

HSCC (INDIA) LIMITED
(A Subsidiary of NBCC (India) Limited)
(A GOVERNMENT OF INDIA ENTERPRISE)

Dated: 22.12.2023

AMENDMENT No.- I

Project Name: Tender for “Construction of 50 Bedded, 100 Bedded Critical Care Block (CCB) & DIPHL at various location in Jammu & Kashmir and their Maintenance during Defect Liability Period on Comprehensive Design, Engineering, Procurement and Construction (EPC) basis”

Tender No. HSCC/NHM/J&K/CCB/EPC/2023/20, dated 11.12.2023

This has reference to subject work, the following Amendment in the tender documents issued. The prospective bidders may be noted, which shall be treated as a part of the contract to be uploaded along with tender/ bid:

Sl. No.	Vol./ Cl.No. / Ref.	As per Tender / Existing provision	Amended / May be read as
1.	Volume - I (Notice Inviting e-Tender & Pre-Qualification) – Annexure – I (Memorandum) – page no. 11 - Sl. No. 14 - Deviation limit beyond which clause 6.2 & 6.3 shall apply for all works except foundation (CC/6.0) :	Not Applicable	Deleted
2.	Volume - I (Notice Inviting e-Tender & Pre-Qualification) – Annexure – I (Memorandum) – page no. 11 - Sl. No. 15 - Deviation limit beyond which clause 6.2 & 6.3 shall apply for foundation work (CC/6.0) :	Not Applicable	Deleted
3.	Volume - I (Notice Inviting e-Tender & Pre-Qualification) – Annexure – I (Memorandum) – page no. 11 - Sl. No. 16 – Escalations (CC/10.0) :	Not Applicable	No escalation shall be applicable on this contract for entire contract period as well as extended period for completion of the works if any.

Sl. No.	Vol./ Cl.No. / Ref.	As per Tender / Existing provision	Amended / May be read as
4.	Volume - I - (Notice Inviting e-Tender & Pre-Qualification) – Annexure – I (Memorandum) - – page no. 11 - Sl. No. 18) - Defect Liability Period (CC/38) :	24 months from the date of taking over the respective works by the Client.	12 months from the date of taking over the respective works by the Client.
5.	Volume - II - Instructions to Tenderer (ITT) & General Conditions of Contract (GCC) – Section -2 - Instructions to Tenderer (ITT) – Page No.-13, Clause No. 1.0 :	1.0 HSCC (India) Limited on behalf of Dean, Goa Medical College and Hospital, Government of Goa invites tenders on Comprehensive Design, Engineering, procurement & Construction (EPC) basis open e- tender from experienced and eligible contractors, for Construction of 50 Bedded, 100 Bedded Critical Care Block (CCB) & DIPHL at various location in Jammu & Kashmir and their Maintenance during Defect Liability Period on Comprehensive Design, Engineering, Procurement and Construction (EPC) basis.	1.0 HSCC (India) Limited on behalf of National Health Mission, Jammu & Kashmir (J&K) invites tenders on Comprehensive Design, Engineering, procurement & Construction (EPC) basis open e- tender from experienced and eligible contractors, for Construction of 50 Bedded, 100 Bedded Critical Care Block (CCB) & DIPHL at various location in Jammu & Kashmir and their Maintenance during Defect Liability Period on Comprehensive Design, Engineering, Procurement and Construction (EPC) basis.
6.	Volume - III – Specific Conditions of Contract (SCC), Page No. 2 - Clause No. 4. :	4. Maintenance during defect liability Period is included in the scope of bidder. The period of two (02) year for maintenance shall be started after handing over of project as a whole to the client	4. Maintenance during defect liability Period is included in the scope of bidder. The period of one (01) year for maintenance shall be started after completion and handing over of project of respective site to the client.
7.	Volume - III – Specific Conditions of Contract (SCC), Page No. – 4, Sl.No.(e) of 11.1. “Conditions of Contract - Clause 22 - Scope of works” :	(e). Any changes as per requirement of Client/HSCC will be done by agency with no any extra charge and time overrun	(e). Any changes as per requirement of Client/HSCC will be done by agency with no any extra charge and time overrun except as specified in clause no.15 of SCC (Vol.-III).
8.	Volume - III – Specific Conditions of Contract (SCC), Page No. – 9, Sl.No. i) of Cl.No.14. Clause-1.0 “Definitions”:	i) ‘Execution’ shall mean carrying out /cause to carry out every work by the contractor so as to fulfil his contractual obligation as per his Scope of Work commencing from the issue of Letter of Award including (but not limited to) Design, preparation of Drawings, Construction activities, approval processes etc. till completion/handling over of work also including Defects liability period & maintenance for two (02) years.	i) ‘Execution’ shall mean carrying out /cause to carry out every work by the contractor so as to fulfil his contractual obligation as per his Scope of Work commencing from the issue of Letter of Award including (but not limited to) Design, preparation of Drawings, Construction activities, approval processes etc. till completion/handling over of work also including Defects liability period & maintenance for one (01) year.

Sl. No.	Vol./ Cl.No. / Ref.	As per Tender / Existing provision	Amended / May be read as
9.	Volume - III – Specific Conditions of Contract (SCC), Page No. - 15, Sl.No. ii) of Cl.No.17. (A) Stage Payment Statement for Works” :	ii) The Contractor shall base its claim for interim payment for the work executed till the end of the month for which the payment is claimed, supported with necessary particulars and documents in accordance with this Agreement. The basis of payment on "Pro rata basis" shall be worked out on the percentage of work done of total scope of work under their activity/item for the respective Cost Centre/Stage payment schedule. The contractor shall not be entitled to be paid any such interim payment if the gross work done together with net payment/ adjustment of advances for material collected, if any, since the last such payment is less than (a) Rs.2 Crores for 1st three R/A Bills and (b) Rs. 5 crores for all intermediate bills (except the final Bill), in which case the interim bill shall be prepared on the appointed date of the month after the requisite progress is achieved.	ii) The Contractor shall base its claim for interim payment for the work executed till the end of the month for which the payment is claimed, supported with necessary particulars and documents in accordance with this Agreement. The basis of payment on "Pro rata basis" shall be worked out on the percentage of work done of total scope of work under their activity/item for the respective Cost Centre/Stage payment schedule. The contractor shall not be entitled to be paid any such interim payment if the gross work done together with net payment/ adjustment of advances for material collected, if any, since the last such payment is less than (a) Rs.2 Crores for 1st three R/A Bills and (b) Rs. 5 crores for all intermediate bills (except the final Bill), in which case the interim bill shall be prepared on the appointed date of the month after the requisite progress is achieved or as per decided by Engineer-in-charge (EIC).

10. Refer, Volume – V – Design Basis Report (DBR) : The earlier uploaded DBR of HVAC Works is now hereby amended & accordingly “Amended-HVAC work DBR” is attached with this amendment.

All other terms & Conditions of the Tender shall remain unchanged.

Prospective bidders are advised to regularly visit through HSCC e-tender portal <https://hsc.enivida.com> & HSCC website <http://www.hsccltd.co.in> as corrigendum/amendments etc. if any, will be notified on this portal only and no separate advertisement will be made for this.

(- Sd -)
Chief General Manager,
HSCC (India) Ltd.

AMENDED HVAC-DBR

for

**Construction of 50 Bedded Critical Care Block
(CCB) at various location in Jammu & Kashmir
on Comprehensive Design, Engineering,
Procurement and Construction (EPC) basis**

HVAC

CONTENTS

1	HVAC DBR.....	1
1.1	General.....	1
1.2	Design Standard.....	1
1.3	Scope of Work	1
1.3.1	Type of Air Conditioning System.....	2
1.3.2	HVAC Equipments & Materials.....	2
1.3.3	HVAC Design Principles.....	4
1.3.4	Special Consideration for Critical Areas	5
1.3.5	Indoor Air Quality	6
1.3.6	Refrigerant Piping Loop	7
1.3.7	Zoning of area.....	7
1.3.8	Drive for AC Equipments/Motors/Fans.....	7
1.3.9	Thermostat & Humidistat	7
1.3.10	Air Distribution.....	7
1.3.11	Air Cooled VRV / VRF System.....	8
1.3.12	Green Building Considerations.....	8
1.3.13	Energy Efficiency considerations	9
1.3.14	Fire safety considerations	9
1.3.15	Design and Layout Considerations	9
1.3.16	Painting & Identification of Services.....	10
1.3.17	Safe Custody and Storage	11
1.3.18	Training of Personnel.....	11
1.4	Basis of Design.....	11
1.4.1	Geographical Data	11
1.4.2	Outside Design Conditions	12
1.4.3	Inside Design Conditions.....	12
1.4.4	Other Design Parameters	12
1.4.5	Mechanical Ventilation.....	12
1.5	Design Engineering & Calculation	13
1.5.1	Tender Drawings.....	13
1.5.2	GFC Drawings, Shop Drawings & Technical Submittal	13
1.5.3	Completion Drawings (As Built Drawings)	15
1.5.4	Operation and Service Manuals	15
1.5.5	Technical Submittals.....	16
1.5.6	Samples and Prototypes	16
1.5.7	Inspection at Work / Contractor's Premises	16
1.6	Testing, Commissioning & Handing Over	16
1.6.1	Testing	16
1.6.2	HVAC System Balancing	17
1.6.3	Provisional Taking Over.....	17
1.6.4	Final Performance and Capacity Test.....	17
1.7	Performance Guarantee from Sub-contractor	18
1.8	Estimated Refrigeration Load.....	18
1.9	Design Parameters for HVAC Equipment.....	19

END OF CONTENTS

1 HVAC DBR

1.1 General

The HVAC DBR given below shall be read in conjunction with the Detailed HVAC Specification, List of Make & overall other contract documents forming part of the EPC contract. In case of any variance, HVAC requirements given here in DBR or stringent among those shall supersede any other requirements mentioned in any other parts of EPC contract document & the instructions / directions of engineer-in-charge will be binding on the contractor.

1.2 Design Standard

The following design standard shall be followed in HVAC:-

National Building Code 2016

CPWD HVAC Specification – 2017

NABH Standard

Green Building Rating System

Energy Conservation Building Code 2017

ASHRAE Standard 170-Ventilation of Health Care Facilities (As per latest revision)

ASHRAE 62.1- Indoor Air Quality

ASHRAE 52.2- Filter Selection & Efficiency

ASHRAE Handbooks latest

ASHRAE 90.1- Energy Standards for Building

SMACNA – Sheet Metal & Air-conditioning Contractors National Association – For Air Distribution

Latest BIS codes for Motors, Cabling, Wiring and accessories

National Electric Codes (NEC) latest version

1.3 Scope of Work

The scope of HVAC work shall include complete design engineering calculation and approval from statutory authority wherever required, approval from the Engineer-in-charge / architect / consultant, Supply, Installation, Testing, Commissioning, TAB (Testing, Adjusting, and Balancing) & handing over in satisfactory working

condition. Specifications & list of makes given in the tender shall be followed. The HVAC part of MEP design objective is to achieve a sustainable building that are energy and resource efficient and promote a healthier environment for building occupants & also to achieve required Green Building Certification. As per the Final Calculation of the contractor's design team and as approved by EPC Consultant & HSCC, final design and capacities may increase from as specified in Design Basis Report. Nothing Extra shall be payable on this ground.

The entire Design Basis Report, Specifications, List of Makes, Special Conditions of Contract etc. shall form Part of the Scope of Work.

Tender for this project shall have following buildings as under:-

- a) 50 Bedded Critical Care Block (CCB)

The detailed scope of HVAC work shall be as under:-

1.3.1 Type of Air Conditioning System

A) Buildings connected with DX AHUs with VRV/VRF system in dual mode (Heating & cooling)

- a) 50 Bedded Critical Care Block (CCB)- (Partially air-conditioned Building- ICU, Dialysis, Emergency, HDU, LDR, OT Complex & other Critical areas are air conditioned.)

- Smoke extraction system at all the floors as per NBC 2016 requirements
- Suitable RCC/Cement concrete foundation for the all the equipments shall also be done as per the manufacturer drawing.
- All the equipment shall be suitable for operation on 415+/-10% volts/3ph/50Hz AC power supply.

1.3.2 HVAC Equipments & Materials

The HVAC System shall comprise of following Equipments & Materials but not limited to & in compliance with detailed specification given in tender:-

- DX-AHUs /indoor VRV unit with VRV.
- The system shall be suitable for running at -15° C.
- Air Cooled VRV / VRF Air Conditioning
- All the Electrical work related to HVAC system shall be in accordance with Electrical DBR.
- Double skinned air handling units(AHU)-Direct expansion (DX) type with AHRI /Eurovent certified coils- Supply, installation, testing & commissioning of

DOUBLE SKIN, FLOOR MOUNTED, sectionalized construction, draw through type, THERMAL BREAK DESIGN air handling unit (AHU) as per the requirement. The air handling units shall consist of mixing box with return air & fresh air duct connection flanges. Fresh air port will have a volume control damper. Return & supply air duct connections will have fire retardant flexible connection and fire dampers. The air handling units shall be complete with mixing chamber, pre-filter section with synthetic fibre filters, coil section with multirows deep DX cooling / heating coil of copper tube & aluminium fin construction, strip duct heater of required capacity & humidifier with humidifier section, fan section complete. For CCB each AHU shall comprise of minimum 2 stage filtration system for all the areas and 3 stage filtration for Operation theatres etc is to be provided. The units shall be compatible with outdoor condensing units/VRV units. The unit shall be supplied with starter for motor, electronic expansion valve/s (Dx). Accordingly Pre-filter section with MERV-8 filters. (Synthetic Fiber Pre-filter) (90% down to 10 micron), Fine Filter section with MERV-14 filters.(99% down to 3 micron) and Hepa Filters with MERV-17 filters.(99.97% down to 0.3 micron) shall be provided. Wherever fine/hepa filters are required, item shall include factory fabricated double skin plenum of same specifications as AHU panels and complete with filter frameworks. Fine/hepa filter section along with discharge plenum shall be part of AHU. Cooling coil section with 6/8 Row deep (3+3 or 4+4) copper tubes & aluminum fins cooling coil. The AHU shall also consist of Fan section with AMCA certified low noise high efficiency DIDW Centrifugal fan, Backward Curved, direct/belt driven with fire retardant flexible connection at fan outlet. Each AHU shall have High efficiency 'IE3', continuous duty (S1), IP55 squirrel cage suitable induction motor and starter . AHUs shall be complete with V-Belt drive/direct drive package. Fan & motor shall be mounted on a common base frame with motor sliding rails & complete base frame mounted on the AHU casing with vibration isolator/spring isolators. Fresh air intake arrangement, necessary water drain & air purge valves wherever required etc. The unit shall be provided with water resistance marine light and limit switch with power cabling. Canvass connections, necessary foundations, 2 nos pressure gauges, 2 nos thermometers etc. Insulated SS 304 Drain pan, drain connection. The heaters shall be controlled by independent thermostats / humidistats / through electromagnetic type contractors and safety thermostats / geyser stats as specified complete with wiring for interconnections with 1.5 sq. mm. copper conductor multi core armoured cable. The oil tank shall be 2mm thick SS 304L, pipe 19 mm dia of SS 304 L.

- Toilet ventilation suction Grills, inline fans etc as required.
- Centrifugal / Axial / Propeller / Inline Fans for basement ventilation ,upper floors smoke extraction, toilet ventilation, Lift well/staircase well pressurization, Lift lobby/staircase lobby pressurization as per Fire guidelines of NBC 2016.
- All Electrical Motors min IE-3 efficiency ratings
- Motor Control Centre, Sub Panel, Power & Control Cabling, Earthing etc.as per IS standards

- Air Distribution – GSS Ducting, Aluminium Ducting for OT, Aluminium Construction Grilles Double / Single Louvers, Continuous Linear Grills, Square Diffusers, Slot Diffusers, Round Diffusers, Helical Diffusers, swirl diffusers, plaque diffusers, Ventilation Supply / Exhaust Air Valves, Air Volume Controllers etc.
- Motorized Fire & Smoke Dampers shall be CBRI approved (250deg, 2hrs).
- VRV/VRF Chilled/Hot & Drain Water Piping with insulation Valves & Fittings, HVAC system controls etc.
- Insulation / Lining – Duct Insulation & Duct Acoustic Lining.
- Supply, Installation & Commissioning of Air Conditioning & Mechanical Ventilation System.
- Testing- commissioning & Balancing of Water/ Refrigerant & Air System complete.

1.3.3 HVAC Design Principles

- Objective of HVAC System Design is to ensure proper thermal comfort & Indoor Air Quality as per design standards mentioned above along with Energy Efficiency, Flexibility of Operation and Cost Optimization & Green Building Rating Compliances.
- The ratings and capacities of various equipments are indicative and subject to up gradation/revision during detailed designing stage. However Central DX-Plants capacities of major equipment specified in the tender shall be minimum & any enhancement in the capacity of Central DX-system & other equipments if required shall be done as per the engineer in charge without any extra cost.
- Equipment sizing of HVAC system shall take into account factors such as geographical location, climatic conditions, water availability & quality etc.
- The cooling/heating requirements shall be achieved through efficient air-conditioning system having DX-AHUs (VRV/VRF System).
- The air conditioning system shall consist of VRV/VRF System with DX-AHUs, refrigerant pipe, expansion valve/kit , temperature & humidity controller, temp & RH sensor etc.
- Suitable size shafts, cutouts, Niche, openings etc. shall be provided to facilitate installation of Pipelines, Ducts etc. in all floor slabs of various buildings for various service areas, as required. All shafts, cutouts, niche, openings etc. provided on floor slabs shall be suitably closed after laying of services lines as per fire safety norms as per NBC 2016. Doors shall be provided for all shafts at all floors as per fire safety norms as per NBC 2016.

- All Services as required like, drainage, plumbing, HVAC provisions, ducting etc. shall be adequately provided by the EPC Contractor for all Medical Equipment, OT Rooms etc.
- Air Handling Units shall be floor mounted & shall be installed in AHU Rooms of sufficient size with service space all around. AHU shall be stacked one above other with vertical shaft in AHU Room. Insulated drain piping shall be separate from any other pipe and shall not be connected to toilet /sluice or any other building services.
- Fresh Air Supply & Smoke Extraction in case of fire from Passage / Fire Escape Route / ICU / NICU / Patient Ward / Waiting Area / Any high occupancy area or others shall be provided. Smoke extraction to be done by installing the fan at terrace level & preferably using internal/external shafts in the building. Fresh air supply shall be from shafts. Fresh air grills shall be provided at floor level in individual area and smoke extraction grills at ceiling level. System shall be as per NBC 2016. All the fans shall be 250 degree C and 2 hours fire rating.
- In VRV / VRF system the Outdoor Unit shall be air cooled, variable refrigerant flow / volume air conditioner and indoor units shall be combination of DX AHUs VRF ductable / FCU / Cassette type to suit the interior layout. The system shall cool in summer and heat in winter. The outdoor unit shall have all inverter multiple scroll compressors and shall be able to operate even in case of breakdown of one of compressor. The system shall be provided with a central controller, which will control and monitor all the units from one location. Treated ducted fresh air shall be provided to each indoor unit. Provision of user controls for temperature shall be made AHUs wise other than the central controller.

1.3.4 Special Consideration for Critical Areas

- Areas shall be designed on air recirculation and outside air intake system as per standards specified by ASHRAE, ISHRAE and NABH etc except areas as mentioned in ASHRAE 170 to be on 100% fresh air
- Operation theatres: ASHRAE codes to be followed.
- RH & temperature inside Operation theatres shall be controlled/ monitored with surgeon control panel.(By Specialised OT agency.)
- All critical areas (such as HDU, ICU, CCU, Pre-operation, Post-operation, Minor OT, NICU) shall be design as per ASHRAE 170.
- OT shall have terminal HEPA Filters. (By Specialised OT agency.)
- Compartmentalizing and Zoning of air conditioned areas in Hospitals to restrict air movement and prevent cross contamination.

- Ventilation Design and Air Filtration to dilute and remove contamination in the form of odor, airborne microorganisms and viruses, hazardous chemical and radioactive substance.
- High Efficiency Filtration system to prevent bacterial contamination whether it is from Outdoor Air or from re-circulated air within space as per ASHRAE.
- Two Stage Filtration comprising of Air Filtration System (Pre Filter- equivalent to MERV-08) and Fine Filters (equivalent to MERV 14) for Critical Areas as per ASHRAE.
- Aluminium ducting shall be used for supplying air to operation theatres to reduce the risk of bacterial formation in the air handling equipment and the ducts.
- For OTs, the Supply and Installation of HEPA Filters at Terminals, Laminar Flow Diffusers and inside supply / return OT Ducting shall lie within the scope of Modular OT vendor.

1.3.5 Indoor Air Quality

- Emphasis on maintaining desirable Indoor Air Quality by setting and controlling parameters of Temperature, Air Flow, Humidity Levels and Air Changes per Hour (Total & Fresh Air) for each room / zone of air conditioned area.
- Conformity of Indoor Quality parameters by providing single stage / two stage / three stage filtration with ISHRAE, ASHRAE and NABH Standards.
- Pre filters of MERV 8 rating shall be installed in all the AHU / FCU as detailed above.
- Fine filters of MERV 14 Rating shall be installed in the entire AHUs of CCU block as per ASHRAE Standard 170-Health Care Facilities.
- Hepa filters of MERV 17 Rating shall be installed with the selected AHUs as per ASHRAE Standard 170-Health Care Facilities. For OT Hepa filter shall be installed in OT Plenum by OT agency. AHU fan shall be selected with required static pressure accordingly.
- All AHU shall be provided with one set of commissioning Pre Filters which shall be replaced with actual pre filter after testing and commissioning. .
- For DX Indoor Unit Air Cooled VRV / VRF Unit or Air Cooled Hi CFM Packaged Unit or Air Cooled Precision Packaged Unit etc. shall have standard filter supplied by manufacturer.
- Filter frame shall be made of anodized aluminum.

1.3.6 Refrigerant Piping Loop

- Refrigerant Copper pipes (type L) with suitable Insulation and hard drawn copper tubes with suitable Insulation in case of VRV/VRF System.
- GI pipes (Class B) for drain pipe with suitable insulation for chilled water system.
- u-PVC Pipe for VRV/VRF/DX AHUs ,Split drain pipe to be provided with insulation.

1.3.7 Zoning of area

- Zoning of area depending upon the uses and working flow pattern & also as per ASHRAE Standard 170-Health Care Facilities shall be done for selection of DX type AHU & FCU. All AHUs shall be floor mounted type and FCU shall be ceiling suspended type.
- Outdoor AHU shall be with 50 mm thick panel and shall be with thermal break profile with canopy and roofing arrangement for protection from Sun , Rain & snow.
- For OT AHU/ 100% fresh air AHUs, cooling coil shall be (3+3 or 4+4) rows deep. Minor / Emergency OT all the Major OT shall be with 25% Fresh Air. AHU with Pre & Fine filter in AHU and HEPA in OT Plenum and for Exhaust Side Pre & Fine Filters.
- AHU stack shall be created one above other with AC shaft for running copper pipe & Drain pipe along with fresh air riser etc. Floor mounted AHU shall have raw fresh air provision from the external wall of AHU by installing fresh air grille / louvers with bird screen and damper.
- AHU Dehumidified/humidifier CFM shall not be less than ACPH mentioned in ASHRAE 170 for hospital area.

1.3.8 Drive for AC Equipments/Motors/fans

- AHU Fan / Fan Motor – Suitable capacity DOL/Star delta starter.

1.3.9 Thermostat & Humidistat

- In AHU Room, there shall be provision of digital programmable Thermostat and digital programmable Humidistat to set the desired temperature and relative humidity.

1.3.10 Air Distribution

- OT shall be supply and return both ducted with Aluminium Ducting. Supply shall be from the top with laminar flow plenum and return shall be taken from all the four corner of OT room. Return grille location shall be 300 mm / 450 mm from finish floor level. Ducting, damper, vanes etc all shall be of Aluminium. NO GI / MS shall be used through-out the supply and return path.
- CT scan etc. Air conditioning shall be done by Equipment supplier.
- Rest all ducting shall be of GSS / GI construction.
- All the other air conditioned space in CCU fed by AHU shall have ducted supply & ducted return except mentioned as above.
- Air distribution duct system shall have duct damper, splitter damper, collars / volume control dampers at terminals etc for control and balancing of designed CFM.
- CBRI approved Fire damper on the AHU rooms' walls at supply and return path of the air shall be installed.
- All Grilles double / single louvers, Continuous Linear Grills, Square Diffusers, , Ventilation Supply / Exhaust Air Valves, Air Volume Controllers etc. shall be in aluminium anodised construction in powder coated finish & type of grills / diffusers / nozzles / air valves / volume control dampers shall be selected as per interior design / Engineer in Charge / Consultant / Architect.

1.3.11 Air Cooled VRV / VRF System

- VRV / VRF System shall have all inverter compressors for variable speed of compressor for actual demand requirement.
- VRV / VRF System shall be dual mode type fan heating and cooling both.
- COP of VRV / VRF System shall be as per Green Building requirement (Min COP-3.50) at AHRI parameters at 100% load.

1.3.12 Green Building Considerations

- Minimize ozone -depleting substances:
- Employ 100% zero ODP (ozone depletion potential) refrigerant (CFC & HCFC free).
- HCFC and CFC free insulation in complete HVAC system.
- Acceptable outdoor and indoor noise levels.
- Indoor air quality.
- To optimize use of energy systems in buildings:
- Refrigerant used shall be eco-friendly and zero ODP refrigerant such as R-134a / R-410 A in compliance with green building ratings.

1.3.13 Energy Efficiency considerations

Following have been considered in the HVAC system:-

- Energy efficient VRV/VRF System
- Insulation of exposed roofs for reducing heat ingress.
- Airtight windows and doors for reducing leakage.
- Natural ventilation shall be as per National Building Code of India 2016.

1.3.14 Fire safety considerations

For fire safety, fire dampers shall be provided in supply and return air ducts which shall automatically shut off in case of detection of fire. Also the air conditioning system shall be electrically interlocked with the central fire alarm system of the building such that in case of detection of fire the complete air conditioning system shall stop automatically except very critical areas which will remain operational unless the smoke is detected in itself.

- All the materials used for ducting and insulation shall be fire retardant type and CFC and HCFC free.
- Combination smoke cum fire dampers will maintain the integrity of firewalls and also prevent the spread of smoke.
- AHU operation under fire conditions: - AHU's will be configured to operate in the following manner under fire conditions:
 - Supply and return fan off
 - Smoke extract fan on
 - Recirculation dampers closed
 - Exhaust dampers fully open
 - Fresh air dampers fully open
 - Each lift well and staircase shall be pressurised during fire condition with necessary ventilation as per the statutory requirement (NBC).

1.3.15 Design and Layout Considerations

- The Design and Layout Considerations for HVAC System in a Building must strictly conform to the provisions stated in NBC, ECBC and CPWD/PWD.
- The floor shall have suitable drain with grating.
- Adequate level of illumination must be ensured to enable smooth maintenance and repair procedure.

- **HVAC Shaft:-**
 - a) Sufficient number of shafts shall be provided so that piping length is optimized.
 - b) The HVAC Shaft must be adequately sized to enable smooth passage of pipes and ducts with insulation along with its supporting arrangement through it.
 - c) Inspection Doors must be provided in HVAC Shaft wherever necessary. The door must be Fire rated capable of withstanding 250 degree Celsius for a period of 2 hours.

- **AHU Rooms:-**
 - a) Air Handling Units shall be floor mounted & shall be installed in AHU Rooms of sufficient size with service space all around. AHU shall be stacked one above other with vertical shaft in AHU Room for running chilled / hot / drain water / fresh air duct etc.
 - b) AHU Room slab shall be structurally designed to take loads of various equipments.
 - c) The AHU Room Layout must be planned in such a manner so that it allows easy movement of personnel to conduct daily routine and maintenance procedures.
 - d) AHU foundation shall be proper. All measures shall be taken including providing vibration isolation pads etc. should be used to dampen noise generated at source itself.
 - e) Floor loading of approx. 800 kg/sqm shall be considered for AHU Rooms. AHU Room should have a fresh air opening, water connection & drain trap.

1.3.16 Painting & Identification of Services

Painting & identification of services shall be done as per details given in the NIT. All equipment and ancillary items such as pipes, supports etc., will be painted in an Approved manner, using standard primer & paints as approved by HSCC / Engineer-in-charge. The original colour of all equipments like water chilling machines, air-handling units, cooling towers & all other HVAC equipments which if get damaged during transportation or during installation shall be painted in original shade with the two coat of paint to give a final finish.

A wall mounted, glass covered plan to the endorsement of the Client / Consultant shall be provided and displayed in each plant room showing the plant layout with pipe work, valve diagram and valve schedule indicating size, service, duty, etc.

All AC equipments shall be provided with permanent mounted identification labels and unique tagging numbers. The shop drawings shall also include these tagging numbers for easy identification on site.

Pipe work and duct work shall be identified by colour bands 150 mm. wide or colour triangles of at least 150 mm. / side. The bands of triangles shall be applied at termination points, junctions, entries and exits of plant rooms, walls, in ceiling spaces, ducts and control points to readily identify the service, but spacing shall not exceed 8.0 meters.

Each valve shall be provided with a label indicating the service being controlled, together with a reference number corresponding with that shown on the Valve Charts and “ as fitted” drawings.

1.3.17 Safe Custody and Storage

The contractor shall be responsible for safe custody of all machinery and equipment supplied and installed till the final taking over by the CLIENT.

1.3.18 Training of Personnel

The Contractor shall arrange to train the CLIENT's/Equipment staff on the following aspects prior to provisional takeover of the plant:

- a) Operation of plant
- b) Gas charging and pumping down of the system
- c) Adjustments of settings for controls and protective devices
- d) Preventive maintenance
- e) Disassembling and assembling of compressor including identification and replacement.

1.4 Basis of Design

The HVAC system shall be designed, installed & commissioned on EPC contact basis to provide thermally controlled environment for the proposed area of the building. The HVAC systems shall be designed for automated round the clock year round operation to provide for the Inside environmental conditions.

Air conditioning system shall be designed as per following design parameters:-

1.4.1 Geographical Data

Site Location	As per various site locations
Latitude & Longitude	As per various site locations

1.4.2 Outside Design Conditions

Based on outdoor design data specified in India Weather Data 2017, ISHRAE, or as per local weather department report.

Climate Zone as per ECBC: Cold./ As per climatic Zone of India

1.4.3 Inside Design Conditions

VRV/VRF with DX units/Indoor units shall be provided to maintain the specified inside design conditions during summer, monsoon and winter for the proposed buildings.

Classification of various spaces in terms of temperature, humidity control, Occupancy, air filtration, air changes & pressurization requirements in various rooms / areas / department shall be As per NBC, ASHRAE & NABH design standard.

1.4.4 Other Design Parameters

Lighting Load – As per ECBC / NBC/As per actual.

Equipment Load – As Per Actuals

1.4.5 Mechanical Ventilation

- For Mechanical Ventilation designing, NBC 2016 (National Building Code of India) guidelines shall be followed.
- Lab shall be ventilated as per ASHRAE guidelines.
- ICU, Emergency Area, OT Area etc. i.e. where patients cannot move them self and area with high population density, will have Supply & Exhaust Axial fan for smoke ventilation purpose in case of fire and fan to be hooked with Fire Alarm Panel.
- All the escape route / passage / waiting / open space merging with corridor will have supply & exhaust air axial fans to operate in case of fire for smoke ventilation. Fresh air supply at floor level & smoke extraction at ceiling level will be provided.
- All the smoke extraction axial fans shall be fire rated as per NBC 2016 & Fire Department. Smoke extraction & zoning of areas must comply with approved fire plans from the fire department or their recommendations.
- Cabinet type acoustically insulated Inline fan shall be used for toilet ventilation of larger toilet area (Common/Public toilet).

- All fire mode fans shall be hooked with fire control panel for automatic run in case of fire as per NBC
- Pressurization of Lift Lobby, Lift Well, Staircase & Staircase Lobby shall be done as per latest NBC norms prevailing at the time of approval & execution to be followed.
- Dampers shall be installed at each exhaust air grill from toilet to ensure the required quantity of exhaust.
- Separate exhaust duct shall be provided for toilets, pantries, and dirty utility areas. These shall not be combined with each other or with any other exhaust ducts of AC System.
- Exhaust outlets shall be located at a minimum height of 3 m away from ground level and away from doors, occupied areas and operable windows.

1.5 Design Engineering & Calculation

All required detail calculations shall be done by the EPC Contractor's appointed team and it shall be submitted to EPC Consultant for approval before starting the execution of the project. Calculations shall be prepared by a qualified Engineer. Furnish following engineering calculations showing the design criteria, including, but not limited to, as asked by Client & Main Consultant:-

- a) Room wise heat load calculation for summer, monsoon & winter
- b) AHU & Vent Fan pressure drop calculation (One for each type of AHU & Vent Fan)
- c) Mechanical ventilation & smoke extraction calculation as per NBC.

1.5.1 Tender Drawings

The drawings issued with the tender documents are only for guidance of the tenderer. The actual & final AC GFC & Shop Drawings shall be prepared by the successful EPC Contractor after due co-ordination with other services & shall be approved by the Engineer-in-Charge / AC Consultant / Architect before commencement of site work. The tenderer has to ensure that their proposal will meet with all the current rules & regulations pertaining to the relevant local / national statutory & NBC 2016.

1.5.2 GFC Drawings, Shop Drawings & Technical Submittal

On the award of the work, the Contractor shall prepare & submit the detailed technical submittal of equipments & materials along with Services Space Planning Drawings indicating services rooms & cutouts along with shafts in architectural & structural drawings clearing defined with numberings, GFC drawings for approval of Engineer-in-Charge / AC Consultant / Architect. Based on GFC drawings contractor shall submit shop drawings for approval before commencement of HVAC execution work at site.

To achieve the desired parameters/requirements as specified in Design Basis Report/Technical Specifications/Tender Drawings etc., the Contractor shall prepare detailed Heat Load Sheets of all rooms/occupancies of Air conditioned areas, CFM sizing of Fans (ventilation/pressurization) & submit to Engineer-in-charge for approval.

Subsequent to approval of the scheme as above, the Contractor shall prepare and submit to the Engineer-in-charge for approval, requisite sets of detailed shop drawings/layouts of various rooms/floors, AHUs Room, External Layout.GA drawing of various equipment like VRV/VRF /AHUs /FCUs /Panels along with foundation & other relevant details etc., equipment characteristics and capacity details of all equipment, accessories and devices etc. as per specifications shall be submitted well in advance or as required for approval of Engineer-in-charge. The structure works should not be affected due to delay on this account. No claims for extension of time shall be entertained because of any delay in the work due to failure on part of the contractor to produce shop drawings in time.

If the Engineer-in-charge makes any amendment in the above drawings, the contractor shall supply requisite sets of fresh drawings with the amendments duly incorporated, along with the drawings on which corrections were made. After final approval has been obtained from the Engineer - in- Charge, the Contractor shall submit further requisite sets of shop drawings for the exclusive use of and retention by the Engineer-in-charge.

Approval of shop drawings shall not be considered as a guarantee of measurement or of building condition. It will in no way relieve the contractor from his responsibility of furnishing materials or performing work as required by the contract.

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

The EPC Contractor shall prepare the following shop drawings:-

- a) Equipment Layout along with sectional drawings of each installed equipment.
- b) Schematic piping layout, floor piping layout, pipe support details drawing showing the level of pipes.
- c) HVAC duct layout plans of all floors with sections, support details, position of controlling, insulation, lining item etc.
- d) HVAC equipments foundation layout plans and load data.
- e) The Electrical Panel, Sub Panel / Starter Panel, power & control wiring drawings & schedule.
- f) Electrical power requirements of all HVAC Equipments on Layout Plans along with Summary in Excel Format.
- g) Individual equipment drawings from equipment manufacturer along with technical data sheets for Engineer-in-Charge / Consultant's Approval.

- h) Any other shop drawings necessary for the project and required by client team such as Architects / Consultant.

1.5.3 Completion Drawings (As Built Drawings)

The EPC Contractor shall submit three sets (or as required by the engineer in charge) of paper prints of the as-built drawings & one soft copy, showing accurate record of the work as installed to the Client for his reference.

Following "AS BUILT" drawings shall be submitted by the Contractor on completion of the work:

- a) AHU Room installation drawings giving complete details of the entire equipment including , AHU's and their foundations.
- b) Ducting drawings showing all sizes, damper (Fire/VCD) locations and sizes of all air outlets and intakes, for all floors.
- c) Electrical drawings showing sizes, equipment capacities, control components and control wiring.
- d) Schematic control drawings giving detailed sequence of operation and notes to explain the operation of the control circuit.
- e) Piping drawings showing all pipe sizes, valves and fittings etc.
- f) Any other drawings to be supplied as per instructions of the Engineer-in- charge.

1.5.4 Operation and Service Manuals

The contractor shall also submit three copies (or as required by the engineer in charge) of an Operating Manuals in ring binder describing the brief write up on the system installed, operating instruction for all equipments, catalogues, maintenance of equipments etc.

The Contractor shall submit requisite sets of operation and service manuals in respect of the air-conditioning plant including salient details of plant including internal circuit diagrams. Following minimum details shall be furnished:

- i. Detailed equipment data as approved by the Engineer-in-charge.
- ii. Manufacturer's maintenance and operating instruction.
- iii. Approved test readings.

The Contractor shall also submit requisite sets of technical literature on all automatic controls and complete technical literature on all equipment and materials. The Contractor shall frame under glass, in the Air conditioning plant room all consolidated control diagrams and all piping diagrams.

Coloured Layouts of all electrical lines in A-1 size properly laminated to be fixed at various locations at the time of handing over of building.

1.5.5 Technical Submittals

The Contractor shall submit Technical Submittals for all materials, equipment and machinery for approval in writing of the Engineer-in-charge before placing orders. The material submittals shall comprise of at least the following:

- a) Manufacturer's technical catalogues and brochures, pump curves, Certifications etc. giving technical data about performance and other parameters.
- b) Manufacturers drawings / sketches showing construction, dimensional and installation details.
- c) Rating charts and performance curves clarifying rating of equipment proposed.

1.5.6 Samples and Prototypes

The Contractor shall submit samples of items such as grilles/ diffusers, controls and/ or any other parts or equipment as required by the Engineer-in-charge for prior approval in writing before placing the order. The Contractor shall also construct prototype or samples of work as laid down in the Contract or as instructed by the Engineer-in-charge.

1.5.7 Inspection at Work / Contractor's Premises

The CLIENT, HSCC, Consultant, Architect or their representatives shall at all reasonable time have free access to the Contractor's premises/works. The Contractor shall give every facility to them and necessary help for inspection and examinations and test of the materials and workmanship.

These representatives shall have full powers to inspect drawings of any portion of the work or examine the materials and workmanship of the plant at the contractor's works or at any other place from where the material or equipment is to be obtained. Acceptance of any material or equipment shall in no way, relieve the Contractor of his responsibility for meeting the requirement of the specifications.

1.6 Testing, Commissioning & Handing Over

1.6.1 Testing

Tests on equipment as called for in the specifications shall be carried out by the Contractor in accordance with the specifications, the relevant Bureau of Indian Standard Codes (BIS) and International Standards.

The Contractor shall pay for and arrange without any cost, all necessary balancing and testing equipment, instruments, materials, accessories, power, water, fuel and the requisite labor for testing. Any defects in materials and/or in workmanship detected in the course of testing shall be rectified by the Contractor entirely at his own cost, to the satisfaction of the Engineer-in-charge. The installation shall be tested again after removal of defects if any and shall be commissioned only after approval by the

Engineer-in-charge. All tests shall be carried out in the presence of the Engineer-in-charge or his representative.

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

On the completion of the installation, the EPC Contractor shall arrange to carry out various initial tests as detailed below:-,

- a) To operate and check proper functioning of all electrically operated components viz. Compressor motor, pumps, fan of air handling units etc. as well as other electrical motors.
- b) To test and check the proper functioning of electrical gears, safety and other controls to ensure their proper functioning.
- c) To check the air distribution system and to provide designed airflow in all areas by adjusting the grills, diffusers and dampers for air-conditioning.
- d) To check & balance / adjust the refrigerant / water in the circuit for smooth and noiseless flow.
- e) To check the systems against leaks in different circuits, alignment of motor, 'V' belt adjustments, control setting and all such other tests which are essential for smooth functioning of the plant.
- f) EPC Contractor shall have to submit the capacity test of all equipment at site.

1.6.2 HVAC System Balancing

The EPC contractor shall leave the system operating in complete balance with water/Refrigerant and air quantities as shown on approved drawings. Set stops on all balancing valves and lock all damper quadrants in proper position. Secure all automatic damper and valve linkage in proper positions to provide correct operating ranges. Proper damper positions shall be marked on ducts with permanent indication.

1.6.3 Provisional Taking Over

After completion of the HVAC system, the same shall be put to a continuous running test for a period of 72 (Seventy Two) hours. All adjustments should be made prior to this test so that proper conditions / working are achieved during this testing.

The Contractor shall pay for and arrange at his own cost for materials, accessories, power, water, fuel and the requisite labour for this testing the test readings shall be noted in the Testing format approved by the Engineer-in-charge.

The plant will be provisionally taken over after successful completion of the above test and the defects liability period shall commence after taking over of the system.

1.6.4 Final Performance and Capacity Test

In addition to the above testing, final performance and capacity tests shall be carried out on the equipment as per the "Testing Schedules" during the defects liability period as follows:-

- a) Peak summer / monsoon test on the dates decided by HSCC/ CLIENT. The installations should be able to maintain the specified inside temperature/conditions within the tolerance limits prescribed in the Contract and the duration of the test shall be 72 hours.
- b) Peak winter test during the period on the dates decided by HSCC/ CLIENT. The installations should be able to maintain the specified inside temperature within the tolerance limits permitted in the Contract. The duration of the test shall be 72 hours.
- c) All the arrangements required for making the entire system operational /running, for the performance test as above, including cost of manpower, and fuel (Gas etc.), electricity etc. will be borne by the Contractor.
- d) After provisional taking over of the plant, CLIENT shall provide staff for operation. Staff will work under the supervision of the Contractor for proper operation of the plant. This responsibility of the Contractor shall continue till completion of test liabilities with respect to the plant or the defect liability period whichever is later.
- e) The user shall have the right to operate all equipment, if these are in the operating condition if such equipment, have been accepted as complete and satisfactory. Repairs and alterations if required shall be carried out as and when directed by the CLIENT/HSCC. In special circumstances, CLIENT/ HSCC may request Air conditioning of some areas even before the completion of whole of HVAC work. The Contractor shall co-operate fully under such circumstances.

1.7 Performance Guarantee from Sub-contractor

The Contractor shall submit a performance guarantee certificate from the agency which executed the HVAC work, counter signed by the Contractor that the system shall maintain the desired parameters within tolerance limit of the specified parameters who shall also guarantee that the capacity of various components as well as the whole system covered under the scope of work, technical schedules and requirements etc., shall not be less than the specified capacities. The guarantee of the specific equipment supplied alone with regard to the performance of the system shall not be acceptable and overall responsibility of the Contractor for performance of HVAC work & its compliance with the Contract terms and conditions remains unchanged.

1.8 Estimated Refrigeration Load

Detailed heat load estimation sheet shall be prepared by EPC Contractor during detailed engineering stage for all the seasons (summer/ Monsoon/ winter) in which, the specified conditions are to be maintained based on above design parameters.

The rating and capacity of equipment indicated herein below for AC plant room are minimum to be provided. However, during detailed designing, if required and found necessary, the capacity /rating of the equipment will be increased by the contractor as per the design requirement within the contract:

S.N.	Proposed Central Plant Capacity	Working (W)
1	VRF/VRV system with AHUs (COP Min 3.5 & IPLV as per ECBC) Refrigerant R410a	Total 110 HP
2	AHUs of various Capacities	

1.9 Design Parameters for HVAC Equipment

A) Air-handlers

- a) Maximum Face velocity across cooling coil MPM : 152
- b) Maximum face velocity across filters MPM : 152
- c) Maximum Fan outlet velocity MPS : 8.5

B) Ducting Work

- a) Method of Duct Design : EFM
- b) Maximum air velocity in supply duct (AC) MPM : 450
- c) Maximum air velocity in return duct (AC) MPM : 400
- d) Friction loss in duct (Maxm.) MM Wg in 100 Mt run. : 8.33
- e) Maximum Velocity at supply air grill outlet (AC) MPM : 150.00

C) Axial Fan (Long Casing)

- a) Fan Outlet Velocity (Maxim) in Meter / Sec. : 12.0
- b) Drive For Axial Fan. : Direct
- c) Fan Motor RPM, Maxm : 1500

End of DBR

AMENDED HVAC - DBR

for

**Construction of 100 Bedded Critical Care Block
(CCB) at various location in Jammu & Kashmir
on Comprehensive Design, Engineering,
Procurement and Construction (EPC) basis**

HVAC

CONTENTS

1	HVAC DBR	1
1.1	General.....	1
1.2	Design Standard.....	1
1.3	Scope of Work	1
1.3.1	Type of Air Conditioning System.....	2
1.3.2	HVAC Equipments & Materials	2
1.3.3	HVAC Design Principles.....	4
1.3.4	Special Consideration for Critical Areas	6
1.3.5	Indoor Air Quality	6
1.3.6	Chilled / Hot Water Piping Loop.....	7
1.3.7	Zoning of area in Central Plant.....	7
1.3.8	Drive for AC Equipments/Motors/Fans.....	8
1.3.9	Thermostat & Humidistat	8
1.3.10	Air Distribution.....	8
1.3.11	Green Building Considerations.....	9
1.3.12	Energy Efficiency considerations	9
1.3.13	Fire safety considerations	9
1.3.14	Design and Layout Considerations	10
1.3.15	Painting & Identification of Services.....	11
1.3.16	Safe Custody and Storage	12
1.3.17	Training of Personnel.....	12
1.4	Basis of Design	12
1.4.1	Geographical Data	12
1.4.2	Outside Design Conditions	13
1.4.3	Inside Design Conditions.....	13
1.4.4	Other Design Parameters	13
1.4.5	Mechanical Ventilation.....	13
1.5	Design Engineering & Calculation	14
1.5.1	Tender Drawings.....	14
1.5.2	GFC Drawings, Shop Drawings & Technical Submittal	14
1.5.3	Completion Drawings (As Built Drawings)	16
1.5.4	Operation and Service Manuals	16
1.5.5	Technical Submittals.....	17
1.5.6	Samples and Prototypes	17
1.5.7	Inspection at Work / Contractor's Premises	17
1.6	Testing, Commissioning & Handing Over	17
1.6.1	Testing	17
1.6.2	HVAC System Balancing	18
1.6.3	Provisional Taking Over.....	19
1.6.4	Final Performance and Capacity Test.....	19
1.7.1	Performance Guarantee from Sub-contractor	19
1.8	Estimated Refrigeration Load.....	20
1.9	Design Parameters for HVAC Equipment.....	20

END OF CONTENTS

1 HVAC DBR

1.1 General

The HVAC DBR given below shall be read in conjunction with the Detailed HVAC Specification, List of Make & overall other contract documents forming part of the EPC contract. In case of any variance, HVAC requirements given here in DBR or stringent among those shall supersede any other requirements mentioned in any other parts of EPC contract document & the instructions / directions of engineer-in-charge will be binding on the contractor.

1.2 Design Standard

The following design standard shall be followed in HVAC:-

National Building Code 2016

CPWD HVAC Specification – 2017

NABH Standard

Green Building Rating System

Energy Conservation Building Code 2017

ASHRAE Standard 170-Ventilation of Health Care Facilities (As per latest revision)

ASHRAE 62.1- Indoor Air Quality

ASHRAE 52.2- Filter Selection & Efficiency

ASHRAE Handbooks latest

ASHRAE 90.1- Energy Standards for Building

SMACNA – Sheet Metal & Air-conditioning Contractors National Association – For Air Distribution

Latest BIS codes for Motors, Cabling, Wiring and accessories

National Electric Codes (NEC) latest version

1.3 Scope of Work

The scope of HVAC work shall include complete design engineering calculation and approval from statutory authority wherever required, approval from the Engineer-in-charge / architect / consultant, supply, installation, testing, commissioning, TAB (Testing, Adjusting, and Balancing) & handing over in satisfactory working

condition. Specifications & list of makes given in the tender shall be followed. The HVAC part of MEP design objective is to achieve a sustainable building that are energy and resource efficient and promote a healthier environment for building occupants & also to achieve required Green Building Certification. As per the Final Calculation of the contractor's design team and as approved by EPC Consultant & HSCC, final design and capacities may increase from as specified in Design Basis Report. Nothing Extra shall be payable on this ground.

The entire Design Basis Report, Specifications, List of Makes, Special Conditions of Contract etc. shall form Part of the Scope of Work.

Tender for this project shall have following buildings as under:-

- a) 100 Bedded Critical Care Block (CCB)

The detailed scope of HVAC work shall be as under:-

1.3.1 Type of Air Conditioning System

A) Buildings connected with common Centralized air to water Screw Heat Pump system.

- a) 100 Bedded Critical Care Block (CCB)-(Partially air-conditioned- ICU, Dialysis, Emergency, HDU, LDR, OT Complex & other Critical areas are air conditioned.)
 - Smoke extraction system at all the floors as per NBC 2016 requirements
 - Suitable RCC/Cement concrete foundation for the all the equipments shall also be done as per the manufacturer drawing.
 - All the equipment shall be suitable for operation on 415+/-10% volts/3ph/50Hz AC power supply.

1.3.2 HVAC Equipments & Materials

The HVAC System shall comprise of following Equipments & Materials but not limited to & in compliance with detailed specification given in tender:-

- Air to water Reversible Heat Pump system. The chilled water (30 % glycol + 70 % Water) inlet/outlet temperature shall be 44 deg F/54 deg F respectively with chilled water circulation rate at 2.4GPM/TR while hot water inlet/outlet temperature shall be 110 deg F/120 deg F respectively with hot water circulation rate at 0.7 GPM/KW. Reversible Heat Pump Should be Capable to Operate at Air Ambient Temp from -15 to 40 Deg C.
- All the electrical work related to HVAC system shall be in accordance with Electrical DBR.
- Water Circulation Pumping System shall consist of following types of pumps:

- i) ***Pumps System*** Split casing end suction back pull out /vertical inline with pump efficiency more than 75% having IP 55 TEFC induction motor with class F insulation, IE-3 efficiency class and variable load duty for continuous operation . Pumps shall include channel base with vibration isolators, coupling, coupling guard etc along with cladded insulation and anti corrosive coating inside and outside casing etc. of chilled/Hot water pump. Pumps must also consists of 1 No. dedicated microprocessor based pump logic to be provided with suitable starter DOL/Star delta
- Suitable Capacity pressurized expansion tank with dosing pumps & vacuum degasser for Chilled/Hot water circuits - Supply, installation, testing and commissioning of pressurized closed type Expansion tank with air separator and dosing pumps (1w+1s) for chilled water and hot water circuits. The expansion tank shall be complete with all necessary valves, vent connection. Suitable insulation and cladded with 24 gauge aluminum sheet. Tank shall be equipped with 15 mm dia vent, 450 mm dia manhole with cover, 40 mm dia make up with overflow connection (ball valve should be provided at the make up line), 50 mm dia drain and over flow with necessary valves and 50 mm dia insulated pipe connection to nearest chilled water return line.
 - Double skinned air handling units(AHU) with AHRI / Eurovent certified coils-Supply, installation, testing & commissioning of DOUBLE SKIN, FLOOR MOUNTED, sectionalized construction, draw through type, THERMAL BREAK DESIGN air handling unit (AHU) as per the requirement. The air handling units shall consists of mixing box with return air & fresh air duct connection flanges. Fresh air port will have a volume control damper. Return air duct connection will have fire retardant flexible connection and damper. Controls for AHUs comprising of a set of PN-16 rating 3 Way Mixing cum diverting valve of required size fitted with actuators having manual override facility on each AHU along with wiring for interconnections with 1.5 sq. mm Cu Conductor multicore armoured complete as required. The actuator shall have required shut off capability of minimum 4 bar rating. The valve actuator shall be capable of accepting 2-10 volt DC, 4-20 mA electric signal and shall provide similar transduced feedback output signal to control system. For Critical Care Block (CCB), each AHU shall comprise of minimum 2 stage filtration system for all the areas and 3 stage filtration for Operation theatres and ICUs etc is to be provided. Accordingly Pre-filter section with MERV-8 filters. (Synthetic Fiber Pre-filter) (90% down to 10 micron), Fine Filter section with MERV-14 filters.(99% down to 3 micron) and Hepa Filters with MERV-17 filters.(99.97% down to 0.3 micron) shall be provided. Wherever fine/hepa filters are required, item shall include factory fabricated double skin plenum of same specifications as AHU panels and complete with filter frameworks. Fine/ hepa filter section along with discharge plenum shall be part of AHU. Cooling coil section with 6/8 Row deep copper tubes & aluminum fins cooling coil. Minimum 2 bend GSS/PVC eliminators. The AHU shall also consists of Fan section with AMCA certified low noise high efficiency DIDW Centrifugal fan, Backward Curved, direct/belt driven with fire retardant flexible connection at fan outlet. Each AHU shall have High efficiency 'IE3', continuous duty (S1), IP55 squirrel cage induction motor suitable fan dia.

AHUs shall be complete with V-Belt drive/direct drive package. Fan & motor shall be mounted on a common base frame with motor sliding rails & complete base frame mounted on the AHU casing with vibration isolator/spring isolators. Necessary vibration isolators & supporting arrangement. Fresh air intake arrangement, necessary water drain & air purge valves wherever required etc. The unit shall be provided with water resistance marine light and limit switch with power cabling. Canvass connections, necessary foundations, 2 nos pressure gauge, 2 nos thermometer etc. Insulated SS 304 Drain pan, drain connection. All AHUs shall have humidifier section for winter humidification.

- Toilet ventilation suction Grills, inline fans etc as required for all common and public toilets.
- Axial Fans for ventilation of upper floors smoke extraction, Lift well & Lobby pressurization, as per Fire guidelines of NBC 2016.
- All Electrical Motors min IE-3 efficiency ratings
- Motor Control Centre, Sub Panel, Power & Control Cabling, Earthing etc.as per IS standards
- Air Distribution – GSS Ducting, Aluminium Ducting for OT, Aluminium Construction Grilles Double / Single Louvers, Continuous Linear Grills, Square Diffusers, Slot Diffusers, Round Diffusers, Helical Diffusers, swirl diffusers, plaque diffusers, Ventilation Supply / Exhaust Air Valves, Air Volume Controllers etc. GSS Ducting can be rectangular, circular.
- Motorized Fire & Smoke Dampers shall be CBRI approved (250deg, 2hrs).
- Chilled/Hot & Drain Water Piping with insulation Valves & Fittings, HVAC system controls etc.
- Insulation / Lining – Duct Insulation, Chilled / Hot / Drain Water Pipe & Fittings Insulation with aluminum cladding, Factory Insulated Valves in Chilled / Hot Water Pipes or Site Insulation with aluminum cladding etc.
- Supply, Installation & Commissioning of Air Conditioning & Mechanical Ventilation System.
- Testing- commissioning & Balancing of Water & Air System complete.

1.3.3 HVAC Design Principles

- Objective of HVAC System Design is to ensure proper thermal comfort & Indoor Air Quality as per design standards mentioned above along with Energy Efficiency, Flexibility of Operation, Cost Optimization and Green Building Rating Compliances.

- The ratings and capacities of various equipments are indicative and subject to up gradation/revision during detailed designing stage. However, Reversible Heat Pump system and capacities of major equipment specified in the tender shall be minimum & any enhancement in the capacity of Reversible Heat Pump system & other equipments if required shall be done as per the engineer in charge without any extra cost.
- Equipment sizing of HVAC system shall take into account factors such as geographical location, climatic conditions, water availability & quality etc.
- The cooling/heating requirements shall be achieved through efficient air-conditioning system having Heat Pump.
- The central air conditioning system shall consist of air to water screw type Reversible Heat Pump, chilled/hot water pumping system, Pressurized Expansion Tank, AHUs temperature /humidity control system I each AHUs & electrical panel.
- One number working & standby shall be considered for Reversible Heat Pump system.
- HVAC Plant Room shall be provided with safety equipments / items like suitable elastomeric mat (as per relevant IS codes), fire buckets, fire extinguishers, hand gloves, safety charts, framed Schematic / SLD etc.
- Suitable size shafts, cutouts, Niche, openings etc. shall be provided to facilitate installation of Pipelines, Ducts etc. in all floor slabs of various buildings for various service areas, as required. All shafts, cutouts, Niche, openings etc. provided on floor slabs shall be suitably closed after laying of services lines as per fire safety norms as per NBC 2016. Doors shall be provided for all shafts at all floors as per fire safety norms as per NBC 2016.
- All Services as required like, drainage, plumbing, HVAC provisions, ducting etc. shall be adequately provided by the EPC Contractor for all Medical Equipment, OT Rooms etc.
- Air Handling Units shall be floor mounted & shall be installed in AHU Rooms of sufficient size with service space all around. AHU shall be stacked one above other with vertical shaft in AHU Room for running chilled / hot / drain water / fresh air duct etc. Insulated drain piping shall be separate from any other pipe and shall not be connected to toilet /sluice or any other building services.
- Fresh Air Supply & Smoke Extraction in case of fire from Passage / Fire Escape Route / ICU / NICU / Patient Ward / Waiting Area / Any high occupancy area or others shall be provided. Smoke extraction to be done by installing the fan at terrace level & preferably using internal/external shafts in the building. Fresh air supply shall be from shafts. Fresh air grills shall be provided at floor level in

individual area & smoke extraction grills at ceiling level. System Shall be as per NBC2016. All the fans shall be AMCA certified and 250 degree C and 2 hours fire rating.

1.3.4 Special Consideration for Critical Areas

- Areas shall be designed on air recirculation and outside air intake system as per standards specified by ASHRAE, ISHRAE and NABH etc except areas as mentioned in ASHRAE 170 to be on 100% fresh air. One OT & ICU shall be 100% fresh air.
- Operation theatres: ASHRAE codes to be followed.
- RH & temperature inside Operation theatres shall be controlled/ monitored with surgeon control panel By specialised agency.
- All critical areas (such as HDU, ICU, CCU, Pre-operation, Post-operation, Minor OT except NICU) shall be design as per ASHRAE 170. The system shall be designed with local RH controller with strip heater & humidifier in AHU.
- OT shall have terminal HEPA Filters.
- Compartmentalizing and Zoning of Areas in Hospitals to restrict air movement and prevent cross contamination.
- Ventilation Design and Air Filtration to dilute and remove contamination in the form of odor, airborne microorganisms and viruses, hazardous chemical and radioactive substance.
- High Efficiency Filtration system to prevent bacterial contamination whether it is from Outdoor Air or from re-circulated air within space as per ASHRAE.
- Two Stage Filtration comprising of Air Filtration System (Pre Filter- equivalent to MERV-08) and Fine Filters (equivalent to MERV 14) for Critical Areas as per ASHRAE.
- Aluminium ducting shall be used for supplying air to operation theatres to reduce the risk of bacterial formation in the air handling equipment and the ducts.
- For OTs, the Supply and Installation of HEPA Filters at Terminals, Laminar Flow Diffusers and inside supply / return OT Ducting shall lie within the scope of Modular OT vendor.

1.3.5 Indoor Air Quality

- Emphasis on maintaining desirable Indoor Air Quality by setting and controlling parameters of Temperature, Air Flow, Humidity Levels and Air Changes per Hour (Total & Fresh Air) for each room / zone / area of air conditioned area.
- Conformity of Indoor Quality parameters by providing single stage / two stage / three stage filtration with ISHRAE, ASHRAE and NABH Standards.
- Pre filters of MERV 8 rating shall be installed in all the AHU as detailed above.
- Fine filters of MERV 14 Rating shall be installed in the entire AHUs of CCB and selected AHUs of other blocks as per ASHRAE Standard 170-Health Care Facilities.
- Hepa filters of MERV 17 Rating shall be installed with the selected AHUs as per ASHRAE Standard 170-Health Care Facilities. For OT Hepa filter shall be installed in OT Plenum by OT agency. AHU fan shall be selected with required static pressure accordingly.
- All AHU shall be provided with one set of commissioning Pre Filters which shall be replaced with actual pre filter after testing and commissioning. .
- Filter frame shall be made of anodized aluminum.

1.3.6 Chilled / Hot Water Piping Loop

- Primary pumping system will be installed in AC plant room.
- CCB building will have 2 pipe systems i.e. with cooling/heating and provision of local RH controller.
- Pressurised expansion tank and air separator will be considered in chilled water and hot water circuit in AC plant room.
- Chilled Water Circuit comprising of MS pipes (“C” Class heavy duty) with suitable Insulation in case of Centralized Chilled Water System.
- GI pipes (Class B) for drain pipe with suitable insulation for chilled water system.
- All the valves & fittings must be PN16 rated and suitable for Chilled Water and Hot Water applications. Insulation of valves shall be the same as that of pipe.

1.3.7 Zoning of area in Central Plant

- Zoning of area depending upon the uses and working flow pattern & also as per ASHRAE Standard 170-Health Care Facilities shall be done for selection of AHU. All AHUs shall be floor mounted type

- Outdoor AHU shall be with 50 mm thick panel and shall be with thermal break profile with canopy and roofing arrangement for protection from Sun & Rain.
- For OT AHU/ 100% fresh air AHUs, cooling coil shall be 6/8 rows deep (3+3 or 4+4). Minor / Emergency OT all the Major OT shall be with 25% Fresh Air. AHU with Pre & Fine filter in AHU and HEPA in OT Plenum and for Exhaust Side Pre & Fine Filters.
- AHU stack shall be created one above other with AC shaft for running CHW/ HW & Drain pipe along with fresh air riser etc. Floor mounted AHU shall have raw fresh air provision from the external wall of AHU by installing fresh air grille / louvers with bird screen and damper.
- AHU Dehumidified/humidified CFM shall not be less than ACPH mentioned in ASHRAE 170 for hospital area.

1.3.8 Drive for AC Equipments/Motors/Fans

- AHU Fan / Fan Motor – Suitable capacity DOL/Star delta starter.

1.3.9 Thermostat & Humidistat

- In AHU Room, there shall be provision of digital programmable Thermostat and digital programmable Humidistat, to set the desired temperature and relative humidity.

1.3.10 Air Distribution

- OT shall be supply and return both ducted with Aluminium Ducting. Supply shall be from the top with laminar flow plenum and return shall be taken from all the four corner of OT room. Return grille location shall be 300 mm / 450 mm from finish floor level. Ducting, damper, vanes etc all shall be of Aluminium.
- Air conditioning of equipment room of Diagnostic area shall be done by equipment supplier.
- Rest all ducting shall be of GSS / GI construction.
- All the other air conditioned space in Hospital fed by AHU shall have ducted supply & ducted return with GSS / GI construction Duct.
- Air distribution duct system shall have duct damper, splitter damper, collars / volume control dampers at terminals etc for control and balancing of designed CFM.

- CBRI approved Fire damper on the AHU rooms' walls at supply and return path of the air shall be installed.
- All Grilles double / single louvers, Continuous Linear Grills, Square Diffusers, Slot Diffusers, Round Diffusers, Helical Diffusers, Displacement Diffuser, Long Throw Jet Nozzles, Ventilation Supply / Exhaust Air Valves, Air Volume Controllers etc. shall be in aluminium anodised construction in powder coated finish & type of grills / diffusers / nozzles / air valves / volume control dampers shall be selected as per interior design / Engineer in Charge / Consultant / Architect.

1.3.11 Green Building Considerations

- Minimize ozone -depleting substances:
- Employ 100% zero ODP (ozone depletion potential) refrigerant (CFC & HCFC free).
- HCFC and CFC free insulation in complete HVAC system.
- Acceptable outdoor and indoor noise levels.
- Indoor air quality.
- To optimize use of energy systems in buildings:
- Refrigerant used shall be eco-friendly and zero ODP refrigerant such as R-134a / R-410 A in compliance with green building ratings.

1.3.12 Energy Efficiency considerations

Following have been considered in the HVAC system:-

- Energy efficient reversible Heat Pump system
- Airtight windows and doors for reducing leakage.
- All heating, ventilation and air conditioning equipments and system will comply with the mandatory provisions of ECBC-2017.
- Natural ventilation shall be considered as per National Building Code of India 2016.
- Minimum equipment efficiencies will meet or exceed the minimum efficiency requirements as per ECBC-2017 and ASHRAE-90.1.

1.3.13 Fire safety considerations

For fire safety, fire dampers shall be provided in supply and return air ducts which shall automatically shut off in case of detection of fire. Also the air conditioning system shall be electrically interlocked with the central fire alarm system of the building such that in case of detection of fire the complete air conditioning system shall stop automatically except very critical areas which will remain operational unless the smoke is detected in itself.

- All the materials used for ducting and insulation shall be fire retardant type and CFC and HCFC free.
- Combination smoke cum fire dampers will maintain the integrity of firewalls and also prevent the spread of smoke.
- AHU operation under fire conditions: - AHU's will be configured to operate in the following manner under fire conditions:
Supply and return fan off
Smoke extract fan on
Recirculation dampers closed
Exhaust dampers fully open
Fresh air dampers fully open
- Each lift well shall be pressurised during fire condition with necessary ventilation as per the statutory requirement (NBC).

1.3.14 Design and Layout Considerations

- The Design and Layout Considerations for HVAC System in a Building must strictly conform to the provisions stated in NBC, ECBC and CPWD/PWD.
- **Plant Room Layout :-**
 - a) Plant Room slab & its terrace shall be structurally designed to take loads of various equipments. Also, dimensions of plant room shall conform to CPWD norms & other relevant codes so as to have proper distance between Heat Pump /pumps/other equipment.
 - b) The HVAC Plant Room Layout must be planned in such a manner so that it enables easy movement of personnel to conduct daily routine and maintenance procedures. Additional space for circulation shall be considered as per relevant codes. Provision shall also be kept for anticipated future requirements. Minimum clear height of plant room (approx. 5 m) shall be maintained as per relevant codes. The entrance to A.C plant room shall be preferably through rolling shutters having minimum width as per relevant codes.
 - c) Proper spacing must be ensured between the foundations of Pumps, Chillers/ reversible Heat Pump system and other equipment to enable repairs and easy replacement of parts.
 - d) The Plant Room must be adequately ventilated with Fans maintaining optimum Air Flow and ACPH level. The design and sizing of Fan must be in conformity with the CPWD & NBC norms for the same.
 - e) Floor loading of approx. 2000 kg/sqm shall be considered for HVAC Plant Room. The Plant Room should have a fresh water connection & drain trap.
 - f) The floor shall have suitable drain with grating.

- g) Adequate level of illumination must be ensured to enable smooth maintenance and repair procedures.
- **HVAC Shaft:-**
 - a) Sufficient number of shafts shall be provided so that piping length is optimized.
 - b) The HVAC Shaft must be adequately sized to enable smooth passage of pipes and ducts with insulation along with its supporting arrangement through it.
 - c) Inspection Doors must be provided in HVAC Shaft wherever necessary. The door must be Fire rated capable of withstanding 250 degree Celsius for a period of 2 hours.
- **AHU Rooms:-**
 - a) Air Handling Units shall be floor mounted & shall be installed in AHU Rooms of sufficient size with service space all around. AHU shall be stacked one above other with vertical shaft in AHU Room for running chilled / hot / drain water / fresh air duct etc.
 - b) AHU Room slab shall be structurally designed to take loads of various equipments.
 - c) The AHU Room Layout must be planned in such a manner so that it allows easy movement of personnel to conduct daily routine and maintenance procedures.
 - d) AHU foundation shall be proper in conformance to relevant standards. All measures shall be taken including providing vibration isolation pads etc. should be used to dampen noise generated at source itself.
 - e) Floor loading of approx. 800 kg/sqm shall be considered for AHU Rooms. AHU Room should have a fresh air opening, water connection & drain trap.

1.3.15 Painting & Identification of Services

Painting & identification of services shall be done as per details given in the NIT. All equipment and ancillary items such as pipes, supports etc., will be painted in an Approved manner, using standard primer & paints as approved by HSCC / Engineer-in-charge. The original colour of all equipments like water chilling machines, air-handling units & all other HVAC equipments which if get damaged during transportation or during installation shall be painted in original shade with the two coat of paint to give a final finish.

A wall mounted, glass covered plan to the endorsement of the Client / Consultant shall be provided and displayed in each plant room showing the plant layout with pipe work, valve diagram and valve schedule indicating size, service, duty, etc.

All AC equipments shall be provided with permanent mounted identification labels and unique tagging numbers. The shop drawings shall also include these tagging numbers for easy identification on site.

Pipe work and duct work shall be identified by colour bands 150 mm. wide or colour triangles of at least 150 mm. / side. The bands of triangles shall be applied at termination points, junctions, entries and exits of plant rooms, walls, in ceiling spaces, ducts and control points to readily identify the service, but spacing shall not exceed 8.0 meters.

Each valve shall be provided with a label indicating the service being controlled, together with a reference number corresponding with that shown on the Valve Charts and “ as fitted” drawings.

1.3.16 Safe Custody and Storage

The contractor shall be responsible for safe custody of all machinery and equipment supplied and installed till the final taking over by the CLIENT.

1.3.17 Training of Personnel

The Contractor shall arrange to train the CLIENT's/Equipment staff on the following aspects prior to provisional takeover of the plant:

- a) Operation of plant
- b) Gas charging and pumping down of the system
- c) Adjustments of settings for controls and protective devices
- d) Preventive maintenance
- e) Disassembling and assembling of compressor including identification and replacement.

1.4 Basis of Design

A centralized HVAC system shall be designed, installed & commissioned on EPC contact basis to provide thermally controlled environment for the proposed complex. The HVAC systems shall be designed for automated round the clock year round operation to provide for the Inside environmental conditions as specified below.

Air conditioning system shall be designed as per following design parameters:-

1.4.1 Geographical Data

Site Location	Jammu & Kashmir (As mentioned in NIT)
Latitude & Longitude	As per actual site location
Altitude	As per actual site location

1.4.2 Outside Design Conditions

Based on outdoor design data specified in India Weather Data 2017, ISHRAE, or as per local weather department report.

Climate Zone as per ECBC: Cold/as per climatic Zone of India.

1.4.3 Inside Design Conditions

Centralized Heating, Ventilation & Air Conditioning system shall be provided to maintain the specified inside design conditions during summer, monsoon and winter for the proposed buildings.

Classification of various spaces in terms of temperature, humidity control, Occupancy, air filtration, air changes & pressurization requirements in various rooms / areas / department shall be As per NBC, ASHRAE & NABH design standard.

1.4.4 Other Design Parameters

Lighting Load – As per ECBC / NBC/As per actual

Equipment Load – As Per Actual

1.4.5 Mechanical Ventilation

- For Mechanical Ventilation designing, NBC 2016 (National Building Code of India) guidelines shall be followed.
- Lab shall be ventilated as per ASHRAE guidelines.
- ICU, Emergency Area, OT Area etc. i.e. where patients cannot move them self and area with high population density, will have Supply & Exhaust Axial fan for smoke ventilation purpose in case of fire and fan to be hooked with Fire Alarm Panel.
- All the escape route / passage / waiting / open space merging with corridor will have supply & exhaust air axial fans to operate in case of fire for smoke ventilation. Fresh air supply at floor level & smoke extraction at ceiling level will be provided.
- All the smoke extraction axial fans shall be fire rated as per NBC 2016 & Fire Department. Smoke extraction & zoning of areas must comply approved fire plans from the fire department or their recommendations.

- Box type acoustically insulated Inline fan shall be used for toilet ventilation of larger toilet area (Common/Public toilet).
- All fire mode fans shall be hooked with fire control panel for automatic run in case of fire as per NBC
- Pressurization of Lift Lobby, Lift Well, Lift shall be as per latest NBC norms prevailing at the time of approval & execution to be followed.
- Dampers shall be installed at each exhaust air grill from toilet to ensure the required quantity of exhaust.
- Separate exhaust duct shall be provided for toilets, pantries, and dirty utility areas. These shall not be combined with each other or with any other exhaust ducts of AC System.
- Exhaust outlets shall be located at a minimum height of 3 m away from ground level and away from doors, occupied areas and operable windows.

1.5 Design Engineering & Calculation

All required detail calculations shall be done by the EPC Contractor's appointed team and it shall be submitted to EPC Consultant for approval before starting the execution of the project. Calculations shall be prepared by a qualified Engineer. Furnish following engineering calculations showing the design criteria, including, but not limited to, as asked by Client & Main Consultant:-

- a) Room wise heat load calculation for summer, monsoon & winter
- b) Pump head calculation
- c) Pressurized Expansion Tank Capacity
- d) Pressurization calculation
- e) AHU & Vent Fan pressure drop calculation (One for each type of AHU & Vent Fan)

1.5.1 Tender Drawings

The drawings issued with the tender documents are only for guidance of the tenderer. The actual & final AC GFC & Shop Drawings shall be prepared by the successful EPC Contractor after due co-ordination with other services & shall be approved by the Engineer-in-Charge / AC Consultant / Architect before commencement of site work. The tenderer has to ensure that their proposal will meet with all the current rules & regulations pertaining to the relevant local / national statutory & NBC 2016.

1.5.2 GFC Drawings, Shop Drawings & Technical Submittal

On the award of the work, the Contractor shall prepare & submit the detailed technical submittal of equipments & materials along with Services Space Planning Drawings indicating services rooms & cutouts along with shafts in architectural &

structural drawings clearing defined with numberings, GFC drawings for approval of Engineer-in-Charge / AC Consultant / Architect. Based on GFC drawings contractor shall submit shop drawings for approval before commencement of HVAC execution work at site.

To achieve the desired parameters/requirements as specified in Design Basis Report/Technical Specifications/Tender Drawings etc., the Contractor shall prepare detailed Heat Load Sheets of all rooms/occupancies of Air conditioned areas, CFM sizing of Fans (ventilation/pressurization) & submit to Engineer-in-charge for approval.

Subsequent to approval of the scheme as above, the Contractor shall prepare and submit to the Engineer-in-charge for approval, requisite sets of detailed shop drawings/layouts of various rooms/floors, Plant Room, External Layout.GA drawing of various equipment like Chillers/pumps /AHUs /Panels along with foundation & other relevant details etc., equipment characteristics, pump curves and capacity details of all equipment, accessories and devices etc. as per specifications shall be submitted well in advance or as required for approval of Engineer-in-charge. The structure works should not be affected due to delay on this account. No claims for extension of time shall be entertained because of any delay in the work due to failure on part of the contractor to produce shop drawings in time.

If the Engineer-in-charge makes any amendment in the above drawings, the contractor shall supply requisite sets of fresh drawings with the amendments duly incorporated, along with the drawings on which corrections were made. After final approval has been obtained from the Engineer - in- Charge, the Contractor shall submit further requisite sets of shop drawings for the exclusive use of and retention by the Engineer-in-charge.

Approval of shop drawings shall not be considered as a guarantee of measurement or of building condition. It will in no way relieve the contractor from his responsibility of furnishing materials or performing work as required by the contract.

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

The EPC Contractor shall prepare the following shop drawings:-

- a) HVAC Plant Room Equipment Layout along with sectional drawings of each installed equipment.
- b) Schematic water piping layout, pipe support details drawing showing the level of pipes.
- c) HVAC layout plans of all floors with sections, support details, position of controlling, insulation, lining item etc.
- d) HVAC equipments foundation layout plans and load data.

- e) The Electrical Panel, Sub Panel / Starter Panel, power & control wiring drawings & schedule.
- f) Electrical power requirements of all HVAC Equipments on Layout Plans along with Summary in Excel Format.
- g) Individual equipment drawings from equipment manufacturer along with technical data sheets for Engineer-in-Charge / Consultant's Approval.
- i) Any other shop drawings necessary for the project and required by client team such as Architects / Consultant.

1.5.3 Completion Drawings (As Built Drawings)

The EPC Contractor shall submit three sets (or as required by the engineer in charge) of paper prints of the as-built drawings & one soft copy, showing accurate record of the work as installed to the Client for his reference.

Following "AS BUILT" drawings shall be submitted by the Contractor on completion of the work:

- a) Plant Room/ AHU Room installation drawings giving complete details of the entire equipment including Heat Pump, Pumps, AHU's and their foundations.
- b) Ducting drawings showing all sizes, damper (Fire/VCD) locations and sizes of all air outlets and intakes, for all floors.
- c) Electrical drawings showing sizes, equipment capacities, control components and control wiring.
- d) Schematic control drawings giving detailed sequence of operation and notes to explain the operation of the control circuit.
- e) Piping drawings showing all pipe sizes, valves and fittings etc.
- f) Any other drawings to be supplied as per instructions of the Engineer-in-charge.

1.5.4 Operation and Service Manuals

The contractor shall also submit three copies (or as required by the engineer in charge) of an Operating Manuals in ring binder describing the brief write up on the system installed, operating instruction for all equipments, catalogues, maintenance of equipments etc.

The Contractor shall submit requisite sets of operation and service manuals in respect of the air-conditioning plant including salient details of plant including internal circuit diagrams. Following minimum details shall be furnished:

- i. Detailed equipment data as approved by the Engineer-in-charge.
- ii. Manufacturer's maintenance and operating instruction.
- iii. Approved test readings.

The Contractor shall also submit requisite sets of technical literature on all automatic controls and complete technical literature on all equipment and materials. The Contractor shall frame under glass, in the Air conditioning plant room all consolidated control diagrams and all piping diagrams.

Colored Layouts of all electrical lines in A-1 size properly laminated to be fixed at various locations at the time of handing over of building.

1.5.5 Technical Submittals

The Contractor shall submit Technical Submittals for all materials, equipment and machinery for approval in writing of the Engineer-in-charge before placing orders. The material submittals shall comprise of at least the following:

- a) Manufacturer's technical catalogues and brochures, pump curves, Certifications etc. giving technical data about performance and other parameters.
- b) Manufacturers drawings / sketches showing construction, dimensional and installation details.
- c) Rating charts and performance curves clarifying rating of equipment proposed.

1.5.6 Samples and Prototypes

The Contractor shall submit samples of items such as grilles/ diffusers, controls and/ or any other parts or equipment as required by the Engineer-in-charge for prior approval in writing before placing the order. The Contractor shall also construct prototype or samples of work as laid down in the Contract or as instructed by the Engineer-in-charge.

1.5.7 Inspection at Work / Contractor's Premises

The CLIENT, HSCC, Consultant, Architect or their representatives shall at all reasonable time have free access to the Contractor's premises/works. The Contractor shall give every facility to them and necessary help for inspection and examinations and test of the materials and workmanship.

These representatives shall have full powers to inspect drawings of any portion of the work or examine the materials and workmanship of the plant at the contractor's works or at any other place from where the material or equipment is to be obtained. Acceptance of any material or equipment shall in no way, relieve the Contractor of his responsibility for meeting the requirement of the specifications.

1.6 Testing, Commissioning & Handing Over

1.6.1 Testing

Tests on equipment as called for in the specifications shall be carried out by the Contractor in accordance with the specifications, the relevant Bureau of Indian Standard Codes (BIS) and International Standards.

The Contractor shall pay for and arrange without any cost, all necessary balancing and testing equipment, instruments, materials, accessories, power, water, fuel and the requisite labour for testing. Any defects in materials and/or in workmanship detected in the course of testing shall be rectified by the Contractor entirely at his own cost, to the satisfaction of the Engineer-in-charge. The installation shall be tested again after removal of defects if any and shall be commissioned only after approval by the Engineer-in-charge. All tests shall be carried out in the presence of the Engineer-in-charge or his representative.

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

On the completion of the installation, the EPC Contractor shall arrange to carry out various initial tests as detailed below:-,

- a) To operate and check proper functioning of all electrically operated components viz. Compressor motor, pumps, fan of air handling units etc. as well as other electrical motors.
- b) To test and check the proper functioning of electrical gears, safety and other controls to ensure their proper functioning.
- c) To check the air distribution system and to provide designed airflow in all areas by adjusting the grills, diffusers and dampers for air-conditioning.
- d) To check & balance / adjust the refrigerant / water in the circuit for smooth and noiseless flow.
- e) To check the systems against leaks in different circuits, alignment of motor, 'V' belt adjustments, control setting and all such other tests which are essential for smooth functioning of the plant.
- f) EPC Contractor shall have to submit the capacity test of all equipment at site.

1.6.2 HVAC System Balancing

The EPC contractor shall leave the system operating in complete balance with water and air quantities as shown on approved drawings. Set stops on all balancing valves and lock all damper quadrants in proper position. Secure all automatic damper and valve linkage in proper positions to provide correct operating ranges. Proper damper positions shall be marked on ducts with permanent indication.

1.6.3 Provisional Taking Over

After completion of the HVAC system, the same shall be put to a continuous running test for a period of 72 (Seventy Two) hours. All adjustments should be made prior to this test so that proper conditions / working are achieved during this testing.

The Contractor shall pay for and arrange at his own cost for materials, accessories, power, water, fuel and the requisite labour for this testing the test readings shall be noted in the Testing format approved by the Engineer-in-charge.

The plant will be provisionally taken over after successful completion of the above test and the defects liability period shall commence after taking over of the system.

1.6.4 Final Performance and Capacity Test

In addition to the above testing, final performance and capacity tests shall be carried out on the equipment as per the "Testing Schedules" during the defects liability period as follows:-

- a) Peak summer / monsoon test during dates decided by HSCC/ CLIENT. The installations should be able to maintain the specified inside temperature/conditions within the tolerance limits prescribed in the Contract and the duration of the test shall be 72 hours.
- b) Peak winter test during the dates decided by HSCC/ CLIENT. The installations should be able to maintain the specified inside temperature within the tolerance limits permitted in the Contract. The duration of the test shall be 72 hours.
- c) All the arrangements required for making the entire system operational /running, for the performance test as above, including cost of manpower, and fuel (Gas etc.), electricity etc. will be borne by the Contractor.
- d) After provisional taking over of the plant, CLIENT shall provide staff for operation. Staff will work under the supervision of the Contractor for proper operation of the plant. This responsibility of the Contractor shall continue till completion of test liabilities with respect to the plant or the defect liability period whichever is later.
- e) The user shall have the right to operate all equipment, if these are in the operating condition if such equipment, have been accepted as complete and satisfactory. Repairs and alterations if required shall be carried out as and when directed by the CLIENT/HSCC. In special circumstances, CLIENT/ HSCC may request Air conditioning of some areas even before the completion of whole of HVAC work. The Contractor shall co-operate fully under such circumstances.

1.7 Performance Guarantee from Sub-contractor

The Contractor shall submit a performance guarantee certificate from the agency which executed the HVAC work, counter signed by the Contractor that the system

shall maintain the desired parameters within tolerance limit of the specified parameters who shall also guarantee that the capacity of various components as well as the whole system covered under the scope of work, technical schedules and requirements etc., shall not be less than the specified capacities. The guarantee of the specific equipment supplied alone with regard to the performance of the system shall not be acceptable and overall responsibility of the Contractor for performance of HVAC work & its compliance with the Contract terms and conditions remains unchanged.

1.8 Estimated Refrigeration Load

Detailed heat load estimation sheet shall be prepared by EPC Contractor during detailed engineering stage for all the seasons (summer/ Monsoon/ winter) in which, the specified conditions are to be maintained based on above design parameters.

The rating and capacity of equipment indicated herein below for AC plant room are minimum to be provided. However, during detailed designing, if required and found necessary, the capacity /rating of the equipment will be increased by the contractor as per the design requirement within the contract:

S.N.	Proposed Central Plant Capacity	Working + Standby (W+S)
1	Reversible Heat Pump capacity (COP & IPLV as per ECBC) Refrigerant R134a/ R410a Chilled water Inlet temp 6.6 deg C Chilled water Outlet temp 12.2 deg C Hot water Inlet temp 45deg C Hot water Outlet temp 50 deg C Fluid (30 % glycol + 70% water)	2 x 75 TR (250 KW) (2W)
2	Primary Pumping	(2W)

1.9 Design Parameters for HVAC Equipment

A) Air-handlers

- a) Maximum Face velocity across cooling coil MPM : 152
- b) Maximum face velocity across filters MPM : 152
- c) Maximum water pressure drop across the coil in Mt. : 4.6
- d) Maximum water velocity through coil in MPS : 2.5
- e) Maximum Fan outlet velocity MPS : 10.0

B) Ducting Work

- a) Method of Duct Design : EFM
- b) Maximum air velocity in supply duct (AC) MPM : 450
- c) Maximum air velocity in return duct (AC) MPM : 400
- d) Friction loss in duct (Maxm.) MM Wg in 100 Mt run. : 8.33
- e) Maximum Velocity at supply air grill outlet (AC) MPM : 150.00

C) Piping Work

- a) Friction loss (Maxm.) Mt / 100 Mt lengths : 5.0
- b) Flow velocity (Maxm.) Mt / Sec. : 2.50

D) Axial Fan (Long Casing)

- a) Fan Outlet Velocity (Maxim) in Meter / Sec. : 12.0
- b) Drive For Axial Fan. : Direct
- c) Fan Motor RPM, Maxm : 1500

End of DBR