

MINISTRY OF HEALTH & FAMILY WELFARE,  
GOVT. OF INDIA, NEW DELHI

**SAFDARJUNG HOSPITAL, New Delhi**

**TECHNICAL SPECIFICATION**

**FOR**

**Animal House Facility & other Miscellaneous work at VMMC,  
Safdarjung Hospital, New Delhi.**

**VOLUME-III**

**APRIL 2009**



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**Tender No. HSCC/BU-II/AH/2009**

## TECHNICAL SPECIFICATIONS

### 1.0 GENERAL

- 1.01 The specifications and mode of measurements for Civil and Plumbing works shall be accordance with C.P.W.D. specifications 1996 Volumes 1 to VI.

Unless otherwise specified in the nomenclature of individual item or in the specifications, the entire work shall be carries out as per the C.P.W.D. specifications with upto date correction slips upto the date of opening of tender.

- 1.02. For the item not covered under CPWD Specifications mentioned above, the work shall be executed as per latest relevant standards/codes published by B.I.S. (formerly ISI) inclusive of all amendments issued thereto or revision thereof if any upto the date opening of tenders.
- 1.03 In case of B.I.S. (formerly I.S.I.) codes/specifications are not available, the decision of the Engineer based on acceptable sound engineering practice and local usage shall be final and binding on the contractor.
- 1.04 However, in the event of any discrepancy in the description of any item as given in the schedule of quantities or specifications appended with the tender and the specifications relating to the relevant item as per CPWD specifications mentioned above or in drawings the former shall prevail.
- 1.05 The rates for different items of work shall be for all heights, lifts, leads and depths of the building except where otherwise specified in the item of work or in special conditions appended with the tender.
- 1.06 The work shall be carried out in accordance with the architectural, structural, plumbing and electrical drawings etc. The drawing shall have to be properly co-related before executing the work. In case of any difference noticed between the drawings, final decisions in writing of the Engineer shall be obtained by the contractor. For items, where so required samples shall be prepared before starting the particulars items of work for prior approval of the Engineer and nothing extra shall be payable on this account.
- 1.07 All materials to be used on works shall bear I.S. Certification mark unless specifically permitted otherwise in writing. In case I.S. marked materials are not available (not produced) the materials used shall conform to I.S. code or CPWD specifications as applicable in this contract.

In such cases the Engineer shall satisfy himself about the quality of such materials and give his approval in writing. Only articles classified as "First Quality" by the manufacturers shall be used unless otherwise specified. All materials shall be tested as per provisions of the Mandatory Tests in CPWD specifications and the relevant IS specifications. The Engineer may relax the condition regarding testing if the quality of materials required for the work is small. Proper proof of procurement of materials from authentic manufacturers shall be provided by the contractor to the satisfaction of Engineer. Grade of cement used shall be 43/53 unless otherwise specified explicitly. The contractor (if them of Design Mix specified in BOQ) shall get the Design Mix for RCC done by the labs approved by HSCC only. Reinforcement Steel used shall be of FE-415 unless otherwise specified. All materials shall be bought from only approved sources.

- 1.08 In respect of the work of the sub-agencies deployed for doing work of electrification, air-conditioning, external services, other building work, horticulture work, etc. for this project and any other agencies simultaneously executing other works, the contractor shall afford necessary coordination and facilities for the same. The contractors shall leave such necessary holes, opening etc. for laying / burrying in the work pipes, cables, conduits clamps, boxes and hooks for fan clamps, etc. as may be required for the electric, sanitary air conditioning, fire fighting, PA system, telephone system, CCTV system, etc. and nothing extra over the agreement rates shall be paid for the same.
- 1.09 Unless otherwise specified in the bill of quantities the rates for all items of work shall be considered as inclusive of plumping out or bailing out water if required for which no extra payment will be made. This will include water encountered from any source such as rains, floods, subsoil water table being high or due to any other cause whatsoever.
- 1.10 Any cement slurry added over base surface (or) for continuation of concreting for bond is added its is deemed to have in built in the item unless otherwise/explicitly stated and nothing extra shall be payable or extra cement considered with consumption on this account.
- 1.11 The rate for all items in which the use of cement is involved of charges for curing.
- 1.12 The contractor shall clear the site thoroughly of all seaffolding materials and rubbish etc. left out of his work and dress the site around the building to the satisfaction of the Engineer before the work is considered as complete.
- 1.13 Rates for plastering work (excluding washed grit finish on external wall surfaces) shall include for making grooves, bands etc wherever required and nothing extra shall be paid for the same.

- 1.14. The rates quoted for all brick/concrete work shall be deemed to include making openings and making good these with the same specifications as shown in drawings and/or as directed. No extra payment shall be made to the contractor on this account.
- 1.15 Rtes for all concrete/plaster work shall include for making drip course moulding, grooves etc. wherever required and nothing extra shall be paid for the same.
- 1.16 The drawing(s) attached with the tender documents are for the purpose of tender only, giving the tenderer a general idea of the nature and the extent of work to be executed. The rates quoted by the tenderer shall be deemed to be for the execution of works taking into account the "Design Aspect" of the items and in accordance with the "Construction Drawings" to be supplied to the Contractor during execution of the works.
- 1.17 The quoted rates shall be for finished items and shall be complete in all respects including the cost all materials, labour tools & plants machinery etc. all taxes duties levies octroi, royalty charges, statutory levies etc. applicable from time to time and any other item required but not mentioned here involved in the operations described above. The client/HSCC/Employer shall not be supplying any material, plant etc. unless explicitly mentioned so.

## TECHNICAL SPECIFICATIONS (Electrical works)

### 1.0 GENERAL SCOPE OF WORK

The scope of work shall cover internal and external Electrical Works for Animal House Facility & other Miscellaneous work at VMMC, safdarjung Hospital, New Delhi. The Scope Covers Supply, Installation, Testing And Commissioning of Electrical works of the project including the following main items/systems:

- a. Internal electrification through concealed MS conduit and provide light points, fan points, socket outlets etc. including supplying, installation, testing and commissioning wiring/cabling.
- b. Providing MCB Distribution Boards and Panels (MDB/SDB) including submain wiring/cabling.
- c. Conduiting and wiring for telephone points including Main Telephone Distribution Boards (Tag Blocks), telephone outlets etc. complete with telephone cabling from tag blocks to telephone outlets.
- d. Earthing of electrical installation complete in all respect.
- e. Testing and commissioning of all electrical installations.
- f. Obtaining approvals from Chief Electrical Inspector, Local Electricity Supply Authority, Telecom Department, and any other statutory authorities for the complete scope.
- g. Any other works required for complete of electrical works.
- h. Mode of all measurement will be as per latest CPWD norms/ specifications.
- i. Guarantee period for all installations will be 12 months after handing over of installation.
- j. After all required tests and statutory approvals the handing over of all installation will be as per CPWD norms/ specifications.
- k. List of approved manufacturers is enclosed at the end of the technical specification. In the interest of work HSCC reserves the right to choose any of the approved manufacturers / make.

### 2.0 REGULATIONS AND STANDARDS

- 2.1 **All equipments their installation, testing and commissioning shall conform latest CPWD/ IS specifications in all respects.** Indian Standard Code of Practice for Electrical Wiring Installation IS:732-1989. It shall also be in conformity with Indian electricity Rules and the Regulations, National Electric Code, National Building Code,

latest CPWD specifications amended up to date and requirements of the Local Electric Supply Authority. In general, all materials equipment and workmanship shall conform to the Indian Standards specifications and code. Mode of all measurement will be as per latest CPWD norms/ specifications Some of the applicable codes/standards are as under:

- |    |   |                                    |
|----|---|------------------------------------|
| a) | CPWD specification for electrical works   | Part-I (Internal)- 2005            |
| b) | CPWD specification for electrical works   | Part-II (External)-1995            |
| c) | CPWD specification for electrical works   | Part-III (Lifts & Escalators)-2003 |
| d) | CPWD specification for electrical works   | Part-IV (Substation)-2007          |
| e) | CPWD specification for fire fighting protection work-2007                                       |                                    |
| f) | CPWD specification for Generating set- 2007   |                                    |
| g) | CPWD Specification/norms for measurement  | Latest revision                    |
| h) | Guide for marking of insulated conductors   | IS 5578                            |
| i) | Guide for uniform system of marking and identification of conductor and apparatus terminals.    | IS 11353                           |
| j) | Low voltage switchgear and control gear assemblies  | S 8623 Part-1 to 3                 |
| k) | Specification for low voltage switchgear and control gear                                       | IS 13947                           |
| l) | Enclosed distribution fuse boards and cutouts for voltages not exceeding 1000V AC and 1200 V DC | IS 2675                            |
| m) | Code of practice for selection, Installation and maintenance of switchgear and control gear.    | ISI 10118 Part – 1 - 4             |
| n) | Low-voltage fuses for voltages not exceeding 1000V AC or 1500V DC                               | ISI13703 Part-1&2                  |
| o) | PVC insulated (heavy duty) electric cables  | IS 1554                            |
| p) | PVC insulated cables for working voltages upto and including 1100V.                             | IS 694                             |
| q) | Conduit for electrical installations  | IS 9537                            |
| r) | Accessories for rigid steel conduits for electrical wiring                                      | IS 3837                            |
| s) | Boxes for the enclosure of electrical accessories   | IS 14772                           |

t)	General and safety requirements for luminaries	IS 1913
u)	Code of practice for earthing	IS 3043
v)	Electrical accessories – circuit breakers for over current protection for household and similar installations.	IS 8828
w)	Low voltage switchgear and control gear	IS 13947 part 1 – 5
x)	Residual current operated circuit breakers	IS 12640
y)	Current Transformers	IS 2705
z)	Voltage Transformers	IS 3156
A1)	Direct acting indicating analogue electrical measuring instruments and their accessories	IS 1248 part – 1 to 9
B1)	Control Switches (switching device for control and auxiliary circuits including contactor relays) for voltages upto and including 1000V ac and 1200V DC.	IS 13947 & IS 1336
C1)	Dry type power transformer	IS 11171

In case of contradiction in specification the priority of the documents shall be as follows:  
CPWD/ IS specification, BOQ, drawings, Technical specifications.

### **3.0 INTERNAL ELECTRIFICATION OF BUILDING**

#### **3.1 SCOPE**

As specified in subhead 1.00

#### **3.2 GENERAL**

The electrical Installation work shall be carried out in accordance with Indian Standard Code of Practice for Electrical Wiring Installation IS: 732-1989 and IS: 2274 -1963. It shall also be in conformity with the current Indian Electricity rules and regulations and requirements of the Local Electricity Supply Authority and Fire Insurance regulations, so far as these become applicable to installation. Electrical work in general shall be carried out as per following CPWD Specifications with upto date amendment.

- CPWD Specifications for Electrical Works Part-I (internal)-2005
- CPWD Specifications for Electrical Works Part-II (External)-1995.

Wherever these specifications calls for a higher standard of material and or workmanship than those required by any of the above mentions regulations and specification then the specification here under shall take precedence over the said regulations and standards.

### **3.3 DISTRIBUTION BOARDS**

Distribution board will be factory assembled, pre-wired distribution boards. Distribution Board shall be standard type. Distribution boards shall contain miniature circuit breakers of rating specified in BOQ/DB Schedule.

Miniature circuit breakers shall be quick make and quick break type with trip free mechanism. MCB shall have thermal and magnetic short circuit protection. All miniature circuit breakers shall be of 9 KA rated rupturing capacity unless otherwise specified.

Neutral busbars shall be provided with the same number of terminals, as there are single ways on the board, in addition to the terminals for incoming mains. An earth bar of similar size as the neutral bar shall also be provided. All live parts shall be screened from the front. Ample clearance shall be provided between all live metal and the earth case and adequate space for all incoming and outgoing cables. A circuit identification card in clear plastic cover shall be provided for each distribution board.

MCB's shall be provided on the phase of each circuit. The individual banks of MCB's shall be detachable. There shall be ample space behind the banks of MCB's to accommodate all the wiring. All the distribution boards shall be completely factory wired ready for connections. All the terminals shall have adequate current rating and size to suit individual feeder requirements. Each circuit shall be clearly numbered from left to right to correspond with wiring diagram. All the switches and circuits shall be distinctly marked with a small description of the service installed.

Earth Leakage Circuit Breaker shall be current operated type and of 30mA sensitivity unless otherwise specified. It shall also provide over-current and short circuit protection i.e. it shall be MCB-cum-RCCB (Residual Current Circuit Breaker). In case ELCB doesn't have inbuilt short circuit protection, same rating MCB have to be provided for short circuit protection along with ELCB. Cost of this MCB is deemed to be included in the cost of ELCB. EICB shall be housed within the Distribution Board.

Before procurement of Distribution Boards, MCB's, ELCB's (incomer and outgoing) etc., the contractor has to take approval of the DB Schedule/Drawings of each DB from the HSCC Electrical Engineer. The whole unit i.e. Distribution Board, MCB's ELCB's etc. shall come from the manufactures premises/ workshop. After inspection and clearance from the HSCC Electrical Engineer the same may be dispatched to site for installation. However if a single component (such as ELCB of MCB or DB) is required for any reason such as replacement, increase in no. of circuits in the DB, change in the load of existing circuit, change in the total load on a particular DB etc. the same may be ordered separately but after the approval of HSCC Electrical Engineer.

### **3.4 METALLIC CONDUIT WIRING SYSTEM**

#### **3.4.1 TYPE AND SIZE OF CONDUIT**

All conduit pipes shall be of approval gauge (not less than 16 SWG for conduits of sizes up to 32 mm diameter and not less than 14 SWG for conduit of size above 32mm diameter) solid drawn or reamed by welding finished with black stove enameled surface. All conduit accessories shall be of threaded type and under no circumstance pin grip type accessories shall be used. The maximum

number of PVC insulated 650/1100 volts grade copper conductor cable that can be drawn in conduit of various sizes shall be as per IS Code. No steel conduit less than 20mm in diameter shall be used.

#### **3.4.2 CONDUIT JOINTS**

Conduit pipes shall be joined by means of threaded couplers, and threaded accessories only. In long distance straight run of conduits, inspection type couplers at reasonable intervals shall be provided or running threads with couplers and jamnuts shall be provided. In the later case the bare threaded portion shall be treated with anti-corrosive preservative. Threads on conduit pipes in all cases shall be between 13mm to 19mm long sufficient to accommodate pipes to full threaded portion of couplers or accessories.

Cut ends of conduit pipe shall have neither sharp edges nor any burrs left to avoid damage to the insulation of conductor while pulling them through such pipes.

#### **3.4.3 PROTECTION AGAINST CONDENSATION**

The layout of conduit should be such that any condensation or sweating inside the conduit is drained out. Suitable precaution should also be taken to prevent entry of insects inside the conduit.

#### **3.4.4 PROTECTION OF CONDUIT AGAINST RUST**

The outer surface of conduit including all bends, unions, tees, junction boxes etc. forming part of conduit system shall be adequately protected against rust when such system is exposed to weather by being painted with two coats of oxide paint applied before they are fixed. In all cases, no bare threaded portion of conduit pipe shall be allowed. Unless such bare thread portion of conduit is treated with anticorrosive preservative or covered with approved plastic compound.

#### **3.4.5 PAINTING OF CONDUIT AND ACCESSORIES**

After installation, all accessible surface (if any) of conduit pipes, fittings etc. shall be painted with two coats of approved enameled paint or aluminium paint as required to match the finish of surrounding wall, trusses etc.

#### **3.4.6 RECESS/CONCEALED CONDUIT**

The chase in the wall shall be neatly made and of ample dimensions to permit the conduit to be fixed in the manner desired. In the case of building under construction, conduit shall be buried in the wall before plastering and shall be finished neatly after erection of conduit. In case of exposed brick/rubble masonry work, special care shall be taken to fix the conduit and accessories in

position alongwith the building work. Entire work of chasing the wall, fixing the conduit in chases, and burring the conduit in mortar before plastering shall form part of point wiring work.

The conduit pipe shall be fixed by means of staples or by means of saddles not more than 60cm apart or by any other approved means of fixing. Fixing of standard bends and elbows shall be avoided as far as practicable and all curves maintained by bending the conduit pipe itself with the long radius, which shall permit easy drawing approved preservative compound to secure protection against rust. Suitable inspection boxes to the barest minimum requirements shall be provided to permit periodical inspection and of facilities replacement of wired, if necessary. These shall be mounted flush with the wall. Suitable ventilating holes shall be provided in the inspection box covers. Wherever the length of conduit run is more than 10 meters, then circular junction box shall be provided.

#### **3.4.7 METAL OUTLET BOXES & COVERS**

The switch box shall be made of modular metal boxes with suitable size modular cover plates. Modular metal box shall be made of mild steel on all sides except on the front.

The metal box (other than modular type) shall be made of metal on all sides except on the front. Boxes shall be hot dip galvanized mild steel. Metal boxes upto 20 x 30cm size M.S. box shall have wall thickness of 18 SWG and MS boxes above 20 x 30cm size shall be of 16 SWG. The metallic boxes shall be painted with anticorrosive paint before erection. Clear depth of the box shall not be less than 60mm. All boxes shall be covered from top with Phenolic laminated sheet of approved shade. These shall be of 3mm thick synthetic phenolic resin bonded laminated sheet as base material and conform to grade P-I of IS: 2036-1994.

#### **3.4.8 ERECTION AND EARTHING OF CONDUITS**

The conduit of each circuit of section shall be completed before conductors are drawn in. The entire system of conduit after erection shall be tested for mechanical and electrical continuity throughout and permanently connected to earth conforming to the requirement by means of special approved type of earthing clamp effectively fastened to conduit pipe in a workmen like manner for a perfect continuity between the earth and conduit.

#### **3.4.9 SWITCHES**

All 5 and 15 Amp switches shall be modular type of 240 volts A.C. grade. All switches shall be fixed on modular metal boxes. All 5 Amp socket shall be 5 pin type and 15 Amp socket shall be 6 pin type (unless otherwise specified) suitable for 15/5 Amp. All modular switches, sockets, telephone outlets, TV outlet etc. shall be in off white finish unless otherwise specified. The switches controlling the lights or fans shall be connected to the phase wire of the circuit. Switchboards shall be located at 1200 mm above finished floor level unless otherwise indicated on drawings or directed by HSCC Electrical Engineer.

In case of computer power points, power points, telephone points etc. to be fixed on laminated partition board (furniture), same shall be fixed on laminated board (portion of laminated board mean for fixing power points) with base plate/cover plate as applicable, duly fixed with screws.

#### **3.4.10 COVER PLATE**

All modular switches, sockets, telephone outlets etc. shall be fixed modular metal boxes with modular base plates and modular cover plates on top.

#### **3.4.11 WALL SOCKET PLATE**

Each outlet shall have a switch located beside the socket preferably on the same cover plate / modular base. The earth terminal of the socket shall be connected to the earth wire.

### **3.5 WIRING**

#### **3.5.1 WIRES**

3.5.2 The low voltage wiring cables shall be PVC insulated single core, colour coded, stranded Copper conductor rated for 1100 V and conforming to IS 694 and IEC 227. Conductor strand diameter and resistance of the conductor shall be in conformity with IS: 8130 – 1984.

3.5.3 The stranded conductor shall be made of thin strands of electrolytic copper not less than 0.25mm. The number of strands shall be suitable for the size of the cable. However the minimum number of strands shall be as follows:

<b>Size of the Wire</b>	<b>Thickness of the conductor</b>	<b>No. of Strands.</b>
1.5 Sq.mm	0.25 or 0.3 mm	32 or 22
2.5 Sq.mm	0.25 or 0.3mm	50 or 36
4.0 Sq.mm	0.3 mm	56
6.0 Sq.mm	0.3 mm	84

3.5.4 The insulation used in manufacturing the cable/wires shall be of flame retardant and low smoke generating material.

3.5.5 All wiring shall be done in loop in and loop out method and joints shall be made only at switches, outlets or in ceiling rose. Draw wires shall be pulled through before wiring and all wires shall be drawn only after completing conduit work. The wires shall be adequately sized for suitable current rating, taking into account the load on the circuit, de-rating factors necessary for bunching several wires and operating temperature and ambient temperature.

3.5.6 The wires shall be colour coded as follows:

<b>Phase</b>	<b>Colour of wire</b>
R	Red
Y	Yellow
B	Blue
Neutral	Black
Earth	Yellow Green (or) Green

3.5.7 The colour coding shall be maintained throughout the installation as per IEE regulations and Local Code of Practice.

3.5.8 Flexible cords for short extensions to the luminaries, equipment shall be with heat resistant PVC insulated copper conductors conforming to relevant Indian Standard Specification.

### **3.6 WIRING ACCESSORIES**

3.6.1 Wiring accessories shall be provided as listed out in the drawings, BOQ and as directed. All wiring accessories shall be flush mounted unless otherwise approved.

3.6.2 The switches and sockets shall conform to IS 3854 and relevant IEC standards, supplied, complete with overlapping cover plates unless otherwise specified with shockproof rocker bars mounted in sheet boxes. Switch contact shall of silver welded to rocker arm.

3.6.3 The switches shall be sunk pattern where used with concealed conduit or other wiring accessories. Switches shall be quick make and break type. The distance between the edge of the switch plate and the edge of the Architrave shall be minimum 150mm as far as possible.

3.6.4 In general different phases shall not be allowed in one switch box. Upon an unavoidable circumstance where more than one circuit necessarily to be allowed in one-multi gang switches box, phase barrier shall be used for separating the phases/circuits.

3.6.5 Plate switches shall be mounted in sheet steel boxes of minimum 35mm deep with one adjustable lug to allow for variations in the thickness of plaster.

3.6.6 The faceplates of switches shall be fixed square and flush with the wall. The door opening positions shall be checked on site prior to locating switch positions. The switch boxes shall be located 200mm away from the door openings.

3.6.7 Surface mounted switches in surface conduits system shall be fitted to malleable Cast Iron or pressed sheet steel boxes with cover plates giving protection to Dollies. Watertight switches shall be fitted to malleable Cast Iron boxes with spout nipple entries or in weatherproof ABS boxes specially made for this purposes.

- 3.6.8 Dimmer switches shall be flush mounted with cover plates matching with other switch plates.
- 3.6.9 Timer switches shall be 16 Amp rated, single pole, 30 minute dial type, recess mounted and with 20000 guaranteed cycles.
- 3.6.10 Double pole switches shall be complete with Neon indicating lights mounted on the same switch plate. The Neon light shall be arranged to switch on when the switch is in the 'ON' position.
- 3.6.11 Where the light points are not visible from the switch position, the switch plates shall be engraved with the point position and the engraved letters shall be filled in black.
- 3.6.12 All switches and sockets used in the work shall be of grid type ones.
- 3.6.13 Light switches shall be rated 6A complying with IS 3854 and be suitable for operating on inductive load.
- 3.6.14 Weatherproof switches shall be used in all external or damp areas. The switches shall be made of robust UV stabilized PVC or ABS plastic. Threaded conduit entry shall be provided on the enclosure. The WP switch sockets shall be manufactured to relevant IEC standards. The ingress Protection class of the switch socket shall be IP 55.
- 3.6.15 Weatherproof light switches shall be suitable for semi flush type installation conforming to IP 55 protection. The Neon indicator fitted to the switch plates shall be wired as a locator, illuminating when the relevant switch is on off position.
- 3.6.16 The sockets shall be supplied with plug tops conforming to IS 3854. The socket shall be rated for 250V AC supply unless otherwise stated. Industrial sockets shall conform to IEC 309. All plug top pins shall be shrouded for accidental contact.
- 3.6.17 Surface and flush mounted sockets shall be 6/16A, 6 pin round type and wiring shall be installed on the ring main principle. The flush mounted 6/16A sockets shall be with single pole switches and shall be single or double gang as shown in the drawing with removable front plates.
- 3.6.18 The outlets tot the equipment shall be protected with fuse of rated capacity 6/16 amps. Flex outlet units with fuse shall be used to tapping connection to equipment.
- 3.6.19 The colour of the faceplate of all socket outlets fed from UPS power supply shall be different from normal power supply. The shade of the faceplate shall be decided in consultation with Project Manager/Engineer.
- 3.6.20 Exposed length of flexible cable for final connection to the equipment shall be as short as possible. Cables shall not be installed directly on walls/ceilings without prior approval. Cables shall be fixed on cable tray /trunking as directed by the Project Manager/Engineer.

3.6.21 Exposed length of flexible cable for final connection to the equipment shall be as short as possible. Cables shall not be installed directly on walls/ceilings without prior approval. Cables shall be fixed on cable tray/trunking as directed by the Project Manager/Engineer.

**3.7 MOUNTING HEIGHTS FOR WIRING ACCESSORIES**

3.7.1 The various types of wiring accessories shall be mounted at level as noted below unless specified otherwise. The levels shown shall be measured above finished floor level. All dimensions noted below other than Distribution Board shall be from FFL to the center line of the face plate.

Light switches	1400 mm FFL
Socket /Telephone/TV outlets	450 mm FFL
Bell push near the door (if applicable)	1400 mm FFL
Socket on Bench/work top	200 m above the worktop
Distribution boards	1800 mm to top of boards FFL
Flex out for Water Heater in Toilet	2100 mm FFL
Flex out let for FCU of Split AC	case may be
Flex out let for FCU of Split AC	2300 mm FFL or Ceiling mounted as the case may be
Flex out let for window AC	2100 mm FFL (or at Lintel Level)

**3.7.2 WIRING OF SUB-CIRCUITS**

The final sub-circuits shall be wired with the following minimum wire sizes copper conducted wires unless otherwise specified. However size of the cable shall be based on the permissible voltage drop. Sub main wiring shall be carried out with 2.5 Sq.mm wire.

Lighting Circuit	2.5 Sq. single core PVC + 2.5 Sq.PVC insulated earth continuity conductor
Socket Circuits	2.5 Sq. single core PVC + 2.5 Sq. PVC insulated earth continuity conductor
20A Power outlets	4 Sq. single core PVC + 4Sq. PVC insulated earth continuity conductor
Water Heaters (20A)	4 Sq. single core PVC + 4Sq. PVC insulated earth continuity conductor

- 3.7.3 All lighting circuits shall be wired on a Loop-in and loop-out system using rock connectors or loop in ceiling roses as approved by the Engineer and in conformity with code of practice for Electrical Wiring Installation IS-732-1989 with latest revisions. Where the above type of terminal is not specified, the line connector shall be used at the light point terminal box or in light fitting itself.
- 3.7.4 Surface mounted light fittings shall be connected with heat resistant PVC insulated cables.

### **3.8 WIRING OF MECHANICAL EQUIPMENT**

- 3.8.1 The electrical power requirements of mechanical equipment shall be as shown on the drawings or as specified by the equipment manufacturer / supplier.
- 3.8.2 The contractor shall be required to connect each of this equipment in two separate operations. First fix to local isolators for the units upon clearance by the Mechanical Installation Contractor. The second fix shall be from isolator to the equipment. Cable size and number of cable runs shall be as recommended by the equipment supplier. The wiring shall be carried-out in accordance with the manufacturer's wiring diagrams.

### **3.9 TESTING OF WIRING**

On completion of the electrical installation work and before energizing the system all wiring shall be tested for continuity of circuits and earthing.

The insulation resistance shall be measured between earth and the whole system of conductors and any section thereof with all switches closed and except in concentric wiring all lamps in position of both poles of the installation otherwise electrically connected together a direct current pressure of not less than twice the working pressure provided that it does not exceed 660 volts for medium voltage circuits. Where the supply is derived from AC three phase system, the neutral pole of which is connected to earth either direct or through added resistance, pressure shall be deemed to be that which is maintained between the phase conductor and the neutral. The insulation resistance measured, as above shall not be less than 50 divided by the number of points provided on the circuit, the whole installation should have an insulation resistance greater than five meg-ohms. The insulation resistance between the frame work of housing of power appliances and all live parts of each appliances shall not less than that specified in the relevant standard specification or where there is no such specification shall not be less two meg-ohms. All cabling to equipment shall be inspected at works by the Project Manager/Engineer as per relevant IS and testing & commissioning of installation as per Appendix 'E' of IS: 732-1989 shall be done and all record to be maintained.

The earth continuity conductor of power and distribution cables shall be tested for electrical continuity and resistance of the same along with the earthing lead but excluding any added resistance or earth leakage circuit breaker, measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed one ohm.

In a two wire system a test shall be made to verify that all non-linked single pole switches have not connected to the same conductor throughout the such conductor shall be labeled or marked for connection to an outer or phase conductor or to non-earthed conductor of the supply. In a three of four wire installation, a test shall be made to verify that every non-linked single pole is fitted to one of the outer or phase conductor of the supply. The entire electrical installation shall be subject

to the final acceptance of the Project Manager/Engineer as well as the Local Authority, CPWD and Directorate of Electrical Inspector.

## **DETAILED SPECIFICATIONS FOR HVAC**

### **SYSTEM DESIGN DATA**

#### **1.0 General**

The system design, basis of design, estimated requirements and other relevant data are outlined in this section. The specifications and specific requirements are outlined in the subsequent sections.

#### **2.0 Location :**

The proposed Animal Housing Facility at VMMC college Building at sixth Floor for Vardhman Mahaveer Medical college and Safdurjung Hospital, New Delhi

#### **3.0 Scope of work :**

3.1 The work proposed under this tender includes providing and fixing central air conditioning system for the proposed hospital as detailed in the technical specifications and schedule of prices.

#### **4.0 Special Considerations in Design :**

4.1 Application of air conditioning to health facilities presents many problems not encountered in conventional comfort air conditioning systems. The air conditioning systems have been designed taking into consideration the following factors :

4.1.1 The need to restrict air movement in a between various departments and zones to prevent cross contamination.

4.1.2 The need to maintain different temperature and humidity requirement for various areas.

4.1.3 Specific requirements for ventilation and air filtration to dilute and remove contamination in the form of odour, airborne micro organisms and viruses, and hazardous chemical and radioactive substances.

4.1.4 The need to provide controls for maintaining accurate control of environment conditions.

4.1.5 The need to design systems which should be easily maintained by the hospital staff.

4.1.6 The need to maintain relative pressure differentials with respect to adjoining areas and the outside.

#### **5.0 Design Considerations**

The HVAC system should provide a healthy and comfortable environment for the animals and for persons working in the facility. The system(s) should also be capable of regulating the environment within minimally variable set limits in order to supply a constantly stable environment that will not contribute significantly to experimental variability. This includes the uniform constant supply of quality air to all within this room

HVAC system in laboratory animal facility must operate continuously 24 hours per day year round

The temperature of each animal room should be controllable within  $\pm 1^\circ \text{C}$

The temperature of each room should be controlled separately

Animal facilities should be supplied with 100% fresh air. Air should not be re-circulated within the facility

The air circulation systems have been designed using micro-vee filters having 99 % efficiency to prevent bacterial contamination whether from outdoor air.

Animal Holding rooms, Procedure room and quarantine room have been designed on 100% fresh air system. These areas have been designed to maintain positive pressure with respect to other surrounding parts of the buildings to ensure that no contamination should enter these areas.

## **6. Basis of design :**

### **6.1 Assumptions :**

Following assumptions have been made for calculation of airconditioning cooling load :

- i. Construction of walls will be :

External walls	:9 inch thick brick masonry , plastered inside and outside.
Internal walls	:4.5 inch thick brick masonry, plastered inside and outside.
- ii. Glazing :Single pane transparent glass .
- iii. Lighting load :2 W /Sq.Ft.
- iv. Fresh Air room :100 % Fresh air for Animal rooms, Procedure rooms and quarantine room
- v. Occupancy : App. 60-100 Sqft per person or as per actuals
- vi. Equipment load : As per standards or as per Actuals
- vii ROOF INSULATION :The exposed roof of air conditioned areas shall be insulated with 50 mm thick expanded polystyrene or equivalent insulation by other agencies

## 6.2 Outside Ambient conditions :

Season	Dry Bulb temp (deg. F)	Wet Bulb temp. (deg.F)
Summer	110.0	75.0
Monsoon	95.0	83.0
Winter	45.0	41.0

## 6.3 Inside Conditions:

### Summer & Monsoon:

Animal Rooms : 72 +/- 2 deg F DB & 55 +/- 5% RH

Procedure Rooms and Quarantine: 72 +/- 2 deg F DB & 55 +/- 5% RH

### Winters:

: 70 +/- 2 deg F DB & 55 +/- 5% RH

6.4 Electric Power supply : 415 V/3ph/50Hz/AC

## 7.0 Summary Of Heat Load Calculation

Sl No	Name of Area	Area in Sqft	Summer Load in TR	Monsoon Load in TR	Winter Load in KW	Dehumidified Air Qty CFM	Filtration
1	Sixth Floor, Animal Rooms (AR1+AR2+AR3+AR4)	393	11.93	2.48	-22.34	2216	Microvee
2	Sixth Floor Procedure Room	87	3.61	1.2	-6.65	671	Microvee
3	Sixth Floor Quarantine Room	93	3.06	1.2	-5.83	591	Microvee

To cater to the above load, the air conditioning system proposed is as follows:

### **7.1 System Design**

The present Lab and Animal House has 4 Animal rooms, Procedure room, Quarantine rooms and Staff Room. It is proposed that Animal Holding Rooms shall be considered as a single zone and shall be supplied by a single supply and Exhaust system. The other two rooms i.e Procedure and Quarantine room shall have individual and separate supply and exhaust system. For the staff room suitable split AC unit shall be considered.

Since 100% Fresh air is required for Animal room, Procedure room and Quarantine room and to cater the above load it is proposed that an Air cooled Package type DX Units of following capacities shall be provided:

Animal House/Holding rooms:	12 TR and 2400 CFM Capacities
Procedure Room	: 5 TR and 800 CFM Capacities
Quarantine Room	: 5 TR and 800 CFM Capacities

It is proposed to provide Pan Type Humidifiers and Electric strip heaters for Monsoon reheating and winter heating respectively.

#### **Items to be provided by the AC contractor:**

- 9.1 Civil works such as trenches for piping, cables and making foundations of equipments.
- 9.2 Construction of AC plant rooms, AHU rooms etc.
- 9.3 Main 3 ph, 415 v, 50 hz, A.C. supply power supply upto main Electrical Distribution Panel in A/C plant room.
- 9.4 Soft filtered water supply upto each cooling tower and expansion tank etc.
- 9.5 Make up water tanks for soft water.
- 9.6 Drain trap in plant room and AHU rooms.
- 9.7 Any kind of false ceiling, boxing etc.
- 9.8 Making frames for fixing grilles & diffusers in false ceiling, boxing or in walls.
- 9.9 Single phase power supply point upto 1 meter of Fan Coil Unit

#### **10.0 Drawings:**

The drawings forming part of these specifications provide a feasible scheme for locating the equipment. the contractor may re-arrange the equipment for improving the layout and meeting the site conditions. All such changes shall however be subject to the architects approval. These drawings are not meant to be working drawings which shall be prepared by the contractor or as required.

#### **11.0 Test Data :**

The complete HVAC system shall be tested as per the specifications given elsewhere and complete test data shall be furnished on prescribed data sheets:

**12.0 Technical Data :**

The contractor shall furnish complete technical data, on the equipment offered as required under the heading 'Technical data'. In this specifications every effort has been taken to put forth only general specifications of various equipments/ material .If inadvertently, any of the specification drawn happens to match with the specifications of any one particular firm's product only, in respect of critical parameters, than it will not automatically mean that this particular firm's offer is only technically suitable. In general, the specifications offered by other firms will be assessed in their own entirety to ascertain whether or not the broad functions in general expected of the requirements are available with reasonable tolerance on the desired requirements of the client and accordingly the offers would be considered based on prudent assessment and sole discretion of the Engineer.

**13.0 Performance Guarantee :**

13.1 The contractor shall guarantee that the air-conditioning plant and system shall maintain the desired inside temperature within +/- 2 % tolerance.

13.2 The contractor shall guarantee that the capacity of various components as well as the whole system shall not be less than specified.

13.3 The contractor shall ensure, that the system shall be free of vibrations and disturbing

## **Air cooled Package Type DX Units**

### **1. Scope:**

The section sets out the general requirements for factory built or assembled Air cooled condenser type Package DX Units complete with safety controls, instruments electrical installation\,including installation testing and commissioning

### **2. Components of Machines**

Each Air cooled Package DX unit shall be complete with hermetic type compressor/s, Indoor Unit, Outdoor Unit, compressor motor, interconnecting refrigerant piping of required size from indoor to outdoor unit with necessary valves, strainers ,thermal insulation etc, refrigerant controls and accessories, gauge panel, motor starters, and electrical controls, safety controls and devices and first charge of refrigerant, oil etc.

### **3. Compressor**

Compressor shall be multi cylinder semi hermetic/hermetic type complete with drive and motor, dynamically balanced removable cylinder sleeves, oil return check valves suction and oil strainers, discharge and suction shut-off valves, site glass etc .Compressor and motor assembly shall be installed on a spring mounted floating platform to provide quite vibration less operation. Compressor shall be provided with overload protection switches etc.

The compressor shall be enclosed in a hermetically sealed casing and shall be suitable for R-22 Refrigerant.

### **4. Outdoor Unit (Air cooled Condenser)**

The air cooled condenser coil shall be of heavy gauge suitable copper tubes with aluminium fins and condenser shall be so designed to give the required capacity for the specified peak ambient conditions. Suitable axial flow heavy duty condenser Fans for low speed quite operation shall be selected. The condenser Fan shall be suitable for 415 V/3Ph/AC supply. The casing shall be fabricated from galvanized steel, zinc phosphated and finished with baked enamel paint. The casing shall make the whole unit weather proof suitable for outdoor installation. The unit shall include a remote control assembly with thermostat and starting and speed switches.The necessary charge of refrigerant gas and lubricated oil shall be provided to run the system.

### **5. Indoor Unit (Double skin Air Handling unit)**

The Indoor Unit/air handling units shall be double skin fully enclosed construction, draw-thru type and shall include flat filter section, fan section, coil section, Microvee Filter section, and humidifier section etc with necessary vapour arrangement. The AHU shall be two tier type with the Microvee filter sections in the upper tier.

#### **5.1 Fan Section**

Fan shall be centrifugal with forward or backward inclined blades. Fan casing shall be made of galvanised steel sheet. Fan wheels shall be made of galvanised steel. Fan shaft shall be ground C40 carbon steel and supported in pre-greased ball bearings operating less than 75% of first critical speed. Fan wheels and pulleys shall be individually tested and precision balanced dynamically. The fan shall be selected for a fan speed not exceeding 1000 rpm for fan dia of more than 350 mm .The fan outlet shall be connected with casing with the help of fire retardant canvas.

#### **5.2 Coil Section**

The cooling coil shall be of seamless copper tubes, the intenal and outer dia of the cooling coil shall be as per the standards of the approved makes with aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and such that the air velocity across the coil shall not exceed 500FPM. The coil shall be pitched in the unit casing for proper drainage. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of air flow.

The fins shall be uniformly bonded to the tubes by hydraulic mechanical expansion of the tubes. Fin spacing shall not exceed 5fins per cm. The coiling coil assembly shall be on aluminium rails and nylon rollers for easy with drawl from either side.

#### **5.3 PreFilter**

Each unit shall be provided with a factory assembled filter sections containing washable synthetic type air filters. Filter framework shall be duly sealed and constructed from aluminium alloy. The media shall be supported with HDP mesh on one side and aluminium frame mesh on other side. Filters face velocity shall not exceed 500 FPM. Filters shall fit so as to prevent by pass. Holding frames shall be provided for installing a number of filters cells in bank. These cells shall be held within the frames by sliding the cells between guiding channels.

#### **5.4 Humidifier Section**

A separate humidifier section shall be provided in the AHU's in the lower tier. Pan humidifier shall be placed outside the AHU & within the AHU room & steam shall be supplied in the humidifier section.

### **5.5 Housing/ Casing**

The housing /casing of the air handling unit shall be of double skin panels, sandwiched type with polyurethane foam insulation of 25 mm thickness ( overall ). The housing shall be so made that it can be delivered at site in the total/ semi knock down conditions depending upon the location. The frame work shall be of extruded aluminium hollow section duly powder coat painted/ anodized. All the frame shall be assembled using mechanical joints to make a sturdy & strong frame work for various sections.

The outer sheet of panel shall be of made of galvanised pre-plasticised sheet/powder coated CRC sheet of 0.80 mm thickness, and inner sheet of 0.63 mm thick GSS. These panels shall be bolted from inside on the frame with soft rubber gasket in between to make the joints air tight.

Frame work for each section shall be bolted together with soft rubber gasket in between to make the joints air tight, suitable doors with chrome plated hinges and latches shall be provided for access to various panels for maintenance. The entire housing shall be mounted on steel channel frame work. Units shall have hinged, quick operating access door in the fan section etc. The access doors shall also be double skin type similar to the casing.

The special (Microvee) filters shall be housed in a separate AHU upper tier casing of suitable size & length.

The enclosure shall be sized to accommodate the standard microvee filter. The inspection doors shall have double synthetic rubber seals doors & locking arrangements. The gaps between filter frames & housing shall have synthetic rubber packing to eliminate any air leakage. All filter frames & metallic parts shall be made of Aluminium. The microvee filter sections shall have provision for fixing a portable inclined manometer for taking filter pressure drop readings.

Drain pan shall be constructed of 18 gauge aluminium sheet with necessary slope to facilitate fast removal of condensate. It shall be isolated from the bottom floor panels through 12 mm thick kinny foam insulation or equivalent.

### **5.6 Fan Motor and Starter**

The totally enclosed fan cooled squirrel cage fan motor shall have a minimum rating as given under "Schedule of Equipments and the starter rating shall match the motor rating and both control panel shall conform to the specifications under "Motors and Switchgears". Drive to fan shall be provided through belt-drive arrangement. Belts shall be of oil resistant type.

### **5.7 Controls**

Each air handling unit shall be provided with a modulating valve motor and modulating thermostat, conforming to specifications under "Controls".

### **5.8 Accessories**

Each indoor/air handling unit shall be complete with :-

Thermostat at coil inlet and outlet with display on microprocessor base contropanel of the system.

Pressure gauges with cocks at inlet and outlet of the coil.

Drain line from unit to drain trap.  
Flexible connection between fan outlet and duct.  
Vibration isolators of high efficiency.

## **6.0 Refrigerant System**

The air conditioning units shall be complete with pre-charged refrigerant line including fittings, valves and thermostatic expansion valve. Automatic resetting type low and High Pressure cut outs shall be provided to safe guard the unit against abnormal operation.

## **7.0 Control, Instrumentation and Accessories**

Each unit shall be equipped with but not restricted to the following

Crankcase heaters

High –low cut outs

Safe guard against short cycling of compressor

Insulated drain piping

Compressor and Fan motor starters with bi-mettalic overload relays with restting

Isolation valves for air cooled condensers in refrigerant lines

Expansion Valves

Vibration isolation Pads below the units

Double canvass connection b/w indoor unit and starting ducts

A snap acting type fixed differential double throw type air thermostat shall be provided to start and stop the compressor depending upon the air conditioned space requirements in addition to a manually operated switch. The thermostat shall be able to be adjusted from 18 0C to 26 0C with an increment of minimum 0.5 0C

All the moving parts in the units shall be mounted in the steel frame work with the help of suitable vibration isolators in order to ensure quite operation of the unit

## **8.0 Microvee filters (fine filters)**

Microvee filters shall be of dry type. Filters media shall be made from washable nonwoven synthetic fibre replaceable media reinforced with HDPE cloth & Aluminum mesh, specially treated with antifungal and bactericidal agents to prevent growth of micro organisms. The filter media shall be treated to permit washing with water several times before discharged. The media shall be properly supported and spaced so that air flow through the filter is uniform. The filter shall be housed in aluminium frame work. Filters shall be designed to remove particle down to 5 micron size and with efficiently of 98.0 percent tested as per BS 2831 using Test Dust II. The filters shall be installed in the air handling units after the chilled water coils. They shall be capable of being replaced or removed for servicing without the use of special tools.

## **9.0 Refrigerant Piping:**

The indoor and outdoor unit shall be interconnected by a suitable type seamless copper refrigerant liquid and suction lines using flared or brazed fittings. Necessary accessories shall be incorporated in the circuit.

**Limitations :**

The air velocity across the cooling coil shall not exceed 500 FPM.

The fan outlet velocity shall not exceed 1800 FPM.

The air velocity across the filters shall not exceed 500 fpm.

## **Pan Type Humidifier**

**1 Type :**

The pan type humidifier shall be closed type and connected to the supply air duct for introduction of steam when required.

**2 Construction**

The body of the humidifier shall be fabricated out of stainless steel sheet at least 2mm thick with all joints welded with stainless steel welding rods and all edges rounded off. The pan shall be made completely air tight and leakproof. On top of the pan an openable cover shall be provided for maintenance of internal components.

The humidifier shall be externally insulated with Resin bonded fibreglass of density not less than 32 Kg/cub.m and then clad with 0.8 mm thick aluminium sheet.

The humidifier shall have two chambers with two banks of heaters. One bank of heaters shall always remain ON when the AHU is in operation to maintain the temperature of water between 60 - 70 deg. C and the other bank should come on when there is signal from the humidistat for humidification.

The electric heaters shall be submersible type made out of incoy sheeth and brass/bronze flanges. The heaters shall be of suitable rating to produce instant steam when required.

**3 Electrical panel ( Pan type Humidifier)**

The electrical panel box shall be made of 16 GCRC sheet and painted with heat and water resistant paint. All switchgears and internal components of the panel shall be of L&T/seimens/EE make only.

**4 Controls and accessories:**

The humidifier shall be complete with following controls and accessories:

- a. Water proof light in the tank
- b. Water level indicator
- c. Low water level cutoff switch
- d. Float valve with bronze ball
- e. Make up , quick fill and drain connections
- f. Safety thermostats.
- g. Fault indication lamp.

## **VENTILATION FANS**

### **1. General :**

The ventilation fans shall be complete in all respects and shall generally comply with the following specifications given below :

### **2. Exhaust Fans :**

2.1 The exhaust fans shall be propeller type with steel hub and blades, mounted directly on the shaft of a totally enclosed motor.

2.2 The fan blades shall be of pressed steel of aerofoil design for high efficiency and static pressure.

2.3 The mounting frame shall be of cast/sheet steel with steel brackets to connect the frame, with the fan/motor assembly. Rubber mounts shall be provided between the mounting frame and the mounting brackets.

2.4 The fan motor shall be to totally enclosed squirrel cage type.

### **3. Centrifugal Blowers :**

3.1 The centrifugal blowers shall be double/single inlet, double/single width, non-overloading type, of suitable construction. The blower performance must be rated in accordance with approved test codes and procedures.

3.2 The blower housing comprising of scroll & side plates shall be accurately cut, heavy gauge all welded sectional construction and reinforced with angle bracings. Outlets shall be flanged to assure proper duct connections. Inlet cones shall be spun venturi type or curved vane type to ensure smooth air entry. The base frame shall be of angle iron in bolted/welded construction.

3.3 Impeller shall be fabricated from sheet steel with backward curved, properly designed. blades, heavy c.i. hub and shall be both dynamically and statically balanced, to a close tolerance for quiet and vibration free performance.

3.4 Shaft shall be of hot rolled steel or forged steel, sized adequately, but in no case less than 40 mm dia-meter and shall be accurately ground and polished to a close tolerance.

3.5 Bearings shall be self aligning, heavy duty ball or tapered roller type with integral dust and grease seals.

3.6 After assembly, the complete fan shall be painted with rust proof primer and two coats of synthetic enamel paint.

3.7 Fan having wheel diameter of 1220 mm or more, shall be supplied with split, bolted housing for convenience of handling and installation.

#### 4. **Blower Drive Assembly :**

4.1 Drive assembly for each blower shall consist of blower pulley, motor pulley, a set of 'V' belts, belt guards, and belt tension adjusting device.

4.2 Pulleys shall be selected to provide the required speed. They shall be multi-groove type, with section and grooves selected to transmit 33% more load than the required power and shall be statically balanced.

4.3 The belt guards shall be of m.s. sheet with angle iron reinforcement and expanded metal screen.

5. **Exhaust Blowers (Fan Section of AHU)**

5.1 The exhaust fans (fan section of AHU) shall be as described in under AHU.

6. **Motors and Starters :**

6.1 The motor for each blower, shall be squirrel cage induction type and conform to specifications as given under section on control panel, motors and switchgear. The motor h.p. shall be at least 20% more than the limit load of fan and of minimum rating as given under 'Schedule of Equipments'.

7. **Limitation :**

The air velocity limits are as follows :

7.1 Velocity at blower outlet shall not exceed 12.5 mps.

**8.0 AXIAL FLOW FANS**

Casing shall be constructed of heavy gauge sheet steel. Casing shall be provided with hinged door enabling easy replacement of wheel, shaft and bearings. A small inspection door with handle and neoprene gasket shall also be provided. Casing shall have flanged connection on both ends for ducted applications. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be de-rusted, cleaned, primed and finish coated with enamel paint.

ii) Rotor hub and blades shall be of cast aluminium, or cast steel construction. Blades shall be die-formed aerofoil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Fan blade mounting on the hub shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control maybe manually readjustable at site, upon installation, for obtaining actual airflow values, as specified.

iii) Motor shall be of 3 phase squirrel-cage totally enclosed, fan cooled type. Motor and starter shall be in accordance with para 6.6. (V) and 13.9. The speed of fan shall not exceed 1000 RPM for fans with impeller diameter above 450 mm, and 1450 RPM for fans with impeller diameter of 450 mm and less.

iv) Drive to fan shall be provided through belt drive with adjustable motor sheaves and belt guard or direct driven . Belt shall be oil resistant type.

## MOTOR STARTERS CONTROL PANELS

### 1. General :

The motors and switchgears required for various items shall generally be as per specifications given below. All electric motors shall be suitable for 3 phase, 50 cycles 415 volts a.c. supply.

### 2. Control Panel :

2.1 These panels should be floor/wall mounted, sheet steel clad, modular construction, cubicle design, compartmentalised. These panels shall comprise of incoming & outgoing feeders (circuit breakers, fuse switch units/switch fuse units, contactor starters with overload relays, single phasing preventor etc. as indicated in the drawings.

2.2 The panels shall be provided wherever necessary with necessary interlocks designed to prevent incorrect operation and to ensure safety of operating personnel and equipment.

2.3 All feeders are to be operated from the front and they shall be interlocked suitably. Padlocking arrangement and interlock defeating device shall also be provided. Each module shall have separate door and partition plate. The feeder incomer switches shall be interlocking with the door so that the door can only be opened when switch is in 'off' position. The doors and covers shall be provided with thick gaskets to make it dust tight. All the door covers shall be provided with synthetic rubber gaskets to make it dust tight. Feeder name tags shall be provided.

### 2.4 Air Circuit Breaker and Fuse Switch Units

The circuit breaker shall be air break fully draw out type equipped with arc chutes and their face barriers of proper design. The continuous current rating of the circuit breakers shall be as given in the detailed technical specifications. The circuit breakers shall have a breaking capacity of 31 mva at 415 volts, 50 hz ac & they shall be able to withstand full fault current for one second.

2.5 The circuit breaker shall be provided with manually operated spring closing mechanism. The operating mechanism shall be trip-free throughout the breaker travel. The breaker shall be equipped with inside 'on' & 'off' position indicator mechanism and so located that the position of the circuit breaker i.e. whether closed or open, is indicated on the front door of the compartment. The 'on' & 'off' trip indicating lights shall also be provided for each breaker feeder.

2.6 The moving portion of the circuit breaker shall be so interlocked that it is not possible to isolate it and draw out from the service position or to plug it in from the isolated position when the circuit breaker is closed. The interlock being provided shall be such as to prevent operation of a circuit breaker unless it is fully plugged in or fully isolated and is locked correctly in either of the two positions.

2.7 The circuit breaker compartment doors shall be so interlocked as to prevent access to the breaker while in the plugged in position. However special means shall be provided for undoing this interlocked in an emergency.

2.8 The draw out feature shall clearly provided three distinct positions of the circuit breaker viz., 'service', 'test' & isolated. Inadvertant withdrawal of a circuit breaker removable unit too far beyond its supports shall be prevented by a suitably interlock, the design shall provide for the testing of breaker in the test positions i.e. when the breaker's moving unit is in fully disconnected position and the secondary circuit remains connected or energised. The secondary connections between the fixed and removable units shall be provided with means of spring loaded sliding type contacts to make the breaker fully draw out type.

2.9 The circuit breaker unit shall be provided with complete range of releases including the overload releases and release for short circuit protection.

2.10 The circuit breaker shall be provided with necessary auxiliary contacts with 2 No. spare contacts. All contacts shall be wired upto the terminal board.

2.11 The fuse switch unit shall be of load break heavy duty, industrial design and of double break pattern with quick make and quick break mechanism, however, the design shall be such that it shall ensure positive opening even if quick break action is lost due to spring stretching or breaking.

2.12 The 'on' and 'off' position of the switch handle shall be distinctly indicated and interlocks shall be provided to ensure that switch cover can not be opened unless the switch is in the 'off' position.

2.13 The fuse switch units shall be provided with non-deteriorating type of hrc cartridge fuse link and having rupturing capacity not less than 31 mva at 415 volts.

2.14 All live parts inside switch shall be properly shrouded and interphase barriers shall be provided. Design of the switch handles shall be such that they do not protrude out of the panel in the manner so as to prevent free passage of operating personnel. Design with normal conventional position of switch handle up in 'on' position & down in 'off' position shall be preferred.

## 2.15 **415 Volts Bus Bars**

2.15.1 The 415 volts main bus-bar shall have continuous current rating as indicated in the specification or equivalent standard rating of at least 50 percent of these of the phase bus bars. The bar and its connections shall be so arranged and supported as to withstand without any damage or deformation, the specific shortcircuit current. The bus bars shall be braced and supported on reinforced fibre glass support and shall be of electrolytic grade type E 91e of is:5082. these bus bars shall withstand 43.12 ka for one second during short circuit conditions. The bus bars shall be colour coded with pvc tapes or insulating painting for identification purposes. The bus bars shall be sleeved with special type heat shrinkable pvc sleeving.

2.15.2 Bus supports shall be resistant low absorption type moulded insulation of high impact strength and high creepage surface.

2.15.3 All bus work shall be braced to withstand without damage a short circuit

current of 43.12 ka symmetrical for one second.

## **2.16 Instruments and Meters**

2.16.1 Current transformer shall comply with the requirements of is:2705. They shall have ratio outputs and accuracies as specified or required as shown in single line diagram.

2.16.2 All indicating instruments shall be of industrial pattern and should be provided as shown in the single line diagram.

2.16.3 All instruments shall be switch board type flush mounted with proper scale dimensions so as to be clearly visible to the operators standing on the floor. The instruments shall be provided with front of board zero adjuster shall be not preferably be mounted at heights lower than one meter and higher than two meters above the floor level.

2.16.4 The operating handles, meters, instruments etc. shall be mounted at the front of the switch board. Approved means shall be provided for locking the control switch/operating handles in the open position. For fuse switch gear section of the switch board, meters where specifications shall be mounted in such a manner that it is possible to readily identify the meters for individual units and the arrangements does not create hinderance to maintenance of individual units without having to shut down the bus.

2.16.5 All wires carried within the switch gear enclosure shall be pvc insulated and shall be neatly arranged to be readily accessible and to facilitate easy replacement. Only pvc copper cables shall be used for all power and control inter connections. The cables of 660 volts shall be used. Trained copper cables lugs shall be used. All small wires shall be colour coded and provided with numbered ferrules for easy indentification of circuits. As for as possible, each essential circuit shall be connected within the respective switch gear unit. Control wiring terminal shall preferably be near the panel.

## **3. Cable Termination :**

3.1 The cables entries and terminals shall be provided in the switch board to suit the number, type and size of aluminium conductor cables as given in the line diagram. Cable entries shall be so designed as to avoid damage to cables and there shall be sufficient space to avoid short bending of cables. The positions of the cable lugs and terminals shall be such that the cable could be neatly drawn and connected through one meter deep trench below the switch gear and the jointing carried out in a convenient and satisfactory manner. The cable entry, design panel, cable boxes and terminals and their locations will have to be approved by the engineer/owner. However the access for cabling shall preferably be from the back of the switch board. The panels shall be provided with control transformers of suitable va rating along with control bus and hr fuses from control supply to contractors.

3.2 The cables socket shall be of copper and of crimping type. Cables risers shall be adequately supported to withstand the effects of rated short circuit current without damage.

3.3 Cable glands of sizes as required shall be provided at all cable entry points in the bottom plate. The glands shall form part of switch board.

4. **Indication :**

Each incoming and outgoing feeder units shall be provided with 'on' 'off' indicating lamps of standard conventional colour coding.

5. **Subsidiary Panels :**

Subsidiary panels shall be provided wherever required such as ahu room, air washer room. The construction of these panels should be similar to the main panel and shall have all related accessories.

6. **Contactor Starters :**

6.1 **Star Delta Starter**

The star delta starter shall be air break automatic contactor starter provided with main contactor, star contactor, delta contactor, timer and automatic change over from start to delta, bimetallic over load relay, operating coil, start/stop push button, single phasing preventor, auxiliary make and break contacts, indicating lamps etc. The contactor shall quick make, quick break, double break consisting of robust silver contacts. The coil voltage shall be 415 volts ac at 50 hz. The starter shall be provided with trip indication light and overload reset push button for overload relay.

6.2 **DOL Contactor Starter**

The contactor shall be air break type coil operate, dol contractor starter, provides with cables entries, ambient temperature compensated bimetallic over load relay, single phasing preventor, solenoid coil, start and stop push buttons, 8 auxiliary make and break contacts, indicating lamps etc. The contactors shall be quick make quick make and quick break, double break type consisting of robust silver contacts. The coil voltage shall be 440 volts at 50 c/s. The starter shall be provide with trip indication light and over load reset bush button for overload relay.

7. **Squirrel Cage Induction Motors :**

7.1 The motor shall be of well tried out and design and of reputed make. The motors provided on the equipment shall conform to is:325 in general. The motors shall be squirrel cage induction motors rates for operation at 415 volts, 3 phase, 50 hz a.c. supply. The motor for various equipments shall have the following enclosure level.

- (a) Cooling tower & exhaust blower - ip:55(tefc)
- (b) Compressor and A.H.U. motor-ip:44(tefc).
- (c) Pumps ip:34(spdp).

7.2 The horse power and speed of the motor shall match that of driven equipment and the motor shall be suitable for star delta startings or direct on line starting with class '3' insulation. The motors of 7.5 HP and above 7.5 HP shall be suitable for star delta starting and below 7.5 HP suitable for dol starting. The compressor motor shall be provided with automatic star delta starter

## DUCT WORK AND OUTLETS

### 1. General :

1.1 The work under this part shall consist of furnishing labour materials, equipment and appliances as specified necessary and required to install all sheet metal and other allied work to make the air conditioning supply, ventilating, exhaust system ready for operation as per drawings.

1.2 Except as otherwise specified all duct work and related items shall be in accordance with these specifications.

1.3 Duct work shall mean all ducts, casings, dampers, access doors, joints, stiffners and hangers.

### Duct materials

2.1 The ducts shall be fabricated from galvanized steel sheets class VIII GSS sheets conforming to IS:277-1962 (revised) or aluminium sheets conforming to IS:737-1955(with latest amendments) (wherever aluminium ducts are specified).

2.2 All duct work, sheet metal thickness and fabrication unless otherwise directed, shall strictly meet requirements, as described in IS: 655-1963 with amendment-i (1971 edition)

The thickness of the sheet shall be as follows :-

	size of duct	sheet thickness		type of joints	bracing if any
		GI	Aluminium		
2.2.1	Upto 750mm	0.63 mm	0.80 mm	GI flange	
2.2.2	751 mm to 1000 mm	0.80 mm	1.00 mm	25x25x3 mm Angle iron Frame With 8 mm dia.nuts & bolts.	25x25x3 mm at the rate of 1
2.2.3	1001 mm to 1500 mm	0.80 mm	1.00 mm	40x40x5 mm angle iron frame with 8 mm dia. Nuts & bolts.	40x40x3mm at the rate of 1
2.2.4	1501 mm to 2250 mm	1.00 mm	1.50 mm	50x50x5 mm angle iron to be cross braced diagonally with 10 mmdia nuts & bolts at 125	40x40x3mm at the rate of 1.2

				mm centre.
2.2.5	2251 mm and above	1.25 mm	1.80 mm	50x50x6 mm angle iron frame with 10 mm nuts & bolts at 125 mm centre.
				40x40x3 mm at the rate of 1.6

2.3 The gauges, joints and bracings for sheet metal duct work shall further conform with the provisions as shown on the drawings.

2.4 Ducts larger than 450 mm shall be cross broken, duct sections upto 12 00 mm length may be used with bracing angles omitted.

2.5 Changes in section of duct work shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 deg. Angle from the axis of the main duct unless otherwise approved by the engineer-in-charge.

2.6 All ducts shall be supported from the ceiling/slab by means of m.s.rods of 9 mm (3/8") dia with m.s. angle at the bottom.

### 3. Installations

3.1 During the construction, the contractor shall temporarily close duct openings with sheet metal covers to prevent debris entering ducts and to maintain opening straight and square, as per direction of engineer-in-charge.

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

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

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

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

3.5 The duct work shall be varied in shape and position to fit actual conditions at building. All changes shall be in accordance with accepted airconditioning duct design and subject to the approval of the engineer-in-charge. The contractor shall verify all measurements at building and shall notify the engineer-in-charge of any difficulty in carrying out his work before fabrication.

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

3.7 The ducts shall be supported from the structure by means of suitable supports grouted in the r.c.c. work. The type of support should meet the approval of the engineer-in-charge and should involve minimum damage or breakage. In no case the duct will be rested upon the flase ceiling/boxing or on supports grouted in the wall.

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

3.9 Joints, seams, sleeves, splitters, branches, takeoffs and supports are to be as per duct details as specified, or as decided by engineer-in-charge.

3.10 Joints requiring bolting or rivetting may be fixed by hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed centre top rivets or spot welding. Self tapping screws must not be used. all fixing must have a permanently non-corrosive finish such as cadmium plating or galvanizing as appropriate. Spot welds and bronze welds are to be coated on all surfaces with zinc rich paint, as approved by engineer-in-charge.

3.11 The flexible joints are to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvass or as directed by engineer-in- charge. On all circular spigots the flexible materials are to be screwed or clipband with adjustable screws or toggle fitting. For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.

3.12 The flexible joints are to be notless than 75 mm and not more than 250 mm between faces.

3.13 The duct work should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling contractors.

#### 4. **Dampers**

4.1 At the junction of each branch duct with main duct and split of main duct, volume dampers must be provided.dampers shall be two gauges heavier than gauge of the large duct, and shall be rigid in construction to the passage of air.

4.2 The volume dampers shall be of an approved type,lever operated and complete with locking devices which will permit the dampers to be adjusted and locked in any positions.

4.3 The dampers shall be of splitter, butterfly or louver type. the damper blade shall not be less than 1.25 mm (18) gauge, reinforced with 25 mm angles 3 mm thick along any unsupported side longer than 250 mm angles shall not interface with the operation of dampers, nor cause any turbulence.

4.4 Automatic and manual volume opposed blade dampers shall be complete with frames and bronze bearings as per drawings. dampers and frames shall be constructed of 1.5 mm steel and blades shall not be over 225 mm wide. The dampers for fresh air inlet shall additionally be provided with fly mesh screen, on the outside, of 0.8 mm thickness with fine mesh spacking.

4.5 Wherever required for system balancing, provide a volume balancing opposed blade damper with quadrant and thumb screw lock. provide damper rod and damper block with upset screws.

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

#### 4.7 **Motorised Combined Smoke & Fire dampers:**

The fire dampers shall be provided at all supply and return air ducts at AHU room crossings and at all floor crossings or wherever shown on the drawings. The fire & smoke dampers shall be of atleast 90 minutes fire rating certified by CBRI, Roorkee as per UL 555 : 1973. Fire damper blade & outer frame shall be formed of 1.6 mm galvanized sheet steel. The damper blade shall be in pivoted on both ends using chrome plated spindles in self lubricated bronze bushes. Stop seals will be provided on top & bottom of the damper housing made of 16 G galvanized sheet steel. For preventing smoke leakage side seals will be provided. In normal position damper blade shall be held in open position with the help of a 24 V operated electric actuators thereby providing maximum air passage without creating any noise or chatter. The damper shall be actuated through electric actuator. The actuator shall be energised with the help of a signal from smoke detector installed in AHU room. Smoke detector shall be provided by the A/C contractor. The fire

damper shall also close due to temperature rise in SA ducts through the electric temperature sensor factory set at 165 deg F micro switches with bakelite base will be provided to stop fan motor and give open & close signal at remote panel in case of motorised actuator.

Each fire dampers shall have its own panel which will incorporate necessary circuit required to step down voltage available from power supply to shown status of the damper ( open or close ), to allow remote testing of damper & indication in event of damper closure due to signal from smoke sensor/ temperature sensor & reset button. Additional terminal will be provided to have signal ( sound beep or visual ) in Central Control Room

Damper actuator shall be spring return Belimo make so as to close the damper in the event of power failure automatically and open the same in case of power being restored. Spring return action of the actuator shall be an in built mechanism and not mount externally.

The fire damper shall be mounted in fire rated wall with a duct sleeve 600 mm long. The sleeve shall be factory fitted on fire damper. The joints at sleeve end shall be slip on type. Minimum thickness of GI sheet shall be 18 G.

#### 5. **Access panel**

5.1 A hinged and gasketed access panel shall be provided on duct work before each reheat coil and at each control device that may be located inside the duct worl.

#### 6. **Miscellaneous**

- 6.1 All ducts above 450 mm are to be cross broken to provide rigidity to the ducts.
- 6.2 All duct work joints are to be true right angle or approaching with all sharp edges removed.
- 6.3 Sponge rubber gaskets also to be provided behind the flange of all grilles.
- 6.4 Each shoot from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grille through the shoot.
- 6.5 Inspection doors measuring at least 450 mm x 450 mm are to be provided in each system at an appropriate location, as directed by engineer-in-charge.
- 6.6 Diverting vanes must be provided at the bends exceeding 600 mm and at branches connected into the main duct without a neck.
- 6.7 Proper hangers and supports should be provided to hold the duct rigidly, to keep them straight and to avoid vibrations additional supports are to be provided where required for rigidity or as directed by engineer-in-charge.
- 6.8 The ducts should be routed directly with a minimum of directional change.
- 6.9 The duct work shall be provided with additional supports/hangers, wherever required or as directed by the engineer-in-charge, at no extra cost.
- 6.10 All duct supports, flanges, hangers and damper boxes etc. shall be given 2 coats of red oxide paint before installation and one coat of aluminium paint after the erection, at no extra cost.
- 6.11 All angle iron flanges to be welded electrically and holes to be drilled.
- 6.12 All the angle iron flanges to be connected to the gss ducts by rivets at 100 mm centres.
- 6.13 All the flanged joints, to have a 4 mm thick felt packing stack to the flanges with shellac varnish. the holes in the felt packing are to be burnt through.
- 6.14 The g.s.s. ducts should be lapped 6 mm across the flanges.
- 6.15 The ducts should be supported by approved type supports at a distance not exceeding 2.4 metres.
- 6.16 Sheet metal connection pieces, partitions and plenums required, shall be constructed of 1.25 (18 gauge) sheet throughly stiffened with 25 mm x 25 mm angle iron braces and fitted with access doors.

## 7. Grilles

- 7.1 The supply and return air grilles shall be fabricated from aluminium extruded sections and the supply air grilles shall have single louvers and the return air grille shall have single horizontal extruded section fixed louvers the grilles may or may not be with an outer frame.

7.2 The grilles shall have opposed blade dampers of m.s. black sheets, which shall be key operated from the grille face wherever required.

7.3 The damper blades shall be of 1.00 mm (18 gauge) m.s. black sheets and shaped to form air tight joints the frame work for dampers shall be fabricated from 1.00 mm (18 gauge) m.s. black sheet the grill flange shall be fabricated out of 25 x 25 x1.5 mm aluminium angle grilles longer than 450 mm shall have intermediate supports for the horizontal louvers.

#### 7.4 **Linear Grille**

The linear grille shall be of 1.25 mm (18 G) aluminium extruded section with flush mounted with single louvers for air flow direction adjustment.

### 8. **Diffusers**

8.1 The ceiling type round or square diffusers shall be of 1.25 mm (18 gauge) aluminium extruded sections with flush or step down face, as specified with fixed pattern and round neck.

8.2 The diffusers shall be die formed for proper air diffusion.

8.3 All supply diffusers shall be provided with m.s. sheet dampers, with knurled knobs for adjustment from the bottom.

### 9. **Laminar flow diffusers**

9.1 The laminar flow diffusers shall be fabricated from aluminium sheets supported in a framework.

9.2 The diffuser shall be fabricated from aluminium sheet of 1.25 mm thickness double folded and pressed with mechanical perforations of suitable size and at suitable spacing to provide the rated air quantity.

9.3 The framework shall be fabricated from 25 \* 25 \* 3 mm aluminium angle.

9.4 The dampers shall be fabricated from 1.25 mm aluminium sheet and shaped to form airtight joints. The damper shall be key operated from the face of the diffuser.

### 10. **Painting**

10.1 All grilles, and diffusers shall be anodised or powder coated, as required, before installation.

10.2 All ducts immediately behind the grilles/diffusers etc. are to be given two coats of black paint in matt finish.

10.3 All grilles, diffusers & registers shall be provided with rubber gasket between flanges and the wall or ceiling.

### 11. **Testing**

11.1 After completion, all duct system shall be tested for air leakage.

11.2 The entire air distribution system shall be balanced to supply the air quantity as required in various areas and the final balance of air quantity through each outlet shall be submitted to the engineer-in-charge for approval.

## **ELECTRIC WIRING**

### **1. General :**

The electric wiring of motors for compressors, pumps, air handling units etc. As well as controls, heaters etc. and earthing of all equipment shall be carried out as per specifications given hereunder.

### **2. Power Cabling for Motors, Heaters etc :**

2.1 Unless otherwise specified, the power cables shall be PVC insulated, and PVC sheathed aluminium conductor, armoured cables to 1100 V grade conforming to IS 1554. The power cables shall be of 2 core for single phase, 4 core for sizes upto and including 25 sq.mm, 3-1/2 core for sizes higher than 25 sq.mm for 3 phase. Where high voltage equipments are to be fed, the cables shall be rated for continuous operation at the voltages to suit the same.

2.2 Power cables shall be of sizes as indicated in the tender specifications. In all other cases, the sizes shall be as approved by the Engineer-in-Charge, after taking into consideration the load, the length of cabling and the type of load.

2.3 Cables shall be laid in suitable metallic trays suspended from ceiling, or mounted on walls, or laid directly in ground or clamped on structures, as may be required. Cable ducts shall not be provided in plant rooms. Cable trays shall be fabricated from slotted angle/solid angles to make ladder type cable tray, designed with adequate dimensions for proper heat dissipation and also access to the cables. Alternatively, cable trays may be of steel sheet with adequate structural strength and rigidity, with necessary ventilation holes therein. In both the cases, necessary supports and suspenders shall be provided by the Air-conditioning Contractor as required.

2.4 Cable laying work shall be carried out in accordance with IS 1255/1967, Indian standard code of practice. The scope of work for the Air-conditioning Contractor shall include making trenches in ground and refilling as required, but excludes any masonry trenches for the cable work.

### **3.0 CONTROL WIRING**

3.1 Control wiring in the plant rooms and AHU rooms shall be done using control wire as per IS 1554 PVC insulated and PVC sheathed, 2.5 sq.mm copper conductor, 1100 V grade, cables drawn in ISI marked steel or PVC conduits. The control cables interconnecting the plant room and the AHU rooms shall be of multi-core armoured type only, and suitable for laying direct in ground.

3.2 The number and size of the control cables shall be such as to suit the control system design adopted by the Air-conditioning Contractor.

3.3 ISI marked steel conduit pipes, wherever used, shall be of gauge not less than 1.6 mm thick for conduits upto 32 mm dia and not less than 2.0 mm thick for higher sizes. All conduit accessories shall be threaded type with substantial wall thickness.

3.4 Control cables shall be of adequate cross section to restrict the voltage drop.

3.5 Runs of control wires within the switchboard shall be neatly bunched and suitably

supported/clamped. Means shall be provided for easy identification of the control wires.

3.6 Control wiring shall correspond to the circuitry/sequence of operations and interlocks approved by Engineer-in-Charge.

3.7 In cold storage involving temperatures below zero deg. C, polythene cables shall be used instead of PVC cables.

#### 4.0 **Laying**

4.1 The cables shall be laid, as per drawings or along a short and convenient route between switch board and the equipment, either in trenches, on wall or on trays. Hangers, supported from the slab. Cable routing shall be checked on the site to avoid interference with structure, equipment etc. Where more than one cables are running close to each other, proper spacing should be provided between them

4.2 The radius of bends of the cable should not be less than 12 times the radius of cable to prevent undue stress and damage at the bends, the cables should be supported and fixed on M.S.supports,when running in trenches, wall or ceiling suspended hangers when laid under ground the cables should be covered with sand and protected with cement concrete covering. suitable G.I. pipe shall be used wherever cable is laid across road, crossing of other services and when passing through R.C.C.

4.3 Wooden bushes shall be provided at the ends of pipes through which cables are taken.

#### 5. **Earthing :**

##### 5.1 **Pipe Earth Electrode**

G.I. pipe shall be of medium class 40 mm dia 4.5 m.long in length. galvanising of the pipe shall conform to relevant is. G.I. pipe electrode shall be cut tapered at the bottom and provided with holes of 12 mm dia drilled not less than 7.5 cm from each other upto 2m of length from bottom. The electrode shall be buried in the ground vertically with its top not less than 20 cms below ground level.

##### 5.2 **Plate Earth Electrode**

For plate electrode minimum dimensions of the electrode shall be as under :

- i. G.I. plate electrode : 60cm x 60cm x 6mm thick.
- ii. Copper plate electrode : 60cm x 60cm x 3mm thick.

The electrode shall be buried in ground with its faces vertical and top not less than 3 m below ground level.

In case of plate earth electrode a watering pipe of 20 mm dia of medium class gi pipe shall be provided and attached to the electrode. A funnel with mesh shall be provided on top of this pipe for watering the earth. In case of pipe electrode a 40mm x 20mm reducer shall be used for fixing the funnel. The watering funnel attachment shall be housed in massonary enclosure of not less than

30cm x 30cm x 30cm. A cast iron/ms frame with cover having locking arrangement shall be suitable embedded in the masonry enclosure.

### 5.3 Loop Earthing

Loop earthing shall be providing for all mountings of main board and other metal clad switches and db's with G.I. strip of size specified but not less than 14 swg copper or 12 swg gi or 4 sq mm aluminium wire. The earthing lead from electrode owner's shall be suitably protected from mechanical injury by a 15 mm dia pipe in case of wire and 40 mm dia medium class G.I. pipe in case of strip. Metallic covers or supports of all medium pressure or ht apparatus or conductor shall in all cases be connected to not less than two separate and distinct earths.

5.3.1 All equipment connected with electric supply shall also be provided with double earthing continuity conductors. The size of G.I. earthing conductors shall be :-

Earthing should be carried out as per is-3043

Size of phase wire sq.mm aluminium tape/wire (swg)	Size of G.I. conductor aluminium tape/wire (swg)
185	25 mm x 4 mm (strip)
150	25 mm x 4 mm (strip)
120	20 mm x 3 mm (strip)
Size of phase wire sq.mm	Size of G.I. conductor aluminium tape/wire (swg)
95	20 mm x 3 mm (strip)
70	4 swg
50	4 swg
35	6 swg
25-6	6 swg
4	8 swg

### 6. Miscellaneous :

6.1 The final connections to the equipment shall be through flexible connections where the equipment is likely to be moved back and forth, such as on slide rails.

6.2 An isolator switch shall be provided at any motor which is separated from the main switch panel by a wall or partition or other barrier or is more than 15 metres away from the main panel.

6.3 Two separate and distinct earthing conduits shall be connected from the equipment upto the main switch board panel.

6.4 The entire installation shall be tested as per electricity rules and I.S. 732-1973/is-3043 with amendments 1,2&3 prior to the commissioning of the plant and a suitable test report furnished by competent local authorities. The test report will be obtained by contractor himself at his own expenses.

6.6 All exposed hangers etc. shall be given 2 coats of suitable paint of approved colour, when all work has been completed.

## **TESTS AT SITE**

### **1. General :**

The contractor must perform all inspection and tests of the system as a whole and of components individually as required, under the supervision of the architect, in accordance with the provisions of the applicable ASHRAE standards or approved equal and furnish necessary test certificates from manufacturers.

### **2. Performance Test**

- i) The installation as a whole shall be balanced and tested upon completion, and all relevant information shall be submitted to the architects.
- ii) Air Volume passing through each unit, grills, apertures.
- iii) Differential pressure readings across each filter, fan and coil and through each pimp.
- iv) Static Pressure in each air duct
- v) Electrical current readings, in amperes of full and average load running and starting, together with name plate current of each electrical motor.
- vi) Continuous recording over a period of ambient wet and dry bulb temperatures under varying degrees of internal heat loads and use and occupation in each zone of each part of the building
- vii) Daily records should be maintained of hourly reading taken under varying degrees of internal heat loads and use and occupation of wet and dry bulb temperatures upstream “on-coil” of each cooling coil. Also suction temperatures and pressures for each refrigerant unit. The current and voltage drawn by each machine.
- viii) Any other reading shall be taken which may subsequently be specified by the architect

### **3. Miscellaneous**

- i) The above tests are mentioned herein for general guidance and information only but not by way of limitation to the provision of conditions of contract and specifications
- ii) The date of commencement of all tests listed above shall be subjected to the approval of the architect, and in accordance with the requirements of this specification.
- iii) The contractor shall the skilled staff and necessary instruments and carry out any test of any kind on a piece of equipment, apparatus, part of systems or on a complete system if the architect requests such a test for determining specified or guaranteed data as given in the specification or on the drawings
- iv) Any damage resulting from the tests shall be repaired and or damaged material replaced , all the satisfaction of the contract

- v) In the repair or any adjustment having to be made, other than normal running adjustment, the tests shall be void and shall be recommended after the adjustment or repairs have been completed
- vi) The contractor must inform the architect when such tests are to be made, giving sufficient notice, in order that the architect or his nominated representative may be present
- vii) Complete records of all tests must be kept and 3 copies of these and location drawings must be furnished to the architect.
- viii) The contractor may be required to repeat the test as required, should the ambient conditions at the time not given, in the opinion of the architect, sufficient and suitable indication of the effect and performance of the installation as a whole or any part as required.

## **MODE OF MEASUREMENTS**

### **1. Unit Prices in the Schedule of Quantities :**

1.1 The item description in the schedule of quantities is in the form of a condensed resume. The unit price shall be held to include every thing necessary to complete the work covered by this item in accordance with the specifications and drawings. The sum total of all the individual item prices shall represent the total price of the installation ready to be handed over.

1.2 The unit price of the various items shall include the following :

1.2.1 All equipment, machinery, apparatus and materials required as well as the cost of any tests which the consultant may request in addition to the tests generally required to prove quality and performance of equipment.

1.2.2 All the labour required to supply and install the complete installation in accordance with the specifications.

1.2.3 Use of any tools, equipment, machinery, lifting tackle, scaffolding, ladders etc. Required by the contractor to carry out his work.

1.2.4 All the necessary measures to prevent the transmission of vibration.

1.2.5 The necessary material to isolate equipment foundations from the building structure, wherever necessary.

1.2.6 Storage and insurance of all equipment apparatus and materials.

1.3 The contractor's unit price shall include all equipment, apparatus, material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as well as all additional equipment, apparatus, material and labour usual and necessary to make in question on its own (and within the system as a whole) complete even though not specifically shown, described or otherwise referred to.

### **2. Measurements of Sheet Metal Ducts, Grilles/Diffusers etc.**

#### **2.1 Sheet Metal Ducts**

2.1.1 All duct measurements shall be taken as per actual outer duct surface area including bends, tees, reducers, collars, vanes & other fittings. Gaskets, nuts, bolts, vibration rotation pads are included in the basic duct items of the boq.

2.1.2 The unit of measurements shall be the finished sheet metal surface area in metres squares. No extra shall be allowed for lapse and wastages.

2.1.3 All the guide vanes, deflectors in duct elbows, branches, grille collars quadrant dampers etc. shall be measured for actual sheet metal surface and paid for at the same rate as duct of same thickness.

2.1.4 The unit duct price shall include all the duct hangers and supports, exposing of concrete reinforcement for supports and making good of the same as well as any materials and labour required to complete the duct frame.

## 2.2 Grilles/Diffusers

All grilles/diffusers as per tender requirements shall be treated as a lump sum item. Where extra grilles diffusers are ordered upto award of work, they should be measured as follows :

2.2.1 All measurements of grilles/diffusers shall be the actual neck size excluding the outer flanges.

2.2.2 The square or rectangular grilles/diffusers shall be measured in plain sq.m.

2.2.3 All round diffusers shall be measured by their diameters in cm.

2.2.4 All linear diffusers shall be measured as per actual length in metres.

## 3. Measurements of Piping, Fittings, Valves, Fabricated Items :

### 3.1 Pipe

Including water piping, steam piping and all other piping required to be executed at site for completion of the works.

3.1.1 All pipes shall be measured in linear metre (to the nearest cm) along the axis of the pipes and rates shall be inclusive of all fittings e.g. tees, bends, reducers, elbows etc. deduction shall be made for valves in the line.

3.1.2 Exposing reinforcement in wall and ceiling and floors of possible and making good the same or installing anchor fasteners and inclusive of all items as specified in specifications and schedule of quantities.

3.1.3 Rates quoted shall be inclusive of providing and fixing vibration pads and wooden pieces, wherever specified or required by the project co-ordinator.

3.1.4 Flexible connections, wherever required or specified shall be measured as part of straight length of same diameter, with no additional allowance being made for providing the same.

3.1.5 The length of the pipe for the purpose of payment will be taken through the centreline of the pipe and all fittings (e.g. tees, bends, reducers, elbows, etc.) as through the fittings are also presumed to be pipe lengths. Nothing extra whatsoever will be paid for over and above for the fittings for valves and flanges, section 3.2 below applies.

### 3.2 Valves and Flanges

3.2.1 All the extra ci & cm flanged valves shall be measured according to the nominal size in mm and shall be measured by number. Such valves shall not be counted as part of pipe length hence deduction in pipe length will be made wherever valves occur.

3.2.2 All gun metal (gate & globe) valves shall include two Nos. of flanges and two numbers 150 mm long ms nipples, with one side threaded matching one of the valves, and other welded to the M.S. slip-on-flange. Rate shall also include the necessary number of bolts, nuts and washers, 3 mm thick insertion gasket of required temp. grade and all items specified in the specifications.

3.2.3 The rates quoted shall be inclusive of making connections to the equipment, tanks, pumps etc. and the connection made with an installed pipe line shall be included in the rates as per the b.o.q.

### 3.3 **Structural Supports**

Structural supports including supports fabricated from pipe lengths for pipes shall be measured as part of pipe line and hence no separate payment will be made. Rates shall be inclusive of hoisting, cutting, jointing, welding, cutting of holes and chases in walls, slabs or floors, painting supports and other items as described in specifications, drawings and schedule of quantities or as required at site by project co-ordinator.

### 3.4 **Copper Connections for Fan Coil Units**

3.4.1 Copper connection assembly for making connections to the fan coil units shall be measured, as part of the fan coil unit price and shall include brass flare nuts, brass straight connector, brass tees, brass reducing fittings, fixing of automatic 3 way valve, making connections and leak testing, complete assembly as per specifications and drawings. Nothing extra shall be payable on account of any variation in the length of copper pipe.

## 4. **Insulation :**

4.1 The measurement for vessels, piping, and ducts shall be made over the bare uninsulated surface area of the metal.

### 4.2 **Pipes, Ducts & Vessels**

#### 4.2.1 **Pipes**

The measurements for installation of piping shall be made in linear metres through all valves, flanges, and fittings. Pipes/bends shall be measured along the centreline radius between tangent points. If the outer radius is  $r_1$  and the inner radius is  $r_2$  the centre line radius shall be measured as  $(r_1+r_2)/2$ . Measurement of all valves, flanges and fittings shall be measured with the running metre of pipe line as if they are also pipe lengths. Nothing extra over the above shall be payable for insulation over valves, flanges and fittings in pipe line/routings. Fittings that connect two or more different sizes of pipe shall be measured.

#### 4.2.2 **Ducts**

The measurements for insulation of ducts shall be made in actual square metres of bare uninsulated duct surface through all dampers, flanges and fittings. In case of bends the area shall be worked out by taking an average of inner and outer lengths of the bends. Measurements for the dampers, flanges, fittings shall be for the surface dimension for the connecting duct, nothing extra over the above shall be payable for insulation over dampers, flanges and fittings in duct routing.

#### 4.2.3 **Vessels**

The area of standard dished and flat ends of vessels shall be the square of the diameter of the uninsulated body of the shell. Areas for other shapes shall be the actual calculated area. There shall be no deduction or additions for nozzles, handles ribs, dampers, expansion joints etc. All projections on vessels or tanks shall be measured separately as pipe/duct.

#### 4.3 **Accessories Insulation**

4.3.1 The unit of measurement for accessories such as expansion tank, pumps, chiller heads etc. shall be uninsulated are in square metres.

4.3.2 In case of curved or irregular surfaces, measurements shall be taken along the curves.

4.3.3 The unit insulation price shall include all necessary adhesives, vapour proofing and finishing materials as well as additional labour and material required for fixing the insulation.

#### 4.4 **Acoustic Duct Lining**

4.4.1 In case of acoustic lining of air ducts, measurements of the bare inside duct surface in square metres, shall be final for billing purposes.

4.4.2 The insulation/acoustic panels shall include cost of battens, supports, adhesives, vapour proofing, finished tiles/boards/sheets as well as additional labour and materials required for completing the work.

## LIST OF APPROVED MAKES AND MANUFACTURERS

The subcontractors/makes/brands of equipment listed below are approved for installation.

All items to be used in the works samples, catalogues and specifications are to be submitted by the contractor for approval of the Engineer. Only approved makes shall be used in the works. The approved samples shall be kept in the custody of the Engineer for comparison.

ITEM	APPROVED MAKES/SUBCONTRACTORS
<b>Water chilling machines</b>	
Screw Type water chilling machine	Blue star/ Carrier/ Voltas/Kirlosker Mcquay/York/Trane
Electric Hot Water Generator/Boiler	Rapidcool /Emerald / Khokar
Outdoor unit:	Bluestar/carrier/Voltas/Kirloskar/Mcquay/York/Trane
<b>Airhandling Unit</b>	
Unitary type	Save-air India/Caryaire/Blue Star/Carrier-Aircon/ZECO
Ductable type	Save-air India/Caryaire/BlueStar/Carrier-Aircon/ZECO
Double skin type	Save-airIndia/Caryaire/BlueStar/Carrier-Aircon/ZECO
AHU cooling coils	Bluestar/voltas/carrier-aircon/Zeco/Coil co./Hitech/Caryaire
Indoor Unit	Save-airIndia/Caryaire/BlueStar/Carrier-Aircon/ZECO
Centrifugal fan of double skin type AHU.	Nicotra/Comefri/Flakt/Kruger/GEC
Cooling Towers	Advance/Bell/Paharpur/Mihir/Aadi
End suction back pull out pump	Kirloskar/Beacon-weir/Mather & Platt/KSB/Greaves
Fan Coil Units	Bluestar/voltas/carrier-aircon/Zeco/Coil co./Hitech

<b>ITEM</b>	<b>APPROVED MAKES</b>
Humidifier	Rapid cool/Emerald/Khokar
<b>Ventillation Fans</b>	
Centrifugal Blower	GEC/ Swent / Flakt/Nadi / Divine
Propeller Fan	GEC(Alsthom)/Crompton Greaves/ Khaitan/Usha
<b>Pipes</b>	
GI	ITC/ Jindal/Tata/SAIL/HSL
MS upto 150 mm dia	ITC/ Jindal/Tata/SAIL/HSL
MS 200 to 300 dia	ITC/ Jindal/Tata/SAIL/HSL
GI Sheets	TATA/SAIL/Jindal/Bhushan Steel
Aluminium Sheet	Balco/Nalco/Hindalco
Grilles/Diffusers	Dynacraft/Servex/Ravistar/Caryaire/Opella/ Mapro
Fire dampers ( Motorized)	Caryaire/Dynacraft / Ravistar
<b>Valves</b>	
Gate Valve	Leader/Divine/Sant/Bankim Sarkar
Butterfly Valves	Advance/C&R/Castle/Arrow/Audco/Intervolve
Balancing Valves	Advance/C&R/Castle/Arrow/Audco
Non-return Valves	Advance/C&R/Castle/Arrow/Kirloskar
Pot & Y- Strainer	Emerald/Sant/Rapid cool
Three way mixing valves Controls	Staefa/Johnson/Honeywell/Danfoss/Anergy/Rapid
Two way motorized valve	Audco/Staefa/Johnson/Honeywell/Danfoss
Actuating motor for 3 way & 2 way valve	Staefa/Johnson/Honeywell/Danfoss/Anergy/Rapid Controls

Ball Valve with & without strainer      Rapid Control/Sant/Leader

**Insulation**

Fibre glass      FGP Ltd./UP Twiga/Kimmco / owen corning

Expanded Polystrene      Beardsell Ltd./ BASF/Styrene Packing/  
Indian Packaging Industries/Lloyd

Air Filters      Thermadyne/Klenzaid/Kirloskar  
/Anfilco/Johnflower/Dynafilter

Thermometers/Pressure Gauge      Fiebig/Emerald/H Guru/Japsin

Thermostats/Humidistats      Honeywell/Penn /Staefa/Johnson/  
Rapidcontrol/Anergy

Electric Strip Heaters      Escorts/Daspass

Controls      Honeywel/ Johnson / Staefa .

Electric Panels      CPRI approved vendor

Electric Motors      Siemens/NGEF/Kirloskar/ABB/ Bharat Bijlee.  
/Crompton Greaves

Starters/Contactors      L&T/ GE Power/ Siemens/ Schneider

ACB/MCCB      L&T/ GE Power/ Siemens/ Schneider

Switch Fuse/ Fuse Switch  
Units      L&T/ GE Power/ Siemens/ Schneider/ Standard

**Cables**

PowerCables & Control cable      CCI/Universal/ICC/NICCO/INCAB/Ford  
Gloster/ National/Rallison Cables

Lamps & Push Buttons  
Relays      L&T/GE/ Siemens/ Schneider

Current Transformer/  
Ammeter/Voltmeter      L&T/GE/ Siemens/ Schneider

MINISTRY OF HEALTH & FAMILY WELFARE,  
GOVT. OF INDIA, NEW DELHI

**SAFDARJUNG HOSPITAL, New Delhi**

**BILL OF QUANTITY**

**FOR**

**Animal House Facility & other Miscellaneous work at VMMC,  
Safdarjung Hospital, and New Delhi.**

**VOLUME-IV**

**APRIL 2009**



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**Tender No. HSCC/BU-II/AH/2009**