



SETTING UP OF HADRON BEAM (PROTON THERAPY) & SUPPORT FACILITIES

FOR TATA MEMORIAL CENTRE AT KHARGHAR, NAVI MUMBAI

Request for Proposal – Volume IV

(Design Requirements and Specifications for buildings & services)

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INTRODUCTION

This Specification defines the service and accommodation outputs that HLL Lifecare Limited requires the Design and Build EPC Developer to provide in respect of the new facilities for Setting up of Hadron Beam (Proton Therapy) & Support Facilities for Tata Memorial Centre at Kharghar, Navi Mumbai. These are only indicative and the Design and Build EPC Developer shall be responsible for the functional suitability and adequacy of the design and specifications to ensure that on completion the facilities are fully functional. Detailed design and specifications along with the price bid are sought from Tenderers for implementation of the Project.

Project Objectives

The overall project objective is for the new development works involving the following. The scope of work shall be as mentioned in Volume I

- Setting up of Hadron Beam (Proton Therapy) Facility
- Construction of Support Facility

Required Outcome

- A design that will inspire all those who use it day to day and will make a positive statement to the community and which confirms to the environment and energy efficiency norms.
- Building design, fabric, materials, systems and services that are consistent with the current architectural style and quality of similar facilities from both the public and private sectors.
- Fittings and furnishings that provide a safe, comfortable and welcoming environment and encourage and enable all members of the community to use the facility.
- A design and use of materials consistent with the government's policies on environment, sustainability and the urban Design Brief.
- The facilities shall have clear signage giving name and directional details enabling visitors, service users, staff and the emergency services to easily locate the required destinations (internally and externally)
- Compliance with Environmental and Energy efficiency norms and obtaining at least 3 Star

GRIHA rating.

Specification Requirements

The Employer's requirements are shown in the following volumes of the RFP documents:

Volume I - Building requirements that sets out the spatial requirements and scope of work.

Volume III - Concept Plans that define the internal planning of the buildings along with

Annexure-I - IBD - detailed specifications and plans for Hadron therapy facility provided by IBA.

Volume IV - BUILDING AND SERVICES DESIGN SPECIFICATION.

This Volume (Volume IV) sets out the key outputs required for the building design and its Services under the following heads

- Civil & Architectural
- Structural
- Electrical
- Backup Power
- Lift
- Fire protection and alarm systems
- Basement ventilation
- HVAC
- Water Supply, Plumbing & Sanitary Installation
- External development works like Roads, Footpaths, landscaping including street lighting
- STP,ETP,WTP,RWH & Solar water heating system & solar power system
- External lighting and signages.
- Medical Gas Piping
- Communication & Data System
- The Proton Therapy Equipment Vendor's /Agency's Technical / Design report (Attached as ANNEXURE-I along with RFP Volume-IV)

For each of the headings, outcomes, scope and standards are set out.

Design

The Design Specification is intended to provide a clear understanding of the building design standards that the Employer wishes to be achieved. Whilst the employer is keen to see

innovation, it is conscious there are basic standards of design that must be achieved. EPC Developers shall outline the means by which they will ensure design quality and the design objectives, which have influenced their scheme. This shall include details of how the Employer's objectives are to be achieved. The design / building team of the EPC Developer shall constantly coordinate and work along with the Proton Therapy Equipment vendor (PTEV) / PTEV's team time to time to check the impact on structure / equipment due to any factors affecting the same.

General Standards

The new facilities shall be completed to high standards of construction and specification.

The facilities shall be technically and functionally suitable to meet the Employer's objectives:

- i. The Architectural finishes shall be of such good quality that will ensure better health, safety & hygienic conditions and aesthetic look and should be corresponding to IBD document provided by IBA (Annexure-I of Volume III)
- ii. The design of building shall ensure control of noise due to walking, movement of trolleys and banging of doors etc. by providing sound proofing materials where ever required.
- iii. The architectural design should take in to account the requirements of physically challenged persons.
- iv. All the material procured or to be used should be to the satisfaction of the Engineer before being used for the works intended to.
- v. All sanitary/ water supply fixture and fittings shall be of approved make confirming to IS Specifications.
- vi. There should be separate inlets for hot and cold water in all the buildings. The Buildings should have sufficient number of water coolers and filters to cater to the needs of different users.
- vii. The design should provide for underground, overhead water tank with necessary pumping arrangement for both portable and fire fighting requirements.
- viii. The deign should incorporate fire fighting system with electrical/hydrants, sprinklers, fire extinguishers and fire alarm system in accordance with the rules and regulations of the local

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fire authority ,Tariff Advisory Committee (TAC) of the Insurance Association of India, as amended up to date and the requirements of NBC 2005.

- ix. Lighting should confirm to NBC for Lighting. All electrical system, fixtures, fittings etc. should confirm to CPWD specifications, latest IS code, IBD document by IBA, etc.
- x. The planning should include landscaping and horticulture to increase the comfort conditions inside the building. The EPC Developer shall create parking, parking for handicapped persons, approach roads and other requirements for the building.
- xi. Provision should be made for internal and external signage's, display boards, public address system in the required area.
- xii. Furnishings in the room should be complete in all respects including, online data/information technology systems including permanent telephone & internet lines, power points etc.
- xiii. 100% power backup after factoring necessary redundancy to be provided
- xiv. Mechanical services shall be designed and installed with provisions to contain noise and the transmission of vibration generated by moving plant and equipment schedules to achieve acceptable noise and vibration with respect to human beings specified by ISO standards 13.140 and 13.160
- xv. All moving plant, machinery and apparatus be statically and dynamically balanced at manufactures work and certificate issued.
- xvi. All aspects of Bio Medical Waste (Management & Handling) Rules 1998 with Subsequent amendments, if any, issued by the Ministry of Environment and Forest, Government of India, latest AERB regulations should be addressed in the provision for waste Management.

Statutory, Industry and Local Standards

The following standards shall apply unless otherwise stated:

- The standards set out in National Building Code of India 2005
- The relevant Development Control Rules/Planning Act/Development Act/Municipal Act/any other applicable statutes and local by-laws

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- The National Electrical Code, 1985
- The Indian Electricity Act 2003
- Requirements of the local Municipal authority for water and sewer connection department, Electricity Supply Company/Department.
- Requirements of the Pollution Control Board, Environment clearances, AERB regulations, NOC from Fire department, Forest Department for tree cutting, Lift license, Explosive department, and Aviation authorities if applicable
- Any other statutory requirement for execution of work and to occupy the buildings and run the services in all respects.
- EPC Developer shall organise all inspections of concerned authorities & obtain the NOC's within the time for completion.
- All standards mentioned in the IBD document provided by IBA.
- The EPC Developer is required to submit the relevant drawings like completion Drawings and any other statutory documentary requirements of local bodies in copies as per requirement to obtain the above etc. at their own cost.
- the Bio Medical Waste (Management & Handling) Rules 1998

Unacceptable Materials and Processes

The materials and processes given below must not be used in the New Facilities or in connection with the New Facilities.

- High alumina cement in structural elements
- Calcium chloride as a concrete additive
- Sea dredged aggregates or aggregates for use in reinforced concrete
- Asbestos cement products; or asbestos in any other form including vermiculite containing asbestiform fibrous dust
- Lead or any products containing lead for use in connection with drinking water
- Materials which are generally composed of mineral fibres either man made or naturally occurring which have a diameter of 3 microns or less and a length of 200 microns or less or which contain any fibres not scaled or otherwise stabilized to ensure that fibre migration is prevented
- Urea formaldehyde forma and cellulose fibre
- Plastics for water storage and delivery that release toxic materials
- Materials containing vinyl chloride unless risk form carcinogen is shown to be negligible
- Vermiculite containing asbestiform fibrous dust
- Cellulose fibre

- Polyurethane foam or poly iso cyanurate foam unless the risk is shown to be negligible
- Plywood with glues, resins and surface treatments that produce irritant volatiles
- Decorative finishes containing lead or asbestos
- Materials containing chlorofluorocarbons (CFCs)
- Paints and wood preservatives containing pentachlorophenois (PCPs) tributyl tin oxide (TBTO) or Lindane
- Any treatment of materials either before or after installation which give rise to toxic or hazardous emissions or particles
- Other substances generally known at the time of use to be deleterious to health and safety or to the durability of the works in the particular circumstances they are used.

1.GENERAL SPECIFICATION

1.1 Reinforced Cement Concrete

- **All RCC work shall be governed by provisions of Section 3 of this document.**
- **The type, mix and control of RCC works in the Hadron Therapy area shall be as per the IBD document provided by IBA (Annexure I of Volume III) and shall also satisfy the norms of latest AERB regulations.**

1.2 Brick work(burnt clay)/Block work

- Bricks of minimum compressive strength of 50 kg/sq.cm shall be used
- 230mm/115mm thick Brick work in C.M 1:5/1:4.
- 230mm/115mm (200/100 mm) thick Solid concrete blocks work in C.M 1:5/1:4.

1.3 Plastering

- All internal walls to be plastered with 12mm thick C.M 1:5 with smooth finish.
- External walls to be plastered with 18mm thick, C.M 1:4 with smooth finish.
- Ceiling Surfaces to be plastered with 6mm thick C.M 1:3.

1.4 Painting

- All external surfaces are painted with two coats of superior grade external emulsion Paint over a coat of primer of approved make and colour.
- All internal surfaces are painted with two coats of superior grade acrylic emulsion over a coat of primer of approved make and colour. The surface preparation must be done properly and with cement based putty only.
- Ceiling surfaces shall be painted with Oil bound distemper in areas without false ceiling.
- All service areas / Rooms shall be painted with Oil bound distemper/enamel paint as Instructed by Engineer-in-charge.
- All internal surfaces (floors, ceiling and walls) of Hadron therapy facility shall be as per the IBD document provided by IBA

1.5 Flooring (Refer architectural material finishes.)

1.6 Skirting & Dado: (Refer architectural material finishes.)

- 100mm high skirting in all areas with respective floor finishes.
- All corridors and ward rooms of the support facilities shall have dado to a height of 1.50 meters with ceramic tiles.
- All toilet areas shall have 2100mm high Glazed ceramic tile Dado from FFL. All pantry, Lab, Dirty Utility, BPW, areas shall have dado 600mm high from counter top.
- Toilet flooring shall be anti skid ceramic tiles.
- Main staircase Treads and Risers shall be finished with Marble slabs in Hospital. Fire escape staircase shall be finished with Kota Stone.

1.7 DOORS & WINDOWS:

Aluminium windows & Wooden Doors shall be provided. The door frames shall be of secondary grade timber, kiln seasoned and chemically treated. Door shutters shall be of solid core flush shutters with water resistant best quality commercial ply. The windows shall be of anodized Aluminium section. Windows shall be side hung and could be with partial fixed panels.

Aluminium Joinery

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- Aluminium framed glazed door.
- Aluminium framed partly glazed and partly panelled with pre laminated particle board panels.
- Aluminium framed fully panelled door with pre laminated particle board panels.
- Aluminium framed glazed side hung windows with glass.
- Aluminium framed louvered ventilators with 4mm thk. ground glass.
- All prelaminated particle boards shall be of BWR grade.

Glazing shall be 4mm thick up to an area of 0.50 sqm and 5.5 mm for areas beyond. Maximum unsupported length of glass shall not exceed 120 cm

All doors / windows in the hadron therapy area shall be as specified in IBD provided by IBA (Annexure I of Volume III) and must satisfy all statutory regulations of AERB.

2.SPECIFICATION FOR ARCHITECTURAL FINISHES

SN	Location	Floor Finish	Wall Finish	Ceiling Finish
SUPPORT FACILITY & HADRON AREA				
1	Engineering Offices & Store (Service rooms, Electrical Rooms, store rooms, AHU etc)	Kota / unpolished ceramic tiles	Emulsion	White wash/Emulsion
2	Entrance lobby, staircase & lift lobby	Granite	Skirting of flooring material. Around lift opening dado of flooring material up to ceiling.	OBD

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3	Chief Physicist/Consulting Room	Vitrified tiles	Oil Bound Distemper (OBD)	False ceiling
4	Conference Room	Laminate Flooring	Perforated Panel boards	False ceiling
5	Admin/Directorate Room	Vitrified tiles	Emulsion Paint	False ceiling
6	Private/General/Relative Waiting	Vitrified tiles	Emulsion Paint	False ceiling
7	Equipment Area/UPS/Control Room/Computer room/ATM	Unglazed ceramic tiles	Emulsion Paint	False ceiling
8	Operation Theater /C.T. Simulator room/ Console room	Anti-static, self-smoothing PU-flooring	Polyurethane paint	GI Coil coated metallic ceiling / modular clean room Panels (Modular OT)
9	Offices	Vitrified tiles	Emulsion Paint	False ceiling
10	Doctors Room	Vitrified tiles	Emulsion Paint	False ceiling
11	General room	Vitrified Tiles	Oil Bound Distemper (OBD)	False ceiling
12	Corridors	Vitrified tiles (Scratch Resistant)	Ceramic tile dado up to 1.50 M height and	False ceiling
13	OPD	Vitrified tiles (Scratch Resistant)	Oil Bound Distemper (OBD)	False ceiling
14	Toilet block	Anti Skid Ceramic tiles	Ceramic tile dado up to lintel ht. &	OBD

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			Emulsion above	
15	Main Staircase (With SS Handrail)	Marble / Granite	Emulsion Paint	OBD
16	Emergency stairs (MS Handrail)	Kota stone	White wash	OBD
17	Portico	Interlocking Paver tiles		
18	HADRON THERAPY AREA	The entire structure shall be of thick concrete walls. All walls, ceiling and floors shall be of high grade epoxy paint finish as specified in IBD provided by IBA (Annexure I of Vol III)		
19	ROOMS inside HADRON THERAPY AREA	All floors, ceiling and walls shall be finished as specified in the IBD provided by IBA (Annexure I of Vol III)		
20	Exterior	Structural glazing / exterior emulsion as per approved design.		

3. STRUCTURAL SYSTEM

3.1 DESIGN PHILOSOPHY

- The proposed Project at Kharghar, Navi Mumbai consists of Setting up of Hadron Beam (Proton Therapy) Facility and Construction of Support Facility for Tata Memorial Centre.
- 3-D Analysis of all the building structures will be carried out using latest versions of modern software packages such as STAAD Pro and the results of the analysis shall be used for designing the various elements. All designs shall strictly conform to the standards specified in National Building Code 2005.
- The employer reserves the right to conduct third party design validation and the successful bidder shall provide all data and carry out all modifications that may be suggested by the third party so appointed. The proof checking will be done by HLL from IIT and if it is advised by IIT to do the redesign, the additional cost for proof checking if any for the revised design

has to be borne by the EPC developer.

- Past Geo Technical investigation indicates the proposed site is located on moderately weathered basalt. The intending bidders shall conduct soil investigations on their own, and shall be responsible for the adequacy of the design.
- Overhead tank for domestic and fire fighting purposes shall be located at terrace level.

A. Setting up of Hadron Beam (Proton Therapy) Facility and Construction of support facility for Tata Memorial Centre at Kharghar, Navi Mumbai.

- The Proposed building for Hadron Facility comprises of three levels, the highest level (or Upper level) includes Power supply room (PSR) and Water cooling room (WCR).
- The middle level (Treatment level) contains most of the PE (Such as cyclotron, the ESS/BTS, the Treatment rooms (TR), the Main control room (MCR), PTEV Server room and Treatment control rooms (TCR).
- Finally, the lowest level (or basement) consists of the cyclotron pit and pits where the gantry structures are supported.
- The building design must consider not only equipment to be supplied under the initial configuration, but also upgrades planned for the future.
- The proposed building for support facility includes two floors (~~4.5 meters~~) for facilitating the patients to accommodate the Hadron treatment.

B. MISCELLANEOUS STRUCTURES

- Air-conditioning Plant, Electrical Substations, STP, ETP, WTP and UG sump and Pump Room.

DESIGN LOADS

The design / building team of the EPC Developer shall work in consultation with the Proton Therapy Equipment vendor (PTEV) / PTEV's team for any special loads (loads due to equipments / crane / vibration / impact of the machinery etc) that needs to be considered during design of the foundation and structure.

3.1.1 Dead Load

The dead load shall be based on the building material, building parts/ components, materials as per IS: 875 (Part 1) – 1987. The load details as mentioned in IBD of IBA shall

also be considered.

3.1.2 Imposed Loads

The imposed loads that are envisaged to act permanently (wherever applicable) are as Follows:

Items	Intensity in KN/m ² of plan area
Weatherproof course ^{Note 1}	Depends on the thickness, slope and kind of material to be used for weatherproofing.
Partitions ^{Note 2}	1
False ceiling + M&E Services (including supporting system)	0.5
Floor Finish + Floor Screed	1.2
Screed in Sunken portion of toilets	2

- Note 1:** The loading due to weatherproof course consists of the following
- 150 average the Brick Bat Coba laid to the required slope

- b. 25 thick Bedding mortar
- c. Weight of pressed clay tiles.

Note 2: In toilet area the actual partition loads shall be calculated and maximum value considered partitions are not considered in lobby and AHU areas.

The superimposed load or otherwise live load shall be based the use & occupancy classifications as per IS: 875 (Part 2) – 1987.

Location	Occupancy Classification	UDL (kN/m ²)	*Concentrated Load (kN)
Hadron area & Support Facility area	a) Bed rooms, wards, dressing rooms, dormitories and lounges	2	1.8
	b) Kitchens, laundries and laboratories if applicable	3	4.5
	c) Dining rooms, cafeterias and restaurants	3	2.7
	d) Toilets and bathrooms	2	
	e) X-ray rooms, operating rooms, C.T Simulator / console room general storage areas -to be calculated but not less than	3	4.5
	f) Office rooms and OPD rooms/	2.5	2.7
	g) Corridors, passages, lobbies and staircases including fire escapes - as per the floor serviced but not less than	4	4.5
	h) Boiler rooms and plant rooms - to be calculated but not less than	5	4.5
	j) Balconies	Same as the rooms to which they give access but with a minimum of 4.0	1'5 per metre run concentrated at the outer edge

* The concentrated loads shall be considered to be applied in positions, which produce maximum stresses and where deflection is the main criteria.

3.1.2.1 Wind Loads: The wind pressure shall be calculated based on the data furnished below and other provisions laid in IS: 875 (Part 3) - 1987.

Basic wind speed	=	44 m/sec
Risk coefficient (k_1)	=	1.08 (Mean Probable Design Life of Structure 100 years for the Hadron & support facility)
Terrain Category	=	2
Structure class ^T _h	=	Class B for structures and/or their components such as cladding, glazing, roofing, etc., having maximum dimension (greatest horizontal or vertical dimension) between 20m and 50 m.
Topography Factor (k_3)	=	1.0

3.1.2.2 Earth quake Loads:

- Loading due to earthquake shall be assessed based on the provisions of IS: 1893-2002. Before the physical commencement of work; the structural design should be modified / checked as per the latest code. (Seismic zone, Seismic zone factor, importance factor, response modification factor shall be taken from the above mentioned latest code)
- Structural analysis shall be done using Response Spectrum Method by giving input for different Time Periods and Acceleration
- For the proposed building, Importance factor of 1.0 shall be considered.
- All other Structures, Importance factor of 1.0 may be considered

3.1.3 Load Combinations

The various loads shall be combined in accordance with the stipulations in IS: 875 (Part 5) - 1987. Whichever combination produces the most unfavorable effect in the building, foundation or structural member concerned shall be adopted.

- Wind load and earthquake load shall be considered for both x & y directions.
- The above load combinations shall be considered and effect of worst combinations shall be taken for design of various building elements.

- Whenever imposed load is combined with earthquake load the appropriate part of imposed load as specified in IS: 1893 – 2002 shall be used both for evaluating earthquake effect and for combined load effects used in such combination
- Safe Bearing Capacity will be suitably increased as per IS 1904-1986 for combination with WL and as per IS 1893 (Part 1) – 2002 for combination with EL

3.2 ANALYSIS METHODS

The analysis of the structure shall be carried out using the software package STAAD Pro-2006 or similar software. The static analysis of entire superstructure shall be carried out modeling them as 3 Dimensional space frames using stiffness method. The analysis shall be carried out for Dead Load (DL), Live Load (LL), Wind Load (WL) and Earth quake Load (EL) and their combinations as given in the table above.

Dead Load:

Self weight: This load case shall comprise of self weight of all the frame and shell elements modeled into the structure as well as self weight of slabs / walls applied as trapezoidal/triangular/uniform loads as applicable on the beams based on the yield line pattern.

Finishes: This case shall comprise of floor finishes, partitions, ceiling hung loads, waterproofing, brick jelly lime concrete and PCC in the toilet areas, machinery weights in the plant room.

Wall Load: All the external and internal walls shall be 230 or 115 mm thick solid brick walls respectively. RCC walls should be as per IBD document provided by Proton Therapy Equipment vendor (PTEV). The same shall be confirmed by the PTEV team during design scrutiny. Loads shall be calculated and applied at appropriate locations as uniformly distributed load on the beams / slabs. Parapet loads shall also be included.

Live Load: Live Loads in the floor areas shall be considered as per table in para 3.1.2 above.

Wind Load: Wind loads and pressures shall be calculated based on the static design wind pressure. This pressure shall be considered for the load analysis and applied to the model. Joint loads for all other floors shall be calculated based on the contributory areas and applied in the respective diaphragms.

Seismic Load: Response Spectrum Method shall be used to carry out dynamic analysis for earthquake forces in both the directions. Response Spectrum values are calculated based on the T vs Sa/g equations as per clause no 6.45 of IS 1893-2002. Base shears of the analysis are raised to a factor of (VB/VB) as per clause no 7.8.2. The effect of torsion has been taken into effect by giving the eccentricity overrides in tabs itself.

3.4 DESIGN METHODOLOGY

All R.C.C. structures shall be designed according to the Limit State Method as specified in IS: 456 - 2000.

3.5 MATERIALS

3.5.1 Concrete shall be used as indicated below and minimum cement content shall be as specified in IS: 456-2000

The Concrete Type and Mix to be used for radiation shielding for Hadron therapy facility shall be as per IBD provided by IBA and shall confirm to latest AERB regulations and shall be confirmed by IBA team during design scrutiny.

Maximum free Water-Cement Ratio of 0.5 for moderate condition as per Table 5 of IS: 456-2000.

3.5.2 Reinforcement

Steel reinforcement shall be of Grade Fe 500 conforming to IS: 1786-2008.

Ductile detailing of reinforcement shall be provided for all RCC structural components to take care of earthquake forces as per IS: 13920 - 1993

3.6 NOMINAL COVER TO REINFORCEMENT

3.6.1 Reinforcement

From Durability requirement, exposure condition is assumed as mild for both external and internal structural elements.

The Nominal cover to main reinforcement to meet Durability requirement shall be as

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follows:

Mild - 30 mm

The Nominal cover to main reinforcement shall be as follows:

Columns - 40 mm or dia of longitudinal reinforcement whichever is greater.
Footings - 50 mm (minimum)

For Two-hour fire resistance requirement, The Nominal cover to reinforcement shall be as follows:

Slab - 35 mm for simply supported

25 mm for continuous

Top cover shall be maintained at 20 mm.

Beams - 40 mm for simply supported

30mm for continuous

Columns - 40 mm or diameter of largest bar whichever is greater

For any other elements not specified above, clear cover shall be as per the clause 26.04 of IS: 456 - 2000.

3.7 DESIGN STANDARDS

The relevant Indian Standard Codes, as given below, but not limited to, shall be followed for structural design.

S.No.	Code	Description
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1	IS-875 (Part 1) - 1987	Code of Practice for Design Loads (other than earthquake) for buildings and structures - Unit weights of buildings and stored material.
2	IS-875 (Part 2) - 1987	Code of Practice for Design Loads (other than earthquake) for buildings and structures - Imposed loads.
3	IS-875 (Part 3) - 1987	Code of Practice for Design Loads (other than earthquake) for buildings and structures - Wind Loads.
4	IS-875 (Part 5) - 1987	Code of Practice for Design Loads (other than earthquake) for buildings and structures - Special loads and load combinations.
5	IS: 456 - 2000	Code of Practice for Plain and Reinforced Concrete.
6	IS: 1786 - 2008	Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement
7	IS: 2062 - 1999	Steel for General Structural Purposes. Specification.
8	IS: 1161 - 1998	Specification for Steel tubes for Structural Purposes.
9	IS: 800 - 1984	Code of Practice for General Construction in Steel.
10	IS: 1893 - 2002	Criteria for Earthquake resistant design of structures.
11	IS: 13820 - 1993	Code of Practice for Ductile Detailing of Reinforced Concrete structures subjected to Seismic Forces
12	IS: 4326 - 1993	Code of Practice for Earthquake Resistant Design and Construction of Buildings
13	IS: 3370 - 2008	Code of Practice for concrete structures for storage of liquids

4.ELECTRICAL SYSTEM

4.1 INTRODUCTION

The design requirements of Electrical systems and LV systems for the Construction of Hadron and Support facility at Tata Memorial Center are identified as briefly explained below. The bidder shall carry out detailed engineering design and provide systems capable of meeting the ultimate functional requirements.

The design and execution shall be carried out in conformity with the CPWD “General Specifications for Electrical Works” Part-I (Internal), Part-IV (Sub-Stations) and Part-VII (DG Sets) with the latest amendments. It is incumbent on the bidder to demonstrate that the system design is energy efficient and guidelines for energy conservation are adopted for the entire work.

The electrical system is to be designed on the basis of National Building Code (NBC) with due considerations to aspects of safety and reliability, and with no possibility of interruption in the function of essential services in the hospital areas. As the load will be of the order of 2500 KVA, a dedicated 33KV HT supply would be required. Which would be stepped down by Indoor type transformers.

4.2 ELECTRICAL SUPPLY SYSTEM

A tentative estimate of the total electrical load is indicated below. However, it is incumbent upon the EPC developer to make a more accurate assessment on the detailed design with due consideration to the future essential loads.

4.3 NORMAL LOAD REQUIREMENT

ELECTRICAL LOAD FOR HADRON & SUPPORT FACILITY				
Sl No.	Load Type	Quantity	Load	Remarks
			KW	
1	Normal Lighting		40	
2	Power load		70	

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3	Air conditioning load 1 KW/TR		250	
4	Lifts @ 8 KW	2	16	
5	CT Equipment		90	
6	MRI Equipment		90	
7	Proton Therapy Hadron Equipment		1330	From IBA specification
8	Exterior Lighting		5	
9	Plumbing / other loads		50	
10	Fire fighting load		40	
	Sub total		1981	
	Future loads @ 20%		396	
	Total connected / Maximum load		2377	
	Taking diversity 80 %(Demand load)		1902	
	Total Demand Load in kVA with 0.9 PF		2113	
	Transformer capacity in kVA with 85 % loading		2486	
	SAY		2500 kVA	

The system shall be designed considering a Diversity Factor of 80% and Power Factor of 0.9.

4.4 EMERGENCY LOAD REQUIREMENT

Full DG back up power is proposed for the building considering for Lifts, Equipment's & Air-conditioning including other critical areas.

- DG back up power is proposed for Lifts, Power circuits, Air-conditioning and lighting and other critical areas. On this basis, 1250 kVA 2 no's DG are required with AMF cum Load sharing panel.
- Silent type, water cooled, radiator type, four stroke, electric start D.G Set with acoustic enclosure and standard AMF control panel. The engine shall be capable of taking 10% overload for one hour after 12 hours of continuous operation. The DG shall be suitable for AMF operation. The alternator shall be brushless, self excited, self regulated, brushless, SPDP enclosure, class F/H insulation, suitable for continuous operation at 1500 rpm, generating 415 V +/- 5% at 0.8 p.f, 50Hz, 0.85 load factor, 3 phase, 4 wire system generally conforming to BS: 2613 & IS: 4722.

4.5 HT POWER DISTRIBUTION SYSTEM

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- The anticipated maximum demand for the entire project is 2500 kVA. The 33 KV HT power supply required for the project shall be obtained from the BRIHAN MUMBAI ELECTRIC SUPPLY AND TRANSPORT from their designated source and terminated with the help of RMU/EB Metering panel (Single VCB Panel) and from there to HT panels located at the substations.
- On this basis, 1250 kVA 2 no's Dry type Indoor Transformers are required. The transformer shall be as per IS 11171 & IS 2026.
- All the transformers shall be provided with OLTC with range of +10 to -10% @ 2.5% steps on HV side. The transformers shall be copper wound with AN cooling. The transformer shall be fitted with cable box on primary side and bus duct flange on secondary side.
- The above proposal is tentative. The developer may have to re-engineer the proposal considering the present and future requirements.

4.6 LT POWER DISTRIBUTION

The LT power distribution starts from the secondary of the transformers and shall be connected to LT switch gear panels through bus ducts / cables for further distribution to various loads centers in the Hadron complex through underground / tray cable network. Necessary power hook up and other requirements of IBA for the successful operation of Hadron facilities has to be provided as per IBD document provided by IBA (Annexure I of Volume III) and shall also satisfy the stipulations/ norms of latest AERB regulation.

4.7 POWER CAPACITORS

For power factor improvement suitable capacity of capacitors shall be introduced.

4.8 INTERNAL ELECTRIFICATION

LED light fitting is to be considered in all areas including general areas, office areas, etc. Incandescent and

From	To	Size of Cu wires	Size of Conduit
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special fittings are to be provided in special areas needing colour radiation properties.

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Lighting MCB DB	Lighting switch boxes in the circuit	2R-2.5 + 1R 2.5 sq mm (P, N & 2E)	20 mm dia
Lighting MCB DB	Light Points directly controlled by MCBs	3R-1.5 sq mm (P, N & 2E)	20 mm dia
Lighting switch box	Light points	3R-1.5 sq mm (P, N & 2E)	20 mm dia
Power / UPS MCB DB	20A / 16A sockets in the circuit	2R-4 + 1R-4 sq mm (P, N & 2E)	25 mm dia
Power / UPS MCB DB	6A sockets in the circuit	2R-2.5 + 1R-2.5 sq mm (P, N & 2E)	20 mm dia

Light and power outlets on emergency supply wherever required shall be on separate emergency circuit connected with battery backup (UPS) to the generator supply.

Convenient power socket outlets shall be provided as per the requirement of different facilities in respective areas. This should be connected to the normal power circuit.

Wiring installation conforming to CPWD/IS specifications would be carried out through medium gauge concealed PVC conduits. The wiring shall be done with FRLS PVC insulated copper conductor wires of suitable size as per IS 694.

Illumination level in different areas is proposed to be as per IS 3646 or NEC or ECBC including special illumination system for Hadron gantry. Special care will be taken in the design to avoid possibility of fire hazard due to electrical short circuiting. Lightning protection system as per IS 2309 shall be provided.

Internal wiring will be provided with PVC insulated FRLS Copper conductors. Surface conduit wiring with PVC conduits is proposed above the false ceiling and concealed conduit wiring with PVC conduits is proposed in wall / ceiling in non false ceiling areas. 5 star rated fans with fan hum free regulators are to provided.

Each computer point is proposed with 2 nos. 6A 3-pin UPS socket controlled by one no.10A switch in UPS power.

4.9 ELECTRICAL LOAD LIST

The anticipated electrical load is only tentative. It is the responsibility of the bidder to correctly estimate the electrical load.

	Transformer Neutral	-	50 mm x 6 mm Cu Flat	
	Transformer Body	-	50 mm x 6 mm GI Flat	
	DG Neutral	-	50 mm x 6 mm GI Flat	
	DG Body	-	50 mm x 6 mm GI Flat	
	LT Bus Duct	-	50 mm x 6 mm GI Flat	
	Main LT Panel/HVAC MAC	-	50 mm x 6 mm GI Flat	
	UPS	-	50 mm x 6 mm GI Flat	
	Floor UPS panels	-	25 mm x 6 mm Cu Flat	
	Lighting/Power/Power panels	-	25 mm c 6 mm Cu Flat	
	Lighting/Power/UPS MCBDB	-	6 / 10 sqmm Cu wire	4.10 EARTHING
Earthing	Lift/Plumbing/Fire Panel	-	25 mm x 6 mm GI Flat	system shall be in
	20A/16A power sockets	-	2.5 sqmm Cu wire	accordance with
	Light points/6A sockets	-	1.5 sqmm Cu wire	
IS 3043.	Motors < 5kW	-	8 SWG G.I. wire	
	Motors > 5kW	-	25 mm x 6 mm GI Flat	
	Lifts	-	8 SWG GI wire	

4.11 EXTERNAL LIGHTING

External lighting shall be provided along the approach road to the new facility with suitable LED fixtures On 6M height hot dipped galvanized octagonal poles (single/double arm). Building façade and canopy lighting also shall be provided. The external lighting shall be controlled automatically using Timer. The lighting design shall be as per NEC/ECBC to attain required illumination level.

4.12 EMERGENCY LIGHTING SYSTEM

Emergency lighting and Exit signage's shall be provided in common areas like corridors Lobbies, staircase etc. and using battery pack units. One third of luminaries in these areas will be online i.e. When grid power is available these luminaries will be ON with grid power and when the grid power is not available these luminaries will continue to be in operation with the help of battery packs, so that the entire building will not become dark.

4.13 LIGHTNING PROTECTION SYSTEM

Lightning protection system for the building shall be provided as per IS 2309.

5. EXTRA LOW VOLTAGE SYSTEMS

5.1 INTRODUCTION

The bidder shall carry out detailed engineering design and provide systems capable of meeting the ultimate functional requirements to the satisfaction of the client.

The bidder shall prepare quantity take off sheets, develop design drawings & riser diagrams, system description/function, prepare rate analysis for non-scheduled items based on offers from leading suppliers/vendors as per the approved list of makes, prepare bill of quantities and technical specifications of all items/equipment's proposed to be installed at the new building

Following systems may be included in the scope of work for this project:

1. Telephone system
2. Data system
3. CCTV system
4. Fire Alarm System

A. Telephone system

1. Standards and Codes

Following standards and codes are to be considered while designing the telephone system for the project.

BIS IEC 60364 -7 – 710 : Wiring in Hospital & Health care Premises
Published by National Electric Code 2011

IEC 60364 -5 -523 : Installation method of electrical
Conductors/cables

Sec 54, Electricity Act 2003 & R36 : Wiring in high rise buildings

IEC 732, IS 4648-1968(reaffirmed 1997) : Electrical wiring

2. Manufacturing standards

- Cables – Cat5e cable : ISO/IEC 11801
- PVC conduits : BIS CODE : 4985 – 2000, IS 9537 part-3, FRLS category
- Telephone sockets : BS 6305, 6312

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- Cable trays/trunking : IS 4759, 2629, 2633
- PVC Ducts : ASTM D1785 & D2665

3. Scope of work & Technical specification

The scope of work shall include supply, installation, testing & commissioning of the following:

- Telephone sockets
- Wiring using cat5e cable
- Cable containment system – conduits, cable trays etc.
- Patch panels & racks
- Cable entry for service provider's cable – Hume pipe/UPVC pipe, manholes etc.

4. Material specifications & installation method

Telephone wires to be used must be 4 pair Cat 5 UTP type

Telephone outlets must be provided generally in all areas except public waiting areas, lift lobby, toilets, Mechanical/Electrical rooms, clean/dirty utility and staircases.

Following criteria shall be adopted to finalize the quantity of outlets:

- Physician room/treatment room
/staff room/counselling area
/physicist/workshop/pantry/
Counselling room/console room - one outlet
Anaesthetist/security/clinical sec
/meeting room/coffee room
- Patient coordinator/nurse station/
Library/housekeeping - 2 outlets

Bill/cash/reception/Office/joint clinic/computer server/Library- Depends on the no of work stations

Cat5 cable must be used for wiring from each telephone outlets to the patch panel. Patch panel of suitable size must be installed in a rack of suitable dimension. Rack must be placed in the service room of each floor.

GI back boxes of suitable size must be concealed in the block/RCC wall to accommodate telephone sockets.

25 mm dia rigid heavy gauge PVC conduit must be used to contain the Cat5 cable. PVC conduit must be either embedded in concrete or installed below RCC slab on surface as per site condition.

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When a bunch of PVC conduits are to be routed from different locations to the service room, suitable containment system of appropriate size must be installed above false ceiling.

Telephone sockets must be RJ45 type and back box must be from manufacturer of wiring accessories. Telephone socket must be modular type matching with other electrical wiring devices. Cable tags must be provided at both ends to identify the cable.

Cable tray/trunking must be of hot dipped galvanised perforated type and installed on wall or hanged from RCC slab using proper support system/ anchor fasteners at regular intervals. Cable laid in the tray shall be neatly dressed using heavy gauge cable tie at regular intervals.

5. Service cable entry

PVC duct/Hume pipe must be provided for service provider's cable entry from main telephone room to a manhole outside compound wall including sufficient no of manholes & draw wires for hassle free cable pulling.

B. Data system

1. Standards and Codes

Following standards and codes are to be considered while designing the data system for the project.

BIS IEC 60364 -7 – 710 : Wiring in Hospital & Health care Premises
Published by National Electric Code 2011

IEC 60364 -5 -523 : Installation method of electrical
Conductors/cables

Sec 54, Electricity Act 2003 & R36 : Wiring in high rise buildings

IEC 732, IS 4648-1968(reaffirmed 1997) : Electrical wiring

2. Manufacturing standards

- Cables : Cat 6 UTP cable – ISO/IEC 11801
- PVC conduits : BIS CODE : 4985 – 2000, IS 9537 part-3, FRLS category
- Data sockets : BS 6305, 6312
- Cable trays/trunking : IS 4759, 2629, 2633
- PVC Ducts : ASTM D1785 & D2665

3. Scope of work & Technical specification

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The scope of work shall include supply, installation, testing & commissioning of following:

- Data sockets
- Wiring using cat6 cable
- Cable containment system – conduits, cable trays etc.
- Patch panels & racks
- Cable entry for service provider's cable – Hume pipe/UPVC pipe, manholes etc.

4. Material specifications & installation method

4 pair unshielded twisted pair cable shall be used for data system wiring. Cat6 cable shall be Gig true 550Hz Solid Cable UTP of 23 AWG. The cat 6 cable must be drawn through 25 mm dia very heavy gauge PVC conduit from each data outlet to the nearest patch panel located in the service room of each floor. The maximum length of the cat6 cable must be limited to 80 meters in the conduit.

The cat 6 cable must comply with following standards:

- ANSI/TIA/EIA-568-C.2 –Category 6.
- UL® 444, Safety Vol.1, Sec 13.
- ISO/IEC 11801 Class E.
- ETL Verified.
- RoHS 2002/95/EC
- E196163-P
- EN71-3, EPA 3050
- PVC: CMR; CSA, CMG, FT4; Plenum: CMP, FT6

Following criteria shall be adopted to finalize the quantity of data outlets:

- Physician room/treatment room
/staff room/counselling area
/physicist/workshop/pantry/
Counselling room/console room - one outlet
Anaesthetist/security/clinical sec
/meeting room/coffee room

- Patient coordinator/nurse station/
Library/housekeeping - 2 outlets

Bill/cash/reception/Office/joint clinic/computer server/Library- Depends on the no of work stations

When a bunch of PVC conduits are to be routed to the service room, cable containment system of appropriate size must be installed above false ceiling.

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GI back boxes of suitable size must be concealed in the block/RCC wall to accommodate data sockets.

Data sockets must be RJ45 type and back box must be from manufacturer of wiring accessories. Data socket must be modular type matching with other electrical wiring devices. Cable tags must be provided at both ends to identify the cable.

Cat 6 cable must be terminated at patch panels kept in metal racks of lockable type located in service room. Patch panel and Ethernet switches must be interconnected using RJ45 jacks.

Cables from different floors to main server room may be laid on cable containment system (cable tray/cable trunking) which runs between floors & main server room.

Tray/Trunking shall be hot dipped galvanised perforated type and installed on wall or hanged from RCC slab using proper support system/ anchor fasteners at regular intervals. Cable laid in the tray shall be neatly dressed using heavy gauge cable tie at regular intervals.

Heavy gauge PVC ducts/Hume pipes of suitable size must be laid at specified depth in the excavated trench and Inspection chambers at regular intervals must be provided in this route. Draw wires/Plastic rope must be provided to achieve hassle free cable pulling.

C. CCTV system

1. Standards and Codes

Following standards and codes are to be considered while designing the CCTV system for the project.

BIS IEC 60364 -7 – 710 : Wiring in Hospital & Health care Premises
Published by National Electric Code 2011

IEC 60364 -5 -523 : Installation method of electrical
Conductors/cables

Sec 54, Electricity Act 2003 & R36 : Wiring in high rise buildings

IEC 732, IS 4648-1968(reaffirmed 1997) : Electrical wiring

2. Manufacturing standards

- Cables : Cat 6 UTP cable – ISO/IEC 11801
- PVC conduits : BIS CODE : 4985 – 2000, IS 9537 part-3, FRLS category
- Cable trays/trunking : IS 4759, 2629, 2633
- PVC Ducts : ASTM D1785 & D2665
- Camera/DVR/LED monitor : UL 60950-1, Emission EN 55022 class B
FCC part 15 Class B

3. Scope of work and Technical specification

The scope of work shall include supply, installation, testing & commissioning of following:

- Dome cameras in waiting area/corridors/entry & exit/ Lift & staircase lobbies
- PTZ cameras in Main entrance of the hospital/building periphery/parking areas

The proposed system shall be IP based type.

The purpose shall be surveillance of vehicular & human traffic within the premises.

Main components of CCTV system comprise of cameras, NVRs, LED Monitors, racks, cables and cable containment system etc.

Areas covered by the system are as follows:

- | | | |
|--|---|----------------------------------|
| • Entry & Exit | - | PTZ camera with night vision |
| • Main/Emergency entry of the building | - | PTZ camera with night vision |
| • Main/Emergency/General entry | - | IR Dome camera with night vision |
| • Lobby/Reception/Lift lobby/
Fire escape staircase | - | IR Dome camera with night vision |
| • Corridors/waiting area | - | IR Dome camera with night vision |

Above mentioned cameras shall be IP based type.

4. Material specifications & installation method

Wiring may be done using cat6 UTP cable

NVR shall have video compression technology, high resolution and high definition picture quality for simultaneous viewing, recording and playback facility, integrated software for web based applications for viewing in I phones, video management solution, Hard disk in NVR shall have storage facility for 30 days minimum without overwriting.

LED monitor shall have high resolution and high definition

NVRs and LED monitors shall be located in the main security room.

Cable from camera shall be drawn through 25 mm dia(minimum) heavy gauge PVC conduit either concealed in block wall or embedded in RCC slab.

If a bunch of conduits are to be taken to main security room, suitably sized GI cable tray must be employed above false ceiling.

Tray shall be hot dipped galvanised perforated type and installed on wall or hanged from RCC slab using proper support system/ anchor fasteners at regular intervals. Cable laid in the tray shall be neatly dressed using heavy gauge cable tie at regular intervals.

D. Fire alarm system

1. Standards and Codes

The system and its components must comply with following standards:

Underwriters Laboratories (UL listed) - manufacturing standards

BS 5839 - material specifications and installation guide

NBC - fire detection & alarm system installation

CPWD - wiring installation code

2. Scope of work and technical specifications

Apart from supply, installation, testing & commissioning of fire alarm system, bidder has to include for coordination with local fire authority for availing initial & final no objection certificate.

An addressable fire alarm system shall be proposed for hadron and common facility

The system shall comprises of the following:-

- Addressable fire alarm control panel. No of loops depends on the quantity of devices to be connected to the system
- Addressable detectors like smoke/heat/multi sensor, depends on the space to be served
- Addressable horn/strobe & manual call points
- Addressable control module for interfacing AHUs, Lifts or other mechanical equipment
- Addressable Monitoring module
- Addressable fault isolator module
- Addressable detectors above false ceiling shall be provided to sense fire above false ceiling
- Response indicators for detectors installed in locations which is not easily accessible
- Armoured fire retardant cable to be used for system wiring

System shall be selected based on the design criteria mentioned in the above mentioned standards. Detector spacing and its selection shall be determined based on the codes and standards mentioned above.

Material shall be selected by following the approved list of makes

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System shall be tested in the presence of consultant, client and representative from local fire authority.

6. FIRE FIGHTING SYSTEM

As per Maharashtra Govt Fire Policy/Rules

Various Uses of Buildings Group C:

Institutional - (Less than 15 meters)

SubDivisionC1-Hospitals, Sanatoria and Nursing Homes.		
(1) Less than 15 meters in height		
ii. Up to ground plus one storey with plot area greater than 1000 m² with beds		
Sl. No.	Types of Fire Protection Required (Active Measures)	Requirements
1.	Fire Extinguishers	Required
2.	Hose Reel Assembly	Required
3	Dry Riser	Not Required
4	Wet Riser	Not Required
5	Down Comer	Required
6	Yard Hydrant	Not Required
7	Automatic Sprinkler System	Not required. (Provided in the basement if the area exceeds 200
8	Manually operated fire alarm (MCP) Call points	Required
9	Automatic Detection and alarm System	Not Required
10	Water: (a) Terrace level tank	Required: 5000 L (10000 L if the basement area exceeds 200 sq.m)

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	(b) Underground Static water storage tank	Not Required
11.	Pump capacity	(a) 450LPM(900LPMifthebasementarea exceeds 200 sq.m)at the tank level with minimum pressure of 0.3N/mm ² (b) Pump near Underground Static storage tank not required

Note:

- The Firefighting system shall be in compliance with the Maharashtra fire and life safety 2007, in consultation with CIDCO fire department so as to obtain the initial and final NOC for the proposed building.
- Wherever the requirement are not specified in the Maharastra Govt. fire policy alternatively NBC 2005 shall be considered.

7.HVAC SYSTEM

1. SCOPE

The scope of work includes the following:

- a. Design, Supply, Installation, Testing & Commissioning of Air-conditioning Plant, Equipment's & Accessories required for air-conditioning the HBTF at ACTREC
- b. The entire building to be air-conditioned.
- c. Approximate capacity of the Chilling plant is 250TR .2 no's of 125 TR chiller with one stand by chiller of 125 TR shall be provided
- d. Toilets air to be exhausted out mechanically.

2. STANDARDS

The system design, equipment selection and material selection shall confirm the local as well as the following codes and standards:

- AMCA – Air Movement and Control Association

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- ARI – Air conditioning and Refrigeration Institute
- ASHRAE – American Society of Heating, Refrigerating and Air-conditioning Engineers.
- BIS – Bureau of Indian Standards
- ISHRAE – Indian society of Heating, Refrigerating and Air-conditioning Engineers.
- NBC 2005 – National Building Code of India 2005
- SMACNA – Sheet Metal and Air-conditioning Contractors National Association.

3. AIR-CONDITIONING SYSTEMS

3.1 DESIGN CONDITIONS

The designed Indoor conditions are given in the following table.

INDOOR CONDITIONS			
Rooms	Temperature (°C)	Relative Humidity (%)	Equipment Power Dissipation (kw)
Cyclotron Vault Area	22 +/- 2.5	35-60	9
ESS Vault Area	22 +/- 2.5	35-60	2
BTS Vault Area	22 +/- 2.5	35-60	2
Gantry Pit	22 +/- 1.5	40-60	3
Treatment Area	22 +/- 1.5	40-60	2
Fixed Beam Treatment Room - Basement	22 +/- 2.5	40-60	3
Fixed Beam Treatment Room – Treatment Area	22 +/- 2.5	40-60	2
Power Supply Room	22 +/- 2.5	35-60	60
Water Cooling Room	22 +/- 2.5	40-60	5
Main Control Room	22 +/- 2.5	40-60	2
Treatment Control Room	22 +/- 2.5	40-60	2.5
Server Room	22 +/- 2.5	40-60	9
Storage Rooms	22 +/- 2.5	40-60
Maintenance Room	22 +/- 2.5	40-60

Other Rooms	22 +/- 2.5	40-60
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4. VENTILATION SYSTEMS

4.1 DESIGN CONDITIONS

The number of air changes per hour in the ventilated areas (toilet) is ASHRAE standards.

5. SYSTEM DESCRIPTIONS – CHILLER SYSTEM

It is proposed to provide common water cooled chilling plant for the hospital block with screw compressors. The tentative load is expected to be around 250 TR. However, the Bidder shall provide detailed load calculations and ensure that air-conditioning is provided for all functional requirements whether not mentioned in the employer's requirements.

- a. Primary and Secondary pumps with VFD are proposed to distribute the chilled water from the central plant to the Air Handling Unit (AHU) of the buildings. All the pipes shall be properly insulated.
- b. The conditioned air distributed from the AHU to the space to be conditioned through the insulated ducts. Supply and return air ducts to be provided for all areas. Necessary arrangements for the fresh air intake in the AHU shall be provided.
- c. Floor Mounted AHUS, Ceiling mounted AHUs and Fan Coil Units shall be proposed wherever necessary. All AHUs and CSUs shall complete with Double Inlet Double Width (DIDW) forward curve blade supply fans only.
- d. Individual AHUs are proposed for Gantry/Treatment Area
- e. Aluminum ducts are proposed for both supply & return in Gantry/Treatment Area
- f. AHU's with Hepa filters are proposed for treatment areas. All HEPA filters shall be of disposable type Aluminum powder coated filter with filtration efficiency of 99.97% down to 0.3 micron.

6. SYSTEM REQUIREMENTS

- a. Fresh Air Changes for all the areas must satisfy the ASHRAE requirements
- b. Nitrile rubber Thermal/Acoustic insulation to be provided for all ducts.
- c. Volume Control Dampers are proposed to control the air movement in the duct
- d. Fire Dampers with motorized actuators proposed for fire and smoke control through ducts
- e. All the valves shall satisfy the PN rating of 16
- f. All Aluminum powder coated supply diffusers/grilles shall be provided with volume control dampers and all return diffusers/grilles shall be provided without volume control dampers.
- g. FCU to be either ceiling mounted or high wall mounted type according to the location with room thermostat.

8. ELEVATORS

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SCOPE

Supply, installation, testing & commissioning of Machine room less Electric traction type (VVVF) Passenger & hospital elevator of following features

TECHNICAL REQUIREMENT

Sl.No.	Items	Technical requirement
1	Type of Elevator	1.Passenger cum bed Lift(15 Passenger)-2 Nos 2. Passenger Lift(13 Passenger)- 1 no 3. Goods Lift(3 Ton)- 1 no
2	Capacity	1020Kgs (minimum) for 15 Passenger (minimum) & 884Kgs (minimum) for 13 Passenger (minimum)
3	Speed	1.00 Mtr/sec for Passenger Lifts and 0.5 Mtr/s for Goods Lift
4	Serving Floors	Ground & First floor
5	Travel in meters	Approx. 8M
6	Stops & Opening	2 Stops & 2 Openings
7	Machine	Machine Room less Gearless traction machine with electro-magnetic brake placed in the hoist way on top.
8	Control system	Micro-processor based control with variable voltage variable frequency technology.
9	Operation	Simplex full collective.
10	Car Enclosure	1. Mat finish stainless steel panel on all the four sides & Ceiling along with stretcher protection with rubber beeding on three sides for passenger Lift. 2. Painted Mild steel for Goods lift

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11	Flooring	<ol style="list-style-type: none"> 1. Granite flooring for Passenger Lift 2. Aluminium Chequered plate flooring for Goods Lift
12	Number of Entrance	Entrance at front side on all the serving floors (All stops – Center / side opening).
13	Car & Hoist way Entrance (landing) Doors.	<ol style="list-style-type: none"> 1. Automatic center opening automatic mat finish stainless steel door for passenger 2. Painted Mild steel for Goods lift
14	Safety Feature	(i) All safety feature required as per IS / International Standards.
		(ii) Additional features.
		a) Reverse phase relay on controller.
		b) Single Phasing power supply protection.
		c) Overload warning indicator on car (visual and audio)
		d) Fireman's switch
		e) Battery operated alarm bell & emergency light with battery and charger.
15	Signals	f) Infra red rays sensing device along the edge of the car door for full height.
		a) LED Hall buttons/ landing call registered indicator at all landings.
		b) Digital car position indicator in car and at all landings.
		c) Up/ Down pre-announcing indicator at all landings
		d) Integral car operating panel with aesthetic luminous switches, emergency stop switch, key switch for auto/ attendant mode.
e) Annunciator in car		
16	Fixtures (In car)	a) Concealed decorative luminaries with CFL lamps complete with housing, reflector and accessories.

		b) Axial pressure fan suitable design to suit the ceiling.
17	Inter com (In car)	Suitable to hook to EPABX system.
18	Automatic rescue device.	Solid state battery operated device to automatically rescue passengers trapped in the elevator car in between floors in the event of power failure.
19	Manual Rescue Device	Manual rescue device shall also be provided so as to bring the elevator car to the nearest floor in the event of failure of battery operated automatic rescue device.

9. WATER SUPPLY, PLUMBING & SANITATION SYSTEM

WATER SUPPLY SYSTEM

9.1. DESIGN METHODOLOGY

External water supply design shall be based on total water requirement for the individual building and internal water supply on effective fixture unit basis. The water requirement shall be considered as per relevant Indian standards, Manuals and SP35. All water supply lines and sewer lines are designed based on Indian standards and manuals.

9.2 DESIGN STANDARDS – WATER SUPPLY & SEWERAGE

- CPHEEO - Manual on water supply and treatment
- CPHEEO - Manual on sewerage and sewage treatment
- SP 35 - Handbook on water supply and Drainage

Relevant Indian Standards

9.3 SOURCE OF WATER

The source of water supply for the proposed buildings shall be Bore wells. The Bore wells location shall be considered inside the campus with the permission of competent authority. However the number of bore wells shall be based on the yielding capacity of bore well.

9.4 WATER DEMAND

WATER REQUIREMENT CALCULATIONS

To meet the above water requirement, an underground raw water sump & treated water sump is proposed with a storage capacity of 150% of one day's water requirement excluding Fire requirement. In addition to that the building OHT has ½ day storage capacity.

9.5 PUMPS

Submersible pump is considered for pumping raw water from bore well to UG raw water sump and coupled pumps are considered for pumping water from underground sump to individual overhead tanks at each building. The pumping capacity shall be arrived in such a way that all the OHTs are filled in 2 hours. All the pumps shall have 100% stand by.

9.6 WATER TREATMENT PLANT (WTP)

- The water treatment plant (WTP) is considered to treat the raw water for all buildings.. The quality of water from the WTP shall meet all the required parameters of Domestic Purposes.

9.7 WATER SUPPLY DISTRIBUTION (EXTERNAL)

- Water from the bore wells shall be pumped to the underground raw water sump through submersible pumps. The raw water from underground treated water sump is pumped to the building OHTs.
- Necessary sluice valve, air valves, pressure regulating valves and scour valves will be located along the water mains as per design
- GI pipes are proposed for external water supply distribution conforming to IS 1239.

9.8 WATER SUPPLY DISTRIBUTION (INTERNAL)

- Supply by gravity from PVC pipes are proposed for internal water distribution.
- G.I. pipes, CPVC and Rigid PVC pipes shall be used appropriately for internal distribution system.

- WCs and Urinals shall be provided with Flushing cisterns & sensor based flush respectively.

SEWERAGE SYSTEM

9.9 DESIGN METHODOLOGY

Sewer lines are designed as running partially full with a maximum depth of sewage equal to half depth of the sewer diameter. All necessary appurtenances like manholes, drop manholes, grease trap etc., are provided for the efficient functioning of the sewerage system while complying with the relevant authorities requirements.

9.10 SEWERAGE SYSTEM (INTERNAL)

- Soil and wastewater from water closets and toilet are collected by two-pipe system. Soil pipes are connected to manholes and waste pipes are connected to gully trap and then to manholes. Minimum diameter of soil pipe is 100mm and waste pipe is 75mm. All the soil and waste stacks shall be properly vented and minimum diameter of vent pipe is 50 mm.
- For hospital building CI pipes as per IS 1729 shall be provided for internal sewerage system. For rest of the buildings PVC pipe conforming to IS 13592 are proposed.

9.11 SEWERAGE SYSTEM (EXTERNAL)

- All building manholes shall be interconnected with suitable diameter of sewer lines for final disposal on to the manhole in the sewer network connected to the sewage treatment plant (STP).
- Manholes are provided wherever change in direction, slope and diameter of pipelines are encountered. Sewers are designed to run half depth. Sizes and slopes are arrived for a peak flow factor 3.0 and minimum self-cleansing velocity of 0.6 m/sec Min. diameter of sewer is kept as 150 mm (Ref. CPHEEO – Manual on sewerage and sewage treatment).
- UPVC of IS 4985 shall be used for sewerage system.

9.12 STORM WATER DRAINAGE AND RAIN WATER HARVESTING SYSTEM

- Rainwater from terrace shall be collected with rainwater down take pipes and terminated 150 mm above FGL/FRL. The rainwater is allowed to flow in the surface and collected in the proposed storm water drainage.
- For rainwater harvesting auger boreholes are integrated in the storm water drainage. The boreholes are filed with coarse sand and pebbles. Part of storm water percolates through the boreholes.

I. LIST OF APPROVED MAKES / AGENCIES FOR CIVIL & PLUMBING MATERIALS

S. N	Materials	Manufacturers / Agencies
1	Ready mixed Concrete	L&T/RMC/RAMCO/ACC/Birla
2	Ordinary Portland Cement (Minimum 43 Grade) and Sulphate Resisting Portland Cement	A.C.C. Ultra Tech, India Cements, Ramco Cement, /Birla/ /Madras Cements/Chettinad Cement, Cement Corporation of India
3	Steel Reinforcement/Structural Steel (Each LOT shall accompany manufacturer's Test Certificate)	SAIL, TISCO, RINL,VSP, JINDAL
4	Stainless Steel	Salem Steel
5	White Cement	JK Cement, Birla White
6	Bricks, Stones slabs, Lime, Neeru Stone aggregate & fine aggregate	Sample to be got approved by E-in-C before use
7	Vitrified Tiles	Nitco, Johnson, Naveen, Euro, Morbito, Somany, Kajaria
8	Flush doors	Kutty Flush Doors, Mysore Boards, Indian Plywood Mfg, Co, 'KIT' Ply' brand or any BIS approved brand
9	Fire check steel doors	Godrej, Sukri, Pacific works controls, Navair
10	FRP Doors	Fibrevent, Techno skills or Equivalent (or as approved by E-IN-C)
11	Aluminium Fittings	Dorma, Everite, Crown Classic

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12	Hydraulic floor Spring/ Door Closers	Dorma, Everite, Hardwyn
13	Aluminium Extruded Sections	Jindal, Hindalco, Indalco, Bhoruka
14	Aluminium Doors/Windows	Fabricator to be approved by E-IN-C
15	Paints, Distempers	Jenson & Nicholson, Asian, ICI, Nerolac, Berger
16	Glazing	Float Glass of Modiguard, Saint Gobain, Asahi
17	Water proofing Works	As approved by E-IN-C.
18	Water Proofing Cement Paint	Showcem India, ICI, Nerolac, Asian
19	Ceramic Glazed Floor Tiles	Nitco, Johnson, Somany, Naveen, Kajaria,
20	Super plasticizer	CICO, MC Bauchemie (India) Pvt Ltd, Roffes Construction Chemicals, Pedilite Industries, FOSROC
21	PVC Flooring	Armstrong
22	False Ceiling (a) Fibre (b) Galvanized Steel (c) Calcium Silicate	Armstrong, Gyproc Armstrong, Gyproc, Hunter Douglass Aerolite, Gyproc, Armstrong, Ramco Hilux
23	Cast Iron Pipes/ Fittings (Soil Pipes)	BIC, HEP, NECO, Ajmera
24	RCC Pipes	Indian Hume Pipe Co, Spun Pipe Co., Sementia, CH Patel & Co

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25	Stoneware Pipes & Fittings	Dalmia, Parry
26	Cast Iron Pressure Pipes & Fittings	Tisco, BRM, KESORM
27	GI Pipes (ISI marked)	TATA, Zenith, Jindal, Gujarat Steel, ITC
28	GI Fittings (ISI marked)	'R' Brand KS/UNIK
29	Gunmetal Valves & Fittings	Premier/Leader/Zoloto/Sant
30	CI Sluice Valves, Check valves	IVC (Calcutta) Kirloskar/ Upadyaya
31	CP Brass Sanitary and water supply Fittings	Jaguar/Essess/SOMA/BILMAT/ Dripless
32	Indian/European Closet/Washbasin	Somany/Aquaware/HIndware/Parryware/ Orient (Coral)
32	Vitreous China Sanitary ware	Hindustan, EID Parryware/Cera/Neycer
33	WC Seats & Covers	Commander/Diplomat/Admiral/Hindusthan sanitaryware
34	Polyethylene/Polypropylene cistern	Everlast/Flushflo/Esyflo/Challener/Champion/ Commander, Marvel
35	CI Fixtures	Ashok Iron Works/Bombay Iron Works/ Husainji / Ismaelji
36	Stainless Steel Works	SP Fabricators, JINDAL ER Manda & Co
37	Curtain/Wall/Structural Glazing	Specialist Agency to be employed with Prior Approval of E-In-C
38	Plywood Products, Particle Boards &	Duroply (BWR) Century Plywood, Green

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	Veneers	Plywood, Kitply, Mysore Boards
39	Adhesive	Pidilite, Araldite
40	Plastic Laminates	Formica, Greenlam, Bakelite HYLAM
41	Powder Coatings	Berger/Nerocoat/Jenson & Nicholson
42	Tile Joint Filler	Bal Adhesives & Grouts, "ROFFE" Rainbow Tile Mate, Silicon Sealant of GE Bayer /"Zentrival FM" of MC-Bauchemie (India) Ltd
43	Resin Bonded Glass Wool	Crown Fibre Glass/Rock lloyd
44	MS Tubes	TATA , JINDAL
45	Silicon Sealant	Dow corning, GE Bayer Silicone, SIKA,
46	Anchor Fastener	Hilti, Bosch
47	Formwork Release Agent	Fosroc, MBT, MC Baucheme CICO, ADO Conmat
48	EPOXY	FOSROC. SIKA Qualcrete, Aradlite MBT
49	Water proofing System	CICO, FOSROC, SIKA, Supreme Siltech Chemicals, ADO Conmat, Roff
50	Stainless Steel Sinks	Prestige/AMC/Jayna/Kingston/Neelkanth
51	CP Waste, Spreaders for Urinals	Jaguar / Essess/ Orient/Parko
52	Sensor based Auto Flushing System for Urinals	AOS Systems/Angash ,Parryware/Hlindware/Seabird/Orient
53	SFRC Manhole Covers	KK/SK & Precast Concrete

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54	UPVC Pipes/Fittings	Supreme/Prince/ Finolex
55	Mirror	Atul / Modifloat/Saint Gobain/Golden Fish
56	Toilet Accessories	Jaguar
57	Soil, Waste & Rain water Pipes & Fittings	Supreme / Prince / Finolex
58	Cast Iron Pipes	NECO/B.C/RIF
59	Centrifugally Cast Spun Cast Iron Pipes	Electrosteel/Kesoram/IISCO

II. LIST OF APPROVED MAKES FOR ELECTRICAL ITEMS

ITEM	MANUFACTURERS / AGENCIES
RMU	Schneider / ABB/ Crompton greaves
Transformer	Kirloskar / Universal / Crompton /ABB
Bus trunking/Rising mains	L&T / Schneider / Legrand / GE
Diesel Generator Engine	Kirloskar / Cummins / Caterpillar/ Perkins
Alternator	Stamford / Leroy somer / Kirloskar / BHEL
HT Panel	Schneider / Crompton / ABB
ACBs	Schneider / ABB / Legrand /L&T
MCCBs	Schneider / ABB / Legrand /L&T

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MCBs , RCCB, Isolator, MCB Distribution board	Legrand /Schneider /Siemens / Hager
Industrial plug & Socket	Legrand /ABB/Schneider/Siemens
Capacitors	Schneider / Sprague / Legrand/ABB
Contactors, Switch Disconnecter unit, Change over switch	Schneider / ABB / Siemens / L&T
Indication lamp ,Selector switch, Push button	Technic /L&T/Schneider
Battery charger	Waves Electronics / Sabnife
HT/LT cables	Polycab / Gloster / Havells /Finolex
HT Cable Termination kit	Raychem / M seal /Brila-3M
PVC wire-FRLS(copper)	Polycab / Havells/ RR Kable /Finolex
Modular Switches	Legrand (Arteor) / Schneider (Livia) / Panasonic (Vision) / MK (Blenze)
UPS	Apc / Numeric / Emerson/ Socomec
Solar System	Tata BP,Lanco, Approved vendor of MNRE
Storage Battery	Exide / Amaron / Panasonic/ Bosch
Relay & controls	ABB / L&T/ Beluk / Schneider
CTs / PT	Kappa / AE/Indus

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Cable trays	OBO Bettermann / Profab / Ercon /Indiana
PVC Conduit & Accessories	Precision / Konseal /Clipsal/Avonplast
Ceiling /Exhaust fan/Wall fan	Crompton / Bajaj/ Usha/ Almanrod
Light Fittings	Crompton / Philips /Wipro/ Bajaj
Street light pole	Crompton / Bajaj / Wipro
Ceiling rose/ Batten holder/Buzzer	HPL / Anchor / GM / Havells
Multifunction meters, Voltmeter, Ammeter	Secure / Schneider / L&T/ AE
Cable gland & Lugs	Hex / Jainson / Dowells / Comet

* The supplier /manufacturer of LT panels shall have valid CPRI certificate for similar types of panels with ACB, MCCB, and SDFU etc. of approved makes as per RFP.

III. LIST OF APPROVED MAKES -ELV SYSTEM

1. <u>FIRE ALARM SYSTEM:</u>		
SL. No.	Details of equipment/ material	Make/ Manufacturer
1.	System Integrator	Honeywell/Siemens/Notifier/Tyco/Schneider

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2.	Armoured FRLS copper cable	Polycab/Finolex/Havells/RR cable
3.	Addressable type smoke detector	Honeywell/Siemens/Notifier/Tyco/Schneider
4.	Addressable type heat detector	Honeywell/Siemens/Notifier/Tyco/Schneider
5.	Addressable type multi detector	Honeywell/Siemens/Notifier/Tyco/Schneider
6.	Addressable type manual call point	Honeywell/Siemens/Notifier/Tyco/Schneider
7.	Addressable type sounder with strobe	Honeywell/Siemens/Notifier/Tyco/Schneider
8.	Addressable type Interface module	Honeywell/Siemens/Notifier/Tyco/Schneider
9.	Addressable type control module	Honeywell/Siemens/Notifier/Tyco/Schneider
10.	Addressable type fire alarm control panel	Honeywell/Siemens/Notifier/Tyco/Schneider
11.	Addressable type response indicator	Honeywell/Siemens/Notifier/Tyco/Schneider
12.	Addressable type fault isolator module	Honeywell/Siemens/Notifier/Tyco/Schneider
13.	Work station - Server PC	HP/ DELL/SONY
14.	LED Monitor for work station	HP/ DELL/SONY
15.	Software	customized software from the system integrator
<u>IV. CCTV SYSTEM</u>		
1.	Cable - CCTV system	Polycab/Finolex/Havells/RR cable
2.	Indoor dome camera	Honeywell/Bosch/Tyco/Pelco

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3.	PTZ camera	Honeywell/Bosch/Tyco/Pelco
4.	Digital Video Recorder	Honeywell/Bosch/Tyco/Pelco
5.	Hard Disk	Thoshiba/Samsung/Seagate
6.	LED monitor	Samsung/Sony/LG/Panasonic
7.	PTZ controller	Honeywell/Bosch/Tyco/Pelco
8.	Rack	Rittal/Netrack/APW President/Valrack
<u>V. VOICE & DATA SYSTEM</u>		
1.	PVC rigid/flexible conduits, medium duty	Balco/Konseal /Precision
2.	GI Back boxes	MK/Legrand/Panasonic/Crabtree
3.	UTP Cat5e cable 4 pair – telephone system	D Link/ Schneider/Dax/Amp
4.	UTP Cat 6 cable, 4 pair – data system	D Link/ Schneider/Dax/Amp
5.	Telephone socket, RJ 45	MK/Legrand/Panasonic/Crabtree
6.	Data socket, RJ 45	MK/Legrand/Panasonic/Crabtree
7.	Face plate for telephone & data sockets	MK/Legrand/Panasonic/Crabtree
8.	Patch panel	D Link/ Schneider/Dax/Amp
9.	Rack	Rittal/Netrack/APW President/Valrack

VI. LIST OF APPROVED MAKES OF FIRE FIGHTING SYSTEM

(All materials should carry the IS mark in case for any material is marked is no available prior approval for the same shall be taken by the contractor)		
S. No.	Details of Materials / Equipment	Manufacturer's Name
1	Fire / Sprinkler Main Pump / Jockey	Kirloskar,KSB,Wilo-Mather&Platt
2	Diesel Engine	Cummins,Greaves,KOEL
3	Motor	ABB,Bharat Bijlee,Kirloskar,Siemens
4	G.I. / M.S. Pipes (IS : 1239 / IS : 3589)	Jindal,Prakash,Tata Steel
5	Standard M.S. Fittings	Seamless Fittings,Pipeline products
6	DI / CI / Forged Steel Fittings	Jainsons Industries,VS,SS fittings,BM fittings
7	C.I. Pipes	Electro Steel Calcutta,IISCO,NECO,Kesoram Calcutta
8	RCC Pipe	K K ,Pranali,Local ISI Approved
9	DI MH Cover & Frame	Kartar Pipe and fittings,NECO,Agra
10	Paints	Asian Paints,Berger,ICI,Shalimar Paints

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11	Double / Single Headed Landing Valve	New Age, Tyco, Viking.
12	Fire Hose	New Age,Safeguard,Minimax
13	First Aid Hose Reel	New Age,Safeguard,Minimax
14	Branch Pipe	New Age,Safeguard,Minimax
15	Fireman Axe	New Age,Safeguard,Minimax
16	Installation Control Valve	Tyco,Viking,Victaulic
17	Sprinkler Heads	Reliable,Tyco,Victaulic,Viking,Newage,HD,Sharp
18	Fire Extinguishers	Tyco,Minimax,Safefire,Safegaurd
19	Water Flow Switch	Honeywell,Rapid Control,System Sensor,Spray safe
20	Pipe Protection Wrapping	IWL – Pypkote,Rustech - Coatek
21	Pipe clamp & supports	Chilly,Euroclamp,Kanwal
22	GM / Forged Brass Valves	Danfoss,RB,Honeywell,Zoloto
23	Sluice Valves	Indian Valve Company,Kirloskar,Kalpana
24	Butterfly Valve	Audco,Danfoss,Honeywell,Tyco,Viking
25	Check Valve – Wafer	Advance,Danfoss,Kirloskar,Honeywell

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	Type	
26	Check Valve – Dual Plate	Advance,Audco,Honeywell
27	Air Release Valve	Arco,OR,RB,Zoloto
28	Mechanical Seal	Burgmann,Sealol
29	Y Strainer	Emerald ,Sant,SKS,Zoloto
30	Couplings	Lovejoy
31	Anti Vibration Mounting & Flexible Connections	Cori,Dunlop,Flexionics,Kanwal industrial Corporation,Resistoflex
32	Pressure Gauge	Emerald ,Fiebig,H Guru,Wika
33	Paints	Asian Paints,Berger,ICI,Shalimar Paints
34	Welding Rods	ADOR,Esab
35	Fastener	Fisher,Hilti
36	Switch gears and control switchs and other items for fire control panel	L&T,ABB, Schneider

VII. LIST OF APPROVED MAKES FOR HVAC SYSTEM

S. No.	Details of equipment/ material	Make/ Manufacturer
1.	Water Cooled Screw type Chiller	York ,Trane, Carrier, Daikin McQuay

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2.	Water circulation Pumps	Grundfos, XYLEM, Armstrong
3.	Variable Frequency Drive system	Armstrong, Danfoss, Siemens, ABB
4.	Pressurized Expansion Tank and Air separator	Armstrong, Anergy
5.	Air Handling Unit	Carrier, VTS, Caryaire, Edgetech, Zeco
6.	Fan Coil/Cassette Unit	Caryaire, Edgetech, Zeco, Midea
7.	Cooling Tower	Paharpur, Advance, Bell, Flow Tech, Mihir
8.	Centrifugal fans	GREENHECK, Nikotra, Comfrei, Kruger
9.	Thermal Heat Recovery Wheel	ABB, Bry Air, Novelaire, VTS
10.	M.S. & GI Pipes.	Tata Steel, Jindal
11.	Balancing valves	TA Auto Flow, Advance, Navtech, Flowcon
12.	Ball valve (up to 30 mm)	Danfoss, RB, Sant, Rapid
13.	Butterfly valve	Intervlve, C&R, Audco, Advance, Econsto
14.	Check valve	Advance , Intervlve, Kirloskar, Econsto
15.	Pot / Y Strainer	Emerald , Rapidcool, Sant
16.	Pressure Gage	Fiebig, Wika, H Guru.
17.	Thermometer	Emerald, H Guru, Feibig
18.	Ball valves (Fan Coil Units)	Rapid Control, Emerald, Castel
19.	Auto Air Vent Valve	Rapid Control, RB, Anergy

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20.	Grille/diffuser	Caryaire, Ravistar, Air Master, Dynacraft
21.	Volume/Fire Damper	GREENHECK, Caryaire, Ravistar, Air Master,
22.	Closed Cell Elastomeric Insulation along with adhesive	Armacell, Armaflex, Eurobatex, K Flex
23.	Fiberglass (Foil Faced)	UP Twiga, Owens Corning, Kimmco
24.	Expanded Polystyrene (TF Quality)	Beardsell, Qualty thermopack, Coolite
25.	Two way motorized valve for AHU & FCUs	Tour Andover , Johnson Control , Honeywell, Siemens
26.	Room Thermostat/Humidistat	Tour Andover , Johnson Control,Honeywell, Siemens
27.	Flow Switch	Honeywell, Siemens, Rapid Control
28.	Factory Fabricated Ducts	Zeco, Rollarstar, Camduct, Western Air
29.	GI Sheets	Jindal, Tata
30.	Aluminium Sheet	Hindalco, Balco, Nalco
31.	Acoustic Insulation	UP Twiga, Owens Corning, Kimmco
32.	Hepa Filter	AAF, Aerofil, Pyramid

VII. LIST OF APPROVED MAKES ELEVATORS

ELEVATORS	OTIS/ KONE/ SCHINDLER/ MITSUBUSHI
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