function	Smoke Extraction
Duct Material	Resistant to Water Impingement From Any Sprinkler System
Impact Resistance	BS EN 1128
Stability And Integrity	Must Retain at least 75% of its overall Cross Sectional Area (BS – 476 Part 24 (1987)
Leak Test	HVCA Specification DW – 143
Sealant	Flame Retardant
Duct Accessories	
Supports And Angle	Should Have 800^0 C Melting Point And Tensile Stress is 15 N / mm2 For min 2Hour
Hangers And Stiffeners Flanges	
Gasket And Nut / Bolts	
Duct Work Seals	As Per BS – 476 Part 24, ISO – 6944

5.1.3.13 Guide Vanes

- Guide vanes shall be provided as required to maintain an acceptable system pressure loss.
- All blanking plates and sealing plates shall be provided for a complete installation.
- Vanes, supports, stiffeners, flanges, washers, bolts and welding filler shall be of galvanised steel (275 GSM) and constructed to the recommendations of DW/144.
- Vanes shall be of continuous seam welded construction, except for stiffening ribs, which may be stitch welded. Welding shall be in accordance with relevant British Standards.
- Curved sections shall be rolled or alternatively formed by a series of creases in a break press as long as the creases are closely spaced, not obstructive and form a smooth profile of air flow. If a break press is to be used, a sample of a section of vane shall be submitted for Approval.

5.1.3.14 Ductwork Installation

- Provide complete ductwork systems and ensure that the installation can be adjusted to the designed flow rates to the satisfaction of the Engineer.
- Check all the Drawings provided in regard to structural requirements and other finishes before detailing the ducting system. Allowance shall be made for the detailed development and on Site co-ordination.
- Submit all drawings to indicate the fabrication and installation of ductwork for Approval before fabrication commences.
- Replace damaged ductwork and other appurtenances at no additional cost to the Employer.
- Provide hangers and supports (Slotted rail), fabricated of hot-dipped galvanised steel, for the proper installation of ducts in accordance with DW/144. Hanger rods shall be 10 mm or 13 mm in diameter, depending on size of duct. All such hangers shall be provided with screwed lengths on lower end for adjustment of ducting runs to level. All nuts shall be provided with washers and with lock-nuts, and projecting ends of bolts shall be cut off.
- Supports shall not be riveted or bolted to the air ducts.
- Install dampers and splitters in a manner so that they can be adjusted at any time after completion of the work.
- Install dampers without strain or distortion of any part of the dampers.
- Adjust moving parts to move freely without binding.
- Caulk dampers airtight around frames.
- Adjust dampers and splitter adjusting rods to operate freely, between the open and closed position.
- Install flexible connections in accordance with Part 7 of DW/144.

- All ductwork shall be manufactured according to the dimensions taken on Site. Provision shall be allowed to accommodate any discrepancies between the Drawings and the Site dimensions.
- All branches and openings in ducts shall be purpose made prior to erection of the ductwork.
- Cross-breaking will be permitted on low velocity ductwork only and in no case where rigid external insulation shall be applied.
- Internal roughness, sharp edges or obstructions to air flow shall not be allowed.
- External edges and corners formed from cleated joints shall be neatly dressed down with air tight joints.
- Provide at least 75 mm clearance from ductwork to walls, ceiling and obstructions where a high standard of cleanliness shall be maintained.

Diffusers, Registers and Grilles Installation

- Install diffusers, registers and grilles so that they can be key adjusted from the face directly without special tools.
- Unless otherwise specified, install vanes, volume control dampers and multiple- blade extractors so that they can be removed through the diffusers and registers for access to the duct.
- Install diffusers, grilles, registers and louvres with frame connected to the ductwork and provide soft gaskets inserted under the frame or otherwise so arranged so as to avoid air leakage around the diffusers and grilles.

5.1.3.15 Air Duct Cleaning points

- The Contractor shall supply and install air duct cleaning points access doors at suitable locations to the duct work system. The cleaning points shall be installed at fully accessiable locations. The contractor shall also supply proprietary type compressed air lance, disinfection application lance and ambling probe which shall be suitable for use with the cleaning points. All joints must be air/water tight to prevent leakage.

5.1.4 GRILLS AND DIFFUSERS

- All grills and diffusers shall be designed and rated in accordance with ASHRAE 32-7/ASHRAE 70.
- All grills and diffusers shall be of pure polyester finish aluminum unless otherwise specified. Color of grills and diffusers shall be selected by the Engineer. Samples of finishes shall be submitted for approval.
- All supply, return and exhaust diffusers shall be complete with opposed blade dampers, suitable for mounting with appropriate diffuser and shall be fitted with concealed adjustment devices. Straightener grids are required before diffusers except for the last diffuser on the route. Each supply air grille shall be complete with an opposed blade multi-leaf damper. One set of tool for every 10 grilles or diffuser shall be provide for volume adjustment.

- The inside of all components and surfaces of all diffusers and grilles shall be painted matt black. The drawings show provisional locations of diffusers and grilles but in each instance outlets shall be installed in accordance with the final detail drawings and reflected ceiling plans.
-
- Velocities, net airways and distribution patterns shall give satisfactory air distribution and temperature equalization, be free of draughts stratification or noise nuisance. The contractor shall make final adjustments to air patterns when balancing.
- The sizes of the grilles (including linear grille) indicate on drawings imply the neck sizes of the fittings. Whereas the sizes of ceiling diffusers on drawings imply overall external dimensions.

Diffusers

- Diffusers constructed of extruded aluminum shall be power coated polyester finish to a color approved by the Engineer.
- Diffusers with removable cores shall have square necks or alternatively round necks. Diffuser sizes are shown on the drawings.
- Provide aluminum or steel opposed blades volume control dampers of black color with concealed adjustment lever. In general, dampers will not be
- required for fan coil unit system having supply diffuser.
- Provide galvanized steel sheet painted black at the front view to seal off dummy parts of diffuser.
- Diffusers ring or frames shall be compatible with the ceiling construction in which they are installed. A transition piece shall be provided to connect the diffuser to the duct. All edges exposed to view shall be rolled or otherwise stiffened and rounded. Internal parts shall be removable to permit cleaning of the diffuser and provide access to the duct.
- Baffles, turning vanes or other devices shall be provided for the required air distribution pattern. Equalizing grids shall be provided for ceiling diffusers.
- Volume control dampers shall be equipped and factory fabricated by the diffuser manufacturer. The adjustment position shall be easily accessed.
- Square and rectangular diffusers shall comply with the following performance requirements at design flow :

    - Maximum pressure drop : 30 Pa
    - Throw : 4m
    - Noise criteria : NC 30
    - Maximum air velocity at diffuser neck : 4 m/s
    - Maximum terminal velocity : 0.5 m/s

Supply and Transfer Air Grilles and Register for general use.

- Double deflection supply air grilles/register shall be tapped from top or bottom of ducts with provision for tamper proof adjustment of air pattern spread along its width. Adjusting tool shell be provided by the manufacturer. Grilles/register shall have a minimum of 80% free area.
- Provide grilles/registers to meet the size and capacities as shown in the

drawings required to connect ducts to grilles and registers.

- Grilles and register shall be factory assembled with opposed blade volume control dampers operable through the grilles face. The adjustment shall be by a key through the face of the register and the volume control damper shall be group operated or opposed blade type. The operating mechanism shall not project through any part at the register face.
- Diffusers constructed of the extruded aluminium shall be pure polyester finish o a colour approved by the Engineer.
- All grille cores shall be capable of being removed easily from the duct work of access to dampers.
- All edges exposed to view shall be rolled or otherwise stiffned and rounded. All edges shall be equipped with air tight, non- combisible neoprene or sealing stips to prevent leakage. The register ring of frames shall be compitable with ceiling construction in which they are installed.
- Multi-blade volume extractors shall be of the air deflecting and air straightening type with blades spaced a maximum of 50mm apart.
- Supply air registers shall comply with the following performance requirements at design flow as :

    - Maximum presuure drop : 30 Pa
    - Throw : 4m
    - Noise criteria : NC 30

Return/Exhaust Grilles and Registers for General use

- Grilles shall have single set of fins which shall be vision proof to effectively mask the return opening. Grilles shall have 450 inclined fins spaced approximately 19 mm apart.
- Free area of grille core shall be at least 80%.
- Grilles and registers will be fixed type.
- Return air diffusers shall match the supply diffusers in appearance and shall be constructed of the same material and identical in surface finish as approved by the Engineer.
- Register rings or frames shall be compatible with the ceiling construction in which they are installed.

Linear Air Diffusers

- Each diffuser shall be of single/multi-slotted vertical/horizontal discharge, ceiling mounted type fitted into a field-insulated boot with spigot for receiving supply air duct as detailed on the drawings.
- Diffusers of extruded aluminum shall be power coated polyester finish to a color as approved by the Engineer.
- Number of slots and lengths of diffusers and capacity shall be as indicated on the drawings.

- Provide air boot to the diffusers as shown on the drawings. Air boot casing shall be constructed of 0.6 mm thick galvanized steel with interior surfaces insulted to prevent erosion. Insulation and air boot shall be extended to cover the collar of diffuser. Volume control dampers shall be provided in the

air boot spigot.

- Subject to the ceiling panel design, the flanges of the diffusers shall be designed to support —drop in — ceiling pane.
- Provide suitable support points independent of suspended ceiling for the air boots and the associated diffusers.
- Air boot spigot location and dimensions shall generally be as indicated on the drawings.
- Provide galvanized steel sheet painted black at the front view to seal off the dummy part of the diffusers.
- Linear air diffuser shall comply with the following performance requirements at design flow as :

    - Maximum pressure drop : 30 Pa
    - Throw : 6m
    - Noise criteria : NC 35
    - Minimum terminal velocity : 0.5 m/s

5.1.5 Nozzle/Jet Diffusers

- Nozzle/Jet diffuser assembly shall consist of round diffuser element which shall be fitted to square or rectangular back plate, opposed blade volume damper and duct collar.
- Each nozzle/Jet diffuser assembly shall consist of the diffuser element and shall be compatible with the architectural design in which they are installed.
- Individual diffuser element shall be capable of adjusting the air deflection up to 300 from any plane perpendicular to the face. Adjustment shall be accomplished from front or back of the diffuser without tools.
- Volume control dampers shall be provided for the diffusers.
- The Nozzle/Jet diffuser shall comply with the following performance requirements as design flow :

    - Maximum pressure drop : 60 Pa
    - Throw : 15m
    - Noise criteria : NC 35

DATA SHEET FOR GRILLS AND DIFFUSER	
Function	Air Distribution
Standard	Air Diffusion Council
Requirement	For Supply Air, Return Air And Air Extraction
Grills	Linear Flow / Double Deflection Registers
Diffuser	Four Way Rectangular / Square / Round
Construction Material	Aluminium
Flange	As per manufacturer standard Suitable For Continuous Joint With Alignment Strips
Design	Extruded section

Blade / Louvers	Adjustable Front and Rear
Bars	
Front	Aluminum
Rear	Aluminum
Damper	
Type	Adjustable Lever Operated
Fire Rating	Non Fire Rated
Finish	Black Anodized
Paint	Material Duly Treated for corrosion And Anti Corrosive Paint
Noise Generation	Should Have Very Low Air Noise Generation

Access Door- (As applicable)

- Gasketed airtight access doors shall be provided at the duct for access, inspection and maintenance of fans, equipment, dampers, filters, smoke probes and controls.

- Doors shall be hinged type complete with minimal of two sash locks and shall be made of same metal thickness as ducts. Doors shall have suitable size to access.

- Access doors for insulated ductwork shall be of double skin construction with insulation in between. The insulation for the access doors shall be of the same type and thickness as the adjacent ductwork.

- The door panels shall be made of suitable material and they shall have not less than 12 mm wide neoprene rubber gasket around the entire perimeter to ensure air tightness. It shall have the same fire rating as the adjacent duct construction.

- The access doors shall be hung on approved heavy duty hinges and provided with suitable quantity with locks. The locks shall be able to operate both from inside and outside. Where it is impracticable to use hinge doors, the access doors may be fixed in position with wedge type locks on opposite sides with suitable quantity per door. The section of the duct where the access door is located shall be reinforced with suitable material.

- Where the duct is of smaller dimensions than the access door specified, the door shall be of the full width of the duct Sealant and gasket used shall be in accordance with the recommendations of HVCA, DW/144 Specification.

5.1.6 DAMPERS – GENERAL

The respective functions, types and general constructional requirements of dampers shall be in accordance with the HVAC ductwork specification unless otherwise indicated, sufficient dampers shall he provided to regulate and balance the system. Dampers on grilles or diffusers shall he used for line control only.

All dampers shall he of flanged type for connection to ductwork and shall he sufficiently rigid to prevent fluttering. Air leakage rate for dampers shall be tested according to EN 1751 Section 3 when the damper is in the closed position. For dampers installed for shut- off purpose, the maximum air leakage rate shall be tested according to EM 1751 Section 4.

LOW LEAKAGE DUCT DAMPER

Air volume control dampers shall be of the aerofoil, double skin, opposed blade type with low pressure drop and noise regeneration characteristics. Damper blades in rectangular ductwork shall not exceed 225 mm in width and 1500 mm in length. Blades shall be of hollow section constructed from the same material of the ductwork or of stainless steel encapsulating an internal double contoured stud longitudinal reinforcing bar, mounted on square section steel spindles. Bearings shall be of nylon material and the units shall be of low-leakage design by incorporation of synthetic trailing edge seals and a peripheral gasket which shall be tested according to BS 476. All manually and automatically operated dampers shall include a means for indicating externally the position of the blades. Manual dampers shall include a device for positioning and locking the damper blades. The positions of all dampers 'as-set' after final regulation shall be indelibly marked at the adjusting device.

Each air volume control damper in the ductwork shall be fitted with a non-corrodible label stating the actual air flow in m3/s when in the fully open position, its overall cross sectional area, and the degree to which the damper has been closed in order to achieve the design or actual air flow.

Unless otherwise indicated, quadrants and operating handles shall be of die-east aluminum or other material approved by the Architect with the words 'OPEN' and 'SHUT’ marked on the quadrant. Quadrants shall be securely fixed and the damper spindles shall be closely fitted in the quadrant hubs to prevent any damper movement when the damper levers are locked.

Access openings with readily removable air sealed covers shall be provided adjacent to all dampers. Subject to limitations of ductwork size the dimensions of access openings shall not be less than 300 mm x 300 mm and shall be located so as to afford easy access for inspection and maintenance.

BUTTERFLY & BIFURCATING DAMPERS

Butterfly dampers shall each consist of two plates, edge seamed, of at least the same thickness as the material from which the associated ductwork is made, and rigidly fixed to each side of a mild steel operating spindle, the ends of which shall be turned and housed In non-ferrous bearings.

Bifurcating dampers shall be of 2 mm thick sheet for sizes up to 450 mm square, for larger sizes the thickness shall be as specified. The damper blades shall be rigidly fixed to square section mild steel spindles, the ends of which shall be turned and housed in non-ferrous bearings,

Each leaf of a multi leaf damper shall consist of two plates of material of the same thickness as the associated ductwork and rigidly fixed to each side of an operation spindle, the ends of which shall he housed in brass, nylon, oil impregnated sintered metal, PTEE impregnated or ball bearings. The ends of the spindles shall be linked so that one movement of the operating handle shall move each leaf for an equal amount. The mechanism shall be located outside the air stream.

For system static pressure below 1000 Pa or ductwork velocity below 12 m/s, blade of at least 50 mm wide shall be used. For static pressure at or above 1000 Pah at least 100 mm wide blade shall be used. Central blade reinforcement bar shall be provided for damper span longer than 1500 mm. Single module of a damper shall not exceed 2000 mm width and 1000 mm height.

TERMINAL DAMPERS

Grilles and air diffusers with rectangular neck connections shall be provided with an opposed blade dumper, screwed or riveted lo the neck connection and designed specially lo facilitate final balancing of the system.

Damper frames, blades and operating mechanism shall be constructed from an aluminum alloy or, alternatively, formed mild steel suitably finished to give protection to the material during the design working life.

Blades shall be made of solid section material and shall be firmly held in position by a spring steel retaining mechanism. The blade setting mechanism shall be accessible through (he grille or diffuser blades and shall be suitable for operation with an ''Alien" key. Where dampers are visible through the grille or diffuser they shall be finished with a mall black paint.

5.1.7 MOD Installation - (As applicable)

- Each damper shall be installed so as to provide smooth operation, opening and closing without shock in accordance with the manufacturer‘s recommendations.
- Undue flexing or bending of connecting rods and linkage will not be acceptable. Such connecting rod or linkage shall be replaced with either a corrected design, higher strength material or increased size of such a

component at no extra cost to the Employer.

- Dampers shall be supported independently of the ductwork.
- Wall and floor mounted dampers: All slight, unavoidable spaces and purpose-provided spaces between the damper frames and the structure shall be sealed as required or as Approved. Blanking-off plates for such purpose shall be considered as part of the damper assembly and shall be provided at no additional cost to the Employer.
- Damper module installations shall be fully sealed by gaskets between the module frame and the mounting frame. The gasket material for MSFD/MFD shall meet the continuous operation in an air stream temperature of 250°C for not less than one hour criteria. Identification of damper position is required on easy visible and accessible position, and the damper setting position after balancing shall be marked in a permanent manner.

Manual Damper & Volume Control Damper

DATASHEET FOR MANUAL DAMPER & VOLUME CONTROL DAMPER	
Type	Manual Damper
Operation	Lever Arrangement, For Adjustment And Locking At Any Position
Service	Continuous Duty
Mounting	Horizontal Or Vertical
Construction	Splitter, Butterfly Type
Damper Free Area	80 % Of Damper Face Area
Damper Operating Mounting Bracket	Galvanized Steel
Leakage	Less than 0.1m3/s/sqm of net damper face area
Frame Construction	Galvanized Steel
Blade	
Pressure Drop	38 Pascal @ 10 Mtr. / sec. Air Velocity or as per manufacturer standard
Construction	Aerofoil design/3V design, Galvanized Steel
Type	For Manual Damper - Parallel/OpposedBlade For VCD – Opposed Blade
Material	Galvanized Steel
Thickness	2.0 mm Thick
Linkages	Stainless Steel – 316
Shaft	Stainless Steel – 316,
Bearing	
Type	Bush Bearing
Material	Brass

Handle	Suitably Supported For Ease of Movement, sufficient strength and shall be made of similar material and shall be easy to operate.
1. Damper shall be factory tested for fully closed position and holding against a different pressure of 1000 Pa and air leakage through the damper shall not exceed 0.1m3/s/sqm of net damper face area as per specification.	

5.1.8 MOTORISED FIRE & SMOKE DAMPERS GENERAL

WORK INCLUDED

Combination fire smoke dampers with steel 3-V blades meeting requirements of UL Standard 555 7th Edition and UL Standard 555S 4th Edition.

RELATED WORK

1. Section 15810 – Ducts.
2. Section 15900 – HVAC Instrumentation and Controls: Connections to actuators.

REFERENCES

3. AMCA 500-D – Laboratory Methods for Testing Dampers for Ratings.
4. AMCA 511 – Certified Ratings Program for Air Control Devices.
5. CSFM – California State Fire Marshall Listing for Fire Damper and Smoke Damper (leakage).
6. New York City MEA – New York City, Department of Buildings, Material and Equipment Acceptance Division.
7. IBC – International Building Code
8. NFPA 80 - Fire Doors & Other Opening Protectives
9. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.
10. NFPA 92 – Smoke Control Systems
11. NFPA 101 – Life Safety Code.
12. UL 555 (Seventh Edition)– Standard for Safety: Fire Dampers
13. UL 555S (Fourth Edition) – Standard for safety: Leakage Rated Dampers for Use in Smoke Control Systems.

SUBMITTALS

14. Comply with requirements of Section 01330 – Submittal Procedures.
15. Product Data: Submit manufacturer's product data.
    Include UL ratings for fire resistance, leakage, ww

QUALITY ASSURANCE

1. Dampers shall meet requirements for combination fire smoke dampers in accordance with:
    i. NFPA 80, 90A, 92A, 92B, and 101.
    ii. CSFM Fire Damper Listing.
    iii. CSFM Leakage (Smoke) Damper Listing.

iv. New York City MEA Listing 260-91-M Vol. III.
v. Applicable Building Codes.

2. Dampers shall be tested, rated, and labeled in accordance with:
   i. UL 555 (Seventh Edition), Listing R13317
   ii. UL 555S (Fourth Edition), Listing R13317

3. Dampers shall bear the AMCA Certified Ratings Seal for Air Performance in accordance with AMCA 511.

DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver Materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, and location of installation.

B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions.

C. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

PRODUCTS

COMBINATION FIRE SMOKE DAMPERS

Ratings:

1. Fire Resistance:
   - **Dampers shall have a UL 555 fire resistance rating of 1½ hours.**
2. Fire Closure Temperature:

2 Each combination fire smoke damper shall be equipped with a factory installed heat responsive device rated to close the damper when the temperature at the damper reaches:

   - 165°F
3. Elevated Operational Temperature:
   - **Dampers shall have a UL 555S elevated temperature rating of 350°F.**
4. Leakage:
   - **Dampers shall have a UL555S leakage rating of Leakage Class I**
5. Differential Pressure:
   - Dampers shall have a minimum UL 555S differential pressure rating of 4 in. wg.
6. Velocity:
   - Dampers shall have a minimum UL 555S velocity rating of 2000 fpm.

Construction:

I. Frame:

Damper frame shall be 16 ga. galvanized steel formed into a 5" x 1" structural hat channel. Top and bottom frame members on dampers less than 17" high shall be low profile design to maximize the free area of these smaller dampers. Frame shall be 4- piece construction with 1 ½" (minimum) integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking.

II. Blades:

Damper blades shall be 16 ga. galvanized steel strengthened by three longitudinal 1" deep Vee grooves running the entire length of each blade. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening.

III. Blade Stops:

Each blade stop (at top and bottom of damper frame) shall occupy no more than ½" of the damper opening area to allow for maximum free area and to minimize pressure loss across the damper.

IV. Seals:

- Blade Edge: Blade seals shall be extruded silicone rubber permanently bonded to the appropriate blade edges.
- Jamb: Flexible stainless steel compression type.

V. **Linkage:** Concealed in jamb.

VI. **Axles:** Minimum ½ inch dia. plated steel. Frame: Galvanized steel (in gauges required by manufacturer's UL listing).

VII Sleeves: Damper shall be supplied as a single assembly with an integral factory sleeve.

VIII Bearings: Axle bearings shall be sintered bronze sleeve type rotating in polished extruded holes in the damper frame.

Actuators:

1. Type:

▭ Electric, 230V AC, 2-position

2. Mounting: External

SOURCE QUALITY CONTROL

Factory Tests: Factory cycle damper and actuator assemblies to assure proper operation.

EXECUTION EXAMINATION

Examine areas to receive dampers. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization of dampers. Do not proceed with installation until unsatisfactory conditions are corrected.

INSTALLATION

a) Install dampers in accordance with manufacturer's UL Installation Instructions, labeling, and NFPA 90A at locations indicated on the drawings. Any damper installation that is not in accordance with the manufacturer's UL Installation Instructions must be approved prior to installation.

b) Dampers must be accessible to allow inspection, adjustment, and replacement of components. The sheet metal contractor shall furnish any access doors in ductwork or plenums required to provide this access. The general contractor shall furnish any access doors required in walls, ceilings, or other general building construction.

c) Install dampers square and free from racking.

d) The installing contractor shall provide and install bracing for multiple section assemblies to support assembly weight and to hold against system pressure.

e) Do not compress or stretch the damper frame into the duct or opening.

f) Attach multiple damper section assemblies together in accordance with manufacturer's instructions. Install support mullions as reinforcement between assemblies as required.

g) Handle dampers using the frame or sleeve. Do not lift or move dampers using blades, actuator or jackshaft.

h) Install connections to [electric, pneumatic] actuators as specified in section 15900.

i) Attach multiple damper section assemblies together in accordance with manufacturer's instructions. Install support mullions as reinforcement between assemblies as required.

APPENDIX-XXIX

FIRE DAMPERS (MOTORIZED) (Non UL Listed) - If Applicable

- Fire Dampers shall be motorized of atleast 2 hours Fire Rating certified by CBRI, Roorkee as per UL 555:1973.

- Fire Damper blades & outer frame shall be formed of 1.6 mm galvanized sheet steel. The damper blade shall be pivoted on both ends using chrome plated spindles of self-lubricated bronze bushes. Stop seals will be provided on top and bottom of the damper housing made of 16 G galvanized sheet steel. For preventing smoke leakage side seals will be provided.

- In normal position damper blade shall be held in open position with the help of a 220V operated motorized actuators thereby providing maximum air passage without creating any noise or chatter.

- The damper shall be actuated through electric motorized actuator. The actuator shall be enerzised with the help of a signal from smoke detector. Smoke detector shall be provided by Fire Fighting agencies. The Fire Damper shall be provided with micro switches with bakelite base to stop fan motor in the event of damper closure. The reopening of damper shall be manual.

- Fire Dampers shall be mounted in Fire Rated Wall with flange connection.
- Dampers shall be installed in accordance with the installation method recommended by the manufacturer.

Fusible Link Fire Dampers (FLFD)

- Provide fire dampers in air ducts where ducts penetrate fire compartments.
- Fire dampers shall fully comply with the requirements of DW/144.
- Fire dampers shall be constructed to the same standards of air tightness as the rest of the system.
- Fire damper casings and blades shall be constructed of galvanised sheet (275 GSM) and provided with a galvanised steel angle frame to each side of wall or floor.
- Fire damper casings shall be flanged to suit the ductwork which they are fitted and the cross-sectional area shall not be less than that of the ductwork.
- Blade and fusible link shall be accessible for servicing through air-tight inspection doors placed upstream or downstream of the air path whichever provides the better access.
- Provide UL Listed fusible link set at 68°C / 74°C or else as approved to all fire dampers unless otherwise specified. Fusible link shall be arranged in an exposed position and at upstream of the damper.
- Details and position of all fire damper and associated access doors shall be submitted for Approval prior to installation on Site.
- Provide all necessary fixing framework for the installation of fire dampers.
- Provide fire rated material to seal off the clearance between the fire dampers and wall.

APPENDIX-XXIX

DATA SHEET FOR FIRE DAMPER	
Type	Fusible Link Snap Acting (FLFD)
Reference Code / Standard	UL 555 BS 476 Part 20.,UL Classified
Fire Rating	Two Hour @ 250^0 C
Service	Continuous Duty
Mounting	Horizontal Or Vertical
Construction	In Single / Two Module
Differential Pressure	1000 Pascal
Damper Free Area	80 % Of Damper Face Area
Damper Operating Mounting Bracket	As per manufacturer standard complying UL555
Open / close Indication	Manual indication handle
Leakage	Max 5% Of The Rated Air Flow Across Damper In Open Position
Frame Construction	As per manufacturer standard complying UL-555
Blade	
Pressure Drop	38 Pascal @ 10 Mtr. / sec. Air Velocity
Construction	Material As per manufacturer standard complying UL- 555 Design – Aerofoil Design OR 3V-Type Design
Type	Opposed/parallel Blade as per requirements
Blade Thickness	For Aerofoil Design – Min 1.6mm For 3V-Type Design – Min 1.5mm Both complying UL-555
Linkages	As per manufacturer standard complying UL-555
Shaft	As per manufacturer standard complying UL-555
Bearing	As per manufacturer standard complying UL-555

END OF AIR DISTRIBUTION SYSTEM SPECIFICATION

APPENDIX-XXIX

6.1 INSULATION / LINING WORK

6.2 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.

6.3 Materials

The materials to be used for insulation shall be as follows, unless some other material is specifically mentioned elsewhere. The detailed specifications of the materials are listed under respective sub heads.

Drain Pipe Insulation Duct Insulation	Closed Cell Elastomeric Insulation with class ‗O' for fire rating Closed cell Elastomeric insulation with class ‗O' for fire rating
Acoustic Insulation	Resin Bonded Fibre glass in roll form
Equipment Insulation Floor Insulation	—Closed Cell Elastomeric Insulation with class ‗O' for fire rating‖ Closed Cell Elastomeric insulation with class ‗O' for fire rating (other than plant room)
Fire Duct Insulation	Pre-laminated mineral wool

6.4 Drain Pipe Insulation

- The material for insulation of drain pipes shall be pipe sections of flexible closed cell elastomeric insulation having a 'K' valve of 0.037 W/mk at a mean temperature of 20^{o}C and a minimum density of 55 Kg./cubm.
- The thickness of insulation shall be 6 mm thickness.

6.5 Duct Insulation

- The materials for duct insulation shall be sheets of closed cell elastomeric insulation. The density of insulation shall not be less than 55 kg/cubm and The thickness of duct insulation shall be as follows :
- material shall be in the form of sheets of uniform thickness. The K'value at 20ºC. Shall not be less than 0.037 W/mK.

Duct in conditioned space	15 mm thick
Duct in unconditioned space	25 mm thick

- The insulation shall have fire performance of class O' as per BS476 Part-7

6.6 Floor Insulation

- The material of insulation shall be closed cell elastomeric insulation having a K- value less than 0.039 W/ M o K at a temp. of 30 o C. Water vapour permeability (Moisture resistance factor) shall be greater than 400.
- The insulation shall have fire performance of —class O‖ of BS476 Part – 7.
- The thickness of the insulation shall 15 mm.

6.7 Acoustic Treatment

- The material for acoustic treatment of ducts, rooms, roofs etc. shall be resin bonded fibre glass, as described earlier, conforming to I.S. 8183 of 1976. The density of fibre glass shall be 32 kg/cub.m and the material shall be in the form of boards of uniform density. The ‗k' value at 10oC shall not be less than 0.03 W/mK. Facing shall be provided with 0.5 mm perforated aluminium sheet held with G.I. Nuts bolts or nailed to the batten work as required.
- The thickness of insulation shall be as follow unless otherwise specified elsewhere

Duct Acoustic	25 MM
Room Acoustic	50 MM

6.8 Fire Rated Duct & Insulation

- The material for fire duct insulation shall be pre-laminated rigid board mineral wool of density 100 kg/cubm. Facing shall be provided with aluminum foil with backing of kraft paper.
- The thickness of insulation shall be 100 mm.
- For fire rated duct work, fire resistant board/fire pan is required to be provided over GI duct work. Fire rated duct work should meet the requirement of BS 476 part 24.
- The duct work system (all supports, hardware, accessories etc.) shall be fire rated for 2 hours and shall maintain mechanical stability, fire resistant integrity and thermal insulation criteria to BS 476 part 24 and as per ISO CELLULOSIC fire curved at temperature of 1029 Deg. C for both vertical and horizontal duct arrangement and for both inside and outside. All components/ materials used in fire rated duct shall be fire rated.

6.9 Cold Adhesive Compound

- The Cold adhesive compound for closed cell elastomeric insulation with class ‗O' fire rating (other than plant room) shall be synthetic glue with glue thinner as per insulation supplier recommendations.

- The adhesive compound for floor insulation shall be synthetic adhesive SR 998 of pidilite.

6.10 Tar Felt

- The Tar felt used for water proofing shall conform to IS: 1322 Type 3 Grade I.

6.11 Installation

Closed Cell Elastomeric Insulation

- The pipe shall be thoroughly cleaned with a wire brush and rendered free from all rust and grease.
- The pipes shall be given a coat of red oxide primer.
- Two coats of synthetic glue shall be applied on the cleaned pipe surface.
- The preformed sections of insulation shall be fixed tightly to the surface to take care to seal all joints.
- All longitudinal joints and circumferential joints shall be sealed with synthetic glue.
- Insulation on pipe and valves in the AHU rooms shall be covered with protective coating as recommended by the insulation manufacturer.

Floor Insulation

- Clean the roof surface to remove all grease, oil, dirt, etc. prior to carrying out insulation work.
- Material shall be fixed under compression and no stretching of material shall be permitted.
- A thin layer of synthetic adhesive SR 998 of pidilite make shall be applied on the back of the insulating material sheet and then on to the floor surface.
- When the adhesive is tack dry insulating material sheet shall be placed in position and pressed firmly to achieve good bond.
- The joints shall be finally covered with self adhesive PVC pipe.

Drain Piping

- The pipe shall be thoroughly cleaned with a wire brush and rendered free from all rust and grease.
- Then preformed sleeves of 6 mm thick insulation shall be slipped on the pipe.
- All joints shall be insulated with sleeves cut in two sections and fixed to the pipes with cold adhesive compound.
- All joints shall be covered with 3 mm x 50 mm PVC self adhesive.

Ducting

- Clean the surface with a wire brush and make it free from rust and oil.
- Apply two coats of synthetic glue to the surface.
- Wrap the duct with insulation sheets of the thickness mentioned above.
- The joints shall be sealed with synthetic glue to form a seamless bond. The duct joints shall be additionally covered with a 150mm strip of insulation material.

Duct Acoustic Lining

- The duct surface shall first be cleaned from inside.
- Then frame of 25 mm square section made of 18 Ga (1.2 mm) thick G.I. sheet should be fixed on both ends of the duct piece.
- The insulation slabs should be fixed between these sections of ducts using adhesive compound and self adhesive stick pins.
- The insulation shall the be covered with RP tissue, sealing all joint so that no fibre is visible.
- The insulation shall then be covered with 0.5 mm perforated aluminium sheets.
- The sheet of insulation shall be secured to the duct by means of stick pins as mentioned above.

Room Acoustic

- Fix 40 mm x 50 mm G.I. channels at 0.5 metre interval longitudinally then fix cross battens at 1.0 metre centre using suitable gutties, and brass screws.
- Fill each rectangle with 50 mm glass wool and covered with RP tissue.
- Tie with 24 gauge G.I. Wires at 300 mm intervals.
- Then cover with 22 gauges (0.80 mm) perforated Aluminium sheet having 3 mm perforations at 6 mm centres. Overlap all joints and provide beading of 25 mm by 2 mm flats.
- All corners joints shall be covered with 25 x 25 x 2 mm thick aluminium angles.

Fire Duct Insulation

- Clean the surface with wire brush to make it dust and grease free.
- Fix self adhesive GI stick pins having base of 25mmx25mm and pin height of 110mm covered with GI washer of size 30mmx30mm at regular interval of 300mm c/c on vertical faces of duct, 350mm c/c on top surface and 200mm c/c on bottom side of duct.
- Apply uniform coat of cold setting compound MAS-17 on the duct surface.
- Fix 100mm mineral wool in 2 layers of 50mm with joints staggered.
- Seal all joints using 50 mm self adhesive aluminium tapes.

- Provide 40mmx40mmx50mm GI corners at 300mm longitudinal distance on all corners of the duct and secure insulation with 25mmx0.60mm aluminium straps over the corners.

END OF INSULATION / LINING SPECIFICATION

7.1 NOISE & VIBRATION CONTROL

7.2 Scope of Work

This section deals with design, supply, installation, testing and commissioning of noise and vibration control equipment and accessories.

7.3 NOISE CONTROL

7.3.1 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:

STANDARDS	DESCRIPTION
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.
BS 4773 Part 5: 1976	Acoustic performance with additional ducting of forced fan convection equipment
BS 4857 Part 2:1978 (1983)	Acoustic Testing and Rating of High Pressure Terminal Reheat Units.
BS 4954 Part 2:1978 (1987)	Acoustic Testing and Rating of Induction Units
BS 5643 : 1984	Glossary of Refrigeration, Heating, Ventilating and Air Conditioning Terms
Note: British standards shall also be applicable for noise control.	

7.3.2 General

Mechanical services shall generally be designed and installed with provisions to contain noise and the transmission of vibration, generated by moving plant and equipment at source where illustrated on the tender drawings and plant and equipment schedules to achieve acceptable noise rating specified for occupied areas.

APPENDIX-XXIX

In addition to the provisions specified in the Specification, particular attention must be given to the following details at time of ordering plant and equipment and their installation :-

a) All moving plant, machinery and apparatus shall be statically and dynamically balanced at manufacturers works and certificates issued.
b) The isolation of moving plant, machinery and apparatus including lines equipment from the building structure.
c) Where duct work and pipe work services pass through walls, floors and ceilings, or where 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.
d) 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.
e) 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.
f) All duct connections to fans shall incorporate flexible connections, except in cases where these are fitted integral within air handling units.
g) Duct work connections to the fan inlets / outlets shall be concentricity aligned so that the flexible connections are not subjected to any strain and not used as a means of correcting base misalignment.
h) 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.
i) Where practicable, silencers 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 silencer and the wall subjected to noise infiltration shall be acoustically clad as specified.

7.4 VIBRATION CONTROL

7.4.1 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.

7.4.2 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 chancel section pre-galvanised sheet steel framework retaining acoustic fill of a density to attain the required performance. Splitters shall have round Nos.,e 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.

7.4.3 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.

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.

7.4.4 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.

7.4.5 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.

END OF NOISE & VIBRATION CONTROL SPECIFICATION

8.1 QUALITY ASSURANCE

8.2 General

The following quality assurance, inspection, testing and commissioning procedures shall be required to be carried out upon award of work.

I. Provide quality assurance program (QAP), Manufacturing quality assurance program (MQAP), field quality assurance program (FQAP) and quality plan.

II. Tests at manufacturer's works.

III. Perform site tests and commissioning.

8.3 Submittals

I. After award of work following information shall be submitted.

a. Quality Assurance Program (QAP)
b. Manufacturing Quality Assurance program (MQAP)
c. Field Quality Assurance Program (FQAP)

II. For inspection and testing, submit inspection and testing procedures, program, and record sheets applicable at each hold point.

III. After completion of testing, submit test records, packaging, transportation and storage instructions and methods.

IV. For site installation and commissioning, submit installation methods or procedures, notification and procedures for pre-commission and commissioning.

V. After commissioning, submit site test records, as-built drawings, manufacturer's operation maintenance manuals and list of recommended spares and tools.

8.4 Quality Assurance Concept and Control

I. Minimum requirements for establishing and implementing a quality assurance program shall be applied to all aspects of the work necessary for carrying out the contract. Quality assurance shall extend to material parts, components, systems and services as a means of obtaining and sustaining the reliability of critical items, operating performance, maintenance and safety.

II. Acceptance of the AC Contractor's quality assurance program does not relieve the Contractor's obligation to comply with the requirement of the contract document. If the program is found to be ineffective, then the Consultant / Client or his authorized representatives reserves the right to request for necessary revisions of the program.

III. The AC Contractor is required to produce readily identifiable documentary evidence covering the extent and details of both his own and his Subcontractor's quality assurances system as follows:

a. Quality Assurance Program (QAP)
b. Manufacturing Quality Assurance program (MQAP)
c. Field Quality Assurance Program (FQAP)
d. Quality Plan.

IV. These documents shall be prepared separately and submitted to the Consultant / Client or his authorized representatives at the time of starting the work.

V. Quality Plan and Manual shall be prepared by the AC Contractor for all items and services to be supplied, after the contract has been placed, but before commencement of fabrication, and shall be subject to evaluation and acceptance by the Consultant / Client or his authorized representatives before start of work.

8.5 Quality Assurance Manual (QAM)

I. The QAM shall be a general comprehensive document outlining the AC Contractor's basic organization, policies and procedures. The information to be given in the QAM shall include but not limited to:

a. Quality Policy.
b. Quality Assurance Program
c. Organization Structure showing inter relationships.
d. Functional responsibilities and levels of authority.
e. Lines of communication.
f. Customer relations.
g. Laboratory Facilities.

8.6 Manufacturing Quality Assurance Programme (MQAP)

I. The MQAP shall identify the AC Contractor's Quality Assurance Program at works applicable throughout all phases of Contract performance, including design, procurement, manufacture, inspection and testing. It shall identify each of the program elements to be designed, developed, executed and

maintained by the AC Contractor for the purpose of ensuring that all supplies and services comply with these specifications.

II. The information to be given under this program shall include but not limited to :

a. Organization and Responsibility.
b. Contract Review.
c. Design and Document Control.
d. Procurement Control.
e. Production Control.
f. Control on Subcontractors.
g. In-process Quality Control and Traceability.
h. Inspection and Testing.
j. Control of Non-conformances.
k. Corrective Action.
l. Control of Inspection, Measuring and Test Equipment.
m. Handling, Storage, Packaging and Delivery.
n. Records.
p. Quality Audits.
q. After - Sales Servicing.

8.7 Field Quality Assurance Programme (FQAP)

I. This programme shall identify the AC Contractor's Quality Assurance Program at site applicable throughout site construction, erection and commissioning. It is the underlying philosophy that the quality built into the product at works shall be maintained throughout the construction and commissioning stages.

II. While, in principle, the FQAP shall include the items discussed in MQAP, it shall, however, be approached differently to take into account site conditions.

III. The FQAP shall include, but not limited to the following information:

a. Organization and responsibility.
b. Control of Drawings and Documentation.
c. Product Checklist.
d. Control and Traceability of Purchased materials and services.
e. Receipt Inspection of materials at site.
f. Material Storage Control.
g. Inspection and Examination Procedures.
h. Control of Painting and Insulation Works.
j. Pre-commissioning.
k. Commissioning.
l. Control of Non-conformances.

m. Corrective Action.
n. Control of Inspection, Measuring and Test Equipment.
p. Records.
q. Completion Documents.
r. List of recommended spares and tools.
s. Personal Training.
t. Servicing during DEFECTS RECTIFICATION PERIOD.

8.8 Quality Plan

I. The AC Contractor shall be required to prepare manufacturing and construction/erection quality plans for all equipment items and services. The quality plan shall also define the involvement of Consultant / Client or his authorised representatives in the inspection and test programs.

II. The Quality Plan shall incorporate as appropriate:

a. Charts indicating flow of materials, parts and components through manufacturing quality control inspection and test to delivery and erection.
b. The charts shall indicate the location of hold points for quality control, inspection and test beyond which manufacture shall not continue until the action required by the hold point is met, and the documentation required is generated.
c. The control documents Assoc.ciated with each hold point, i.e. drawings, material, specification, Works Process Schedule (WPS), Process Quality Records (PQR), quality control methods and procedures and acceptance standards.

8.9 Site Quality Control Section

I. The AC Contractor's Quality Control (Q.C.) section shall be headed by an experienced Quality Control Engineer. He shall be assisted by other supervisors. The section shall bean independent one, reporting to the AC Contractor's Site Manager only on administrative matters, but otherwise under full control by the AC Contractor's Corporate Quality System Management.

II. The AC Contractor's Q.C. Section shall liaise closely with the Consultant's or his authorized representatives in charge of Quality Assurance/Quality Control, and to whom it shall give fullest cooperation. It is the underlying principle of this contract document that while the AC Contractor's Q.C. Engineer implements the Consultant's Quality Program, the adequacy and effectiveness of that implementation shall be audited by the Consultant / Client or his authorised representatives whose recommendations on improving or maintaining quality shall be acted upon promptly by the AC Contractor's Q.C. Section.

8.10 Inspection and Testing

I. All equipment and components supplied may be subjected to inspection and tests by the Consultant / Client or his authorised representatives during manufacture, erection/installation and after completion. The inspection and tests shall include but not be limited by the requirements of this contract document. Prior to inspection and testing, the equipment shall undergo pre-service cleaning and protection.

II. Tenderers shall state and guarantee the technical particulars listed in the Schedule of Technical Data. These guarantees and particulars shall be binding and shall not be varied without the written permission of the Consultant / Client or his authorised representatives.

III. No tolerances shall be allowed other than the tolerances specified or permitted in the relevant approved Standards, unless otherwise stated.

IV. 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 Consultant / Client or his authorised representatives may reject the item, or defective component thereof, whichever he considers necessary; and after adjustment or modification as directed by the Consultant / Client or his authorised representatives, the Consultant shall submit the item for further inspection and /or test.

V. The acceptance of the Consultant / Client or his authorised representatives of inspection and / or test results shall not prejudice the right of the Consultant or his authorised representatives to reject an item of equipment if it does not comply with the contract document when erected, does not or prove completely satisfactory in service.

VI. The Consultant / client's representative shall be responsible for the timely transmission of the relevant and appropriate sections of the contract document to manufacturers and AC Contractors for the proper execution of all tests at their works as per contract specifications.

8.11 Tests at Manufacturer's Works

I. All tests to be performed during manufacture, fabrication and inspection shall be agreed with the Consultant or his authorised representatives prior to commencement of the work. The AC Contractor shall prepare the details of the schedule and submit these to the Consultant / Client or his authorised representatives for endorsement. It must be ensured that adequate relevant information on the design code/standard employed, the manufacture /fabrication/assembly procedure and the attendant quality control steps proposed are made available to the Consultant / Client or his authorised

representatives who will mark in the appropriate spaces his intention to attend or waive the invited tests, or inspections. AC Contractor shall arrange inspection and factory witness test for chiller.

II. A minimum of fifteen days' notice of the readiness of equipment for test or inspection shall be provided to the Consultant / Client or his authorised representatives by the AC Contractor (whether the tests be held at the Subcontractor of AC Contractor's works). The subject items should remain available for Consultant / Client or his authorised representatives inspection and test up to a minimum 10 days beyond the agreed date of witnessing the test. Every facility in respect of access, drawings, instruments and manpower shall be provided by the Subcontractor and AC Contractor to enable the Consultant / Client or his authorized representatives to carry out the necessary inspection and testing of the Plant.

III. No plant shall be packed, prepared for shipment, or dismantled for the purpose of packing for shipment, unless it has been satisfactorily inspected, all tests called for have been successfully carried out in the presence of the Consultant / Client or his authorised representatives or approved for shipment, or alternatively inspection has been waived.

IV. Functional electrical, mechanical and hydraulic tests shall be carried out on completed assemblies in the works. The extent of these tests and method of recording the results shall be submitted to, and agreed by, the Consultant / Client or his authorised representatives in sufficient time to enable the tests to be satisfactorily witnesses, or if necessary for any changes required to the proposed program of tests to be agreed.

V. The Consultant / Client or his authorised representatives reserves the right to visit the Manufacturer's works at any reasonable time during fabrication of equipment and to familiarize himself with the progress made and the quantity of the work to date.

VI. Within 30 days of completion of any tests, triplicate sets of all principal test records, test certificates and correction and performance curves shall be supplied to the Consultant / Client or his authorised representatives.

VII. These test records, certificates and performance curves shall be supplied for all tests, whether or not they have been witnessed by the Consultant / Client or his authorized representatives or not. The information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificate refers and should also bear the Contract reference title.

VIII. When all equipment has been tested, the test certificates from all works and site tests shall be compiled by the AC Contractor into volumes and bound in

an approved from complete with index and four copies of each volume shall be supplied to Consultant / Client or his authorized representatives.

IX. Stage wise inspection of equipment in factory in waived.

8.12 Performance Tests at Manufacturer's Works

I. All equipment may be subjected to routine performance tests at the Manufacturer's Works in accordance with the relevant ANSI, ASME, ASTM, BIS standard including operating tests of complete assemblies to ensure correct operation of apparatus and components.

II. Pumps, fans, compressor, and other rotating equipment shall be given full load tests, and run to 15% over speed for 5 minutes to check vibration. Main and auxiliary gear boxes shall be subjected to shock load tests and a six-hour endurance run at rated speed and maximum torque.

III. The AC Contractor shall submit single line diagrams including the layout of the Plant together with the location of test instrumentation and the principal dimensions of the layout. All calculations to derive performance data shall be made strictly in accordance with format given in the approved standards. Any alterations or deviations from the approved standard test layout or formulae shall be subjected to the prior endorsement of the Consultant / Client or his Authorised representatives.

IV. The performance test shall be conducted over the full operating range of the pump to a closed valve condition and a minimum of five measurement points covering the full range shall be taken. Curves indicating Quality vs. Head, Quantity vs. Power absorbed, and Quantity vs. Pump efficiency shall be provided. In addition a curve of the NPSH required vs. Quantity shall be provided except when the suction conditions do not require this test. Any proposal for the omission of this test shall be to the endorsement of the Consultant / Client or his authorised representatives.

V. On completion of the tests the AC Contractor shall submit a report showing the test results obtained together with the curves corrected to the site operating conditions.

END OF QUALITY ASSURANCE SPECIFICATION

9.1 TESTING, ADJUSTING AND BALANCING

The AC Contractor shall have a dedicated experienced, specialized, approved, testing and commissioning (T&C) team /agency responsible for coordination with other trades, preparation of T&C plan method statement & T&C procedures, organizing & scheduling the T&C activities along with the progress of works, supervision any re-testing, coordination with third parties for commissioning & certification, organizing & performing testing for satisfaction of all Statutory Bodies, T&C record documentation & handover

9.2 General

a. Testing, adjusting and balancing of heating, ventilating and air-conditioning systems at site.

b. Testing, adjusting and balancing of HVAC Hydronic system at site.

c. Testing, adjusting and balancing of exhaust system at site.

Comply with current editions of all applicable practices, codes, methods of standards prepared by technical societies and Assoc.ciations including:

ASHRAE : 2007 HVAC Application.

SMACNA : Manual for the Balancing and Adjustment of air distribution system.

d. AC Contractor shall submit a Test, adjust, balance procedure/method statements/charts for approval to Client.

9.3 Performance

a. Verify design conformity.

b. Establish fluid flow rates, volumes and operating pressures.

c. Take electrical power readings for each motor.

d. Establish operating sound and vibration levels.

e. Adjust and balance to design parameters.

f. Record and report results as per the formats specified.

9.4 Definitions

a. Test : To determine quantitative performance of equipment.

b. Adjust : To regulate for specified fluid flow rates and air patterns at terminal equipment (e.g. reduce fan speed, throttling etc.)

c. Balance : To proportion within distribution system (submains, Branches and terminals) in accordance with design quantities.

9.5 Testing, Adjusting and Balancing (TAB) Procedures

The following procedures shall be directly followed in TAB of the total system. Before commencement of each one of the TAB procedure explained hereunder, the AC Contractor shall intimate the Client about his readiness to conduct the TAB procedures in the format given in these specifications.

9.6 Air Systems

I. Ductable Unit Performance

The TAB procedure shall establish the right selection and performance of Ductable Unit with the following results :

a. Air-IN DB and WB temperature.
b. Air-OUT DB and WB temperature.
c. Dew point air leaving.
d. Sensible heat flow.
e. Latent heat flow.
f. Sensible heat factor.
g. Fan air volume.
h. Fan air outlet velocity.
i. Fan static pressure.
j. Fan power consumption.
k. Fan speed.

II. Air distribution

Both supply and return air distribution for each AHU and for areas served by the AHU shall be determined and adjusted as necessary to provide design air quantities. It shall cover balancing of air through main and branch ducts.

III. The Preparatory Work

To conduct the above test, following preparatory works are required to be carried out including the availability of approved for construction shop drawings and submittals:

a. All outside air intake, return air and exhaust air dampers are in proper position.

b. All system volume dampers and fire dampers are in full open position.

c. All access doors are installed & are air tight.

d. Grilles are installed & dampers are fully open.

e. Provision and accessibility of usage of TAB instruments for traverse measurements are available.

f. All windows, doors are in position.

g. Duct system is of proper construction and is equipped with turning vanes and joints are sealed.

h. Test holes and plugs for ducting.

9.7 Readiness for Commencement of Tab

Before starting of any of the tests, the readiness to do so should be recorded as per the prescribed check list.

SYSTEM READY TO BALANCE CHECK LIST (NOT LIMITED TO FOLLOWING)

Description	**Ready**		**Date**
	Yes	**No**	**Corrected**

1. HVAC Units
   a) Outdoor Units
      a) Outdoor Units Make and Model
      b) Type (Cooling or heat pump)
      c) Dimension of unit (Overall)
      d) Actual capacity (TR) at specified conditions
      e) Permissible length of refrigerant piping
      f) Type of compressor
      g) No. of compressor (each unit)
      h) No. of digital compressor Electrical characteristics
      i) Power consumption at
         ARI conditions for each
         capacity 100%
         75%
         50%
         25%

g) Manufacturer Type
h) Nominal capacity (TR)
i) Airflow Min/Max (CFM) Sound level (Hi/Lo)
j) Overall dimensions (L x W x H)
k) Unit weight (Kg)
l) Remote controller for each indoor unit (Yes/No)

b) Centralized Controller

c) Fans No. of controllers
d) Features
e) Power consumption
f) Technical brochures to be attached.

Rotation
Wheel clearance and balance
Bearing and motor lubrication
Drive alignment
Belt tension
Drive set screws tight
Belt guard in place
Flexible duct connector alignment
Starters and disconnect switches
Electrical service & connections.
Nameplate data

e) Vibration Isolation
Springs & Compression
Base Level & Free

2. Duct System
a) General
Manual dampers open & locked
Access doors closed and tight
Fire dampers open and accessible
Terminal units open and set
Registers and diffusers open and set
Turning vanes in square elbows
Provisions made for TAB measurements.
Systems installed as per plans.
Ductwork sealed as required
b) Architectural
Windows installed and closed.
Doors closed as required.
Ceiling plenums installed and sealed.
Access doors closed and tight
Air shafts and openings as required

APPENDIX-XXIX

INSTRUMENT CALIBRATION REPORT

PROJECT _____

S/N	INSTRUMENT/ SERIAL NO.	APPLICATION	DATES OF USE	CALIBRATION TEST DATE
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				

REMARKS

TEST DATE_____READINGS BY _____

APPENDIX-XXIX

AIR HANDLING EQUIPMENT TEST REPORT

PROJECT_____

SYSTEM/UNIT_____**LOCATION**_____

Description	**Data**
a) UNIT	
Make/Model No.	
Type/Size	
Serial Number	
Arr./Class	
Discharge	
Pully dia/Bore	
No. Belts/make/size	
No.Filters/type.size (Pre.)	
No.Filters/type/size (secondary)	
b) MOTOR	
Make / Frame	
H.P / RPM	
Volts/Phase/cycles	
F.L amps.	
Pully Dia/Bore	
Pully /Distance.	
Total Cfm	
Total S.P	
Fan RPM	
Motor Volts. T	
Outside air Cfm	
Return air Cfm	
Discharge S.P	
Cooling Coil S.P	
Filters S.P	

REMARKS

TEST DATE_____**READINGS BY** _____

APPENDIX-XXIX

FAN TEST REPORT

PROJECT_____

FAN DATA Location	**FAN NO.**	**FAN NO.**	**FAN NO.**
Service Manufacturer			
Model No. Serial No. Type / Class Motor Make / Style Motor H.P/RPM/ Frame Volts/Phase/Cycles F.L Amps. Motor pully Dia./Bore Fan pully Dia./Bore No. Belts/ Make/Size Pully Distance. CFM FAN RPM S.P IN/OUT			
TOTAL S.P Voltage Amperage			

REMARKS

TEST DATE_____**READINGS BY** _____

APPENDIX-XXIX

RECTANGULAR DUCT TRAVERSE REPORT

FPM_____CFM_____ **FPM_____CFM_____**

PROJECT

SYSTEM

LOCATION / ZONE

ACTUAL AIR TEMP.

DUCT S.P

DUCT

REQUIRED

ACTUAL SIZE_____SQ.FT._____

APPENDIX-XXIX

POSITION	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
VEL1OCITY SUBTOTALS											
REMARKS											

TEST DATE_____READINGS BY _____

APPENDIX-XXIX

GRILLES AND DIFFUSERS TEST REPORT

PROJECT_____SYSTEM _____

OUTLET_____MANUFACTURER_____

TEST APPARATUS_____

S/N	AREA SERVED	OUT LET NO./TYPE/SIZE	DESIGN CFM/VEL	PRLIMINARY VEL/CFM	FINAL VEL/CFM
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					

REMARKS

TEST DATE_____READINGS BY _____

END OF TESTING, ADJUSTING & BALANCING SPECIFICATION

10.1 PAINTING WORK

This section deals with painting of various equipment / material supplied under this contract. It gives basic guidance for painting as specified below:-

Application : The original colour of all equipments like water chilling machines, air-handling units etc. which if get damaged during transportation or during installation shall be painted in original shade with the two coat of paint to give a final finish.

All AC works shall be painted as per standard code and requirement of practice and arrows shall be marked to indicate direction of flow of water.

10.2 Colour Scheme For The Equipments / Materials

Description	Standard Colour & Reference	Lettering Colouring
Exposed Duct Work (other than plant room)	To requirement	Contractor instruction
Air Conditioning Duct Work (Plant Rooms)	BSS 111 Pale Blue	Black
Ventilation Duct Duct Work (Plant Rooms)	BSS 111 Pale Blue	Black
Conditioner Casings Air Handling Units, Filter Plenums	BSS 111 Pale Blue	Black
Electrical (Conduit Ducts and Motors)	BSS 557 Light Orange	Black
Chilled Water Pipe	Jade Green	Black
Drains	Black	White
Vents	White	Black
Fans	BSS 111 Pale Blue	Black
Valves and Pipe Line Fittings	White with black handles	Black
Beltquards	Black and yellow diagonal stripes (45 25 mm wide)	

APPENDIX-XXIX

Description	Standard Colour & Reference	Lettering Colouring
Switchboards- exterior – interior	BS 366 Light Beige	White
Machine Bases, Inertia Bases and Plinths	Charcoal	Grey
Chilling M/C	As Per Manufacturer's Standard	
Pump-sets	Battle ship grey	
Condenser water pipes	Light green	Black
Electrical panels/sub-panel/ remote control console	Light grey powder coated RAL 7032 as per DIN	
Supports for ducts		Silver

END OF PAINTING WORK SPECIFICATION

11.1 MODE OF MEASUREMENT

The following measurement code shall apply to the Contract:

11.2 Sheet Metal Work

11.1.1 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.

11.1.2 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.

11.1.3 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.

11.2 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) All kinds of supports, hangers etc shall be part of piping work & no extra measurements shall be done.

11.3 Insulation

11.3.1 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.

11.3.2 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.

11.3.3 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.

11.4 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.

11.5 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.

11.6 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.

END OF MODES OF MEASUREMENT SPECIFICATION

APPENDIX-XXIX

12.0 VENDOR APPROVAL & LIST OF MAKES

1. Contractor shall generally use the items/material of the makes as indicated in the below given list and as approved by the Employer/ Engineer.
2. The contractor shall ensure the correct selection of the make, meeting the technical specifications and all contractual, functional and application requirements. The technical submission made by the contractor should clearly indicate deviation or improvements (if any) from specifications. Before placing order for procurement, the Engineer may ask for the sample of the item/ material of proposed make to verify its suitability to the technical specification and all contractual, functional and application requirements. However, in case Employer / Engineer considers that the make / model proposed by the contractor does not meet the requirements, the contractor will propose an alternate make acceptable to the Employer/ Engineer. The decision of Employer/ Engineer in this regard shall be final and binding on the both the parties.
3. The alternate makes if contractor so wants, can be used only after Notice of No Objection accorded by the Engineer/Employer, whose decision will be final in the matter and binding.
4. Vendor selected by the contractor should be capable of providing good after sales service in Delhi area during DLP and thereafter.

General:

(a) It shall be obligatory for the Contractor to obtain "Notice of No Objection" from the Engineer for the vendors of all item/ material required for work, even if the name of the vendor is specified in the Contractor's Technical Submission..

(b) The contractor will submit a list 'A' of vendors (for all the items/ material required for works) which they are proposing from the make list.

The list should include the items/ material for which the contractor is proposing the product of the indicated vendor. The contractor will be advised 'No Objection' with following caveat -

- The model etc. to be supplied, will be the latest or superior one.
- The contractor will be required to submit the technical proposal for the scrutiny

For all the items/ material required for works, for which contractor wants to propose new vendor, the contractor shall submit a List 'B' .

The contractor shall submit the undertaking that above lists i.e. List 'A' and List 'B' includes all the items required to execute the works in the contract.

Vendor Approval and Selection Procedure

1. If the contractor wants to use alternate makes other than those stipulated, the contractor can send a proposal after ensuring that what they propose meets the technical specifications and all the contractual, functional and application requirements and the quality & safety standard of the stipulated makes. The alternate proposed product should be a proven one. He shall also stand full

guarantee to his alternate proposal and if at any stage it is found that the material is not suitable or meeting the tender requirement, the contractor shall replace the material and provide the material from the indicated vendor without any additional cost to OIL INDIA LIMITED (OIL). The alternate makes can be used only after a Notice of No Objection is accorded by the Employer/Engineer, whose decision will be final in the matter.

2. The approval of the vendor & Technical approval of any equipment or product to be used, shall be done in two stages: -

a. Stage-I

- Assessment of capability of proposed Vendor to supply a particular equipment or product, with quality and performance requirements, as required by the technical specification and all contractual, functional and application requirements. The proposed product/ vendor should be a proven product in service from last 5 years (at least).
- Assessment of the financial and functional strength of the Vendor to supply the requisite quantity of equipment and product as per delivery schedule acceptable to contractor and engineer to deliver the project in time.

b. Stage-II

This stage is called Technical Submission Stage, selection of Equipment or product from the equipment / products manufactured / supplied by the approved vendor will be done. This stage includes thorough technical assessments about the conformance of the offered equipment / product to the Specifications and other requirements.

c. To obtain Vendor Approval (especially in case of new vendor) the Contractor must apply with the four sets of the following documents to the Engineer

(i) Company Profile and Experience of the Vendor
(ii) Clause wise compliance of the relevant Clauses of Specifications.
(iii) Details of supplies / orders executed in last ten years for the type of equipment / product offered. Supplies / orders executed for underground metro/ rail stations shall be specifically mentioned
(iv) Details of the facilities available at the Works / Manufacturing Unit where the proposed equipment / product shall be manufactured.
(v) ISO 9000 Certification for the Works / Manufacturing Unit where the proposed equipment / product shall be manufactured (The Works / Manufacturing Unit where the proposed equipment / product shall be manufactured must have ISO 9000 Certification)
(vi) Proof regarding compliance to Manufacturer's Qualifications. The offered products must be proven in service.
(vii) Audited Financial Statements of the Vendor for the last three years.
(viii) Type test certificates/ Performance certificate from accredited laboratories for the proposed type of equipment / products to establish the technical capability of the vendor (In case, specific requirements are

mentioned in the relevant sections of Specifications with regard to type testing, same shall also be complied additionally).

(ix) The vendor shall not have been blacklisted by any Govt. Agency in India.

(x) Any other item as required by Employer / Engineer.

(xi). Contractor must certify the check list provided that vendor Proposal is complete and all the above documents are available in the Vendor Proposal. In addition, the Contractor must check / certify compliance to the Specifications before forwarding the same.

(xii).Incomplete Vendor Proposal will not be treated as a submission and will be returned and delay thereon will be responsibility of contractor.

(xiii) Engineer will give Approval to the Vendor Proposal (received complete with all the documents mentioned above) expeditiously.

(xiv) Technical submission shall be accompanied with the calculations / other technical documents to justify the selection of any particular model of equipment / product, detailed technical features / parameters of the selected product, type test certificates from the accredited laboratories for the offered products, any other document required by the Engineer.

(xv) Engineer will give Approval to the Technical Proposal (received complete with all the documents mentioned above) expeditiously.

d. It may be noted that Approval of Vendors/ Technical as per Point C above shall only be done by Employer / Engineer after the award of the work. Vendor/ Technical submissions shall not be evaluated during the tender evaluation. Conditional Tender offers received from Tenderers with particular Vendors for supply of equipment/ products will not be evaluated during evaluation and will be dealt with after award of the work.

e. It may further be noted that Employer / Engineer shall be under no obligation to accept equipment / products manufactured by the successful Tenderer, unless it meets the entire criterion mentioned above. The Employer/ Engineer's decision on contractor's proposal shall be final and binding.

In addition to above, the following shall also be ensured for approval of System/Product/ Vendor/ Sub-Vendor -

i. Proven Design

The Contractor shall develop the design based on this specification and on sound proven and reliable engineering practice. The broad design details shall be submitted with technical support data in the technical bid. Detailed calculations shall be submitted to the engineer during the design process stage for review and approval.

ii. Systems and Sub-Systems

Manufacturer shall have at least 5 years experience of design and manufacturing of similar system. Proposed systems from the proposed manufacturing unit shall have been in use and have established their satisfactory performance and reliability for 3 years in minimum.

All sub-systems, equipment and major components etc. (hereinafter referred as 'sub-systems') shall be state-of-art and of proven design.

Proposed Systems/ sub-systems shall have been in use and have established their satisfactory performance and reliability on at least two mass rapid transit system/ high speed/ big building projects (including Railway or Airports) in revenue service over a period of three years or more either outside the country of origin at an average in two different countries or in underground metro/ rail stations. Systems/ sub-systems/ components used in any other Metro do not get automatically qualified for use unless specifically approved by the Engineer for this project. If required by the Engineer, Contractor shall provides certificates of satisfactory performance for a period of five years or more from the Metro Operators. Where similar System/ Sub-system of a different rating are already proven in service as per the above criterion then the supply shall be based on such sub-systems.

All 'Sub- Systems' shall be procured from the approved vendors and sourced from only such manufacturing units that have supplied the sub-systems that fulfill the proven design requirements as above.

In case the contractor proposes to use systems or subsystem(s) that do not fulfill the above said criterion then the contractor shall furnish sufficient information to prove the basic soundness and reliability of the offered systems and subsystem(s) for review of the Engineer. The Engineer's decision on contractor's proposal shall be final and binding.

For sourcing the equipment from indigenous manufacturing facilities, following conditions shall be complied: -

i. In case the vendor uses his own facilities for indigenization after part supply of equipment from the approved manufacturing unit, no change in design, component type/make, quality standards, manufacture procedure, etc. shall be made without specific approval of the Engineer.

ii. In case OEM wants to use manufacturing facilities in India (other than his own) for items for which the OEM has been approved, it shall enter into an agreement with such selected Indian equipment manufacturer and obtain prior approval from OIL INDIA LIMITED (OIL). No change in composition, rating, type, model no., manufacturing process, quality standards, design, etc. and make of the components used in assemblies/sub- assemblies of such equipment as manufactured by the approved parent vendor shall be made without specific approval of the Engineer.

iii. In case OEM wishes to change/make/type specifications, etc. of any sub-components for supplies to be sourced from Indian facility, specific prior approval of the Engineer shall be obtained for changes made, model, specification, etc. Responsibility for obtaining such prior approval shall rest solely with the contractor.

Format for submitting the vendor approval request shall be given to the contractor during initial stages and approved format shall be followed throughout the contract.

APPENDIX-XXIX

LIST OF MAKE

1.	VRV/VRF Units	Daikin, Toshiba, Blue Star, Mitsubishi
2.	HI Wall Split A.C Units	Daikin, Toshiba, Blue Star, Mitsubishi
3.	Air Handlers Unit	Waves / Edgetech / Caryaire (Flakt)
4.	Fan Coil Unit with AMCA Certified Fan for Sound & Performance	Waves / Edgetech / Caryaire (Flakt) /
5.	Refrigerant Copper Piping	Mandev tubes, Rajco, Mehta
6.	Acoustically Insulated Inline Fans	Ambassador / Wolter / Emerald / Eflow / Lloyd / Waves/System Air
7.	Axial Fan / Centrifugal Fan (AMCA Certified for Sound & Performance)	System Air / Krugger / Wolter / Greenheck
8.	Propeller Fan	Usha / Bajaj/Havells/GE
9.	Duct And Copper Tube Insulation	Armacell/K-Flex/Aeroflex/Thermobreak
10.	GSS & Stainless Steel Sheet	Tata/Jindal/Essar/Sail
11.	Factory Fabricated Duct	Rolastar/ShreVenus/Seven Star/Waves
12.	Fire Rated Paint (Gasket/Sealant)	Flamebar/Promat
13.	Fiber Glass Insulation	UP Twiga/K-flex/Ownes Coning
14.	Rockwool Insulation	Rockwool or Equivalent
15.	Fire & Smoke Damper Spring Type	Greenheck/Trox/Rustin Titus
16.	Extruded aluminum grills / Diffusers/Louvers	Trox/Ruskin Titus/System Air/Air Master/ Mapro
17.	Manual VCD	Green Heck/Trox/Air Master/Rustin Titus/System Air/ Cosmic
18.	Variable Air Volume	Trox/Barcol Air/Trane
19.	Variable Frequency Drive	Danfoss/ABB/Schenider
20.	High Temperature VCD	Rustin Titus/Green heck/Trox
21.	NRD –Non Return damper and PRD-Pressure Relief damper	Rustin Titus/Green heck/Trox
22.	Sound Attenuator	Rustin Titus/Green heck/Trox/Kruger /System air
23.	Pre, Fine & Hepa Filters	Thermodyne / Klenzoid / Purolator / Spectrum / Mechmark
24.	Vibration Isolation Spring & Flexible Pipe Connector	Resistoflex / Dunlope/ Kanwal Industries
25.	Closed Cell Fire Retardant XPE (For Duct Insulation)	Paramount / Supreme / Aeroflex
26.	Expanded Polystyrene (For Underdeck / Overdeck Insulation)	Mettur Beardsell / Styrene Packing / Toshiba

27.	Fibre Glass Rigid Board	U.P.Twiga / Owen corning / Kimco

28	Paints	ICI / Asian/Equivalent
29.	Tar felt / CPRX compound	Shalimar tar product
30.	Dash Fasteners	Canon / Fisher / TKS
31.	Welding Rods/Electrodes	Profab/Indiana/Rukumani
32	Fire Stopping/fire Sealant	Hilti/3M/Flame Bar /Mupro
33.	Support material For Duct, Pipe & refrigerant Tray Works	Hi tech/Mupro/Hilti/Gripple
34.	Humidifier	KEPL / Emerald/Rapid Cool
35.	Humidistat	Siemens / Johnson / Honeywell / Danfoss / Sauter Race
36.	UPVC-Drain Pipe	Astro/Supreme/Appollo pipe
37.	Insulated Flexible Duct	Caryaire / Atco
38.	Anchor Fasteners	Hilti/Fisher/Rawal plug
39.	Smoke Sensor	Siemens / Honeywell / Johnson / MSR Electronic
40.	Any Missing Item	Prior Approval from OIL INDIA LIMITED (OIL)/OIL INDIA LIMITED (OIL) Representative

NOTE: All makes shall confirm to standard specifications of each items as enclosed with the tender documents.

END OF SCHEDULE OF MAKES

APPENDIX-XXIX

13.0 EXCLUDED ITEMS FROM THE SCOPE OF HVAC CONTRACTOR

a) Housing of equipments.

b) Foundations of all equipments, supporting structure for VRV outdoor unit etc.

c) Main incoming stabilised power supply with double earthing in the Main Panel i.e. 415 ±10 % volts, 50 Hz ± 5% AC supply.

d) Any kind of masonry work such as openings in walls/slabs and making good thereof.

e) Any kind of false ceiling work, return air boxing, wooden / aluminium frames for fixing grills / diffuser.

g) Drain points in near each indoor unit.

h) Power and water for erection, testing and commissioning of the HVAC System.

i) Any kind of masonry shafts & trenches for laying pipes / cables / ducts etc.

END OF EXCLUDED ITEMS WORK

14.1 IDENTIFICATION OF SERVICES

14.2 General

This section comprises of identification of services for each piece of equipment

14.3 Identification of Services

Pipe work and duct work shall be identified by colour bands 150 mm. wide or colour triangles of at least 150 mm. / side. The bands of triangles shall be applied at termination points, junctions, entries and exits of plant rooms, walls, in ceiling spaces, ducts and control points to readily identify the service, but spacing shall not exceed 4.0 metres.

14.3.1 Pipe Work Services

For pipe work services and its insulation the colours of the bands shall comply with BS.1710: 1971.

Basic colours for pipe line identification:

Pipe Line Contents	BS. 4800 Colour Reference	Colour
Water	12 D 45	Green
Steam	10 A 03	Grey
Oils	06 C 39	Brown
Gas	08 C 35	Yellow / Brown
Pipe Line Contents	BS. 4800 Colour Reference	Colour
Air	20 E 51	Blue
Drainage	00 E 53	Black
Electrical	06 E 51	Orange

Colour code indicator bands shall be applied as colour bands over the basic identification colour in the various combinations as listed below :-

Pipe Line Contents	**Colour Bands to BS. 4800**
Water Services :	
Cooling	00 E 55
Fresh / drinking	18 E 53
Boiler feed	04 D 45/00 E 55 / 04 D 45
Condensate	04 D 45/14 E 53 / 04 D 45
Chilled	00 D 55/14 E 53 / 00 D 45
Central Heating Services :	
Below 100 Deg. C	18 E 55/04 D 45/18 E 53

Pipe Line Contents	**Colour Bands to BS. 4800**
Above 100 Deg. C	04 D 45/18 E 53 /04 D 45
Cold Water Storage	
Tanks:	00 E 55/18 E 53/00 E 55
Hot Water Supply	00 E 55/04 D 45/00 E 55
Hydraulic Power	04 C 33
Sea / River Untreated	Basic Colour only
Fire Extinguishing	04 E 53
Steam Services :	Basic Colour only
Air : Compressed	Basic Colour only
Vacuum	White
Town Gas : Manufactured	14 E 53
Natural	10 E 53
Oils :	
Diesel	00 E 55
Lubricating	14 E 53
Hydraulic Power	04 C 53
Transformer	04 D 45
Drainage and other fluids :	Basic Colour only
Electrical Services :	Basic Colour only

In addition to the colour bands specified above all pipe work shall be legibly marked with black or white letters to indicate the type of service and the direction of flow, identified as follows:-

High Temperature Hot Water	HTHW
Medium Temperature Hot Water	MTHW
Low Temperature Hot Water	LTHW
Chilled Water	CHW
Condenser Water	CONDW
Steam	ST
Condensate	CN

Pipe shall have the letters F and R added to indicate flow and return respectively as well as directional arrows.

14.3.2 Duct Work Services :

For Duct work services and its insulation the colours of the triangles shall comply with BS.1710 : 1971. The size of the symbol will depend on the size of the duct and

the viewing distance but the minimum size should not be less than 150 mm. length per side. One apex of the triangle shall point in the direction of airflow.

Services	Colour	BS.4800 Colour Reference
Conditioned Air	Red and Blue	04 E 53 / 18 E 53
Ward Air	Yellow	10 E 53
Outdoor air	Green	14 E 53
Exhaust / Extract / Recirculated Air	Grey	AA 0 09
Foul Air	Brown	06 C 39
Dual Duct System Hot Supply Air	Red	04 E 53
Cold Supply Air	Blue	18 E 53

In addition to the colour triangles specified above all duct work shall be legibly marked with black or white letters to indicate the type of service, identified as follows:-

Supply Air	S
Return Air	R
Outdoor Air	O
Exhaust Air	E
Smoke Extract Duct	M
Spill Air	A

The colour banding and triangles shall be manufactured from self adhesive cellulose tape, laminated with a layer of transparent ethyl cellulose tape.

END OF IDENTIFICATION OF SERVICES SPECIFICATION

15.1 PERFORMA OF TECHNICAL DATA TO BE FILLED UP BY THE AC CONTRACTOR

Contractor should furnish technical data as mentioned below, of the equipment and accessories offered by him as per scheme, specification, bill of quantities given in the tender.

Appendix – A

15.2 TECHNICAL DATA TO BE FURNISHED BY THE TENDERER FOR THE VRF/VRV SYSTEM

Tenderers are required to separately fill the Data for each rating of the equipment offered.

S. No.	System Offered	VRF/VRV
1.0	**OUTDOOR UNITS (ODU)**	
1.1	Make and model number of the compressor	
1.3	Normal rating of the Outdoor unit	
1.4	Actual rating of the ODU	
1.5	Number of compressors in each outdoor unit	
1.6	Type of compressor	
1.7	No. Of Inverter Compressor	
1.8	Capacity of each compressor	
1.12	Motor rating of each compressor	
1.13	AC or DC motor	
1.14	Type of starter for the compressor motor	
1.16	Type of refrigerant	
1.17	Starting Current	
2.0	**INDOOR UNITS (IDU)**	
2.1	Make and model number of the IDU	
2.2	Material of construction	
2.3	Type of indoor unit	
2.4	Type of mounting of the indoor unit	
2.5	Power consumption of each indoor unit at full load	
2.6	Air flow through the indoor unit	
2.7	Type of fan for the indoor units	
2.8	Make and model number of the fan	

2.9	Number of indoor units connected to one circuit	
2.10	Type of expansion valve	
2.11	Make and model number of the expansion valve	
3.0	**REFRIGERANT PIPING**	
3.1	Dia and thickness of cold refrigerant pipe	
3.2	Dia and thickness of hot refrigerant pipe	
3.3	Field test pressure for the refrigerant piping	
3.4	Type of insulation material for the refrigerant piping	

15.3 Duct Insulation

a) Manufactures Name :

b) Material :

c) Density Kg. Per Cmt :

d) Thermal Conductivity Kcal / Hr. Deg. C. :

e) Facing / finish of Insulation :

15.4 Duct Lining

a) Manufactures Name :

b) Material :

c) Density Kg. Per Cmt :

d) Thermal Conductivity Kcal / Hr. Deg. C. :

15.5 Pipe Insulation

a) Manufactures Name :

b) Material :

c) Density Kg. Per Cmt :

d) Thermal Conductivity Kcal / Hr. Deg. C. :

15.6 Axial Flow Fan

a) Manufactures Name :

b) Capacity CMH :

c) Static Pressure :

d) Motor BHP & HP :

e) Fan Diameter mm :

f) Efficiency of Fan :

g) dB level at 2.5 Meter :

h) RPM of Fan :

15.7 Centrifugal Fan

a) Manufactures Name :

b) Capacity CMH :

c) Static Pressure :

d) Motor BHP & HP :

e) Fan Diameter mm :

f) Efficiency of Fan :

g) dB level at 2.5 Meter :

h) RPM of Fan :

15.6.1 Fan & Fan Motor

a) Make of Fan & Motor :

b) Type of fan :

c) No. of fans :

d) Width and dia of fans (MM) :

e) Type of blade :

f) Air quantity CMH :

g) Static pressure in wg :

h) Type of balancing :

i) Brake horse power in HP :

j) Horse power of motor in HP :

k) Motor RPM :

l) Fan speed :

m) Type of Drive (Belt Driven / Direct Driven) :

15.8 Inline Fans

a) Manufactures Name :

b) Capacity CMH :

c) Static Pressure :

d) Motor BHP & HP :

e) Fan Diameter mm

15.9 Grills / Diffusers / Dampers

Please indicate make / material / gauge of the following:

a) Duct Dampers

b) Grills / Diffusers :

c) Fire Dampers :

d) Smoke & Temperature Sensor :

e) Volume Control Dampers :

APPENDIX-XXIX

15.10 Ductable Unit

a)	Air quantity CFM	:
b)	Fan Static pressure (External) in mm	:
c)	Face area of Cooling Coil	:
d)	Minim. no. of fins / cm	:
e)	No. of rows deep	:
f)	Motor HP	:
g)	Sandwiched tray	:
h)	Type of painting	:
i)	Noise Level in db at a distance of 1.0 m	:
k)	Make	:

END OF TECHNICAL DATA TO BE FILLED BY AC CONTRACTOR

END OF APPENDIX-XXIX

TECHNICAL SPECIFICATIONS

PLUMBING AND FIRE FIGHTING SERVICES

CONTENTS

END OF CONTENTS

1.1 TECHNICAL SPECIFICATIONS

1.2 Sanitary Fixture & Fitting

1.2.1 Scope of Work

Work under this section shall consist of furnishing all labour as necessary and required to completely install all Sanitary Fixtures, Brass and Chromium plated fittings and accessories as required.

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 as per relevant IS codes.

1.2.2 European Water Closest

General

The item pertains for providing white or colour glazed vitreous chinaware European water closet with seat and cover of size and colour as specified in the schedule including fixing.

Material

European type water closet shall be washing down pattern unless otherwise specified. Water closet shall be vitreous china conforming to IS 2556 (Part-I & II). The closet shall be of one piece construction and shall have minimum two hole of 6.5 mm diameter for fixing closet to floor. Closet shall have an integral flushing rim of self draining type. Each water closet shall have an integral

Trap with either `S` or `P` outlet with and trap shall be uniform and smooth in order to enable an efficient flush. Plastic seat and cover shall be of black colour or as specified, they shall have conformity to IS2548 Part I & II.

Fixing

The water closet pan shall be placed in position. If the pan trap is damaged during handling or fixing, it shall be replaced by the contractor at his own cost. The pan, soil pipe shall be jointed in 1:1 Cement Mortar with hemp yarn caulked. The gap between W.C. and floor shall be finished with white/matching cement and sand as directed. Seat and cover shall be fixed to the Pan by two corrosion resistance hinge with 65 mm shank and threaded to within 25 mm from of flange. Seat shall be fixed in level by providing the washers of rubber with non ferrous or stainless steel washer to bolt.

1.2.3 Indian Water Closest

General

The item pertains for providing white or colour glazed vitreous chinaware Indian 84 water closet of size and colour as specified in the schedule including fixing.

Material

EWC is of white or colour glazed vitreous China conforming IS 2556 Part III. Pan shall have flushing rim and are inlet of self draining type. It shall have weep hole at the following inlet to the Pan. The flushing inlet shall be in front unless otherwise specified. The inside of the bottom of the pan shall have sufficient slope from the front to the outlet and surface shall be uniform and smooth to enable easy and quick disposal while flushing. The exterior surface of the outlet below the flange shall be an unglazed surface which shall have groove at right angle to the axis of the outlet. In all the cases pan shall have be provided with 100 mm Glazed Vitreous China `P` or `S` trap with 50 mm water seal and 40 mm size vent harm

Fixing

The water closet pan shall be placed in position. The EWC shall be supported on brick masonry in CM 1:4 or as directed by the Engineer-in-charge. The pan shall be fixed slightly lower than the floor level. If the pan or trap is damaged during handling of fixing, it shall be replaced by the contractor at his own cost. The pan, trap and C.I. pipe shall be jointed in 1:1 Cement Mortar with hemp yarn caulked. The gap between W.C. and floor shall be finished with white/matching cement as directed.

1.2.4 Lavatory Basin

General

The item pertains for providing colour or white glazed vitreous chinaware wash basin with or without pedestal of size and colour as specified in the schedule including fixing.

Material

Wash basins shall be of vitreous china conforming to IS : 2556(Part-IV) of flat back or angle back as specified shall be of one piece construction including combined over flow, basin shall be provided with single or double tap holes of size 28 mm square or 30 mm rounded. Each basin shall have circular waste hole, or 5 sq.cm slot type over flow. Pedestals for wash basin shall be exactly same glazing that of basin. Pedestal shall be capable of supporting the basin and completely recessed at the back to accommodate supply and waste pipes and fittings. The basin shall be supported on pan of C.I Cantilever brackets conforming to IS 775. Use of MS angle or Tee Section as bracket is not permitted.

Fixing

The wash basin shall be fixed in position. Basin shall be supported on a pair of C.I brackets which is embedded in cement concrete (1:2:4) block 100 x 75 x 150 mm. Oval shape or round shape wash basins are required to be fixed in RCC platform with stone tapping either fully sunk in stone top or flush with stone topping. The wall plaster on seat shall be cut to rest over the top edge of the basin so as not to leave any gap for water seepage through between wall plaster & skirting of basin. The gap between basin and wall shall be finished with white matching cement.

1.2.5 Urinal

General

The item pertains for providing colour or white glazed vitreous chinaware urinal in single or range (1, 2 & 3) and size as specified in the schedule with necessary fittings and appliances including fixing.

Material

Bowl Type with Flushing Rim: Urinal basin shall be flat back or corner wall type lipped in front. The vitreous china conforming to IS 2556 (Part VI). Urinal shall have and integral flushing rim and inlet or supply horn for connecting flush pipe. Flushing rim and inlet shall be of the self draining type. at bottom of basin and outlet horn for connecting outlet shall be provided. The inside surface of the urinal shall be uniform and smooth throughout to ensure efficient flushing.

Bowl Type Flat Back without Flushing Rim: They shall be of vitreous china Conforming to IS: 2556 (Part-VI) constructed in one piece with providing slot or alternative fixing Arrangement at flat back and where the integral flushing rim is not provided, they shall be provided with ridges inside the bowl to divert towards the front line of the urinal.

Stall Urinals: The stall urinal and its screen shall be glazed fire clay conforming IS: 771(Part-III, Sec-2). The inside surface of stall and screen shall be regular and smooth throughout to ensure efficient flushing.

CP Brass Flush Pipe: The flushing arrangement to urinals for single or in range shall be of CP brass with CP brass spreader of 15 mm dia conforming to IS: 407. The capacity of flush pipe for urinal in a range shall be as follows:

Nos. of urinals in range	Capacity of flush tank	Size of C.P. brass Flush pipe	
		Main	Distribution
One	5 litres	15mm	15mm
Two	10 litres	20 mm	15 mm
Three	10 litres	25 mm	15 mm

Fixing

Bowl Type Flat Back without Flushing Rim: Urinal shall be fixed in position by using rawl plug, wooden plug, C.P screws etc. It shall be fixed at height of 65 cm from the standing level to the top of the lip of urinal or as directed by the Engineer-in-charge. Each urinal shall be connected with 32 mm size waste pipe which shall discharge into channel or a floor trap

Stall Urinals: The stall urinal shall be flush with the finished floor level. The stall urinal shall be laid over a fine sand cushion on average 25 mm thickness. The gap between wall surface, finished floor level and urinals shall not be more than 3mm and filled with water proofing plastic compound.

CP Brass Flush Pipe: The flushing arrangement to urinal in single or range shall be of CP brass from 25 mm dia to 15 mm dia and CP brass spreader of 15 mm size to each urinal including the cost of CP brass elbows, tees, coupling, crosses, clamps, clips, union CP brass check nut and screws etc. CP brass

uPVC 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.

1.2.6 Flushing Cistern

General

The item pertains to provide white or colour glazed chinaware / PVC flushing cistern with all inside syphonic fitting including fixing.

Material

The flushing cistern shall be automatic or manually of rates high level or low level as specified for water closets and urinals. Cisterns shall be of cast iron, vitreous china, enamelled pressed steel conforming to IS 774 for Flushing Type and IS 2326 for Automatic flushing cistern and Plastic (IS 7231). Cistern shall be mosquito proof. All working parts shall be designed to operate smoothly and efficiently. the cistern shall have removable covers which shall fit closely on it and be screwed against top displacement where operating mechanism is attached to the cover. This may be made in two section, but the section supporting the mechanism shall be securely fitted or screwed to the body. The outlet fitting of the cistern shall be securely connected to the cistern. The nominal internal diameter of the cistern outlet shall not be less than 32 mm and 38 mm for high level and low level respectively. Length of outlet cistern shall be 37 +/- 2 mm. Ball valve shall be screwed type 15 mm in diameter and shall confirm of IS 1703. The flat shall be made of polyethylene as specified in IS 9762. A high level cistern is intended to operate with minimum height of 125 cm and a low level cistern with maximum height of 30 cm between the top of the pan and under side of the cistern. A G.I chain strong enough to sustain a sudden applied pull of 10 kg or a dead load of 50 kg without any apparent or permanent deformation of the chain rings shall be attached to the ring or hook of the level manually operated high level C.I cistern. In case of low level cistern handle shall be of CP brass. In case of Plastic cistern, operation of cistern shall be through Push Button at the top for dual system and beyond plastic handle.The discharge rate of the cistern as per IS

774 shall be 10 +/- .5 litres 6 second and 5 +/- .5 litres in 3 second for cistern capacity 10 ltrs. and 5 ltrs. respectively. Flush pipe shall be of class `B` G.I pipe of 32 +/- mm diameter for high level. Polyethylene flush pipe shall be low density confirming to IS 3076 or high density confirming to IS 4984 or UPVC pipe confirming to IS 4965 of 40 mm outer diameter. Over flow pipe shall not be less than +/- 5mm `B` diameter. It shall be of G.I valve with mosquito proof jalli of 1.25 mm dia.

Fixing

The chinaware flushing cistern shall be placed over a pair of C.I. brackets. C.P. brass flush pipe shall be fixed to cistern and W.C. pan using check nut, spun yarn, cement mortar etc.The cast iron flushing cistern shall be placed over a pair of C.I. or G.I. or PVC flush pipe of specified diameter shall be fixed to cistern and W.C. pan by using check nut, white zinc, spun yarn, cement mortar etc.The PVC flushing cistern shall be placed or fixed as recommended by the manufacturer, PVC flush pipe of specified diameter shall be fixed to cistern and W.C. pan by using check nut, white zinc, spun yarn, cement

1.2.7 Stainless Steel Sinks

General

Item includes providing the stainless steel sink with or without drain board of size as specified in the schedule including fixing.

Material

The sink shall be manufactured from stainless steel of Salem or equivalent steel conforming to IS: 13983. Stainless steel sink shall be of one piece construction moulded out of 19 SWG (1mm) stainless steel sheet of grade AISI 304 (18/8) with stainless steel choke – stop strainer (waste coupling) check nuts conforming to IS 13983.

Fixing

The sink shall be fixed in position. The sink shall be placed over the brackets or on the platform. Gap between sink and platform / wall shall be finished.

1.2.8 Glazed Fire-Clay / Vitreous China Sink

General

Item includes providing white or colour glazed -fire clay sink for kitchen or vitreous china sink for lab as specified in the schedule of quantities including fixing.

Material

Laboratory sink shall be of vitreous china confirming to IS 2556 (PART-V) and kitchen sink shall be of glazed fire-clay conforming to IS 771 (Part-II) and shall have combined over flow of the weir type and invert shall be 30 mm below the top edge. These shall be of one piece construction and floor of sink shall gently slope towards the outlet. The outlet of sink should be suitable for waste fitting having flanges 88 mm diameter and waste hole of 65 mm diameter. the waster hole shall be either rebated or beveled having the depth of 10 mm. C.I brackets for supporting sink shall confirm to IS: 775.

Fixing

The sink shall be supported on C.I cantilever brackets, embedded in cement concrete 1:2:4 block of size 100 x 75 x 150 mm. Bracket shall be fixed in the position before dado work is done. The height of front edge of sink from floor level shall be 80 cm or as directed by the Engineer-in-charge. The gap between floor/wall and sink shall finish with white cement.

1.2.9 Half Round Channel

General

The item pertains for providing colour or white glazed vitreous chinaware half round channel of size and colour as specified in the schedule including laying and fixing.

Material

The half round channel shall be of white or colour glazed vitreous chinaware of size as mentioned in the schedule with or without dead end and shall conform to IS 2556 part VII.

Fixing

The channel shall be laid to the correct alignment to required slope. It shall be fixed on 80 mm thick bed of 1:2:4 cement concrete. The channel shall be used in standard length. Pieces are not allow except where it is necessary to make up exact length.

1.2.10 Glass Mirror

General

The item providing beveled or plain edges mirror with or without frame of size as mentioned in the schedule including fixing.

Material

The mirror shall be of superior sheet glass with edges rounded off or beveled, size 600 x 450 mm unless specified in the schedule. It shall be free from flaws, specks or bubbles and thickness plated and should not be less than 6.0 mm. The back of mirror shall be uniformly silver plated and should be free from silvering defects. Silvering shall now have a protective uniform covering of red lid paint, where beveled edge mirror are not available. Fancy looking mirrors with PVC beading/border or aluminum beading on stainless steel beading/border based on manufacturer's specification, provided nothing extra shall be paid on this account. The backing of mirror shall be provided with 6mm thick marine plywood or environmentally friendly material other than asbestos cement sheet.

Fixing

Mirror shall be fixed in position with 6mm thick marine ply wood backing. It shall be fixed by means of 4 nos. of CP brass screws & caps over rubber washers and rawl plug or as per the manufacturer's specification unless specified otherwise the longer side shall be fixed horizontally.

1.2.11 Shower Rose & CP Fittings

General

The item pertains to provide chromium plated brass shower rose of specified diameter with accessories including fixing.

Material

The shower rose & CP fittings shall be CP brass of approved and heavy quality. It's accessories shall conform to IS 1239 Part II.

Fixing

Shower rose & CP Fittings shall be fixed to be water supply pipe line with necessary G.I fittings etc. as required by the Engineer-in-charge. Jointing shall be done with the zinc, spun yarn etc. A few turns of fine hemp yarn dipped in linseed oil shall be taken over the threaded ends to obtain complete water tightness. Leaky joint shall be remade to make it leak proof at his risk & cost.

1.2.12 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 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.

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.

1.2.13 Urinal Partitions

Urinal partitions shall be white glazed vitreous china or 25mm/40 mm thick marble of size of 690x325mm.

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.

1.2.14 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.

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.

1.2.15 Testing and Acceptance

Testing is done as per BS-5572

1.3 Internal Drainage Soil, Waste & Vent Pipes

1.3.1 Scope of Work

Work under this section shall consist of furnishing all labour, materials, equipments and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes.

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.

1.3.2 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 Hubless centrifugally cast (Span) iron pipes epoxy coated in sides and outside as per IS code 15905. & fittings (for Soil, waste, anti-siphon age pipes)

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.

1.3.3 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 or to an external manhole directly wherever feasible.

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.

f) Vent pipes shall be provided at all sewer lines at the starting manholes.

1.3.4 Rainwater Pipes

a) All terraces shall be drained by providing down-takes rainwater pipes.

b) A separate piped drainage system for slopping roof with leaders shall be provided.

c) Rainwater pipes are separate and independent connected to the external storm water drainage system.

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.

1.3.5 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.

1.3.6 C.I pipe for Soil & Waste

Soil, waste, vent and anti-siphonage pipes, fittings and accessories shall be cast iron pipes. All pipes shall be straight and smooth and their inside free from irregular bore, blow holes, cracks and other manufacturing defects. Pipes shall be centrifugally cast (spun) iron hub less soil pipes conforming to IS: 15905-2011.

1.3.7 Nominal & Minimum Thickness of Pipes & Fittings

For pipes conforming to IS: 15905 (centrifugally spun soil hub less pipes)

Nominal Size	Diameter	Pipe Thickness Nominal	Pipe Thickness Minimum	Fittings Thickness Nominal	Fittings Thickness Minimum
In	mm	mm	mm	mm	mm
2	50	3.5	3.0	4.2	3.0
3	75	3.5	3.0	4.2	3.0
4	100	3.5	3.0	4.2	3.0
5.	150	4.0	3.5	5.3	3.5

1.3.8 Tolerance

Acceptable tolerance for pipes to IS: 15905 shall be as follows:

Nominal Size	Diameter	External Diameter DE	Tolerance on External diameter DE
In	mm	mm	mm
2	50	58	+2 -1
3	75	83	+2 -1
4	100	110	+2 -2
5.	150	160	+2 -2

1.3.9 Fittings

Fittings shall conform to the same Indian Standard as for pipes. Contractor shall use pipes and fittings of matching specifications.

Fittings shall be of the required degree of curvature with or without access door or as directed.

Access door shall be made up with 3mm thick insertion rubber washer and white lead. The bolts shall be lubricated with grease or white lead for easy removal later. The fixing shall be air and water tight. Fitting shall be SS 304 coupling as per manufacture with EPDM gaskets.

1.3.10 Fixing

All vertical pipes shall be fixed by MS clamps truly vertical. 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).

Horizontal pipes running along ceiling shall be fixed on structural adjustable clamps of special design 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.

Conractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the building Contractor for making such provisions in the structure as necessary. All damages shall be made good by the Contractor at his own cost to restore the surfaces.

1.3.11 Clamps

Holder bat clamps shall be of standard design fabricated from MS flats 40x3mm thick and 12mm dia MS rod and 6mm nuts and bolts; painted with two coats of black bitumen paint before fixing. The clamps shall be fixed in cement concrete 1:2:4 mix (1 cement : 2 sand : 4 stone aggregate 20mm nominal size) blocks 100x100x100mm deep.

Where holder bat clamps are to be fixed in RCC column or slotted angles, walls or beam they shall be fixed with 40x3mm flat iron “U” type clamps with anchor fasteners of approved design.

Structural clamps shall be fabricated from MS structural members e.g. rods, angles, channels, flats or as directed. Contractor shall provide all nuts, bolts, welding material and paint the clamps with one coat of red oxide and two or more coats of black enamel paint to give an even shade.

Wherever MS clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement, RCC block and making good with cement concrete 1:2:4 mix (1

cement : 2 sand : 4 stone aggregate 20mm nominal size) as directed by the Architect/Consultants.

1.3.12 uPVC pipes for rain water system

Pipes

- All pipes shall be straight and smooth and inside free from cracks and other manufacturing defects. Pipes shall be conforming to I.S. 4985 (6kg/cm2) 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 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.

- Structural clamps shall be fabricated by electro-welding from M.S. structural members e.g. rods, angles, channels flats. 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 as required. 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

		<-------- Commercial Pipe Dia.(Spacing in m) ---------->						
S.No.	Type of Pipes & Position	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							
	Soil & Wate CI Pipes	x	x	<---------- 1 m ---------->				
1.3	uPVC /cPVC Pipes							
	IS 4985 for Water Supply	x	x	x		<----------1 m---------->		
	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							
	Soil & Waste Pipes			<---------- 1.0 m ---------->				
	IS							
	Water Supply Pipes uPVC					<----------1 m---------->		
	IS 4985							
2.3	Fittings	All traps and tees and fittings runing below ceiling shall be supported on both sides						

1.3.13 Traps

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.

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.

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 CI 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 CI. 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. CI 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	C.I.	75/100 mm dia 'P' or 'S'	50 mm
Urinals	C.I.	100 mm dia 'P' or 'S'	50 mm
AHU's	C.I.	75 mm dia 'P' or 'S'	50 mm

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.

1.3.14 Cleanout Plugs (On Soil Pipes)

Brass 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.

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 150 mm.

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.

1.3.15 Waste pipe from appliances

General

a) Waste pipe from appliances e.g. wash basins, sinks and urinals shall be of uPVC pipes 32, 40 mm conforming to IS:4985 (6kg/cm2).

b) All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase or as directed. 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.

Encasing Pipe in Cement Concrete

C.I (Cast iron) 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.

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.

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.

1.4 Excavation for Pipe Line

1.4.1 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.

1.4.2 Opening out Trenches

In excavation the trenches, etc. the solid road metal ling, 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 of 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.

1.4.3 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.

1.4.4 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.

1.4.5 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 inverts 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 required 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.

1.4.6 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.

1.4.7 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.

1.4.8 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.

1.4.9 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.

1.4.10 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.

1.4.11 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.

1.4.12 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.

1.5 Water Supply System (Cold & Hot)

1.5.1 Scope of Work

Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to completely install the water supply system as required & 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 tube well to raw water tank
c) Over Head Tank filling mains from hydro pneumatic system.
d) Distribution system from overhead tank to toilets and other wet area in the building except upper three floors.
e) Distribution mains from hydro pneumatic system to all fixtures and appliances for upper three floors to all buildings.
f) Excavation and refilling of pipes trenches.
g) 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.

1.5.2 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.

1.5.3 G.I. Pipes & Fittings

All pipes inside the building and pipes running in Shaft & terrace 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. 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 or as directed.

1.5.4 316 L Stainless Steel Pipes & Fittings for RO water supply

All pipes inside the building and pipes running in Shaft, terrace level & chases shall be Stainless steel pipes conforming to JIS 3448 grade 304 standard complete with press type fittings for Hot and cold water supply, RO water supply system capable to withstand temperature upto 110^0 centigrade and pressure up to 16 bars made from 304 grade of annealed and pickled stainless steel sheet, with ends deburred at 90^0 and with length of 3 meters. Pipe qualifying to 100% eddy current, 100% hydrostatic tested and air-under water tested under 10 kgs. Fittings also conforming to JWWAG-116 standard in AISI 304 stainless steel grade stainless steel grade in accordance with DVGW regulation such as tees, coupling, elbow, male adapter, connectors etc with Black grooved O-ring of EPDM material which can withstand temperature upto -20^0 to 110^0 C including suitable connection as per site requirement. Direct contact of stainless steel pipes and fittings to galvanized iron should be avoided by inserting approved type of filler material as per project manager's /consultant requirement. Flanges, clamps with hanger at spacing of 2 m centre to centre min or as required etc.

1.5.5 Clamps

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

1.5.6 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.

1.5.7 Flanges

Flanged connections shall be provided on pipes where required, 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.

1.5.8 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.

1.5.9 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.

1.5.10 Pipe protection

Where ever required all pipes below ground shall be protected against corrosion by wrapping 100mm wide and 4mm thick layer of PYPKOTE/MAKPOLYKOTE over the pipe.

1.5.11 Sand Filling

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

1.5.12 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.

1.5.13 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.

1.5.14 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 or as directed by Engineer-in-Charge.

1.5.15 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.

1.5.16 Insulation

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.

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

1.5.17 Anchor Block

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

1.5.18 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 and in drawings including excavation, back filling complete.

1.5.19 Water Meters

Water meters of approved make and design shall be supplied for installation at locations as per approved drawings. 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.

1.5.20 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.

1.5.21 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.

1.5.22 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

1.5.23 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 approved 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.

1.5.24 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.

1.5.25 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.

1.5.26 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).

1.5.27 Responsibility

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

1.6 Garden Hydrant System

1.6.1 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 labour, materials equipment and appliances necessary and required to completely install the garden irrigation system as required by the approved drawings, specified hereinafter and given in the approved 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.

1.6.2 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.

1.6.3 HDPE Pipes & Fittings

All pipes used in Garden hydrant System shall be HDPE (High density Poly Ethylene pipe and conforming to I.S. 4984 of class IV (6 kg/cmsq)

Fittings shall be HDPE fittings, of approved make.

Pipes and fittings shall be jointed with butt welding joint.

1.6.4 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.

1.6.5 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.

1.6.6 Pipe Protection

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

1.7 Sewerage / Drainage System

1.7.1 Scope of Work

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

1.7.2 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 un-obstructive 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.

1.7.3 Alignment and Grade

The sewer pipes shall be laid to alignment and gradient shown on the approved 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.

1.7.4 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.

1.7.5 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.

1.7.6 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 approved 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 approved 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.

1.7.7 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.

1.7.8 Laying

R.C.C. spun pipes shall be laid on cement concrete bed or cradles as specified and shown on the detailed approved 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

1.7.9 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.

1.7.10 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.

1.7.11 Curing

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

1.7.12 Cement Concrete and Masonry Works for Manholes and Chambers etc.

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.

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.

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.

Cement

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

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).

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.

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.

1.7.13 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.

1.7.14 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 approved drawing in cement mortar 1:5 mix (1 cement: 5 coarse sand). All joints shall be properly raked to receive plaster.

1.7.15 Cement Concrete for Pipe Support

Wherever specified or shown on the approved 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 approved 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 approved shop drawings.

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

1.7.16 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 approved shop drawing.

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

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

(All dimensions internal clear in cms)

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 coast 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.

1.7.17 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.

1.7.18 Commissioning

After successful testing of the different sewerage and drainage pipes in parts, the Contractor shall provide all facilities including necessary piping's, labours, 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 Leakages/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.

1.7.19 Desalting Chamber & Rain Water Harvesting Tank

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

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 4500mm. Pit shall be filled with boulders, gravel and coarse sand.

Bore shall be 450mm dia and pipe shall be 250 mm uPVC (10 Kg/cm2) pipe. 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.

1.8 Handing Over Procedure

1.8.1 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					

1.9 Fire Fighting System

1.9.1 Technical Specification

Work under this sub-head consists of furnishing all Labour, 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.

1.9.2 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.

1.9.3 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.

1.9.4 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.

1.9.5 Jointing

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)

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.

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.

Unions

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

1.9.6 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.

1.9.7 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 approved shop 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.

1.9.8 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.

1.9.9 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).

1.9.10 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.

1.9.11 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 approved shop 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.

1.9.12 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.

1.9.13 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 confirm 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.

1.9.14 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.

1.9.15 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.

1.9.16 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.

1.9.17 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 minimu requrement 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.

1.9.18 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.

1.9.19 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.

1.9.20 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

1.9.21 Portable Fire Extinguisher

Portable fire extinguishers shall be provided as per the approved shop drawing and shall confirm to 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)

1.9.22 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 approved 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 approved shop 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.

1.9.23 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.

1.9.24 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.

END OF PL & FF SECTION

2 SCHEDULE OF APPROVED MAKES

2.1 Plumbing & FF System

2.1.1 Plumbing System

1.	VITREOUS CHINA SANITARYWARE		HINDWARE / PARYWARE / JAQUAR /AQUAVIVA
2.	WC PAN CONNECTOR		SUPREME/PRINCE/MC ALPINE
3.	BATH FITTINGS		JAQUAR/ROCA/AQUPLUS /GROHE
4.	STAINLESS STEEL SINK		PARYWARE/NILKANTH
5.	AUTO URINAL FLUSH SYSTEM		EURONICS/CMR/ROCA
6.	HAND DRIER		EURONICS/CMR/KOPAL
7.	CISTERN		VIEGA/GEBRIT/HINDWARE
8.	CP BRASS FITTINGS		JAQUAR/ AQUPLUS/GROHE
9.	GEYSER		RACOLD/BAJAJ/HAVELLS
10.	FLOOR DRAIN FIXTURE RAIN WATER OUTLETS		VIEGA/GMGR/GEBRIT
11.	CP GRATING FOR FLOOR TRAP		VIEGA/GMGR/NEER
12.	CAST IRON PIPES & FITTINGS MANHOLE COVER & FRAME		
13.	A. AS PER IS:3989(PIPES & FITTINGS) OF CAST IRON PIPES & FITTINGS		NECO/KESORAM/SKF

14.	B. AS PER IS:1729(PIPES & FITTINGS) CAST IRON PIPES & FITTINGS		NECO/BIC/RAJ IRON FOUNDARY AGRA
15.	C. AS PER IS: 1536 (PIPES & FITTINGS) (CI CLASS LA PIPES)		NECO/ IISCO/KESORAM CALCUTTA
16.	D. DI MANHOLE COVERS & FRAMES		KARTAR VALVES & FITTINGS/ NECO/BIC
17.	CILA FITTINGS		KARTAR VALVES & FITTINGS/ NECO/BIC
18.	SUSPENDED MANHOLE & GULLY TRAP		PATEL PATTERN OR EQUIVALENT
19.	DRIP SEAL		ACQUA BOND/BINOD CEMENT COMPANEY/MEGGASEAL
20.	GI / MS PIPE (IS : 1239 and IS : 3589)		TATA STEEL/JINDAL(HISAR)/SAIL
21.	GI PIPE FITTINGS		NVR/MAC/ZOLOTO M/UNIK
22.	GI PIPE SEALENT		HENKEL- LOCTITE 55
23.	PIPE CLAMP & SUPPORT		CHILLY EURO CLAMP/KANWAL
24.	D.I PIPES		ELECTRO STEEL/JINDAL/LANCOKALAHASTHI
25.	UPVC PIPE		SUPREME/AKG/ASTRAL/FINOLEX
26.	CPVC PIPES		AJAY/ASHIRWAD/AKG/ASTRAL/SUPREME
27.	RCC PIPE		KK/PRAGATI/LOCAL ISI APPROVED

28.	STONEWARE PIPE,GULLEY TRAP		ANAND/RAJURA/PERFECT POTTERIES
29.	GM /FORGED BRASS BALL VALVES		DANFOS/KITZ/ UTAM
30.	SLUICE VALVE		AUDCO/LEADER/ ZOLOTO/CASTLE VALVE
31.	BUTTERFLY VALVE		AUDCO/LEADER/ ZOLOTO/CASTLE VALVE
32.	CHECK VALVE-WAFER TYPE		AUDCO/LEADER/ ZOLOTO/CASTLE VALVE
33.	CHECK VALVE-DUAL PLATE		AUDCO/LEADER/ ZOLOTO/CASTLE VALVE
34.	CHECK VALVE-FORGED SCREWED		AUDCO/LEADER/ ZOLOTO/CASTLE VALVE
35.	PRESSURE REDUCING VALVE		AUDCO/LEADER/ ZOLOTO/CASTLE VALVE
36.	SOLENOID VALVE		DANFOS/ HONEYWELL
37.	THERMOSTATIC VALVE		OVENTROP
38.	AIR RELEASE VALVE		ADVANCE/ ZOLOTO/AIP/LEADER
39.	BALL FLOAT VALVE		ZOLOTO/ VTM/ UTAM
40.	NRV-BALL TYPE-SEWAGE APPLICATION		DANFOS/SILVERSPARK/NORMEX/UTAM
41.	Y STRAINER CI		AUDCO/KITZ/VTM
42.	HYDROPNEUMATIC SYSTEM		GRUNDFOS/XYLEM/WILLO-MATHER & PLATT
43.	STORM WATER DRAINAGE & SEWAGE SUMP PUMPS		GRUNDFOS/XYLEM/WILLO-MATHER & PLATT

44.	TRANSFER PUMPS		GRUNDFOS/XYLEM/WILLO-MATHER & PLATT
45.	SELF PRIMING PUMP		JOHNSON/KIRLOSKAR
46.	MECHANICAL SEAL		BURGMANN/SEALOL
47	COUPLINGS		LOVE JOY
48.	ANTYVIBRATION MOUNTING & FLEXIBLE CONNECTION		DUNLOP/KANWAL INDUSTRIES/RESISTOFLEX
49.	PRESSURE GAUGE		H GURU/FIEBIG/EMERALD
50.	WATER METER (MECHANICAL TYPE)		KRANTI/ACTARIS/KENT/CAPSTAN
51.	ELECTRONIC FLOW METER		KROHNE/ROCKWIN
52.	LEVEL CONTROLLER & INDICATOR WATER		ELEGGENT CONTROLL/TECHNIKA/TECHTROL
53.	PAINTS		ASIAN PAINTS/BERGER
54.	MH/WATER TANK PLASTIC STEP		KGM/PATEL/PRANALI INDUSTRIES
55.	INSULATION FOR HOT WATER PIPE		ARMACELL-ARMAFLEX/K-FLEX/THERMAFLEX
56.	THREE WAY MOTORISED VALVE		DANFOSS/HONEYWELL/SIEMENS/AIP
57.	GREASE TRAP		ACO/WADE
58.	WELDING RODS		ADOR/ESSAB
59.	FASTENER		FISHER/HILTI
60.	FIRE SEALANT		BIRLA 3M/HILTI

61.	MANHOLE(PREFABRICATED)		OK PLAT/CRESCENT FOUNDARY
62.	TEMPERATURE SENSOR/GAUGE		FORBES MARSHALL/WIKA
63.	DOSING PUMPS		LMI/PULSER FEEDER/TOSCHON
64.	FLANGES		CLASS 150 TABLE H
65.	U.V STERLIZER		ALFA/EUREKA
66.	FLOW CONTROL DEVICES		AQUAPLUS/JAQUAR/RST
67.	SOLAR PANNEL & HEAT PUMP		EPL INDIA/SOLAR HART/ RACOLD/ HONEYWEL/BLUEBIRD
68.	SS PIPE		JINDAL/VIEGA/PRIME GOLD

Electrical Accessories			
46.	MOTOR CONTROL CENTER		TRICOLITE ELECTRICAL/ADLEC CONTROL SYSTEM/SK POWER SOLUTION
47.	VARIABLE SPEED DRIVES		DANFOS/ABB/SIEMENS
48.	MOULDED CASE CIRCUIT BREAKER(MCB)		L&T/SCHNEIDER ELECTRIC/SIEMENS
49.	STARTER CONTACTOR		LARSEN & TURBO
50.	MINIATURE CIRCUIT BREAKER(MCB)		HAGER/ SCHNEIDER ELECTRIC/SIEMENS
51.	OVERLOAD RELAYS WITH BUILT IN SINGLE PHASE PREVENTER		L&T/SCHNEIDER ELECTRIC/SIEMENS

52.	CURRENT TRANSFORMER		GILBERT & MAXWELL/PRAGATI/AUTOMATIC ELECTRIC
53.	ROTARY SWITCH		L&T/SCHNEIDER ELECTRIC/SIEMENS
54.	TIMER DELAY RELAY		L&T/SCHNEIDER ELECTRIC/SIEMENS
55.	TIMER		ASIA BROWN/L&T/ SIEMENS/GE POWER
56.	SELECTOR SWITCH,TOGGLE SWITCH		L&T/KAYCEE
57.	CHANGE OVER SWITCH		L&T/HPL-SOCOMEC
58.	ELECTRONIC DIGITAL METER		L&T/SCHNEIDER ELECTRIC/SIEMENS
59.	INDICATING LAMPS LED TYPE, PUSH BUTTON		L & T / SCHNEIDER ELECTRIC/ SIEMENS
60.	PVC INSULATED ALUMINIUM/COPPER CONDUCTOR, AURMERED MV CABLE(1100 V GRADE)		FINOLEX/POLYCAB/HAVELLS
61.	METALIC CONDUIT		BEC/AKG
62.	PVC CONDUIT & ACCESSARIS		BEC/AKG/POLYCAB
63.	SANDWITCHED CONSTRUCTION BUS DUCTS		CONTROL & SWITCHGEAR-HENIKWON/ SCHNEIDER ELECTRIC
64.	CABLE TRAY (FACTORY FABRICATED)		SLLOTCO/NEEEDO/MEM

65.	LT JOINTING KIT/TERMINATION		BIRLA-3M/RAYCHEM
66.	BIMETTALIC CABLE LUGS		COMET/DOWELLS(BILLER INDIA)
67.	PROTECTION RELAY		
68.	A. NUMERIC TYPE		ABB/AREVA/L&T/ SIEMENS/WOODWORD
69.	B.ELECTROMAGNETIC TYPE		ABB/AREVA/L&T

2.1.2 Fire Fighting System

1.	C.I. MANHOLES FRAME & COVER		NECO/BIC/SKF
2.	BUTTERFLY VALVE		AUDCO/ CRANE/KITZ/ ZOLOTO/ CASTLE
3.	GATE VALVE		AUDCO/ CRANE/KITZ/ ZOLOTO/ CASTLE
4.	NON RETURN VALVE		AUDCO/ CRANE/KITZ/ ZOLOTO/ CASTLE
5.	BALL VALVE		UTAM/ ZOLOTO/ DANFOSS/ VTM
6.	M.S. FORGED FITTINGS		V.S/JOHNSON
7.	DASH FASTENERS		HILTI/ FISHER
8.	AUTOMATIC AIR VENT		CIM/AIP/ZOLOTO
9.	PIPE HANGERS/CLAMPS/SUPPORT		EURO CLAMP/ CHILLY/GRIPPLE
10.	PAINT		SHALIMAR/ BERGER/ NEROLAC

11.	FIRE HOSE		CEASE FIER/ OMEX/UTAM/MINIMAX
12.	FIRE HYDRANT VALVE		CEASE FIER/ OMEX / UTAM//MINIMAX
13.	FIRST AID HOSE REEL DRUM & TUBING		CEASE FIER/ / OMEX / UTAM//MINIMAX
14.	BRANCH PIPE		CEASE FIER/ / OMEX / UTAM//MINIMAX
15.	DOUBLE/SINGLE HEADED LANDING VALVES		CEASE FIER/ / OMEX / UTAM//MINIMAX
16.	FIRE MAN AXE		CEASE FIER/ OMEX / UTAM//MINIMAX
17.	FIRE BRIGADE INLET CONNECTION		CEASE FIER/ / OMEX UTAM//MINIMAX
18.	FIRE /SPRINKLER MAIN PUMP/JOCKEY PUMPS		KIRLOSKAR/WILLO-MATHER & PLATT/ KSB
19.	DIESEL ENGINE		CUMMINES/GREAVES/ KIRLOSKAR
20.	MOTOR		ABB/KIRLOSKAR/ CROMPTON/ CUMMINS
21.	BATTERY		AMCO/EXIDE/ AMRON
22.	BATTERY CHARGER		BCH/HBL/KINETIC
23.	MS PIPE		TATA STEEL/JINDAL HISSAR
24.	SPRINKLER HEAD		TYCO/VIKING/NEWAGE/EVERSAFE
25.	ALARM CONTROL VALVE		TYCO/VIKING/SAFEX/EVERSAFE
26.	FLOW SWITCH		SYSTEM SENSOR/HONEYWELL/POTTER
27.	WELDING ROD		ESAB/ ADOR/ SUPERON OERLIKON

28.	PRESSURE SWITCH		SYSTEM SENSOR/HONEYWELL/POTTER
29.	CONTROLS		HONEYWELL/ SIEMENS/ DANFOSS
30.	VIBRATION ELIMINATOR		RESISTOFLEX/ KANWEL
31.	G.I FITTINGS		UNIK/ ZOLOTO
32.	HOOTER		HONEYWELL/ SIEMENS/ DANFOSS
33.	SLUICE VALVE		LEADER/ AUDCO/ ZOLOTO/VTM/ UTAM
34	Y STRAINER		KITZ/ AUDCO/ VTM/UTAM
35.	DELUGE VALVE		VIKING/TYCO/HD
36.	WATER CURTAIN NOZZLE		VIKING/TYCO/HD
37.	FIRE EXTINGUISHERS		NEWAGE/EXFLAME/KANNEX/ MINIMAX
38.	FLEXIBLE DROP CONNECTION		NEWAGE/SEFEX/EVERSAFE
39.	ELECTRICAL PANNEL DECTION & SUPPERESSION SYSTEM		AVEC INDIA/FIRE TERRACE/SVS BUILDWEL/FOAM TECH
40.	PIPE PROTECTION WRAPPING		PIPEKOTE/COATEK
41.	INSPECTOR TEST ASSEMBLY		EVERSAFE/VIKING/VICTAULIC
42.	FIRE BUCKETS		NEWAGE/SEFEX/MINIMAX
43.	FOOT VALVE		KIRLOSKAR/NORMEX/ VTM/ UTAM
44.	MECHANICAL SEAL		BURGMANN/SEALOL
45.	PRESSURE GAUGE		HGURU/EMERALD/FIEBIG

Electrical Accessories			
46.	MOTOR CONTROL CENTER		TRICOLITE ELECTRICAL/ADLEC CONTROL SYSTEM/SK POWER SOLUTION
47.	VARIABLE SPEED DRIVES		DANFOS/ABB/SIEMENS
48.	MOULDED CASE CIRCUIT BREAKER(MCB)		L&T/SCHNEIDER ELECTRIC/SIEMENS
49.	STARTER CONTACTOR		LARSEN & TURBO
50.	MINIATURE CIRCUIT BREAKER(MCB)		HAGER/ SCHNEIDER ELECTRIC/SIEMENS
51.	OVERLOAD RELAYS WITH BUILT IN SINGLE PHASE PREVENTER		L&T/SCHNEIDER ELECTRIC/SIEMENS
52.	CURRENT TRANSFORMER		GILBERT & MAXWELL/PRAGATI/AUTOMATIC ELECTRIC
53.	ROTARY SWITCH		L&T/SCHNEIDER ELECTRIC/SIEMENS
54.	TIMER DELAY RELAY		L&T/SCHNEIDER ELECTRIC/SIEMENS
55.	TIMER		ASIA BROWN/L&T/ SIEMENS/GE POWER
56.	SELECTOR SWITCH,TOGGLE SWITCH		L&T/KAYCEE
57.	CHANGE OVER SWITCH		L&T/HPL-SOCOMEC
58.	ELECTRONIC DIGITAL METER		L&T/SCHNEIDER ELECTRIC/SIEMENS

59.	INDICATING LAMPS LED TYPE, PUSH BUTTON		L & T / SCHNEIDER ELECTRIC/SIEMENS
60.	PVC INSULATED ALUMINIUM / COPPER CONDUCTOR, AURMERED MV CABLE(1100 V GRADE)		FINOLEX/POLYCAB/HAVELLS
61.	METALIC CONDUIT		BEC/AKG
62.	PVC CONDUIT & ACCESSARIS		BEC/AKG/POLYCAB
63.	SANDWITCHED CONSTRUCTION BUS DUCTS		CONTROL & SWITCHGEAR-HENIKWON/ SCHNEIDER ELECTRIC
64.	CABLE TRAY (FACTORY FABRICATED)		SLLOTCO/NEEEDO/MEM
65.	LT JOINTING KIT / TERMINATION		BIRLA-3M/RAYCHEM
66.	BIMETTALIC CABLE LUGS		COMET/DOWELLS(BILLER INDIA)
67.	PROTECTION RELAY		
68.	A. NUMERIC TYPE		ABB/AREVA/L&T/ SIEMENS/WOODWORD
69.	B.ELECTROMAGNETIC TYPE		ABB/AREVA/L&T

NOTE: All makes shall conform to specifications of each items as enclosed with the tender documents.

END OF SCHEDULE OF APPROVED MAKES SECTION

END OF APPENDIX-XXX