BIOTECHNOLOGY INDUSTRY REASERCH ASSISTANCE COUNCIL AT MTNL BUILDING, 9 CGO COMPLEX, NEW DELHI

TENDER DOCUMENT VOL-II

BIRAC SPECIFICATIONS

Name of work: Interior works for BIRAC at MTNL Building, 9 CGO Complex, New Delhi

1.0 BIRAC SPECIFICATIONS

Works shall be carried out in accordance with Specifications as detailed below:

1.1(a) For Civil Works

Central Public Works Department's Specifications -2009 Volume-I &II read with correction slips issued upto the date of receipt of tenders and relevant I.S. codes.

1.1(b) For Electrical works

Central Public Works Department's General Specifications for Electrical Works (Part-1 Internal 2005, (Part-11 External)- 2007, (Part- 1V, Substation), 2007 (Part-VI, File Alarm System)- 1988 & Air conditioning- 2004 with correction slips issued upto the date of receipt of tenders.

All installations shall comply with the requirements of Indian Electricity Rules, 1956 and Indian Electricity Act-1910 as amended upto date, and bye-laws of Haryana Electricity Department.

1.2 Wherever reference to any Indian Standard Specifications occurs in the documents relating to this contract, the same shall be inclusive of all amendments issued thereto or revisions thereof, if any, upto the date of receipt of tenders.

1.3 Before commencement of the work , the contractor shall co- relate nomenclature of the items with all the relevant architectural and structural drawings to satisfy himself that the information available there from is complete and unambiguous. The figures and written dimensions on the drawings shall be followed. The dimensions shall not be scaled out. The contractor shall submit for approval of Engineer – in – Charge his workshop drawings and the sample of work to be performed under the specified items of work before actually commencing the mass execution of work under the item . Nothing extra shall be payable on this account.

1.4 The discrepancy in the drawings issued, if any , shall be brought to the notice of Engineer – in- Charge for immediate decision before execution of the work . The contractor , alone shall be responsible for any erroneous and incomplete information and no claim whatever, shall be entertained and on this account

1.5 In the event of any difference or discrepancy in the description of any item or its specifications, the same shall be resolved in the following sequence and decision of the Engineer – in-Charge shall be conclusive, final and binding on the contractor.

a. The nomenclature of the item shall take precedence over all and anything stated elsewhere.

b. The conditions and specifications attached to the tender documents shall take precedence over the provisions of CPWD specifications 2009(Vol 1 to II) with upto date correction slips and relevant IS Codes for civil work and CPWD's general specifications for electrical works(Part-1, Internal-2005 (Part-II External-2007, (Part IV, Substation)-2007, Part-VI Fire Alarm System)-1988 and Air-Conditioning-2004 with correction slips upto the date of receipt of tenders.

c. The CPWD Specifications shall take precedence over provisions of relevant IS Codes.

d. In case, it is not possible to resolve the dispute with the help of tender documents, the provisions of relevant IS Codes shall be relied upon

e. In case, it is not possible to resolve dispute with the help of any of the above stated documents, the decision and directions of the Engineer-in-Charge shall be followed for execution and completion of any item of work.

ADDITIONAL CONDITIONS AND SPECIFICATIONS FOR INTERNAL ELECTRICAL WORKS

1. The sub-work of internal EI shall be carried out by the main contractor through an Experienced Electrical Sub-contractor who must have executed electrical works of similar nature and magnitude. The Sub-contractor shall be appointed with the approval of Engineer-in-charge.
2. Notwithstanding the arrangement with the associated Sub-contractor, the main contractor shall be entirely responsible and answerable for all the works done by his associated electrical contractor regarding their quality, adherence to the laid down specifications, terms and conditions, warranty/ guarantee etc. and he shall be liable to bear any compensation that may be levied by the department under any of the clauses of the agreement.
3. All additions, substitutions and deviations in the items of work that become necessary during execution of work, as part of the internal EI work, shall be executed by the main contractor and the associated electrical sub contractor as part of the contract and the rate(s) shall be derived under the schedule of work or as extra/ substituted item(s) of work as per the contract. The element of profit in case of extra /Substituted items of work shall be 15% only. Profit both for main contractor & sub contractor separately shall not be considered.
4. The main contractor/ associated electrical contractor shall make available one wireman and one khallasi for attending to day to day complaints from the date of testing and commissioning and upto the end of period of 6 months from the date of completion of the work as part of this contract at no extra cost.
5. The work shall be carried out as per CPWD specifications for electrical works Part-(Internal) 2005,

   Part-II (External) 2007, amended upto date, and as per additional specifications and conditions for this work.

6 The materials shall be procured only from the manufacturers and their authorized dealers and documentary proof for such procurement and supply shall be produced by the contractor.

7 The department reserves the right to send such materials to the manufacturers/ authorized test laboratory to verify the genuineness and quality of the product.

8. The contractor is advised to visit the site before quoting for this tender to apprise himself about the site environment and other conditions.

9 The work shall be progressed with the progress of civil work. As such, the contractor doing electrical works shall work in close coordination with casting of the slabs, erection of the walls etc. as required.

No claim of the contractor shall be entertained by the department for the idle labour.

10 The conduit shall be laid in the false ceiling and in walls well before false ceiling work done their plastering and in MS/ AI channels. The actual run of conduit and size of the boxes are to be marked on the drawing by the contractor and shop drawings shall be got approved from Engineer-in- charge before erection at site.

11 Earthing shall be done in the presence of the Engineer-in-charge or his authorized representative.

12 The work shall be carried out in engineering like manner and bad workmanship shall be rejected summarily. For redoing the job, no claim of the contractor shall be entertained on this account.

13 The site shall be cleared of malba, debris caused by working at site by the Electrical Contractor without any extra cost to the department.

14 The contractor will ensure that all the skilled persons managed/ deployed for executing the electrical work possess the wireman license issued by approved authorities. Consequences arising due to the default of the contractor to comply with this condition would be contractor's responsibility only.

15 The contractor will make his own arrangement for storage of his own material. The watch and ward of the materials and of the installations would be responsibility of contractor till the work is completed/ handed over to the department. Nothing extra shall be paid to the contractor on this account.

16 All the DB's, switchgears shall have identification marking on them written in white paint. Nothing extra shall be paid on this account.

17 Earth points with studs are to be provided on each of the switchboards/ DBs.

18 The MCBDB made of MS sheet should not be less than 1.6mm thick. Left out MCB outlets in the DB (not occupied by the MCBs) shall be covered with blanking plates.

19 A MS loose wire box of suitable size with cover shall be provided with each DB Box

20. The drawing showing layout of the main board, allied equipment shall be got approved by the contractor from the Engineer-in-charge before fabrication and execution.

21 All hardware, fastening material viz. nuts, bolts, washers and screws etc. to be used on work shall be of Zinc/ cadmium plated iron.

22 The contractor shall have to furnish the insulation test report, earth report, alongwith all required details of electrical load on the prescribed Proforma for the electric connection from the Supply Company.

23 The contractor shall submit the completion certificates and completion plans as per Clause of General Specification for Electrical Work (Part-I Internal) 2005.

24 All concealed works and earthing shall have to be done in the presence of engineer-in-charge or his authorized representative.

25 A list of approved make of materials to be used in the work is appended as **Annexure-I.** The contractor should use only the makes of materials as specified in the list and approved by Engineer-In-Charge

26 The chases in wall shall be done by chase cutting machines, for which contractor shall arrange adequate numbers of chase cutting machines (Chase Cutters).

27 The fan & fittings to be supplied by the contractor shall be procured & brought to site as per site requirement and ensure so that these fans & fittings are not damaged & do not lose their manufacturers' warrantee.

28 The work will be executed as per general arrangement drawing, fabrication drawing duly approved by the Engineer-in-Charge. The various materials/ equipments/ panels/ switchboards will be ordered only after approval of the drawings and quantities in respect of the items are ascertained as per actual requirement.

29 Sample of Pre-wired DB and Cubical panel etc. shall be approved in the factory before the items are taken up for regular fabrication. All fabricated items shall be inspected in the factory and duly tested before final dispatch to site

Name of work: Providing Air conditioning at BIRAC office in MTNL Bldg., New Delhi.

SCOPE OF WORK

1. **General**

This document pertains to supply, installation ,testing and commissioning of Comfort Air Conditioning (CAC) system and intended to be read in conjunction with the relevant IS codes and IS Specifications (latest).

2. **Details of Site**

The site is situated at address BIRAC office, First Floor, MTNL Building Lodhi Road, New Delhi. . Construction of the proposed BIRAC office comprises of following floors:

a. First Floor Area to be Air conditioned =10325 sqft. (approx.) in multistory building.

3. **Contractor's Scope of Work**

The scope of work proposed under this contract includes supply, installation, testing and commissioning of the complete HVAC system as elaborated in design drawings, detailed specifications and bill of quantities.

The scope shall cover Supply and Installation of all necessary equipment including Variable Refrigerant Volume (VRV) system, comprising of Outdoor & Indoor units, ductable split units and Hi wall split units, Cassette Units, copper refrigerant piping, condensate drain piping, Inline fans, propeller fans etc.

Scope of work also includes supply, fabrication and installation of GSS ductwork, grilles/diffusers and insulation as required.

Routine testing, pressure testing of fabricated components, balancing and Commissioning of the entire HVAC system and performance testing as per system requirement shall also be covered in the scope.

The Contractor shall be responsible to complete the entire work under scope in all respect in line with the contract documents and with the directions of and to the satisfaction of the Architects and Owners.

The Contractor shall furnish all labour, materials and equipment (except those to be supplied by the Owners, if any) as listed under bill of quantities and specified otherwise, transportation and incidental necessary for supply, installation, testing and commissioning of complete HVAC system.

The scope shall also cover supply and installation of materials, equipment, appliances and incidental work not specifically mentioned herein or noted on the drawings or documents as being furnished or installed, but which are necessary and customary to make a complete installation. Supply of such material/equipment and execution shall be carried out in accordance with the most latest IS codes and IS specifications. In the event of non availability of relevant IS codes/specifications, good engineering practices shall be adopted.

4. **Items to be provided by other agencies:**

The following activities associated with the said contract shall be carried out by other agencies under direct supervision of the AC contractor:

4.1 **Civil Works:**

All associated civil works listed below shall be carried out by civil /interior contractor:

4.1.1 Foundation for VRV Outdoor Units (Heat Pumps) including PCC/RCC blocks as required or as mentioned in the BOQ.

4.1.2 False ceiling work.

4.1.3 Providing aluminium channel trough in the false ceiling for fixing of diffusers and GI frame work in walls/partitions for fixing of grilles.

4.1.4 Providing opening in walls/slabs for crossing of ducts/piping and making them good & finished.

4.2 **Plumbing Works:**

All associated plumbing works listed below shall be carried out by plumbing contractor.

4.2.1 Providing floor trap for termination of condensate drain piping to be carried out by the AC contractor.

4.3. **Electrical Works:**

All associated electrical works listed below shall be carried out by electrical contractor:

4.3.1 Providing 415 $\pm$ 10 % volts, 50 Hz, 3 phase stabilized power supply at each VRV Outdoor unit in the form of power cabling and necessary earthing.

4.3.2. Providing 415 ± 10 % volts, 50 Hz, 3 phase stabilized power supply at control panel of ductable/Non ductable split unit as pecified in the form of power cabling and necessary earthing.

4.3.3 Providing 220 ± 6 % volts, 50 Hz, 1 phase power point near each VRV indoor unit, non ductable split units, propeller fan and inline fan for toilet exhaust as shown in the design drawings.

****

SYSTEM DESIGN

1. **Introduction:**

An air-conditioning system using combination of Ductable/Non Ductable Heat Pump type split units & VRV system is being designed for the proposed office for BIRAC at Lodhi Road, New Delhi to provide summer/monsoon cooling.

The design being proposed also envisages mechanical ventilation system for toilets.

2. **Basis of Design**:

The various design parameters pertaining to air-conditioning system are being given hereunder:

a. Orientation:

The orientation of the building is shown in the interior layouts drawings.

b. Outside design conditions :

The outside design conditions for **NEW DELHI** are given hereunder:

For All Office Areas/ Rooms to be operated during day (8AM to 8PM):

For Other Spaces to operate during day time :

Season	Dry Bulb Temperature	Wet Bulb Temperature
Summer	110 F (43.3 C) db	75 F (23.9 C) wb
Monsoon	95 F (35 C) db	83 F (28.3 C) wb
Winter	45 F (7.2 C) db	41 F (5 C) wb

c. Inside design conditions :

The inside design conditions for various spaces being considered are given hereunder:

i. Summer & Monsoon :

Temperature : 75± 1° F (24±1°C)
Relative Humidity : 55± 5%

Note :

Design Data considered above is subject to further confirmation from Client's end.

3. **Heat Loads and Proposed Equipment Selection**

Based on the interior plans and above design data the heat loads for the various spaces to be air-conditioned have been worked out and heat load results along with equipment selection are given hereunder:

BIRAC OFFICE MTNL BUILDING AT LODHI ROAD, NEW DELHI													
S. No.	**Location**	**Area, Sqft**	**Occupancy**	**Inside Temp. Deg. °F**	**Inside RH %**	**TR Summer**	**Calcu. Dehum. CFM , Summer**	**TR Monsoon**	**Calcu. Dehum. CFM , Monsoon**	**Light. Load W/sqft**	**Equip. Load W/sqft**	**Fresh Air (cfm)**	**Equipment Selected**
FIRST													
1	CEO OFFICE	251	10	75±1	55±5	2.37	941	2.85	645	1.2	2	150	1XFXFQ 100PVE 3.3 TR, 1130 CFM
2	BOARD ROOM	312	20	75±1	55±5	3.34	1099	4.31	806	1.2	2	300	1XFXFQ 80PVE 2.64 TR, 742 CFM
3	CONFE. ROOM	629	50	75±1	55±5	6.54	1733	8.95	1420	1.2	2	750	2XFXM Q140PV E 4.75 TR, 1377 CFM
4	VISITOR DISCUSSION -1	149	8	75±1	55±5	1.41	483	1.8	346	1.2	2	120	1XFXA Q63PVE 2.08 TR, 671 CFM
5	VISITOR DISCUSSION -2	149	8	75±1	55±5	1.41	483	1.8	346	1.2	2	120	1XFXA Q63PVE 2.08 TR, 671 CFM
6	LIBRARY	251	15	75±1	55±5	2.29	701	3.01	537	1.2	2	225	1XFXFQ 100PVE 3.3 TR, 918 CFM

7	CHAIRMEN CABIN	265	15	75±1	55±5	2.94	1067	3.66	764	1.2	2	225	1XFXFQ 125PVE 4.13 TR, 1165 CFM
8	WORKSTATI ON-4	1075	25	75±1	55±5	5.84	2303	7.04	1715	1.2	2	375	2XFXM Q125PV E 4.125 TR, 1377 CFM
9	DINING AREA	371	25	75±1	55±5	4.72	1675	5.92	1258	1.2	5	375	2XFXFQ 100PVE 3.3 TR, 1130 CFM
10	PASSAGE-1	1495	5	75±1	55±5	6.74	3208	7.62	2259	1	0.5	274	2XFXM Q140PV E 4.75 TR, 1624 CFM
11	STAFF DINIG EXEC WAITING	2506	50	75±1	55±5	13.2 3	5005	16.44	3756	1.2	2	100 0	2XFXM Q140PV E 4.75 TR 1624 CFM, 2XFXFQ 63PVE 2.08 TR 671 CFM, 2XFXA Q63PVE 2.08 TR 671 CFM 1XFXFQ 50PVE 1.65 TR, 565 CFM
12	CABIN-1	105	3	75±1	55±5	0.92	399	1.06	267	1.2	2	45	1XFXA Q50PVE 1.65 TR, 530 CFM
13	CABIN-2	103	3	75±1	55±5	0.9	390	1.05	261	1.2	2	45	1XFXA Q50PVE 1.65 TR, 530 CFM

14	CABIN-3	105	3	75±1	55±5	0.91	396	1.06	265	1.2	2	45	1XFXA Q50PVE 1.65 TR, 530 CFM
15	CABIN-4	120	3	75±1	55±5	1.4	666	1.54	429	1.2	2	45	1XFXA Q50PVE 1.65 TR, 530 CFM
16	CABIN-5	128	3	75±1	55±5	1.16	535	1.31	359	1.2	2	45	1XFXA Q50PVE 1.65 TR, 530 CFM
17	CABIN-6	97	3	75±1	55±5	0.92	397	1.06	271	1.2	2	45	1XFXA Q50PVE 1.65 TR, 530 CFM
18	CABIN-7	96	3	75±1	55±5	0.94	408	1.08	277	1.2	2	45	1XFXA Q50PVE 1.65 TR, 530 CFM
19	CABIN-8	121	3	75±1	55±5	0.97	427	1.11	290	1.2	2	45	1XFXA Q50PVE 1.65 TR, 530 CFM
20	CABIN-9	97	3	75±1	55±5	0.94	409	1.08	278	1.2	2	45	1XFXA Q50PVE 1.65 TR, 530 CFM
21	CABIN-10	97	3	75±1	55±5	0.92	397	1.06	271	1.2	2	45	1XFXA Q50PVE 1.65 TR, 530 CFM
22	CABIN-11	76	3	75±1	55±5	0.82	345	0.97	237	1.2	2	45	1XFXA Q50PVE 1.65 TR, 530 CFM
23	CABIN-12	76	3	75±1	55±5	0.87	371	1.01	236	1.2	2	45	1XFXA Q50PVE 1.65 TR, 530 CFM
GROUND FLOOR		8674	267			62.5	23838	76.79	17293				
GRAND TOTAL		**8674**	**267**			**62.5**	**23838**	**76.79**	**17293**				

		TOTAL AREA				TR (SUMM.)		TR (MONS.)					
9	**WORKSTATION-5**	**2191**	**40**	**75±1**	**55±5**	**9.7**	**3885**	**11.63**	**2950**	**1.2**	**2**	**600**	**6X2.5 TR EXISTING**

Assumptions:

The above heat load calculations and equipment selection has been considered adequate based on the following assumptions:

a. Window frames to incorporate rubber gaskets to make them air tight.

b. All windows shall be provided with double glass.

c. Windows within Office Rooms shall be provided with thick curtains as required.

d. All Office Rooms have been considered to be operational during night.

e. Exposed roof shall be insulated with at least 50mm thick extruded polystyrene insulation material in the form of over deck insulation (By other agencies).

f. External Building Fabric detail (to be further verified by the Architects) :

i. **For insulated double glass** :

Solar Factor : 0.60
Overall Heat Transfer Co-efficient ("U" Value) : 0.43 BTUs/Hr Sft F (2.44 Watt/SqM K).

ii. **For Walls** (230mm Brick Wall):

Overall Heat Transfer Co-efficient ("U" Value): 0.32 BTUs/Hr Sft F (1.82 Watt/SqM K).

iii. **For Roof Exposed to Sun (with 50mm thick Expanded Polystyrene insulation)** :

Overall Heat Transfer Co-efficient ("U" Value) : 0.16 BTUs/Hr Sft F (0.91 Watt/SqM K).

4.0 System Designing

A comfort air conditioning system using combination of Ductable/Non Ductable Heat Pump type split units & VRV system is being designed to facilitate comfort air conditioning for the proposed Office for BIRAC, New Delhi.

The indoor units shall be installed within the suspended ceiling spaces in line with interior requirement. Outdoor units shall be installed on terrace and ground floor or other suitable places as shown in the design drawings with minimum refrigerant piping between indoor & outdoor units.

The air distribution system would comprise of GSS supply air ducting with thermal insulation. Cool and dehumidified air from the indoor units shall be carried through the supply air ducting and distributed to the areas to be air conditioned by means of grilles and diffusers. The return air shall be picked up through return air grilles/diffusers and brought back to indoor units through the same suspended ceiling spaces.

Condensate drain piping associated with indoor units shall be carefully carried out to ensure **leak proof disposal of condensate water.**

Toilets shall be mechanically ventilated using inline fans as required.

Mechanical ventilation system has been provided for toilets

5.0 Noise Level

Noise level in conditioned spaces due to all air conditioning equipment shall not exceed 52 dB at 125 Hz when measured at any point in occupied spaces less than 1500 mm above finish floor level and not closer than 1500 mm from any supply air register or 600 mm from any return air grille.

****

ADDITIONAL CONDITIONS OF THE CONTRACT

1. Date of Commencement

The Date of commencement be consider from the Date of award of work.

2. Period of completion

i) The entire air conditioning work to be completed within agreed time period from the date of award of work.

ii) However, installation of entire factory fabricated duct work including application of insulation in the factory/office spaces has to be completed within agreed time period from the date of award of work. Entire work including testing and commissioning shall be completed in all respects within agreed time period from the award of work.

3. Defects liability period.

One Year after the virtual completion of the work as certified by the Architect/ Consultant.

4. **Quantities**

a) Quantities of items listed in schedule of Quantities may be increased, reduced or omitted to any extent. Exact quantity of every item shall be measured and paid as per actual work done at site.

b) The owner reserves the right to exclude any items from the scope of work of the main contract and may appoint a sub- contractor for the work directly.

c) All tenders in which any of the prescribe conditions are not fulfilled are liable to be rejected.

5. Engineering Responsibility of the system

The responsibility of system design, manufacturing, erection, working and safety will solely be responsibility of the Contractor for the parameters as mentioned in the tender documents prepared by the consulting engineers.

The system after commissioning shall be handed over to the Owners and thereafter they will monitor the performance for standard designed parameters for 30 days continuously. In case during this period the performance is not found satisfactory and rectification/ replacement, design improvement or any other change is felt necessary, will be made by the Contractor at no extra cost to the Owner. Though these improvements can only be done after getting the approval from the Owners/Architects.

6. Liability to Govt. Regulations

The Contractor shall be responsible and shall abide by all the government rules and regulations pertaining to erection, testing and commissioning of complete HVAC system at site. Any compensation towards damage/loss of property/ material/equipment or to any person working at site shall be borne by the Contractor as per standard terms of contract.

7. Store

A lockable storage space shall be provided by the Clients but safe custody shall be the responsibility of the contractor till the installation is taken over.

8. Certificate of Inspection

The contractor shall obtain and deliver to the owner, a certificate of final inspection by the local authorities concerned, if required at site. The inspection fee shall be reimbursed as per actual on the production of receipt in original.

Further the Owners/Architects shall have full powers to order the materials or work to be tested by an independent agency at the Contractors expense in order to prove its fault & in-adequacy.

9. **Design Drawings**

The drawings prepared by the Consultants are indicative only of the general arrangement of the entire installation. The Contractor shall follow these drawings and specifications in preparation of his shop drawings and subsequent installation. He shall check the drawings of other trades to verify space for his installation. The Contractor shall examine all relevant architectural, structural, plumbing, electrical and other services layout drawings before preparing the shop drawings for this installation, and report to the Architects/Consultants any discrepancy and obtain clarifications. Any changes found necessary for co-ordination and installation of this work with other services and trades shall be made with prior approval of the Architects/Consultants and Owner without any additional cost to the Owner.

10**. Site visit & Shop/layout Drawings**

The contractor shall visit the site and shall satisfy himself as to condition under which work is to be performed. No claim for consequences of ignorance at the later date shall be entertained. He should also check and ascertain the location of existing structure or equipment or any other situation which may affect the work.

The contractor shall submit five sets of shop drawings for air distribution system layout, Electrical panels & Equipment Layout drawings for approval of the Owners/Architects. Contractor shall also submit technical submittals for all major items including packaged units, air washer , air scrubber , extract fan section, inline fans, split units, cooling towers, pumps, piping, valves, GS sheet, grilles, diffusers, fire dampers, insulation material, electrical components etc. for the approval of the Owners/Architects.

Five sets of detailed shop drawings of all equipment and materials including plant room, ducting, piping, ventilation system, electrical work associated with the HVAC system required to complete the project as per specifications and as required by the Architect/ Consultant. These drawings shall contain details of construction, size, arrangement, operating clearances, performance characteristics and capacity of all equipment, also the details of all related items of work by other Contractors. Each item of equipment proposed shall be a standard catalogue product of an established manufacturer as per specifications.

If the Architect/Consultants make any amendment in the above drawings, the contractor shall supply two fresh sets of drawings with the amendments duly incorporated, along with the drawings on which corrections were made. After final approval has been obtained from the Architect/Consultant, the Contractor shall submit a further six sets of shop drawings for the exclusive use of and retention by the Architect/Consultant. No material or equipment may be delivered or installed at the job site until the contractor has in his possession, the approved shop drawings for the particular material or equipment.

The shop drawings shall be submitted for approval sufficiently in advance of planned delivery and installation of any material to allow Architects/ Consultants ample time for scrutiny. No claims for extension of time shall be entertained because of any delay in the work due to his failure to produce shop drawings at the right time, in accordance with the approved CPM charts.

Samples, drawings, specifications, catalogues, pamphlets and other documents submitted for approval shall be in quadruplicate, each item in each set shall be properly labeled, indicating the specific service for which material or equipment is to be used, giving reference to the governing section and clause number of Specifications clearly identifying in ink the items and the operating characteristics. Data of a general nature shall not be accepted.

Approval rendered on shop drawings shall not be considered as a guarantee of measurements of building conditions. Where drawings are approved, said approval does not mean that drawings have been checked in detail nor does it any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the contract.

Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and detailing required thereof, shall be prepared by the Contractor at his own cost and approved by the Architect/Consultant.

Where the work of the Contractor has to be installed in close proximity to, or will interfere with work of other trades, he shall assist in working out space conditions to make satisfactory adjustments. If so directed by the Architect/Consultant, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than 1:50, clearly showing how his work is to be installed in relation to the work of other trades. If the Contractor installs his work before coordinating with other trades, or so as to cause any interference with work of other trades, he shall make all the necessary changes without extra cost to the Owner.

Within two weeks of approval of all the relevant shop drawings, the Contractor shall submit to the Architect/Consultant four copies of comprehensive itemized price list of recommended imported and local spare parts and tools covering all equipment and materials in this contract. The Owner shall make arrangements to procure these spare parts and tools.

11. Material & Workmanship

All material used in work shall be of the best quality, obtainable and of approved list of manufacturers and shall conform to latest Indian Standard specifications unless otherwise stated.

The work shall be carried out as per CPWD General Specifications for HVAC works 2004 as amended up to date along with specifications listed in this document, CPWD General specification for electrical works Part-I,II & IV, as amended up to date, relevant IE rules, ASHRAE/ISHRAE specifications and as per direction of Engineer-in-charge. For electrical panels, CPWD General Specifications for Electrical Works Part-IV shall be applicable.

12. Erection and Supervision

The Contractor shall depute specialized engineers in HVAC from time to time of commencement of installation work to inspect all relevant foundation/fabrication and other necessary facilities to make improved action if felt necessary. However, a qualified experienced engineer to be deputed at site beginning from commencement of HVAC activities at site & till handing over of the project.

13. Testing and Commissioning

On completion, the installation shall be tested for conformity with the stipulated performance specifications. Any defect, shortcoming detected in the system/material/workmanship shall be rectified by the Contractor to the entire satisfaction of the Consultants without any extra cost to the Owner. The installation shall be tested again after the removal of the defects and shall be commissioned only after approval by competent inspecting authority or the Consultants and the Owner. All tests shall be carried out in the presence of the Consultants and Owner's representative.

Testing and commissioning shall include furnishing all labour, materials, instruments etc. and incidentals necessary for complete testing of each component as per the specifications and manufacturer's recommendations.

Maintenance Services for the complete HVAC installation shall be provided during the defects liability period of one year.

14 Training of Owner's representative

Upon completion of work and conclusion of all tests, the Contractor shall furnish necessary skilled labour and helpers for operating the entire installation for a period of thirty working days of minimum twelve hours each, to enable the Owner's representative to get acquainted with the operation of the system. During this period, the Contractor shall train the Owner's representatives in the operation, adjustments and maintenance of equipment installed.

15 Completion Certificate

On successful completion of the installation, a Certificate in the approved format shall be furnished by the Contractor. The Contractor shall be responsible for getting the entire installation duly approved by the Electrical Inspector or concerned authority, if any, and shall bear all the expenses in connection with the same.

16 Correction of Work before Final Payment

The Consultants/Owner shall conduct a final inspection just before the virtual completion of the work and prepare a final list of materials, equipment and item of work which fail to conform to the contract specifications. The Contractor shall promptly replace or re-execute such items in accordance with the contract and shall bear all expenses of making good all work and the cost of all work of the Contractor destroyed or damaged by such replacement or removal.

If the Contractor fails to remove and replace above rejected materials, equipment/ or workmanship within a reasonable time, fixed by written notice, the Owner may employ and pay other persons to amend and make good such defects at the expense of the Contractor. All expenses incurred by the Owner in rectifying the defects including all damages, loss and expense consequent on the defects shall be recoverable from any amount due or which may become due to the Contractor.

17 **Virtual Completion**

The work shall be considered virtually complete only upon fulfillment of the procedure laid down in the preceding clause and when the Consultants/Architects and the Owner has certified in writing that the work has been virtually completed. The defect liability period shall commence from the date of such certificate.

18 **Clearance of Site**

The Contractor shall have to remove all dirt and other unwanted materials from site of work, before handing over HVAC installation to the Owner. The work shall not be treated as complete in all respects unless these requirements are fulfilled by him. In the event of the Contractor failing to do so, the Consultants and the Owner shall have the right to get the site cleared at the Contractor's expenses.

19 **Mechanical Maintenance**:

a. Scope:

The Contractor shall provide the necessary skills and labour to assure the proper operation of the complete installation by the Owner's staff and to provide all required current and preventive maintenance for all equipment and controls under this contract, for the defects liability period of 12 months from the date of acceptance.

b. Operation:

The Contractor shall receive calls for any and all problems experienced in the operation of the equipment under this contract and shall take steps to immediately correct any deficiencies that may exist.

c. Maintenance:

The Contractor shall provide monthly inspection of all equipment and record the findings on a check list hereinafter specified.

d. Check List:

The Contractor shall provide to Owner/Consultant four copies of a comprehensive maintenance check list and shall post a copy of it in the plant room. The check list shall be a list of each piece of equipment in this contract, and shall provide a space for each of the next fifty two weeks to record the maintenance provided to and status of various equipment. Each month at the time of inspection, the Contractor shall certify on this check list that he has examined each piece of equipment and that, in his opinion, it is operating as intended by the manufacturer, and that all necessary maintenance has been performed.

e. Repairs:

All equipment that requires repairing shall be immediately serviced and repaired. Since the period of Mechanical Maintenance runs for one year concurrently with the Defects Liability Period all parts and labours shall be furnished at no extra cost to the Owner.

f. Control System:

Once each month the Contractor shall check all controls in various areas to ensure that these are functioning as designed. This shall apply to all temperature and humidity sensors, controllers, fire dampers, time-delay relays, flow switches, high and low pressure cutouts and motorized valves etc.

g. Emergency Services:

When emergency service is required beyond regular working hours to maintain the system in operation, the Contractor shall furnish service on the basis of prior arrangements with the Owner.

20. **After Sales Services**:

The HVAC Contractor shall ensure adequate and prompt after sales service in the form of maintenance personnel and spares as and when required with a view to minimizing the breakdown period. Particular attention shall be given to ensure that all spares are easily available during the normal life of the installation.

21**. Performance Guarantee**

The contractor shall guarantee the installation for a period of 12 months against defective materials and workmanship from the date of taking over by the owner and shall rectify or replace the defective material or workmanship without any extra cost of the owner without any delay. If the contractor fails to attend the

defects within the period as asked by owner, then the owner has right to get it done at the risk and cost of contractor without giving any further notice. Equipment/component after replacement shall further bear a warrantee of 6 months from the date of replacement.

22. Water & Electricity

Power / water shall be made available at one point at site and further extension shall be carried out by contractor as required at his own cost.

23. Security

Security of all the materials and labour at site shall be contractor's responsibility at his own cost.

24. Records

Contractor shell keep complete and daily records as per standard system of all the materials, labour, drawings, work done at site and the Architect / owner can Inspect all/ any records whenever he desires.

25. Samples & Technical Submittals

Samples, make or brand of all the materials must be got approved by the Architect/ Consultants/Owner in writing before they are brought to the site. Nothing extra shall be paid for presenting samples of any item as desired by Owner/Architect/Consultants.

Technical submittals of all the major items or as desired by the Architects/Consultants incorporating complete technical details in line with the tender specifications & catalogue prior to procurement of equipment/material shall be submitted for the approval.

26. Contradiction between BOQ, Specifications and Drawings:

In the event of conflicts between BOQ, Specifications and Drawings, the BOQ shall take precedence over the specifications and drawings. Keeping the general intent of the scope of work under said contract, the Architects/Consultants would interpret the requirements of the design intent & contract and their decision shall be final and acceptable to all concerns including the contractors.

27. Owner reserve the right to relax or modify any condition listed in conditions of the contract in overall interest of the work. .

28. All tools, plant and machinery provided by the contractor shall, when brought to the site, be deemed to be exclusively intended for construction and completion of this work and the Contractor shall not remove the same or any part thereof without the consent of the Architect / Owner.

29. The rates quoted by the contractor shall be all inclusive keeping in mind the specifications, additional and special conditions in view and nothing extra shall be payable whatsoever.

30. Unless otherwise provided in the schedule of quantities the rates tendered by the contractor shall be all inclusive and shall apply to all heights, lifts, leads and depths of the building.

Nothing extra shall be payable to him on this account.

31**.** The equipments erected, commissioned at site should be suitable for maximum temperature of 50 degree C.

32. The electrical installation shall be carried out in accordance with Indian electricity rules, relevant Indian standard such as IS 732, IS 3043 and the requirements stipulated by local statutory body such as electrical inspectors for such installations. It is to be clearly understood that the final responsibility for sufficiency, adequacy, and conformity to the performance of the HVAC system shall be with the Contractor.

33. The equipment and materials to be supplied shall conform to the requirements of the relevant IS standards.

34. The work shall be executed strictly as per the specifications drawn and "Approved for Construction Shop Drawings" and to the entire satisfaction of the Owners/Architects.

35. Completion Drawings & Documents - After completion of the work, the contractor shall furnish four sets of completion documents complete with "As Built Drawings".

36. The contractor shall ensure good conduct of the workman at the site of work.

****

TECHNICAL SPECIFICATIONS

A - "SPECIFICATIONS- MAIN EQUIPMENT"

1. VARIABLE REFRIGERANT VOLUME SYSTEM (HEAT PUMP)

Scope

The scope shall be supply, installation, testing and commissioning of air cooled variable refrigerant volume (VRV) system conforming to these specifications and meeting all design parameters as mentioned in the " Bill of Quantities" and drawings. Variable Refrigerant Volume System shall be a standard product, however all these specifications shall fully comply.

Type

Unit shall be heat pump type consisting of outdoor units and multiple indoor units, each suitable to facilitate cooling during summer & monsoon and heating in winter as per the requirements.

It shall be possible to connect minimum 10 indoor units on one refrigerant circuit. The indoor units on any circuit can be of different type and also controlled individually.

Compressor installed in outdoor units shall be equipped with at least one inverter compressor up to 18HP and minimum two inverter compressors in bigger machines for higher reliability, improved life, better backup and duty cycling purpose. The system shall be capable of changing the rotating speed of inverter compressor by inverter controller to follow variations in cooling and heating load.

Outdoor unit shall be suitable for mix match connection of all type of indoor units.

The refrigerant piping between indoor units and outdoor unit shall be possible to extend up to 165M with maximum 50M level difference **without any oil traps.**

Both indoor units and outdoor unit shall be factory assembled, tested and filled with first charge of refrigerant gas before delivering at site.

Units shall be factory finished with paint as per manufacturer's standard. However, shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirit, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop painted surfaces.

Capacity

The refrigeration capacity of VRV outdoor and indoor units shall be as mentioned in the “Bill of Quantities” and as reflected on the drawings.

Outdoor Unit

The unit shall be heat pump type with automatic changeover in different seasons.

The outdoor unit shall be a factory assembled unit housed in a sturdy weather proof casing constructed from rust-proofed heavy gauge mild steel panels coated with a baked enamel finish. The unit should be completely factory wired, tested with all necessary controls.

All outdoor units shall have minimum two scroll compressors and be able to operate even in case of breakdown of one compressor. In case of outdoor units above 18HP, the outdoor unit shall have compulsorily at least 2 separate inverter compressors so that the operation is not disrupted with failure of any inverter compressor and if one inverter compressor malfunctions, other continues to provide emergency operation smoothly till repair is affected. The unit shall be provided with duty cycling arrangement for multiple inverter compressors to facilitate sequenced operation of the machine for better stability and prolonged life.

The outdoor unit shall be modular in design and should be allowed for side by side installation. The unit shall be provided with its own microprocessors control panel.

The outdoor unit should have anti-corrosion paint free steel plate for easy mounting of unit.

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

The outdoor unit should be fitted with low noise, aero spiral design fan with grill for spiral discharge airflow to reduce pressure loss and should be fitted with DC fan motor for better efficiency. The noise level shall not be more than 60dB (A) at normal operation measured horizontally 1M away and 1.5M above ground. For Residential application or wherever night operation is required the unit shall be suitable to operate on nighttime quiet operation mode having minimum three step of operation sound level i.e. 55dB to 45dB. Wherever required or as shown on the drawings the unit shall be selected for high external static pressure (ESP) not less than 78Pa (8mm WG) to meet long exhaust duct connection requirement.

The outdoor unit shall be designed to operate safely when connected to multiple fan coil units.

The unit shall be suitable to operate on environment friendly R 410A refrigerant.

Compressor

The compressor shall be highly efficient, high COP scroll type and capable of inverter control. The inverter compressor shall change the speed in accordance to the variation in cooling or heating load requirement.

All outdoor unit shall have multi-steps of capacity control to meet load fluctuation and indoor unit individual control. All parts compressor shall be sufficiently lubricated stock. Forced lubrication may also be employed.

Oil heater shall be provided in the compressor casing.

Inverter compressor shall preferably by Reluctance DC inverter compressor for higher efficiency and improved reliability.

Heat Exchanger

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 film. The unit should be with e-pass heat exchanger to optimize the path of heat exchanger and for better efficiency of condenser. 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.

Refrigerant Circuit

The refrigerant circuit shall include an accumulator, liquid and gas shut off valves and a solenoid valves at condenser end. The equipment must have in built refrigerant stabilization control for proper refrigerant distribution.

All necessary safety devices shall be provided to ensure the safety operation of the system.

Safety Devices

VRV system shall be provided with all safety devices as required and to ensure safe operation of the system, but not restricted to the following :

a. High pressure switch.

b. Low pressure switch.

c. Fuse.

d. Fan drive overload protector.

e. Fusible plug

f. Overload relay.

g. Overload protection for inverter.

h. Fan motor safety thermostat

Oil Recovery System

Each unit shall be equipped, with an oil recovery system to ensure stable operation with long refrigerant piping.

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

Anti-corrosion Treatment

Outdoor units should be designed with anti-corrosion specifications as detailed below for use in area, which are subject to salt damage and atmospheric pollution as specified in the BOQ.

The portion of machines like side panel, outer panel, bottom frame, which are exposed to corrosive atmosphere, should be of alloyed hot-dip zinc coated steel plate, coated with corrosion protection powder polyester resin coating on both inner and outer surfaces in thickness of 64 micron or more.

Finned coil protection net should have coating of resin coating containing ultraviolet ray absorbent. Fan and its fan protective net should be with weather resistant polypropylene resin.

The copper pipe with aluminium fins shall be special acrylic resin coated and internal supports, frame, control box shall also be hot-dip zinc coated steel plate and with rust preventive powder coating of 64 micron or more on inner and outer surfaces.

All screws and bolts used in outdoor unit shall be provided with SUS410, Zinc-nickel alloy plating, zinc chrome acid film treatment and rust inhibitor coating.

Indoor Units

This section deals with supply, installation, testing, commissioning of various type of indoor units confirming to general specification and suitable for the duty selected. The type capacity and size of indoor units shall be as specified in detail Bill of Quantities.

Indoor unit shall be either ceiling mounted cassette type, or ceiling mounted ductable type or floor standing type or wall mounted type or other as specified in BOQ. Each unit shall have electronic control valve to control refrigerant flow rate respond to load variations of the rooms. The indoor units shall have following features :

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

b. In case of centralized control, it shall be set by liquid crystal remote controller.

c. The fan shall be dual suction, aerodynamically designed turbo, multi blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having supported from housing.

d. The cooling coil shall be made out of seamless copper tubes and have continues aluminium fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/ mechanically expended for minimum thermal contact resistance with fins. Each coils shall be factory tested at 21kg/sqm air pressure under water.

e. Unit shall have cleanable type filter fixed to an integrally moulded plastic frame. The filter shall slide away type and neatly inserted.

f. Each indoor unit shall have computerized PID control for maintaining design room temperature. Each unit shall be provided with microprocessor thermostat for cooling and heating.

g. Each unit shall be with wired LCD type remote controller. The remote controller shall memorize the latest malfunction code for easy maintenance. The controller shall have self diagnostic features for easy and quick maintenance and service. The controller shall be able to change fan speed and angle of swing flap individually as per requirement.

The indoor units shall generally be of following type :

Ceiling Mounted Ductable Type Unit

Each Indoor unit shall be ceiling mounted ducted type, as specified in scope of work. It shall have electronic control valve to control refrigerant flow rate in response to load variations of the room. The fan shall be of the dual suction multi blade type and statically and dynamically balanced to ensure low noise and vibration free operation. The unit shall have high static fan for Ductable arrangement.

Ceiling Mounted Cassette Type Unit (Multi Flow/ Round Flow Type)

The unit shall be ceiling mounted type. The unit shall include pre-filter, fan section and DX-coil section. The housing of the unit shall be powder coated galvanized steel. The body shall be light in weight and shall be able to suspend from four corners. The fan shall be aerodynamically designed diffuser turbo fan type. Noise level should not be more then 35 dB at low speed.

Unit shall have an external attractive panel for supply and return air. Unit shall have four way supply air grilles on sides and return air grille in center.

Each unit shall have high lift drain pump, fresh air intake provision (if specified) Low gas detection system and very low operating sound.

All the indoor units regardless of their difference in capacity should have **same decorative panel size** for harmonious aesthetic point of view. It should have provision of connecting branch ducts.

Ceiling Suspended Type

Unit shall be suitable for ceiling suspended arrangement below false ceiling.
The units include pre filter, fan section & DX-coil section. The housing of unit shall be light weight powder coated galvanized steel.

High Wall Mounted Units

The unit shall be wall mounted type. The unit includes pre filter, fan section & DX-coil section. The housing of unit shall be light weight powder coated galvanized steel.

Unit shall have an attractive external casing for supply and return air.

Floor Standing Type

Unit shall be suitable for floor standing arrangement. The units include pre filter, fan section & DX-coil section. The housing of unit shall be light weight powder coated galvanized steel.

Centralized Type Remote Controller

(Optional, if specified in BOQ)

A multifunctional compact centralized controller shall be provided with the system.

The controller must be necessarily a graphic Controller type to act as an advanced air-conditioning management system to give complete control of VRV air-conditioning Equipment, It should have case of use for the user and must have a user friendly colored touch screen, icon display and color LCD display.

a. It shall be able to control up to 64 groups of indoor units with the following functions:

b. Starting/stopping of Air-conditioners as a zone or group or individual unit.

c. Temperature settling for each indoor unit or zone.

d. Switching between temperature control modes, switching of fan speed and direction of airflow, enabling/disabling of individual remote controller operation.

e. Monitoring of operation status such as operation mode & temperature setting of individual indoor units, maintenance information, trouble shooting information.

f. Display of air conditioner operation history.

g. Daily management automation through yearly schedule function with possibility of various schedules.

h. The controller shall have wide screen user friendly color LCD (Liquid Crystal Display) and can be wired by a non polar 2 wire transmission cable to a distance of 1KM away from indoor unit.

Heat Reclaim Ventilation Unit.

In order to achieve the purpose of better indoor air quality, the Heat Reclaim ventilation (HRV) unit must exchange the heat between supplied fresh air and exhausted air in order to bring the outside air closer to indoor temperature and humidity conditions. Thus it must recover the thermal energy of exhaust air and reuse it for supplied fresh air. This must lead to ventilation without increasing the load and thus saving in running cost.

It shall be possible to interlock this HRV system with operation of VRV system to simplify installation and improving the efficiency of air-conditioning. It shall be possible to set automatic ventilation mode so that heat exchange mode and ventilation mode can be automatically selected to enhance energy conservation.

The casing of the HRV unit shall be made of galvanized steel plate, insulation with self extinguishable polyurethane foam. The HRV must have air filters of multi directional fibrous fleeces type.

The heat exchanger element must be designed without any moving parts for higher durability and reliability, It should have high permeability high efficiency specially processed paper which is flame retardant and fungi proof to keep air clean.

The unit must be provided with built in multi directional fibrous filter.

The unit must have optimized design of fan and air flow passage to make it compact and supply air & exhaust air passage must be arranged in such pattern so as to prevent mixing of supply (fresh) and exhaust air.

The unit must be suitable for single phase power supply and have their control panel.

2. SPLIT UNITS/HEAT PUMPS

Scope

The scope of this section comprises supply, installation, testing and commissioning of self contained air cooled split type air conditioning units each comprising of an outdoor and single/twin indoor units conforming to these specifications and in accordance with the requirement of drawings and schedule of quantities.

Outdoor Unit

Outdoor unit shall be an air cooled condensing unit suitable for out door installation conforming to the following specifications.

a. Unit Base & Casing

Base panel shall be constructed out of fabricated steel structure of adequate size. Casing panels shall be of 1.2 mm thick, welded construction, removable type to provide easy access to equipment and shall be bonderized and painted. Casing shall be complete with discharge outlets, grilles, space for refrigeration equipment, fans, condenser coil etc.

b. Compressor

i. Scroll Compressor

The scroll compressor shall be an industrial quality rugged, cast iron, direct hermetic compressor with scroll plates, suction & discharge service valves. The compressor shall be complete with straight suction tube, centrifugal oil pump, oil charging valve, oil level sight glass, crank case heater and check valve on the scroll discharge port. The compressor shall be complete with the provision of two-point lubrication for each motor bearing. The compressor shall be completely enclosed in a chamber with no leakage path and providing the capability for scroll plates to separate. The compressor shall be provided with industrial solid motor mounts internal motor protection and vibration isolation pads. Each compressor shall be independently wired and piped to its own circuit for efficient operation & ease of maintenance. The compressor speed shall not exceed 3000 RPM.

ii. Rotary Compressor

The rotary compressor shall be an industrial quality rugged, cast iron, hermatic/ semi hermatic compressor with capacity control side valve , oil sump heater & differential pressure refrigerant oil flow system. The compressor shall be provided with multiple pressure lubricated rolling element bearing group shall support the rotating assembly. Suitable overload protection shall be provided & necessary isolating valves shall be provided at suction & discharge . The compressor shall be fitted with electrically operated oil heaters with built in thermostats. The heaters shall be shall be automatically actuated when the compressor is stopped. Necessary time delay shall be provided for restart of compressor. The compressor shall be provided with industrial solid motor mounts internal motor protection and vibration isolation pads. Each compressor shall be independently wired and piped to its own circuit for efficient operation & ease of maintenance. The compressor speed shall not exceed 3000 RPM.

c. Condenser

Condenser shall be air cooled in copper tube & aluminium fins construction. Condensers shall be complete with provisions for refrigerant piping connections, shut off valves and any other standard accessory necessary with the equipment supplied.

d. Condenser Fan

Fan shall be preferably propeller type suitable for fractional horse power drive with IP-55 protection.

Indoor Unit

The indoor unit shall be basically a fan coil unit suitable for wall, floor and under ceiling installation of various types conforming to the following specifications.

a. Indoor units shall be either ceiling mounted cassette type, wall mounted type, floor mounted type or ceiling mounted ductable type in conformity with the design drawings and schedule of quantities.

Each indoor unit shall consist of PID controller for maintaining design room conditions besides microprocessor based thermostat for cooling. The indoor unit shall also be provided with wired LCD type remote controller which shall memorize the latest malfunction code for ease in maintenance. The controller shall incorporate self diagnostic features. Such remote controllers associated with cassette type and hi-wall type indoor units shall incorporate inbuilt feature to be able to change fan speed and angle of swing flap individually as desired by the user.

The ceiling mounted cassette type indoor units shall comprise of an attractive molded ABS plastic exterior enclosure provided with four way supply air grilles on the periphery and square return air grill at the centre with filter behind. Each cassette type indoor unit shall consist of high efficiency paddle type condensate water pump to facilitate forced disposal of condensate water and low gas detection system.

The hi-wall indoor units shall be suitable for installation on the wall preferably at lintel level. The specifications shall otherwise be similar to above.

Ceiling mounted ductable indoor units shall comprise of high static centrifugal fan, direct driven or belt driven through TEFC squirrel cage induction motor suitable for moderate amount of duct work. The housing shall be of light weight construction fabricated out of powder coated galvanized sheet steel single skin panels, internally insulated with 9mm thick closed cell elastomeric insulation material.

b. Cooling coil

Cooling coil shall be of the fin and tube type, having aluminium fins, firmly bonded to seamless copper tubes. Face and surface areas shall be such as to assure rated capacity and the air velocity across the coil shall not exceed 170 MPM. The coil shall be factory tested under water at 21 Kg/Sqcm air pressure.

c. Fan Section

The fan associated with non ductable indoor units shall be dual suction, aero dynamically designed, multi blade type, statically-dynamically balanced to ensure smooth circulation of air exhibiting lower noise level. The fan shall be direct driven type mounted directly on motor shaft supported from the housing.

Fan associated with ductable indoor unit shall be centrifugal double inlet double width forward curved type, preferably with variable pitch pulleys. The fan housing shall be statically-dynamically balanced at works to ensure noise and vibration free operation.

d. Filters

Filters shall be cleanable, synthetic fiber media of approved make. Velocity through filters shall not exceed 105 MPM and pressure drop across filters shall not exceed 5 mm of WG.

e. Insulation

All indoor unit shall be factory insulated with minimum 9 mm thick closed cell elastomeric insulation material towards thermal/acoustic treatment.

Drain pan shall be insulated with minimum 9mm mm thick closed cell elastomeric insulation material. Fixing of coil section and drain pan shall be done in such a way to avoid direct metal contact with any other un-insulated metal part in order to avoid condensation.

Condensate drain piping around the indoor unit shall also be insulated with minimum 9mm thick closed cell elastomeric insulation preferably in tubing form.

f. **Refrigerant Piping**

The copper refrigerant piping shall be carried out neatly to connect outdoor and indoor unit/s and shall run along with wires/cables. The refrigerant piping associated with ductable units shall be carried out using hard drawn copper pipes & ready made copper fittings for pipe diameter exceeding 19mm. Piping less than 19mm shall be carried out using soft seamless copper pipes. Joints shall be affected by soldering/brazing process using silver rods. Suitable sleeves shall be provided at all wall crossings as required. The refrigerant circuit shall include liquid line and gas shut-off valves at the end of condenser.

After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using nitrogen at pressure of 21Kg/ Sqcm. Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum equivalent to 700mm Hg and held for another 24 hours prior to commencement of gas charging.

All refrigerant pipes shall be properly supported and anchored to the building structure using steel hangers, anchors, brackets and supports which shall be fixed to the building element by means of inserts or expansion shields of adequate size and number to support the load imposed thereon.

The liquid and suction refrigerant lines including all fittings, valves, strainer etc. shall be insulated with 13 mm thick closed cell elastomeric insulation material preferably in tubing form as specified in Schedule of Quantities.

To protect nitrile rubber insulation associated with exposed copper piping from degrading due to ultra violet rays & atmospheric conditions, it shall be covered with poly-shield coating. Fiberglass tape shall be helically wrapped & applied with two coats of resin with hardener to give smooth finish.

g. Electrical Installation

Factory fabricated local control panel shall be provided with each three phase ductable unit. The armoured conductor power cabling along with earthing shall be carried out as required and the cables shall be as per the “Approved Makes”.

3. VOLTAGE STABILIZERS

The stabilizers shall be automatic type of approved make. The stabilizers shall be three step and suitable to convert 140-280V incoming power supply to 200-240V outgoing power supply. Capacities of the stabilizers shall be as reflected in the "Schedule of Quantities". The stabilizers shall be equipped with the following accessories:

a. Low & high voltage trip.
b. Time delay relay.
c. Ammeter.

4. SUPPLY AIR FAN (FOR FRESH AIR)/EXTRACT FAN SECTION

Scope

The scope shall be supply, installation, testing and commissioning of packaged type supply air fan meeting all design parameters as mentioned in the "Bill of Quantities".

Construction

Casing

Casing shall be single skin constructed out of minimum 1.6mm thick GI sheet suitably braced. The casing shall be of bolted construction designed for outdoor installation. Casing shall be ribOffice and re-in forced with access panels as may be required. Casing shall be factory painted with aluminium paint as required.

Accessories

The packaged type supply air fan shall be complete with following accessories :

a. 50mm thick aluminium wire mesh filters at the air intake.

Centrifugal Fan & Motor

The fan shall be forward curved floor standing double inlet double width type. The wheel and housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy duty ball bearings. The fan shall be selected for speed not exceeding 1000 RPM. The impeller and fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 2000 FPM. Fan housing with motor shall be mounted on a common steel base mounted inside the air handling housing on anti-vibration spring mounts or rubber mounts.

The fan outlet shall be connected to casing with the help of fire retardant canvass constructed out of imported fabrics.

Fans shall be driven by an electric motor as specified in the schedule of quantities. Motor ratings are only tentative and where a fan requires a higher capacity motor, the contractor shall clearly point out the requirement and make his offer accordingly. Motor ratings shall be at least 10% over limit load plus transmission losses.

Fan motors shall be suitable for operation on 415 ±10% volts, 50 cycles, 3 phase, AC power supply and shall be TEFC squirrel cage induction type totally enclosed fan cooled with IP-55 protection. Motors shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt-drive arrangement. Belts shall be of the oil-resistant type.

Note :

Construction of EXTRACT FAN SECTION shall generally be similar to supply air fan as elaborated above but without filters. For detail description of extract fan section please refer “Bill of Quantities”.

5. AIR COOLING MACHINE (AIR WASHER)

Scope

The scope shall be supply, installation, testing and commissioning of double skin packaged type Air cooling machines meeting all design parameters as mentioned in the “ Bill of Quantities”.

Construction

Material of Construction & Design for fan section

The housing shall be so constructed that it can be delivered at site in total/SKD conditions depending upon the requirement.

Inner panels shall be constructed out of 24 gauge (0.63mm) plain galvanized sheet and outer panels shall also be made out of 24 gauge (0.63mm) pre painted galvanized steel sheet. Width of each panel shall not exceed 750mm. Insulation shall be injected polyurethane foam in between the double skin panels of minimum 25mm thickness. These panels shall be bolted from inside on to the frame work with soft rubber gasket in between to make the joints air tight.

AW framework shall be made out of extruded aluminium hollow sections filled with preformed insulation section. Frame work for each section shall be bolted together with soft rubber gasket in between to make the joints air tight. Frames shall be assembled using mechanical joints to make a sturdy and strong framework for various sections. Suitable doors with pressure die cast aluminium hinges and latches shall be provided for access to various panels for maintenance. The entire housing shall be mounted on steel channel frame work. The inside of the cabinet shall be applied with epoxy paint thoroughly.

Wet Section

Wet section of air cooling machine shall be constructed out of stainless steel SS-304 grade of appropriate thickness. However, sump shall be constructed out of 1.25mm thick stainless steel having SS-304 grade.

Pump Sets

Pumps shall be mono block type having following material of construction :

a.	Casing	:	Cast Iron
b.	Impeller	:	Bronze
c.	Bearing	:	Heavy duty Ball/Roller
d.	Shaft	:	High Tensile Steel
e.	Motor	:	TEFC

Driver ratings to be selected at least 15% in excess of the maximum B.H.P of the pump plus transmission losses if any.

The following accessories shall be provided with each pump among other standard accessories required :

a. Lubrication fittings and seal piping.
b. Test and /or air vent cocks.

Accessories

The air cooling machines shall be complete with following accessories :

a. 50mm thick aluminium wire mesh filters at the air intake.

b. 200mm thick cellulose based paper fills of imported origin duly enclosed in PVC frame work.

c. FRP water header with equidistant slits for uniform water distribution over the paper fills.

d. Drain, overflow, make-up and quick fill connections with float valve.

e. Suction screen constructed out of brass and shall be of sufficient area to maintain velocity not exceeding 25cms/sec.

f. 4mm thick PVC eliminators to be provided between the pad section & blower section to eliminate water carry over.

g. All interior and exterior GI piping with valves and fittings to connect the water circulating pumps including 'Y' strainer, ball valves etc.

h. Cabinet type supply air fan section shall be completely factory assembled and tested of approved manufacture.

i. 1mm thick FRP lining to be provided at the base of blower section.

j. Limit switch at door of air washer.

Centrifugal Fan & Motor

The fan shall be forward curved floor standing double inlet double width type. The wheel and housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy duty ball bearings. The fan shall be selected for speed not exceeding 1000 RPM. The impeller and fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 2000 FPM. Fan housing with motor shall be mounted on a common steel base mounted inside the air handling housing on anti-vibration spring mounts or rubber mounts. The fan outlet shall be connected to casing with the help of fire retardant canvass constructed out of imported fabrics. The centrifugal fans shall be coated with epoxy paint to avoid moisture abuse.

Fans shall be driven by an electric motor as specified in the schedule of quantities. Motor ratings are only tentative and where a fan requires a higher capacity motor, the contractor shall clearly point out the requirement and make his offer accordingly. Motor ratings shall be at least 10% over limit load plus transmission losses.

Fan motors shall be suitable for operation on 415 $\pm$10% volts, 50 cycles, 3 phase, AC power supply and shall be TEFC squirrel cage induction type totally enclosed fan cooled with IP-55 protection. Motors shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt-drive arrangement. Belts shall be of the oil-resistant type.

Note :

Construction of scrubber shall generally be similar to air cooling machines. For detail description of scrubber please refer " Bill of Quantities".

6. FILTERS

6.1 Viscous Metallic Filters

Viscous metal filter shall be all metal, washable type. The filter media shall be composed of layers of crimped GI wire mesh. The velocity over face of filter shall not exceed 90 MPM. and pressure drop shall not exceed 5mm for 50mm thick filter. The filter shall be of GI and suitable for mounting as required at site.

6.2 Synthetic Fibre Filters

Synthetic fibre filter shall be cleanable in light weight aluminium framed with non-woven synthetic fibre replaceable media. The filter shall have an efficiency of 90% down to 10 microns when tested as per BS: 2831 standard. It shall be suitable for operation under 100% Relative Humidity & 120 degree C temperature conditions. The velocity over the face of filter shall not exceed 105 MPM and the pressure drop across the filter shall not exceed 2.5mm WG for 25mm thick filter. The filter frame shall be of aluminium and shall be suitable for mounting in air handling unit as required at site.

7. AIR CURTAINS

Air curtains shall be vertical down throw type and shall comprise of twin centrifugal blowers, statically and dynamically balanced, designed for noiseless and continuous operation, motor etc. Necessary documents establishing Dynamic balancing carried out at factory shall be provided with the consignment. The enclosure shall be factory fabricated out of 18 gauge aluminium/CRCA sheet duly powder coated. The outlet shall be carefully designed to create laminar draft providing an invisible air curtain at critical junction isolating clean and semi-clean areas or as required.

****

B- “SPECIFICATIONS - VENTILATION FANS"

Propeller Type Fans:

The propeller type fans shall be used for exhaust air or for fresh air supply as shown on the drawings having following constructional features :

a. Fans shall be of ring mounted type having steel hub and MS blade, mounted directly on the shaft of a totally enclosed motor Bearings shall be maintenance free permanently lubricated type.

b. The fan blades shall be constructed out of pressed steel in aerofoil design to achieve high efficiency. The mounting frame shall be of cast/sheet steel with steel brackets to connect the frame with the fan/motor assembly.

c. Rubber mounts shall be provided between the mounting frame and the mounting brackets. The fan shall be direct driven type and motor shall either be capacitor start –run or three phase squirrel cage induction type totally enclosed.

d. The fan shall be fitted with gravity type louvers. The speed of fan shall be as mentioned in “Bill of Quantities” and drawings.

e. All the fans shall be tested for performance and the following test results shall be furnished :

   i. Air flow rate in C.F.M.
   ii. Static pressure at the fan supply end.

2. **Inline Fans :**

The inline fans shall be used for exhaust air or for fresh air supply as shown on the drawings having following constructional features :

a. The casing shall be constructed out of hot rolled heavy gauge GSS metal epoxy coated embodied with required inspection doors.

b. Fan shall be direct driven SISW forward or backward curved centrifugal type. Material of construction for impeller shall GSS. Fan wheel shall be statically and dynamically balanced.

c. The bearing shall be completely maintenance free and can be used in any mounting position, at maximum indicated temperature.

d. Motor shall be total enclosed external rotor type and suitable for operation on 415±10% volts, 3phase or 220±6% volts, 1 phase, 50Hz AC power supply. Fans shall be provided with capacitor as required.

e. Single phase inline fans shall be provided with factory fitted speed regulators and three phase inline fans shall be provided with GI dampers.

f. All the fans shall be tested for performance and the following test results shall be furnished:

i. Air flow rate in C.F.M.
ii. Static pressure at the fan supply end.

****

C- "**SPECIFICATIONS - PIPING"**

1. **General :**

a. The scope under this section covers supply, laying, erection, testing and commissioning of pipes, pipe fittings and associated valves conforming to these specifications and the general arrangements shown on the drawings.

b. All piping including pipe fittings and valves shall follow the relevant Indian Standards/manufacturer's recommendations.

2. **Refrigerant Piping :**

All refrigerant piping for the VRV air conditioning system shall be constructed out of hard drawn copper refrigerant pipes with copper fittings and silver-soldered joints. The refrigerant piping arrangements shall be in accordance with good engineering practice within the air-conditioning industry, and shall be inclusive of charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits.

All joints in copper piping shall be sweet joints using low temperature brazing and or silver solder. Before joining any copper pipe or fittings, its interiors shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently, it shall be thoroughly blown out using nitrogen.

The Refnet Joints (Y-joints) and Refnet Headers shall be made from copper and would be imported, factory fabricated and pre-insulated.

After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using nitrogen at pressure of 20Kg/Sq. Cm and 10 Kg/Sq.Cm (low side). Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum of 700mm Hg and held for 24 hours.

The air-conditioning system supplier shall verify the refrigerant piping design conceived and brought to the notice of Consultants if any discrepancy is found.

The OD & wall thickness of copper refrigerant piping shall be as follows:

Outside Pipe Dia (mm)	**Wall thickness (mm)**
54.1	1.5
41.3	1.3

34.9	1.3
28.6	1.2
Outside Pipe Dia (mm)	**Wall thickness (mm)**
25.4	1.2
22.2	1.2
19.1	1.0
15.9	1.0
12.7	0.8
9.5	0.8
6.4	0.8

The suction line pipe size and the liquid line pipe size shall be selected according to the manufacturers specified outside diameter. All refrigerant pipes shall be properly supported and anchored to the building structure using steel hangers, anchors, brackets and supports which shall be fixed to the building structure by means of inserts or expansion shields of adequate size and number to support the load imposed thereon.

The whole of the liquid and suction refrigerant lines including all fittings, valves and strainer bodies, etc. shall be insulated with 19mm thick closed cell elastomeric insulation material.

The joints shall be properly sealed with synthetic glue to ensure proper bonding of the ends.

3. **Drain Piping :**

a. All pipes to be used for drain, condensate drain and fittings shall be galvanized steel class 'B' (medium class) confirming to relevant IS & BIS Codes.

b. All jointing in the pipe system shall be by screwed and / or by screwed flanges using 3mm 3 ply rubber insertion gaskets. Pipe threads and flanges shall be as per relevant BIS Codes.

c. All pipes supports shall be mild steel, thoroughly cleaned and given one primary coat of red oxide paint before being installed.

d. Fittings shall be galvanized steel “medium class” malleable casting of pressure rating suitable for the piping system. Flanges shall be of approved make. Supply of flanges shall include bolts, nuts, and gaskets as required. Sufficient number of flanges and unions shall be provided for future cleaning and servicing of piping. Tee-off connection shall be through equal or reducing Tees. All equipment and valve connections or connections to any other mating pipes shall be through flanges required for the mating connections.

All condensate drain piping shall be insulated with closed cell elastomeric insulation material of thickness as mentioned in “Schedule of Quantities”.

4. **Insulation**

Drain Pipes shall be insulated as required or as shown on the approved drawings and in line with specifications stipulated in section ‘INSULATION’.

****

D - "**SPECIFICATIONS - DUCTWORK AND AIR TERMINALS"**

1. General :

a. The scope under this section covers supply, fabrication, installation and testing of all GS sheet metal ducts and supply, installation, testing and balancing of grilles, diffusers conforming to these specifications and the general arrangements shown on the tender drawings.

b. Duct work shall mean all ducts, dampers, access doors, joints, stiffeners, supports and hangers.

2. Duct Work Fabricated at Site as per BIS Standards

2.1 Duct Material and Fabrication

Material used for ducts shall be galvanized steel sheets class VIII conforming to IS:277-1962(revised) or aluminium sheets conforming to IS:737-1955 as specified in the Bill of Quantities. All ducts shall be fabricated and installed in a workman like manner, generally conforming to IS : 655-1963 (Revised) with amendment- I(1971 edition).Fabrication of ducts shall be through well conditioned Triplex lock former or multiple lock formers, conforming to relevant BIS Codes. Round exposed ducts shall be die formed for achieving perfect circle configuration.

Thickness of the sheet shall be as given hereunder :

	Sheet thickness	
Size of Duct	**GSS**	**Aluminium**
Up to 750 mm	24 Gauge (0.63mm)	22 Gauge (0.80mm)
751 mm to 1500mm	22 Gauge (0.80mm)	20 Gauge (1.00mm)
1501 mm to 2250mm	20 Gauge (1.00mm)	18 Gauge (1.25mm)
2251 mm and above	18 Gauge (1.25mm)	16 Gauge (1.6mm)
All Round Ducts	20 Gauge (1.00mm)	--

Joints and bracing of ductwork shall generally be as per IS Specifications. However, minimum size of accessories involved shall be as given hereunder:

Size of Duct	Joint Type	Bracing
Up to 750 mm	G.I. Flange	----------
751 mm to 1000 mm	25 mm x 25 mm x 3 mm angle iron frame with8 mm dia nuts and bolts	25 mm x 25 mm x 3 mm angle iron frame at 1000 mm centre
1001 mm to 1500 mm	40 mm x 40 mm x 5 mm angle iron frame with8 mm dia nuts and bolts	40 mm x 40 mm x3 mm angle iron frame at 1000 mm centre
1001 mm to 1500 mm	40 mm x 40 mm x 5 mm angle iron frame with8 mm dia nuts and bolts	40 mm x 40 mm x3 mm angle iron frame at 1000 mm centre
1501 mm to 2250 mm	50 mm x 50 mm x 5 mm angle iron frame with 10 mm dia nuts and bolts. at 125 mm centre	40 mm x 40 mm x 3mm angle iron frame at 1200 mm centre(diagonally cross braced)
2251 mm and above	50 mm x 50 mm x 6 mm angle iron frame with 10 mm dia nuts and bolts. at 125 mm centre	40 mm x 40 mm x 3mm angle iron frame at 1200 mm centre(diagonally cross braced)

2.1.2 GI sheets shall be produced using hot deep galvanization process and minimum acceptable coating of zinc shall be 120gm/SqM. Sample of GI sheet along with test certificate to be submitted for approval prior to supply of GI sheets.

2.1.3 GI sheets shall be checked for hardness/flexibility and water marks prior to dispatch. Zinc coating if found peeled –off or duct work with water marks after fabrication shall be rejected.

2.1.4 Ducts shall be straight and smooth on the inside with neatly finished joints. All joints shall be made air tight.

2.1.5 All exposed ducts within conditioned spaces shall have only slip joints and no flanged joints. The internal ends of slip joints shall be made in the direction of air flow.

2.1.6 Change in dimensions and shape of ducts shall be gradual. Curved elbows, unless otherwise approved, shall have a centre line radius equal to one and half times the width of the duct. Air turns shall be installed in all abrupt elbows and shall consist of curved metal blades or vanes, arranged to permit the air to make the turns without appreciable turbulence.

2.1.7 GI splitter dampers complete with brass metal lever shall be installed at each bifurcation / trifurcation point of duct for proper flow of air quantity in each duct.

2.1.8 Ductwork shall be fabricated strictly in accordance with the "Approved for Construction" Shop drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees or angles of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.

2.1.9 All sheet metal connections, partitions and plenums required to confine the flow of air to and through the filters and fans, shall be constructed out of 18 gauge galvanized steel sheet, thoroughly stiffened with angle iron braces mentioned above and fitted with all necessary doors as required by the Consultants, to give access to all parts of the apparatus. Doors shall not be less than 45cm x 45cm in size. All hardware fittings such as thunder bolts, hinges, handles etc shall be in extruded aluminium construction.

2.2 Installation of Ductwork

2.2.1 During construction, the contractor shall temporarily close the duct openings with sheet metal covers to prevent debris and any foreign material entering ducts and to maintain opening straight and square.

2.2.2 All ducts shall be installed generally as per the drawings and in strict accordance with approved shop drawings to be prepared by the contractor.

2.2.3. The contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these specifications and drawings. This work shall meet with the approval of the Architects/Owners in all its parts and details.

2.2.4. All ducts shall be supported from the ceiling /slab using 9mm to 12mm dia MS rods depending upon the size of the duct unless & until mentioned otherwise in the BOQ. MS angle iron of size not less than 40mmx40mmx5mm or more if duct size is large enough shall be used at the bottom. The MS rods shall be anchored to RCC slab using suitable metallic expansion fasteners.

2.2.5 All necessary allowances and provisions shall be made by the contractor for beams, pipes or other obstructions in the buildings, whether or not the same are shown on the drawings. Where it becomes necessary to avoid beams or other structural work, plumbing or other pipes, and /or conduits, the ducts shall be transformed, divided or curved to one side, the required area being maintained as approved or directed by the Architects/Consulting Engineer.

2.2.6 If a duct can not be run as shown on the drawing, the contractor shall install the duct between the required points by any path available, subject to the approval of the Architect/ Consultant.

2.2.7 All duct work shall be independently supported from building elements or as required by the Architect/ Consultant. All horizontal ducts shall be rigidly and securely supported, in an approved manner, within hangers formed of MS rods and angle iron under ducts not greater than 2 M centers. All vertical duct work shall be supported by structural members at each floor.

2.2.8 Ducting on top of the ceiling shall be supported from the slab above, or from beams with the help of adequate strength dash fasteners, after obtaining approval of the Architect/ Consultant. In no case shall a duct be supported from the ceiling hangers or be permitted to rest on a hung ceiling.

2.2.9 All metal work in dead or closed down spaces shall be erected in time to occasion no delay to other contractors in the building.

2.2.10 All air turns of 45 degrees or more shall include curved metal blades or vanes so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration. All supply air collars shall be provided with GI vanes properly secured using rivets.

2.2.11 All ducts shall be totally free from vibration under all conditions of operations. Whenever duct work is connected to fans, that may cause vibrations in the duct, ducts shall be provided with two flexible connections located close to the unit in mutually perpendicular directions. Flexible connection shall be constructed of fire resistant flexible double canvas sleeves at least 150mm long, secured properly and bolted at both ends. Sleeve shall be made smooth and the connecting duct work rigidly held by independent supports on both ends. The flexible connection shall be suitable for pressures at the point of installation.

2.2.12 The two mating flanges of the ducts being joined with each other shall be made air tight by providing 4mm thick rubber gasket fixed on both mating flanges by means of good quality adhesive. Rubber strip shall also be provided between bottom surface of duct and angle iron at each duct support to avoid metal to metal contact.

2.2.13 All duct supports including MS rods, cleats and angle iron shall be primer coated and thereafter, painted with black enamel paint.

2.3 Round Ductwork

Spiral/round ductwork wherever required shall meet following parameters :

a. Conform to BIS round ductwork requirements.

b. Round Ducts shall be constructed out of galvanized sheet steel as per relevant BIS standards.

c. Upto 1200mm dia ducts spiral lock seam shall be provided.

d. Ducts more than 1200 mm diameter shall be provided with welded longitudinal or spiral seam.

e. Lap or snap lock seams are not permitted for round ductwork of any size.

f. Provide beaded sleeve or flanged and gasketed joints for ducts.

g. Provide all welded long radius elbows.

h. Provide conical tees, all welded.

i. Butt tees or butt taps are not permitted.

All round ducts, 750 mm and larger, shall be supported with two hangers at each support point in an approved manner.

3. **Duct Work Fabricated in Factory as per SMACNA Standards**

3.1 Duct Material and Fabrication

Material used for ducts shall be galvanized steel sheets class VIII, light coating of zinc, nominal 120gm/SqM surface area conforming to IS:277-1962 (revised) or aluminium sheets conforming to IS:737-1955 as specified in the Bill of Quantities. GI sheet shall be of Lock Forming Quality prime material along with mill test certificates. In addition, if deemed necessary, samples of raw material, selected at random by Client's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

3.2. Recommended Thickness and Type of Joints

All ducts shall be fabricated using galvanized steel/aluminum sheet with thickness as mentioned hereunder:

3.2.1 For Ducts with External Static Pressure (SP) upto 250 Pa (25mm) :

GSS Rectangular Ducts	Pressure 250 Pa (25mm) Duct Section Length 1.2 m (4 ft)		
Maximum Duct Size	**Gauge as per BOQ**	**Joint Type**	**Bracing Spacing**
1–750 mm	26 or 24	"C & SS" for ducts concealed within false ceiling and **"4 Bolt Transverse Duct Connector-E (TDC) with built in sealant" for all exposed ducts.**	Nil
751 – 899 mm	26 or 24	4 Bolt Transverse Duct Connector-E (TDC) with built in sealant	Nil
900 – 1200 mm	24 or 22	4 Bolt TDC –E	Nil
1201 – 1500 mm	24 or 22	4 Bolt TDC-H	Nil
1501 – 1800 mm	22 or 20	4 Bolt TDC-H	Nil
1801 – 2100 mm	20	4 Bolt TDC-J	Nil
2101 – 2700 mm	18	4 Bolt TDC-J	Nil

3.2.2 For Ducts with External Static Pressure (SP) upto 500 Pa (50mm) :

GSS Rectangular Ducts	External Pressure 500 Pa (50mm) Duct Section Length 1.2 m (4 ft)		
Maximum Duct Size	**Gauge**	**Joint Type**	**Bracing Spacing**
1–600 mm	26 or 24	"C & SS" for ducts concealed within false ceiling and **"4 Bolt Transverse Duct Connector-E (TDC) with built in sealant" for all exposed ducts.**	Nil
601-750 mm	26 or 24	4 Bolt Transverse Duct Connector-E (TDC) with built in sealant	Nil
751-1000 mm	24 or 22	4 Bolt TDC-E	Nil

1001-1200 mm	22 or 20	4 Bolt TDC-H	Nil
1201-1300 mm	20	4 Bolt TDC-J	Nil
1301-1500 mm	18	4 Bolt TDC-J	Nil
1501-1800 mm	18	4 Bolt TDC-J	Nil
1801-2100 mm	18	4 Bolt TDC-J	Nil
2101-2250 mm	18	4 Bolt TDC-J	Nil
2251-2400 mm	18	4 Bolt TDC-J	Nil
2401-2700 mm	18	4 Bolt TDC-J	600 *

'C'-cleat; 'S'-S cleat; 'SS'-Standing S cleat; 'AI' -Angle Iron in mm
* Distance of reinforcement/bracing from each joint. Bracing material to be same as of material used for joining of duct sections.

For Aluminium ducts material shall be one commercial gauge higher with 22 gauge as minimum.

3.3 Fabrication Standards and Equipment

All duct construction and installation shall be in accordance with SMACNA standards. In addition ducts shall be factory fabricated utilizing the following machines to provide the requisite quality of ducts.

3.3.1 Coil (Sheet metal in Roll Form) lines to facilitate location of longitudinal seams at corners/folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct.

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

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

3.4 Duct Construction

All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes.

a) Ducts so identified on the Drawings shall be acoustically lined and insulated from outside as descriOffice in the section “Insulation” and as indicated in schedule of Quantities. Duct dimensions shown on drawings, are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in Schedule of quantities. The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps.

b) Ducts shall be straight and smooth on the inside with longitudinal seams shall be airtight and at corners only which shall be either Pittsburgh or snap button as per SMACNA practice, to ensure air tightness.

c) All concealed ducts up to 750mm width within conditioned spaces shall have slip and drive (C & S/SS) joints. The internal ends of slip joints shall be in the direction of airflow. Care should be taken to ensure that S/SS Cleats are mounted on the longer side of the duct and Cleats on the shorter side. Ducts and accessories within ceiling spaces, visible from air-conditioned areas shall be provided with two coats of mat black finish paint.

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

e) Ducts shall be fabricated as per details shown on Approved for Construction Shop Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.

f) All sheet metal connection, partitions and plenums, required to confine the flow of air to and through the filters and fans, shall be constructed of 18 gauge GSS / 16gauge aluminum, thoroughly stiffened with 25mm x 25mm x 3mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 450mm x 450mm in size.

g) Plenums shall be shop/factory fabricated panel type and assembled at site. Fixing of galvanized angle flanges on duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside.

h) Self adhesive Neoprene rubber / UV resistant PVC foam lining 5mm nominal thickness instead of felt, shall be used between duct flanges and between duct supports in all ducting installation

3.5 Duct Installation

All ducts shall be installed generally as per tender Drawings, and in strict accordance with approved shop drawings to be prepared by the Contractor. The contractor shall also carry out the feasibility study at site, coordination with other services and interior drawings before fabrication of duct at the factory. Any fabricated duct rejected due to these reasons shall not be paid and only final measured and installed duct shall be certified for payment.

a. The Contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these Specifications and Drawings. The work shall meet with the approval of Architects/Consultants/Client's site representative in all its parts and details.

b. All necessary allowances and provisions shall be made by the Contractor for beams, pipes, or other obstructions in the building, whether or not the same are shown on the Drawings. Where necessary to avoid beams or other structural work, plumbing or other pipes, and conduits, the ducts shall be transformed, divided or curved to one side (the required area being maintained) all as per the site requirements.

c. If a duct cannot be run as shown on the Drawings, the Contractor shall install the duct between the required points by any path available, in accordance with other services and as per approval of Client's site representative. Fabrication of duct shall be commenced only after verifying the feasibility at site.

d. All duct work shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of fully threaded galvanized steel rods and galvanized steel angle/channel under ducts at no greater than 2 meter centre. All vertical duct work shall be supported by structural members on each floor slab. Galvanised steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods and angles/ channels shall be hung through these cleats. Duct support shall be through dash /anchor fastener driven into the concrete slab by electrically

operated gun. Hanger rods shall then hang through the cleats. Size of supports shall be as given hereunder :

Larger Size of Duct	"C" channel size	Fully threaded GI Vertical Rod size	Maximum spacing between supports
Up to 600mm	40mmx40mmx18gauge	8mm	2000mm
601mm to 1200mm	40mmx40mmx16gauge	10mm	2000mm
1201mm to 1800mm	50mmx50mmx5mm MS angle iron duly painted	12mm	2000mm
1801mm & above	65mmx65mmx6mm MS angle iron duly painted	12mm	2000mm

e. Ducting over false ceiling shall be supported from the slab above, or from beams, after obtaining approval of Client's site representative/Architects. In no case shall any duct be supported from false ceiling hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other Contractor's work in the building. All supports of ducts shall be taken from structural slab/wall by means of fastener.

f. Where ducts pass through brick or masonry openings, it shall be provided with 25 mm thick TF quality expanded polystyrene around the duct and totally covered with mortar for complete sealing. Contractor shall ensure that contact between metal duct and mortar is avoided.

g. All ducts shall be totally free from vibration under all conditions of operation. Whenever duct work is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a fire resistant double flexible connection, located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve atleast 100mm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting duct work rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation.

h. In case of grid type false ceiling, the entire diffuser assembly with plenum shall be independently hung from the ceiling through adjustable GI wires and the same shall be connected to the main duct through a flexible round duct.

i. Duct shall not rest on false ceiling and shall be in level from bottom. Taper pieces shall taper from top.

j. Suitable arrangement shall be provided in duct for fixing of duct smoke sensor (supplied by other vendor).

k. Toilet exhaust duct shall be provided with goose necking as shown in design drawings and exhaust shall continue operation in case of fire.

4. **Air Terminals**

4.1 Dampers

4.1.1 Opposed blade type louver dampers with quadrant and thumb screw lock shall be used at supply air collars for balancing of air distribution system and box type volume control dampers having lever operation shall be used at the outlet of air conditioning equipment or as shown on the approved shop drawings.

4.1.2. All dampers shall be multi blade type of robust construction of galvanized steel unless and until specified otherwise in the Bill of Quantities and tightly fitted. The design, method of handling, and control shall be suitable for the location and service required.

4.1.3 Dampers shall be provided with suitable links, levers and quadrants as required for their proper operation ; control or setting devices shall be made robust, easily operable and accessible through suitable access doors in the ducts. Every damper shall have an indicating device clearly showing the damper position at all times.

4.1.4 Dampers shall be placed in ducts and at each supply air collar, whether or not indicated on the drawings, for the proper volume control and balancing of the system.

4.1.5 Automatic and manual volume control opposed blade dampers shall be complete with frames and bronze bearings as per drawings. Dampers and frames shall be constructed out of 1.6mm steel sheets and blades shall not be over 225mm wide. The dampers for fresh air inlet shall additionally be provided with fly mesh screen, on the outside, of 0.8mm thickness with fine mesh.

4.1.6 Wherever required for system balancing, a volume balancing opposed blade damper with quadrant and thumb screw lock shall be provided.

4.1.7 After completion of the duct work, dampers are to be adjusted and set to deliver air flow as specified on the drawings.

4.2 Double Louvered Grilles

4.2.1 The supply air grilles shall be fabricated from extruded aluminium sections. The supply air grilles shall have double adjustable louvers i.e. front horizontal and rear vertical louvers, both adjustable. The louvers shall be suitable to hold deflection settings under all conditions of velocity and pressure. The grilles shall be provided with outer frame. The louvers shall be pivoted in Nylon bushes for smooth operation for return air grilles similar to supply air as descriOffice above will be provided but with out volume control damper. The grilles shall be painted as per approved powder coated shade.

4.2.2 Volume control dampers in extruded aluminium construction shall be factory fitted for supply air grilles.

4.2.3 Longer grilles having size more than 45cm shall have intermediate supports for the horizontal louvers. The sample of grille shall have to be got approved by the consultants before delivery.

4.3 Linear Grilles

4.3.1 The linear supply cum return air grilles shall be fabricated from extruded aluminium sections. Flanges shall be of minimum 1.3 mm thick extruded aluminium suitable to hold the louvers tightly in fixed position.

4.3.2 Louvers shall be minimum 4.5mm thick in front and minimum 2mm thick in the rear constructed out of extruded aluminium sections with 15 degree deflection unless and until specified otherwise. Grilles shall be provided with removable/fixed internal core as mentioned in the BOQ. The sample of grille shall have to be got approved by the consultants before delivery.

4.3.3 All sections of grills shall be powder coated for color and shade as approved by the Architects to match interior finishes.

4.3.4 Linear grilles at each supply air outlet shall be provided with volume control dampers as mentioned above and accounted for in BOQ separately. The linear grilles shall be fixed in to a plenum chamber having GI spacers with concealed screws. End pieces or corner pieces shall be provided as required.

4.4 Diffusers

4.4.1 Square ceiling diffuser shall be anti-smudge ring type fabricated out of extruded aluminium sections. The four directional air flow diffuser shall consist of outer ring fixed to duct collar with concealed screws. Foam gasket shall be provided between outer ring and suspended ceiling. The central core shall be clip fixed to the outer ring.

4.4.2 Opposed blade volume control damper in extruded aluminium construction shall be fixed to the neck of diffuser. The damper shall be adjusted after removing the central core.

4.4.3 All sections of diffusers shall be powder coated for color and shade as approved by the Architects to match interior finishes. The sample of diffuser shall have to be got approved by the consultants before delivery.

4.4.4 In the event diffuser being fixed in grid type false ceiling, the entire diffuser assembly with plenum shall be independently hung from the ceiling through adjustable GI wires and the same shall be connected to the main duct through a pre insulated flexible round duct.

4.5 **Plaque Diffuser**

4.5.1 The Plaque diffusers shall be constructed out of Extruded Aluminium powder coated sections and designed to integrate with grid type false ceiling arrangement.

4.5.2 The diffuser shall consist of a rear pan and a removable heavy gauge front flat panel attached to the rear pan through spring loaded locking posts. The flat panel may be removed whenever need arises to facilitate adjustment of the damper for air balancing.

4.5.3 The front panel shall be aerodynamic in appearance, rigid and preferably in single piece construction and free from any welding or forming blemishes.

4.5.4 The horizontal air discharge pattern shall be 360 deg type . Blank off baffles shall be provided to obtain one, two or three way blow pattern if specifically asked for in the BOQ. Diffusers shall be provided with following accessories :

a. Opposed blade damper

b. Spiggot to facilitate round duct connection at neck.

4.5.5 The performance criteria shall be in conformity with relevant ANSI/ASHRAE standards.

4.6 Multislot Linear Diffuser

Linear ceiling diffuser shall be multislot type. The diffuser shall be fabricated out of extruded aluminium sections. Each slot shall be 19mm wide. Each slot shall be equipped with air flow direction control louver mechanically fixed. Integral sliding type hit & miss type volume control damper in extruded aluminium construction shall be provided for each slot for fine control of air flow in supply air portion only. The damper shall be fabricated out of anodized extruded aluminium sections.

Other sections of ceiling diffuser shall be powder coated in colour & shade approved by the Consultants/Architects.

The linear diffuser shall be fixed in to a plenum chamber with concealed screws. Side end pieces or corner pieces shall be provided if requir

4.7 Air Transfer Grille

4.7.1 Air transfer grilles shall be in extruded aluminium construction. The grilles shall be complete with single /double frame suitable to be fixed on the door panel from both sides. The central core shall be no-see-thru type.

4.7.2 The grilles shall be anodized or powder coated in colour and shade as approved by the Architects. The grilles shall be provided with insect screen.

4.7.3 The ATGs shall be provided at the door of pantry and toilets as shown in the approved drawings. The sample of grille shall have to be got approved by the consultants before delivery.

5. Painting

5.1 All grilles and diffusers shall be powder coated at factory prior to delivery at site of approved color and shade.

5.2 All ducts immediately behind the grilles/diffusers etc. to be applied with two coats of black paint in matt finish.

6. **Testing and Balancing**

6.1 After completion of the installation of the complete air distribution system, all ducts shall be tested for air leaks.

6.2 Before painting the interiors, air distribution system shall be allowed to run continuously for 48 hours for driving away any dust or foreign material lodged within ducts during installation.

6.3 The entire air distribution system shall be balanced using approved anemometer. Air quantities at the fan discharge and at various outlets shall be identical to, or less than 5 percent in excess of, those specified and quoted. Leakage in each air distribution system shall be within 3 percent so that supply air volume at each fan shall be identical to , or no greater than 3 percent in excess of, the total air quantity measured at all supply outlets served by the fan. Branch duct adjustments shall be made by volume or splitter dampers. Dampers shall be permanently marked after air balance is complete so that these can be restored to their correct position if distur Office at any time. Complete air balance report shall be submitted to the Consulting Engineer for scrutiny and approval, and six copies of the approved report shall be provided with completion documents.

E- "SPECIFICATIONS - INSULATION"

1. **Scope**

The scope of this section comprises of supply and application of insulation conforming to these Specifications and as shown on the drawings & BOQ.

2. **Duct Insulation (External)**

Material

Insulation material shall be factory laminated aluminium foil faced closed cell elastomeric material (nitrile rubber) having fire retardant Class "O" properties. Density of insulation material shall range between 0.04-0.07 gm/Cucm. Thermal conductivity (K value) at 40 C mean temperature and Service temperature limit shall be 0.039 W/M.K and –40C to 105C respectively. Water vapour permeability shall not be less than 7000 Kg/Pa/s.m.Water absorption shall not be more than 1.5% by weight. Insulation material shall have excellent ozone resistance properties. Excellent Thermal Stability. Insulation material shall be tested for the said properties in accordance with the relevant international codes including BS 874 Part 2 1986 ,DIN 52612(K Value),DIN 52615 (Water vapour permeability), BS 476 Part6 & Part7 (Flammability).

Application

Duct insulation shall be applied as follows :

a. External surface of the ducts to be cleaned vigorously to remove dirt and any other foreign material from the surface of the ducts.

b. Apply adhesive SR-998/505 on the surface of ducts.

c. Wrap closed cell insulation material having thickness as mentioned in BOQ butting all joints. All joints to be sealed with adhesive.

3. **Acoustic Lining of Ducts**

3.1 **Material**

Acoustic insulation material shall generally possess the properties mentioned above, however, insulation material shall be processed Nitrile Rubber Foam having fire retardant Class "O" properties. Density of insulation material shall range between 140-180 Kg/CuM. The insulation material shall conform to the international codes including BS 476 Part6 & Part7 (Flammability).

3.2 **Application**

Acoustical lining of duct wherever specified shall be applied as under :

a. Internal surface of the ducts to be cleaned vigorously to remove dirt and any other foreign material from the surface of the ducts

b. Apply Low VOC adhesive on the surface of ducts.

c. Cut foamed sheets into required sizes using sharp knives. Apply adhesive on the foam and stick it to the duct surface.

3. **Acoustic Lining**

3.1 **Material**

Insulation material shall be resin bonded fiberglass. The Thermal conductivity of the insulation material shall not exceed 0.034 K cal./ hr-SqM C/M or 0.27 Btu/hr sft- F/inch at 32 C (90 F) mean temperature, and density shall not be less than 24 Kg/ CuM (1.5 lb/c.ft). Thickness of the insulation shall be as specified for the individual application. Samples of insulation material shall be submitted for approval.

3.2 **Application**

3.2.1 **Duct Lining (Internal)**

Acoustical lining of duct wherever specified shall be applied as under :

a. Internal surface of the ducts to be cleaned vigorously to remove dirt and any other foreign material from the surface of the ducts

b. 22 gauge G.S. Sheet channel frames having size 25mm wide & depth equal to thickness of insulation to be fixed at maximum 600mm centre, screwed to the sheet metal using brass metal screws.

c. Fibre Glass blankets of 32 Kg/CuM density and thickness as mentioned in the BOQ to be fixed in the G.S.sheet channel frame work with joints well butted together. Thereafter, insulation shall be covered with R.P tissue.

d. Finally cover the insulation with 26 SWG perforated aluminium sheet having atleast 20% perforation with joints overlapped and screwed to the G.S. sheet channel frame using brass metal screws, to produce an even surface.

Note : specifications shall be applicable as specified in the BOQ.

4. **Underdeck Thermal Insulation for Exposed Roof**

Material

Insulation material shall be closed cell elastomeric material (nitrile rubber) having fire retardant Class "O" properties. Density of insulation material shall range between 0.04-0.07 gm/Cucm. Thermal conductivity (K value) at 40 C mean temperature and Service temperature limit shall be 0.039 W/M.K and – 40C to 105C respectively. Water vapour permeability shall not be less than 7000 Kg/Pa/s.m.Water absorption shall not be more than 1.5% by weight. Insulation material shall have excellent ozone resistance properties. Excellent Thermal Stability. Insulation material shall be tested for the said properties in accordance with the relevant international codes including BS 874 Part 2 1986, DIN 52612(K Value), DIN 52615 (Water vapour permeability), BS 476 Part6 & Part7 (Flammability).

Application

Following procedure towards application of closed cell elastomeric insulation material having properties as mentioned above for roof exposed to sun shall be adopted :

a. The underside of the roof slab surface to be thoroughly cleaned with wire brush and rendered free from bitumen or any other coating that exists.

b. Basic surface preparation using sand paper.

c. Adhesive Pidilite, SR 998/505 to be applied thereafter, preferably in the evening and be left for overnight.

d. Finally next morning 16mm thick CSE insulation to be applied using adhesive with longitudinal and cross sectional joints glued properly and left open to facilitate inspection. Thereafter, CSE adhesive based tapes shall be applied on such longitudinal and transverse joints.

e. Metal screws shall be fixed with dash fasteners at centre of each piece and longitudinal as well as transverse joints of CSE insulation with a 4"x4" GI cleat at bottom to give extra precaution in fixing of insulation.

****

F- "SPECIFICATIONS - ELECTRICAL WORK"

1. **Scope**

In general, the contractor shall supply, store, erect, test and commission all the equipment required for Electrical Installation. The contractor shall furnish all the materials, labour, tools and equipments for the electrical work, as shown in the accompanying drawings and in the bill of quantities and specifications hereinafter descry Office.

2. **Definitions**

The following abbreviations used in the bill of quantities specifications and drawings represents:

ISS	-	Indian Standard specification.
IER	-	Indian Electricity Rules, 1956.
BS	-	British Standard (where specifically called for)
BSCP	-	British Standard Code of Practice (if called for).
HRC	-	High Rupturing Capacity
GI	-	Galvanised Iron
MS	-	Mild Steel
CI	-	Cast Iron
APLSTS tape	-	Aluminium conductor, paper insulated lead sheathed, Double steel armoured and serving.
PVC	-	Polyvinyl Chloride.
XLPE	-	Cross Linked Polyethylene.
HT	-	High Tension.
LT	-	Low Tension.
A-Amp	-	Ampere.
KV	-	Kilo Volts.
PT	-	Potential Transformers.
CT	-	Current Transformers.
OCB	-	Oil circuit Breakers
VCB	-	Vacuum Circuit Breaker
ACB	-	Air Circuit Breakers
SFU	-	Switch fuse Unit
COS	-	Change Over Switch
CFS	-	Combination Fuse Switch
MCCB	-	Moulded Case Circuit Breaker.
MCB	-	Miniature Circuit Breaker
IC	-	Iron Clad
ICTPN	-	Iron Clad Triple Pole and Neutral

ICDP - Iron Clad Double Pole
DB - Distribution Board
KVA - Kilo Volts Ampere.
KVAR - Kilo Volts Ampere - Reactive.
NC - Normally Close
NO - Normally open
SWG - Standard Wire Gauge.

3. REGULATION & STANDARDS

The installation shall conform in all respects to Indian standard Code of Practice for Electrical Wiring Installation I.S. - 732 and 'National Electrical Code'. It shall be in conformity with the current I.E Rules and Regulations and requirements of the local Electric Supply Authority in-so-far as these become applicable to the installation. Wherever this specification calls for a higher standard of materials and/or workmanship then those required by any of the above regulations, this specifications shall take precedence over the said regulations and standards.

In general, the materials, equipments and workmanship not covered by the above, shall conform to the following Indian Standards (Latest Edition) unless otherwise called for:

a. SWITCHGEAR

- Requirements of A.C. Circuit Breakers. : IS 2516 (Part I) Sec.1,2 & 3 (Part-II)

- Switches and Switch Isolators above 1000V
- But Not Exceeding 1.1 KV : IS 4710

- Markings & arrangements for switchgear
- bus-bars, main connection & auxiliary wiring : IS 375

- Specification for normal duty air break switches & composites unit for air break switches and fuses for voltage not exceeding 1000 Volts. : IS 4064

- Heavy duty air-break switches and composite units of air-break switches and fuses for voltages not exceeding 1000 Volts. : IS 4047

- Specification for miniature circuit breakers. : IS 8828

- Specification for enclosed distribution, fuse boards and cut-outs for voltage not exceeding 1000 Volts : IS 2675

• Installation and maintenance of switchgear.	:	IS 3072 (Part I)
• HRC cartridge fuse links 650 Volts.	:	IS 2208

b. **CABLE & MISCELLANEOUS ITEMS**

• Specification for paper insulated and lead sheathed cables	:	IS 692
• Code of Practice for installation and maintenance of paper insulated power cables (upto and including 33 KV)	:	IS 1255
• Specification for PVC insulated (Heavy Duty) electric cables Part-I for Voltage upto 1100 Volts.	:	IS 1554
• Specification for PVC insulated cables (for voltage upto 1100 V) (Part-II) with Aluminium conductors.	:	IS 694 (Part-II)
• Specification for rigid steel conduit for electrical wiring.	:	IS 9537
• Specifications for rigid non metallic conduits for electrical installations.	:	IS 9537
• Specifications for accessories for rigid steel conduits for Electrical wiring.	:	IS 3837
• Box for the enclosure of electrical accessories steel and C.I. Boxes.	:	IS 5133 (Part I)
• 3Pin plugs and sockets outlets	:	IS 1293
• Adhesive insulating tapes for Electrical purposes (Part- I & II)	:	IS 2448
• Propeller type AG Ventilating fans	:	IS 2312
• Code of Practices for earthing.	:	IS 3043
• Glossary of terms for electrical cable and conductors.	:	IS 1885
• Code of Practice for buildings (General)		

Electrical installation	:	IS 1646
• Current Transformers	:	IS 2705 (Part-I to III)
• Voltage Transformer	:	IS 3156 (Part-I to III)
• Shunt capacitors for Power system	:	IS 2834
• Direct acting electrical indicating instruments	:	IS 1246
• Factory assembled switchgear	:	IS 8623
• Rating for Cable	:	IS 3961 (Part -II)
• Earthing	:	IS 3843

3. INSPECTION & APPROVAL OF THE WORK BY LOCAL AUTHORITY

On completion of this work, the contractor shall obtain and deliver to the owners the certificates of inspection and approval by electrical inspectorate of Local Administration. The fees paid for inspection will be reimbursed on production of challan/receipt. The contractor shall include in his rates all charges necessary for getting electrical installation approved which includes Sub-station, LT distribution, etc. by the Chief Electrical Inspector to the state government or/ and from any other authority required for this job.

5. INSPECTION OF MATERIALS

The Architect/ owners shall have access to the manufacturer's premises for inspection of any items of the tender for which contractor has made arrangement with manufacturer/ suppliers. All such inspection shall not need any prior intimation by the owners or architects.

6. WORKING DRAWINGS & SHOP DRAWINGS

The contractor shall prepare and submit to the Architects/ owners for approval detailed working drawings & shop drawings of all MCC/panels ,cable layout, earthing etc.

7. AS BUILT DRAWINGS

At the completion of the work and before issuance of certificate of virtual completion, the contractor shall submit to the Architect/ employers layout drawings drawn on tracing film and approved scale indicating the complete wiring as installed.

8. ENGINEER/ SUPERVISOR

The contractor shall employ a competent, licence, qualified full time electrical engineer / supervisor to direct the work of electrical installations in accordance with the drawings and specifications. The engineer / supervisor shall be available at all times at the site to receive instructions from the Architect/employers in any day to day activities throughout the duration of the contract. The engineer & supervisor shall correlate the progress of the work in conjunction with all the relevant requirements of the supply authority. The skilled workers employed for the work should have requisite qualifications and should possess competency certificate from the Electrical Inspectorate of Local Administration.

9. APPLICATION FOR ELECTRIC SUPPLY/ LIASON

The Contractor shall be responsible for filing and follow up application for electric supply to the project. The contractor shall carry out all the liason work required for obtaining electric supply at site commencing from filing of application. This liason shall be deemed to be a part of the contract.

GENERAL SPECIFICATION FOR: MEDIUM VOLTAGE POWER CONTROL CENTRE AND SWITCH BOARD PANELS:

1.1 GENERAL:

Medium voltage power control centres (generally termed as switch board panels) shall be in sheet steel clad cubicle pattern, free floor standing type, totally enclosed, compartmentalized design. This specification shall cover the following types of panels :

a) Air circuit breaker panels - Drawout type with single or double tier arrangement as per design shown on the drawings.

b) Panels with one or more Air circuit breakers with Draw-out arrangement and switch-fuse units/moulded case circuit breaker of non-drawout design.

c) Panels with switch- fuse unit/moulded case circuit breaker of non- drawout type. However, the switch-fuse units can have drawout fuse-carriage if a particular make of switch-fuse is used.

The panels shall generally be of extensible type with provision for bus extension on or both sides as desired at the time of approved of shop drawings.

1.2 CODE/STANDARDS :

The panels shall generally conform to the requirements of following codes/ specifications:

a) IS-8623
b) IS-4237
c) IS-2147
d) IS-3072
e) IS-375
f) IS-1248 & 2419
g) IS-5082
h) IS-2705
i) IS-722
j) IS-4064
k) IS-2208
l) IS-6875
m) IS-6005

The equipment shall conform to Indian Electricity Rules as amended upto-date.

The supplier shall examine the provision of these codes and confirm or indicate his comments.

1.3 CONSTRUCTION :

Power control centres/ switch board panels shall of free standing type, with sheet steel enclosure having following features :

a) The panel shall be constructed of sheet steel of minimum 1.6mm thickness. The internal frames shall be made of structural steel angles or made up sections (as per standard design of the manufacturer) specifications of which, shall be submitted along with offers.

b) The panel shall be compartmentalized to accommodate one feeder n each compartment. The main bus bar chamber shall be provided at the top of panel or bottom of the panel as required. The compartments shall be arranged in section with metallic/ phenolic barrier in between.

   A vertical cable alley of at least 200mm width shall be provided to serve one/ two vertical section of feeders. Cable alley shall have hinged door/ doors with rubber gaskets. Suitable

   cable clamping arrangement with slotted steel members shall be provided in the cable alley. Similarly, vertical bus bar shall be housed in-between two feeder compartments in a separate bus chambers. The opening between bus chamber and feeder compartments shall be properly covered with Bakelite/ Hylam sheets of 3mm minimum thickness. The vertical bus chamber shall be provided with removable bolted covers on the front and back side. All the interconnecting links to the feeders shall be shrouded so as to avoid accidental contact, by means of phenolic barriers.

c) Each compartment shall have its own hinged door with concealed hinges. The doors shall have heavy duty rubber gasket fixed on the inner side of the door. The door shall have interlocking facility with the feeder unit.

d) The Panel shall have punched openings for mounting meters, lamps, push buttons, relays, etc.

e) The dimensions of feeder compartments, bus chambers and cable alleys shall be as shown on the relevant drawings. However, the following minimum dimensions shall be strictly adhered to :

i. ACB compartment : Draw out -600mm wide x 1000mm deep x 900mm high.

ii. SWITCH FUSE UNITS/MOULDED CASE CIRCUIT BRACKER (NON-DRAWOUT TYPE) :

Up to 63A/ 100A	:	300mm wide x 225mm high x 400mm deep
250A	:	400mm wide x 400mm high x 400mm deep
400A to 630A	:	400mm wide x 500mm high x 400mm wide. (or vice- versa).

iii. BUS CHAMBER :

Main bus (Horizontal)	:	400mm high x 300mm deep
Vertical bus (Feeder bus)	:	300mm wide x 400mm deep

iv. Cable alley : Min. 200mm wide.

These dimensions are furnished as a guide and the clearances required in between each live bus/ link and between bus/ links to the earth (panel wall/ sheet) shall be as per relevant Indian Standard Code of practice. However, minimum clearance between neutral bus and earth shall not be less than 25mm. The panel supplier shall furnish detailed sectional drawings and also arrange to get the panel inspection done at intermediate stages of fabrication to avoid fault defective febrication of the panels (however, the compliance of these specifications shall entirely be the suppliers' responsibility).

1.4 BUS BARS :

a) The bus bars shall be suitable for 3 phase, 4 wire, 415 volts 50 Hz AC supply. The bus bars shall be made of high conductivity aluminium. The bus bars shall have uniform cross-section throughout the length. The bus bars shall be designed for carrying rated-current continuosly. The bus bars and links shall be

designed for a maximum temperature of 75^{O}C. The max. current density of bus bars shall be as follows:

i. Copper : 1.86 Ampere/ Sq.mm. of cross section area.
ii. Aluminium : 1.28 Ampere/ Sq.mm. of cross section area.

It may be noted that these ratings are the upper limit to which the bus could be stressed. Suitable derating factors shall be applied to arrive at the correct cross section of bus bars.

b. Bus bars shall be supported on suitable non hygroscopic, non combustible, material such as DMC/ SMC at sufficiently close intervals to prevent bus bar sag. All bus bar joints shall be provided with high tensile steel bolts (electro plated with suitable metal such as Nickel/ Cadmium), spring washer and nuts so as to ensure good contact. Alternatively, electroplated/ tinned brass bolts shall be used. The joints shall be formed with fish-plates on either side of bus bar to provide adequate contact area. Bus supports shall be provided on either side of joints (max. unsupported distance from the joint 400mm)

c. Power shall be distributed to feeders in dual section by a set of vertical bus bars (Phases+neutral). Individual module shall be connected to the vertical bus bars through sleeved connections.

d. Bus bars shall be insulated with PVC sleeves (heat shrink type) with colour coding (Red/ Blue/ Yellow/ Black).

e. The bus bars and their supports shall be able to withstand thermal and dynamic stresses due to the system short-circuits. The supplier shall furnish calculations alongwith his drawing establishing the adequacy of bus bars both for continuous duty and short -circuit rating. Short circuit withstand capacity shall be for one second. Calculations for spacing of supporting of supports shall also be furnished.

1.5 EARTHING :

The panels shall be provided with a copper earth bus running throughout the width of the switchboard. Suitable earthing eyes/bolts shall be provided on the main earthing bus to connect the same to the earth grid at the site. Sufficient number of star washers shall be provided at the joints to achieve earth continuity between the panels and the sheet metal parts.

1.6 MOUNTINGS :

Panels incorporating switchfuse units shall have suitable compartments of standard width. Each compartment shall incorporate a heavy duty load break switch fuse and HRC fuses. Suitable cable termination arrangement shall be

provided for switch fuse/ fuse-switch unit feeders. Equipment shall be provided with proper fastening arrangements to ensure vibration free operation. Proper designation as given on the respective drawings, shall be provided for every equipment.

Circuit breakers shall be mounted such that they are accessible from the front of the panel. More than two circuit breakers shall not be incorporated in a vertical section. The breakers compartment shall be divided into two parts, one for the breaker and the other for incorporating associated control gear. The necessary instrumentation shall be provided on the door of the compartment.

1.7 INTERLOCKING

The panels shall be provided with the following interlocking arrangements :

a. The door of the feeder compartments is so interlocked with the switch drive or handle that the door can be opened only if the switch is in “OFF” position. De-interlocking arrangement shall also be provided for inspection.

b. It shall not be possible for the breakers to be withdrawn when in “ON” position.

c. It shall not be possible for the breakers to be switched “ON” unless it is either in fully inserted position or for testing purposes it in fully isolated position.

d. The breaker shall be capable of being racked into “testing”, “isolated” and maintenance position and kept in any of these positions.

e. A safety catch to ensure that the movement of the breaker as it is withdrawn, is checked before it is completely out of the cubicle shall be provided.

1.8 PROTECTION AND INSTRUMENTATION :

Protection and instrumentation shall be as per standard specification.

1.9 WIRING

All the interconnections between the incoming, bus and the outgoings of 100A and above rating shall be done by insulated links/ strips of suitable sizes. Switch fuses and equipments below 100A rating shall be wired with PVC insulated copper conductors. The wiring for instrumentation protection and control equipment shall be carried out with PVC insulated flexible copper conductors.

The Power interconnections shall be carried out by means of bolted connections with washers. The wiring shall be terminated by using crimping sockets. Wring shall be laid out neatly in bunches which are fastened to the steel members of the panel. All the potential circuits shall be protected by fuses mounted near the tap-off point from the main connections.

1.10 TERMINALS:

All the control, instrumentation and protection wiring shall be provided with printed PVC ferrules at both ends. For terminating control cables on to the equipment in the panels, suitable terminals blocks shall be provided. The terminal shall also be numbered for easy identification and maintenance.

1.11 SURFACE TREATMENT

All sheet metal accessories and components of power, control centres and switchboard panels shall be thoroughly cleaned, degreased, derusted and phosphatised before redoxide primer is applied. The panel shall be stove enameled to the required final finish. The interior surfaces of the panel shall also be painted to required shade. The supplier shall indicate in his offer, if there is any deviation from the treatment specified above.

1.12 ENCLOSURES

The panel enclosure shall be dust and vermin proof and shall be suitable for indoor installation. Enclosure design shall be in accordance with the requirements of IP 54 as per IS-2147-1962. The supplier shall confirm whether this requirement is met and a type test certificate furnished. If type test certificate for IP-54 is not available, the same shall be brought out clearly in his offer.

1.13 NAME PLATE

The panel as well as the feeders compartment doors shall be provided with name plates giving the switchboard/ feeder descriptions as indicated on the drawings.

1.14 TESTING

The power control centres shall be tested at factory after assembling of all components and completion of all interconnections and wiring. Tests shall be coducted in accordance with the requirements relevant IS Codes/ specifications.

a. INSULATION TEST

i. Insulation of the main circuit, that is, the insulation resistance of each pole to the earth and that between the poles shall be measured.

ii. Insulation resistance to earth of all secondary wiring should be tested with 1000V megger.

Insulation test shall be carried out both before and after high voltage test.

b. HIGH VOLTAGE TEST :

A high voltage test with 2.5KV one minute shall be applied between the poles and earth. Test shall be carried out on each pole in turn with the remaining poles earthed. All units racked in position and the breakers closed. Original test certificate shall be submitted along with panel.

1.15 STORING, ERECTION AND COMMISSIONING

a. STORING

The panels shall be stored in a well ventilated, dry places. Suitable polythene covers shall be provided for necessary protection against moisture.

b. ERECTION

Switchboards shall be installed on suitable foundation. Foundation shall be as per the dimensions supplied by the panel manufacturer. The foundation shall be flat and level. Suitable grouting holes shall be provided in the foundation. The switch boards shall be properly aligned and bolt000ed to the foundation by atleast four bolts. Cable shall terminated on the bottom plate or top plate as the case may be, by using brass compression glands. The individual cables shall then be lead through the panel to the required feeder compartments for necessary terminations. The cables shall be clamped to the supporting arrangement. The switch board earth bus shall be connected to the local earth grid.

c. PRECOMMISSIONING TESTS :

Panels shall be commissioned only after the successful completion of the following tests. The tests shall be carried in the presence of engineer-in-charge.

i. All main and auxiliary bus bar connections shall be checked and tightened

ii. All wiring terminations and bus bar joints shall be checked and tightened.

iii. Wiring shall be checked to ensure that it is according to the drawing.

iv. All wiring shall be tested for insulation resistance by a 1000V megger.

v. Phase sequence/ rotation shall be estimated.

vi. Suitable injection tests shall be applied to all the measuring insuring instruments to establish the correctness and accuracy of calibration and working order.

iii. All relays and protective devices shall be tested for correctness of settings and operation by introducing a current generator and an ammeter in the circuit.

GENERAL SPCIFICATION FOR : MOULDED CASE CIRCUIT BREAKERS

1.1 GENERAL :

Moulded case circuit breakers or fuse free breaker shall be incorporated in the switch board wherever specified. MCCBS shall conform to BS : 3871 Part II or JIS-C-8370 in all respects. MCCBS shall be suitable either for single phase 230V or three phase 415volts.

1.2 CONSTRUCTION :

The MCCB and case shall be made of high strength heat resistant and flame retardant thermo-setting insulating material. Operating handle shall be quick make/quick break, trip-free type. The operating handle shall have suitable “ON”, “OFF” and “TRIPPED” indicators. Three phase MCCBS shall have a common operating handle for simultaneous operation and tripping of all the three phase. Suitable arc extinguishing device shall be provided for each contact. Tripping unit shall be of thermal-magnetic type provided on each pole and connected by a common trip bar such that tripping of any one pole actuates three poles to open simultaneously. Thermal magnetic/tripping device shall have IDMT characteristics for sustained over loads and short circuits. Contact tips shall be made of suitable are resistant, sintered alloy for long electrical life. Terminals shall be of liberal design with adequate clearances.

1.3 ACCESSORIES :

MCCBS shall be provided with the following accessories, if specified in schedule of quantities:

i. Under voltage release
ii. Shunt release
iii. Alarm Trip alarm
iv. Auxiliary contacts.

1.4 INTERLOCKING :

Moulded case circuit breakers shall be provided with the following interlocking devices for interlocking the door of switch board:

a. Handle interlock to prevent unnecessary manipulation of the breaker.
b. Door interlock to prevent the door being opened when the breaker is in "ON" position.
c. De-interlocking device to open the door even, if the breaker is in "ON" position.

1.5 RUPTURING CAPACITY:

The moulded case circuit breaker shall have a returning capacity of not less that 10KA Rms at 415 volts. Wherever required, higher rupturing capacity breakers to meet the system short circuit fault shall be used. All such ratings shall be as per equipment schedule/B.O.Q.

1.6 TESTING:

a. Original certificate of the MCCBS as per BS:3871 or JS-C-8370 shall be furnished.
b. Pre-commissioning tests on the switch boards panel incorporating the MCCB shall be done as per specifications.

GENERAL SPCIFICATION FOR: MEDIUM VOLTAGE CABLES

1.1 TYPE :

Medium voltage cables shall be aluminium conductor, PVC insulated, PVC sheathed and steel wire armoured or steel tape armoured construction. Aluminium conductors up to 10sq.mm. may be solid, circular in cross section, and sizes above 10sq.mm. shall be stranded. Sector shaped stranded conductors shall be used for sizes above 25sq.mm. The cable shall conform to IS 1554 (Part I).

1.2 RATING

The cable shall be rated for a voltage of 650/1100 Volts.

1.3 CONSTRUCTION

The conductors for power cables shall be made of electrical purity aluminium & that for control cable from annealed high conductivity copper. The conductors shall be insulated with high quality PVC base compound. A command covering (Officeding) shall be applied over the laid up cores by extrusion or wrapping of a filling material containing unvulcanized rubber or thermoplastic material, armouring shall be applied over the inner shath of Officeding, over the armouring a tough outer sheath of PVC sheathing shall be extruded. The outer sheath shall bear the manufacturers name and trade mark at every 30 meter interval.

1.4 CORE IDENTIFICATION :

Core shall be provided with the following colour scheme of PVC insulation.

i.	Core	:	Red/Black/Yellow/Blue
ii.	Core	:	Red and Black
iii.	Core	:	Red, Yellow, and Blue
iv.	3.5/4 core	:	Red, Yellow, Blue and black.

1.5 CURRENT RATINGS :

The current rating shall be based on the following conditions.

i.	Maximum conductor temperature	:	$70^{O}C$
ii.	Ambient air temperature	:	$40^{O}C/50^{O}C$
iii.	Ground temperature	:	$70^{O}C$
iv.	Depth of laying	:	75cm

1.6 SHORT CIRCUIT RATING:

Short circuit ratings for the cables shall be as specified in IS : 1554 Part -I.

1.7 SELECTION OF CABLES :

Cables have been selected considering the conditions of the maximum connected load, ambient temperature, grouping of cables & the allowable voltage drop. However, the contractor shall recheck the sizes before the cables are fixed and connected to the service.

a. Storing

All the cables shall be supplied in drums. On receipt of cables at site, the cables shall be inspected and stored in drums with flanges of the cable drums in vertical position.

b. Laying

Cables shall be laid as per the specifications given below. The system adopted for this job shall be as per BOQ :

i. Cable on Tray/ Racks:

Cables shall be laid on cable trays/ racks wherever specified. Cable racks/trays shall be of ladder, trough or channel design suitable for the purposes. The nominal depth of the trays/ racks shall be 150mm. The width of the trays shall be as per the design shown on drawing. The cable trays shall be made of steel or aluminium. The trays/ racks shall be completed with end plates, tees, elbows, risers, and all necessary hardware. Steel trays/ Rack shall be painted with two coats of enamel paint of approved shade over a coat of red oxide primer. Cable trays shall be erected properly to present a neat and clean appearance. Suitable cleats or saddles made of aluminium strips with PVC covering shall be used for securing the cables to the cable trays. The cable trays shall comply with following requirements :

1. The trays shall have suitable strength and rigidity to provide adequate supports for all contained cables.

2. It shall not present sharp edged, burrs or projections injurious to the insulation of the wiring/ cables.

3. If made of metal, it shall be adequately protected against corrosion or shall be made of corrosion resistant material.

4. It shall have side rails or equivalent structural members.

5. It shall include fittings or other suitable means for changes in direction and elevation of runs.

1.9 INSTALLATION

1. Cable trays shall be installed as a complete system. Trays shall be supported properly from the building structure. The entire cable tray system shall be rigid.

2. Each run of the cable tray shall be completed before the installation of cables.

3. In portion where additional protection is required, non combustible covers/ enclosures shall be used.

4. Cable tray shall be exposed and accessible.

GENERAL SPECIFICAITON FOR: EARTHING FOR ELECTRICAL WORK

1.1 General

All non-current carrying metal parts of the electrical installation shall be earthed as per IS: 3043. All metal conduits, trunkings, cable armour, switchgear, distribution boards, meter, light fixtures, fans and all other metal parts forming part of the work shall be bonded together and connected by two separate and distinct conductors to earth electrodes. Earthing shall also be in conformity with the provisions of Rules 32, 61, 62, 67 & 68 of IER 1956. These specifications apply to both copper and GI earthing system. The material to be used shall be as per that give in BOQ.

1.2 Earthing Conductors

1.2.1 All earthing conductors shall be of high conductivity copper or GI and shall be protected against mechanical damage and corrosion. The size of earth conductors shall not be less than half that of the largest current carrying conductor. The connection of earth continuity conductors to earth bus and earth electrodes shall be strong and sound and shall be easily accessible. The earth tapes shall be joined together using double rivets. The earthing conductor shall be laid in cable trenches, cable trays or conduits or on cable by using suitable clamps made of non-ferrous metals compatible with the earthing conductor. The following earthing conductors and required to be used for various sections of the installations.

a. 10SWG bare copper wire or GI wire.

b. All single phase switches and DBs above 30A and upto 63A rating shall be earthed with one run of 8SWG bare copper wire or GI wire.

c. All three phase switches/ DBs upto 30A rating shall be earthed with 2 runs of 10SWG copper wire/ GI wire.

d. All three phase switches/ DBs above 30A and upto 63A shall be earthed with 2 runs of 8 SWG copper wires/ GI wires.

e. All three phase switches/DBs above 63A and upto 100A shall be earthed with 2 runs of 25x3mm Copper Strip/GI Strip.

f. All three phase switches/DBs of 200A rating and above shall be earthed with 2 runs of 25x6mm copper Strip / GI Strip.

g. All motor frames shall be earthed by two earthing conductors of specified cross section.

Earth conductors shall be properly terminated with bolts to the frames of panels/eqpts. And provided with crimped sockets in case of wires.

1.2.2 Main earth bus shall be taken from the main medium voltage panel to the earth electrodes. The number of electrodes required shall be arrived at taking into consideration the anticipated fault on the medium voltage net-work and soil resistivity.

1.2.3 All the sub mains and sub circuits shall be provided with earth continuity conductors as specified and connected to the main earth bus. Earthing conductors for equipment shall be run from the exposed metal surface of the equipment and connected to a suitable point on the sub main or main earthing bus. All switches shall be connected through double earthing conductor to the earth bus. Earthing conductors shall be terminated at the equipment using suitable lugs, bolts, washers and nuts.

1.2.4 All conduits, cable armouring, raceway, rising mains, etc. shall be connected to the earth all along their run by earthing conductors of suitable cross sectional area, sprinkler, pipes, LPG pipes, water pipes, steel structural elements, cable trays/ racks lighting conductors shall not used as a means of earthing an installation. The electrical resistance of earthing conductors shall be low enough to permit the passage of fault current necessary to operate a fuse/ protective device a circuit breaker and shall not exceed 2 ohms. As rough guide the following sizes of earth continuity conductors shall be used for circuit wiring.

Size of circuit wires/ cables	Size of copper or GI earth wires
a. 2.5 sq.mm. insulated	16 SWG or 1.5sq.mm. Cu. PVC
b. 4 sq.mm. insulated	14 SWG or 2.5sq.mm. Cu. PVC
c. 6 sq.mm. insulated	12 SWG or 2.5sq.mm. Cu. PVC
d. 10 sq.mm./ 16 sq.mm. insulated	8 SWG or 4.0sq.mm. Cu. PVC
e. 25 sq.mm. / 35 sq.mm. insulated	6 SWG or 6.0sq.mm. Cu. PVC

All Single phase wiring have one run of earth wire and three phase wiring shall be provided with two runs of earth wires.

1.4 PRECAUTIONS :

1.4.1 Earthing system shall be mechanically robust and the joints shall be capable of retaining low resistance even after passages of fault currents.

1.4.2 Joints shall be soldered, tinned and double rivertted in case of copper and joints shall be filed and doubled rivertted in case of GI. All the joints shall be mechanically, electrically, continuous and effective.

1.5 TESTING :

1.5.1 On the completion of the entire installation, the following tests shall be conducted.

a. Earth resistance of electrodes.
b. Earth loop impedance as per IS L 3043/NEC.

1.5.2 All meters, instruments and labour required for the tests shall be provided by the contractor. The results shall be submitted in triplicate to the engineer-in-charge for approval.

5.13 Other Components

5.13.1 Moulded Case Circuit Breaker (MCCB)

The MCCB (moulded case circuit breaker) shall conform to the latest IEC 947-2 & IEC 947-3–1989. The Service Short Circuit Breaking Capacity (Ics at 415VAC) should be as specified at the required level.
The MCCB shall be Current Limiting type and comprise of Quick Make – Break switching mechanism, preferably Double Break Contact system, arc extinguishing device and the Tripping unit, contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses. All MCCBs shall be capable of defined Variable overload adjustment. All MCCBs rated 200Amps and above shall have adjustable Magnetic short circuit pick up.

The trip command shall over ride all other commands. The MCCB shall employ maintenance free double break contact system to minimize the let thru energies and capable of achieving discrimination up to the full short circuit capacity of the downstream MCCB. The manufacturer shall provide both the discrimination tables and let thru energy curves. The MCCB shall not be restricted to Line/ Load connections.

The handle position shall give positive indication of 'ON', 'OFF'' or 'Tripped' thus qualifying to Disconnection as per the IEC947-3 indicating the true position of all the contacts. In case of 4 pole MCCB the neutral shall be defined and capable of offering protection . **MCCBs controlling motors should be suitable for motor protection.**

5.13.2 Miniature Circuit Breaker (MCB)

Miniature Circuit Breaker shall comply with IEC898 – 1996. The Miniature circuit breakers (MCB) shall be quick make and break type for 230 / 415 VAC 50 Hz application with thermal magnetic releases for over current and short circuit protection. The Breaking capacity shall not be less than 10 KA at 415VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Energy Class–3). MCBs shall be classified (B,C,D as per the IEC 898 standards) as per their Tripping characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values.

The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection . All DP, TP and TPN miniature circuit breakers shall have a common trip bar independent to the external operating handle.

5.13.3 Switch Fuse Units

a. High rupturing capacity fuse (HRC Fuse) shall carry ISI mark on it and shall be rated for duty as indicated on the drawing/schedule of Quantities. The rating of HRC fuse shall be as per the rating of motor/equipment. The rating of fuse shall be selected so as to provide discrimination.

a. The switch fuse units shall be three pole double break action with switched neutral. All switch fuse units shall be provided with the hinged doors duly interlocked with operating mechanism so as to prevent opening of the door when the switch is 'ON' position and also to prevent energizing the switch when the door is not properly secured. All contacts shall be silver plated and alive parts shall be shrouded. High rupturing capacity (HRC) fuse links shall be provided with switch fuse units and shall have rupturing capacity of not less than 31 MVA at 415 volts. All switch fuse units shall be provided with visible indicators to show that they are in 'ON or OFF' position. All switch units shall be of AC-23 category.

5.13.4 Motor Starter

The Motor Starter shall be a combination starter consisting of motor protection circuit breaker and suitable contactor for remote starting.

a. Motor protection circuit breaker

The motor protection circuit breaker must comply to the latest IEC 947-4 and the corresponding IS 13947-4. The motor protection circuit breaker should be suitable for AC3 duty at 415V. The motor protection circuit breaker should offer built in coordinated overload and short circuit protection. The motor protection circuit breaker should have built in single phase / phase loss preventor. The motor protection circuit breaker should offer separate ON/OFF indication and Fault signal contacts which should be wired onto the panel for indication. The motor protection circuit breaker should offer Type 2 coordination along with the contactor.

b. Contactors

The contactor should be suitable for AC3 duty at 415V and should comply to the latest IEC 947-4 and the corresponding IS 13947-4. The contactor should have minimum 10 x IE rated making / breaking capacity as per the latest standard. The same should be suitable for Type 2 coordination along with motor protection circuit breaker. The contactor should have Class H insulation for the coil to prevent heating and to facilitate frequent start / stop function without heating.

5.13.5 Earth Leakage CB/ Residual Current CB

The ELCB/RCCB shall comply with IEC 1008. The ELCB/RCCB shall current operated independent of the line voltage. ELCB / RCCB shall work on the principle of core balance transformer. The ELCB / RCCB shall be rated for current sensitivity of a Min of 30mA and a Max of 300mA at 240 / 415VAC.The terminals shall be protected against finger contact to IP20 degree of protection. The ELCB / RCCB shall have a minimum of 20,000 electrical operations.

Testing Provision for the Earth Leakage Circuit Breaker

A test device shall be incorporated to check the integrity of the earth leakage detection system and the tripping mechanism. When the unit is connected to service, pressing the test knob shall trip the ELCB and the operating handle shall move to the "OFF" position.

5.13.6 Air Circuit Breaker (ACB) :

The ACB shall conform to IEC 947-2-1989 & IS 13947 (Part –2). The Service Short Circuit Breaking Capacity shall be as specified and equal to the Short circuit Withstand Values. The ACB shall be provided for controlling the in coming supply feeder or as required and specified in schedule. Shall be available in 3 or

4 pole with modular construction, fixed or draw out, manually or electrically operated versions as specified. ACB shall be capable of providing short circuit, overload and earth fault protection (in absolute values) if required, through microprocessor based control unit sensing the true RMS values to ensure accurate measurement meeting the EMI/ EMC requirement as per the standard.

The breaker should have 3 distinct positions – SERVICE /TEST / ISOLATED within the cubicle. It should be possible to withdraw the breaker for testing with the door closed. Safety interlock must be provided to prevent the ACB from falling out in a fully withdrawn position. The ACB shall be provided with a door interlock. The contacts should be copper and silver plated only with a feature of contact wear inspection indicating the life of the contacts. The ACB shall have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhanced safety and inaccessibility to live parts.

All electrical closing of breaker should be with Electrical motor wound stored energy spring closing mechanism with Mechanical indicator to provide. ON/ OFF status of ACB.

For all ACBs the Operating handle should be provided for charging the spring in continuous action. The spring shall be released with ON / OFF push button command in one operation at the correct speed independent of operator speed. A direct mechanical coupling should indicate the ACB in ON or OFF position thus qualifying to Disconnection as per the IS/IEC indicating the true position of all the contacts. One set of NO / NC potential free contacts to be provided for operation on Building Management System. All accessories like shunt, under voltage motorized mechanism etc shall be front mounted, requiring no adjustments and can be fitted at site.

The manufacturer shall provide details of opening time and deration with temperature to ensure discrimination and proper selection for feeders protection. All ACBs of 4000 A and above shall be a single ACB and Tandom operated will not be acceptable.

5.13.7 <u>SAFETY FEATURES</u> :

1. The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.
2. It should not be possible to interchange two circuit breakers of two different thermal ratings.
3. There should be a provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism.
4. Earthing bolts must be provided on the cradle or body of fixed ACB.
   Arc Chute covers should be provided wherever necessary.

5. The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, voltmeter and ammeter of size not less than 96mm x 96mm, selector switches, fuses for potential circuit and current transformers.
6. It should 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.

5.13.8 PROTECTIONS

1. The Electro magnetic and thermal release or Microprocessor based unit should be provided on circuit breaker for short circuit , over current and earth fault protection with adjustable settings.
2. Specific LED indications should be provided for over current and earth fault operation.
3. Relays should be CT operated through shunt trip for short circuit and earth fault protection.
4. Under voltage relays should be provided.
5. Minimum 6 NO and 6 NC auxiliary contacts shall be provided on each breaker. The contacts shall be rated 5 Amps.
6. Rated insulation voltage is 1000 volts AC.

5.13.9 Push Button Stations

Push button stations shall be provided for manual Start & Stop of equipment. Push button shall have ON & OFF indicating lamp in red and green colour. Push button shall be fabricated in 16 gauge sheet steel.

These station shall be factory fabricated. ON & OFF operations shall be carried out from front without opening the door. One set of NO & NC contact shall be provided in push button station as spare.

5.13.10 Toggle Switch

The toggle switch shall be of minimum 5 Amps rating.

5.13.11 Thermal Overload

The relay shall be factory calibrated, sealed and suitable for an ambient temperature at site or 50 deg C whichever is higher.

It should provide reliable and accurate protection against overload, single phasing and locked rotor conditions. Relays are to be provided with :

(a) Trip alarm contact
(b) Trip lever for testing

(c) Auto reset facility

Rated insulation voltage shall be 660 volts AC.

5.14 **Instruments**

a. General :

The specifications hereinafter laid down shall cover all the meters and instruments.

b. **Instrument Transformers**

(i). Current Transformers

Current transformers shall be in conformity with IS : 2705 (Part I,II,III & IV) in all respects . All current transformers used for medium voltage applications shall be rated for 1 KV. However, the rated secondary current shall be 5 A unless otherwise specified. The acceptable minimum class of various applications shall be as given below :

Measuring : Class 0.5 to 1
Protection : Class 10 p

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault of 35 MVA on medium voltage system. Terminals of the current transformers shall be marked permanently for easy identifications of poles. Current transformers shall be provided with earthing terminals, for earthing chasis frame work and fixed part of the metal casing (If any). Each CT shall be provided with rating plate indicating the following :

i. Name and make
ii. Serial Number
iii. Transformation Ratio
iv. Rated Burden
v. Rated Voltage
vi. Accuracy Class

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 & clean manner.

c. Potential Transformers

Potential transformers shall be provided if specifically called for potential transformers shall comply with the requirements of IS : (Part I,II,III) in all respects.

d. **Measuring Instruments**

i. General

Direct reading electrical instruments shall be in conformity with IEC-51, BS:89 or IS :1248. The accuracy of direct reading shall be 1.0 for voltmeters and 1.5 for ammeters. Other type of instruments shall have accuracy of 1.5. The meters shall be suitable for continuous operation between -10 deg C and +50 deg C. All meters shall be of flush mounting type with square pattern. The meter shall be enclosed in a dust tight housing . 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.

ii. Ammeters

Ammeters shall be of moving-iron type. The moving part assembly shall be with jewel bearings. The jewel bearing shall be mounted on a spring to prevent damage to pivot due to vibrations and shocks. The ammeters shall be manufactured and calibrated as per the latest edition of IS: 1248 or BS:89. Ammeters shall be instrument transformer operated, and shall be suitable for 5 A secondary.

Upto 30 Amps the ammeter shall be direct operated without current transformer on one phase only. Beyond 30 Amps the ammeter shall be CT operated with selector switch.

iii. Voltmeters

Voltmeters shall be of moving-iron type. The range for 400 volts, 3 phase voltmeters shall be 0 to 500 volts. The voltmeter shall be provided with protection fuse of suitable capacity.

5.15 **Earthing**

a. General

All non-current carrying metal parts of the electrical installation shall be earthed as per IS-3043. All metal conduits, trunking, cable sheathes, switchgear, distribution boards and all other metal parts forming part of the work shall be bonded together and connected by two separate and distinct conductors to control panel. Earthing shall meet the requirements of IER 1956.

b. Earthing Conductor

All earthing conductors shall be of high conductivity copper as specified and shall be protected against mechanical damage and corrosion. The size of the earth conductor shall not be less than half of the largest size of the current carrying conductor. The connection of the earth continuity conductor of earth and earth electrodes shall be strong and sound and shall be rigidly fixed to the walls, cable trenches, cable trays or conduits and cables by using suitable clamps made of non ferrous metals. Incoming power supply along with earthing upto MCC/AHU control panel shall be provided by other agency. The panel shall be earthed to building main earthing. The motor shall be double earthed to the panel.

The earthing shall be done with wires/flat as under :

S.No.	Equipment	Size of Earth Wire/Strip	
		GI	Copper
01.	Motors Upto 5 HP	2 Nos 8 SWG	2 Nos. 14 SWG
02.	Motors Upto 15 Hp	2 Nos 8 SWG	2 Nos 12 SWG
03.	Motors Upto 30 HP	2 Nos 4 SWG	2 Nos. 8 SWG
04.	Motors Upto 50 HP	2 Nos 25x6mm Flat	2 Nos. 4 SWG
05.	Motors above 50 HP	2 Nos 32x6mm Flat.	2 Nos. 25x3mm Flat.

Packaged unit electrical panel shall generally be wall mounted type. Above stated specifications shall also stand good where applicable. The packaged unit motor shall be double earthed with two independent earth conductors as per the Indian Electricity Rules & Regulations-1956.

****

PREAMBLE TO BILL OF QUANTITY

1. All equipment descriOffice hereafter shall be in accordance with the specifications.

2. All equipment shall be selected and installed for the lowest operating noise level.

3. Supply of various equipment shall include all expenses for correspondence with manufacturers, submission of shop drawings, documents and their approval by the Architects , procurement of equipment, transportation, shipping, payment of all taxes and levies, storage, supply of equipment at the point of installation, furnishing all technical literature required, replacement of defective components and warranty obligations for the individual equipment.

4. Installation of various equipment shall include all material and labour associated with hoisting and lowering of equipment in position, insulation of the components and vibration isolation as required, grouting & anchoring or suspension arrangements and all incidentals associated with the installation as per the specifications and manufacturer's recommendation.

5. Vibration isolators as specified or as recommended by the manufacturer shall be installed with each component. Performance ratings, power consumption and sound power data for each component shall be verified at the time of testing and commissioning of the installation, against the data submitted with the tenders.

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

7. Testing and commissioning shall include furnishing all labour, materials, equipment, instruments and incidentals necessary for complete testing of each component as per the specifications & manufacturer's recommendations, submission of test results to the Owners/Architects, obtaining their approval and submission of necessary completion documents & drawings. Providing minor dressing of walls and floor, providing and installing pipe sleeves as required and treatment to pipes as per the specifications.

8. All piping should be installed conforming to the relevant Indian Standards, approved shop drawings and the specifications. All water re- circulation piping should be tested as per the specifications.

9. Piping installation should include all costs towards supplying and fixing of pipes and fittings (elbows, tees, reducers) cutting, threading, joining, welding, soldering and affecting connections are required, providing non- hardening sealing material as well as rubber gaskets for screwed flanges, providing and installing adequate

number of clamps, hangers, saddles, brackets, rawl plugs and other accessories for pipe supports, providing minor dressing of walls and floor, providing and installing pipe sleeves as required and treatment to pipes as per the specifications.

10. Exposed steel pipes shall be given two coats of approved paint as per the relevant Indian Standards for color coding of pipes and direction of flow of fluid in the pipes shall be visibly marked with identifying arrows.

11. Valves, union, strainers, drain, air- valves, expansion joints, pressure gauges and thermometers shall be provided in the various pipe lines as per the approved shop drawings and specifications.

12. After completion of the installation, the entire piping system shall be tested for leak in accordance with the specifications.

13. All ducts shall be fabricated and installed conforming to the relevant Indian Standards, approved shop drawings and the specifications.

14. Duct installation shall include fabricating and installing the ducts, splitter dampers, turning vanes, distribution grids within the ducts in position extruded aluminium hardware fittings such as handles thunder bolts hinges, factory fabricated access door and providing , installing , MS hangers with dash fasteners, foam rubber insertions, nuts, bolts and screws as required. Making all joints air tight using rubber insertions in addition multi-louvered manually adjustable dampers shall be provided in various branch ducts as required or shown on drawings for proper balancing of air flow. All primer coated MS hangers, dampers, base frames etc. shall be painted with black enamel paint.

15. All registers and diffusers shall be provided with soft continuous rubber gaskets between their periphery and the surface on which these have to be mounted.

16. MS registres and diffusers shall be given, at the factory, a rust resistant primer coat and enamel paint finish of approved color. Aluminium grilles and diffusers shall be fabricated out of extruded aluminium sections.

17. After completion of the installation, the entire air distribution system shall be tested for leaks and balanced in accordance with the specifications.

18. All equipment and material to be supplied under this contract shall be conforming to the relevant latest Indian Standards and international standards as applicable.

19. Appropriate troughs in the suspended ceiling be provided for terminating duct collars for diffusers and grilles by other agencies to achieve desired interior finishes.

20. Contractor to verify the static pressure of various air handling units and Head of pumps in accordance with the approved for construction shop drawings before selection of motor.

21. **Mode of Measurement**

The mode of measurement for the various items, unless otherwise specified, shall be as follows :

21.1 Ducting

Payment for ducting shall be made on the basis of the external surface area of the ducting including all material and labour for installed duct.

The rates per Sft of the external surface shall include MS angle iron /GSS flanges, gaskets for joints, nuts & bolts , duct supports & hangers, vibration isolation pads or suspenders, dash fasteners, inspection doors, dampers, turning vanes, major hardwares such as thunder bolts, hinges, handles in extruded aluminium construction and any other item which will be required to complete the duct installation except external insulation and acoustic lining.

The external area shall be calculated by measuring the overall width and depth (including the corner joints) in the centre of the duct sections and overall length of each duct section from flange face incase of duct lengths with uniform cross section. Total area will be arrived at by adding up the areas of all duct sections.

In case of taper pieces average width and depth will be worked out as follows :

W1 = width of small cross section
W2 = width of large cross section
D1 = depth of small cross section
D2 = depth of large cross section

$$\text{Average width} = \frac{W1 + W2}{2}$$

$$\text{Average depth} = \frac{D1 + D2}{2}$$

Width and depth in the case of taper pieces shall be measured at the edge of the collar of the flange for duct sections fitted with angle iron flanges, otherwise at the bottom of the flange where flanges are of duct sheet.

For the circular pieces the diameter of the section mid-way between large and small diameters shall be measured and adopted as the mean diameter for calculating the surface at the taper piece.

For the face length of taper piece shall be the mean of the lengths measured face to face from the centre of the width and depth of flanges.

For the special pieces like bends, branches, and tees etc. same principle of area measurement as for linear lengths shall be adopted except for bends and elbows, the length of which shall be the average of the lengths of inner and outer periphery along with curvature or angle of the piece.

21.2 Duct Insulation

This item is provided separately for various thickness and shall be paid for on area basis of uninsulated duct. The area of the duct to be insulated shall be measured before application of insulation.

21.3 Grilles & Diffusers

All extruded aluminium grilles and diffusers shall be paid on the basis of actual measurement at site on area basis using neck size as base for diffusers having outer size less than 600mm. For 600mm x600mm size diffusers being installed in grid ceiling, shall be counted at site and payment shall be made on unit basis.

21.4 Refrigerant Piping

Refrigerant piping shall be measured and paid on linear length basis including bends, fittings, insulation and supporting arrangement.

21.6 Refnet Joints

Payment shall be made on unit basis.

22. All quantities reflected in the schedule are for contractor's guidance only.

****

GUARANTEE PROFORMA FOR HVAC INSTALLATION

Owner : **BIRAC**

Location : First Floor, MTNL Building Lodhi road
New Delhi

1. The Contractor shall furnish the following guarantee :

   "We warrant that everything supplied by us including all components fitted into the equipment manufactured by others also, shall be in all respects free from all defects and faults in material, workmanship and manufacture and shall be of the highest grade and quality to acceptable standards for all materials of the type ordered and shall be in full conformity with all the specifications, drawings or samples if any and we shall be fully responsible for its efficient performance. This guarantee shall survive inspection for acceptance and payment for the equipment and installation, but shall expire (except in respect of the complaints notified to us) 12 months from the date of issue of completion certificate by the Architect/Consultants. The complaints, workmanship, manufacturer or performance of any of the equipment or part/parts thereof shall be notified by fax within 12 months from the date of issue of such completion certificate".

2. The Contractor shall replace such of these parts which require replacement under these conditions free of cost, charge and expenses to the purchaser. In addition, the Contractor shall be responsible for a period of 12 months from the date of issue of completion certificate for any defect that may develop or appear under the conditions provided by the Contractor or use thereof arising from faulty material design or workmanship in the equivalent or any part thereof or faulty installation of the equipment by the Contractor but not otherwise and shall correct such defects within one week from the date of notification at his own cost when called upon to do so by the purchaser who shall state in writing in what respect the portion is faulty.

3. Any faulty component replaced or renewed under the clause shall also be guaranteed for a period of six months from the date of such replacement or removal of until the end of the above mentioned period whichever is later.

4. If defects are not rectified within a reasonable time as mentioned in the written notice, the Project Managers/Architects/Owners shall proceed to do so at the Contractor's risk and cost without prejudice to any other right thereof.

SIGNATURE AND STAMP OF THE CONTRACTOR

DATE :

TECHNICAL DATA TO BE FILLED UP BY THE VENDORS AND

TO BE SUBMITTED ALONG WITH THE OFFERS

VARIABLE REFRIGERANT VOLUME SYSTEM

S.No.	Item	Particulars	
		40HP	**28HP**
1.	**Outdoor Units**		
	General		
1.1	Manufacturer		
1.2	Country of Origin		
1.3	Type of Unit		
1.4	Model and No. of Units		
1.5	Overall Dimensions (mm)		
1.6	Noise Level (dB) at 1M distance		
1.7	Whether Night time quiet operation feature adopted		
1.8	Operating Weight (Kg)		
1.9	Material of casing		
1.10	Type of finish		
1.11	Cooling Capacity (HP)		
1.11.1	Nominal		
1.11.2	Actual		
1.12	Power consumption of overall unit at 35C ambient (KW)		
1.13	Power consumption of overall unit at 43.3C ambient (KW)		
1.13.1	Running Current drawn (Amp)		
1.13.1	Starting Current drawn (Amp)		
1.14	Recommended Incomer switch rating (Amp)		
1.15	Recommended Aluminium cable size		
1.16	Vibration isolation		

	arrangement		
1.17	COP of overall unit		
1.18	Maximum allowable actual piping length (M)		
1.19	Maximum Level Difference (M)		
2.	**Compressor**		
2.1	Manufacturer		
2.2	Country of origin		
2.3	Type and number of compressor/s		
2.4	Model No.		
2.5	Nominal capacity		
2.6	Suction Temperature		
S.No.	**Item**	**Particulars**	
		40HP	**28HP**
2.7	Discharge Temperature		
2.8	Actual capacity at above parameters		
2.9	Type of refrigerant		
2.10	Type of capacity control		
2.11	Number of steps of capacity control		
2.12	Power consumption (KW)		
2.13	Number of Fixed Speed Type Compressors		
2.14	Number of Variable Speed Type Compressors		
2.15	Power Supply requirement		
2.16	Power consumption at rated capacity		
3.	**Air Cooled Condenser**		
3.1	Manufacturer		
3.2	Type of condenser		
3.3	Tube material		

3.4	Fin material		
3.5	Coil face velocity (FPM)		
3.6	Type of fans		
3.7	Number of fans		
3.8	Motor rating of each fan		
3.9	Static Pressure of each fan (mmWG)		
4.	**Indoor Units**		
4.1	Manufacturer	--	
4.2	Country of Origin		
4.3	Type of Unit		
4.4	Model No. of Unit		
4.5	Overall Dimensions (mm)		
4.6	Noise Level (dB) Hi/Low		
4.7	Airflow Min/Max (Cfm)		
4.8	Cooling Capacity (TR)	--	
4.9	Operating Weight (Kg)		
4.10	Is remote controller provided with each unit		
4.11	Type of remote controller provided		
4.12	Power Characteristics (3Ph/1Ph)		
S.No.	**Item**	**Particulars**	
		40HP	**28HP**
4.13	Electrical Power Requirement (Watts)		
5.	**Centralized Controller**		
5.1	Manufacturer		
5.2	Country of Origin		
5.3	Type of Controller		
5.4	Salient Features		
6	**Refrigerant Piping**		
6.1	Material of piping		
6.2	Material of Fittings		

SPLIT UNITS

S.No.	Item	Particulars
1.	**General**	
1.1	Manufacturer	
1.2	Type of Unit	
1.3	Overall Dimensions (mm)	
1.4	Noise Level	
1.5	Operating Weight (Kg)	
1.6	Power consumption of overall unit (KW)	
2.	**Compressor**	
2.1	Manufacturer	
2.2	Country of origin	
2.3	Type and number of compressor/s	
2.4	Model No	
2.5	Nominal capacity	
2.6	Suction Temperature	
2.7	Discharge Temperature	
2.8	Actual capacity at above parameters	
2.9	Type of refrigerant	
2.10	Power consumption (KW)	
3.	**Condenser**	
3.1	Manufacturer	
3.2	Type of condenser	
4.	**DX Cooling Coil**	
3.1	Manufacturer	
3.2	Type of cooling coil	
3.3	Tube material	
3.4	Fin material	
3.5	Coil face velocity (FPM)	
5.	**Supply Air Fan**	
5.1.	Manufacturer	
5.2	Type of fan	
5.3	Model No.	
5.4	Air Quantity. (Cfm)	
5.5	Static Pressure (mm WG)	
5.6	Fan Outlet Velocity	

6.	**Motor**	
6.1	Manufacturer	
6.2	Type	
6.3	Rating (HP)	
S.No.	**Item**	**Particulars**
6.4	Speed (RPM)	
6.5	Electrical Characteristics	
7.	**Filters**	
7.1	Manufacturer	
7.2	Type	
7.3	Thickness (mm)	
7.4	Filter Face Velocity	
8.	**Controls**	
8.1	Manufacturer	
8.2	Type	

INLINE FANS

S.No.	Item	Particulars
1.	**General**	
1.1	Manufacturer	
1.2	Type	
1.3	Electrical Characteristics	
1.4	Whether Capacitors Provided	
1.5	Whether speed regulators Provided	
1.6	Whether gravity louvers and bird screen provided	

PROPELLER FANS

S.No.	Item	Particulars
1.	**General**	
1.1	Manufacturer	
1.2	Type	
1.3	Electrical Characteristics	
1.4	Whether Capacitors Provided	
1.5	Whether gravity louvers and bird screen provided	

GS SHEET FOR DUCT WORK

S.No.	Item	Particulars
1.	**General**	
1.1	Manufacturer of GI Sheet	
1.2	Class	
1.3	Zinc coating (gm/SqM)	
1.4	Thickness	
1.5	Manufacturer of Factory Fabricated Ducts	
1.6	Type of flanges for factory fabricated ducts i. For Exposed Ducts ii. For Concealed Ducts	

GRILLES, DIFFUSERS AND DAMPERS

S.No.	Item	Particulars
1.	**General**	
1.1	Manufacturer	
1.2	Material	

ACOUSTIC LINING OF DUCT

S.No.	Item	Particulars
1.	**General**	
1.1	Material	
1.2	Manufacture	
1.3	Density	
1.4	Thickness	
1.5	Thermal Conductivity (K Value)	

EXTERNAL THERMAL INSULATION OF DUCTS

S.No.	Item	Particulars
1.	**General**	
1.1	Material	
1.2	Manufacture	
1.3	Density	
1.4	Thickness	
1.5	Thermal Conductivity (K Value)	

EXPOSED DUCT THERMAL INSULATION

S.No.	Item	Particulars
1.	**General**	
1.1	Manufacturer	
1.2	Material	
1.3	Density	
1.4	Thickness	

THERMAL INSULATION FOR EXPOSED ROOF

S.No.	Item	Particulars
1.	**General**	
1.1	Manufacturer	
1.2	Material	
1.3	Density	
1.4	Thickness	

ELECTRICAL

S.No.	Item	Particulars
1.	**General**	
1.1	Power Cables	
1.2	Control Cables	
1.3	Stabilisers	

REFRIGERANT PIPING

S.No.	Item	Particulars
1.	**Hard Drawn Piping**	
1.1	Make	
1.2	Material	
1.3	Material of fittings	
1.4	Thickness	
1.5	Make & Material for Drain pipes	

APPROVED MAKES OF EQUIPMENT & MATERIALS

S. No.	EQUIPMENT AND MATERIAL	ACCEPTABLE MAKE
A.	**EQUIPMENT**	
1.	VRV System	Daikin/Toshiba
2.	HRV System	Daikin/Toshiba
3.	Ductable & Non-Ductable Split Units/Heat Pumps	Daikin/Blue Star/ Carrier / Hitachi/ Toshiba
4.	Compressor for Split Units	Tecumseh/Copeland/Carrier/ Hitachi/Daikin
5.	Voltage Stabilisers	Logicstat
6.	Extract Fan Sections /Air Washers/ Scrubber	Zeco/Edgetech
7.	Centrifugal Fans	Nicotra(Italy)/ Kruger(Singapore)/Comefri
8.	Axial Flow Fans	Kruger/ Alstom/ Nicotra
9.	Motor	ABB/ Siemens/Bharat Bijli
10.	V-Belts	Fenner India/ Dunlop
11.	Inline Fans	Sphere-Vents/Pine Air
12.	Propeller Fans	Alstom
13.	Vibration isolators/ suspenders	Resistoflex/Easyflex
14.	Air curtain	Beacon/Thermodyne
B.	**PIPING**	
1.	Pipes (MS & GI)	Tata Steel/ Jindal (Hissar)
2.	Copper Refrigerant Piping	Rajco/Mandev
3.	Welding Rods	Advani
C.	**DUCTWORK AND AIR TERMINALS**	
1.	GS Sheet	SAIL/ Tata Steel/ National/ Jindal
2.	Factory Fabricated Ducts & TDC flanges	Zeco/ Rolastar/ Technofab/Ductofab
3.	Pre Filters	Purolator/ Thermodyne/ Spectrum
4.	Extruded Aluminium Grills &	Dynacraft/Tristar/Servex

	Diffusers	
5.	Dash Fasteners	HILTI
6.	Intake Louvers	Servex/Tristar/ Dynacraft
S. No.	**EQUIPMENT AND MATERIAL**	**ACCEPTABLE MAKE**
7.	Duct/ grille dampers & Air Transfer Grille	Servex / Dynacraft/Tristar
8.	Smoke Cum Fire Dampers	Caryaire/ Mapro/Servex
9.	Actuators for fire dampers	Belimo(Swiss), Joventa(Swiss), Siemens
10.	Flexible connections for fan outlet	Mapro/Caryaire/Balance/Pine air
11.	PLC Autosequencers	Proton
12.	Flexible Ducts	Sphere/GP Spiro/PineAir
D.	**INSULATION**	
1	Fibre Glass	UP Twiga/ Owens Corning
2.	Closed Cell Elastomeric Insulation	Armacell/ Eurobatex/K Flex
3.	Expanded Polystyrene	Beardsell/ Toshiba
4.	RP Tissue	UP Twiga/ Owens Corning
5.	Adhesive for application of closed cell insulation (Low VOC)	Armaflex/ Pidilite
6.	Glass cloth & UV protection paint	Armacell/Paramount
F	**ELECTRICAL**	
1.	Panel Manufacturers	Madhu Electricals/Shivam Control/ Neptune
	Components	
1.	MCCB	L&T/ ABB/ Siemens/ GE power/ Merlin Gerin
2.	MCB	L&T/ Hager/ Merlin Gerin/ MDS
3.	ELMCB/ELCB	L&T/ Hager/ Merlin Gerin/ MDS

4.	Contractors	L&T/ GE/ Siemens
5.	Overload Relay	L&T/ GE/ Siemens
	Cables	
1.	Power Cables	Gloster/ Skytone/ Gemscab/ National
2.	Copper Control Cables	Finolex/ National/ Skyline/ Rallison
	Meters/ Indicators	
1.	Ammeters/ Volmeters (Digital Type)	L&T/ Rishab/ AE/ Enercon/ Secure
2.	Indicating Lamps (LED Type)/ Push Buttons	Siemens/ ESBEE/ L&T
3.	Current Transformer	AE/ L&T/ EE/ AVK-SEGC
4.	Selector Switches	Salzer (I&T)/ Kaycee

NOTES :

1. Make of any other equipment/ material not mentioned above shall be got approved from the Architects/ Owners before execution.

2. Relevant catalogue to be submitted alongwith the offers.

3. Relevant Test Certificates to be produced for various equipment & material during billing process.

4. Under electrical, wherever, there is multiple choices of brands /approved makes, the brands/make nominated by Owners/ Architects out of the multiple brands shall have to be supplied.

****

LIST OF APPROVED MAKES FOR CIVIL WORK

S. No.	Description	Approved Makes
1.	Sanitary ware (Vitreous China)	Hindustan/Parryware/CERA
2.	Seat Covers	Commander (Heavy Duty)
3.	C.P. Fittings	Gem/Parko/Jaquar/Kingston /Marc
4.	Stainless Steel Sink	Neelkanth/AMC / Jayna
5.	G.I. Pipes	Tata/Jindal (Hissar) /Surya
6.	G.I. Fittings	UNIK/R brand/KS/Zoloto-M
7.	Ball Valves	Zoloto/AM/Leader
8.	Butterfly Valves	Audco/Intervalve/Keystone/Venus/KSB
9.	Non return Valves Gunmetal or C.I.	Leader/Zoloto/Kirloskar/IVC
10.	CI Pipes/Fittings & Manhole covers	RIF/Neco/Bombay Iron Works
11.	CI Pipes “Class LA’	IISCO/Kesoram/Electro Steel
12.	Stoneware pipes/traps	Perfect/Burn/’ISI’ marked
13	UPVC pipes/fittings	Supreme/Finolex/Polypack/Prince / SFMC
14	Insulation	UP Twiga/Lloyd’s India Ltd. /Supreme
15.	SFRC Manhole Covers/Gratings / Precast Kerb Stone	K.K. Manholes/Moonlite/S.K. Precast Concrete/Pragati Concrete.
16.	RCC Pipes	I.H.P./Akshay/ISI Marked
17.	Automatic Flushing	Angash International/KOPAL
18.	PVC Storage Tank / Doors for Toilets	Sintex / Uniplas / Duraplast
19	Flush valves	Gem/Jaqaur/Orient
20.	(i) Cement (Grey) (ii) White Cement	ACC/Ultra tech /BIRLA /VIKRAM/ BIRLA /JK
21.	T.M.T. Steel	SAIL/TATA/RINL
22.	Structural steel	SAIL / TATA / RINL
23.	Flush Doors	Duraboard / Alpro/ Merino / Kitply/Green ply / Legend

S. No.	Description	Approved Makes
24.	Laminate sheet	Merino/Green ply/Archid
25.	Vitrified Ceramic Tiles	Kajaria/Orient/Johnsont/ Somany
26.	Stainless Steel	Jindal/SAIL/Golden
27..	Aluminium Sections	Hindalco/Jindal/Mahavir/Indal
28.	Glass	Saint Gobain/Modi Float/Asahi Float
29.	Expansion hold fasteners	Hilti/Cannon /Chilli
30	Polycarbonate Sheet	Danpalon/Sunpal /Polygal
31.	Interlocking Cement Concrete precast paver blocks	Hindustan Tiles/Nimco Prefab/K.K. Manholes/ Nitco
32.	Gunmetal gate valves, Non return valves	Leader/Zoloto
33.	Paint/primer/oil bound distemper Acrylic paint	1st Quality paints of Asian/ Berger / Nerolac / ICI
34.	Ceramic Tiles (For walls & floors)	Kajaria/Somany/Orient/Bell/Johnson/ Euro
35.	Precast mosaic & P.C. Tiles	NITCO/MODERN
36.	Anodized aluminum fittings for doors/windows	Crown/ALANS/Classic/Bharat/ Argent
37.	Mild Steel Butt Hinges/Piano Hinges	Jolly/Garg/AMIT/ASI Supreme
38.	Pre-laminated particle board – Exterior grade	Novopan/Merino /Anchorlam/Bhutan Board/Archid ply
39.	Water Proof cement paint	Snowcem/Asian Paints/Berger
40.	Ready Mixed Concrete	ACC/L&T /AHLCON/ JK Cement /Unitech /Grasim
41.	Block Board /Ply	Phenol bonded boards of Merino/ Duro / Legend / Kit Ply /Alpro/Bhutan Board/Kit ply/ Archid ply.
42.	Fire cum smoke check Doors	Navair /Adhunik / Sukri
43.	Nuts Bolts /Screws	Kundan /Puja / Atul

S. No.	Description	Approved Makes
44.	Parquet Floor	Nemo /Prima/Pergo
45.	Mineral Fiber Ceiling	Lloyd/Nittobo/ Armstrong /Rockfon
46	CP GM Ball Valve	Zoloto/Cim
47	Air Release Valve	Sukan/Leader
48	Fire Hydrant Valve	Minimax/Padmini
49	RRL Hose	Minimax/Jyoti/Padmini
50.	Branch Pipe	Minimax /Padmini
51.	GM Coupling	Minimax/Padmini
52.	Pumps	Kirloskar/Cropton Greaves/Beacon
53	Fire Extinguishers	Minimax /Padmini
54	Rubber Tube for Hose reel	Jyoti/Maruti
55	Welding rods	Victor/Maruti
56	Fasteners(Galvanised)	GKW/Canon
57	Dash fastners/clamps	Cannon/Chilly
58	Hose Box/Hose reel drum	Minimax /Padmini
59.	Anti vibration pads	Kanwal/Dunlop
60.	Mechnical Seal	As per OEM Cert./Duramat
61	GM Siemese Connection	Minimax /Padmini
62	Draw out Connection	Minimax /Padmini
63	Pressure switch	Indfoss
64	Pressure Gauge	H.Guru/Fiebig
65	PVC conduit	AKG/BEC
66	Manual Call point/Hooter	Agni
67	Strainer	WJ/Strainwel
68.	Sluice Valves	Kartar/Kalpana

LIST OF APPROVED OF MAKES FOR ELECTRICAL ITEMS

S. No.	Items	Approved Makes
	Panels, Switchgears and related Items:	
1.	LT Panel / Bus Duct / DG Panel / APFC Panel	Panel Manufacturer who posses CPRI Certificate for specified fault level and IP level Protection. Tricolite, Control and Switchgear Veekay steel, Adlec, L&T , Advance Panel(To be approved prior to fabrication of panel).
2.	Air Circuit Breaker	L & T(C-power) / GE Power (Spectronic) / Siemens(3WT) / ABB Emax/Legrand Dmax
3.	Moulded Case Circuit Breakers	L & T (D-sine) / Siemens (3VT) / GE Power (Record plus) / ABB (Isomax)
4.	Fuse Disconnector Switch / Switch Fuse Units.	L & T / Siemens / GE Power
5.	HRC Fuses	L & T /Siemens / GE Power
6.	MCB's	Legrand / L & T /Hager
7.	Ammeter, Voltmeter	MECO / Universal / Rishab/AE/HAGER
8.	Selector Switch, Push Button Switch / Emergency Switch/	KAY CEE / L & T / Salzer
9.	LED Indication Lamps & Push Buttons	Siemens / Vaishnov / L & T
10.	CT's	Kappa / C&S / L&T /Maxell/Gilbert
11.	Starters	Siemens / L&T / Cutler Hammer
12.	Single Phasing Preventor / Over Load Protection Unit.	Omeron
13.	Relays	L&T / ABB /Areva / C & S
14.	Change Over Switch	H.P.L. Socomec
15.	Contactors	L&T / Siemens / ABB/Hager
16.	KWH, PF, Frequency Meter	Universal / L&T / HPL Socomec / Conzerve

S.No.	Items	Approved Makes
17.	Timers	L&T / Siemens
18.	Time Switch	L&T / Siemens / Legrand
19.	Digital Meters and Intelligent Multifunction Meter	Conzerve / HPL / Trinity
	Sub-station Equipments, Cables & Related Items	
20.	11KV VCB Panels	Schneider / ABB / Areva/Sudhir/Siemens/Crompton
21.	11 KV / 433 V Transformer (Oil Cooled/ Dry Type)	Crompton Greaves / Areva/ Schneider/Bhel/IntraVidut
22.	a) HT Termination & Joining kit	Ray Chem / Mahindra / Denson
23.	b) Cables Glands	Commet / Dowell / Electromac / Siemens / Braco / Indiana.
24.	c) Lugs & Thimbles	Dowells / Jainsons.
25.	a) 11 KV LT Cables (ISI Marked) b) 1.1 KV LT Cables (ISI Marked)	CCI / Gloster / Nicco / Universal / RPG (Asian)/ Skytone/Kei/Ravin(Primecab)
26.	Insulating Mats.	ISI Marked.
27.	Synthetic Insulating Mats	Sintex (Insulatica)
28.	Pre Fabricated Cable Tray	SLOTCO / PILCO/STEEL WAYS/or Fabricated as per approved design.
29.	Capacitor Bank (ISI Marked)	Meher / L&T / Siemens / Epcos / Universal
30.	APFC Relay	Seimens / Epcos
31.	Protection & Other Relays	Alstom / L&T / ABB/ Siemens / Allen Bradley
32.	PLC Relay	Alan Bradley / Omeron
33.	Auxiliarie Relays	Omeron
	Internal Wiring Related Items: -	
34.	PVC Insulated Copper wire (ISI Marked)	Skytone / Grandlay / Finolex/ / Rajni Gandha / KEI
35.	Control Cable	Asian Cable / Finolex / Universal / Glostar / CCI /Skytone

36.	M. S. CONDUIT PIPE (ISI MARKED-ERW)	BEC/M Kay/ NIC/AKG/Steel Craft
37.	PVC INSULATED COPPER CONDUCTOR WIRES (F.R.L.S)	SKYLINE/FINOLEX/NATIONAL/RR CABLE/KEI/PLAZA/HAVELLS
38.	Modular TYPE SWITCH/SOCKET	ANCHOR-ROMA/M.K./Legrand/CRABTREE NORTH-WEST/PHILIPS
39.	TV Outlet	PHILIPS/LEGRAND/ CLIPSAL/CRABTREE/M K / L&T
40.	Fan Regulators	PHILIPS/LEGRAND/ CLIPSAL/CRABTREE/M K / L&T
41.	Telephone Outlet	PHILIPS/LEGRAND/ CLIPSAL/CRABTREE/M K / L&T
42.	Industrial Sockets	LEGRAND/ ABB / SCHNEIDER
43.	LUGS/FERRULES	DOWELLS/JAINSON
44.	BRASS COMPRESSION GLAND (HEAVY DUTY)	COMMEX/GRIPWELL/HENSEL
45.	MCB/MCCB/MCB/ DB's	Legrand/SIEMENS/L&T/GE/MG/HAGER/Hensels
46.	CUBICAL TYPE EDB / FEADER PILLARS	MILE STONE/TRICOLITE/ C&S /ASPL
47.	DWC HDPE PIPE	Duraline / Rex
48.	GI Pipe for earthing etc.	Jindal/T.T.Swastik / Surya
49.	GI wire for loop earthing GI Strip	Hot Dip Galvanised make to be got approved.
50.	Decorative Poles	Bajaj/HILITE/Twinkle/PHILIPS
51.	INDICATING LIGHT	Concord/Vaishno/LT & LK/ Seimens/Rass Control/Kaycee
52.	AMMETER/VOLTMETER	AE/IMP/Universal/Kaycee
53	Earth Leakage Circuit Breaker (RCCB) ISI Marked	DS/Legrand/DATAR/Neptune/L&T/HAGER
54.	Power Cables ISI Marked XLPE	Polycab/Grandlay/Fort Gloster / Havells/Skytone

55.	Raceway	Legrand/M.K. / L&T
56.	SENSOR (Light & Occupancy)	Phillips /L&T/Legrand/Wipro/Schinder
	LIGHT FIXTURES:	
57.	Fluorescent Light Fixture (T-5) ,CFL & LED	Philips/Wipro/Bajaj/Schreder
58.	CEILING FANS	On DG S&D R/c Rate Usha/Bajaj/Crompton/GEC/Orient
59	EXHAUST FANS	GEC/Bajaj/Crompton
60	FLUORESCENT /CFL lamps	Philips/GEC/Osram or as in BOQ
61	Street Light Fixtures/Gate Light(IP-65)	Schreder/Philips/Bajaj/GEC/Wipro
62	Aviation Light	WIPRO/GEC
63	UPS	Eaton/ Mitsubishi/ APC
	DG Set and Related Items: -	
63.	Diesel Engine	Cummins-K38 / Caterpillar / KOHELER / GREAVES/Kirloskar.
64.	Alternator	Kirloskar / Jyothi / Crompton Greaves / NGEF / Stamford / Caterpiller
65.	Cushy Foot Mounting (AVM PAD)	Dunlop
66.	Batteries	Exide / AMCO / Prestolite / Amaron Standard Furukawa

Note: -All material shall be subject to approval of the Engineer-in-Charge/Consultant
-Only approved makes of the materials are to be used.