GOVERNMENT OF INDIA/BHARAT SARKAR
MINISTRY OF RAILWAYS/RAIL MANTRALAYA
(RAILWAY BOARD

No. 2016/Elect(G)/150/9 New Delhi, dt. 08.03.2018

General Managers,
All Indian Railways & PUs

Sub:- Energy Efficiency guidelines for all new Railway Buildings

Ref:- BEE's letter No. 09/06/07/IMPL/ECBC/2510-12 dt.29.05.17

Energy efficiency guidelines for redevelopment of Railway stations and other buildings have been developed with Super ECBC compliance, i.e. **40% more energy savings against ECBC compliant as per new Energy Conservation Building Code (ECBC) 2017. This code has been developed by Bureau of Energy efficiency (BEE)** which has been set up under the Energy Conservation Act 2001 with a mandate to initiate programmes and schemes in India for energy efficiency.

2. These Super ECBC guidelines have been developed with a goal to minimize energy demand through climatic responsive building design and energy efficient technologies. They could also harvest renewable energy on-site through a combination of technologies like solar, geo-thermal, biomass, wind etc. These guidelines include in its scope the building envelop and fenestration, comfort systems, control, electrical systems and renewable energy systems also. The detailed guidelines developed by BEE are enclosed*.

3. These guidelines shall be made part of scope of work/specification for all new buildings that will be constructed in future having area more than 2500 sqm. However, in the cases of buildings having area less than 2500 sqm, these guidelines should be made "desirable" and Residential buildings/complex less than 2500 sqm area will not be covered under scope of ECBC 2017 concept.

4. This issues with the approval of Board (MTR & ME).

*DA

08/3/18
(Punit Agrawal)
Director Elect.Engg.(PS)
Railway Board

No. 2016/Elect(G)/150/9 New Delhi, dt. .03.2018

Copy to: PEE's of all Zonal Railways- For information and necessary action please.

08/03/18
(Chander Shekhar)
Joint Director(L&A)
Railway Board

Copy to : i) PCEE's of all Zonal Railways- For information and necessary action please.
ii) CMDs of all Railway PSUs

08/3/18
(Punit Agrawal)
Director Elect.Engg.(PS)
Railway Board

अभय बाकरे, आईआरएसईई
महानिदेशक

ABHAY BAKRE, IRSEE
Director General

सत्यमेव जयते

ENERGY IS LIFE
CONSERVE IT

ऊर्जा दक्षता ब्यूरो
(भारत सरकार, विद्युत मंत्रालय)

BUREAU OF ENERGY EFFICIENCY
(Government of India, Ministry of Power)

F.No. 09/06/07/IMPL/ECBC/2510-12

Date: May 29, 2017

To
Shri Ghanshyam Singh, IRSEE
Member (Traction), Railway Board,
Room No.212, Rail Bhawan,
New Delhi-110001

Subject: Energy Efficiency guidelines for Redevelopment of Safdarjung Railway Station for SuperECBC compliance.

This has reference to the discussions held between Ministry of Railways and the officials of Bureau of Energy Efficiency (BEE).

BEE was set up under the Energy Conservation Act 2001 with the mandate to initiate programmes and schemes in India on Energy Efficiency. The building sector has been found to be a key potential area for implementing energy conservation measures. BEE has recently developed Energy Conservation Building Code (ECBC) 2017 with an objective to promote higher standards in Energy Efficient buildings. Under the new code ECBC 2017, following categories are included:

i. ECBC compliance building as per new code.
ii. ECBC plus having 20% more efficiency.
iii. Super ECBC building having about 40% energy savings against item 1 above.

Super ECBC buildings are designed and developed with a goal to minimize energy demand through climatic responsive building design and energy efficient technologies. They could harvest renewable energy on-site through a combination of technologies like solar, geo-thermal, biomass, wind, etc. to become Near Zero establishments.

M/o Railways is requested to incorporate the specifications for SuperECBC compliant buildings in the redevelopment of Safdarjung Railway Station for creating exemplary Energy Efficient Railway Stations. BEE is willing to support this endeavor of M/o Railways by providing technical assistance. Following documents are attached for your kind perusal:

a. Technical Assistance proposal from Bureau of Energy Efficiency
b. Specifications for SuperECBC compliant Railway Station buildings
c. Case Studies of ECBC compliant buildings

M/o Railways may also consider Implementation of SuperECBC measures in all future redevelopment of Railway Stations with the above technical assistance.

Yours sincerely,

A Bakre 29/5/17

(Abhay Bakre)

Encl: a/a

Copy to:
1. Shri R. K. Chaudhary, Advisor (Station Development) Railway Board, Rail Bhawan, New Delhi.
2. Shri Sudhir Garg, EDEEM, Railway Board, Rail Bhawan, New Delhi.

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TECHNICAL ASSISTANCE FOR REDEVELOPMENT OF SAFDARJUNG RAILWAY STATION

Technical Assistance for Redevelopment of Safdarjung Railway Station

1 BACKGROUND

Built environment is a significant contributor to the global warming due to extensive emission of greenhouse gases (GHGs) from the buildings. Building sector accounts to about 35 percent of total energy used in India. The project aims to assist the redevelopment of Safdarjung Railway Station at New Delhi for Energy Conservation Building Code (ECBC) compliance, through a comprehensive and integrated approach.

The new ECBC 2017 standard sets stringent minimum energy efficiency standard for new buildings. Super ECBC buildings aim towards a near zero target and are 30-40% more efficient than ECBC. Super ECBC buildings are designed to be amongst the most energy efficient on any global scale. With addition of renewable energy on-site, Super ECBC buildings can easily become Net Zero. Pilot projects can showcase the performance and cost-benefit of such buildings in order to accelerate transition to Super ECBC standards. The demonstration can showcase the advantages of energy efficient buildings at the same time also incorporate the state of the art of building products, technology and building energy management tools.

2 SUPPORT OFFERED BY BEE

Project will support by providing technical assistance for incorporating energy efficiency measures. The scope of work includes following tasks:

- ✓ Task 1. Provide specifications for ECBC compliant equipment to assist in preparation of tender document
- ✓ Task 2. Evaluate and endorse building design drawings, specifications for ECBC compliance. Assess baseline EPI based on building simulation
- ✓ Task 3. Monitor construction progress, provide guidance and recommendations to align with ECBC
- ✓ Task 4. Review As-built drawings and equipment, confirm compliance to design
- ✓ Task 5. Monitor, verify performance data in terms of EPI

3 DELIVERABLES AND MILESTONES

The Task based deliverables and milestones will be as follows:

	Task	**Deliverable**
1	Task 1 report: Provide specifications for ECBC compliant equipment	• Report enclosing equipment specifications for ECBC compliance • Assist in preparation of tender document o Support in tender evaluation process
2	Task 2 report: Evaluate, endorse building	• A report to be developed that should have details of o Proposed design drawings incorporating

	design drawings, specifications for ECBC compliance and estimate Baseline EPI	mandatory provisions of ECBC o Load calculations with list of approved equipment and material specifications o Input and output compliance report of simulation modelling of Standard Design and Proposed Design as per Whole Building Performance method specified in ECBC
3	Task 3 report: Monitor construction progress, provide guidance and recommendations to align with ECBC	• A task report to be developed that should include details of o construction progress status with details of support provided o validated specification sheets of materials and equipment that building developers have procured and installed
4	Task 4 report: Review As-built drawings and equipment, confirm compliance to design	• A task report to be developed that should include details of o Endorsement of As-built drawings matching with approved design drawings, material and equipment specification o ECBC compliance/conformity check report as specified in Appendices of ECBC
5	Task 5 report: Acquire, verify performance data and demonstrate reduction on baseline EPI	• Perform annual energy audit and prepare a task report that should include details of o Building EPI data

4 ELEMENTS OF A SUPER ECBC BUILDING:

There are five basic critical elements of a successful Net-Zero Energy Building that include building design, efficient lighting and HVAC technologies, renewable energy, energy efficient appliances and plug loads, and finally, the behavior and lifestyle of the building occupants in favor of energy conservation.

1. Building Design: The most critical and cost-effective step for reducing energy consumption in a building starts with a climatic responsive building design process. A zero energy building design departs from conventional construction practices and combines innovative strategies that include natural ventilation, passive heating and cooling, day-lighting, high performance windows, insulation and thermal mass.

2. Energy Efficient Systems: After optimization of energy consumption through architectural design features, a Super ECBC building incorporates energy efficient building systems/technologies for lighting, heating and cooling to provide occupant comfort with minimal energy usage. Super ECBC buildings are also designed to make optimal use of all energy sources- including waste heat; for example, using refrigerator exhaust to heat domestic water, hot water heat recycling, combined heat and power etc.

3. Renewable Energy: Going beyond Super ECBC, NZEB's harvest energy from renewable energy to meet their electricity and heating or cooling needs. The choice of renewable technologies is carefully made after evaluating many parameters that include available renewable sources, efficiency, cost, etc., and examples include micro-generation, solar, wind, biofuels, hydro etc. The diurnal and seasonal fluctuations in demand may be

managed by using thermal storage and/or and staying connected to the electric grid, which allows a NZEB to use grid power when facing an energy deficit and exporting electricity to the grid when there is a surplus.

4. Energy Efficient Appliances: Super ECBC buildings should also incorporate the usage of highly energy efficient appliances such as office equipment, consumer electronics and other plug loads. The management of these appliances is also carefully monitored to avoid phantom loads and wastage of energy during times when appliances are not in use.

5. Occupant Behavior: Super ECBC buildings can be made operationally successful through modification of occupant behavior and finding an optimal programming for thermostats, lighting levels, hot water temperatures, etc.

Table 3. Key Specifications of Super ECBC building Office building

Building envelope			
Roof insulation	0.2	W/m2K	In all climatic zones
Wall insulation	0.22	W/m2K	In all climatic zones
Vertical Fenestration			
SHGC	0.27		
U Value	3	W/m2K	
VLT	0.27		
Comfort Systems and Controls			
Chiller (Water Cooled)	COP ranges from 5.8 to 6.7 depending on the size of chiller		
Fan efficiency	70%		
Motor Efficiency	IE4		
Chilled Water Pump (Primary & Secondary)	14.9	W/ kWr with VFD on secondary pump	
Condenser Water Pump	14.6	W/ kWr	
Pump Efficiency	85%		
Cooling tower	0.017	kW/kWr	
Alternately, system efficiency	0.2	kW/ kWr	
Mandatory piping and ducting insulation			
Lighting and Controls			
Use of LEDs	Lighting power density requirement is 50% more efficiency compared to ECBC level		
Use of lighting controls			
Electrical and Renewable Systems			
Most energy efficient transformers as per IS 1180			
Motor efficiency	IE4		
DG set	5 Star BEE star rated		
Power factor correction	0.99		
Power distribution loss	1%		
RE generation	4%		

Energy Efficiency Guidelines for Redevelopment of Safdarjung Railway Station

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Specifications for SuperECBC Compliance

Draft Report v1.0
5/26/2017

Prepared by Bureau of Energy Efficiency, Ministry of Power, Government of India

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1 Purpose

The purpose of these guidelines is to provide requirements for the energy-efficient design and construction of Safdarjung Railway Station buildings.

1.1 Precedence

The following codes, programs, and policies will take precedence over the Code in case of conflict:

(a) State or Central Government notified statutory act or rules on safety, security, health, or environmental issues,

(b) Bureau of Energy Efficiency's Standards and Labelling for appliances and Star Rating Program for buildings, provided both or either are more stringent than the requirements of this Code,

(c) Any policy notified as taking precedence over this Code, by Central, State, or Local Government.

1.2 Reference Standards

The National Building Code of India (NBC) is the reference standard for lighting levels, heating, ventilating, and air conditioning (HVAC), thermal comfort conditions, natural ventilation, and any other building materials and system design criteria addressed in this Code.

2 Building Envelope

2.1 Building Envelope Sealing

Following areas of the building envelope, of all except naturally ventilated buildings or spaces, shall be sealed, caulked, gasketed, or weather-stripped:

(a) Joints around fenestration, skylights, and door frames

(b) Openings between walls and foundations, and between walls and roof, and wall panels

(c) Openings at penetrations of utility services through roofs, walls, and floors

(d) Site-built fenestration and doors

(e) Building assemblies used as ducts or plenums

(f) All other openings in the building envelope

(g) Exhaust fans shall be fitted with a sealing device such as a self-closing damper

(h) Operable fenestration should be constructed to eliminate air leakages from fenestration frame and shutter frame

2.2 Roof

Roofs shall comply with the maximum assembly U-factor of 0.20 W/m2K. The roof insulation shall be applied externally as part of structural slab and not as a part of false ceiling.

2.3 Opaque External Wall

Opaque above grade external walls shall comply with the maximum assembly U-factor of 0.22 W/m2K.

2.4 Vertical Fenestration

For all climatic zones, vertical fenestration compliance requirements shall comply with the following:

(a) Maximum area weighted U-factor is 3 W/m²K. The U-factor shall include both frame and glass for effective U-factor

(b) Minimum allowable Visual Light Transmittance (VLT) is 0.27

(c) Vertical fenestration shall comply with the following:

i. Maximum SHGC Non-North - 0.27

ii. Maximum SHGC North - 0.50

2.5 Skylights

Skylights shall comply with the following:

(a) maximum U-factor – 4.25 3 W/m²K

(b) maximum SHGC requirements – 0.35

2.6 Vegetated and Cool Roof

All roofs that are not covered by solar photovoltaics, or solar hot water, or any other renewable energy system, or utilities and services that render it unsuitable for the purpose shall be either cool roof or vegetated roof.

a) For compliance to cool roof, roofs with slopes less than 20° shall have an initial solar reflectance of no less than 0.60 and an initial emittance no less than 0.90. Solar reflectance shall be

determined in accordance with ASTM E903-96 and emittance shall be determined in accordance with ASTM E408-71 (RA 1996).

b) For compliance to vegetated roof, roof areas shall be covered by living vegetation.

3 Comfort Systems and Controls

3.1 Natural Ventilation Air Quantity Design Requirements

Naturally ventilated building or spaces in a mixed-mode ventilated building that are naturally ventilated shall:

(a) Comply with guidelines provided for natural ventilation in National Building Code of India

(b) Have permanent roof or wall openings, windows, doors, louvres to the outdoors, or other apertures for ventilation, the openable area of which shall not be less than 5% of the floor area of the naturally ventilated space. Openable area shall be calculated on basis of free unobstructed area through the opening.

(c) Have BEE 5 star rated ceiling fans, if provided with ceiling fans

The design guidelines on natural ventilation stated in the relevant section of NBC should be referred to achieve the requirements on natural ventilation.

3.2 Mechanical Ventilation Air Quantity Design Requirements

Buildings that are ventilated using a mechanical ventilation system or spaces in mixed-mode ventilated buildings that are ventilated with a mechanical system, either completely or in conjunction with natural ventilation systems, shall:

(a) install mechanical systems that provide outdoor air change rate as per National Building Code of India

(b) have a ventilation system controlled by CO sensors for basement carpark spaces with total car park space greater than or equal to 600 m^2.

3.3 Demand Control Ventilation

Mechanical ventilation systems shall have demand control ventilation if they provide outdoor or fresh air greater than 1500 liters per second, to a space greater than 50 m^2, with occupant density exceeding 40 people per 100 m^2 of the space, and are served by one or more of the following systems:

(a) An air side economizer

(b) Automatic outdoor modulating control of the outdoor air damper

3.4 Chillers

Chillers shall meet or exceed the minimum efficiency requirements presented in Table 3-1 under ANSI/ AHRI 550/ 590 conditions. The application of air-cooled chiller is allowed in all buildings with cooling load less than 530 kW. For buildings with cooling load equal to or greater than 530 kW, the number of air-cooled chiller shall be restricted to 33% of the total installed chilled water capacity.

Table 3-1 Minimum Energy Efficiency Requirements for water cooled Chillers

	SuperECBC Building	
Chiller Capacity (kWr)	COP	IPLV
<260	5.8	7.1
≥260 & <530	6.0	7.9
≥530 &<1050	6.3	8.4
≥1050 &<1580	6.5	8.8
≥1580	6.7	9.1

3.5 Unitary, Split, Packaged Air-Conditioners

Unitary air-conditioners shall meet or exceed the efficiency requirements presented in Table 3-2. EER shall be as per IS 8148 for all unitary, split, packaged air conditioners greater than 10 kWr.

Table 3-2 Minimum Requirements for Unitary, Split, Packaged Air Conditioners in SuperECBC Building

Cooling Capacity (kWr)	Water Cooled	Air Cooled
≤ 10.5	NA	BEE 5 Star
>10.5	3.9 EER	3.4 EER

*Table 3-3 Minimum Efficiency Requirements for VRF Air conditioners for ECBC Building**

		For Heating or cooling or both	
Type	Size category (kWr)	EER	IEER
VRF Air Conditioners,	< 40	3.28	4.36
Air cooled	>= 40 and < 70	3.26	4.34
	>= 70	3.02	4.07

3.6 HVAC Controls

3.6.1 Timeclock

Mechanical cooling and heating systems shall be controlled by timeclocks that:

(a) Can start and stop the system under different schedules for three different day-types per week,

(b) Are capable of retaining programming and time setting during loss of power for a period of at least 10 hours, and

(c) Include an accessible manual override that allows temporary operation of the system for up to 2 hours.

3.6.2 Temperature Controls

Mechanical heating and cooling equipment 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. These controls should meet the following requirements:

(a) where a unit provides both heating and cooling, controls shall be capable of providing a temperature dead band of 3°C within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum

(b) where separate heating and cooling equipment serve the same temperature zone, thermostats shall be interlocked to prevent simultaneous heating and cooling

3.6.3 Occupancy Controls

Occupancy controls shall be installed to de-energize the ventilation and/or air conditioning systems when there are no occupants in:

(a) each guest room

(b) Each toilet with more than 2 water closets and/ or 3 urinals

(c) Each conference and meeting room, of size more than 80 m^2

3.6.4 Fan Controls

Cooling towers shall have fan controls based on wet bulb logic, with either:

(a) two speed motors, pony motors, or variable speed drives controlling the fans, or

(b) controls capable of reducing the fan speed to at least two third of installed fan power

3.6.5 Dampers

All air supply and exhaust equipment, having a Variable Frequency Drive (VFD), shall have dampers that automatically close upon:

(a) Fan shutdown, or,

(b) When spaces served are not in use

(c) Backdraft gravity damper is acceptable in the system with design outdoor air of the system is less than 150 liters per second, provided backdraft dampers for ventilation air intakes are protected from direct exposure to wind.

(d) Dampers are not required in ventilation or exhaust systems serving naturally conditioned spaces.

(e) Dampers are not required in exhaust systems serving kitchen exhaust hoods.

3.6.6 Centralized Demand Shed Controls

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

(a) 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.

(b) 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

(c) Controls that can provide an adjustable rate of change for the temperature setup and reset

The centralized demand shed controls shall have additional capabilities to

i. Be disabled by facility operators

ii. Be manually controlled from a central point by facility operators to manage heating and cooling set points

3.6.7 Supply Air Temperature Reset

Multi zone mechanical cooling and heating systems shall have controls that automatically reset the supply-air temperature in response to building loads or to outdoor air temperature. Controls shall reset the supply air temperature to at least 25% of the difference between the design supply air temperature and the design room air temperature.

3.6.8 Chilled Water Temperature Reset

Chilled water systems with a design capacity exceeding 350 kWr supplying chilled water to comfort conditioning systems shall have controls that automatically reset supply water temperatures by representative building loads (including return water temperature) or by outdoor air temperature.

3.6.9 Variable Air Volume Fan Control

Fans in Variable Air Volume (VAV) systems 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 when static pressure set point equals one-third of the total design static pressure, based on manufacturer's certified fan data.

3.7 Piping and Ductwork

3.7.1 Piping Insulation

Piping for heating, space conditioning, and service hot water systems shall meet the insulation requirements listed in Table 3-4. 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.

Table 3-4 Insulation Requirements for Pipes in SuperECBC Buildings

Operating Temperature (ºC)	**Pipe size (mm)**	
	< 40	>=40
	Insulation R value (m^2-ºK/W)	
Heating System		
94°C to 121°C	1.5	1.5
60°C to 94°C	1.0	1.3
40°C to 60°C	0.7	1.1
Cooling System		
4.5°C to 15°C	0.7	1.2
< 4.5°C	1.5	1.5
Refrigerant Piping (Split Systems)		
4.5°C to 15°C	0.4	0.7
< 4.5°C	1.5	1.5

3.7.2 Ductwork and Plenum Insulation

Ductwork and plenum shall be insulated in accordance with Table 3-5.

Table 3-5 Ductwork Insulation (R value in m^2K/W) Requirements

Duct Location	**Supply ducts**	**Return ducts**
Exterior	R -1.4	R -0.6
Unconditioned Space	R -0.6	None
Buried	R -0.6	None

3.8 System Balancing

Compliance documents shall include a written balance report from a third-party commissioning consultant.

3.9 Condenser Location

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.

3.10 Fan Efficiency

Supply, exhaust, and return or relief fans with motor power exceeding 0.37 kW shall meet or exceed the minimum energy efficiency requirements specified in Table 3-6

Table 3-6 Mechanical and Motor Efficiency Requirements for Fans in SuperECBC Buildings

System Type	***Fan Type***	***Mechanical Efficiency***	***Motor Efficiency (As per IS 12615)***
Air-handling unit	Supply, return and exhaust	70%	IE 4

3.11 Pumps

Chilled and condenser water pumps shall meet or exceed the minimum energy efficiency requirements specified in Table 3-7. Requirements for pumps in district chiller systems and hot water pumps for space heating are limited to the installed efficiency requirement of individual pump equipment only. To show compliance, calculate the total installed pump capacity in kilo watt and achieve the prescribed limits per kilo watt of refrigeration installed in the building.

Table 3-7 Pump Efficiency Requirements for SuperECBC Building

Equipment	*SuperECBC Building*
Chilled Water Pump (Primary and Secondary)	14.9 W/ kW_r with VFD on secondary pump
Condenser Water Pump	14.6 W/ kW_r
Pump Efficiency (minimum)	85%

3.12 Cooling Towers

Cooling towers shall meet or exceed the minimum efficiency requirements specified in Table 3-8. Buildings shall have additional VFD installed in the cooling towers.

Table 3-8 Cooling Tower Efficiency Requirements for ECBC, ECBC+, and SuperECBC Buildings

Equipment type	*Rating Condition*	*Efficiency**
Open circuit cooling tower Fans	35°C entering water 29°C leaving water 24°C WB outdoor air	0.017 kW/kW_r *0.31 kW/ L/s*

3.13 Economizer

Each individual cooling fan system shall include either:

(a) An air economizer capable of modulating outside-air and return-air dampers to supply 50 percent of the design supply air quantity as outside-air.

(b) A water economizer capable of providing 50% of the expected system cooling load at outside air temperatures of 10°C dry-bulb/7.2°C wet-bulb and below.

3.13.1 Partial Cooling

Economizers shall be capable of providing partial cooling even when additional mechanical cooling is required to meet the cooling load.

3.13.2 Controls

Air economizer shall be equipped with controls

(a) That allow dampers to be sequenced with the mechanical cooling equipment and not be controlled by only mixed air temperature.

(b) capable of automatically reducing outdoor air intake to the design minimum outdoor air quantity when outdoor air intake will no longer reduce cooling energy usage.

(c) High-limit shutoff shall be specified.

3.14 Variable Flow Hydronic Systems

3.14.1 Variable Fluid Flow

HVAC pumping systems having a total pump system power exceeding 7.5 kW shall be designed for variable fluid flow and shall be capable of reducing pump flow rates to an extent which is lesser or equal to the limit, where the limit is set by the larger of:

(a) 50 per cent of the design flow rate, or

(b) the minimum flow required by the equipment manufacturer for proper operation of the chillers or boilers.

3.14.2Isolation Valves

Water cooled air-conditioning or heat pump units with a circulation pump motor greater than or equal to 3.7 kW shall have two-way automatic isolation valves on each water cooled air-conditioning or heat pump unit that are interlocked with the compressor to shut off condenser water flow when the compressor is not operating.

3.14.3Variable Speed Drives

Chilled water or condenser water that have pump motors greater than or equal to 3.7 kW shall be controlled by variable speed drives.

3.15 Energy Recovery

All systems of capacity greater than 2100 liters per second and minimum outdoor air supply of 70% shall have air-to-air heat recovery equipment with minimum 50% recovery effectiveness.

At least 50% of heat shall be recovered from diesel and gas fired Generator sets. Gas and oil fired boilers shall meet or exceed the minimum efficiency requirements specified in Table 3-9.

Table 3-9 Minimum Efficiency Requirements for Oil and Gas Fired Boilers for SuperECBC building

Equipment Type	Sub Category	Size Category	Minimum FUE
Boilers, Hot Water	Gas or oil fired	All capacity	85%
FUE - fuel utilization efficiency			

4 Service Hot Water Heating

4.1 Solar Water Heating

Building shall have solar water heating equipment installed to provide at least 60% of the total hot water design capacity. Exception: Systems that use heat recovery to provide the hot water capacity required as per the efficiency level or building size.

4.2 Heating Equipment Efficiency

Service water heating equipment shall meet or exceed the performance and minimum efficiency requirements presented in available Indian Standards

(a) Solar water heater shall meet the performance/ minimum efficiency level mentioned in IS 13129 Part (1&2)

(b) Gas Instantaneous water heaters shall meet the performance/minimum efficiency level mentioned in IS 15558 with above 80 per cent Fuel utilization efficiency.

(c) Electric water heater shall meet the performance/ minimum efficiency level mentioned in IS 2082.

4.3 Other Water Heating System

Supplementary heating system shall be designed to maximize the energy efficiency of the system and shall incorporate the following design features in cascade:

(a) Maximum heat recovery from hot discharge system like condensers of air conditioning units,

(b) Use of gas fired heaters wherever gas is available, and

(c) Electric heater as last resort.

4.4 Heat Traps

Vertical pipe risers serving storage water heaters and storage tanks not having integral heat traps and serving a non-recirculating system shall have heat traps on both the inlet and outlet piping.

5 Lighting and Controls

5.1 Automatic Lighting Shutoff

At least 90% of interior lighting fittings in building shall be equipped with automatic control device. Additionally, occupancy sensors shall also be provided in:

(a) All habitable spaces less than 30 m2, enclosed by walls or ceiling height partitions;

(b) All storage or utility spaces more than 15 m2 in all building types with

(c) Public toilets more than 25 m2, controlling at least 80 % of lighting fitted in the toilet. The lighting fixtures, not controlled by automatic lighting shutoff, shall be uniformly spread in the area;

(d) in all conference rooms

Automatic control device shall function on either:

(a) A scheduled basis at specific programmed times. An independent program schedule shall be provided for areas of no more than 2,500 m^2 and not more than one floor; or,

(b) Occupancy sensors that shall turn the lighting 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.

Exception: Lighting systems designed for emergency and firefighting purposes.

5.2 Space Control

Each space enclosed by ceiling-height partitions shall have at least one control device to independently control the general lighting within the space. Each control device shall be activated either manually by an occupant or automatically by sensing an occupant. Each control device shall

(a) control a maximum of 250 m^2 for a space less than or equal to 1,000 m^2, and a maximum of 1,000 m^2 for a space greater than 1,000 m^2.

(b) have the capability to override the shutoff control required in § 5.1 for no more than 2 hours, and

(c) be readily accessible and located so the occupants can see the control.

Exception: The required control device may be remotely installed if required for reasons of safety or security. A remotely located device shall have a pilot light indicator as part of or next to the control device and shall be clearly labeled to identify the controlled lighting.

5.3 Control in Daylight Areas

Luminaires, installed within day lighting 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:

(a) Has a delay of minimum 5 minutes,

(b) can dim or step up to 50% of total power.

Overrides to the daylight controls shall not be allowed. Building shall have centralized control system for schedule based automatic lighting shutoff switches.

5.4 Exterior Lighting Control

(a) 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.

(b) Lighting for all exterior applications, shall have lamp efficacy not less than 100 lumens per watt unless the luminaire is controlled by a motion sensor.

(c) Façade lighting and façade non-emergency signage of Shopping Complexes shall have separate time switches.

Exemption: Exterior emergency lighting.

5.5 Exit Signs

Internally-illuminated exit signs shall not exceed 5 Watts per face.

5.6 Interior Lighting Power

The installed interior lighting power shall not exceed the interior lighting power allowance of 4.6 W/m2.

5.7 Exterior Lighting Power

Connected lighting power of exterior lighting applications shall not exceed the lighting power limits specified in Table 5-1. Trade-offs between applications is not permitted.

Table 5-1 Exterior Building Lighting Power for SuperECBC Buildings

Exterior lighting application	*Power limits*
Building entrance (with canopy)	5.0 W/m^2 of canopied area
Building entrance (w/o canopy)	45 W/ linear m of door width
Building exit	30 W/lin m of door width
Building façade	2.5 W/m^2 of vertical façade area
Emergency signs, ATM kiosks, Security areas façade	0.5 W/m^2
Parking areas (covered/ basement)	1.1 W/m^2
Driveways (covered/ basement)	1.5 W/m^2
Driveways and parking (open/ external)	0.8 W/m^2
Pedestrian walkways	1.0 W/m^2
Stairways	5.0 W/m^2
Landscaping	0.25 W/m^2
Outdoor sales area	4.5 W/m^2

6 Electrical Systems

6.1 Transformers

6.1.1 Maximum Allowable Power Transformer Losses

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

Permissible total loss values shall not exceed

(a) 5 per cent 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) 7½ percent of the maximum total loss values mentioned in above IS 1180 for oil type transformers in voltage class above 22 kV and up to and including 33 kV

(c) values listed in Table 7.1 for dry type transformers

Table 6-1 Dry Type Transformers

Rating (kVA)	***Impedance (percent)***	**Max. losses (W)**	
		50 % Load	100% Load
16	4.5	120	400
25	4.5	175	595
63	4.5	300	1,050
100	4.5	435	1,500
160	4.5	570	1,700
200	4.5	670	2,100
250	4.5	920	2,700
315	4.5	955	2,750
400	4.5	1,150	3,330
500	4.5	1,430	4,100
630	4.5	1,745	4,850
1000	5	2,620	7,000
1250	5	3,220	8,400
1600	6.25	3,970	11,300
2000	6.25	4,790	14,100
2500	6.25	5,900	17,500

Table 6-2 Permissible Losses for Oil Type Transformers. Total losses for oil type transformers should confirm with Indian Standard IS 1180.

Rating (kVA)	***Impedance (percent)***	**Max. losses (W)**	
		50 % Load	100% Load
16	4.5	120	400
25	4.5	175	595
63	4.5	300	1050

100	4.5	435	1500
160	4.5	570	1700
200	4.5	670	2100
250	4.5	920	2700
315	4.5	955	2750
400	4.5	1150	3330
500	4.5	1430	4100
630	4.5	1745	4850
1000	5	2620	7000
1250	5	3220	8400
1600	6.25	3970	11300
2000	6.25	4790	14100
2500	6.25	5900	17500

6.1.2 Measurement and Reporting of Transformer Losses

All measurement of losses shall be carried out by using calibrated digital meters of class 0.5 or better accuracy and certified by the manufacturer. All transformers of capacity of 500 kVA and above would be 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.

6.2 Voltage Drop

Voltage drop for feeders shall not exceed 2% at design load. Voltage drop for branch circuit shall not exceed 3 per cent at design load.

6.3 Energy Efficient Motors

Motors shall also comply with the following:

i. Three phase induction motors shall conform to Indian Standard (IS) 12615 and shall fulfil the following efficiency requirements:

ii. Buildings shall have IE 4 (super premium efficiency) class motors

iii. All permanently wired polyphase motors of 0.375 kW or more serving the building and all permanently wired polyphase motors of 50kW or more serving the building shall have a minimum acceptable nominal full load motor efficiency not less than levels specified in the latest version of IS 12615.

iv. Motors of horsepower differing from those listed in the table shall have efficiency greater than that of the next listed kW motor.

v. Motor horsepower ratings shall not exceed 20 per cent of the calculated maximum load being served.

vi. Motor nameplates shall list the nominal full-load motor efficiencies and the full-load power factor.

vii. Motor users should insist on proper rewinding practices for any rewound motors. If the proper rewinding practices cannot be assured, the damaged motor should be replaced with a new, efficient one rather than suffer the significant efficiency penalty associated with typical rewind practices. Rewinding practices from BEE guideline for energy efficient motors shall be followed.

viii. Certificates shall be obtained and kept on record indicating the motor efficiency. Whenever a motor is rewound, appropriate measures shall be taken so that the core characteristics of the motor is not lost due to thermal and mechanical stress during removal of damaged parts. After rewinding, a new efficiency test shall be performed and a similar record shall be maintained.

6.4 DG Sets

DG sets in buildings shall have:

(a) minimum 5 stars rating in SuperECBC Buildings

6.5 Power Factor Correction

All 3 phase shall maintain their power factor at the point of connection as follows:

(a) 0.99

6.6 Check-Metering and Monitoring

(a) 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.

(b) Services not exceeding 1000 kVA but over 65 kVA shall have permanently installed electric metering to record demand (kW), energy (kWh), and total power factor (or kVARh).

(c) Services not exceeding 65 kVA shall have permanently installed electrical metering to record energy (kWh).

Table 6-3 Sub Metering Requirements

	120 kVA to 250 kVA	**Greater than 250 kVA**
Energy kWh	Required	Required
Demand kVA	Required	Required
Total power factor	Required	Required
HVAC system and components	Required	Required
Lighting (interior and exterior) *	Not required	Required
Domestic hot water	Not required	Required
Plug loads	Not required	Required
Renewable power source	Required	Required

6.7 Power Distribution Systems

The power cabling shall be sized so that the distribution losses do not exceed

(a) 1 per cent of total power usage

Record of design calculation for the losses shall be maintained. Load calculation shall be calculated up to the panel level.

6.8 Uninterruptible Power Supply (UPS)

In all buildings, UPS shall meet or exceed the energy efficiency requirements listed in Table 6-4.

Table 6-4 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%

7 Renewable Energy Systems

All buildings shall have provisions for installation of renewable energy systems in the future on rooftops or the site.

7.1 Renewable Energy Generating Zone (REGZ)

A dedicated REGZ equivalent to at least 25 % of roof area or area required for generation of energy equivalent to 4 per cent of connected load of the building shall be provided in all buildings. The REGZ shall be free of any obstructions within its boundaries and from shadows cast by objects adjacent to the zone.

7.2 Main Electrical Service Panel

Minimum rating shall be displayed on the main electrical service panel. Space shall be reserved for the installation of a double pole circuit breaker for a future solar electric installation.

7.3 Demarcation on Documents

The following shall be indicated in design and construction documents:

(a) Location for inverters and metering equipment,

(b) Pathway for routing of conduit from the REGZ to the point of interconnection with the electrical service,

(c) Routing of plumbing from the REGZ to the water-heating system and,

(d) Structural design loads for roof dead and live load.