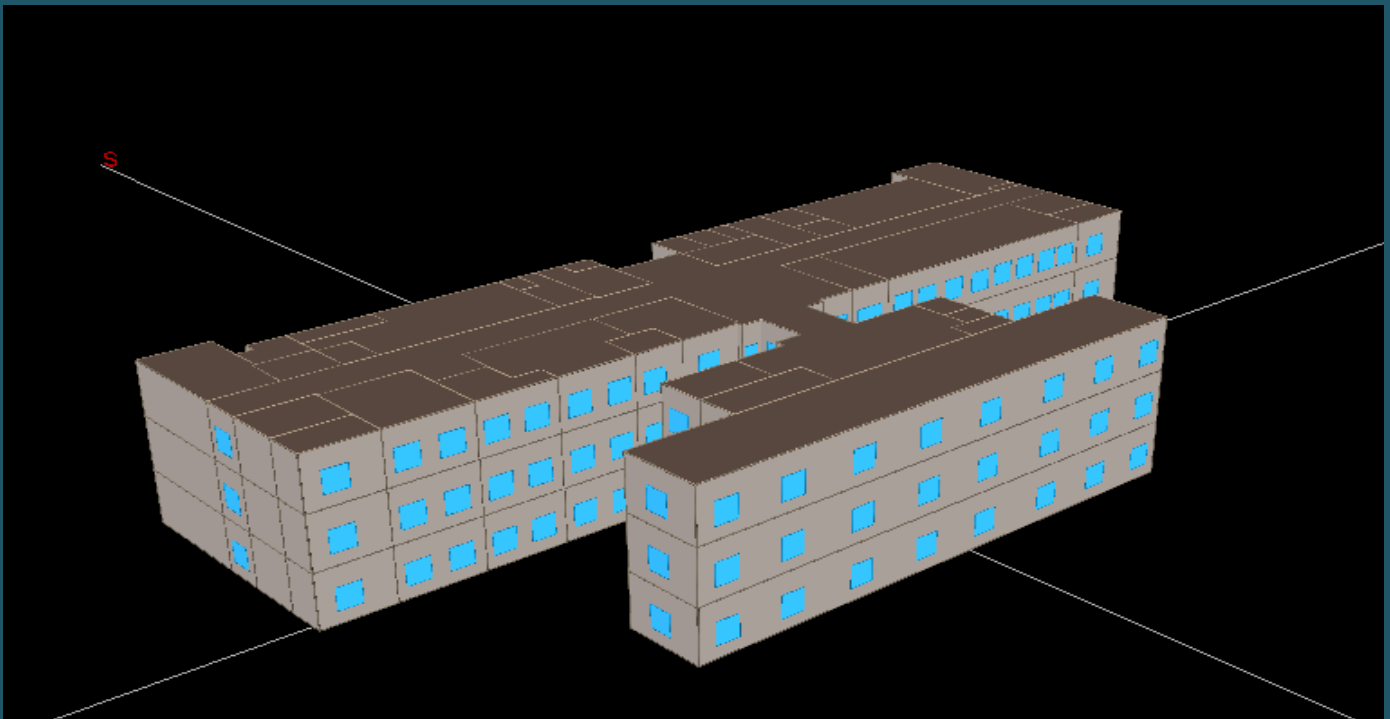


# ECBC COMPLIANCE REPORT FOR MOTHER AND CHILD HOSPITAL AT PALWAL

Towards Compliance of  
Energy Conservation Building Code- 2017



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# ECBC Compliance Report

## List of Abbreviations

- BEE- Bureau of Energy Efficiency
- ECBC – Energy Conservation Building Code
- EPI – Energy Performance Index
- HVAC- Heating Ventilation & Air Conditioning
- SRI- Solar Reflectance Index
- SHGC – Solar Heat Gain Coefficient
- SC – Shading Coefficient
- VLT – Visible Light Transmittance
- DGU – Double Glazing Unit
- DG – Diesel Generator
- kWh – Kilo-Watt-Hours
- kW – Kilo-Watt
- LED - Light Emitting Diodes
- LPD - Lighting Power Density
- PF – Power Factor
- UPS - Uninterruptible Power Supply
- VRF – Variable Refrigerant Flow
- AHU – Air Handling Unit
- VAV- Variable Air Volume
- WWR – Window to Wall Ratio
- COP – Coefficient of Performance

## ECBC Compliance Report

### Summary

| Input Parameter                                                                       | Baseline          | Proposed                                                                                                                           | Units              |
|---------------------------------------------------------------------------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| Wall material                                                                         | As per ECBC       | 15 mm Internal Plaster + 200 mm AAC Block + 40 mm Cavity + 20 mm External High SRI Tile + 50 mm External XPS Insulation (optional) |                    |
| Wall U-value                                                                          | 0.0704            | 0.162                                                                                                                              | Btu/hrsqt F        |
| Roof material                                                                         | As per ECBC       | 20 mm High SRI tiles + 125 mm RCC + 50 mm XPS Insulation + 5 mm Waterproofing membrane                                             |                    |
| Roof U-value                                                                          | 0.058             | 0.090                                                                                                                              | Btu/hrsqt F        |
| Glazing U Value                                                                       | 0.53              | 0.88                                                                                                                               | Btu/hrsqt F        |
| SHGC                                                                                  | 0.27              | 0.27                                                                                                                               |                    |
| Window Shading                                                                        | No                | As per Architectural Drawings                                                                                                      |                    |
| Cooling Sizing Ratio                                                                  | 1.15              | 1                                                                                                                                  |                    |
| Heating Sizing Ratio                                                                  | 1.25              | 1                                                                                                                                  |                    |
| HVAC System                                                                           | VRV with DOAS sys | VRV with DOAS sys                                                                                                                  |                    |
| HVAC System Efficiency (EER)                                                          | 3.02              | 3.5                                                                                                                                |                    |
| <b>Lighting Power Density calculation (As per space function method- ECBC §6.3.2)</b> |                   |                                                                                                                                    |                    |
| Internal                                                                              | 0.91              | 0.71                                                                                                                               | W/ ft <sup>2</sup> |
| External                                                                              | 0.79              | 0.88                                                                                                                               | W/ ft <sup>2</sup> |
| Zone Cooling set point                                                                | 75                | 75                                                                                                                                 | deg F              |
| Zone Heating set point                                                                | 70                | 70                                                                                                                                 | deg F              |

| Description                            | Energy Consumption/ Generation |
|----------------------------------------|--------------------------------|
| Proposed case energy consumption (kWh) | <b>4,76,535</b>                |
| Base case energy consumption (kWh)     | <b>5,25,820</b>                |
| <b>Savings %</b>                       | <b>9.37%</b>                   |
| Base case EPI (kWh/Sq.m./Annum)        | <b>93.5</b>                    |
| Proposed case EPI (kWh/Sq.m./Annum)    | <b>84.7</b>                    |
| EPI ratio                              | <b>0.90</b>                    |

# ECBC Compliance Report

## 1. Overview of ECBC

The Energy Conservation Building Code (ECBC) was introduced by the Bureau of Energy Efficiency (BEE) in 2007 to establish minimum energy performance standards for commercial buildings in India. In 2017, BEE released an updated version, ECBC 2017, which introduced more stringent and comprehensive standards to meet modern energy efficiency requirements and global sustainability goals. The 2017 version included revised thermal performance requirements for walls, roofs, and windows; lighting system, including daylighting, and lamps and luminaire performance requirements; HVAC system, including energy performance of chillers and air distribution systems; Electrical & renewable energy system; and Water heating and pumping systems, including requirements for solar hot-water systems.

ECBC 2017 standards are divided into three categories: ECBC, ECBC+, and Super ECBC. ECBC compliance is mandatory for all commercial buildings, including hospitality, education, healthcare, shopping complexes, business, and assembly buildings, that exceed a specified energy consumption threshold. Buildings compliant with ECBC can save approximately 25% of annual energy consumption compared to conventional buildings in the same climate zone.

ECBC+ and Super ECBC go beyond the minimum standards of ECBC, allowing buildings to achieve greater energy savings. By implementing the prescribed design parameters for ECBC+ and Super ECBC, energy savings can increase from 25% to 50% compared to conventional buildings in the same climate zone.

As per ECBC 2017, the project is classified under the "Healthcare Building" category of Commercial buildings. Energy simulation models analysed that Mother and Child Hospital Palwal building, could achieve significant energy savings by meeting the desired EPI ratio in accordance with the ECBC-2017 compliance guidelines.

### 1.1 Integration with other ratings compliance mechanisms

Complementing the efforts of the Government of India, the ECBC has been integrated in other rating & compliance systems being followed in the country such as EIA (Environmental Impact Assessment) for large area development under MoEF (Ministry of Environment & Forest), Green Rating for Integrated Habitat Assessment (GRIHA) rating system, USGBC LEED rating system, the Indian Green Building Council (IGBC) rating systems and ASSOCHAM's GEM rating system.

# ECBC Compliance Report

## 1.2 Mandatory requirement

The code mandates that the criterion be followed verbatim. These criteria are mandatory, as the name suggests. The criterion has been laid down to impose minimum standards of compliance in any compliant building.

## 1.3 Prescriptive requirement

The prescriptive requirements are in addition to the mandatory requirements. These requirements are in the form of efficiencies for equipment, U-value for envelope parameters etc. The same may be followed as is, as per the guideline laid down by ECBC. Alternatively, a trade off method is available, as detailed below.

## 1.4 Whole building simulation approach

The whole building simulation software performs hourly simulation in approved software and derives the estimated energy consumption for a given building. Energy conservation measures may be applied in addition to the mandatory requirement to achieve an improved performance over ECBC baseline. This method gives the necessary flexibility to the owner over the prescriptive requirement and enables the possibility of a trade off in efficiency for different building elements.

## 1.5 Climate

As per ECBC 2017 section 4.3, Palwal falls under the composite Climate Zone, and the building envelope parameters for this zone are designed to minimize heat gain and enhance energy efficiency, given the region's respective temperatures and humidity. In this climate zone, the envelope should be designed with high thermal mass materials that absorb heat during the day and release it during the cooler night, thereby reducing cooling loads.

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## 1.6 Technical software

The building was analyzed in eQUEST version 3.65.7173. It is a building energy analysis software designed and developed by DOE2 (Copyright James J. Hirsch). eQuest uses the DOE-2.2 Building energy simulation engine. It has the ability to explicitly model all the following:



*Figure 1 eQuest*

- 8,760 hours per year
- Hourly variations in occupancy, lighting power, miscellaneous equipment power, thermostat set points, and HVAC system operation, defined separately for each day of the week and holidays
- Part-load performance curves for mechanical equipment
- Capacity and efficiency correction curves for mechanical heating and cooling equipment

## 1.7 Procedure for whole-building simulation

Project has decided to go through whole building performance approach for ECBC compliance. As per ECBC requirement, both mandatory and whole building performance requirement shall be necessary to comply with the code. Therefore, the project team has studied the whole ECBC requirement categorized in building envelopes, HVAC, service hot water & pumping lighting & electrical system. The model is simulated using the appropriate weather file for the project's location.

In accordance with ECBC guidelines, the baseline model is simulated for four orientations 0°, 90°, 180°, and 270° based on parametric runs. The final energy consumption is determined by taking the average of these parametric runs. After conducting the simulation, the Energy Performance Ratio (the ratio of the Proposed EPI to the Standard Case EPI, equivalent to the ECBC benchmark) was calculated to determine the minimum performance requirements as per the ECBC 2017 guidelines

## 1.8 Weather File

The building is to be constructed at Palwal, Haryana which comes under composite climate zone. Envelope parameters for Baseline model have been selected as per the composite climate zone. Weather file (IND\_Delhi.421310\_ISHRAE.BIN) used for simulation for the Project. The same weather file has been used for both Baseline and Proposed models.

# ECBC Compliance Report

## 2. Project Description

Mother and Child Hospital Building to be constructed in Palwal District of Haryana spans a built-up area of 5622 m<sup>2</sup>. The project is a G+2 story building. The project is now at design stage and the project will implement all the measures which make the building to comply with ECBC-2017. The project is going for ECBC compliance through Whole Building Simulation Approach. The project will use LED lights and high COP VRV systems for air conditioning & BEE star rated electrical equipment of the building.

The project aims to achieve ECBC compliance through a whole-building simulation approach, comparing the proposed model with a standard benchmark.

## 3. Building Envelope

The building envelope refers to the exterior façade and is comprised of opaque assembly and fenestration systems. Opaque components include walls and roof etc. The fenestration system includes windows, ventilators etc. The envelope of the building protects the building interior and occupants from exterior weather conditions. So, to make the building envelope energy efficient and to comply with the mandatory requirement following energy efficient material shall be recommended in the envelope design. The envelope considered in the baseline case and proposed case is detailed in the compliance forms.

### 3.1 WWR Calculations

WWR is the window wall ratio. As more heat comes from the windows than compared to wall & roof. Detailed WWR calculation has been mentioned in further section of this report. The WWR is required to calculate as this is a necessary parameter to find the

baseline envelope requirement of building. Windows accounts for the maximum amount of heat in the building. The overall WWR of the building is about 2.94%. The WWR is in the acceptable range and hence by the simulation approach will be easily compliant.

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The envelope requirement is divided as per the percentage WWR calculation mentioned below for building:

Total Window Area = 1620 (sq. ft), Total Window + Wall Area = 5498 (sq. ft.)

The formula to calculate WWR is:  $WWR = (\text{Total Window Area} / \text{Total window + wall Area}) \times 100$

$WWR = (1620/5498) \times 100$

So, the Window -to- Wall Ratio (WWR) is approximately 2.94%.

## ECBC Compliance Report

### 3.2 Roof construction

| OPAQUE Roof Assembly |                            |               |        |                         |           |                  |           |
|----------------------|----------------------------|---------------|--------|-------------------------|-----------|------------------|-----------|
| S. no                | LAYER                      | THICKNESS (L) | L/1000 | THERMAL CONDUCTIVITY(K) | REFERENCE | RESISTANCE (L/K) | U - VALUE |
|                      |                            | mm            |        | W/m K                   |           |                  | W/sq m K  |
| 1                    | High SRI Tile              | 20            | 0.02   | 1.500                   | ECBC 2017 | 0.00             |           |
| 2                    | Extruded polystyrene (XPS) | 50            | 0.05   | 0.035                   | ECBC 2017 | 1.43             |           |
| 3                    | Waterproofing membrane     | 5             | 0.005  | 0.850                   | ENS 2018  | 0.14             |           |
| 4                    | RCC                        | 125           | 0.12   | 1.580                   | ENS 2018  | 0.13             |           |
|                      | Total thickness            | 200           |        |                         |           | 1.96             | 0.51      |

Table 1 Proposed Roof construction

## ECBC Compliance Report

### 3.3 Wall construction

| OPAQUE Wall Assembly |                                    |               |        |                          |                 |                  |           |
|----------------------|------------------------------------|---------------|--------|--------------------------|-----------------|------------------|-----------|
| S.No                 | LAYER                              | THICKNESS (L) | L/1000 | THERMAL CONDUCTIVITY (K) | REFERENCE       | RESISTANCE (L/K) | U - VALUE |
|                      |                                    | mm            |        | W/m K                    |                 |                  | W/sq m K  |
| 1                    | External High SRI Tiles            | 20            | 0.02   | -                        | ECBC User Guide | 0.04             |           |
| 2                    | Internal Cement Plaster            | 15            | 0.01   | 0.750                    | ECBC User Guide | 0.03             |           |
| 3                    | External XPS Insulation (optional) | 50            | 0.05   | 0.035                    | ENS             | 0.00             |           |
| 4                    | AAC Block                          | 200           | 0.20   | 0.184                    | ECBC 2017       | 0.82             |           |
| 5                    | Air Gap/ Cavity                    | 40            | 0.04   | -                        | ECBC User Guide | 0.13             |           |
|                      | Total thickness                    | 325           |        | -                        |                 | 1.09             | 0.92      |

Table 2 Proposed Wall construction

## 3.4 Fenestration Specification

| Fenestration Heat Transfer Coefficients |                                      |                      |                           |
|-----------------------------------------|--------------------------------------|----------------------|---------------------------|
| S.No.                                   | Glass Specification                  | Evo-Lite (ET II 150) |                           |
|                                         | Window Glass                         | Values               | Unit                      |
| 1.                                      | U Value - Thermal Transmittance (SI) | 5                    | W/m <sup>2</sup> -K       |
| 2.                                      | U Value - Thermal Transmittance (IP) | 0.88                 | Btu/hr-ft <sup>2</sup> -F |
| 3.                                      | SHGC - Solar Heat gain coefficient   | 0.5                  | Unitless                  |
| 4.                                      | SC - Shading Coefficient             | 0.57                 | Unitless                  |
| 5.                                      | Visible Light Transmittance (VLT)    | 0.5                  | Unitless                  |

*Table 3 Fenestration Specifications of proposed design*

## ECBC Compliance Report

### 4. HVAC Parameters

Heating, ventilating & air conditioning system refers to the equipment, distribution systems and terminals that provide heating, ventilation or air conditioning requirement to a building or portion of the building. The HVAC systems contribute to the major energy consumption in buildings having larger conditioned areas. The ECBC contains mandatory as well as prescriptive requirements for ventilation, refrigerant piping, controls, system balancing etc.

| S. No. | HVAC Parameters                  |                 |
|--------|----------------------------------|-----------------|
|        | Standard Design<br>(As per ECBC) | Proposed Design |
|        | VRV                              | Same as ECBC    |
| 1.     | COP                              | COP             |
| 2.     | 3.28                             | 3.6             |

Table 4 HVAC Parameters

#### 4.1 Mandatory ECBC requirements

##### ➤ Ventilation (5.2.1-ECBC 2017):

- The project building shall follow all the necessary provisions of NBC 2016 including the design guidelines for Natural /mechanical/Mixed mode ventilation.

##### ➤ Space Conditioning Equipment Efficiencies (5.2.2-ECBC 2017):

- Variable Refrigerant Flow with Direct expansion with air cooled condenser 3.6 cop shall be provided.

##### ➤ Temperature Controls (5.2.3.2-ECBC 2017):

- Mechanical cooling equipment in all buildings shall be installed with controls to manage the temperature inside the conditioned zones. Each floor or a building block shall be installed with at least one control to manage the temperature.

## ECBC Compliance Report

- A separate thermostat control shall be installed in each room less than 30 m<sup>2</sup> in Business.

### ➤ **Centralized Demand Shed Controls (5.2.4.1-ECBC 2017):**

- The building shall have a building management system. All mechanical cooling shall be equipped with any programmable logic controller (PLC) to the zone level shall have the following control capabilities to manage centralized demand shed in noncritical zones.
- Automatic demand shed controls that can implement a centralized demand shed in non-critical zones during the demand response period on a demand response signal. Controls that can remotely decrease or increase the operating temperature set points by four degrees or more in all noncritical zones on signal from a centralized control point. Controls that can provide an adjustable rate of change for the temperature setup and reset

### ➤ **Supply Air Temperature Reset (5.2.4.2-ECBC 2017):**

- Buildings should have a building management system. All mechanical cooling and heating systems in the building shall be equipped with any programmable logic controller (PLC) to the zone level shall have the following control capabilities to manage centralized demand shed in noncritical zones

### ➤ **Piping Insulation (5.2.6.1-ECBC 2017):**

- Piping for space conditioning shall meet the insulation requirements listed in Table 5-8 (ECBC 2017). Insulation exposed to weather shall be protected by aluminum sheet metal, painted canvas, or plastic cover. Cellular foam insulation shall be protected as above or be painted with water retardant paint.

| Operating Temperature (°C)         | Pipe size (mm)              |      |
|------------------------------------|-----------------------------|------|
|                                    | <25                         | >=40 |
|                                    | Insulation R value (m².K/W) |      |
| Heating System                     |                             |      |
| 94°C to 121°C                      | 0.9                         | 1.2  |
| 60°C to 94°C                       | 0.7                         | 0.7  |
| 40°C to 60°C                       | 0.4                         | 0.7  |
| Cooling System                     |                             |      |
| 4.5°C to 15°C                      | 0.4                         | 0.7  |
| < 4.5°C                            | 0.9                         | 1.2  |
| Refrigerant Piping (Split systems) |                             |      |
| 4.5°C to 15°C                      | 0.4                         | 0.7  |
| < 4.5°C                            | 0.9                         | 1.2  |

Table 5 Insulation for Pipes (Source Table-5.8-ECBC-2017)

➤ **Condenser Locations (5.2.8.1-ECBC 2017):**

- Condensers shall be located such that the heat sink is free of interference from heat discharge by devices located in adjoining spaces, and do not interfere with other such systems installed nearby.

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### 5. Lighting System

Project is a Healthcare type. Project understands the requirement of ECBC in selection of Lighting & it shall ensure the use of a lighting with a LPD of 0.87 W/sq.ft. or equivalent system.

| Lighting Specifications (Building Area Method) |                                       |                                       |
|------------------------------------------------|---------------------------------------|---------------------------------------|
| Space Name                                     | Standard Design<br>(As per ECBC)      | Proposed Design                       |
|                                                | Lighting Power Density (in W/sq. ft.) | Lighting Power Density (in W/sq. ft.) |
| Healthcare Building                            | 0.76                                  | 0.87                                  |

Table 6 Lighting Specifications

#### 1.1 Mandatory Requirement

➤ **Lighting Control (6.2.1-ECBC 2017):**

90% of interior lighting fittings in buildings or space larger than 300 m<sup>2</sup> shall be equipped with automatic control devices.

**Occupancy Sensors is recommended for below mentioned cases:**

- All habitable spaces are less than 30 m<sup>2</sup>, enclosed by walls or ceiling height partitions.
- In all Business and all conference or meeting rooms.
- Public toilets more than 25 m<sup>2</sup>, controlling at least 80 % of lighting fitted in the toilet. The lighting fixtures, not controlled by automatic lighting shut off, shall be uniformly spread in the area.

➤ **Automatic Controls (6.2.1.1-ECBC 2017):**

- On a scheduled basis at specific programmed times. An independent program schedule is recommended to provide for areas of no more than 2,500 m<sup>2</sup> and not more than one floor.

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- Occupancy sensors that shall turn off the lighting fixtures within 15 minutes of an occupant leaving the space. Light fixtures controlled by occupancy sensors shall have a wall-mounted, manual switch capable of turning off lights when the space is occupied.

➤ **Exterior lighting Control (6.2.1.5-ECBC 2017):**

- Lighting for all exterior applications shall be controlled by a photo sensor or astronomical time switch that is capable of automatically turning off the exterior lighting when daylight is available, or the lighting is not required.

| Table 6-7 Exterior Building Lighting Power for ECBC Buildings |                                              |
|---------------------------------------------------------------|----------------------------------------------|
| Exterior lighting application                                 | Power limits                                 |
| Building entrance (with canopy)                               | 10 W/m <sup>2</sup> of canopied area         |
| Building entrance (w/o canopy)                                | 90 W/ linear m of door width                 |
| Building exit                                                 | 60 W/lin m of door width                     |
| Building façade                                               | 5.0 W/m <sup>2</sup> of vertical façade area |
| Emergency signs, ATM kiosks, Security areas façade            | 1.0 W/m <sup>2</sup>                         |
| Driveways and parking (open/ external)                        | 1.6 W/m <sup>2</sup>                         |
| Pedestrian walkways                                           | 2.0 W/m <sup>2</sup>                         |
| Stairways                                                     | 10.0 W/m <sup>2</sup>                        |
| Landscaping                                                   | 0.5 W/m <sup>2</sup>                         |
| Outdoor sales area                                            | 9.0 W/m <sup>2</sup>                         |

Table 7 Exterior lighting details (source: ECBC 2017)

➤ **Control in Daylight Areas (6.2.1.3-ECBC 2017):**

- Lighting Power Density adjustment factor of 20% is recommended as per ECBC to all spaces with more than 70% of their area under daylight controls.
- Luminaires, installed within daylighting extent from the window shall be
- equipped with either a manual control device to shut off luminaires, installed within day lit area, during potential daylit time of a day or automatic control device that:

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- i. There is a delay of a minimum of 5 minutes, or,
- ii. Can dim or step down to 50% of total power.

➤ **Centralized Controls (6.2.1.4-ECBC 2017):**

- Building shall have centralized control system for schedule based automatic lighting shutoff switches.

➤ **Exit signs (6.2.2 -ECBC 2017):**

- The lighting power for energy exit signs shall not exceed a maximum of 5 watts.

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## 6. Electrical and Renewable Energy

### 1.1 Mandatory Requirement

#### ➤ Transformer (7.2.1-ECBC 2017):

- Power transformers of the proper ratings and design must be selected to satisfy the minimum acceptable efficiency at 50% and full load rating.

Permissible total loss values shall not exceed

(a) 5% of the maximum total loss values mentioned in IS 1180 for oil type transformers in voltage class above 11 kV but not more than 22 kV

(b) 7.5% of the maximum total loss values mentioned above IS 1180 for oil type transformers in voltage class above 22 kV and up to and including 33 kV

(c) values listed in the following Table 7.2 (ECBC-2017) for oil type transformers

*Table 7-2 Permissible Losses for Oil Type Transformers. Total losses for oil type transformers shall confirm with Indian Standard IS 1180.*

| Rating<br>(kVA) | Impedance<br>(%) | Max. Total Loss (W) |           |                |           |                    |           |
|-----------------|------------------|---------------------|-----------|----------------|-----------|--------------------|-----------|
|                 |                  | ECBC Building       |           | ECBC+ Building |           | SuperECBC Building |           |
|                 |                  | 50 %<br>Load        | 100% Load | 50 %<br>Load   | 100% Load | 50 %<br>Load       | 100% Load |
| 16              | 4.5              | 150                 | 480       | 135            | 440       | 120                | 400       |
| 25              | 4.5              | 210                 | 695       | 190            | 635       | 175                | 595       |
| 63              | 4.5              | 380                 | 1250      | 340            | 1140      | 300                | 1050      |
| 100             | 4.5              | 520                 | 1800      | 475            | 1650      | 435                | 1500      |
| 160             | 4.5              | 770                 | 2200      | 670            | 1950      | 570                | 1700      |
| 200             | 4.5              | 890                 | 2700      | 780            | 2300      | 670                | 2100      |
| 250             | 4.5              | 1050                | 3150      | 980            | 2930      | 920                | 2700      |
| 315             | 4.5              | 1100                | 3275      | 1025           | 3100      | 955                | 2750      |
| 400             | 4.5              | 1300                | 3875      | 1225           | 3450      | 1150               | 3330      |
| 500             | 4.5              | 1600                | 4750      | 1510           | 4300      | 1430               | 4100      |
| 630             | 4.5              | 2000                | 5855      | 1860           | 5300      | 1745               | 4850      |
| 1000            | 5                | 3000                | 9000      | 2790           | 7700      | 2620               | 7000      |
| 1250            | 5                | 3600                | 10750     | 3300           | 9200      | 3220               | 8400      |
| 1600            | 6.25             | 4500                | 13500     | 4200           | 11800     | 3970               | 11300     |
| 2000            | 6.25             | 5400                | 17000     | 5050           | 15000     | 4790               | 14100     |
| 2500            | 6.25             | 6500                | 20000     | 6150           | 18500     | 5900               | 17500     |

Total loss values given in above table are applicable for thermal classes E, B and F and have component of load loss at reference temperature according to Clause 17 of IS 1180 i.e., average winding temperature rise as given in Column 2 of Table 8.2 plus 300C. An increase of 7% on total for thermal class H is allowed.

Figure 3 Permissible Losses for Oil Type Transformers

## ECBC Compliance Report

- All transformers of capacity of 500 kVA and above would be recommended to equipped with additional metering class current transformers (CTs) and potential transformers (PTs) additional to requirements of Utilities so that periodic loss monitoring study may be carried out.
- **Voltage Drop (7.2.1.3 -ECBC 2017):**
  - Voltage drop for feeders shall not exceed 2% at design load. Voltage drop for branch circuits shall not exceed 3% at design load.
- **Diesel Generator (DG) Sets (7.2.3 -ECBC 2017):**
  - BEE star rated DG sets shall be used in all compliant buildings. DG sets in buildings shall have a minimum 3 stars rating or equivalent.
- **Energy Efficient Motors (7.2.2-ECBC 2017):**
  - Three phase induction motors shall conform to Indian Standard (IS) 12615 and shall Have minimum IE 2.
- **Check Metering and monitoring (7.2.4-ECBC 2017):**
  - Services exceeding 1000 kVA shall have permanently installed electrical metering to record demand (kVA), energy (kWh), and total power factor. The metering shall also display current (in each phase and the neutral), voltage (between phases and between each phase and neutral), and total harmonic distortion (THD) as a percentage of total current.
- **Power factor correction (7.2.5 -ECBC 2017):**
  - The transformer shall maintain the minimum power factor 0.97.
- **Power distribution system (7.2.6 -ECBC 2017):**
  - The power cabling shall be sized so that the distribution losses shall not exceed 3% of total power usage.
- **Uninterruptible Power Supply (UPS) (7.2.7 -ECBC 2017):**
  - UPS shall meet or exceed the energy efficiency requirements listed in Table 7-4 (ECBC 2017). Any Standards and Labeling program by BEE shall take precedence over requirements listed in this section:

## ECBC Compliance Report

Table 7-4 Energy Efficiency Requirements for UPS for ECBC, ECBC+, SuperECBC building

| UPS Size       | Energy Efficiency Requirements at 100% Load |
|----------------|---------------------------------------------|
| kVA < 20       | 90.2%                                       |
| 20 ≤ kVA ≤ 100 | 91.9%                                       |
| kVA > 100      | 93.8%                                       |

Table 8 Uninterruptible Power Supply (UPS)

➤ **Renewable Energy Systems (7.2.7 -ECBC 2017):**

- A dedicated Renewable Energy Generating Zone (REGZ) equivalent to at least 25% of roof area or area required for generation of energy equivalent to 1% of total peak demand or connected load of the building, whichever is less, shall be provided in all buildings.
- Minimum Electricity 1% of total electrical load shall be Generated in REGZ.

# ECBC Compliance Report

## 7. Energy Simulation Results Calculations

### 7.1 Schedules and Inputs

Schedule Properties

Annual Schedules | Week Schedules | Day Schedules

Currently Active Day Schedule: ECBC Occup WD Type: Fraction

Day Schedule Name: ECBC Occup WD Type: Fraction

Hourly Values

|           |        |       |           |        |       |           |        |       |
|-----------|--------|-------|-----------|--------|-------|-----------|--------|-------|
| Mdnt - 1: | 0.0000 | ratio | 8-9 am:   | 0.2000 | ratio | 4-5 pm:   | 0.9500 | ratio |
| 1-2 am:   | 0.0000 | ratio | 9-10 am:  | 0.9500 | ratio | 5-6 pm:   | 0.9500 | ratio |
| 2-3 am:   | 0.0000 | ratio | 10-11 am: | 0.9500 | ratio | 6-7 pm:   | 0.3000 | ratio |
| 3-4 am:   | 0.0000 | ratio | 11-noon:  | 0.9500 | ratio | 7-8 pm:   | 0.1000 | ratio |
| 4-5 am:   | 0.0000 | ratio | noon-1:   | 0.9500 | ratio | 8-9 pm:   | 0.1000 | ratio |
| 5-6 am:   | 0.0000 | ratio | 1-2 pm:   | 0.5000 | ratio | 9-10 pm:  | 0.1000 | ratio |
| 6-7 am:   | 0.0000 | ratio | 2-3 pm:   | 0.9500 | ratio | 10-11 pm: | 0.0000 | ratio |
| 7-8 am:   | 0.1000 | ratio | 3-4 pm:   | 0.9500 | ratio | 11-Mdnt:  | 0.0000 | ratio |

Done

Figure 4-Occupancy Schedule

Schedule Properties

Annual Schedules | Week Schedules | Day Schedules

Currently Active Day Schedule: ECBC HVAC Fan WD Type: On/Off

Day Schedule Name: ECBC HVAC Fan WD Type: On/Off

Hourly Values

|           |   |           |   |           |   |
|-----------|---|-----------|---|-----------|---|
| Mdnt - 1: | 0 | 8-9 am:   | 1 | 4-5 pm:   | 1 |
| 1-2 am:   | 0 | 9-10 am:  | 1 | 5-6 pm:   | 1 |
| 2-3 am:   | 0 | 10-11 am: | 1 | 6-7 pm:   | 1 |
| 3-4 am:   | 0 | 11-noon:  | 1 | 7-8 pm:   | 1 |
| 4-5 am:   | 0 | noon-1:   | 1 | 8-9 pm:   | 1 |
| 5-6 am:   | 0 | 1-2 pm:   | 1 | 9-10 pm:  | 1 |
| 6-7 am:   | 0 | 2-3 pm:   | 1 | 10-11 pm: | 0 |
| 7-8 am:   | 1 | 3-4 pm:   | 1 | 11-Mdnt:  | 0 |

Done

Figure 5- HVAC Fan Schedule

# ECBC Compliance Report

Schedules for the building show the building’s operational hours, which is how much time the building parameters like HVAC, equipment, fans, water heater etc. will run in the year. The operational hours for the building have been taken similarly for both the proposed and standard case.

Surface Construction, Layers, and Material Properties

Construction

Layers

Material

Currently Active Construction: 

Baseline Wall

 Type: U-Value Input

Surface Construction Parameters

Construction: 

Baseline Wall

Specification Method: 

U-Value Input

Overall U-Value: 

0.070

 Btu/h-ft2-°F

Surface Roughness: 

3

Ext. Color (absorpt.): 

0.700

Wall Parameters: 

- undefined -

Done

Figure 6 Baseline Exterior Wall Properties

Surface Construction, Layers, and Material Properties

Construction

Layers

Material

Currently Active Construction: 

Baseline Roof

 Type: U-Value Input

Surface Construction Parameters

Construction: 

Baseline Roof

Specification Method: 

U-Value Input

Overall U-Value: 

0.058

 Btu/h-ft2-°F

Surface Roughness: 

3

Ext. Color (absorpt.): 

0.700

Wall Parameters: 

- undefined -

Done

Figure 7 Baseline Exterior Roof Properties

# ECBC Compliance Report

Construction

Layers

Material

Currently Active Construction: 

Proposed Wall

 Type: U-Value Input

Surface Construction Parameters

Construction: 

Proposed Wall

Specification Method: 

U-Value Input

Overall U-Value: 

0.162

 Btu/h-ft2-°F

Surface Roughness: 

3

Ext. Color (absorpt.): 

0.700

Wall Parameter: 

- undefined -

Figure 8 Proposed Exterior Wall

Construction

Layers

Material

Currently Active Construction: 

Proposed Roof

 Type: U-Value Input

Surface Construction Parameters

Construction: 

Proposed Roof

Specification Method: 

U-Value Input

Overall U-Value: 

0.090

 Btu/h-ft2-°F

Surface Roughness: 

3

Ext. Color (absorpt.): 

0.700

Wall Parameter: 

- undefined -

Figure 9 Proposed Exterior Roof

## ECBC Compliance Report

### 7.2 Simulation Results

#### 7.2.1 Baseline Case consumption

Baseline model stands for a standard benchmark with which we compare our actual proposed model. The baseline model has inputs as per ECBC against of actual as in the proposed case. The model is then simulated by using an appropriate weather file for the project location.

*Figure 10 Baseline Consumption*

|                         | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Oct  | Nov  | Dec  | Total |
|-------------------------|------|------|------|------|------|------|------|------|------|------|------|------|-------|
| <b>Space Cool</b>       | 4.3  | 6.4  | 10.2 | 19.6 | 20.3 | 24   | 15.5 | 14.7 | 15.2 | 15.2 | 7.8  | 7.1  | 160.3 |
| <b>Heat Reject.</b>     | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0     |
| <b>Vent. Fans</b>       | 5.9  | 6.2  | 6.7  | 7.3  | 9    | 7.6  | 7.7  | 9.1  | 8    | 8.1  | 6.3  | 8.3  | 90.2  |
| <b>Pumps &amp; Aux.</b> | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0     |
| <b>Ext. Usage</b>       | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0     |
| <b>Misc. Equip.</b>     | 5.2  | 4.6  | 5.8  | 5.7  | 6.8  | 3.7  | 6.2  | 5.8  | 3.7  | 6.2  | 3.4  | 4.2  | 60.3  |
| <b>Task Lights</b>      | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0     |
| <b>Area Lights</b>      | 18.2 | 16.3 | 17.8 | 17.2 | 17.8 | 17.2 | 18.7 | 19.8 | 18.2 | 19.2 | 16.4 | 18.3 | 215   |
| <b>Total</b>            | 33.6 | 33.5 | 40.5 | 49.8 | 53.9 | 52.5 | 48.1 | 49.4 | 45.1 | 48.7 | 33.9 | 37.8 | 525.8 |

#### 7.2.2 Analysis of Baseline Energy Consumption:

The simulation results for baseline case consumption revealed that the primary energy usage is attributed to area lighting and space cooling. Miscellaneous equipment consumption remains consistent across both the proposed and baseline cases. The remaining energy consumption is allocated to ventilation fans.

## ECBC Compliance Report

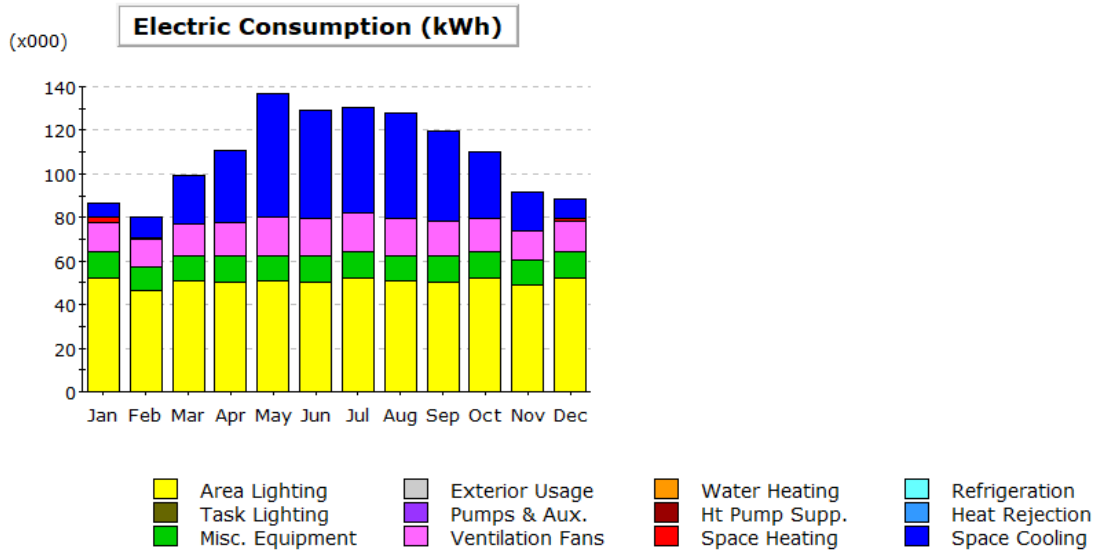


Figure 11 Baseline Consumption Graph

### 7.2.3 Proposed Case Consumption

|              | Jan       | Feb         | Mar         | Apr         | May         | Jun         | Jul         | Aug       | Sep         | Oct         | Nov         | Dec         | Total        |
|--------------|-----------|-------------|-------------|-------------|-------------|-------------|-------------|-----------|-------------|-------------|-------------|-------------|--------------|
| Space Cool   | 2.1       | 3.7         | 9.2         | 11.8        | 19.6        | 16          | 15.7        | 15.7      | 12.2        | 12.5        | 6.9         | 4.9         | 130.3        |
| Heat Reject. | 0         | 0           | 0           | 0           | 0           | 0           | 0           | 0         | 0           | 0           | 0           | 0           | 0            |
| Vent. Fans   | 5.6       | 6.4         | 5.6         | 7.4         | 8           | 7.8         | 7.7         | 8.1       | 6           | 7.1         | 4.3         | 6.2         | 80.2         |
| Pumps & Aux. | 0         | 0           | 0           | 0           | 0           | 0           | 0           | 0         | 0           | 0           | 0           | 0           | 0            |
| Ext. Usage   | 0         | 0           | 0           | 0           | 0           | 0           | 0           | 0         | 0           | 0           | 0           | 0           | 0            |
| Misc. Equip. | 5.1       | 4.3         | 5.2         | 4.3         | 5.4         | 4.3         | 4.5         | 5.4       | 3.1         | 4.5         | 4.2         | 5.1         | 55.4         |
| Task Lights  | 0         | 0           | 0           | 0           | 0           | 0           | 0           | 0         | 0           | 0           | 0           | 0           | 0            |
| Area Lights  | 18.2      | 15.4        | 16.8        | 17.2        | 17.8        | 17.2        | 18.7        | 18.8      | 18.2        | 18.7        | 16.4        | 17.2        | 210.6        |
| <b>Total</b> | <b>31</b> | <b>29.8</b> | <b>36.8</b> | <b>40.7</b> | <b>50.8</b> | <b>45.3</b> | <b>46.6</b> | <b>48</b> | <b>39.5</b> | <b>42.8</b> | <b>31.8</b> | <b>33.4</b> | <b>476.5</b> |

Figure 12 Proposed Consumption

### 7.2.4 Analysis of Proposed Energy Consumption

The simulation results highlight the Proposed Case Consumption, with miscellaneous equipment consumption remaining the same as the baseline. The primary energy consumption is attributed to space cooling, where the proposed system incorporates VRF systems. To enhance efficiency, the project should adopt LED lighting, as lighting power density (LPD) represents the second-highest energy consumption in the building.

## ECBC Compliance Report

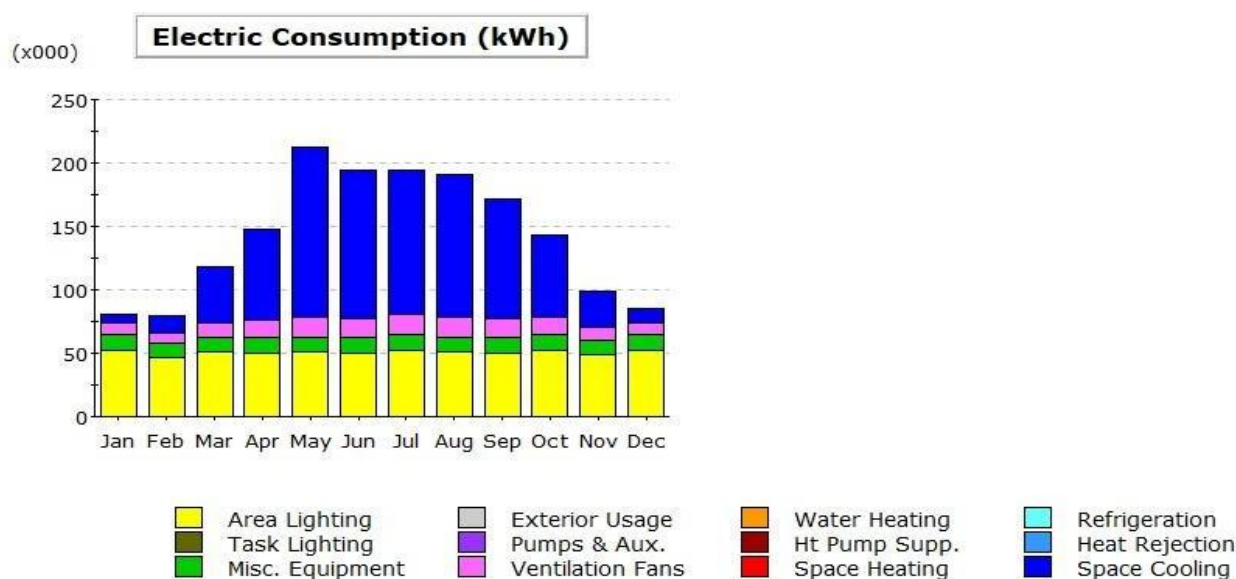


Figure 13 Proposed Consumption Graph

### 7.2.5 Summary and Results of the Simulation

The whole building simulation approach has been used for the project for the ECBC compliance. The models have been prepared for both the cases – Baseline and proposed. The proposed case annual consumption after simulation is around 4,76,535 kWh and for baseline case is 5,25,820 kWh. The results are summarized in the table below:

| S. No | Case Description     | Unit              | Values   |
|-------|----------------------|-------------------|----------|
| 1.    | Proposed Consumption | (kWh)             | 4,76,535 |
| 2.    | Baseline Consumption | (kWh)             | 5,25,820 |
| 3.    | Built-up Area        | (Sq. m.)          | 5622     |
| 4.    | Proposed EPI         | (kWh/Sq. m./year) | 84.7     |
| 5.    | Baseline EPI         | (kWh/Sq. m./year) | 93.5     |
| 6.    | EPI Ratio            | Unitless          | 0.90     |

Table 9 Calculation and Results

It can be observed that the EPI ratio for the project is **0.90** i.e. less than **1** (minimum requirement of EPI ratio as per ECBC for composite climate) hence, the project fulfils the ECBC compliance requirement.

Therefore, the project achieves energy saving of **9.3%** when compared with ECBC baseline case. Thereby, project is meeting the ECBC compliance by 'Whole Building Performance' approach.

### 8. Conclusion-

1. Mother and Child Hospital Building in Palwal District, Haryana spans a built-up area of 5622 m<sup>2</sup>. The project consists of Ground, First and Second Floor (G+2).
2. The project aims to achieve ECBC compliance by utilizing a whole-building simulation approach to attain an Energy Performance Index (EPI) ratio of less than 1, as required for compliance within the relevant building category.
3. The energy performance analysis of the building was conducted using eQUEST Version 3.65. This software, aligned with ECBC requirements, operates on the DOE-2.2 simulation engine.
4. The project considers Palwal, Haryana Composite climate conditions as per ECBC guidelines. Consequently, the weather file for the project is "IND\_Delhi.\_ISHRAE.BIN" was used in the simulation software for both the baseline and proposed cases.
5. The Window-to-Wall Ratio (WWR) of the building is approximately 2.94%, which is significantly below the maximum prescriptive value of 40% set by ECBC standards.
6. For the proposed design, envelope specifications (external wall, roof, windows, skylights & doors) are derived from the actual case, while the baseline case follows ECBC standards.
7. The project's proposed lighting power density (LPD) was considered to be 0.76 W/ft<sup>2</sup> across different space types, which are very efficient from the standard ECBC design which is 0.87 W/ft<sup>2</sup>.
8. The proposed case incorporates efficient VRV systems with a COP of 3.6 and VRV system with COP of 3.28 used of standard ECBC case.
9. The calculated annual energy consumption for the proposed case is 4,76,535 kWh, which is less than the baseline case consumption of 5,25,820 kWh.
10. Based on the proposed and baseline annual energy consumption, the building achieves an Energy Performance Index (EPI) ratio of 0.90, hence meeting the ECBC compliance requirement of less than 1.
11. It is recommended that the proposed building meets the minimum fresh air requirements as specified in the NBC. Furthermore, transformers, DG sets, UPS, motors, and renewable energy systems should have at least the minimum BEE star rating or comply with the efficiency and capacity requirements outlined in the ECBC.
12. It is also recommended that the project building utilize high-SRI (Solar Reflectance Index) paint or tiles on the roof to minimize unwanted heat generation, thereby reducing the energy required for space cooling.

## ECBC Compliance Report

13. It is recommended that the proposed building meets the minimum fresh air requirements as specified in the NBC. Furthermore, transformers, DG sets, UPS, motors, and renewable energy systems should have at least the minimum BEE star rating or comply with the efficiency and capacity requirements outlined in the ECBC.
14. It is also recommended that the project building utilize high-SRI (Solar Reflectance Index) paint or tiles on the roof to minimize unwanted heat generation, thereby reducing the energy required for space cooling.

## ECBC Compliance Report

### 9. Checklist as per ECBC compliance requirements

| S. No.                   | Parameter                                                   | ECBC case                                                                                                                             | Proposed Case | Remarks                                          |
|--------------------------|-------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|---------------|--------------------------------------------------|
| <b>Building Envelope</b> |                                                             |                                                                                                                                       |               |                                                  |
| 1.                       | 4.2.1                                                       | Fenestration Rating                                                                                                                   |               |                                                  |
| 2.                       | Specify whether per 4.2.1.1 or default in Appendix C        | U-factor                                                                                                                              | Complied      | <b>Using Whole Building Performance Approach</b> |
| 3.                       | Specify whether per 4.2.1.2 or default in Appendix C        | SHGC                                                                                                                                  | Complied      | <b>Using Whole Building Performance Approach</b> |
| 4.                       | Specify whether per default in Appendix C or ASHRAE         | Opaque U-factors                                                                                                                      | Complied      | <b>Using Whole Building Performance Approach</b> |
| 5.                       | Indicate sealing, caulking, gasketing and weather stripping | Bldg. envelope sealing                                                                                                                | Recommended   |                                                  |
| <b>HVAC Parameters</b>   |                                                             |                                                                                                                                       |               |                                                  |
| 1                        | Ventilation (5.2.1-ECBC 2017):                              | Necessary provisions of NBC 2016 including the design guidelines for Natural /mechanical/Mixed mode ventilation                       | Recommended   |                                                  |
| 2                        | Demand Control Ventilation (5.2.1.3- ECBC 2017):            | Mechanical ventilation systems shall have demand control ventilation if they provide outdoor air greater than 1,500 litres per second | NA            |                                                  |
| 3                        | Ductwork Insulation (5.2.6.1-ECBC 2017):                    | Ductwork and plenum shall be insulated in accordance with Table 5-11(ECBC-2017)                                                       | NA            |                                                  |
| 4                        | Piping Insulation (5.2.6.1-ECBC 2017):                      | Piping for space conditioning shall meet the insulation requirements listed in Table 5-10 (ECBC 2017).                                | Recommended   |                                                  |

## ECBC Compliance Report

|                            |                                                         |                                                                                                                                                                                                  |             |  |
|----------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--|
| 5                          | Fan Controls<br>(5.2.3.4-ECBC 2017):                    | two speed motors, pony motors, or variable speed drives to control the fans                                                                                                                      | NA          |  |
| 6                          | Centralized Demand Shed Controls (5.2.4.1-ECBC 2017):   | Building Management System (BMS)/SCADA to control HVAC Demand                                                                                                                                    | NA          |  |
| 7                          | Variable Air Volume Fan Control<br>(5.2.5.1-ECBC 2017): | Fans in Variable Air Volume (VAV) systems in Buildings shall have controls or devices that will result in fan motor demand of no more than 30% of their design wattage at 50% of design airflow. | NA          |  |
| 8                          | Air-Handling Units<br>(5.3-ECBC 2017):                  | 60%                                                                                                                                                                                              | NA          |  |
|                            |                                                         | IE2                                                                                                                                                                                              | NA          |  |
| 9                          | Variable Speed Drives<br>(5.3.4.3-ECBC 2017)            | Pump motors greater than or equal to 3.7 kW shall be controlled by variable speed drives                                                                                                         | NA          |  |
| <b>Lighting Parameters</b> |                                                         |                                                                                                                                                                                                  |             |  |
| 1                          | Lighting Control<br>(6.2.1-ECBC 2017):                  | 90% of interior lighting fittings in buildings or space larger than 300 m <sup>2</sup> shall be equipped with automatic control devices                                                          | Recommended |  |
| 2                          | Exterior lighting Control<br>(6.2.1.5-ECBC 2017):       | Photo sensor or astronomical time switch                                                                                                                                                         | Recommended |  |
| 3                          | Exit signs<br>(6.2.2 -ECBC 2017):                       | The lighting power for energy exit signs shall not exceed a maximum of 5 watts.                                                                                                                  | Recommended |  |

## ECBC Compliance Report

| Electrical Parameters |                                                           |                                                                                                                                                |             |  |
|-----------------------|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--|
| 1                     | Transformer<br>(7.2.1-ECBC 2017):                         | Transformer shall be used with maximum losses of at 50% and full load rating as per ECBC                                                       | Recommended |  |
| 2                     | Power factor correction<br>(7.2.5 -ECBC 2017):            | The Building Shall maintain the minimum power factor 0.97                                                                                      | Recommended |  |
| 3                     | Uninterruptible Power Supply (UPS)<br>(7.2.7 -ECBC 2017): | UPS shall meet or exceed the minimum energy efficiency requirements of ECBC                                                                    | Recommended |  |
| 4                     | Renewable Energy Systems<br>(7.2.7 -ECBC 2017):           | Minimum Electricity to be Generated as 1% of Total Electrical Load                                                                             | Recommended |  |
| 5                     | Diesel Generator (DG) Sets (7.2.3 -ECBC 2017):            | BEE 3 Star Rated DG sets shall be used in all compliant buildings                                                                              | Recommended |  |
| 6                     | Voltage Drop (7.2.1.3 -ECBC 2017):                        | Voltage drop for feeders shall not exceed the minimum prescribed as Per ECBC                                                                   | Recommended |  |
| 7                     | Check Metering and monitoring (7.2.4-ECBC 2017):          | Services exceeding 1000 kVA shall have permanently installed electrical metering to record demand (kVA), energy (kWh), and total power factor. | Recommended |  |
| 8                     | Energy Efficient Motors<br>(7.2.2-ECBC 2017):             | Buildings shall have IE 2(high efficiency) class motors                                                                                        | Recommended |  |

Note: - This check list is proposed as ECBC compliance.

# ECBC Compliance Report

## 10. Appendix

### 10.1 Floor Plans

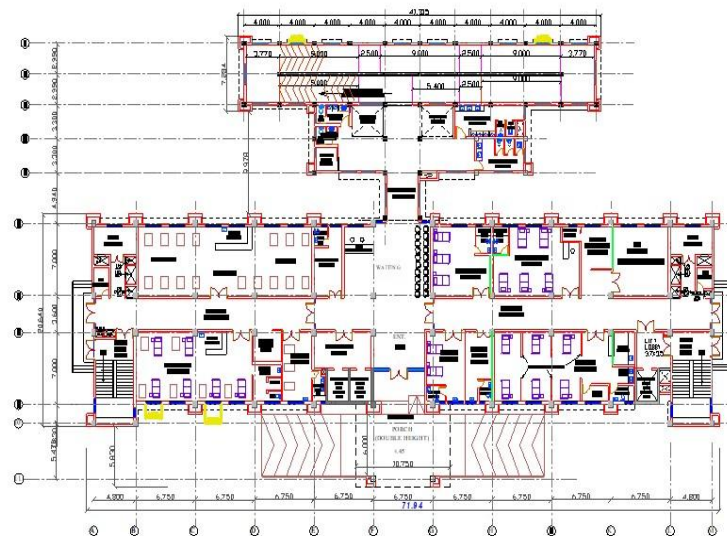


Figure 14- Ground Floor plan

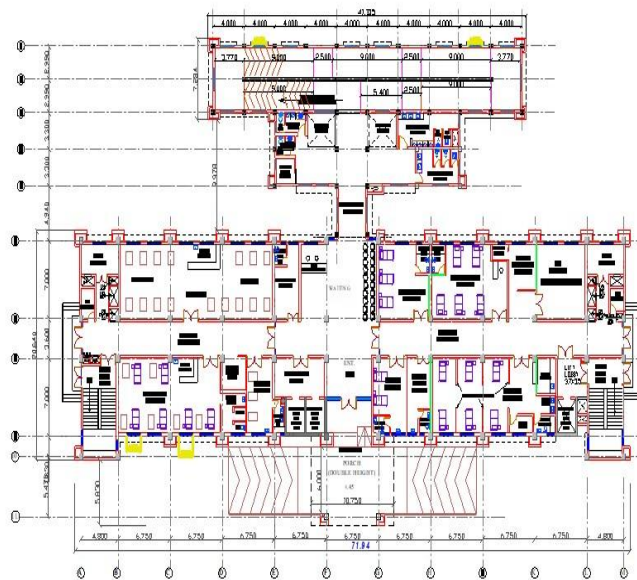


Figure 15- First Floor pan

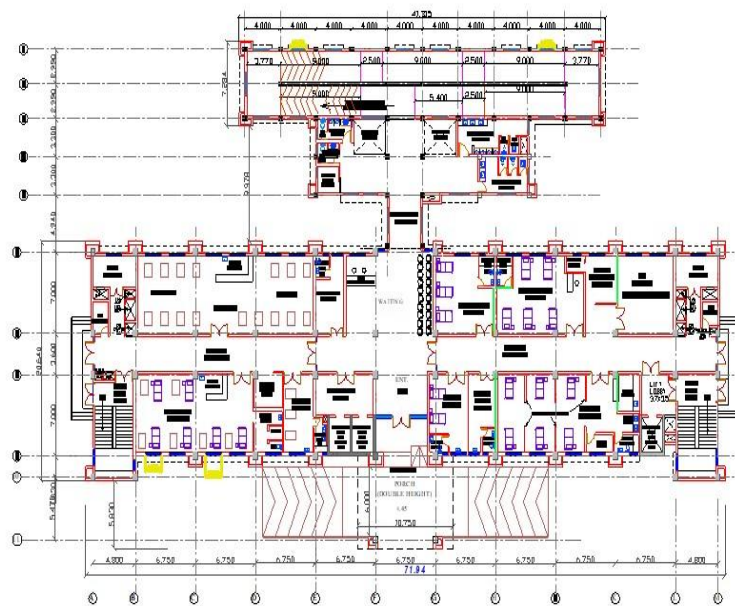


Figure 16- Second Floor plan

THANK YOU