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MINISTRY OF POWER

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Energy Conservation & Sustainable Building Code (ECSBC)

(Commercial and Office Buildings)

ऊर्जा जीवन है, संरक्षण करें
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Content

Chapter 0: Definitions	1
Chapter 1: Purpose	20
Chapter 2: Scope	21
Chapter 3: Approach to Compliance	25
Chapter 4: Sustainable Sites & Planning	27
Chapter 5: Building Envelope	30
Chapter 6: Comfort System and Controls	45
Chapter 7: Lighting and Controls	55
Chapter 8: Electrical and Renewable Energy Systems	69
Chapter 9: Water Management and Controls	76
Chapter 10: Waste Management	87
Chapter 11: Indoor Environment Quality	92
Chapter 12: Whole Building Performance	102
Appendix 1: Default Values for Typical Constructions	139
Appendix 2: Climate Zone Map of India	148
Appendix 3: Air-Side Economizer Acceptance Procedures	150
Appendix 4: Controls And Internet of Things	151
Appendix 5: Commissioning of Building Systems	154
Appendix 6: Sustainable Materials	155
Appendix 7: Power Quality	179

0. Definitions, Abbreviations and Acronyms

0.1 General

This section defines specific terms, abbreviations, and acronyms for the purposes of this code. These definitions apply to all sections. Any terms not defined here should be interpreted according to their commonly accepted meanings in the context in which they appear.

A

Above grade area (AGA): AGA is the cumulative floor area of all the floor levels of a building that are above the ground level. Ground level shall be as defined in building site plan. A floor level is above grade if one-third of the total external surface area of only the said floor level is above the ground level.

Accredited independent laboratory: testing laboratory not affiliated with producer or consumer of goods or products tested at the laboratory and accredited by national or international organizations for technical competence.

Addition: an extension or increase in floor area or height of a building outside of the existing building envelope.

Air conditioning and condensing units serving computer rooms: air conditioning equipment that provides cooling by maintaining space temperature and humidity within a narrow range. Major application is in data centers where dissipating heat generated by equipment takes precedence over comfort cooling for occupants.

Alternate Water Source: Non-potable source of water that includes gray water, on-site treated water, harvested rainwater, and reclaimed (recycled) water from sewage treatment plant.

Alteration: any change, rearrangement, replacement, or addition to a building or its systems and equipment; any modification in construction or building equipment.

Area weighted average (AWA) method: AWA method is based on the concept of weighted arithmetic mean where instead of each data point contributing equally to the final mean; each data point contributes more "weight" than others based on the size of the area the said data point is applicable to. To calculate the area weighted average mean, a summation of each data point multiplied with its respective area is divided with the total area.

$$AWA = \frac{\Sigma(Data\ point\ X\ area)}{Total\ area}$$

Astronomical time control: an automatic time control that makes an adjustment for the length of the day as it varies over the year.

Automatic Control Device: a device capable of automatically turning loads off and on without manual intervention.

Authority having jurisdiction: the agency or agent responsible for enforcing this code.

B

Backflow: The flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable supply of water from any sources other than its intended source. See Back- Siphonage, Back-Pressure Backflow.

Balancing, air system: adjusting airflow rates through air distribution system devices, such as fans and diffusers, by manually adjusting the position of dampers, splitters vanes, extractors, etc., or by using automatic control devices, such as constant air volume or variable air volume boxes.

Balancing, hydronic system: adjusting water flow rates through hydronic distribution system devices, such as pumps and coils, by manually adjusting the position valves, or by using automatic control devices, such as automatic flow control valves.

Ballast: unit inserted between the supply and one or more discharge lamps which by means of inductance, capacitance or resistance, single or in combination, serves mainly to limit the current of the lamp(s) to the required value. It may also include means for transforming from the supply voltage and arrangements which help to provide starting voltage and preheating current, prevent cold starting, reduce stroboscopic effect, correct the power factor and suppress radio interference.

Baseline Building: A building that has the same building floor area, gross wall area and gross roof area as the Proposed Building and it conforms to all the mandatory requirements of ECSBC compliant building.

Boiler: a self-contained low-pressure appliance for supplying steam or hot water

Brownfield Site: Real property or the expansion, redevelopment, or reuse of which may be complicated by the presence or possible presence of a hazardous substance, pollutant, or contaminant.

Building or building complex or complex: a structure wholly or partially enclosed within exterior walls, or within exterior and party walls, and a roof, affording shelter to persons, animals, or property. Building complex means a building or group of buildings constructed in a contiguous area for business, commercial, institutional, healthcare, hospitality purposes or assembly buildings under the single ownership of individuals or group of individuals or under the name of a co-operative group society or on lease and sold as shops or office space or space for other commercial purposes, having a connected load of 100 kW or contract demand of 120 kVA and above.

Building, base: includes building structure, building envelope, common areas, circulation areas, parking, basements, services area, plant room and its supporting areas and, open project site area.

Building, core and shell: buildings where the developer or owner will only provide the base building and its services.

Building, existing: a building or portion thereof that was previously occupied or approved for occupancy by the authority having jurisdiction.

Building envelope: the exterior plus the semi-exterior portions of a building. For the purposes of determining building envelope requirements, the classifications are defined as follows:

(a) Building envelope, exterior: the elements of a building that separate conditioned spaces from the exterior

(b) Building envelope, semi-exterior: the elements of a building that separate conditioned space from unconditioned space or that enclose semi-heated spaces through which thermal energy may be transferred to or from the exterior, or to or from unconditioned spaces, or to or from conditioned spaces

Building grounds lighting: lighting provided through a building's electrical service for parking lot, site, roadway, pedestrian pathway, loading dock, and security applications

Building material: any element of the building envelope through which heat flows and that heat is included in the component U-factor calculations other than air films and insulation

Built up area (BUA): sum of the covered areas of all floors of a building, other than the roof, and areas covered by external walls and parapet on these floors.

24-hour Business Building: Business building operated and occupied for more than 12 hours on each weekday. Intensity of occupancy may vary.

Bar: 1 Bar pressure is equivalent to 1 kg/cm^2 or 10 m of water column.

Backflow: The flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable supply of water from any sources other than its intended source. See Back- Siphonage, Back-Pressure Backflow.

Bio digestor: Biogas digestor uses natural anaerobic decomposition of organic matter under controlled conditions to convert organic waste into manure.

Black Water: Wastewater from toilet, bidet, urinals, kitchen sink, bed pan sink or similar contaminated sources.

C

Cardinal direction: cardinal directions or cardinal points are the four main directional points of a compass: north, south, east, and west **Centralized control:** single hardware/ software for observing and controlling operations of a group of equipment and devices with similar or different functions

Circuit breaker: a safety device that automatically stops flow of current in electrical circuits. It protects the circuit from current surge.

Class of construction: classification that determines the construction materials for the building envelope, roof, wall, floor, slab-on-grade floor, opaque door, vertical fenestration, skylight

Coefficient of Performance (COP) – cooling: the ratio of the rate of heat removal to the rate of energy input, in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions

Coefficient of Performance (COP) – heating: the ratio of the rate of heat delivered to the rate of energy input, in consistent units, for a complete heat pump system, including the compressor and, if applicable, auxiliary heat, under designated operating conditions

Common area: areas within a building that are available for use by all tenants in a building (i.e. lobbies, corridors, restrooms, etc.)

Commercial building: a building or a part of building or building complex which are used or intended to be used for commercial purposes and classified as per the time of the day the building is operational and sub classified, as per the functional requirements of its design, construction, and use as per following details:

a) Group I – 24 hours building covering Type A Hospitality, Type B Health Care and Type C Assembly, Type D Business and,

b) Group II – Regular building covering Type D Business, Type E Educational and Type F Shopping Complexes.

Compliance documents: the forms specified in ECSBC Rules and Regulations to record and check compliance with these rules. These include but are not limited to EPI Ratio Compliance Report, Building Envelope Compliance Form, Mechanical Systems Compliance Form and Permit Checklist, Lighting System Compliance Form and Permit Checklist and certificates from Certified Energy Auditor for existing or proposed buildings.

Connected load: the sum of the rated wattage of all equipment, appliances and devices to be installed in the building or part of building or building complexes, in terms of kilowatt (kW) that will be allocated to all applicants for electric power consumption in respect of the proposed building or building complexes on their completion.

Contaminant: Any substance, that is potentially hazardous to human health or the environment and is present in the environment at concentrations above its natural or background concentration.

Contamination: An impairment of the quality of the potable water that creates an actual hazard to the public health through poisoning or through the spread of disease by sewage, industrial fluids, or waste. Also defined as High Hazard.

Contract demand: the maximum demand in kilo Volt Ampere (kVA) (within a consumer's sanctioned load) agreed to be supplied by the electricity provider or utility in the agreement executed between the user and the utility or electricity provider.

Construction documents: drawings or documents, containing information pertaining to building construction processes and approvals, building materials and equipment specification, architectural details etc. required by the authority having jurisdiction.

Controls or control device: manually operated or automatic device or software to regulate the operation of building equipment

Cool roof: roof with top layer of material that has high solar reflectance and high thermal emittance properties. Cool roof surfaces are characterized by light colors so that heat can be rejected back to the environment.

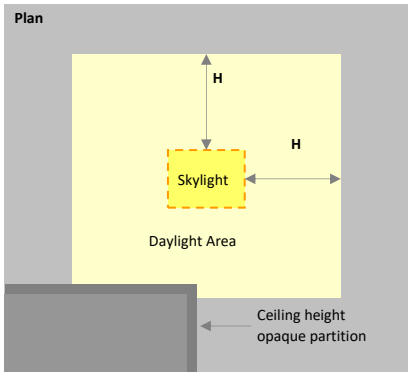
Cumulative design EPI: energy performance index for a building having two or more different functional uses and calculated based on the area weighted average (AWA) method

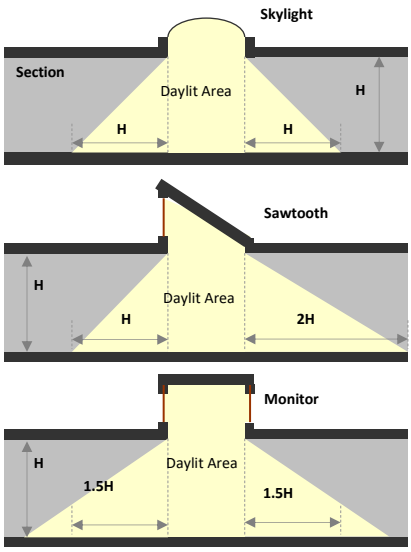
D

Daylight area: the daylight illuminated floor area under horizontal fenestration (skylight) or adjacent to vertical fenestration (window), described as follows:

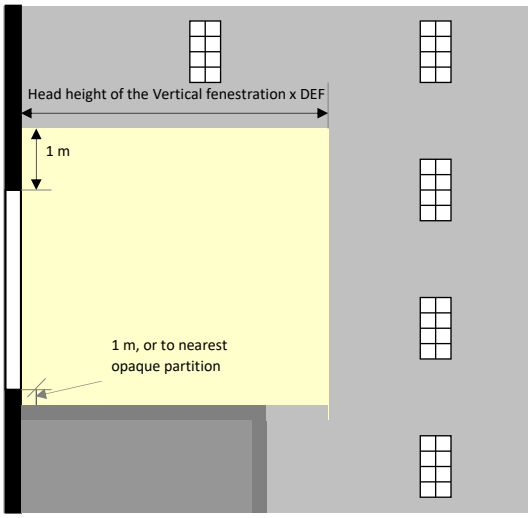
(a) Horizontal Fenestration: the area under a skylight, monitor, or sawtooth configuration with an effective aperture greater than 0.001 (0.1%). The daylight area is calculated as the horizontal

dimension in each direction equal to the top aperture dimension in that direction plus either the floor-to-ceiling height (H) for skylights, or 1.5 H for monitors, or H or 2H for the sawtooth configuration, or the distance to the nearest 1 meter or higher opaque partition, or one-half the distance to an adjacent skylight or vertical glazing, whichever is least, as shown in the plan and section figures below.





(b) Vertical Fenestration: the floor area adjacent to side apertures (vertical fenestration in walls) with an effective aperture greater than 0.06 (6%). The daylight area extends into the space perpendicular to the side aperture a distance equal to daylight extension factor (DEF) multiplied by the head height of the side aperture or till higher opaque partition, whichever is less. In the direction parallel to the window, the daylight area extends a horizontal dimension equal to the width of the window plus either 1 meter on each side of the aperture, or the distance to an opaque partition, or one-half the distance to an adjacent skylight or window, whichever is least.



Daylight Extension Factor (DEF): factor to manually calculate the daylight area on floor plates. It is to be multiplied by the head height of windows. It is dependent on orientation and glazing VLT, shading devices adjacent to it and building location.

Daytime Business Building: Business building operated typically only during daytime on weekdays up to 12 hours each day.

Daylight window: fenestration 2.2 meter above floor level, with an interior light shelf at bottom of this fenestration

Dead band: the range of values within which a sensed variable can vary without initiating a change in the controlled process.

Demand: maximum rate of electricity (kW) consumption recorded for a building or facility during a selected time frame.

Demand control ventilation (DCV): a ventilation system capability that provides automatic reduction of outdoor air intake below design rates when the actual occupancy of spaces served by the system is less than design occupancy

Demand factor: is the ratio of the sum of the maximum demand of a system (or part of a system) to the total connected load on the system (or part of the

system) under consideration. Demand factor is always less than one.

Design capacity: output capacity of a mechanical or electrical system or equipment at design conditions

Design conditions: specified indoor environmental conditions, such as temperature, humidity and light intensity, required to be produced and maintained by a system and under which the system must operate

Distribution system: network or system comprising controlling devices or equipment and distribution channels (cables, coils, ducts, pipes etc.) for delivery of electrical power or, cooled or heated water or air in buildings.

Domestic Sewage: The liquid and water-borne wastes derived from the ordinary living processes, free from industrial wastes, and of such character as to permit satisfactory disposal, without special treatment, into the public sewer or by means of a private sewage disposal system.

Domestic Water: Potable water provided for domestic purposes such as drinking, cooking and supply to fixtures such as kitchen sink, washbasins, shower, clothes washer and dishwasher.

Door: all operable opening areas, that are not more than one half glass, in the building envelope, including swinging and roll-up doors, fire doors, and access hatches.

Door area: total area of the door measured using the rough opening and including the door slab and the frame.

Drinking Water: Drinking water is water intended for human consumption for drinking and cooking purposes from any source. It includes water (treated or untreated) supplied by any means for human consumption.

E

Economizer, air: a duct and damper arrangement with automatic controls that allow a cooling system to supply outdoor air to reduce or eliminate the need for mechanical cooling during mild or cold weather

Economizer, water: a system by which the supply air of a cooling system is cooled indirectly with water that is itself cooled by heat or mass transfer to the environment without the use of mechanical cooling

Effective aperture: Visible light transmittance x window-to-wall Ratio. (EA = VLT x WWR)

Efficacy: the lumens produced by a lamp plus ballast system divided by the total watts of input power (including the ballast), expressed in lumens per watt

Efficiency: performance at a specified rating condition

Efficiency, thermal: ratio of work output to heat input

Efficiency, combustion: efficiency with which fuel is burned during the combustion process in equipment

Emittance: the ratio of the radiant heat flux emitted by a specimen to that emitted by a blackbody at the same temperature and under the same conditions

Energy: power derived from renewable or non-renewable resources to provide heating, cooling and light to a building or operate any building equipment and appliances. It has various forms such as thermal (heat), mechanical (work), electrical, and chemical that may be transformed from one into another. Customary unit of measurement is watts (W)

Energy Efficiency Ratio (EER): the ratio of net cooling capacity in watt to total rate of electric input in watts under design operating conditions

Energy recovery system: equipment to recover energy from building or space exhaust air and use it to treat (pre-heat or pre-cool) outdoor air taken inside the building or space by ventilation systems

Envelope Performance Factor (EPF): value for the building envelope performance compliance option calculated using the procedures specified in 4B.3.5 and 4B.3.5.1.1. For the purposes of determining building envelope requirements the classifications are defined as follows:

(a) Baseline Building EPF: envelope performance factor calculated for the Baseline Building using standardized requirements for walls, vertical fenestrations and roofs

(b) Proposed Building EPF: the building envelope performance factor for the Proposed Building using proposed values for walls, vertical fenestrations and roofs

Equipment: mechanical, electrical or static devices for operating a building, including but not limited to those required for providing cooling, heating, ventilation, lighting, service hot water, vertical circulation

Equipment, existing: equipment previously installed in an existing building

Equivalent SHGC: SHGC for a fenestration with a permanent external shading projection. It is calculated using the Projection Factor (PF) of the permanent external shading projection and Shading Equivalent Factor (SEF) listed in §4B.3.1.

Exemption: any exception allowed to compliance with ECSBC requirements

F

Fan system power: sum of the nominal power demand (nameplate W or HP) of motors of all fans that are required to operate at design conditions to supply air from the heating or cooling source to the conditioned space(s) and return it to the point where is can be exhausted to outside the building.

Fenestration: all areas (including the frames) in the building envelope that let in light, including windows, plastic panels, clerestories, skylights, glass doors that are more than one-half glass, and glass block walls.

(a) Skylight: a fenestration surface having a slope of less than 60 degrees from the horizontal plane. Other fenestration, even if mounted on the roof of a building, is considered vertical fenestration.

(b) Vertical fenestration: all fenestration other than skylights. Trombe wall assemblies, where glazing is installed within 300 mm of a mass wall, are considered walls, not fenestration.

Fenestration area: total area of the fenestration measured using the rough opening and including the glazing, sash, and frame. For doors where the glazed vision area is less than 50% of the door area, the fenestration area is the glazed vision area. For all other doors, the fenestration area is the door area.

Finished floor level: level of floor achieved after finishing materials have been added to the subfloor or rough floor or concrete floor slab.

Fossil fuel: fuel derived from a hydrocarbon deposit such as petroleum, coal, or natural gas derived from living matter of a previous geologic time

Fresh Water: Water obtained from Municipal, Public Utility, bore well, open well and bought out water for domestic use.

Fuel: a material that may be used to produce heat or generate power by combustion

Fuel utilization efficiency (FUE): a thermal efficiency measure of combustion equipment like furnaces, boilers, and water heaters

G

Gathering hall (Type of Assembly): any building, its lobbies, rooms and other spaces connected thereto, primarily intended for assembly of people, but which has no theatrical stage or permanent theatrical and/or cinematographic accessories and has gathering space for greater or equal to 100 persons, for example, stand-alone dance halls, stand-alone night clubs, halls for incidental picture shows, dramatic, theatrical or educational presentation, lectures or other similar purposes having no theatrical stage except a raised platform and used without permanent seating arrangement; art galleries, community halls, marriage halls, places of worship, museums, stand-alone lecture halls, passenger terminals and heritage and archaeological monuments, pool and billiard parlour, bowling alleys, community halls, courtrooms, gymnasiums, indoor swimming pools, indoor tennis court, any indoor stadium for sports and culture, auditoriums

Grade: finished ground level adjoining a building at all exterior walls

Gray Water: Untreated wastewater that has not come into contact with toilet waste, kitchen sink waste, or similarly contaminated sources. Gray water includes wastewater from bathtubs, showers, lavatories, clothes washers, laundry tubs, dishwashers and domestic RO reject water.

Guest room: any room or rooms used or intended to be used by a guest for sleeping purposes

H

Habitable spaces: space in a building or structure intended or used for working, meeting, living, sleeping,

eating, or cooking. Bathrooms, water closet compartments, closets, halls, storage or utility space, and similar areas are not considered habitable spaces.

Heat Island Effect: the thermal absorption by hardscape, such as dark, nonreflective pavement and buildings, and its subsequent radiation to surrounding areas. Other contributing factors may include vehicle exhaust, air conditioners, and street equipment. Tall buildings and narrow streets reduce airflow and exacerbate the effect.

Hospitals and sanatoria (Healthcare): Any building or a group of buildings under single management, which is used for housing persons suffering from physical limitations because of health or age and those incapables of self-preservation, for example, any hospitals, infirmaries, sanatoria and nursing homes.

HVAC system: equipment, distribution systems, and terminal devices that provide, either collectively or individually, the processes of heating, ventilating, or air conditioning to a building or parts of a building.

Hyper Markets (Type F of Shopping Complex): large retail establishments that are a combination of supermarket and department stores. They are considered as a one-stop shop for all needs of the customer.

I

Infiltration: uncontrolled inward air leakage through cracks and crevices in external surfaces of buildings, around windows and doors due to pressure differences across these caused by factors such as wind or indoor and outside temperature differences (stack effect), and imbalance between supply and exhaust air systems

Installed interior lighting power: power in watts of all permanently installed general, task, and furniture lighting systems and luminaries.

Integrated part-load value (IPLV): weighted average efficiency of chillers measured when they are operating at part load conditions (less than design or 100% conditions). It is more realistic measurement of chillers efficiency during its operational life.

Inventory: A complete list of items such as property, goods in stock, or the contents of a building

L

Labeled: equipment or materials to which a symbol or other identifying mark has been attached by the manufacturer indicating compliance with specified standard or performance in a specified manner.

Lighted floor area, gross: gross area of lighted floor spaces

Lighting, decorative: lighting that is ornamental or installed for aesthetic effect. Decorative lighting shall not include general lighting.

Lighting, emergency: battery backed lighting that provides illumination only when there is a power outage and general lighting luminaries are unable to function.

Lighting, general: lighting that provides a substantially uniform level of illumination throughout an area. General lighting shall not include decorative lighting or lighting that provides a dissimilar level of illumination to serve a specialized application or feature within such area.

Lighting system: a group of luminaires circuited or controlled to perform a specific function.

Lighting power allowance:

(a) Interior lighting power allowance: the maximum lighting power in watts allowed for the interior of a building.

(b) Exterior lighting power allowance: the maximum lighting power in watts allowed for the exterior of a building.

Lighting Power Density (LPD): maximum lighting power per unit area of a space as per its function or building as per its classification.

Low energy comfort systems: space conditioning or ventilation systems that are less energy intensive then vapour compression-based space condition systems. These primarily employ alternate heat transfer methods or materials (adiabatic cooling, radiation, desiccant, etc.), or renewable sources of energy (solar energy, geo-thermal) so that minimal electrical energy input is required to deliver heating or cooling to spaces.

Luminaire: Equipment which distributes, filters or transforms the light transmitted from one or more

lamps and which includes all the parts necessary for supporting, fixing and protecting the lamps, but not the lamps themselves, and where necessary, circuit auxiliaries together with the means for connecting them to the supply.

Note: A luminaire with integral non-replaceable lamps is regarded as a luminaire, except that the tests are not applied to the integral lamp or integral self-ballasted lamp.

M

Man-made daylight obstruction: any permanent man-made object (equipment, adjacent building) that obstructs sunlight or solar radiation from falling on a portion or whole of a building's external surface at any point of time during a year is called as a man-made sunlight obstructer.

Manual (non-automatic): requiring personal intervention for control. Non-automatic does not necessarily imply a manual controller, only that personal intervention is necessary.

Manufacturing processes: processes through which raw material is converted into finished goods for commercial sale using machines, labor, chemical or biological processes, etc.

Manufacturer: company or person or group of persons who produce and assemble goods or purchases goods manufactured by a third party in accordance with their specifications.

Mean temperature: average of the minimum daily temperature and maximum daily temperature.

Mechanical cooling: reducing the temperature of a gas or liquid by using vapor compression, absorption, and desiccant dehumidification combined with evaporative cooling, or another energy-driven thermodynamic cycle. Indirect or direct evaporative cooling alone is not considered mechanical cooling.

Modeled Energy Performance Intensity (MEPI): MEPI of a building is estimated annual energy consumption in kilowatt-hours per square meter area of the building (excluding unconditioned basement area, unconditioned refuge area, and stilt parking area) and calculated using a simulation program.

MEPI Ratio: MEPI ratio of a building means the ratio of the MEPI of the Proposed Building to the MEPI of the baseline Building.

Metered Faucet: A self-closing factory calibrated faucet that dispenses a predetermined volume of water for each cycle.

Metering: practice of installing meters in buildings to acquire data for energy consumption and other operational characteristics of individual equipment or several equipment grouped on basis of their function (lighting, appliances, chillers, etc.). Metering is done in buildings to monitor their energy performance.

Mixed mode air-conditioned building: building in which natural ventilation is employed as the primary mode of ventilating the building, and air conditioning is deployed as and when required.

Mixed use development: a single building or a group of buildings used for a combination of residential, commercial, business, educational, hospitality and assembly purposes

N

National Building Code 2016 (NBC): model building code that provides guidelines for design and construction of buildings. In this code, National Building Code 2016 refers to the latest version by the Bureau of Indian Standards.

Natural daylight obstruction: any natural object, like tree, hill, etc., that obstructs sunlight from falling on part or whole of a building's external surface at any point of time during a year and casts a shadow on the building surface.

Naturally ventilated building: a building that does not use mechanical equipment to supply air to and exhaust air from indoor spaces. It is primarily ventilated by drawing and expelling air through operable openings in the building envelope.

Net Exposed Roof Area: Net exposed roof area = Total roof area – equipment area

Non-cardinal directions: any direction which is not a cardinal direction, i.e. perfect north, south, east, or west, is termed as non-cardinal direction.

No Star hotel (Type of Hospitality): any building or group of buildings under the same management, in which separate sleeping accommodation on commercial basis, with or without dining facilities or cooking facilities, is provided for individuals. This includes lodging rooms, inns, clubs, motels, no star hotel and guest houses and excludes residential apartments rented on a lease agreement of 4 months or more. These shall also include any building in which group sleeping accommodation is provided, with or without dining facilities for persons who are not members of the same family, in one room or a series of adjoining rooms under joint occupancy and single management, for example, school and college dormitories, students, and other hostels and military barracks.

O

Occupant/Occupancy sensor: a device that detects the presence or absence of people within an area and causes lighting, equipment, or appliances to be dimmed, or switched on or off accordingly.

On-site electricity generation systems: systems located at the building site that generate electricity, including, but not limited to, generators, combined heat and power systems, fuel cells, and on-site renewable energy systems.

On-site renewable energy: energy from renewable resources harvested at the building site.

Opaque assembly or opaque construction: surface of the building roof or walls other than fenestration and building service openings such as vents and grills.

Opaque external wall: external wall composed of materials which are not transparent or translucent, usually contains the structural part of the building, and supports the glazed façade. This type may be composed of one or more materials.

Open Gallery Mall (Type of Shopping Complex): a large retail complex containing a variety of stores and often restaurants and other business establishments housed in a series of connected or adjacent buildings or in a single large building. The circulation area and atrium of the open gallery mall is an unconditioned space and is open to sky.

Organic waste: Any material that is easily compostable and comes from either a plant or an animal.

Organic waste converters (OWC): Machines that are used to convert organic waste such as vegetable waste, meat waste, bakery waste, leaves, fruits and fruit skins, and flowers into valuable compost that can be used for organic farming activities.

Orientation: the direction a building facade faces, i.e., the direction of a vector perpendicular to and pointing away from the surface of the facade. For vertical fenestration, the two categories are north-oriented and all other.

Outdoor (outside) air: air taken from the outside the building and has not been previously circulated through the building.

Out-patient Healthcare (Type of Healthcare): any building or a group of buildings under single management, which is used only for treating persons requiring treatment or diagnosis of disease but not requiring overnight or longer accommodation in the building during treatment or diagnosis.

Overcurrent: any current in excess of the rated current of the equipment of the ampacity of the conductor. It may result from overload, short circuit, or ground fault.

Overall Efficiency: Efficiency of motor and pump considered together.

Owner: a person, group of persons, company, trust, institute, Registered Body, state or central Government and its attached or sub-ordinate departments, undertakings and like agencies or organization in whose name the property stands registered in the revenue records for the construction of a building or building complex

P

Party wall: a firewall on an interior lot line used or adapted for joint service between two buildings.

Paved Areas: Paved area is an area that is paved with concrete, asphalt, stone, brick, gravel, or other wearing surface.

Percentage of Energy Saving (PES): percentage of energy saving of proposed building in reference to baseline building.

Permanently installed: equipment that is fixed in place and is not portable or movable.

pH: pH is a figure expressing the acidity or alkalinity of a solution on a logarithmic scale on which 7 is neutral, lower values are more acid and higher values more alkaline. The pH is equal to −log10 c, where c is the hydrogen ion concentration in moles per liter.

Plenum: a compartment or chamber to which one or more ducts are connected, that forms a part of the air distribution system, and that is not used for occupancy or storage.

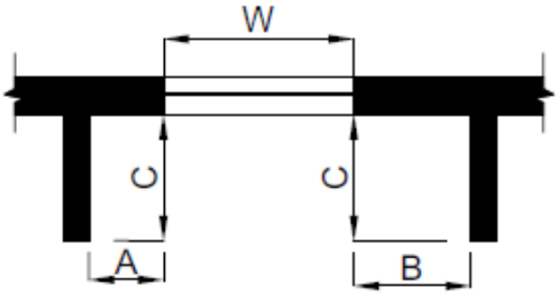
Plug loads: energy used by products that are powered by means of an AC plug. This term excludes building energy that is attributed to major end uses specified in § 5, § 6, § 7, § 8, § 9, § 11 (like HVAC, lighting, water heating, etc.).

Plumbing Appliance: Devices or equipment that are intended to perform a special plumbing function. Its operation and/or control may be dependent upon one or more energized components, such as motors, controls, heating elements, or pressure or temperature-sensing elements. Such device or equipment shall be permitted to operate automatically or manually by the user or operator.

Plumbing Appurtenance: A device or assembly that is an adjunct to the basic piping system and plumbing fixtures. An appurtenance demands no additional water supply, nor does it add any discharge load to a fixture or the drainage system. It performs some useful function in the operation, maintenance, servicing, economy, or safety of the plumbing system.

Plumbing Fixture: An approved-type receptacle or device that is supplied with water or that receives liquid wastes and discharges such wastes into the drainage system to which it may be directly or indirectly connected.

Plumbing System: Includes water, building supply, and distribution pipes; all plumbing fixtures, fittings, appliances and appurtenances; all drainage and vent pipes; and all building drains and building sewers, including on-site water and sewage treatment.



Pool: any structure, basin, or tank containing an artificial body of water for swimming, diving, or recreational bathing. The terms include, but no limited to, swimming pool, whirlpool, spa, hot tub.

Post occupancy: The buyer of a property agrees to allow the seller of the property to stay in the property past the settlement date.

Potable Water: Water that is satisfactory for drinking, culinary, and domestic purposes and that meets the requirements of the Health Authority Having Jurisdiction.

P&I Diagram: Piping & Instrument diagram is a detail diagram which shows all the piping together with the equipment's, instruments & control devices.

Potential daylit time: amount of time in a day when there is daylight to light a space adequately without using artificial lighting. Potential daylit time is fixed for 8 hours per day i.e. from 09:00 AM to 5:00 PM local time, resulting 2920 hours in total for all building types except for Type E-1 - Educational, which shall be analyzed for 7 hours per day i.e. from 08:00 AM to 3:00 PM local time.

Primary inter-cardinal direction: any of the four points of the compass, midway between the cardinal points; northeast, southeast, southwest, or northwest are called primary inter-cardinal direction.

Process load: building loads resulting from the consumption or release of energy due to industrial processes or processes other than those for providing space conditioning, lighting, ventilation, or service hot water heating.

Projection factor, overhang: It is the ratio of the horizontal depth of the external shading projection to the sum of the height of the fenestration and the distance from the top of the fenestration to the bottom of the farthest point of the external shading projection, in consistent units.

Projection factor Right Fin(PFR)= C/(B+W)

Projection factor, side fin: It is the ratio of the horizontal depth of the external shading projection to the distance from the window jamb to the farthest point of the external shading projection, in consistent units.

Projection factor Left Fin(PFL)= C/(A+W)

Projection factor Right Fin(PFR)= C/(B+W)

Projection Factor, overhang and side fin: average of ratio projection factor for overhang only and projection factor of side fin only.

Proposed Building: is consistent with the actual design of the building and complies with all the mandatory requirements of ECSBC.

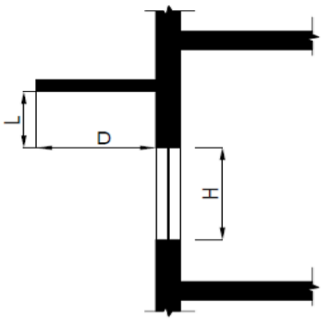
Proposed Design: a computer model of the proposed building, consistent with its actual design, which complies with all the mandatory requirements of ECSBC.

R

R-value (thermal resistance): the reciprocal of the time rate of heat flow through a unit area induced by a unit temperature difference between two defined surfaces of material or construction under steady-state conditions. Units of R value are $m^2.K$ /W.

Readily accessible: capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, chairs, etc. In public facilities, accessibility may be limited to certified personnel through locking covers or by placing equipment in locked rooms.

Recirculating system: a domestic or service hot water



distribution system that includes a close circulation circuit designed to maintain usage temperatures in hot water pipes near terminal devices (e.g., lavatory faucets, shower heads) in order to reduce the time required to obtain hot water when the terminal device valve is opened. The motive force for circulation is either natural (due to water density variations with temperature) or mechanical (recirculation pump).

Reclaimed (Recycled) Water: Non-potable water generated, as a result of tertiary treatment of domestic Black/Grey water that meets requirements of the Authority Having Jurisdiction for its intended uses.

Remediation: The doing of any works, or carrying out of any operations or taking of any steps in relation to a polluted site for the purpose of (a) identifying or investigating or preventing or minimizing or remedying or mitigating the adverse effects by reason of which polluted site is such site; (b) restoring the quality of environment, flora and fauna at the site to an acceptable level; and includes making of subsequent inspections from time to time for the purpose of keeping under review the condition of the site in question, in the manner prescribed.

Renewable Energy Generating Zone: a contiguous or semi-contiguous area, either on rooftop or elsewhere within site boundary, dedicated for installation of renewable energy systems.

Renewable Energy Resources: energy from solar, wind, biomass or hydro, or extracted from hot fluid or steam heated within the earth.

Resort (Type of Hospitality): commercial establishments that provide relaxation and recreation over and above the accommodation, meals and other basic amnesties. The characteristics of resort are as below –

i. Includes 1 or more recreation(s) facility like spa, swimming pool, or any sport;

ii. Is located in the midst of natural and picturesque surroundings outside the city;

iii. Comprises of 2 or more blocks of buildings within the same site less than or equal to 3 floors (including the ground floor).

Reset: automatic adjustment of the controller set point to a higher or lower value.

Roof: the upper portion of the building envelope, including opaque areas and fenestration, that is horizontal or tilted at an angle of less than 60° from horizontal. This includes podium roof as well which are exposed to direct sun rays.

Roof area, gross: the area of the roof measured from the exterior faces of walls or from the centerline of party walls

S

Sedimentation Basin: A sediment basin is a temporary pond built on a construction site to capture eroded or disturbed soil that is washed off during rainstorms, and protect the water quality of a nearby stream, river, lake, or bay. The sediment-laden soil settles in the pond before the runoff is discharged.

Service: the equipment for delivering energy from the supply or distribution system to the premises served.

Service water heating equipment: equipment for heating water for domestic or commercial purposes other than space heating and process requirements.

Set point: the desired temperature (°C) of the heated or cooled space that must be maintained by mechanical heating or cooling equipment.

Sewage: Wastewater containing human excreta (faeces and urine) as well as sources of black water and grey water.

Shading Coefficient (SC): measure of thermal performance of glazing. It is the ratio of solar heat gain through glazing due to solar radiation at normal incidence to that occurring through 3 mm thick clear, double-strength glass. Shading coefficient, as used herein, does not include interior, exterior, or integral shading devices.

Shading Equivalent Factor: coefficient for calculating effective SHGC of fenestrations shaded by overhangs or side fins.

Shopping Mall (Shopping Complex): a large retail complex containing a variety of stores and often restaurants and other business establishments housed in a series of connected or adjacent buildings or in a single large building. The circulation area and atrium of the mall is an enclosed space covered completely by a permanent or temporary structure.

Simulation program: software in which virtual building models can be developed to simulate the energy performance of building systems and daylighting analysis

Single-zone system: an HVAC system serving a single HVAC zone.

Site-recovered energy: waste energy recovered at the building site that is used to offset consumption of purchased fuel or electrical energy supplies.

Slab-on-grade floor: floor slab of the building that is in contact with ground and that is either above grade or is less than or equal to 300 mm below the final elevation of the nearest exterior grade. **Solar energy source:** source of thermal, chemical, or electrical energy derived from direction conversion of incident solar radiation at the building site.

Solar Heat Gain Coefficient (SHGC): the ratio of the solar heat gain entering the space through the fenestration area to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted, or convected into the space.

Solar Reflectance: ratio of the solar radiation reflected by a surface to the solar radiation incident upon it.

Solar Reflective Index: A measure of the constructed surface's ability to stay cool in the sun by reflecting solar radiation and emitting thermal radiation. It is defined such that a standard black surface (initial solar reflectance 0.05, initial thermal emittance 0.90) has an initial SRI of 0, and a standard white surface (initial solar reflectance 0.80, initial thermal emittance 0.90) has an initial SRI of 100. To calculate the SRI for a given material, obtain its solar reflectance and thermal

emittance via the Cool Roof Rating Council Standard (CRRC-1). SRI is calculated according to ASTM E 1980. Calculation of the aged SRI is based on the aged, tested values of solar reflectance and thermal emittance.

Space: an enclosed area within a building. The classifications of spaces are as follows for purpose of determining building envelope requirements:

(a) Conditioned space: a cooled space, heated space, or directly conditioned space.

(b) Semi-heated space: an enclosed space within a building that is heated by a heating system whose output capacity is greater or equal to 10.7 W/m^2 but is not a conditioned space.

(c) Non-conditioned space: an enclosed space within a building that is not conditioned space or a semi-heated space. Crawlspaces, attics, and parking garages with natural or mechanical ventilation are not considered enclosed spaces.

Sullage: Wastewater without faecal matter. Commonly known as Gray water.

Star Hotels/motels (Star Hotel): any building or group of buildings under single management and accredited as a starred hotel by the Hotel and Restaurant Approval and Classification Committee, Ministry of Tourism, in which sleeping accommodation, with or without dining facilities is provided.

Stand-alone Retail (Shopping Complex): a large retail store owned or sublet to a single management which may offer customers a variety of products under self-branding or products of different brands. The single management shall have a complete ownership of all the spaces of the building and no space within the building is further sold or sublet to a different management.

Baseline Design: a computer model of a hypothetical building, based on actual building design, that fulfils all the mandatory requirements and minimally complies with the standardized requirements of ECSBC, as described in the Whole Building Performance method.

Story: portion of a building that is between one finished floor level and the next higher finished floor level or building roof. Basement and cellar shall not be considered a story.

Summer Solar Insolation: measure of solar radiation energy received on a given surface area from the month of March to October within the same calendar year. Units of measurement are watts per square meter (W/m^2) or kilowatt-hours per square meter per day (kW•h/(m^2•day)) (or hours/day).

Super Market (Shopping Complex): supermarkets are large self-service grocery stores that offer customers a variety of foods and household supplies. The merchandise is organized into an organized aisle format, where each aisle has only similar goods placed together.

System: a combination of equipment and auxiliary devices (e.g., controls, accessories, interconnecting means, and terminal elements) by which energy is transformed so it performs a specific function such as HVAC, service water heating, or lighting.

System Efficiency: the system efficiency is the ratio of annual kWh electricity consumption of equipment of water cooled chilled water plant (i.e. chillers, chilled and condenser water pumps, cooling tower) to chiller thermal kWh used in a building.

System, existing: a system or systems previously installed in an existing building.

T

Tenant lease agreement: The formal legal document entered into between a Landlord and a Tenant to reflect the terms of the negotiations between them; that is, the lease terms have been negotiated and agreed upon, and the agreement has been reduced to writing. It constitutes the entire agreement between the parties and sets forth their basic legal rights.

Tenant leased area: area of a building that is leased to tenant(s) as per the tenant lease agreement.

Terminal device: a device through which heated or cooled air is supplied to a space to maintain its temperature. It usually contains dampers and heating and cooling coils. Or a device by which energy form a system is finally delivered, e.g., registers, diffusers, lighting fixtures, faucets, etc.

Tactile warning blocks: Tactile warning blocks indicate an approaching potential hazard or a change

in direction of the walkway, and serve as a warning of the approaching danger to persons with visual impairments, preparing them to tread cautiously and expect obstacles along the travel path, traffic intersections, doorways, etc.

Theater or motion picture hall (Type of Assembly): any building primarily meant for theatrical or operatic performances, and which has a stage, proscenium curtain, fixed or portable scenery or scenery loft, lights, mechanical appliances or other theatrical accessories and equipment for example, theaters, motion picture houses, auditoria, concert halls, television and radio studios admitting an audience and which are provided with fixed seats.

Thermal block: a collection of one or more HVAC zones grouped together for simulation purposes. Spaces need not be contiguous to be combined within a single thermal block.

Thermal comfort conditions: conditions that influence thermal comfort of occupants. Environmental conditions that influence thermal comfort air and radiant temperature, humidity, and air speed.

Thermostat: device containing a temperature sensor used to automatically maintain temperature at a desirable fixed or adjustable set point in a space.

Tinted: (as applied to fenestration) bronze, green, or grey colouring that is integral with the glazing material. Tinting does not include surface applied films such as reflective coatings, applied either in the field or during the manufacturing process.

Topsoil: Topsoil is the upper layer of a soil profile, usually darker in colour (because of its higher organic matter content) and more fertile than subsoil, and which is a product of natural, biological and environmental processes.

Transformer: a static piece of apparatus with two or more windings which, by electromagnetic induction, transforms a system of alternating voltage and current into another system of voltage and current usually of different values and at the same frequency for the purpose of transmitting electrical power

Transformer losses: electrical losses in a transformer that reduces its efficiency.

Transport Buildings (Assembly): any building or structure used for the purpose of transportation and transit like airports, railway stations, bus stations, and underground and elevated mass rapid transit system example, underground or elevated railways.

Type 1 Ecolabel: Type I ecolabels are voluntary labels that signify overall environmental preference of a product or services based on life-cycle considerations that address multiple environmental criteria, which are based on transparent standards for environmental preferability, verified by a qualified organization.

U

Unconditioned buildings: building in which more than 90% of spaces are unconditioned spaces.

Unconditioned space: mechanically or naturally ventilated space that is not cooled or heated by mechanical equipment.

Universities and all others coaching/training institutions (Educational): a building or a group of buildings, under single management, used for imparting education to students numbering more than 100 or public or private training institution built to provide training/coaching etc.

Used Water: Black or Grey water from fixtures or appliances.

Useful Daylight Illuminance: percentage of annual daytime hours that a given point on a work plane height of 0.8 m above finished floor level receives daylight between 100 lux to 2,000 lux.

U-factor (Thermal Transmittance): heat transmission in unit time through unit area of a material or construction and the boundary air films, induced by unit temperature difference between the environments on each side. Unit of U value is $W/m^2.K$.

V

Variable Air Volume (VAV) system: HVAC system that controls the dry-bulb temperature within a space by varying the volumetric flow of heated or cooled air supplied to the space

Vegetative roofs: also known as green roofs, they are thin layers of living vegetation installed on top of conventional flat or sloping roofs.

Ventilation: the process of supplying or removing air by natural or mechanical means to or from any space. Such air is not required to have been conditioned.

Video conferencing: Any space where one- or two-way audio and video communication is supported between two or more sites (refer Figure below). Both audio (aural) and video (visual) communication are supported in real time. The transfer and display of information and data such as documents and multimedia program materials may also be available functions in a videoconference space.

Vermicomposting: It is a process in which earthworms are used to convert organic materials into humus-like material known as vermicompost.

Vision Windows: windows or area of large windows that are primarily for both daylight and exterior views. Typically, their placement in the wall is between 1 meter and 2.2 meter above the floor level.

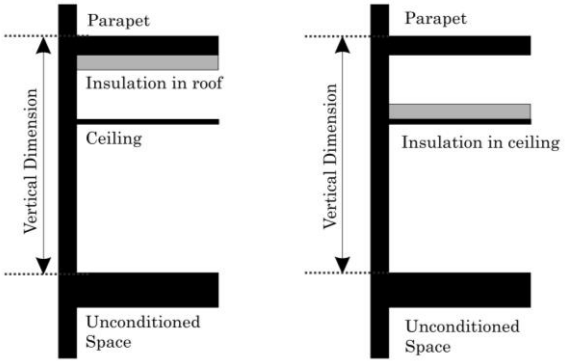
W

Wall: that portion of the building envelope, including opaque area and fenestration, that is vertical or tilted at an angle of 60° from horizontal or greater. This includes above- and below-grade walls, between floor spandrels, peripheral edges of floors, and foundation walls.

(a) Wall, above grade: a wall that is not below grade.

(b) Wall, below grade: that portion of a wall in the building envelope that is entirely below the finish grade and in contact with the ground.

Wall area, gross: the overall area off a wall including openings such as windows and doors measured horizontally from outside surface to outside surface and measured vertically from the top of the floor to the top of the roof. If roof insulation is installed at the ceiling level rather than the roof, then the vertical measurement is made to the top of the ceiling. The gross wall area includes the area between the ceiling and the floor for multi-story buildings.



Water heater: vessel in which water is heated and withdrawn for use external to the system.

Wastewater: Used water from plumbing fixtures or similar equipment which may be a source of black or grey water.

Wet Area: Areas such as bathroom, toilet, kitchen and laundry where water is utilized at fixtures and appliances.

White Light Source: electrically operated product intended to emit, or, in the case of a non-incandescent light source, intended to be possibly tuned to emit, light, or both, with the following optical characteristics:

Chromaticity coordinates x and y in the range $0.270 < x < 0.530$ and

$2.3172\,x^2 + 2.3653\,x - 0.2199 < y < -2.3172\,x^2 + 2.3653\,x - 0.1595$

Z

Zone, HVAC: a space or group of spaces within a building with heating and cooling requirements that are sufficiently similar so that desired conditions (e.g., temperature) can be maintained throughout using a single sensor (e.g., thermostat or temperature sensor).

Zone, Critical: a zone serving a process where reset of the zone temperature set point during a demand shed event might disrupt the process, including but not limited to data centers, telecom and private branch exchange (PBX) rooms, and laboratories.

Zone, non-critical: a zone that is not a critical zone.

Zone, Plumbing: A group of 8-10 adjacent floors categorized as zone for a pumping system.

0.2 SI to IP Conversion Factors

SI Unit	IP Unit
1 cmh	1.7 cfm
1 Pa	0.0040 inch of water gauge
1m	3.28 ft
1m	39.37 in
1mm	0.039 in
1 l/s	2.12 cfm
1 m^2	10.76 ft^2
1 W/m^2	0.0929 W/ ft^2
1 W/ lin m	3.28 W/ ft
1 $W/m^2.K$	0.1761 Btu/ h-ft^2-°F
1 W/ l-s^{-1}	0.063 W/ gpm
1 $m^2.K/W$	5.678 ft^2-h-ºF/ Btu
1 ºC	((ºC X 9/5) + 32) ºF
1 kW_r	0.284 TR
1 kW	1.34 hp
1 kW	3412.142 u/hr

13.3 Abbreviations and Acronyms

AFUE	Annual fuel utilization efficiency
BIS	Bureau of Indian Standards
Btu	British thermal unit
Btu/h	British thermal units per hour
Btu/h-ft^2-°F	British thermal units per hour per square foot per degree Fahrenheit
BUA	Built up area
C	Celsius
cmh	cubic meter per hour
cm	centimetre
COP	coefficient of performance
DEF	daylight extent factor
EER	energy efficiency ratio
EPI	energy performance index
F	Fahrenheit
ft	foot
h	hour
h-ft^2-°F/Btu	hour per square foot per degree Fahrenheit per British thermal unit
h-m^2-°C/W	hour per square meter per degree Celsius per Watt
hp	horsepower
HVAC	heating, ventilation, and air conditioning
I-P	inch-pound
in.	inch
IPLV	integrated part-load value
IS	Indian Standard
ISO	International Organization for Standardization
kVA	kilovolt-ampere
kW	Kilowatt of electricity
kW$_r$	kilowatt of refrigeration
kWh	kilowatt-hour
l/s	liter per second
LE	luminous efficacy
Lin	linear
lin ft	linear foot
lin m	linear meter
Lm	lumens
Lm/W	lumens per watt
LPD	lighting power density
M	meter
Mm	millimetre
m^2	square meter
m^2.K/W	square meter Kelvin per watt
NBC	National Building Code 2016
Pa	pascal
PF	projection factor
R	R-value (thermal resistance)
SC	shading coefficient
SEF	Shading equivalent factor
SHGC	solar heat gain coefficient
TR	tons of refrigeration
UPS	uninterruptible power supply
VAV	variable air volume
VLT	visible light transmission
W	watt
W/ l-s^{-1}	watt per litre per second
W/m^2	watts per square meter
W/m^2.K	watts per square meter per Kelvin

W/m^2	watts per hour per square meter
W/m.K	watts per lineal meter per Kelvin
Wh	watthour
BEP	Best Efficiency Point
BMS	Building Management System
BOD	Biological Oxygen Demand
BWUE	Bureau of Water Use Efficiency
COD	Chemical Oxygen Demand
COP	Coefficient of Performance
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health & Environmental Engineering Organization
ECSBC	Energy Conservation and Sustainability Building Code
ETC	Evacuated Tube Collectors
FPC	Flat Plate Collectors
IE Motors	International Efficiency Motors
IoT	Internet of Things
IPA	Indian Plumbing Association
IS	Indian Standard
LPCD	Litres per capita per day
LPD	Litres per day
LPF	Litres per flush
LPM	Litres per minute
LPS	Litres per second
MoEFCC	Ministry of Environment, Forests & Climate Change
MoUD	Ministry of Urban Development
NGT	National Green Tribunal
NWM	National Water Mission
pH	Hydrogen Ion Concentration
PLC	Programmable Logic Controller
RO	Reverse Osmosis
RWH	Rainwater Harvesting
S&L	Standards and Labelling Program of BEE
Solar PV	Solar Photo-Voltaic panels
SDG	Sustainable Development Goal
TDS	Total Dissolved Solid
TMV	Thermostatic Mixing Valves
TSS	Total suspended Solids
VFD	Variable Frequency Drive
WBD	Water Balance Diagram
WPI	Water Performance Index

1. Purpose

In accordance with section 14(p) of the Energy Conservation Act, 2001, the purpose of the Energy Conservation and Sustainable Building Code (ECSBC) is to provide norms and standards for energy efficiency and its conservation, use of renewable energy and other green building requirements for a building. This Code also provides two additional sets of incremental requirements for buildings to achieve enhanced levels of energy efficiency and sustainability that go beyond the minimum requirements.

2. Scope

The Code is applicable to buildings or building complexes that have a connected load of 100 kW or greater or a contract demand of 120 kVA or greater and are intended to be used for commercial or office building.

Buildings intended for residential purposes are not covered under this Code.

2.1 Performance Levels

The code prescribes the following three levels of compliance:

a) **ECSBC Complaint Building:** ECSBC buildings shall demonstrate compliance by adopting the mandatory requirements listed in Chapters 4 through 11, as well as other ECSBC requirements under one of the two compliance methods (Integrative Compliance Method (ICM) or Standardized Compliance Method (SCM)) specified in Chapter 3.

b) **ECSBC+ Complaint Building**: ECSBC+ buildings shall demonstrate compliance by adopting the mandatory requirements listed in Chapters 4 through 11, as well as other ECSBC+ requirements under one of the two compliance methods (Integrative Compliance Method (ICM) or Standardized Compliance Method (SCM)) specified in Chapter 3

c) **Super ECSBC Complaint Building:** Super ECSBC buildings shall demonstrate compliance by adopting the mandatory requirements listed in Chapters 4 through 11, as well as other Super ECSBC requirements under one of the two compliance methods (Integrative Compliance Method (ICM) or Standardized Compliance Method (SCM)) specified in Chapter 3.

2.2 Building Systems

The provisions of this code apply to:

a) Building envelope,
b) Mechanical systems and equipment, including heating, ventilating, and air conditioning, service hot water heating,
c) Interior and exterior lighting, and
d) Electrical power and motors, and renewable energy systems,
e) Site of building,
f) Water supply systems & Controls,
g) Other relevant systems.

The provisions of this code do not apply to plug loads, and equipment and parts of buildings that use energy for manufacturing processes, unless otherwise specified in the Code.

2.3 Precedence

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

a) Any policy notified as taking precedence over this Code, or any other rules on safety, security, health, or environment by Central, State, or Local Government.
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.

2.4 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, site designing & planning, air quality control, water and waste management, any other building materials and system design criteria addressed in this Code.

***Note**: The National Building Code of India (NBC) 2016 is referenced in this code at various chapters. Any subsequent revisions or updated versions of the NBC, when published, will automatically apply to all relevant sections of ECSBC that are referenced to NBC, throughout this code.*

Standards and labelling (S&L) Program of BEE will be applicable for minimum equipment efficiency standards, wherever specified. In case the schedule of S&L is revised for any equipment, the design approval year of building will be considered as base year for ECSBC compliance.

2.5 Building Classification

Any one or more building or part of a building with commercial or office use is classified as per the functional requirements of its design, construction, and use. The key classification is as below:

a) **Hospitality:** Any building in which sleeping accommodation is provided for commercial purposes, except any building classified under Health Care. Buildings and structures under Hospitality shall include the following:
   I. No-star Hotels – like Lodging-houses, dormitories, no-star hotels/motels
   II. Resort
   III. Star Hotel

b) **Health Care:** Any building or part thereof, which is used for purposes such as medical or other treatment or care of persons suffering from physical or mental illness, disease, or infirmity; care of infants, convalescents, or aged persons, and for penal or correctional detention in which the liberty of the inmates is restricted. Health Care buildings ordinarily provide sleeping accommodation for the occupants. Buildings and structures like hospitals, sanatoria, out-patient healthcare, laboratories, research establishments, and test houses are included under this type.

c) **Assembly:** Any building or part of a building, where number of persons congregate or gather for amusement, recreation, social, religious, patriotic, civil, travel and similar purposes. Buildings like theatres or motion picture halls, gathering halls, and transport buildings like airports, railway stations, bus stations, and underground and elevated mass rapid transit system are included in this group.

d) **Business:** Any building or part thereof which is used for transaction of business, for keeping of accounts and records and similar purposes, professional establishments, and service facilities. There are two subcategories under Business – Daytime Business and 24-hour Business. Unless otherwise mentioned, Business buildings shall include both Daytime and 24-hour subcategories.

e) **Educational:** Any building used for schools, colleges, universities, and other training institutions for day-care purposes involving assembly for instruction, education, or recreation for students. If residential accommodation is provided in the schools, colleges, or universities or coaching/ training institution, that portion of occupancy shall be classified as a No-star Hotel. Buildings and structures under Educational shall include following types: Schools, All other types of institutes, e.g. college, university, training institutes etc.

f) **Shopping Complex:** Any building or part thereof, which is used as shops, stores, market, for display and sale of merchandise, either wholesale or retail. Buildings like shopping malls, stand-alone retails, open gallery malls, super markets, or hyper markets are included in this type.

g) **Mixed-use Building:** In a mixed-use building, each commercial part of a building must be classified separately, and –
   I. If a part of the mixed-use building has different classification and is less than 10% of the total above grade floor area, the mixed-use building shall show compliance based on the building sub-classification having higher percentage of above grade floor area.
   II. If a part of the mixed-use building has different classification and one or more sub-classification is more than 10% of the total above grade floor area, the compliance requirements for each sub-classification, having area more than 10% of above grade floor area of a mixed-use building shall be determined by the requirements for the respective building classification in Chapter 4 through Chapter 11.

Any building which does not fall under any of the categories defined above shall be classified in a category mentioned above that best describes the function of the building.

Table 2.1 Building Typologies for ECSBC 2024

 **Hospitality**	A. Star Hotel B. No Star Hotel C. Resort
 **Educational**	D. College E. University F. Institution G. School
 **Health Care**	H. Hospital I. Out- Patient Healthcare
 **Shopping Complex**	J. Shopping mall K. Stand- Alone Retails L. Open Gallery Malls M. Super Markets
 **Business**	N. Daytime use O. 24- hours use
 **Assembly**	P. Multiplex Q. Theatre R. Building used for Transport Service

3. APPROACH TO COMPLIANCE

3.1. General

This code has two different methods of compliance, all the buildings typologies shall follow any one of the following methods in order to comply with the code:

a) Integrative Compliance Method (ICM) (Simulation approach)
b) Standardized Compliance Method (SCM) (Prescriptive approach)

3.2. Compliance Methods

Buildings that fall under the scope of the code as mentioned in Chapter 2, shall comply with the code by meeting all the mandatory requirements and any of the compliance methods mentioned in section 3.2.2. or 3.2.3.

3.2.1. Mandatory Requirements

Building shall comply with all mandatory requirements mentioned under section 4.2 through 11.2, irrespective of the compliance method.

3.2.2. Integrative Compliance Method

a) Requirement for ECSBC Compliance

A building shall comply with the code using ICM if it meets the simulation requirements mentioned in the section 12.2 & 12.3 and Table 3.1, in addition to meeting all the mandatory requirements (Refer Table 3.2).

b) Requirements for ECSBC Plus and ECSBC Super Compliance

A building shall comply with the code using ICM if it meets the simulation requirements mentioned in the section 12.2 & 12.3 and table 3.1 meets the additional mandatory requirements mentioned in the section 4.3 through 11.3 in addition to meeting all the mandatory requirements (Refer Table 3.2)

c) Modeled Energy Performance Intensity (MEPI)

1. The MEPI of a building is its annual energy consumption in kilowatt-hour per square meter of the building. MEPI can be determined by:

$$MEPI = \frac{\left(Total\ Annual\ Energy\ Consumption\ \left(\frac{kWh}{year}\right)\right)}{Net\ BuiltUp\ Area\ (m^2)}$$

Note: The net built–up area (m^2) is the total built–up area ($sqmt.$) excluding the following areas:

a) Unconditioned basement area (m^2)
b) Unconditioned refuge area (m^2)
c) Stilt Parking Area (m^2)

2. To comply with the code through ICM, MEPI value shall be calculated using simulation as specified in chapter 12 and its value rounded off to two decimal places in accordance with IS 2: 1960 “rules for rounding off numerical values”.

d) Percentage of Energy Saving (PES)

The percentage of energy savings (PES) for a proposed building represents the estimated energy savings compared to a baseline building.

$$PES = \left(\frac{(MEPI_{Baseline} - MEPI_{Proposed})}{MEPI_{Baseline}}\right) * 100$$

1. Proposed Building shall be consistent with the actual design of the building and complies with all the mandatory requirements in addition to the requirements mentioned in chapter 12.
2. Baseline building shall have the same building floor area, gross wall area and gross roof area as the proposed building and complies with the requirements of chapter 12.
3. The PES of the building that demonstrate compliance through ICM method shall not be negative and shall refer to the compliance requirements mentioned in section 12.6.

Table 3.1: Compliance requirement under ICM (Whole building method)

Building Type	MEPI requirement	Minimum PES requirement
ECSBC	$MEPI_{Baseline} = MEPI_{Proposed}$	NA
ECSBC Plus	$MEPI_{Proposed} < MEPI_{Baseline}$	Section 12.6
Super ECSBC	$MEPI_{Proposed} < MEPI_{Baseline}$	Section 12.6

3.2.3. Standardized Compliance Method

a) Requirement for ECSBC Compliance

1. A building shall comply with the code using SCM if it meets the standardized requirement mentioned in the section 5.3 through 8.3, in addition to meeting all the mandatory requirements (Refer Table 3.3).
2. ECSBC buildings that demonstrate compliance through SCM shall be deemed to have PES as defined in section 12.5.3.

b) Requirement for ECSBC + & super ECSBC Compliance

1. A building shall comply with the code using SCM if it meets the standardized requirements mentioned in the section 5.3 through 8.3 and the additional mandatory requirements mentioned in section 4.3 through 11.3, in addition to meeting all the mandatory requirements (Refer Table 3.3).
2. ECSBC Plus and Super ECSBC buildings that demonstrate compliance through the SCM shall be deemed to have PES as defined in section 12.5.3.

c) Building Envelope Trade-off Method

To comply with the SCM the Building Envelope Trade-off Method can be used in place of the standardized requirement of section 5.3.1, 5.3.2 and 5.3.3. A building complies with the Code using the building envelope trade-off method if the envelope performance factor (EPF) of the proposed building is less than or equal to the EPF of the Standard Building, calculated as per section 5.3.5

d) Total System Efficiency

For projects using central chilled water plants, the total system efficiency (TSE) approach can be used.. This approach may be used in place of the standardized requirement criteria of central chilled water plant side systems comprises chillers, chilled water pumps, condenser water pumps, and cooling tower fans Per this approach, a building complies if the TSE thresholds are met as per table 6-25 maximum system efficiency threshold for ECSBC, ECSBC Plus, and super ECSBC Buildings. Compliance with other standardized requirement of section6.3, as applicable, shall be met.

e) Low Energy Comfort Systems

Low Energy Comfort Systems, is a simplified approach that provides projects using Low Energy Comfort Systems an opportunity to achieve improved compliance levels of ECSBC plus and super ECSBC. In addition to compliance with the applicable standardized requirement of section 6.3, the projects must meet the sum of cooling and heating requirement using approved list of low energy systems as per requirements specified in section 6.3.13.

Table3.2: Section required to be followed for ECSBC, ECSBC plus and Super ECSBC compliance with Integrative Compliance Method (ICM)

Mandatory Requirements for ECSBC, ECSBC plus and Super ECSBC	Additional Mandatory Requirements for ECSBC plus and Super ECSBC	Simulation Requirements for ECSBC, ECSBC plus and Super ECSBC
Section 4.2	**Section 4.3**	**Section 12.2 and 12.3**
Section 5.2		
Section 6.2		
Section 7.2		
Section 8.2		
Section 9.2	**Section 9.3**	

Section 10.2	**Section 10.3**	
Section 11.2	**Section 11.3**	

Table 3.3: Section required to be followed for ECSBC, ECSBC plus and Super ECSBC compliance with Standardized Compliance Method (SCM)

Mandatory Requirements for ECSBC, ECSBC plus and Super ECSBC	Additional Mandatory Requirements for ECSBC plus and Super ECSBC	Standardized Requirements for ECSBC, ECSBC plus and Super ECSBC
Section 4.2	**Section 4.3**	
Section 5.2		**Section 5.3**
Section 6.2		**Section 6.3**
Section 7.2		**Section 7.3**
Section 8.2		**Section 8.3**
Section 9.2	**Section 9.3**	
Section 10.2	**Section 10.3**	
Section 11.2	**Section 11.3**	

3.3.1. New Building Compliance

3.3.1. New Building Compliance

a) Complete Building Compliance

New buildings with completed fit-outs shall comply with the provisions of section 3.2.1. and either the provision of section 3.2.2 or 3.2.3.

b) Core and Shell Building Compliance

1. New core and shell building shall comply with the provisions of section 3.2.1 and either the provision of section 3.2.2 or 3.2.3 following base building systems in the common areas:
   a. Building envelope
   b. Thermal comfort systems and controls (only those installed by developer/ owner)
   c. Lighting systems and controls (only those installed by developer/ owner)
   d. Electrical systems (only those installed by developer/ owner)
   e. Renewable energy systems (only those installed by developer/ owner)
   f. Indoor environmental quality (only those installed by developer/ owner)
   g. Water management and controls (only those installed by developer/ owner)
   h. Waste management (only those installed by developer/ owner)
   i. Sustainable sites and planning (only those installed by developer/ owner)
2. Additionally, the tenant lease agreement shall have a legal undertaking clause to ensure interior fit-outs made by tenant shall be Code compliant. The legal undertaking shall mandate the relevant energy efficiency compliance requirements in accordance with the provisions of section 3.2.1 and 3.2.3 for all interior fit-outs within the tenant leased area.

3.3.2 Additions and Alteration to Existing Building

If any existing building after additions or alterations changes its connected load to 100 kilo- Watt (kW) or above or a contract demand of 120 kilo-Volt Ampere (kVA) or above shall comply with the provisions of chapter 4 through 11. Compliance may be demonstrated in either of the following ways:

a. The addition shall comply with the applicable requirements, or
b. The addition, together with the entire existing building, shall comply with the requirements of this Code that shall apply to the entire building, as if it were a new building.

Exceptions to 3.3.2:

When space conditioning is provided by existing systems and equipment, the existing systems and equipment need not comply with this code. However, any new equipment installed must comply with specific requirements applicable to that equipment.

3.4. Approved Compliance Tools

A building following the whole building performance method of chapter 12 or Total System Efficiency – Alternate compliance approach (section 6.3.12) shall show compliance through energy simulation software endorsed by BEE.

3.5. Administrative Requirements

Administrative requirements, including but not limited to, permit requirements, enforcement, interpretations, claims of exemption, approved calculation methods, and rights of appeal are specified by the authority having jurisdiction.

3.6. Compliance Documents

Construction drawings and specifications shall show all pertinent data and features of the building, equipment, and systems in sufficient detail to permit the authority having jurisdiction to verify that the building complies with the requirements of this code. Details shall include, but are not limited to:

a. Building Envelope: opaque construction materials and their thermal properties including thermal conductivity, specific heat, density along with thickness; fenestration U-factors, solar heat gain coefficients (SHGC), visible light transmittance (VLT) and building envelope sealing documentation; overhangs and side fins, building envelope sealing details;
b. Heating, Ventilation, and Air Conditioning: system and equipment types, sizes, efficiencies, and controls; economizers; variable speed drives; piping insulation; duct sealing, insulation and location; solar water heating system; requirement for balance report;
c. Lighting: lighting schedule showing type, number, and wattage of lamps and ballasts; automatic lighting shutoff, occupancy sensors, and other lighting controls; lamp efficacy for exterior lamps;
d. Electrical Power: electric schedule showing transformer losses, motor efficiencies, and power factor correction devices; electric check metering and monitoring system.
e. Renewable energy systems: system peak installed capacity, technical specifications, solar zone area.
f. Sustainable Sites & Planning
g. Water Management and Controls
h. Waste Management
i. Indoor Environment Quality and other relevant parameters.

3.7. Supplemental Information

The authority having jurisdiction may require supplemental information necessary to verify compliance with this code, such as calculations, worksheets, compliance forms, manufacturer's literature, or other data.

4. Sustainable Sites & Planning

4.1 General Requirement

The Sustainable Sites and Planning chapter addresses the preservation of ecological integrity and the reduction of environmental impacts resulting from construction activities. It mandates the restoration and conservation of biodiversity that is impacted or potentially impacted by site development. Buildings must adhere to the mandatory requirements set forth in Section 4.2. Additional mandatory provisions for ECSBC Plus and Super ECSBC are outlined in Section 4.3. Documentation demonstrating compliance must be submitted for verification as prescribed in Section 4.4.

All ECSBC, ECSBC Plus, Super ECSBC compliant buildings shall conform to section 4.2. All ECSBC Plus and ECSBC Super compliant building shall confirm to section 4.3 in addition to section 4.2.

4.2. Mandatory Requirements

4.1.1 Topsoil Preservation

Fertile topsoil, ranging from 150 to 200 mm in depth, must be preserved, stabilized, and its fertility maintained during preconstruction activities. The stored topsoil shall be utilized as the finished grade for planting areas either within the site or externally. If the stored topsoil is not utilized on-site, appropriate measures must be taken to ensure its proper reuse.

4.1.2 Tree Preservation and Compensatory Planting

Ensure the protection or preservation of existing mature trees, either naturally or in accordance with the guidelines of local bylaws or authorities, whichever is more stringent. If preservation is not feasible, compliance with the Model Building Bylaws is required, ensuring compensatory plantation for felled or transplanted trees at a ratio of 1:3 within the premises under consideration.

4.1.3 Selection of site

The site plan must adhere to local bylaws concerning the development plan and master plan, as well as the Urban Development Plans Formulation and Implementation (UDPFI) guidelines and regulations. Compliance is required for eco-sensitive zones, coastal zones, heritage areas, water body zones, hazard-prone areas, and other designated zones. Additionally, construction activities shall not obstruct or interfere with existing infrastructure, such as water bodies, power or communication lines, and sewerage lines located on or adjacent to the project site.

4.1.4 Design for Differently Abled

a) Ramps

Provide minimum one accessible entrance with provision of ramp. Ramps shall conform to NBC 2016 – Part 3, Annexure B-6.2.2 - Table 10 and B-6.2.1 c, B-6.2.4. and also single row of tactile ground surface indicator warning blocks shall be placed at the beginning and end of each ramp conform to NBC-2016, Part-3.

b) Building main entrance gate

The main entrance of any building shall ensure access for all including persons with disabilities, elderly and others with special needs without a need for special entry. The clear width of the accessible entrance door shall not be less than 900mm.

c) Elevators

In Multi-storied buildings provide at least one elevator that shall conform to NBC 2016 – Part 3, Annexure B-6.4, accessible to persons with disabilities at all usable levels. The elevator opening shall be 0.9 m minimum. Audio and braille assistance shall be provided in lifts for visually impaired people.

d) Washroom

Minimum one restroom in the building common areas shall be designed for differently abled people or as defined by the local byelaw, in an easily accessible location.

a. Provide minimum one unisex wheelchair user accessible restroom that shall conform to NBC 2016 – Part 3, Annexure B-9.2.2, with central placement of water closet and provision of washbasin.
b. Depending on footfall, provide additional accessible toilets in male and female restroom that shall conform to NBC 2016 – Part 3, Annexure B-9.2.3
c. The floor surfaces shall be slip resistant, anti-glare and firm.

d. Signages at entrance of accessible toilets shall conform to NBC 2016 – Part 3, Annexure B-9.18.

4.1.5 Heat Island Reduction – Non-Roof Areas

Paved areas including uncovered parking areas and pathways of the site shall not exceed 30% of the total site area excluding building footprint or as per local bye law, whichever is more stringent.

4.1.6 Brownfield Remediation

If applicable, brownfield sites for construction of commercial buildings shall be used only after proper remediation. Remediation techniques shall include but not limited to pump-and-treat, bioreactors, land farming and in-situ remediation.

Note: The remediation measures shall be as per local building bye laws. Post remediation, the site shall be approved by local statutory body for its intended use.

4.3 Additional Mandatory Requirements

All ECSBC Plus and Super ECSBC buildings shall address the following additional measures:

4.3.1 Requirements for ECSBC Plus and Super ECSBC building Compliance

(a) Topsoil preservation

It is required that a sedimentation basin be installed at the stormwater exit from the site during construction to prevent topsoil erosion..

(b) Dedicated Parking for Differently Abled

Preferential parking for differently-abled individuals shall be provided in accordance with NBC 2016 – (Part 3, Annexure B-3.5) and its subsequent revisions if any.

a. One differently abled car park shall be provided for the first 100 parking spaces, additional differently abled car park for every 250 parking spaces thereafter.
b. Dedicated parking shall be accessible within 30m of the main entrance.
c. Signages shall be installed for dedicated differently abled parking at a minimum height of 2.1 m.
d. International symbol of accessibility shall be painted on floor surface as per NBC 2016 -Part 3, Annexure B-3.3.

(C) Access for Differently Abled

Access to the building for differently abled people shall be designed as per NBC 2016 – Part 3, Annexure B-5.3 and its subsequent versions if any:

a. Width of the entrance door shall be minimum 0.9 m.
b. Tactile warning blocks shall be provided at 0.3 m from the entrance.

4.3.2 Other Requirements for Super ECSBC building Compliance

(a) Access to Amenities

Access to at least four amenities shall be provided from the list below, either within the building or within a walking distance of 800 m from the building entrance. These facilities shall be available once the building is operational.

a. Automated Teller Machine (ATM) / Bank
b. Health care Clinic / Hospital
c. Crèche
d. Pharmacy
e. Restaurant / Cafeteria
f. Fitness Centre / Gym

(b) Access to Public Transportation

1. The project shall have access to a public transportation by road, or rail or water within 800 m walking distance from project exit gate, (or)
2. Wherever public transport is not available within 800m walking distance, transport service to the nearest public transport facility to cater to at least 25% of the building occupants shall be provided.

(c) In-situ transit

For all Super ECSBC buildings, if applicable, buildings in large campuses with total ground area above 1,00,000 m^2 shall provide the following:

a. Bicycle lane network for internal commuting to connect all main buildings.
b. Bicycle parking facility for all main buildings within 100 m of walking distance from entrance to cater to 10% of the occupants.

(d) Heat Island Reduction – Roof Areas

For all Super ECSBC buildings, urban heat island effect shall be minimized by providing cool roof or vegetation

for minimum 95% of the net exposed roof area as specified in chapter 5.

(e) Heat Island Reduction – Non-Roof Areas

For all Super ECSBC buildings, Shade shall be provided for 100% of paved area including uncovered parking area and pathways either through vegetation or a combination of vegetation, structural shade with high-reflective materials and open grid paver blocks. The structural roof shall meet the cool roof criteria of minimum SRI of 82. High reflective materials provided in non-roof areas shall have SRI of at least 29 and not greater than 64.

4.4 Compliance Documents Requirement

Specification sheet or cut sheet from manufacturer for material/product/installed fixtures along with the copy of purchase invoice/BOQ/tender documents, whenever possible.

1. Site Plan highlighted trees (existing mature trees, preserved trees, transplanted, removed), along with highlighting top soil excavation and top soil storage and preservation area with volume.
2. Fertility report of soil from a certified lab.
3. Survey-plan highlighted existing features of the site like existing water bodies, power or communication lines, sewerage lines.
4. Accessibility Plan highlighted measures (ramps with handrails on entrances and grade change, tactile guiding system, easily accessible play areas etc.) to ensure universal accessibility including features for differently abled, children and elderly.
5. Landscape Plan highlighted the following:
6. Plant/tree schedule for all vegetated species being planted along with measures taken to preserve local biodiversity and ecology;
7. All type of finishes used on site with legend
8. Waterbodies/ water features, Vegetated areas, paved areas, building footprint.

5 Building Envelope

5.1 General Requirement

The building envelope shall comply with the mandatory requirements as specified in Section 5.2, and the Standardized requirements as specified in section 5.3.

5.2 Mandatory Requirements

5.2.1 Fenestration

(a) U-Factor

U-factors shall be determined for the overall fenestration product (including the sash and frame) in accordance with ISO-15099 by an accredited independent laboratory or labelled by the manufacturer. U-factors for sloped glazing and skylights shall be determined at a slope of 20 degrees above the horizontal. For unrated products, see the default value given in Appendix A of chapter 14.

(b) Solar Heat Gain Coefficient (SHGC)

SHGC shall be determined for the overall single or multi glazed fenestration product (including the sash and frame) in accordance with ISO-15099 by an accredited independent laboratory or labelled or certified by the manufacturer.

Notes:

Exceptions to section 5.2.1-(a):

1. Shading coefficient (SC) of the centre of glass alone multiplied by 0.86 is an acceptable alternate for compliance with the SHGC requirements for the overall fenestration area.
2. Solar heat gain coefficient (SHGC) of the glass alone is an acceptable alternate for compliance with the SHGC requirements for the overall fenestration product.

(c) Visible Light Transmittance (VLT)

Visible light transmittance (VLT) shall be determined for the fenestration product in accordance with ISO-15099 by an accredited independent laboratory or labelled by the manufacturer. For unrated products, VLT of the glass alone shall be derated by 10% for demonstrating compliance with the VLT requirements for the overall fenestration product.

5.2.2 Opaque Construction

(a) U-Factor

U-factors shall be calculated for the opaque construction in accordance with ISO-6946. Testing shall be done in accordance with approved ISO Standard for respective insulation type by an accredited independent laboratory, and labelled or certified by the manufacturer. For unrated products, use the default tables in Appendix A.

(b) Solar Reflectance

Solar reflectance for the external opaque roof construction material shall be determined in accordance with ASTM E903-96 by an accredited independent laboratory and labelled by the manufacturer.

(c) Emittance

Emittance for the external opaque roof construction shall be determined in accordance with ASTM E408-71 (RA 2008) by an accredited independent laboratory, and labelled by the manufacturer.

5.2.3 Daylighting and Visual Comfort

Compliance for daylighting may be demonstrated either with simulation using the Useful Daylight Simulation compliance path as defined in section 5.2.3-(a) or through the Spatial Daylight Autonomy Part as defined in section 5.2.3 (d). Compliance may also be demonstrated as per manual method in section 5.2.3-(c). For Whole Building simulation, the standard building shall be modelled with daylight sensors located within 6m from the building periphery.

(a) Useful daylight illuminance

Above grade floor areas shall meet the useful daylight illuminance (UDI) area requirements listed in Table 5.1 for 90% of the potential daylit time in a year. Exceptions to section 5.2.3 Assembly buildings and other buildings where daylighting will interfere with the functions of 50% (or more) of the building floor area, are exempted from meeting the requirements listed in Table 5.1.

Table 5.1 Daylight Requirement

Building Category	Percentage of above grade floor area meeting the UDI requirement		
	ECSBC	ECSBC+	Super ECSBC
Business, Educational	40%	50%	60%
No Star Hotel Star Hotel Healthcare	30%	40%	50%
Resort	45%	55%	65%
Shopping Complex	10%	15%	20%
Assembly	Exempted		

(b) Useful Daylight Illumination (UDI) Simulation Method

A software validated by an appropriate authority and approved by BEE shall be used to demonstrate compliance through the UDI simulation method. Buildings shall achieve illuminance level between 100 lux and 2,000 lux for the minimum percentage of floor area prescribed in Table 5.1 for at least 90% of the potential daylit time.

Illuminance levels for all spaces enclosed by permanent internal partitions (opaque, translucent, or transparent) with height greater or equal to 2 m from the finished floor, shall be measured as follows:

I. Measurements shall be taken at a work plane height of 0.8 m above the finished floor. The period of analysis shall be fixed for continuously minimum 8 hours per day between 7:00 AM to 5:00 PM IST, resulting in maximum 2,920 hours in total for all building types except for school. Schools shall be analyzed for continuously minimum 7 hours per day between 7:00 AM to 3:00 PM IST.
II. Available useful daylight across a space shall be measured based on point-by-point grid values. UDI shall be calculated for at least one point for each square meter of floor area.
III. Fenestration shall be modelled with actual visible light transmission (VLT) as per the details provided in the material specification sheet.
IV. All surrounding natural or man-made daylight obstructions shall be modelled if the distance between the façade of the building (for which compliance is shown) and surrounding natural or man-made daylight obstructions is less than or equal to twice the height of the man-made or natural sunlight obstructers. If the reflectance of the surfaces is not known, default reflectance of 30% and 0% shall be used for all vertical surfaces of man-made and natural obstructers respectively.
V. Interior surface reflectance shall be modelled based on the actual material specification. If material specification is not available, the default values in Table 5.2 shall be used.
VI. Documentation requirement to demonstrate compliance are:
    i. Brief description of the project with location, number of stories, space types, hours of operation and software used.
    ii. Summary describing the results of the analysis and output file from simulation tool outlining point wise compliance for the analysis grid and compliance in percentage.
    iii. Explanation of any significant modelling assumptions made.
    iv. Explanation of any error messages noted in the simulation program output.
    v. Building floor plans, building elevations & sections, and site plan with surrounding building details (if modelled).
    vi. Material reflectance, analysis grid size, total number of grid size/resolution, total number of grid points.

Table 5.2 Default Values for Surface Reflectance

Surface Type	*Reflectance*
Wall or Vertical Internal Surfaces	50%
Ceiling	70%
Floor	20%
Furniture (permanent)	50%

(c) Manual Daylight Compliance method

This method can be used for demonstrating compliance with daylighting requirements without simulation. Daylight extent factors (DEF) mentioned in Table 5.4 shall be used for manually calculating percentage of above grade floor area meeting the UDI requirement for 90% of the potential daylit time in a year.

I. To calculate the daylit area:

(i) In a direction perpendicular to the fenestration, multiply daylight extent factor (DEF) by the head height of the fenestration or till an opaque partition higher than head height of the fenestration, whichever is less.

(ii) In the direction parallel to the fenestration, daylit area extends a horizontal dimension equal to the width of the fenestration plus either 1 meter on each side of the aperture, or the distance to an opaque partition of 2 m high, or one-half the distance to an adjacent fenestration, whichever is least.

(iii) For skylights, calculate the horizontal dimension in each direction equal to the top aperture dimension in that direction plus either the floor-to-ceiling height (H) for skylights, or 1.5 H for monitors, or H or 2H for the sawtooth configuration, or the distance to the nearest 1 meter or higher opaque partition, or one-half the distance to an adjacent skylight or vertical glazing, whichever is least.

(iv) Glazed façades, with non-cardinal orientation, shall be categorized under a particular cardinal direction if its orientation is within ± 45 degrees of that cardinal direction.

(v) Daylit area overlap: For overlapping daylit areas such as windows on different orientations or in case of skylights the overlapping daylit area shall be subtracted from the sum of daylit area.

Documentation requirement:

(i) A separate architectural plan shall be prepared with all daylit areas marked on the floor plans.

(ii) A summary shall be provided showing compliance as per Table 5.1.

5.3 Standardized Requirements

5.3.1 Roof

Roofs may comply with the maximum assembly U-factors in Table 5.7 through Table 5.9 . The roof insulation shall be applied externally as part of the roof assembly and not as a part of false ceiling.

Table 5.4 Daylight Extent Factors (DEF) for Manually Calculating Daylight Area

Shading	*Latitude*	*Window Type*	*VLT < 0.3*				*VLT ≥0.3*			
			North	South	East	West	North	South	East	West
No shading or PF < 0.4	≥15°N	All window types	2.5	2.0	0.7	0.5	2.8	2.2	1.1	0.7
	< 15°N		2.4	2.0	0.8	0.6	2.7	2.2	1.5	0.8
Shading with PF ≥ 0.4	All latitudes	All window types without light shelf*	2.8	2.3	1.5	1.1	3.0	2.5	1.8	1.5
		Window with light shelf*	3.0	2.5	1.8	1.6	3.5	3.0	2.1	1.8
* To qualify as light shelf the internal projection shall meet the requirements specified under Exceptions to SHGC requirements in Table 5.9 to Table 5.11.										

Table 5.3 Roof Assembly U-factor (W/m2.K) Requirements for ECSBC Compliant Building

	Composite	*Hot and dry*	*Warm and humid*	*Temperate*	*Cold*
All building types, except below	0.26	0.26	0.26	0.26	0.20
Assembly Hospitality > 10,000 m² AGA	0.20	0.20	0.20	0.20	0.20

Table 5.4 Roof Assembly U-factor (W/m2.K) Requirements for ECSBC+ Compliant Building

	Composite	*Hot and dry*	*Warm and humid*	*Temperate*	*Cold*
All Building Types	0.20	0.20	0.20	0.20	0.20

Table 5-5 Roof Assembly U-factor (W/m2.K) Requirements for SuperECSBC Building

	Composite	*Hot and dry*	*Warm and humid*	*Temperate*	*Cold*
All buildings types	0.18	0.18	0.18	0.18	0.18

(a) 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 roofs or vegetated roofs.

For qualifying as a cool roof, roofs with slopes

less than 20° shall have an initial solar reflectance of no less than 0.70 and an initial emittance no less than 0.75. Solar reflectance shall be determined in accordance with ASTM E903 96 and emittance shall be determined in accordance with ASTM E408-71 (RA 2008).

For qualifying as a vegetated roof, roof areas shall be covered by living vegetation of >50 mm high.

5.3.2 Opaque External Wall

Opaque above grade external walls shall comply with the maximum assembly U-factors in table 5.10 through table 5.12

Table 5.6 Opaque Assembly Maximum U-factor (W/m2.K) Requirements for ECSBC compliant Building

	Composite	*Hot and dry*	*Warm and humid*	*Temperate*	*Cold*
All building types, except below	0.40	0.40	0.40	0.55	0.34
No Star Hotel < 10,000 m² AGA	0.63	0.63	0.63	0.63	0.40
Business < 10,000 m² AGA	0.63	0.63	0.63	0.63	0.40
School <10,000 m² AGA	0.85	0.85	0.85	1.00	0.40

Table 5.7 Opaque Assembly Maximum U-factor (W/m2.K) Requirements for ECSBC+ Compliant Building

	Composite	*Hot and dry*	*Warm and humid*	*Temperate*	*Cold*
All building types, except below	0.34	0.34	0.34	0.55	0.22
No Star Hotel < 10,000 m² AGA	0.44	0.44	0.44	0.44	0.34
Business < 10,000 m² AGA	0.44	0.44	0.44	0.55	0.34
School <10,000 m² AGA	0.63	0.63	0.63	0.75	0.44

Table 5.8 Opaque Assembly Maximum U-factor (W/m2.K) Requirements for Super ECSBC Building

	Composite	*Hot and dry*	*Warm and humid*	*Temperate*	*Cold*
All building types	0.22	0.22	0.22	0.22	0.22

Note:

Exceptions to section 5.3.2: Opaque external walls of an unconditioned building of No Star Hotel, Healthcare, and School categories in all climatic zones, except for cold climatic zone, shall have a maximum assembly U-factor of 0.8 W/m².K.

5.3.3 Vertical Fenestration

For all climatic zones, vertical fenestration compliance requirements for all three energy efficiency levels, i.e. ECSBC, ECSBC+, and Super ECSBC, shall comply with the following:

1. Maximum allowable Window Wall Ratio (WWR) is 40% (applicable to buildings showing compliance using the Standrdized Method, including Building Envelope Trade-off Method)
2. Minimum allowable Visible light transmittance (VLT) is 0.27
3. Assembly U-factor shall be determined for the overall fenestration product (including the sash and frame)

Vertical fenestration shall comply with the maximum Solar Heat Gain Coefficient (SHGC) and U-factor requirements of Table5-13 for ECSBC buildings and table 5.14 for ECSBC+ buildings and table 5.15 Super ECSBC buildings. Vertical fenestration on non-cardinal direction, shall be categorized under a particular cardinal direction if its orientation is within ± 45° of that cardinal direction.

Table 5.9 Vertical Fenestration Assembly U-factor and SHGC Requirements for ECSBC Buildings

	Composite	*Hot and dry*	*Warm and humid*	*Temperate*	*Cold*
Maximum U-factor ($W/m^2.K$)	2.20	2.20	2.20	3.00	1.80
Maximum SHGC Non-North	0.25	0.25	0.25	0.25	0.62
Maximum SHGC North for latitude ≥ 15°N	0.50	0.50	0.50	0.50	0.62
Maximum SHGC North for latitude < 15°N	0.25	0.25	0.25	0.25	0.62
See Appendix A for default values of unrated fenestration.					

Table 5.10 Vertical Fenestration U-factor and SHGC Requirements for ECSBC+ buildings

	Composite	*Hot and dry*	*Warm and humid*	*Temperate*	*Cold*
Maximum U-factor ($W/m^2.K$)	1.80	1.80	1.80	2.20	1.80
Maximum SHGC Non-North	0.20	0.20	0.20	0.20	0.62
Maximum SHGC North for latitude ≥ 15°N	0.50	0.50	0.50	0.50	0.62
Maximum SHGC North for latitude < 15°N	0.20	0.20	0.20	0.20	0.62

Table 5.11 Vertical Fenestration U-factor and SHGC Requirements for Super ECSBC buildings

	Composite	*Hot and dry*	*Warm and humid*	*Temperate*	*Cold*
Maximum U-factor ($W/m^2.K$)	1.80	1.80	1.80	2.20	1.80
Maximum SHGC Non-North	0.25	0.25	0.25	0.25	0.62
Maximum SHGC North for latitude ≥ 15°N	0.50	0.50	0.50	0.50	0.62
Maximum SHGC North for latitude < 15°N	0.25	0.25	0.25	0.25	0.62

Exceptions to SHGC requirements in, Table 5.13 and Table 5.15

1. Fenestration with a permanent external projection, including but not limited to overhangs, side fins, box frame, verandah, balcony, and fixed canopies that provide permanent shading to the fenestration, the equivalent SHGC for the proposed shaded fenestration may be determined as less than or equal to the SHGC requirements of Table 5.13-5-15 Equivalent SHGC shall be calculated by following the steps listed below:

   (i) Projection factor (PF) for the external permanent projection, shall be calculated as per the applicable shading type listed in chapter 8, section 8.2. The range of

projection factor for using the SEF is $0.25 \leq PF \leq 1.0$. The SEF is applicable for both side fins shading only other than overhangs. The projection factor shall be calculated for both side fins and the lower projection factor of each fin shall be considered. Other shading devices shall be modelled through the Whole Building Performance Method in chapter 12.

(ii) A shaded vertical fenestration on a non-cardinal direction, shall be categorized either under a particular cardinal direction or a primary inter-cardinal direction if its orientation is within the range of ±22.5° of the cardinal or primary inter-cardinal direction.

(iii) Any surrounding man-made or natural sunlight obstructers shall be considered as a permanent shading of PF equal to 0.4 if;

a. the distance between the vertical fenestration of the building, for which compliance is shown, and surrounding man-made or natural sunlight obstructers is less than or equal to twice the height of the surrounding man-made or natural sunlight obstructers; and
b. the surrounding man-made or natural sunlight obstructers shade the façade for at least 80% of the total time that the façade is exposed to direct sun light on a summer solstice. Compliance shall be shown using a sun path analysis for summer solstice for the vertical fenestration.

(iv) An equivalent SHGC is calculated by dividing the SHGC of the unshaded fenestration product with a Shading Equivalent Factor (SEF). SEF shall be determined for each orientation and shading device type from table 5.13 to 5.15

(v) The maximum allowable SHGC is calculated by multiplying the standardized SHGC requirement for respective compliance level from table 5.13 to 5-15 with the SEF.

Vertical fenestration, located such that its bottom is more than 2.2 m above the level of the floor, is exempt from the SHGC requirements in Table 5.11 to 5-13, if the following conditions are complied with:

i. The Total Effective Aperture (WWR X VLT) for the elevation is less than 0.25, including all fenestration areas more than 1.0 meter above the floor level; and,
ii. An interior light shelf is provided at the bottom of this fenestration area, with a projection factor on interior side not less than:
   a. 1.0 for E-W, SE, SW, NE, and NW orientations
   b. 0.50 for S orientation, and
   c. 0.35 for N orientation when latitude is less than 15°N.

Table 5.12 Shading Equivalent Factors for Latitudes greater than or equal to 15 ºN

Shading Equivalent Factors (SEF) for latitudes greater than or equal to 15˚N									
SEF	PF	North	East	South	West	North-East	South-East	South-West	North-West
Overhang + Fins	0.25	1.25	1.37	1.58	1.36	1.47	1.47	1.42	1.53
	0.3	1.29	1.48	1.72	1.43	1.54	1.65	1.57	1.58
	0.35	1.34	1.58	1.88	1.51	1.62	1.81	1.73	1.65
	0.4	1.39	1.67	2.06	1.61	1.70	1.97	1.89	1.75
	0.45	1.43	1.76	2.26	1.71	1.78	2.11	2.06	1.87
	0.5	1.47	1.85	2.47	1.83	1.86	2.25	2.23	2.00
	0.55	1.51	1.94	2.69	1.96	1.94	2.38	2.40	2.13
	0.6	1.55	2.03	2.92	2.09	2.02	2.51	2.58	2.27
	0.65	1.59	2.13	3.15	2.24	2.10	2.64	2.76	2.40
	0.7	1.63	2.24	3.18	2.39	2.18	2.77	2.94	2.53
	0.75	1.66	2.37	3.19	2.56	2.25	2.90	3.12	2.64
	0.8	1.70	2.52	3.20	2.72	2.33	3.04	3.18	2.73
	0.85	1.73	2.69	3.21	2.90	2.40	3.11	3.23	2.80
	0.9	1.76	2.89	3.24	3.07	2.46	3.15	3.25	2.84
	0.95	1.79	3.11	3.28	3.25	2.52	3.17	3.27	2.85
	≥1	1.80	3.30	3.33	3.33	2.57	3.23	3.30	2.82
Overhang	0.25	1.09	1.21	1.28	1.20	1.17	1.26	1.23	1.20
	0.3	1.11	1.26	1.34	1.27	1.22	1.32	1.27	1.24
	0.35	1.13	1.30	1.39	1.33	1.26	1.39	1.32	1.28
	0.4	1.15	1.35	1.46	1.38	1.30	1.46	1.38	1.32
	0.45	1.16	1.40	1.52	1.43	1.33	1.53	1.46	1.36
	0.5	1.18	1.45	1.59	1.48	1.35	1.60	1.54	1.40
	0.55	1.20	1.51	1.66	1.52	1.38	1.67	1.62	1.44
	0.6	1.21	1.56	1.73	1.57	1.40	1.74	1.70	1.47
	0.65	1.22	1.62	1.81	1.61	1.42	1.81	1.79	1.51
	0.7	1.24	1.68	1.88	1.66	1.45	1.88	1.87	1.55
	0.75	1.25	1.74	1.95	1.72	1.48	1.94	1.94	1.58
	0.8	1.26	1.80	2.02	1.77	1.51	2.00	2.01	1.61
	0.85	1.27	1.86	2.09	1.84	1.56	2.06	2.06	1.64
	0.9	1.28	1.92	2.15	1.91	1.61	2.11	2.10	1.67
	0.95	1.29	1.99	2.21	1.98	1.67	2.15	2.13	1.70
	≥1	1.30	2.06	2.26	2.07	1.75	2.19	2.14	1.72
Side Fins	0.25	1.13	1.11	1.18	1.11	1.21	1.14	1.16	1.23
	0.3	1.15	1.13	1.22	1.13	1.22	1.17	1.22	1.27
	0.35	1.17	1.15	1.26	1.15	1.24	1.20	1.26	1.32
	0.4	1.19	1.17	1.29	1.17	1.27	1.23	1.29	1.36
	0.45	1.21	1.19	1.32	1.19	1.30	1.25	1.31	1.41
	0.5	1.22	1.20	1.35	1.20	1.34	1.27	1.33	1.46
	0.55	1.24	1.22	1.38	1.22	1.38	1.29	1.34	1.50
	0.6	1.25	1.23	1.40	1.23	1.42	1.31	1.35	1.55
	0.65	1.27	1.24	1.42	1.25	1.47	1.32	1.36	1.58
	0.7	1.28	1.26	1.44	1.26	1.51	1.34	1.36	1.61
	0.75	1.30	1.27	1.46	1.27	1.55	1.35	1.37	1.64
	0.8	1.31	1.28	1.48	1.29	1.59	1.37	1.38	1.65
	0.85	1.32	1.30	1.49	1.30	1.62	1.38	1.39	1.65
	0.9	1.34	1.31	1.51	1.31	1.65	1.40	1.40	1.64
	0.95	1.35	1.32	1.53	1.32	1.67	1.42	1.42	1.61
	≥1	1.36	1.33	1.55	1.33	1.69	1.44	1.45	1.57

Table 5.13 Shading Equivalent Factors for Latitudes less than 15 ºN

Shading Equivalent Factors (SEF) for latitudes less than 15°N									
SEF	PF	North	East	South	West	North-East	South-East	South-West	North-West
Overhang + Fins	0.25	1.38	1.33	1.30	1.34	1.42	1.41	1.37	1.42
	0.3	1.44	1.42	1.35	1.42	1.49	1.46	1.41	1.52
	0.35	1.50	1.50	1.42	1.50	1.57	1.52	1.47	1.63
	0.4	1.56	1.59	1.50	1.59	1.66	1.59	1.54	1.73
	0.45	1.61	1.67	1.59	1.69	1.76	1.67	1.61	1.84
	0.5	1.67	1.76	1.68	1.80	1.87	1.75	1.70	1.94
	0.55	1.72	1.85	1.79	1.90	1.98	1.85	1.80	2.05
	0.6	1.77	1.94	1.89	2.02	2.09	1.94	1.89	2.15
	0.65	1.82	2.02	1.99	2.13	2.20	2.04	2.00	2.25
	0.7	1.86	2.11	2.08	2.24	2.31	2.15	2.10	2.36
	0.75	1.90	2.19	2.17	2.35	2.42	2.25	2.21	2.46
	0.8	1.94	2.28	2.25	2.46	2.53	2.35	2.31	2.55
	0.85	1.98	2.36	2.31	2.56	2.64	2.45	2.42	2.65
	0.9	2.02	2.44	2.35	2.66	2.74	2.54	2.52	2.74
	0.95	2.05	2.51	2.38	2.75	2.84	2.63	2.61	2.83
	≥1	2.08	2.58	2.38	2.83	2.93	2.71	2.70	2.91
Overhang	0.25	1.15	1.19	1.09	1.20	1.17	1.08	1.04	1.18
	0.3	1.17	1.23	1.07	1.24	1.22	1.12	1.08	1.21
	0.35	1.20	1.28	1.07	1.29	1.26	1.16	1.12	1.25
	0.4	1.22	1.32	1.07	1.33	1.30	1.19	1.17	1.29
	0.45	1.24	1.37	1.09	1.38	1.33	1.23	1.21	1.32
	0.5	1.26	1.42	1.12	1.42	1.37	1.28	1.25	1.35
	0.55	1.28	1.46	1.15	1.46	1.40	1.32	1.29	1.39
	0.6	1.30	1.51	1.18	1.50	1.43	1.36	1.33	1.42
	0.65	1.32	1.55	1.22	1.55	1.46	1.40	1.37	1.45
	0.7	1.33	1.60	1.26	1.59	1.48	1.43	1.40	1.48
	0.75	1.35	1.64	1.29	1.62	1.51	1.47	1.44	1.50
	0.8	1.37	1.67	1.32	1.66	1.53	1.51	1.47	1.53
	0.85	1.38	1.71	1.35	1.70	1.55	1.54	1.51	1.56
	0.9	1.39	1.74	1.37	1.73	1.57	1.56	1.54	1.58
	0.95	1.40	1.77	1.38	1.77	1.59	1.59	1.56	1.61
	≥1	1.41	1.79	1.38	1.80	1.61	1.61	1.59	1.63
Side Fins	0.25	1.17	1.10	1.06	1.10	1.15	1.14	1.16	1.16
	0.3	1.20	1.12	1.11	1.12	1.18	1.18	1.21	1.19
	0.35	1.23	1.13	1.16	1.14	1.21	1.20	1.25	1.22
	0.4	1.26	1.15	1.20	1.15	1.24	1.23	1.29	1.25
	0.45	1.28	1.16	1.23	1.17	1.27	1.25	1.31	1.28
	0.5	1.30	1.18	1.25	1.19	1.30	1.27	1.34	1.30
	0.55	1.32	1.19	1.27	1.20	1.33	1.29	1.36	1.33
	0.6	1.34	1.20	1.29	1.22	1.36	1.31	1.37	1.35
	0.65	1.36	1.21	1.30	1.23	1.38	1.34	1.38	1.38
	0.7	1.38	1.22	1.31	1.24	1.41	1.36	1.40	1.40
	0.75	1.40	1.23	1.33	1.26	1.43	1.38	1.41	1.42
	0.8	1.42	1.24	1.34	1.27	1.46	1.41	1.43	1.44
	0.85	1.43	1.25	1.35	1.28	1.48	1.44	1.45	1.47
	0.9	1.45	1.26	1.37	1.29	1.50	1.47	1.47	1.49
	0.95	1.46	1.27	1.39	1.31	1.52	1.50	1.50	1.51
	≥1	1.47	1.28	1.42	1.32	1.53	1.54	1.53	1.53

Note 5-1 Equivalent SHGC and Projection Factor

A 5,400 m^2 two story office building in Delhi is trying to achieve ECSBC level compliance. It has a rectangular layout (90 m x 30 m) with floor to floor height of 4.0 m and floor area is evenly distributed over the two floors. Windows are either east or west facing and equally distributed on the two floors. The windows are all 1.85m in length and 2.165m in height with an overhang of 0.85 m, sill level is 1.385 m above floor level. The overall glazing area is 384 m^2. SHGC of the glazing in the East/West Fenestration is 0.30; area weighted U-Factor is 3.0 W/m^2.K. VLT of the glazing in all orientation is 0.5. Will the vertical fenestration comply with the ECSBC through standardized approach?

Table 5.13 lists the U-factor, SHGC and VLT requirements for vertical fenestration for ECSBC compliant buildings. The building is located in Delhi (Latitude: 28^{0}70' N, Longitude: 77^{0}10'E), which falls under the composite climate, as per Appendix B, Table 12.1. To fulfil standardized requirements, Window to Wall ratio ≤ 40%, SHGC ≤ 0.27, U-factor ≤ 3.0 W/m^2.K, and VLT ≥ 0.27.

Total Floor area = 5400 m^2

Total wall area = 2 x (2x ((90m x 4m) + (30m x 4m))) = 1,920 m^2

Total Fenestration area = 384 m^2

Window to Wall Ratio (WWR) = 384/1,920 = 20%

As per the calculations, the building has a WWR of 20%, thus complying with the requirement for WWR. The U-factor is also equal to 3.0 W/m^2.K. Similarly, the VLT is 0.5, which is greater than the minimum specified value of 0.27, thus complying with the U-factor and VLT requirement.

Equivalent SHGC Calculation

The window SHGC is 0.3 which is not meet the standardized requirement of Table 5.13 However, the windows have an overhang of 0.85 m. As the windows have an overhang, this case will fall under the exception, and the *equivalent SHGC* value will be calculated by dividing fenestration SHGC by Shading Equivalent Factor (SEF).

For projection factor (PF) 0.34, the SEF for east, and west are taken from ***Error! Reference source not found.***, as the l atitude is greater than 15˚N.

SEF for east for PF = 0.3 (as worst case) = 1.26

Therefore, equivalent $SHGC_{East}$ = 0.3 ÷ 1.26 = 0.24 Hence the vertical fenestration on the east façade will comply as per standardized approach, as the equivalent SHGC is less than maximum allowed.

Similarly, for the west façade:

SEF for west for PF = 0.3 (as worst case) = 1.27

Therefore, equivalent $SHGC_{West}$ = 0.3 ÷ 1.27 = 0.24, hence the vertical fenestration on the west façade will comply using the standardized approach, as the equivalent SHGC is les than maximum allowed.

Exceptions to U-factor requirements in Table 5.13 and Vertical fenestration on all unconditioned buildings or unconditioned spaces may have a maximum U-factor of 5 W/m2.K provided they comply with all conditions mentioned in Table 5.18

Table 5.14 U-factor (W/m2.K) Exemption Requirements for Shaded Building

Building Type	*Climate zone*	*Orientation*	*Maximum Effective SHGC*	*Minimum VLT*	*PF*
Unconditioned buildings or unconditioned spaces	All except cold	Non-North for all latitudes and North for latitude < 15°N	0.27	0.27	≥0.40
		North for latitude ≥ 15°N	0.27	0.27	≥0.0

5.3.4 Skylights

Skylights shall comply with the maximum U-factor and maximum SHGC requirements of Table 5.19. Skylight roof ratio (SRR), defined as the ratio of the total skylight area of the roof, measured to the outside of the frame, to the gross exterior roof area, is limited to a maximum of 5% for ECSBC Building, ECSBC+ Building, and SuperECSBC Building, when using the Standrdized Method for compliance.

Table 5.15 Skylight U-factor (W/m2.K) and SHGC Requirements

Climate	*Maximum U-factor*	*Maximum SHGC*
All climatic zones	4.25	0.35

Exception to section 5.3.4 Skylights in temporary roof coverings or awnings over unconditioned spaces

5.3.5 Building Envelope Trade-Off Method

The building envelope complies with the code if the Envelope Performance Factor (EPF) of the Proposed Building is less than the EPF of the Standard Building, where the Standard Building exactly complies with the Standrdized requirements of building envelope. This method shall not be used for buildings with WWR>40%. Trade-off is not permitted for skylights. Skylights shall meet requirements of section 5.3.4. The envelope performance factor shall be calculated using the following equations.

Equation 5.1: $EPF_{Total} = EPF_{Roof} + EPF_{Wall} + EPF_{Fenest}$

$$EPF_{Roof} = c_{Roof} \sum_{s=1}^{n} U_s A_s$$

$$EPF_{Wall} = c_{Wall} \sum_{s=1}^{n} U_s A_s$$

$$EPF_{Fenest} = c_{1Fenest,North} \sum_{w=1}^{n} U_w A_w + c_{2Fenest,North} \sum_{w=1}^{n} \frac{SHGC_w}{SEF_w} A_w + c_{1Fenest,South} \sum_{w=1}^{n} U_w A_w + c_{2Fenest,South} \sum_{w=1}^{n} \frac{SHGC_w}{SEF_w} A_w + c_{1Fenest,East} \sum_{w=1}^{n} U_w A_w + c_{2Fenest,East} \sum_{w=1}^{n} \frac{SHGC_w}{SEF_w} A_w + c_{1Fenest,West} \sum_{w=1}^{n} U_w A_w + c_{2Fenest,West} \sum_{w=1}^{n} \frac{SHGC_w}{SEF_w} A_w$$

Whereas

EPF_{Roof}	Envelope performance factor for roofs. Other subscripts include walls and fenestration.
A_s, A_w	The area of a specific envelope component referenced by the subscript "s" or for windows the subscript "w".
$SHGC_w$	The solar heat gain coefficient for windows (w).
SEF_w	A multiplier for the window SHGC that depends on the projection factor of an overhang or side fin.
U_s	The U-factor for the envelope component referenced by the subscript "s".

C_{Roof} A coefficient for the "Roof" class of construction.
C_{wall} A coefficient for the "Wall"
$C_{1\,Fenes}$ A coefficient for the "Fenestration U-factor"
$C_{2\,Fenes}$ A coefficient for the "Fenestration SHGC"

Values of "c" are taken from table 5.18 through table 5.22 for each class of construction.

Table 5.16 Envelope Performance Factor Coefficients – Composite Climate

	Daytime Business, Educational, Shopping Complex		*24-hour Business, Hospitality, Health Care, Assembly*	
	C factor U-factor	C factor SHGC	C factor U-factor	C factor SHGC
Walls	24.3	-	48.1	-
Roofs	40.9	-	71.0	-
North Windows	21.6	201.8	41.0	367.6
South Windows	19.1	342.5	41.0	546.3
East Windows	18.8	295.6	38.4	492.2
West Windows	19.2	295.4	38.3	486.1

Table 5.17 Envelope Performance Factor Coefficients – Hot and Dry Climate

	Daytime Business, Educational, Shopping Complex		*24-hour Business, Hospitality, Health Care, Assembly*	
	C factor U-factor	C factor SHGC	C factor U-factor	C factor SHGC
Walls	27.3	-	55.9	-
Roofs	43.9	-	80.7	-
North Windows	23.7	238.2	49.1	414.4
South Windows	22.8	389.7	49.2	607.4
East Windows	21.6	347.4	46.2	556.2
West Windows	21.7	354.1	46.0	560.8

Table 5.18 Envelope Performance Factor Coefficients – Warm and Humid Climate

	Daytime Business, Educational, Shopping Complex		*24-hour Business, Hospitality, Health Care, Assembly*	
	C factor U-factor	C factor SHGC	C factor U-factor	C factor SHGC
Walls	24.5	-	51.2	-
Roofs	40.1	-	76.1	-
North Windows	20.7	230.7	43.6	401.5
South Windows	20.1	347.1	43.9	546.4
East Windows	19.0	301.8	41.1	490.6
West Windows	18.7	303.1	40.5	483.5

Table 5.19 Envelope Performance Factor Coefficients – Temperate Climate

	Daytime Business, Educational, Shopping Complex		*24-hour Business, Hospitality, Health Care, Assembly*	
	C factor U-factor	C factor SHGC	C factor U-factor	C factor SHGC
Walls	17.2	-	39.1	-
Roofs	32.3	-	76.1	-
North Windows	12.6	201.4	32.3	338.41
South Windows	11.8	287.3	31.9	448.52
East Windows	11.2	300.0	29.9	470.35
West Windows	10.9	303.4	30.0	462.64

Table 5-20 Envelope Performance Factor Coefficients – Cold Climate

	Daytime Business, Educational, Shopping Complex		*24-hour Business, Hospitality, Health Care, Assembly*	
	C factor U-factor	C factor SHGC	C factor U-factor	C factor SHGC
Walls	36.3	-	30.7	-
Roofs	38.7	-	46.0	-
North Windows	21.8	137.6	28.3	163.86
South Windows	20.8	114.3	21.7	295.24
East Windows	22.7	127.5	24.1	283.20
West Windows	23.4	133.2	25.2	270.33

(a) Standard Building EPF Calculation

EPF of the Standard Building shall be calculated as follows:

(a) The Standard Building shall have the same building floor area, gross wall area and gross roof area as the Proposed Building. For mixed-use building the space distribution between

different typologies shall be the same as the Proposed Design.

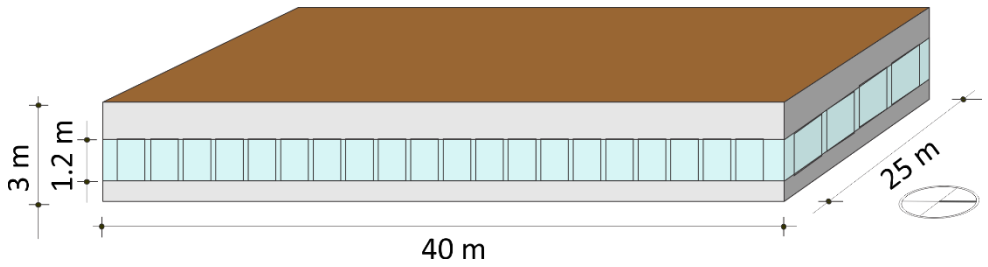
The U-factor of each envelope component shall be equal to the criteria from section5.3 for each class of construction.

The SHGC of each window shall be equal to the criteria from section5.4.3.

Shading devices shall not be considered for calculating EPF for Standard Building (i.e. SEF=1).

Application of Building Envelope Trade-off method

A 1,000 m² single story daytime use office building in Ahmedabad is trying to achieve ECSBC level compliance. Each side has a band of windows, without shading. The materials for the envelope have already been selected, prior to opting for ECSBC compliance. Their thermal properties are: roof assembly U-value= .4 W/m².K, external wall assembly U-value = .25 W/m².K, glazing SHGC = .25, VLT = 0.27, area weighted U-value for glazing = 1.8 W/m².K. Dimensions of the building envelope are as follows:



According to Appendix B, Ahmedabad falls under the hot and dry climate zone. To prove compliance through the Standardised approach, U-factor, and SHGC must comply with requirements listed in table 5.7, 5-10, 5-13 and VLT and window to wall ratio with requirements in section 5.3.3 for a daytime use building in the hot and dry climate zone. The table below lists thermal properties of the building envelope components and the corresponding Standardised requirements for ECSBC complaint buildings.

Table 5.21 Standardized Requirements and Proposed Thermal Properties

	Standrdized U-factor (W/m².K)			*Proposed U-factor (W/m².K)*			*Area (m²)*
Wall 1– North, South	≤0.63			0.25			90
Wall 2– East, West	≤0.63			0.25			144
Roof	≤0.33			0.4			1000
	U-factor	*SHGC*	*VLT*	*U-factor*	*SHGC*	*VLT*	
Window – South	≤3.0	≤0.27	≥0.27	1.8	0.25	0.27	30
Window – North	≤3.0	≤0.5	≥0.27	1.8	0.25	0.27	30
Window-East	≤3.0	≤0.27	≥0.27	1.8	0.25	0.27	48
Window-West	≤3.0	≤0.27	≥0.27	1.8	0.25	0.27	48

Section 5.3.3

requires the WWR to be less than 40%. This condition is fulfilled in the proposed buildings as can be seen in the calculations below.

Total Fenestration Area$_{North, South}$ = 2 x (25m x 1.2m) = 60 m²

Wall Area$_{North, South}$ = 2 x (25m x 3m) = 150 m²

Total Fenestration Area$_{East, West}$ = 2 x (40m x 1.2m) = 96 m²

Total Wall Area $_{East, West}$ = 2 x (40m x 3m) = 240 m²

Total Fenestration Area = 156 m², Total Wall Area = 390 m²

WWR = 156/390= 0.4.

U-value of the roof of the proposed building, at 0.4 W/m^2.K does not fulfil standardized requirements.

Hence, this building will not be compliant if the standardized approach is followed. The compliance in standardized approach can also be demonstrated through building envelope trade-off.

Compliance through Building Envelope Trade-off method

Envelope performance factor (EPF) for the Standard Building and Proposed Building must be compared. As per the Building Envelope Trade-off method, the envelope performance factor (EPF) shall be calculated using the following equations:

$EPF_{Total} = EPF_{Roof} + EPF_{Wall} + EPF_{Fenest}$

Where,

$$EPF_{Roof} = C_{Roof} \sum_{s=1}^{n} U_s A_s$$

$$EPF_{Wall} = C_{Wall} \sum_{s=1}^{n} U_s A_s$$

$$EPF_{Fenest} = C_{1Fenest,North} \sum_{w=1}^{n} U_w A_w + C_{2Fenest,North} \sum_{w=1}^{n} \frac{SHGC_w}{SEF_w} A_w + C_{1Fenest,South} \sum_{w=1}^{n} U_w A_w + C_{2Fenest,South} \sum_{w=1}^{n} \frac{SHGC_w}{SEF_w} A_w + C_{1Fenest,East} \sum_{w=1}^{n} U_w A_w + C_{2Fenest,East} \sum_{w=1}^{n} \frac{SHGC_w}{SEF_w} A_w + C_{1Fenest,West} \sum_{w=1}^{n} U_w A_w + C_{2Fenest,West} \sum_{w=1}^{n} \frac{SHGC_w}{SEF_w} A_w$$

Standard Building EPF will be derived from U-factors, SHGCs and VLTs of walls, roofs and fenestration Table 5.7, 5-10, 5-13 and section 5.3.3 for a daytime use building in the hot and dry climate zone. Values of C are from daytime Office building in hot and dry climatic zone for each class of construction from Table 5.21. Since There is no shading for the windows, SEF_w will not be considered.

Step 1: Calculation of EPF $_{Proposed\ Building}$ ***from actual envelope properties***

$$EPF_{Roof,Actual} = C_{Roof} \sum_{s=1}^{n} U_s A_s$$

= 43.9 x 0.40 x 1,000 = 17,560

$$EPF_{Wall,Actual} = C_{Wall} \sum_{s=1}^{n} U_s A_s$$

= (27.3 x 0.25 x 90) + (27.3 x 0.25 x 144) = 1,597.05

$$EPF_{Fenest} = EPF_{Fenest},North + EPF_{Fenest},South + EPF_{Fenest},East + EPF_{Fenest},West$$

$EPF_{Fenest} = C_{1Fenest,} \sum_{w=1}^{n} U_w A_w + C_{2Fenest,} \sum_{w=1}^{n} \frac{SHGC_w}{SEF_w} A_w$

Hence,

$EPF_{Fenest}, North$ = 23.7 x 1.8 x 30 + 238.2 x 0.25 x 30 = 1,279.8 + 1,786.5 = 3,066.3

$EPF_{Fenest}, South$ = 22.8 x 1.8 x 30 + 389.7 x 0.25 x 30 = 1,231.2 + 2,922.75 = 4,153.95

$EPF_{Fenest}, East$ = 21.6 x 1.8 x 48 + 347.4 x 0.25 x 48 = 1,866.24 + 4,168.8 = 6,035.04

$EPF_{Fenest}, West$ = 21.7 x 1.8 x 48 + 354.1 x 0.25 x 48 = 1,874.88 + 4,249.2 = 6,124.08

Therefore,

EPF_{Fenest} = 19,379.37

$EPF_{Proposed}$ = 17,560 + 1,597.05 + 19,379.37 = 38,536.42

Step 2: Calculating EPF $_{Standard\ Building}$ from standardized envelope requirements

$EPF_{Roof,Actual} = C_{Roof} \sum_{s=1}^{n} U_s A_s$

= 43.9 x 0.33 x 1000 = 14,487

$EPF_{Wall,Actual} = C_{Wall} \sum_{s=1}^{n} U_s A_s$

= (27.3 x 0.63 x 90) + (27.3 x 0.63 x 144) = 1,547.91 + 2,476.66 = 4,024.57

$EPF_{Fenest} = EPF_{Fenest}, North + EPF_{Fenest}, South + EPF_{Fenest}, East + EPF_{Fenest}, West$

Now,

$EPF_{Fenest}, North$ = 23.7 x 3.0 x 30 + 238.2 x 0.5 x 30 = 2,133 + 3,573 = 5,706

$EPF_{Fenest}, South$ = 22.8 x 3.0 x 30 + 389.7 x 0.27 x 30 = 2,052 + 3,156.57 = 5,208.57

$EPF_{Fenest}, East$ = 21.6 x 3.0 x 48 + 347.4 x 0.27 x 48 = 3,110.4 + 4,502.3 = 7,612.7

$EPF_{Fenest}, West$ = 21.7 x 3.0 x 48 + 354.1 x 0.27 x 48 = 3,124.8 + 4,589.14 = 7,713.94

Therefore, EPF_{Fenest} = 26,241.21

$EPF_{Baseline}$ = 14,487 + 4,024.57 + 26,241.21 = 44,752.78

Since $EPF_{Baseline} > EPF_{Proposed}$, therefore the building is compliant with ECSBC building envelope requirements.

6. Comfort System and Controls

6.1. General

All HVAC equipment and systems and their controls shall comply with the mandatory provisions of Section 6.2 and the Standardized requirement criteria detailed in section 6.3 for the respective building energy efficiency level. In case alternative compliance path of total system efficiency or low energy systems is used for compliance, respective requirements of Section6.3.11 or Section6.3.12 and relevant criteria of Section 6.3 shall be complied.

6.2. Mandatory Requirements

6.2.1. Ventilation

All habitable spaces shall be ventilated with outdoor air in accordance with the requirements of Section 6.2.1 and guidelines specified in the National Building Code 2016 or its subsequent revisions (Part 8: Building Services, Section 1: Lighting and Natural Ventilation, Subsection 5: Ventilation).

Ventilated spaces shall be provided with outdoor air using one of the following:

(a) Natural Ventilation
(b) Mechanical Ventilation
(c) Mixed Mode Ventilation

a) Natural ventilation design requirements:

Naturally ventilated buildings shall meet the following requirements.

1. Comply with guideline provided for natural ventilation in NBC.
2. If the building has ceiling fans, they shall comply with the requirements of BEE 4-star rating at the minimum.
3. Air circulators, if provided, shall comply with IS 2997.
4. Exhaust fans, if provided, shall comply IS 2312 with minimum efficiency requirements of fans specified in Section 6.3.1.

b) Mechanical ventilation & air quality design requirement

Buildings that are ventilated using a mechanical ventilation system, either completely or in conjunction with natural ventilation systems, shall have a ventilation system controlled by carbon monoxide sensors for basement carpark spaces where the total car park space is greater then or equal to 600 m2

I. (c) Demand Control ventilation

Mechanical ventilation systems serving Air conditioning spaces shall have demand control ventilation if they provide outdoor air greater than 5400 m3/hr to the conditioned space.Such outdoor air supply to the space shall be through:

1. An air side economizer, or
2. Automatic modulating control of the outdoor air damper actuated through CO_2 sensors mounted within the space (CO2 sensors shall be mounted at breathing height level and shall be provided for any space greater than 50 m2).

Demand control ventilation (DCV) if employed, shall ensure that outdoor air supply to the space meets the minimum ventilation requirement as specified in NBC-2016 or its subsequent revisions.

Exception to 6.2.1-(c):

1. *Any space that has processes or operations that generate dust, fumes, mists, vapours or gases and are provided with mechanical exhaust.*
2. *Systems with exhaust air energy recovery.*

6.2.2. Space Conditioning Equipment

a) Chillers

1. For ECSBC Compliance minimum BEE 2 Star rated chillers shall be installed.
2. At locations where cooling water and / or recycled water is available, water-cooled chillers should be installed. Air-cooled systems or Hybrid configurations (Mix of Water Cooled and Air Cooled) should be used in buildings with cooling load less then 530 kWr. For buildings with cooling load equal to or greater than 530 kWr, the capacity of air-cooled chiller shall be restricted to 33% of the total installed chilled water plant capacity (excluding standby, if any). Local approving authority / Authority Having Jurisdiction (AHJ) may require a higher percentage of air-cooled chillers in a project depending on local

conditions in which case, same shall be complied with.

b) Unitary, Split, Packaged Air-Conditioners

Unitary (Window) and Split air-conditioners which are non- ducted and have a capacity up to 10499 Wr and light commercial air conditioners from 10500 to 18000 Wr (All air cooled systems) shall comply with IS1391 Part 1 and Part 2 are shall meet or exceed the efficiency requirements as per BEE 3 Star rating.

Ducted and Packaged air conditioners of capacity above 3500 Wr shall comply with IS 8148 for both air cooled and water cooled systems and the minimum efficiency requirements shall be as per Table 6.1.

Table 6.1 Minimum Efficiency Requirements for Ducted Split and Packaged Air Conditioners in ECSBC Building

Cooling Capacity (kWr)	*Water Cooled*	*Air Cooled*
≤ 10.5	NA	B*EE 3 Star*
> 10.5	*3.3 EER*	*2.8 EER*

Note: The EER values in Table 6.1 will be replaced by IEER values in respect of units of capacity more than 10500Wr when the BEE Star Labelling Program is made effective for this range. Minimum efficiency levels for Air Cooled as well as Water Cooled systems shall comply with BEE 3 Star for ECSBC Buildings.

c) Variable Refrigerant Flow (VRF air-conditioners)

Variable Refrigerant Flow (VRF) systems shall be of the minimum efficiency requirements as specified in Table 6-2 tested at the capacity rating condition as defined. Rating conditions both at full load as well as part load conditions shall be as per BIS Standard for VRF Air Conditioners which is under development.

Table 6.2 Minimum Efficiency Requirement for VRF Air Conditioners for ECBC Building

For Heating or Cooling or Both		
Type	Size Category (kWr)	ISEER (W/W)
VRF Air Conditioners, Air Cooled	<40	5.4
	≥ 40 and < 70	5.5
	≥ 70	5.6

Note : The ISEER and EER rating calculation shall be as per BIS standard as and when published.

d) Air Conditioning and Condensing Units serving Computer Rooms and other special applications

1. Air conditioning and condensing units serving computer rooms shall be of minimum energy efficiency as per the Table 6-3.
2. In respect of 24-hour operational areas such as server or battery rooms in otherwise 8 or 12-hour occupancies, separate air conditioning units shall be installed. These units can act as standby units when the central system is operational but can take over when the central system is shut down. Similarly, in areas where temperatures lower than those to be maintained in other areas of the building are required, such as operation theatres in hospitals, separate condensing units shall be installed. This arrangement ensures that the central system can operate with higher efficiency.

Table 6.3 Minimum Efficiency Requirements for Computer Room Air Conditioners

Equipment type	*Net Sensible Cooling Capacity*	*Minimum SCOP-127*	
		Downflow	*Upflow*
All types of computer room Acs Air/ Water/ Glycol	*All capacity*	*2.5*	*2.5*

a. Net Sensible cooling capacity = Total gross cooling capacity - latent cooling capacity – Fan power

b. Sensible Coefficient of Performance (SCOP-127): A ratio calculated by dividing the net sensible cooling capacity in watts by the total power input in watts (excluding reheater and dehumidifier) at conditions defined in ASHRAE Standard 127-2012 Method of Testing for Rating Computer and Data Processing Room Unitary Air Conditioners)

e) Hot water production (for heating/reheat in HVAC Systems)

Hot water production for heating/reheat in HVAC systems shall be achieved through any one of the following methods:

1. Solar water heating system shall comply with IS 12976 and shall be minimum BEE 3-star rated.
2. Heat recovery systems using waste heat from air/ water cooled condensers.
3. Air to water or water to water heat pumps.

Note: *The use of electric, gas, or oil-fired boilers shall be discouraged in ECSBC buildings unless they are required for any process requirements and by-product steam or by-product hot water is available for heating or reheat purposes.*

For service water heating in the building, please refer to Section 9.

6.2.3. Controls

To comply with the Code, buildings shall meet the requirements of Section (a) to (f) of 6.2.3.

a) Timeclock

Mechanical cooling and heating systems in all occupancies other than healthcare, shall be controlled by timeclocks that:

1. Can start and stop the system under different schedules for at least three different day-types per week,
2. Include an accessible manual override that allows temporary operation of the system for up to 2 hours.

Exceptions to 6.2.3-(a):

Cooling and Heating systems of total capacity less than 17.5 kWr.

b) Temperature Controls

Mechanical cooling and heating equipment in all buildings shall be installed with automatic controls to manage the temperature inside the conditioned zones. Each zone served by HVAC conditioning equipment shall have individual temperature control for energy saving. These controls shall comply with the following requirements:

I. Where a unit provides both heating and cooling, controls shall be capable of providing a temperature dead band of 3.0°C within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum.

II. Where separate heating and cooling equipment serve the same temperature zone, temperature controls shall be interlocked to prevent simultaneous heating and cooling.

III. Separate temperature control shall be installed in each:
   1. Guest room of hotels and resorts,
   2. Room less than 30 m2 in business building.
   3. Air-conditioned classroom, lecture room, and computer room of educational institutions.
   4. In-patient rooms and wards in healthcare facilities.

c) Occupancy Controls

Occupancy controls shall be installed at each zone level to de-energize fresh air ventilation and/or air conditioning systems when the building, part of the building, or individual zones served by that system are not occupied (ex. hotel guest rooms, office cabins, conference rooms in different building typologies, classrooms, hospital rooms etc.)

For operational reasons, if the HVAC equipment can't be turned-off, the room temperature set-point shall be automatically increased to a higher default value of 27oC or higher for energy saving.

d) Cooling Tower Fan Control

Cooling towers in buildings with built up area greater than 20,000 m2 and located in a place where the wet bulb temperature drops below 17oC shall have fan controls based on wet bulb logic capable to reduce fan speed up to 50 Percent of the rated full speed.

e) AHU Fan

Air Handling Units serving different zones of a building shall deploy fan speed modulation control to save energy, using duct static pressure signal.

Exception to s6.2.3.e:

Air handling units with capacity less than 5000 m^3/hr.

f) Damper Controls

In instances where multiple fans serve the same supply or exhaust system, automatic shutdown dampers shall be provided with input from pressure transducers and close upon when:

1. Fan shutdown
2. Served spaces are not in use.

Exception to 6.2.3-(f):

Dampers shall not be provided in exhaust systems serving kitchen exhaust hoods.

6.2.4. Piping and Ductwork

a) Piping Insulation

Piping for heating, space conditioning, and service hot water systems shall meet the insulation requirements listed in Table 6.4 through Table 6.6 . Insulation exposed to weather shall be protected by aluminium sheet, painted canvas, or plastic cover. Cellular foam insulation shall be protected as above or be painted with water resistant paint.

Where pipes are located within air-conditioned spaces or are buried in ground, the R Value indicated in Table 5.4 through 5.6 may be reduced by 0.2. Where pipes are located outside the building and in direct exposure to weather, the R Values given in Tables 6.4 through 6.6 shall be increased by 0.2.

Table 6. 4 Insulation Requirements for Pipes in ECSBC Building

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

Table 6.5 Insulation Requirements for Pipes in ECSBC+ Building

Operating Temperature (ºC)	Pipe size (mm)	
	< 40	≥40
	Insulation R value (m2.K/W)	
Heating System		
>94°C and ≤121°C	1.1	1.3
>60°C and ≤94°C	0.8	0.8
>40°C and ≤60°C	0.5	0.9
Cooling System		
>4.5°C and ≤15°C	0.9	1.0
< 4.5°C	1.1	1.3
Refrigerant Piping (Split systems)		
>4.5°C and ≤15°C	0.5	0.9
< 4.5°C	1.1	1.3

Table 6.6 Insulation Requirements for Pipes in Super ECSBC Buildings

Operating Temperature (ºC)	Pipe size (mm)	
	< 40	≥40
	Insulation R value (m2.K/W)	
Heating System		
>94°C and ≤121°C	1.5	1.5
>60°C and ≤94°C	1.0	1.3
>40°C and ≤60°C	0.7	1.1
Cooling System		
>4.5°C and ≤15°C	1.0	1.2
< 4.5°C	1.5	1.5
Refrigerant Piping (Split systems)		
>4.5°C and ≤15°C	0.7	0.9
< 4.5°C	1.5	1.5

b) Ductwork and Plenum Insulation

Ductwork and plenum shall be insulated in accordance with Table 6-7.

Table 6.7 Ductwork Insulation (R value in m2. K/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

6.2.5. Condenser Location

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

6.3. Standardized Requirement

Compliance shall be demonstrated with the standardized requirements in this section.

6.3.1. Fans

Supply, exhaust, and return or relief fans with motor power exceeding 0.37 kW shall be of minimum Mechanical Efficiency and minimum fan motor efficiency requirements specified in Table 6.9 through Table 6.10

Exception to 6.3.1:

Fans in un-ducted air conditioning unit where fan efficiency has already been taken into account to calculate the total efficiency of the comfort system.

For all Centrifugal and Axial Flow fans used in the Comfort system that require shaft power of 2.5 kW or higher, the Fan Energy Index (FEI) shall meet or exceed the requirements as outlined below:.

Where,

$$\text{FEI} = \frac{(\text{Baseline Fan Electric Input Power})}{(\text{Actual Fan Input Electric Power})}$$

Table 6.8 Mechanical and Motor Efficiency Requirements for Fans (Supply, return and exhaust) in Air Handling Unit System

Fan	**FEI**
Centrifugal fans	FEI ≥ 1.1
Axial flow fans	FEI ≥ 1.0

Note:

Calculation of Baseline Fan Electric Input Power:

Baseline fan is a conceptual fan whose power input is predefined for a given duty point and can be used as reference to calculate FEI of any fan.

Baseline Electric Power Input to motor = Href /(Eref.trans x E ref.motor)

Where,

Href =Baseline Fan Shaft Power (Watts)

Eref.trans =Baseline Transmission Efficiency

E ref.motor =Baseline Motor Efficiency

Q = Flow Rate m3/hr

Pt = Fan Total Pressure

Fan Type	Href (Watts)
Ducted outlet fans	= (Q+0.118)x(Pt+100)0.66
Free outlet fans	= (Q+0.118)x(Ps+100)/0.60

Pt = Fan Static Pressure Ps + Fan Velocity Pressure Pv

Table 6.9 Mechanical and Motor Efficiency Requirements for Fans in ECSBC Buildings

System type	Fan Type	Mechanical Efficiency	Motor Efficiency (As per IS 12615)
Air-handling unit	Supply, return and exhaust	65%	IE 3

Table 6.10 Mechanical and Motor Efficiency Requirements for Fans in ECSBC+ Buildings

System type	Fan Type	Mechanical Efficiency	Motor Efficiency (As per IS 12615)

Air-handling unit	Supply, return and exhaust	75 %	IE 4

Equipment	ECSBC
Chilled Water Pump (Primary and Secondary)	18.2 W/ kW_r with VFD on secondary pump
Condenser Water Pump	17.7 W/ kW_r
Pump Efficiency (minimum)	70%
Motor Efficiency (as per IS 12615)	IE3 or better

Table 6.13 Pump Efficiency Requirements for ECSBC Building

Motor Efficiency Requirements for
gs

Pump	Mechanical Efficiency	Motor Efficiency (As per IS 12615)

Table 6.14 Pump Efficiency Requirements for ECSBC+ Building

Equipment	ECSBC+ Building
Chilled Water Pump (Primary and Secondary)	16.9 W/ Kw_r with VFD on secondary pump
Condenser Water Pump	16.5 W/ Kw_r
Pump Efficiency (minimum)	75%
Motor Efficiency (as per IS 12615)	IE4 or better

Table 6.15 Pump Efficiency Requirements for Super ECSBC Building

Equipment	SuperECSBC Building
Chilled Water Pump	14.9 W/ kW_r with variable primary pumping
Condenser Water Pump	14.6 W/ kW_r
Pump Efficiency (minimum)	80%
Motor Efficiency (as per IS 12615)	IE4 or better

6.3.2. Chillers

Chillers in ECSBC, ECSBC+, and Super ECSBC buildings shall meet the minimum efficiency requirements specified in Table 6-12. Additionally, chillers shall be rated at both full load and part load conditions in accordance with IS 16590.

Table 6.12 Minimum Efficiency Requirements for Chillers for ECSBC, ECSBC+ and Super ECSBC Buildings

Building Category	Water Cooled	Air Cooled
ECSBC+	4 Star	4 Star
SUPER ECSBC	5 Star	5 Star

6.3.3. Pumps

Pumps used in HVAC Systems shall meet or exceed the minimum energy efficiency requirements specified in Table 6.13 through Table 6.15.

Pump requirements within district cooling systems and hot water pumps for space heating are limited to the installed efficiency of each individual pump unit. Compliance entails calculating the total installed pump capacity (in kilowatts) and meeting the prescribed limits per kilowatt of refrigeration installed in the building.

6.3.4. Cooling Towers

Cooling towers shall be designed for an approach not exceeding 3.9°C for ECSBC building, 2.8°C for ECSBC plus , 1.7°C for Super ECSBC to meet fan efficiency requirements as specified in Table 6.16 through Table 6-18.

Table 6.16 Cooling Tower Fan Efficiency Requirements for ECSBC Buildings

Equipment	Rating Condition	Efficiency

type		
Open circuit cooling tower Fans	37.2°C entering water 31.6^{0}C leaving water 28.3 °C WB outdoor air	0.35 kW/(ltr-sec.)

Table 6.17 Cooling Tower fan Efficiency Requirements for ECSBC+ Buildings

Equipment type	Rating Condition	Efficiency
Open circuit cooling tower Fans for Chillers ≤530kWr	37.8°C entering water 32.2°C leaving water 28.3°C WB outdoor air	0.35 kW/(ltr-sec.)

Table 6.18 Cooling Tower fan Efficiency Requirements for Super ECSBC Buildings

Equipment type	Rating Condition	Efficiency
Open circuit cooling tower Fans for Chillers ≤530kWr	35.6°C entering water 30.0°C leaving water 28.3°C WB outdoor air	0.35 kW/(ltr-sec.)

6.3.5. Economizer

a) Economizer

For buildings with a built-up area exceeding 20,000 m2, each cooling fan system shall include at least one of the following:

1. An air economizer, capable of adjusting outside-air and return-air dampers to provide 50% of the design supply air volume as outside air.
2. A water economizer, capable of providing 50% of the expected system cooling load when outside air temperatures is 10°C dry-bulb/7.2°C wet-bulb and below.

Exception to 6.3.5.(a)

1. *Building in warm-humid climate zone.*
2. *Building with only daytime occupancy in the hot-dry climatic zone.*
3. *Individual cooling or heating fan systems less than 11520 m^3/hr.*

b) Partial Cooling

Where required by Section 6.3.5-(a), economizers shall be capable of providing partial cooling even when additional mechanical cooling is required to meet the cooling load.

c) Economizer Controls

Air side economizer shall be equipped with controls.

1. That allow dampers to be sequenced with the mechanical cooling equipment and not be controlled by only mixed air temperature.
2. 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.
3. Capable of high-limit shutoff at 24 °C dry bulb temperature.

d) Testing of Economizers

Air side economizers shall be tested in the field according to the requirements outlined in Appendix 3 to ensure proper operation.

Exception to 6.3.5.(d):

Air side economizers that have been factory tested and calibrated as per the procedures outlined in Appendix 3 to ensure proper operation and are duly certified by the Authority Having Jurisdiction

6.3.6. Variable Flow Hydronic System

a) 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 equal to or less than the limit, where the limit is set by the greater of:

I. 50% of the design flow rate, or
II. The minimum flow required by the equipment manufacturer for proper operation of the chillers

b) Automatic shut off of Condenser water flow

Water-cooled air-conditioning or heat pump units with a circulation pump motor of 7.5 kW or more shall

include a two-way automatic isolation valve or similar control measures on each water-cooled air conditioning or heat pump circuit. These valves or controls shall be interlocked with the compressor to shut off the water flow through the circuit and the dedicated cooling tower fan as well whenever the respective compressor is not in operation.

6.3.7. Unitary, Split, Packaged Air-Conditioners

Unitary (Window AC) and Split air-conditioners, which are non-ducted and have a capacity of up to 10499 Wr, and light commercial air conditioners from 10500 to 18000 Wr, (all air-cooled systems), shall comply with IS-1391 Part 1 and 2. They must also meet or surpass the minimum efficiency requirements specified in Table 6.19.

Table 6.19 Minimum Efficiency Requirements for Non-ducted Unitary & Split AC, light commercial air conditioners in ECSBC+ and Super ECSBC Buildings

ECSBC Plus	BEE 4 Star
Super ECSBC	BEE 5 Star

Ducted and Packaged air conditioners with a capacity above 3.5 kWr shall comply with IS 8148 for both air-cooled and water-cooled systems, and the minimum efficiency requirements shall be as per Table 6.20 for ECSBC+ and Table 6.21 for Super ECSBC Buildings

Table 6.20 Minimum Efficiency Requirements for Ducted Split and Packaged Air Conditioners in ECSBC+ Building

Cooling Capacity (kWr)	Water Cooled	Air Cooled
≤ 10.5	NA	BEE 4 Star
> 10.5	3.7 EER	3.2 EER

Table 6.21 Minimum Requirements for Ducted Split and Packaged Air Conditioners in Super ECSBC Building

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

Note: The EER values in Table 6.20 and 6.21 will be replaced by IEER values in respect of units of capacity more than 10.5 kWr when the BEE Star Labelling Program is made effective for this range. Minimum efficiency levels for air cooled as well as water cooled systems shall comply with BEE 4 Star for ECSBC + buildings and 5 Star for super ECSBC buildings.

6.3.8. Variable Refrigerant Flow Air conditioners

Variable Refrigerant Flow (VRF) Air conditioners shall meet or exceed the efficiency requirements given in Table 6-22 through Table 6-24. VRF Air Conditioners shall be rated for full load as well as part load operating conditions in accordance with the BIS Standard for VRF air conditioners which is currently in draft form.

Table 6.22 Minimum Efficiency Requirements for VRF Air conditioners for ECSBC Buildings

Cooling Capacity (kWr)	Efficiency
For <40kWr	5.4 ISEER
For ≥ 40kWr and <70kWr	5.5 ISEER
For ≥70kWr	5.6 ISEER

Table 6.23 Minimum Efficiency Requirements for VRF Air conditioners for ECSBC+ Buildings

Cooling Capacity (kWr)	Efficiency
For <40kWr	6.4 ISEER
For ≥ 40kWr and <70kWr	6.5 ISEER
For ≥70kWr	6.6 ISEER

Table 6.24 Minimum Efficiency Requirements for VRF Air conditioners for Super ECSBC Buildings

Cooling Capacity (kWr)	Efficiency
For <40kWr	7.4 ISEER
For ≥ 40kWr and <70kWr	7.5 ISEER
For ≥70kWr	7.6 ISEER

6.3.9. Controls for ECSBC+ Buildings

ECSBC+ buildings shall have control capabilities to meet the following requirements, in addition to complying with the provisions of Section 6.2.3 :

a) Zone Temperature control:

The space temperature set point in common area (which is not accessible to individuals) shall be varied automatically, based on outside temperature and moved up to higher level within the defined comfort zone.

b) AHU fan energy optimization:

The control system shall be capable of optimizing (reducing) the AHU fan static pressure, when the AHU serves multiple zones through "Zone temperature control devices" like VAV boxes, auto-regulating diffusers, etc. It should be able to monitor these devices and optimize the dynamic set point of the fan static pressure sensor in the duct, thereby controlling the fan speed while ensuring thermal comfort in the occupied zones

c) Secondary pump energy optimisation: -

The control system shall have capability optimize the pump speed requirement for various loops and equipment, as well as optimize chilled water flow across AHUs and terminal units.

6.3.10. Controls for Super ECSBC Buildings

Super ECSBC Buildings shall comply with following requirements of this section in addition to complying with requirements of Section 6.2.3 and Section 6.3.9 :

a) Zone Temperature Control

A centralized system shall have the capability to automatically correct the heating and cooling set points of zone temperature controllers, which may be altered by occupants, at regular intervals.

b) Control of Fenestration Louver or Blinds

Buildings with large glass facades shall have capability to automatically adjust, open or close the curtains, blinds or external louvers. This ensures a balance of benefits, including reducing solar heat gain, harnessing natural sunlight, and avoid glare.

c) Occupancy control:

Conditioning equipment serving large zones (like Workstation area) shall have capability to save energy based on real-time headcount.

d) Chiller Plant Control

Chilled water systems greater than 1500KW capacity (cumulative) or having more than three chillers in one plant room shall have controls capability to optimize the performance of chillers, pumps and cooling tower fans and match chilled water demand and supply requirement on real-time basis.

6.3.11. Energy Recovery

All hospitality and healthcare occupancies with energy recovery systems of capacity greater than 7560 m^3/hr and minimum outdoor air supply of 70% shall have air-to-air heat recovery equipment with minimum 60 % recovery effectiveness.

Exception to Section 6.3.11:

Energy recovery from Kitchen, Laundry, Operation theater, ICU space and Laboratory exhaust systems.

6.3.12. Total System Efficiency – Alternate Compliance Approach

Buildings may show compliance by optimizing the total system efficiency for the plant side comfort system instead of the individual equipment mentioned under the standardized requirement.

This alternate compliance approach applies to the central chilled water plant side system in all building types. The ratio of simulated annual cooling production to simulated annual energy consumption for the higher-side plant equipment shall be less than or equal to maximum threshold requirements specified in Table 6-25. Equipment included in the central chilled water plant side system for this alternative approach comprises chillers, chilled water pumps, condenser water pumps, and cooling tower fans where applicable. Compliance check will be based on annual hourly simulation, referring to Table 12.1 for developing the proposed design.

Table 6.25 Maximum System Efficiency Threshold for ECSBC, ECSBC+, and Super ECSBC Buildings

Water Cooled Chilled Water Plant	Maximum Threshold (kW/kWr)
ECSBC	0.24
ECSBC+	0.21
Super ECSBC	0.19

The total system efficiency shall be calculated as follows:

Total System Efficiency

$$= \frac{Annual\ Chiller\ plant \text{ Energy consumption } (kWh)}{\text{Annual Chiller plant } Cooling\ generation (\text{kWrh})}$$

a) Documentation Requirement

Compliance shall be documented, and compliance forms shall be submitted to the certifying authority having judication. The information submitted shall include, at a minimum, the following:

1. Summary describing the results of the analysis, including the annual energy use (kWh) of chilled water plant (chillers, pumps and cooling tower) and annual chilled water use (kWh)for the proposed design, and software used.
2. Brief description of the project with location, number of stories, space types, conditioned and unconditioned areas, hours of operation.
3. List of the energy-related building features of the proposed design.
4. List showing compliance with the mandatory requirements of this code.
5. The input and output report(s) from the simulation program including energy and chilled water usage components: space cooling and heat rejection equipment, and other HVAC equipment (such as pumps). The output reports shall also show the number of hours any loads that are not met by the HVAC system in the proposed design.
6. Explanation of any significant modelling assumptions made.
7. Explanation of any error messages noted in the simulation program output.

6.3.13. Low-energy Comfort Systems

Alternative HVAC systems which have low energy use may be installed in place of (or in conjunction with) refrigerant-based cooling systems. Such systems shall be deemed to meet the minimum space conditioning equipment efficiency levels of Section 6.2.2 , but shall comply with all other applicable mandatory provisions of Section 6.2 as applicable. Wherever applicable, requirements of Section 6.3 and 6.3.12 shall be complied with. The approved list of low energy comfort systems is given below:

1. Evaporative cooling
2. Desiccant cooling system
3. Solar air conditioning
4. Tri-generation (waste-to-heat)
5. Radiant cooling system
6. Ground source heat pump
7. Adiabatic cooling system
8. Under-floor Air distribution (UFAD) system

Buildings with an approved low energy comfort system installed for more than 50 % of the sum of cooling and heating capacity requirement of the building shall be deemed to be equivalent to ECSBC + and those with more than 90 % shall be deemed to be Super ECSBC Compliant subjected to meeting the documentation requirement as per 6.3.13-(a).

a) Documentation Requirement

Compliance shall be documented and submitted to the certifying authority having jurisdiction.
Documentation shall include, at a minimum, the following:

I. Brief details of the low- energy comfort system. type, capacity and efficiency.
II. Details of compliance with mandatory and standardized requirements specified in 6.3.13.
III. Comparison of installed capacity of the approved low-energy comfort system as against the conventional system with calculations for energy consumption of both the systems.

7. Lighting and Controls

7.1 General Requirement

Lighting systems and equipment shall comply with the mandatory provisions of section 7.2 and the standardized requirements of section 7.3. The lighting requirements in this section shall apply to:

(a) Interior spaces of buildings,

(b) Exterior building features namely facades, illuminated roofs, architectural features, entrances, exits, loading docks, and illuminated canopies, and, the building grounds lighting that is provided through the building's electrical service.

Exceptions to section 7.1:

a. Emergency or security lighting that is automatically off during normal building operations.
b. Lighting, including exit signs, that is specifically designated as required by a health or life safety statute, ordinance, or regulation.

7.2 Mandatory Requirements

7.2.1 Compliance with the Lighting Quantity and Quality Parameters

The lighting quantity and quality parameters for respective application areas shall be in compliance with the latest version of IS 3646 – Part 1.

7.2.2 Interior Lighting Control

(a) Automatic Lighting Shutoff

At least 90% of all the interior lighting fixtures by wattage in building shall be equipped with automatic control device that shall function on either:

1. A scheduled basis at specific programmed times. An independent program schedule shall be provided for areas of up to and including 2,500 m2 and not more than one floor, or,
2. Occupancy sensors that shall turn off/ dim (by at least 80% of full light output) the lighting fixtures within 15 minutes of a space becoming un-occupied. Light fixtures controlled by occupancy sensors shall have a wall-mounted, manual switch capable of turning on/off lights when the space is occupied.

Exception to 7.2.2- (a):

a. Lighting required for 24/7 continuous operation.
b. Lighting in spaces where patient care is rendered.
c. General lighting and task lighting in spaces where automatic lighting shutoff would endanger the safety or the security of occupants in the space.

(b) Space Control

1. 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:
   I. Control a maximum of 250 m2 for a space less than or equal to 1,000 m2, and a maximum of 1,000 m2 for a space greater than 1,000 m2.
   II. Offices greater than 30 m2, shall have the following requirements:
   a. Control zones for general lighting shall be limited to 60 m2.
   b. Control zones for general lighting shall be permitted to automatically turn on, up to full power upon occupancy.
   c. General lighting in other unoccupied control zones shall be permitted to automatically turn on to no more than 20% of full power.

III. No more than 50% of the lighting power for the general lighting shall be allowed to be automatically turned-on (using programable controls for scheduled operation) and none of remaining lighting turned on beyond 20% of full power if unoccupied.

IV. Have the capability to override the shutoff control specified in 7.2.2-(a) for a maximum of 2 hours, and

V. Be readily accessible and located so the occupants can see the control.

2. Occupancy sensors shall be provided in:

I. All habitable spaces less than 30 m2, enclosed by walls or ceiling height partitions.
II. All storage or utility spaces more than 15 m2.
III. Public toilets more than 25 m2, controlling at least 80 % of lighting fixtures by wattage, fitted in the toilet. The lighting fixtures, not controlled by automatic lighting shutoff, shall be uniformly spread in the area.
IV. Corridors of all Hospitality buildings, controlling minimum 70% and maximum 80% of lighting fixtures by wattage fitted in the public corridor. The lighting fixtures, not controlled by automatic lighting shut off, shall be uniformly spread in the area.
V. All conference or meeting rooms.

Exception to section 7.2.2-(b)-V: 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 labelled to identify the controlled lighting.

(c) Control in Daylight Areas

Luminaires, installed within day lighting extent from the window as calculated in Sub-Section5.2.3, 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:

1. Has a delay of minimum 5 minutes, and,
2. Can switch off the light fixtures or dim/step down up to 10% of full power.

When automatic control device in daylight area is provided, manual overrides shall not be allowed.

7.2.3 Exterior Lighting Control

a. Lighting for all exterior applications shall be controlled by a photo sensor or astronomical time control that is capable of automatically turning off the exterior lighting when daylight is available or the lighting is not required.
b. Façade lighting and façade non-emergency signage of buildings shall have separate time control.

Exemption to Section7.2.3: Exterior Lighting systems designed for emergency and firefighting purposes.

7.2.4 Controls for Compliance

The following lighting applications shall be equipped with a control device to control such lighting independently of general lighting:

a. Display/ Accent Lighting: Separate controls shall be provided for display or accent lighting in areas 300 m2 and above,
b. Hotel Guest Room Lighting: Guest rooms and guest suites in a hotel shall have a master control device at the main room entry that controls all permanently installed luminaires and switched receptacles.
c. Task Lighting. Supplemental task lighting including permanently installed under shelf or under cabinet lighting shall have a control device integral to the luminaires or be controlled by a wall-mounted control device provided the control device complies with section 7.2.2-(b)
d. Nonvisual Lighting: A separate control device shall be provided for Lighting for nonvisual applications, such as plant growth and food-warming.
e. Demonstration Lighting: A separate control device accessible to authorized personnel only shall be provided for Lighting equipment used for sale or for demonstrations in lighting education.

7.2.5 Exit Signs

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

7.2.6 Lighting Power

a. The Connected lighting power of exterior lighting applications shall not exceed the lighting power limits specified in section 7.3.5 for 'ECSBC Buildings' excluding the luminaires/application provided with exemptions in the section 7.3.5.
b. External Luminaires (excluding lighting chains or direct view luminaires) emitting white light with CCT (correlated colour temperature) ranging from 2700 K – 6500 K for all exterior

applications (except decorative/architectural) shall have efficacy not less than 100 lumens per watt, 110 lumens per watt, and 120 lumens per watt for ECSBC, ECSBC+, and Super ECSBC Buildings respectively.

7.3 Standardized Requirements

7.3.1 Interior Lighting Power

The installed interior lighting power for a building or a separately metered or permitted portion of a building shall be calculated in accordance with section7.3.4 and shall not exceed the interior lighting power allowance determined in accordance with either section 7.3.2 or 7.3.3.

Exception to section 7.3: The following lighting equipment and applications shall not be considered when determining the interior lighting power allowance, nor shall the wattage for such lighting be included in the installed interior lighting power. However, any such lighting shall not be exempt unless it is an addition to general lighting and is controlled by an independent control device.

a. Display or accent lighting that is an essential element for the function performed in galleries, museums, and monuments,
b. Lighting that is integral to equipment or instrumentation and is installed by its manufacturer,
c. Lighting specifically designed for medical or dental procedures and lighting integral to medical equipment,
d. Lighting integral to food warming and food preparation equipment,
e. Lighting for plant growth or maintenance,
f. Lighting in spaces specifically designed for use by the visually impaired,
g. Lighting in retail display windows, provided the display area is enclosed by ceiling-height partitions,
h. Lighting in interior spaces that have been specifically designated as a registered interior historic landmark,
i. Lighting that is an integral part of advertising or directional signage,
j. Exit signs,
k. Lighting that is for sale or lighting educational demonstration systems,
l. Lighting only comprising of theatrical purposes, including performance, stage, and film or video production, and
m. Athletic playing areas with permanent facilities for television broadcasting.

7.3.2 Building Area Method

Determination of interior lighting power allowance (watts) by the building area method shall be in accordance with the following:

a. Determine the allowed lighting power density (LPD) for each appropriate building area type from Table 7.1 for ECSBC Buildings, from Table 7.2 for ECSBC+ Buildings and from Table 7.3 for Super ECSBC Buildings.
b. Calculate the gross illuminated area for each building area type.
c. The interior lighting power allowance is the sum of the products of the gross illuminated floor area of each building area times the allowed lighting power density for that building area type.

7.3.3 Space Function Method

Determination of interior lighting power allowance (watts) by the space function method shall be in accordance with the following:

(a) Determine the numbers of Light fixtures to meet the lighting quantity and quality parameters as per IS3646-Part I
(b) Determine the appropriate building type and the allowed lighting power density from Table 7.4 for ECSBC Buildings, Table 7.5 for ECSBC+ Buildings and, Table 7.6 for Super ECSBC Buildings. In cases where both a common space type and building specific space type are listed, building specific space type LPD shall apply.
(c) For each space, enclosed by partitions 80% or greater than ceiling height, determine the gross lighted floor area by measuring to the Centre of the partition wall. Include the area of balconies or other projections. Retail spaces do not have to comply with the 80% partition height requirements.

(d) The interior lighting power allowance is the sum of the lighting power allowances for all spaces. The lighting power allowance for a space is the product of the gross lighted floor area of the space times the allowed lighting power density for that space.

7.3.4 Installed Interior Lighting Power

The installed interior lighting power calculated for compliance with Section 7.3 shall include total all power consumption of the luminaires, except the exemptions specified in Section 7.1.

Exception to Section 7.3.3: If two or more independently operating lighting systems in a space are controlled to prevent simultaneous user operation, the installed interior lighting power shall be based solely on the lighting system with the highest power without compromising the lighting quantity and quality.

(a) Luminaire Wattage

1. The wattage of lighting equipment, when used to calculate either installed interior lighting power shall be determined in accordance with the following criteria:
2. The wattage of lighting equipment connected to supply voltage shall be the manufacturers' labelled rated wattage.
3. The wattage of lighting equipment with remote ballasts/drivers or similar devices shall be the total input wattage of all components and accessories in the system.
4. The wattage of all other miscellaneous luminaire types not described in (i) or shall be the rated wattage marked on the luminaires and/or its packaging.
5. The wattage of lighting track, plug-in busway, and flexible-lighting systems that allow the addition and/ or relocation of luminaires without altering the wiring of the system shall be the highest of the specified wattage of the luminaires included in the system or 135 Watt per meter length of the lighting system. Systems with integral overload protection, such as fuses or circuit breakers, shall be rated at 100% of the maximum rated load of the limiting device.

7.3.5 Installed Exterior Lighting Power

Connected lighting power of exterior lighting

applications shall not exceed the lighting power limits specified in Table 7.7 for ECSBC Buildings, Table 7.8 for ECSBC+ Buildings and

Table 7.9 for Super ECSBC Buildings. Trade-offs between applications are not permitted.

Exception to exterior lighting power:

a. Lighting integral to equipment or instrumentation and installed by its manufacturer.
b. Theatrical purposes only comprising of performance, stage, film production, and video production.
c. Temporary lighting not permanently installed and can be removed or shifted whenever required.
d. Lighting for industrial activities namely manufacturing, material handling, transportation sites, and associated storage areas where lighting is equipped with hoods or louvers for glare control.
e. Lighting for any monument of national importance, national flag, statue/sculpture etc.

Table 7.1 Interior Lighting Power for ECSBC Buildings – Building Area Method for Lighting system

Building Area Type	LPD (W/m^2)	Building Area Type	LPD (W/m^2)
Office Building	7.37	Motion picture theater	5.06
Hospitals	9.70	Museum	6.60
Hotels /Motel	6.27	Post office	7.48
Shopping Mall	9.24	Religious building	7.81
University and Schools	8.25	Sports arena	7.80
Library	9.90	Transportation	6.60
Dining: bar lounge/leisure	8.80	Warehouse	5.28
Dining: cafeteria/fast food	8.25	Performing arts theater	9.68
Dining: family	7.70	Police station	7.26
Dormitory	6.16	Workshop	10.23
Fire station	6.60	Automotive facility	8.69
Gymnasium	8.91	Convention center	7.48
Manufacturing facility	9.68	Parking garage	1.98

Table 7.2 Interior Lighting Power for ECSBC+ Buildings – Building Area Method for lighting system

Building Area Type	LPD (W/m2)	Building Area Type	LPD (W/m2)
Office Building	6.7	Motion picture ~~theater~~ theatre	4.6
Hospitals	7.8	Museum	6
Hotels /Motel	5.7	Post office	6.8
Shopping Mall	8.4	Religious building	7.1
University and Schools	7.5	Sports arena	7.8
Library	9	Transportation	6
Dining: bar lounge/leisure	8	Warehouse	4.8

Dining: cafeteria/fastfood	7.5	Performing arts theatre	8.8
Dining: family	7	Police station	6.6
Dormitory	5.6	Workshop	9.3
Fire station	6	Automotive facility	7.2
Gymnasium	8.1	Convention Centre	6.8
Manufacturing facility	8.8	Parking garage	1.8

Table 7.3 Interior Lighting Power for Super ECSBC Buildings –

Building Area Method for lighting system

Building Area Type	LPD (W/m2)	Building Area Type	LPD (W/m^2)
Office Building	5.0	Motion picture theatre	4.14
Hospitals	4.9	Museum	5.1
Hotels /Motel	4.8	Post office	5.3
Shopping Mall	7.0	Religious building	6.0
University and Schools	6.0	Sports arena	4.9
Library	6.1	Transportation	4.6
Dining: bar lounge/leisure	6.1	Warehouse	3.5
Dining: cafeteria/fast food	5.8	Performing arts theatre	7.92
Dining: family	5.5	Police station	5.0
Dormitory	4.6	Workshop	7.1
Fire station	4.9	Automotive facility	4.5
Gymnasium	5.0	Convention centre	6.3
Manufacturing facility		Parking garage	1.5

Table 7.4 Interior Lighting Power for ECSBC Buildings – Space Function Method Base LPD without modifiers

Category	LPD (W/m^2)	Category	LPD (W/m^2)
Restrooms	7.7	Stairway	5.5
Storage	5.72	Corridor/ Transition	5.28

Conference/Meeting	10.45	Lobby	9.1
Parking Bays(covered/ basement)	1.32	Driveways (covered/basement)	3.0
Electrical/ Mechanical	7.1	Workshop	10.41
Business			
Enclosed	8.69	Open Plan	6.6
Banking ActivityArea	6.6	Service/Repair	5.5
Healthcare			
Emergency	15.73	Recovery	8.6
Exam/Treatment	13.7	Storage	4.18
Nurses' Station	9.4		
Operating Room	15.73	Laundry/Washing	6.05
Patient Room	7.7	Lounge/Recreation	8.0
Pharmacy	8.25	Medical Supply	6.6
Physical Therapy	9.68	Nursery	5.7
Radiology/Imaging	9.1	Corridor/Transition	7.15
Hospitality			
Hotel Dining	6.16	Hotel Lobby	5.72
For Bar Lounge/Dining	9.02	Motel Dining	4.29
For food preparation	11.44	Motel Guest Rooms	4.84
Hotel GuestRooms	4.84		
Shopping Complex			
Mall Concourse	6.71	For Family Dining	6.16
Sales Area	10.01	For food preparation	11.44
Motion PictureTheatre (Audience SeatingArea)	3.19	Bar Lounge/ Dining	9.02
Educational			
Classroom/Lecture	8.47	Card File and Cataloguing	8.25

For Classrooms	8.47	Stacks (Library)	13.97
Laboratory	12.43	Reading Area(Library)	10.00
Assembly			
Dressing Room	4.62	Seating Area - Performing Arts Theatre	12.98
Exhibit Space – Convention Centre	5.94	Lobby - PerformingArts Theatre	14.3
Seating Area - Gymnasium	2.75	Seating Area – Convention Centre	6.4
Fitness Area - Gymnasium	9.68	Seating ReligiousBuilding	8.58
Museum – General Exhibition	3.63	Playing Area - Gymnasium	9.68
Museum – Restoration	14.74		

Table 7.5 Interior Lighting Power for ECSBC+ Buildings – Space Function Method base LPD without modifiers

Category	LPD (W/m^2)	Category	LPD (W/m^2)
Common Space Types			
Restrooms	6.1	Stairway	4.4
Storage	5.2	Corridor/ Transition	3.6
Conference/Meeting	9.2	Driveways (covered/ basement)	1.5
Parking Bays (covered/ basement)	1.2	Lobby	7.3
Electrical/ Mechanical	5.7	Workshop	9.46
Business			
Enclosed	7.9	Open Plan	6
Banking Activity Area	6	Service/Repair	5
Healthcare			
Emergency	14.3	Recovery	7.0
Exam/Treatment	10.9	Storage	5.2
Nurses' Station	7.5	Laundry/Washing	5.5

Operating Room	14.3	Lounge/Recreation	6.4
Patient Room	6.1	Medical Supply	6
Pharmacy	7.5	Nursery	4.6
Physical Therapy	8.5	Corridor/Transition	6.5
Radiology/Imaging	7.3		
Hospitality			
Hotel Dining	5.6	Hotel Lobby	5.2
For Bar Lounge/Dining	8.2	Motel Dining	3.9
For food preparation	10.4	Motel Guest Rooms	4.4
Hotel Guest Rooms	4.4		
Shopping Complex			
Mall Concourse	6.1	For Family Dining	5.6
Sales Area	9.1	For food preparation	10.4
Motion PictureTheatre (Audience SeatingArea)	2.9	Bar Lounge/ Dining	8.2
Educational			
Classroom/Lecture	7.7	Card File and Cataloguing	7.5
For Classrooms		Stacks (Library)	12.7
Laboratory (in or as a classroom)	11.3	Reading Area (Library)	9.2
Assembly			
Dressing Room	4.2	Seating Area - PerformingArts Theatre	11.8
Exhibit Space – Convention Centre	5.4	Lobby - Performing Arts Theatre	13
Seating Area - Gymnasium	2.5	Seating Area – Convention Centre	5.1
Fitness Area - Gymnasium	7.9	Seating Religious Building	7.8
Museum – General Exhibition	3.3	Playing Area - Gymnasium	8.8

Museum – Restoration	11.0		

Table 7.6 Interior Lighting Power for Super ECSBC Buildings – Space Function Method base LPD without modifiers

Category	LPD (W/m^2)	Category	LPD (W/m^2)
Common Spaces Types			
Restrooms	3.8	Stairway	2.7
Storage	3.4	Corridor/ Transition	2.3
Conference/ Meeting	5.7	Driveways (covered/ basement)	1.35
Parking Bays (covered/ basement)	1.08	Lobby	4.6
Electrical/Mechanical	3.5	Workshop	8.51
Business			
Enclosed	5.4	Open Plan	5.4
Banking Activity Area	5.4	Service/Repair	3.4
HealthCare			
Emergency	11.4	Recovery	4.4
Exam/Treatment	6.8	Storage	2.7
Nurses' Station	5.0	Laundry/Washing	4.95
Operating Room	10.9	Lounge/Recreation	4.6
Patient Room	3.8	Medical Supply	5.40
Pharmacy	5.3	Nursery	2.9
Physical Therapy	4.9	Corridor/ Transition	4.6
Radiology/ Imaging	4.6		
Hospitality			
Hotel Dining	4.6	Hotel Lobby	4.68
For Bar Lounge/Dining	7.0	Motel Dining	3.51
For food preparation	9.36	Motel Guest Rooms	3.8

Hotel Guest Rooms	3.96		
Shopping Complex			
Mall Concourse	5.49	For Family Dining	5.04
Sales Area	8.19	For food preparation	7.5
Motion Picture Theatre (Audience SeatingArea)	2.61	Bar Lounge/ Dining	7.0
Educational			
Classroom/Lecture	6.8	Card File and Cataloguing	4.6
Laboratory (in or as a classroom)	7.5	Stacks (Library)	9.2
Reading Area (Library)	5.7		
Assembly			
Dressing Room	3.78	Seating Area - PerformingArts Theatre	10.62
Exhibit Space – Convention Centre	4.86	Lobby - Performing ArtsTheatre	10.8
Seating Area - Gymnasium	2.25	Seating Area – Convention Centre	3.2
Fitness Area - Gymnasium	3.9	Seating Religious Building	7.02
Museum – General Exhibition	2.97	Playing Area - Gymnasium	6.5
Museum – Restoration	5.5		

Table 7.7 Exterior Building Lighting Power for ECSBC Buildings

Exterior lighting application	Power limits
Building entrance (with canopy)	10 W/m^2 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^2 of vertical façade area
Emergency signs, ATM kiosks, Security areas façade	1.0 W/m^2

Driveways and parking (open/ external)	1.6 W/m^2
Pedestrian walkways	2.0 W/m^2
Stairways	10.0 W/m^2
Landscaping	0.5 W/m^2
Outdoor sales area	9.0 W/m^2

Table 7.8 Exterior Building Lighting Power for ECSBC+ Buildings

Exterior lighting application	Power limits
Building entrance (with canopy)	8.0 W/m^2 of canopied area
Building entrance (w/o canopy)	72 W/ linear m of door width
Building exit	48 W/lin m of door width
Building façade	4.0 W/m^2 of vertical façade area
Emergency signs, ATM kiosks, Security areas façade	0.8 W/m^2
Driveways and parking (open/ external)	1.3 W/m^2
Pedestrian walkways	1.6 W/m^2
Stairways	8.0 W/m^2
Landscaping	0.4 W/m^2
Outdoor sales area	7.2 W/m^2

Table 7.9 Exterior Building Lighting Power for SuperECSBC 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
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

8. Electrical and Renewable Energy Systems

8.1 General

All electric, Vertical Transport and renewable energy equipment and systems shall comply with the mandatory requirements of section 8.2.

8.2 Mandatory Requirements

8.2.1 Transformers

(a) Maximum Allowable Distribution Transformer Losses

Power distribution transformers of the required ratings and design shall satisfy the maximum allowable losses at 50% and 100% loading. The permissible loss shall not exceed the values listed in IS 1180 first published in 2014 and latest amendment 4 issued in 4th march 2021 titled as IS 1180 (PART 1): 2014 and IS 1180 (Part 3): 2021 or as revised from time to time for Mineral Oil type or Ester Oil type transformer respectively and shall conform to BEE star rating.

Dry type transformers shall conform to permissible losses as indicated in Table 8.1

Compliance of Power distribution transformers (oil type) shall be:

1. ECSBC building – Conforming to BEE 3-star labelling requirement.
2. ECSBC Plus building – Conforming to BEE 4-star labelling requirement.
3. ECSBC Super building – Conforming to BEE 5-star labelling requirement.

Table 8.1: Dry Type Transformers

Rating (kVA)	Impedance (%)	Max. Total Loss (W)					
		ECSBC building		ECSBC+ building		ECSBC Super building	
		50% Load	100% Load	50% Load	100% Load	50% 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	1,250	340	1,140	300	1,050
100	4.5	520	1,800	475	1,650	435	1,500
160	4.5	770	2,200	670	1,950	570	1,700
200	4.5	890	2,700	780	2,300	670	2,100
250	4.5	1,050	3,150	980	2,930	920	2,700
315	4.5	1,100	3,275	1,025	3,100	955	2,750
400	4.5	1,300	3,875	1,225	3,450	1,150	3,330
500	4.5	1,600	4,750	1,510	4,300	1,430	4,100
630	4.5	2,000	5,855	1,860	5,300	1,745	4,850
1000	5	3,000	9,000	2,790	7,700	2,620	7,000
1250	5	3,600	10,750	3,300	9,200	3,220	8,400
1600	6.25	4,500	13,500	4,200	11,800	3,970	11,300
2000	6.25	5,400	17,000	5,050	15,000	4,790	14,100
2500	6.25	6,500	20,000	6,150	18,500	5,900	17,500

Total loss values given in above table are applicable for thermal class E, B and F and have component of load loss at reference temperature according to clause 17 of IS. An increase of 7% on total for thermal class H is allowed.

Note:

a. *The permissible loss value shall be superseded by the values as specified in the Indian standard whenever published.*
b. *The values in this table have been developed based on input data sourced from IEC 60076-20. 100% losses from Level 1 to Level 3 are calculated considering the individual losses (No Load Loss and Load Loss) as mentioned in table 10 of IEC 60076-20. 50% losses are computed. Loss level 1 as per IEC recommended level 1, Level 3 as per IEC recommended level 2 & intermediate levels are extrapolated.*
c. *Total loss values given in table 8.1 are applicable for thermal insulation class F. The reference temperature for calculation of performance (Losses and impedance etc may be the maximum or average ambient temperature plus the temperature rise limit as per the insulation class of the Dry Type Transformer (for example 120 Deg C for insulation Class F) - refer table 2 and Clause No. 14.2.3 of IS - 2026 Part 11:2021 for Dry type transformer.*

For transformers having voltage class above 11 kV and up to and including 22 kV, the permissible total loss values shall not exceed by 5% of the maximum total loss values mentioned in Table 8.1.

For transformers having primary highest voltage for equipment 22kV < Um ≤ 33kV and Secondary highest voltage for equipment Um ≤ 3.6 kV, the permissible total loss values shall not exceed by 15% of the maximum total loss values mentioned in above Table. Here Um is highest voltage for equipment.

I. Transformer ratings above 3150 kVA, shall conform to values specified in IS 2026 latest version will be applicable.

(b) 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 shall be certified by BIS certification mark and BEE label. All transformers of capacity of 500 kVA and above shall be equipped with appropriate class energy meters and current transformers (CTs) and potential transformers (PTs) in addition to requirements of utilities for periodic loss monitoring study.

8.2.3 Voltage Drop

Voltage drop for any feeders shall be maximum 2% at design load. Voltage drop for any branch circuit shall be maximum 3% at design load.

8.2.4 Energy Efficient Motors

Motors shall comply with the following:

Three phase induction motors shall conform to (IS) 12615 latest version as amended from time to time and shall fulfil the following efficiency requirements:

(a) ECSBC Buildings shall have motors of minimum IE 3 (high efficiency) class
(b) ECSBC+ Buildings shall have motors of minimum IE 4 (premium efficiency)
(c) Super ECSBC Buildings shall have motors of minimum IE 5 (super premium efficiency) class

NOTE:

I. IE5 efficiency class is as defined in IEC TS 60034-30-2
II. Motors of kW ratings different from those listed in the tables of IS 12615 shall have efficiency greater than that of the next listed kW motor.
III. Motor kW ratings shall not exceed 20% of the calculated maximum load being served.

8.2.5 Standby Generator Sets

BEE star rated DG sets (as per prevalent BEE Standards and Labelling Program) shall be used in all compliant buildings. DG sets in buildings greater than 20,000 m^2 Built Up Area (BUA) shall be BEE star labelled and

(a) ECSBC compliant building – Minimum BEE 3 stars rating
(b) ECSBC Plus compliant building – Minimum BEE 4 stars rating
(c) ECSBC Super compliant building – 5 stars rating in Super ECSBC Buildings

Note: Provided Standby Generating sets, using any other fuels other than diesel, shall comply with BEE's star labelling program as and when comes into effect. The buildings not using DG sets for captive power

generation (no more than 15% of power requirement is being met using DG sets), BEE 3 star rated DG sets shall be used for ECSBC Plus and ECSBC Super compliance.

8.2.6 Check-Metering and Monitoring

At Building mains, installed meters shall monitor Energy use (kWh, kVARh, kVAh), Energy Demand (kW/ kVA), THD (V and I) on a half hour basis. The metering shall also be displaying current (in each phase and the neutral), voltage (between phases and between each phase and neutral).

Need of KVARh metering Explanation: Reactive Power influences the power factor of the system. We know 'Power factor' is a key indicator for an efficient energy delivery in AC electrical system. It is a measure of how effectively a specific load consumes electricity to produce work. So, understanding reactive power consumption in highly no linear load driven electrical system helps user to decide on efficient utilisation of energy, avoid utility penalty and reduce MD in the system.

Building services sub-meters shall comprise of the following:

(a) Services 1,000 kVA and above shall have permanently installed electrical metering to record demand (kVA), energy (kWh), and total power factor on half hourly basis. 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 and voltage.

(b) Services 65kVA to 1,000 kVA shall have permanently installed electric metering to record demand (kW/kVA), energy (kWh/kVAh), and total power factor (or kVARh) on half hourly basis.

(c) Services less than 65 kVA shall have permanently installed electrical metering to record energy (kWh) on hourly basis.

(d) Submetering for building services shall be as defined in Table 8.2

(e) Submetering for specific building types shall be as defined in Table 8.3.

1. All installed energy meters shall conform to IS 13779 and shall be Class 0.2s or higher accuracy for building-level metering and Class 1s for sub-metering and have an active RS-485 port, with industry standard Modbus protocol. For power quality measurement at building-level, the energy meter located in PCC shall be class A as per IEC 61000-4-7 and IEC 61000-4-30..

Sub-metering requirements for different services shall be as defined in Table 8.2 and additional sub-metering for specific building types shall be as defined in Table 8.3.

Table 8.2: Sub Metering: Minimum requirement for separation of electrical load

	Building Contract Demand	
	120 kVA to 250 kVA	Greater than 250 kVA
HVAC system and components	Required	Required
Interior and Exterior Lighting	Not required	Required
Domestic hot water	Not required	Required
Plug loads	Not required	Required
Renewable power source	Required	Required
Public Health Engineering (PHE) Pumps	Not required	Required
Sewage Treatment Plant (STP)	Required	Required
Water Treatment Plant (WTP)	Required	Required

Table 8.3: Additional sub-metering requirements for specific building types

Mandatory requirement of sub- metering of services For specific building types	
Shopping Complex	Façade lighting, Common Area lighting and exterior lighting
Shopping Complex	Elevator, escalators & moving walks
Business	Data centres and Floor loads
Hospitality	Commercial kitchens, laundry & Total Guest rooms
Hospital	Medical Equipment, UPS power, total IPD rooms, Kitchen, and Laundry

2. For tenant-based building, tenants must be provided with tap-off points to install electrical sub-meters.

8.2.7 Power Factor Correction

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

(a) 0.97 for ECSBC compliant Building

(b) 0.98 for ECSBC Plus compliant building

(c) 0.99 for Super ECSBC Super compliant building

8.2.8 Power Quality

(a) Voltage Distortion

At the main metering level of the building, utilities and/or distribution system operators shall limit line-to-neutral voltage harmonics as follows:

1. Daily 99th percentile very short time (3s) values shall be less than 1.5 times the values given in table 8.4.

2. Weekly 95th percentile short time (10 min) values shall be less than the values given in table 8.4.

Table 8.4: Voltage Distortion Limits

Bus voltage V at PCC	Individual harmonic (%) h ≤ 50	Total harmonic distortion THD (%)
V ≤ 1.0 kV	5.0	8.0
1 kV < V ≤ 69 kV	3.0	5.0
69 kV < V ≤ 161 kV	1.5	2.5
161 kV < V	1.0	1.5*

NOTE: High-voltage systems are allowed to have up to 2.0% THD where the cause is an HVDC terminal whose effects are found to be attenuated at points in the network where future users may be connected.

Reference Standard: IEEE 519:2022

(b) Current Distortion

The limits in this sub clause shall be applicable to users connected to systems with the rated voltage at the PCC is from 120 V to above 161 kV. For individual nonlinear load, these limits are not applicable. At the PCC (Point of Common Coupling), users shall limit their harmonic currents as specified.:

1. Daily 99th percentile very short time (3 s) harmonic currents shall be less than 2.0 times the values given in Table 8.5, Table 8.6 and Table 8.7
2. Weekly 99th percentile short time (10 min) harmonic currents shall be less than 1.5 times the value given in Table 8.5, Table 8.6 and Table 8.7
3. Weekly 95th percentile short time (10 min) harmonic currents shall be less than the values given in Table 8.5, Table 8.6 and Table 8.7
4. Maximum allowable limit of current distortion for system design shall comply to Table 8.5

Table 8.5: Current distortion limits for systems rated 120V through 69kV

Maximum harmonic current distortion in percent of I_L						
	Individual harmonic order[b]					
I_{SC}/I_L	**$2 \le h < 11$[a]**	**$11 \le h < 17$**	**$17 \le h < 23$**	**$23 \le h < 35$**	**$35 \le h \le 50$**	**TDD**
<20[c]	4.0	2.0	1.5	0.6	0.3	5.0
20<50	7.0	3.5	2.5	1.0	0.5	8.0
50<100	10.0	4.5	4.0	1.5	0.7	12.0
100<1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0

[a] For h≤6, even harmonics are limited to 50% of the harmonic limites shown in the table.

[b] Current distortions that result in a dc offset, e.g., half-wave converters, are not allowed.

[c] Power generation facilities are limited to these values of current distortion, regardless of actual I_{SC}/I_L unless covered by other standards with applicable scope.

I_{SC} = maximum short-circuit current at PCC.

I_L = maximum demand load current at PCC under normal load operating conditions.

Table 8.6: Current distortion limits for systems rated above 69 kV through 161kV

Maximum harmonic current distortion in percent of I_L
Individual harmonic order[b]

I_{SC}/I_L	$2 \le h < 11$[a]	$11 \le h < 17$	$17 \le h < 23$	$23 \le h < 35$	$35 \le h \le 50$	TDD
<20[c]	2.0	1.0	0.75	0.3	0.15	2.5
20<50	3.5	1.75	1.25	0.5	0.25	4.0
50< 100	5.0	2.25	2.0	0.75	0.35	6.0
100< 1000	6.0	2.75	2.5	1.0	0.5	7.5
>1000	7.5	3.5	3.0	1.25	0.7	10.0

[a] For h≤6, even harmonics are limited to 50% of the harmonic limites shown in the table.

[b] Current distortions that result in a dc offset, e.g., half-wave converters, are not allowed.

[c] Power generation facilities are limited to these values of current distortion, regardless of actual I_{SC}/I_L unless covered by other standards with applicable scope.

I_{SC} = maximum short-circuit current at PCC.

I_L = maximum demand load current at PCC under normal load operating conditions.

Table 8.7: Current distortion limits for systems rated > 161 kV

Maximum harmonic current distortion in percent of I_L						
Individual harmonic order[b]						
I_{SC}/I_L	$2 \le h < 11$[a]	$11 \le h < 17$	$17 \le h < 23$	$23 \le h < 35$	$35 \le h \le 50$	TDD
<25[c]	1.0	0.5	0.38	0.15	0.1	1.5
25< 50	2.0	1.0	0.75	0.3	0.15	2.5
≥5	3.0	1.5	1.15	0.45	0.22	3.75

[a] For h≤6, even harmonics are limited to 50% of the harmonic limites shown in the table.

[b] Current distortions that result in a dc offset, e.g., half-wave converters, are not allowed.

[c] Power generation facilities are limited to these values of current distortion, regardless of actual I_{SC}/I_L unless covered by other standards with applicable scope.

I_{SC} = maximum short-circuit current at PCC.

I_L = maximum demand load current at PCC under normal load operating conditions.

Reference Standard: IEEE 519:2022

All projects shall submit outcome results as per enclosed annexure 7 to validate compliance to award.

8.2.9 Power Distribution Systems

The power cabling size shall be designed for distribution losses to be less than values mentioned as below:

(a) 3% of the total power usage in ECSBC compliant Buildings

(b) 2% of the total power usage in ECSBC Plus compliant Buildings

(c) 1% of total power usage in ECSBC Super compliant Buildings

(d) Design calculation for the losses shall be recorded and maintained. Load calculation shall be calculated up to the panel level.

8.2.10 Uninterruptible Power Supply (UPS)

In all buildings, energy efficiency of UPS shall be equal to or higher than energy efficiency requirements defined in Table 8.8.

Table 8.8: Energy Efficiency Requirements for UPS for ECSBC, ECSBC Plus ECSBC Super building

UPS Size	Energy Efficiency Requirements at 100% Load
kVA< 20	93%
20<=kVA <= 100	94%
kVA > 100	96%

NOTE: Standards and Labelling program by BEE shall take precedence over requirements listed in this section.

8.2.11 Renewable Energy Systems

All buildings shall have provisions for installation of renewable energy systems.

(a) Renewable Energy Generation (REGZ)

The building shall have onsite renewable energy generation capacity in meeting at least 4% of total contract demand of the building on annual basis or

covering minimum of 50% of the available roof area, which ever feasible for ECSBC buildings.
In addition, the rooftop solar system considered for building, should give yield at least 0.46 kWh/sqm/yr. or more.
NOTE: m^2 denotes surface area of the solar panel installed

ECSBC Plus and Super ECSBC building shall fulfil the additional requirements listed in Table 8.9 and Table 8.10 respectively.

Table 8.9: Minimum Renewable Contribution towards meeting Contract Demand in ECSBC Plus Building

Building Type	Minimum Capacity to be Installed in REGZ
All building types	**Minimum 7.5% of total Contract Demand**

Table 8.10: Minimum Renewable Contribution towards meeting Contract Demand in Super ECSBC Building

Building Type	Minimum Capacity to be Installed in REGZ
All Building types	Minimum 15% of total Contract Demand

If states having open access policy, the buildings shall comply in meeting above demand by using combination of off-site green power procured from local energy company along with on-site installed renewable energy sources to meet the target mentioned above.

(b) Main Electrical Service Panel

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

(c)Demarcation on Documents

The following shall be indicated in design and construction documents:

1. Location for inverters and metering equipment
2. Pathway for routing of conduit from the REGZ to the point of interconnection with the electrical service
3. Routing of plumbing from the REGZ to the water-heating system and
4. Structural design loads for roof dead and live load.

(d) Grid Harmonisation/ Demand Response

All buildings should conform to

1. ECSBC -Minimum 5% Building Electricity Peak Demand load reduction capability
2. ECSBC Plus 7.5 % Building Electricity Peak Demand load reduction capability
3. Super ECSBC – 10 % Building Electricity Peak Demand load reduction Capability.

(e) Recommendations on Electric Vehicle Charging Infrastructure and Parking Spaces

1. **EV Charging Infrastructure:**

Parking places in buildings shall be provided with EV Charging infrastructure as per Central Electricity Authority (CEA) guidelines, CEA measures of safety regulations and Ministry of power consolidated guidelines & standards for EV charging infrastructure as applicable at the time of implementation.

I. CEA Measures Relating to Safety and Electric Supply, Amendment Regulations, 2019
II. CEA Technical Standards for Connectivity of Distributed Generation Resources, Amendment Regulations, 2019
III. Ministry of Power Guidelines, Jan 2022
IV. BIS standards (IS 17017 series)
V. Battery Safety and Vehicle Safety standards for EV as per regulations by Ministry of Heavy Industries.
VI. Amendments to Model Building Bye-Laws 2016 for EVCI, 2019

1. ECSBC: Minimum 20% parking capacity with EV charging facility. The requirements shall comply independently for two wheelers, four wheelers and visitors parking.
2. ECSBC Plus: Minimum 25% parking capacity with EV charging facility. The requirements shall comply independently for two wheelers, four wheelers and visitors parking.
3. Super ECSBC: Minimum 35% parking capacity with EV charging facility. The requirements shall comply

independently for two wheelers, four wheelers and visitors parking.

NOTE: The parking space shall comply with all the safety requirements for EVs

8.2.12 Vertical Transportation System

Vertical transportation shall comply to the standard in table 8.11:

Table 8.11: Standards for vertical transportation system

Sl. No.	IS No.	Title
1	17515 (Part 1)	Energy Performance of Lifts, Escalators and Moving Walks: Part 1 Energy Measurement and Verification
2	17515 (Part 2)	Energy Performance of Lifts, Escalators and Moving Walks: Part 2 Energy Calculation and Classification for Lifts (Elevators)
3	17515 (Part 3)	Energy Performance of Lifts, Escalators and Moving Walks: Part 3 Energy Calculation and Classification of Escalators and Moving Walks

E	$E_d \leq 3{,}65 \times Q \times n_d \times S_{av}/1000 + 800 \times t_{nr}$
F	$E_d \leq 5{,}47 \times Q \times n_d \times S_{av}/1000 + 1600 \times t_{nr}$
G	$E_d \leq 5{,}47 \times Q \times n_d \times S_{av}/1000 + 1600 \times t_{nr}$

Escalator and /or Moving Walks: Energy calculations and classification for Escalators and Moving walks is based on Table 7.12 of IS 17515 - Part 3

Energy performance ratio	≤55%	≤60%	≤65%	≤70%	≤80%	≤90%	≤100%	>100%
Energy performance class indicator	A+++	A++	A+	A	B	C	D	E

Note: If there are multiple lifts in a building with different classification as per table above, then the one with lowest class shall be taken for rating computation.

The escalators shall be energy classification 'A+ efficiency' for ECSBC buildings, energy classification 'A++ efficiency' for ECSBC plus buildings and energy classification 'A+++ efficiency' for ECSBC super buildings. The energy classification values are as defined in table 7 of IS 17515 – Part 3.

Note: If there are multiple escalators and /or moving walks in a building with different classification as per *table above, then the one with lowest class shall be taken for rating computation.*

Escalators and Moving walks shall have Variable frequency drives, load and motion sensors for better efficiency and Energy efficient lighting features and soft start capabilities, Regenerative Drives shall be provided to recycle energy. All signal/ signages used for these equipment's shall be of LED fixtures.

The lifts shall be of energy classification 'C' efficient for ECSBC buildings, energy classification 'B' efficiency for ECSBC plus buildings and energy classification 'A' efficiency for ECSBC super buildings. The energy classification values are as defined in table 7 of IS 17515 – Part 2.

Lifts shall have Variable frequency drives, Permanent magnet gearless machines and Energy efficient lighting features with standby mode and prescriptive features like Destination control system where applicable as per traffic analysis requirements, Regenerative drives.

Energy Efficiency Class	Energy Consumption per Day (Wh)
A	$E_d \leq 0{,}72 \times Q \times n_d \times S_{av}/1000 + 50 \times t_{nr}$
B	$E_d \leq 1{,}08 \times Q \times n_d \times S_{av}/1000 + 100 \times t_{nr}$
C	$E_d \leq 1{,}62 \times Q \times n_d \times S_{av}/1000 + 200 \times t_{nr}$
D	$E_d \leq 2{,}43 \times Q \times n_d \times S_{av}/1000 + 400 \times t_{nr}$

buildings. The energy classification values are as defined in table 7 of IS 17515 – Part 3.

9 Water Management and Controls

9.1 General

The basic objective of this chapter is to ensure the sustainable management of water and its availability. The emphasis is on reducing the usage of water through use of water efficient products and techniques and encourage the reuse and recycling of the treated wastewater. As the water footprint gets reduced so will the energy as most of the energy required is spent on transporting, treating and heating of water.

Documentation demonstrating compliance must be submitted for verification as prescribed in Section 9.4.

All ECSBC, ECSBC Plus, Super ECSBC compliant buildings shall conform to section 9.2. All ECSBC Plus and ECSBC Super compliant building shall confirm to section 9.3 in addition to section 9.2.

9.2 Mandatory Requirements

9.2.1 Source of Water

The source of water shall be reliable and must have the potential to cater for the water supply during the lifetime of the building entire life of the building. The different sources of water are:

a) Municipal / Public utility supplying potable water: One of the primary sources of fresh water supply.

b) Bore-well / Open-well: Installation of bore-well/open well shall be with due approval from concerned regulatory authorities, in absence of adequate municipal supply and shall be supported by documentary evidence.

c) Reclaimed used water from sewage treatment plants for non-potable usages.

d) Harvested rainwater to be used for non- potable use after treatment.

e) Desalination of high TDS water shall be allowed after obtaining approval from concerned authorities and can be used for non -potable use.

Exception to 9.2.1-(c)

Reuse of reclaimed water in Hospital and Outpatient Health care is not recommended due to associated health hazards.

9.2.2 Water Quality

The building under consideration shall comply with the mandatory and prescriptive criteria for sources of water and its treatment.

a) Sources of water shall be as per defined in section 9.2.1

b) Potable water quality shall comply with the requirements of IS 10500:2012, Drinking Water – Specification, Tables 1 to 4.

c) Varied recycled applications of treated used water quality such as toilet flushing, vehicle exterior washing, non-contact impoundments, landscape irrigation shall comply with the requirements of CPHEEO manual on Sewerage and Sewage Treatment Systems: 2013, Chapter 7 ("Table 7.19: Recommended norms of treated sewage quality for specified activities at point of use (Modified) Annex 1") issued by Ministry of Housing and Urban Affairs

Exception to section 9.2.2-(c) :

Not mandatory if the wastewater generation is less than 10 kL/day.

9.2.3 Water Treatment

All types of water treatment systems shall comply with the mandatory provisions of section 9.2.3 for the respective ECSBC levels .

1. Representative samples of water from all sources shall be drawn, for laboratory testing of water quality as prescribed in IS 1622 (1981, reaffirmed 2019) and BIS 3025(part 1 to part 79). Samples shall be taken before installation of water treatment plant to establish design basis as well as every day based on operating period of water treatment plant to ensure consistency in water quality.
2. Water Treatment shall be carried out as per guidelines by CPHEEO Manual on Water Supply and Treatment systems (Drink from Tap), 2024, to meet water quality for various applications as specified in section 9.2.2-(b)

3. Based on water test reports if TDS levels exceed quality given by IS 10500: 2012, Reverse Osmosis (RO) treatment is required and the minimum recovery rate shall be 65%.

9.2.4 Pumping System

Water transfer pumps for domestic, wastewater and reclaimed water shall comply with following requirements:

1. All pumps shall be Selected with flow-head characteristics between 70% to 110% of flow at BEP (Best efficiency point) of the curve.
2. All non-submersible pumps shall be coupled with IE 3 and higher efficiency class motors.
3. All submersible pumps shall be coupled with IE 2 and above efficiency class motors.
4. Pumpsshall have minimum overall efficiency as per Table 9.1.

Table 9.1 : Overall Efficiency of pump and motor Requirements for ECSBC Building

Equipment	Minimum Overall Efficiency (%)
Domestic water pumps	60
Flushing water pumps	60
Surface water pumps	60
Wastewater pumps (Solids – 10 to 20 mm size)	45
Sewage pumps (Solids – 40 to 50 mm size)	45
Hot Water circulation pumps	45

9.2.5 Piping Systems

Piping systems shall comply with following mandatory requirements:

1. Piping systems shall comply with guidelines of NBC 2016 (Part 9, Section 1: Water Supply) and its subsequent revisions.
2. Hot water piping shall be provided with required insulation as per section 9.2.8, Table 9.2.

9.2.6 Metering

1. Management of water resources in a system is a function of the measurement of quantity of water at source and its effective usage. Metering facilitates users to generate data and charts to monitor water usage regularly and to fix leaks and wastages so as to minimise water wastage.
2. All measurement of flow of water shall be carried out by using either positive displacement type meters, velocity type meters, multi jet meters shall conform to IS-779. Electromagnetic meter, Ultrasonic and IOT smart meters are also used.
3. Water meters shall be installed on all types of water feed lines entering the building premises on the inflow side and on all outflow, lines supplying water to the building as per section 9.2.15-4.

9.2.7 Controls

1. All storage sumps/tanks shall be provided with float switch level controller for pumping system.
2. Hydro-pneumatic systems, if used, shall be provided with pressure switch to maintain consistent pressure both at suction and delivery manifolds.
3. Auto change overs are recommended for all the pumping systems when working and stand by pumps are installed as per emergency and any exigencies.
4. Mechanical Flow meters shall be provided on all water supply lines supplying various types of water of varied water quality and quality of water depending on the applications.

9.2.8 Service Water Heating

Service Water Heating and equipment's shall comply with following requirements:

ECSBC buildings shall have Centralised Hot Water Systems for Buildings, covered under this code in all climatic zones, shall have heat pump-based water heating meeting following requirements:

1. Air source heat pumps shall meet or exceed minimum COP of 3.5.

2. Water Source Heat Pumps shall meet or exceed minimum COP of 4.5
3. Ground Source Heat Pumps shall meet or exceed minimum COP of 3.0

Exception to 9.2.8:

1. *Hospitality and Healthcare in all climatic zones shall have solar water heating equipment installed to provide at least 40% of the total hot water design requirement, balance 60% requirement shall be met with High Energy Efficient System.*
2. *Systems that use heat recovery (Condenser recovery from Chillers) to provide the hot water capacity required as per the building type and size.*
3. *Buildings that install Solar PV cells of capacity 5% of Total Contractual Power Demand or 200 W/Sqm whichever is less.*

9.2.9 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:

1. Maximum heat recovery from hot discharge system like condensers of air conditioning units.
2. Use of gas fired heaters wherever gas is available, and
3. Electric coil heaters

9.2.10 Heating Equipment Efficiency

Service water heating equipment shall comply or exceed the performance and minimum efficiency requirements presented in relevant Indian Standards:

1. Solar water heater shall comply with the performance/ minimum efficiency level as mentioned in IS 13129 Part (1&2) IS 16368.
2. Gas Instantaneous water heaters shall comply with the performance/minimum efficiency level as mentioned in IS 15558 with above 80% Fuel utilization efficiency.
3. Electric water heater shall comply with the performance/ minimum efficiency level as mentioned in IS 2082 and shall be BEE star labelled.
4. Electric coil heaters shall comply with IS 4149: 2021.
5. For evacuated tube collector, the storage tanks shall comply with IS 16542, tubes shall comply with IS 16543 and IS 16544 for the complete system.

9.2.11 Return Re-circulation Line

In case of centralised system, a return Line from the end of Supply line, shall be installed to avoid Water Loss, with an Automated Pumping System with temperature & timer Controls.

9.2.12 Piping Insulation for Supply & Return Lines

1. Piping for heating, space conditioning, and service hot water systems shall meet the insulation requirements listed in Table 9.2. Insulation exposed to weather shall be protected by aluminium foil. Cellular foam insulation shall be protected as above or be painted with water resistant paint.
2. Hot Water Tank Temperature to be maintained as per NBC 2016, Part 9, Clause 4.14.2.2 and its subsequent revisions.

Exceptions to 9.2.12:

Reduction in insulation R value by 0.2 (compared to values in Table 9.2 to a minimum insulation level of R-0.4 shall be permitted for any pipe located in partition within a conditioned space or laid underground. Insulation R value shall be increased by 0.2 over and above the requirement in Table 9.2 for any pipe located in a partition outside a building with direct exposure to weather.

Table 9.2: Insulation Requirements for Pipes in ECSBC Building Insulation R Value (m2.K/W)

Operating Temperature	Pipe Size <40mm	Pipe Size ≥40mm
>60 Deg. C and ≤94 Deg. C	0.7	0.7
>40 Deg. C and ≤60 Deg. C	0.4	0.7

Exception to Table 9.2:

In case for Insulation if 'R' values as per Table 9.2 is not used the exception will be to use insulation material which will improve the performance by 85%.

9.2.13 Water Heating Controls and Safety

1. **Gas Heaters:** It is important to have an exhaust system properly installed to take out CO (Carbon Monoxide) which gets generated due to Gas burning and thermostat to control the water temperature.
2. **Heat Pumps:** Controls shall be provided for the Heat Pump as follows:
   a) Control for High / Low pressure Cut Off for Refrigerant Gas.
   b) Control for Temperature Cut Off & Re Start – With provision of differential temperature setting.
   c) Control for Chilled / Cooling Water Temperature Cut Off (In case of Water Source Heat Pumps)
3. **Solar Systems:** In an active solar water heating system, control systems are used to switch on a circulation pump whenever energy gain is possible through solar collectors. Otherwise, it automatically switches off the pump. A differential thermostat is recommended as it optimizes the energy gain for the system. Use of Thermostatic Mixing Valves to avoid High Temperature water going out from Solar Panels.

Table 9.3: Energy Consumption Calculation for Various Hot Water System

Type of Hot Water System	Consumption	Consumption per litre	Consumption per litre / Year
	kW	kW/ litre	kW/litre/ year (365 Days)
Electrical water heater	654	0.065	23.87
Diesel / Gas boilers (90% efficiency)	581	0.06	21.22
Solar water heating with electrical backup (90 non solar days)	654	0.065	5.89
Air source heat pumps (with minimum 3.5 COP)	149.5	0.015	5.46
Water source heat pump (with minimum COP 5.0)	104.65	0.01	3.82
Air source heat pumps with Solar -hybrid system (90 non solar days)	149.5	0.015	1.35
Water source heat pumps with Solar -hybrid system (90 non solar days)	104.65	0.01	0.94

9.2.14 Swimming Pool Heating

All heated pools shall be provided with a vapour retardant pool cover on the water surface. Pools heated to more than 32°C shall have a pool cover with a minimum insulation value of R-4.1.

Refer Table 9.3 for Energy consumption calculations. For various Hot water systems.

9.2.15 Water Balance

The purpose of Water Balance is to give information on the total water inflow and outflow within the property or facility through a pictorial diagram. It is a tool which aids in conserving the water, controlling wastage and predict water shortfall.

The water balance shall be made for both 'Dry Season' and 'Wet Season' conditions.

(Dry season can be considered as period of low rainfall. This can be taken as 4 months from June to September. Wet season can be considered as period of prolonged rainfall. This can be taken as 8 months from October to May.)

The buildings shall conform to the following:

1. The population of the building shall be calculated as per Clause 4.1.b Section-1 Part 9 in NBC 2016 and as per any subsequent version released. For building typologies which are not covered in NBC , the actual occupancy for which the building is designed by architect or equivalent competent authority along with the design basis for the derived population estimates shall be submitted.
2. Minimum water requirements for buildings and facilities shall be as given in the Table-1 of Clause 4.1.2 of NBC 2016: Part 9, Section-1: Water supply and as per any subsequent version released
3. The total water supply fixture units for different fixtures shall be as given in the Table 2 of Clause 4.7.3.1 of NBC 2016 Part 9, Section-1: Water Supply. Based on these fixture units the Probable Simultaneous Demand is calculated as per Table 3 Clause 4.7.3.2 of NBC 2016 Part 9 Section-1: Water Supply and as per any subsequent version released
4. Water Efficiency: The fixtures and sanitaryware shall follow the Star rating as per Table 1 and Table 4, IS 17650 Part 1 and Part 2.

Exception to 9.2.15:

In areas where the rainfall pattern is spread over a wider prolonged period, the period of dry season and wet season can be as per the actual seasonal rainfall recorded. This will be supported by documented evidence from the Meteorological department.

9.2.16 Water Efficiency

1. The fixtures and sanitary ware should follow 1 star rating as per Table 1and Table 4, IS 17650 Part 1 and Part 2 (Table & Table for ready reference).
2. Treated recycled sewage will be used for, flushing, landscaping, cooling tower make-up.
3. Rainwater harvesting to be done in the form of rain water storage/recharge pits.
4. Analogy type water meters for supply line, flushing, landscaping, cooling tower make-up, inflow to and outflow from the STP and harvested rainwater.

Table 9.4: Water Efficiency Rating Criteria for Sanitaryware for ECSBC Compliant Building

Unit	Water Consumption Unit	ECSBC
Water closet	lpf full flush	≤6.0
	lpf reduced flush	≤3.0
Urinal	Lpf	≤3.0

Table 9.5: Water Efficiency Rating Criteria for Sanitary Fitting for ECSBC Compliant Building

Unit	Unit	ECSBC
Washbasin Metered Faucet	Litres/use	≤1.0
Urinal Metered Faucet	lpf	≤3.0
Washbasin tap	Lpm	≤8.0
Sink Faucet	Lpm	≤8.0
Overhead Shower	Lpm	≤10.0
Handheld Shower	Lpm	≤8.0
Handheld Ablution Spray	Lpm	≤6.0

9.2.17 Waste Water Treatment and Reclamation

One of the approaches for raw water reduction in building premises is to recycle the water by installing on-site Wastewater Treatment Plant. Treated water can be reused for applications such as flushing, landscaping, water bodies, cooling tower make-up, cleaning, etc.

Wastewater Treatment is a process of removing contaminants from wastewater. Its objective is too Tertiary and/or Polishing treatment such as dual media filter, activated carbon filter, disinfection system shall be provided so that the treated water characteristics as per Pollution Control Board (PCB) norms are achieved.

Further enhanced treated water quality shall be achieved with advanced treatments like Softener, Membrane filtration system to achieve required quality for reuse.

The buildings shall conform to the following:

1. Wastewater treatment plant of capacity capable of treating 100% wastewater shall be installed with the requirements as specified in the CPHEEO Manual on Sewerage and Sewage Treatment System, National Building Code 2016 (Part 9: Plumbing Services, Section 2: Drainage and Sanitation, Subsection 4.13: Sewage Treatment Systems) and shall meet treated waste water quality as specified under Environmental (Protection) Rules, 1989 and amendments thereof.
2. IoT based flowmeter shall be provided each at the inlet and outlet of the sewage treatment plant. IoT based online water quality monitoring system covering the basic parameters like pH, TSS, BOD, COD and TDS shall be provided at the outlet of the sewage treatment plant.
3. Sewage treatment plant shall meet treated wastewater quality for reuse in various applications as specified in CPHEEO Manual on Sewerage and Sewage treatment systems: 2013, Chapter 7, Table 7.19. Reuse treated sewage shall be used for landscaping, flushing, and cooling tower make-up water (if water cooled chillers are installed).
4. STP and pump room installed in basement shall be provided with adequate ventilation as per National Building Code 2016 (Part 8: Building Services, Section 11, Clause 11.3, Table 11) and as per any subsequent version released

9.2.18 Rain Water Harvesting and Reuse

Rainwater harvesting is the direct collection and storage of rainwater, rather than allowing it to run off. Rainwater is collected from building roof top and paved surfaces redirected to a tank, recharge to shallow aquifer, or a reservoir with percolation, so that it infiltrates into the ground.

Rainwater harvesting shall comply with following reqiurments:

For ECSBC compliant Buildings, Rainwater harvesting shall comply with rainwater harvesting and water conservation manual 2019 by CPWD, CPHEEO manual and local bye laws, whichever is stringent shall be followed.

9.3 Additional Mandatory requirements

9.3.1 Water Quality

a) ECSBC Plus Building Requirements:

1. Harvested rainwater: Roof top rainwater to be collected. in storage tank of at least one day capacity or as per local byelaws whichever is stringent. This water shall be used after appropriate treatment for potable applications.
2. Reclaimed used water from sewage treatment plants after adequate treatment can be used for domestic usages other than potable/drinking and culinary.
3. Condensate water from HVAC systems shall be used for various applications like domestic use (wash basins, shower & Pantry) flushing, landscaping, car wash, floor wash & swimming pool make-up water

4. Segregation and separate treatment to be offered for grey and black water for achieving the desired water quality for varied reuse applications.

b) Super ECSBC Building Requirements:

Grey water to be segregated and treated separately and reused for potable drinking purposes.

9.3.2 Water Treatment

a) ECSBC Plus Building Requirement:

1. ECSBC+ Buildings based water quality monitoring system covering basic parameters like flow, pH, TSS, and TDS shall be provided. These parameters shall be monitored after treatment.
2. Based on water test reports if TDS levels exceed quality given by IS 10500: 2012 and Reverse Osmosis if is required, minimum rate of recovery shall be 75%.

b) Super ECSBC Building Requirement:

1. Based on water test reports, if TDS levels exceed quality given by IS 10500: 2012 and Reverse Osmosis treatment is required, minimum rate of recovery shall be 85% which can be achieved by multiple stage treatment.
2. Reject water from RO filtration plants to be treated to reduce TDS level to 2100mg/l, as per Guidelines for Utilisation of Treated effluent in irrigation by CPCB. The treated effluent shall meet the norms prescribed for irrigation under Environment Protection Rules, 1986.
3. R. O. reject water shall be reused after treatment or disposed of by authorized agencies where the Total Dissolved solids (TDS) content is more than 2100 mg/l.

9.3.3 Pumping System

a) ECSBC Plus Building Requirement:

All pumps shall comply with mandatory requirements defined in section 9.3.3-(a)

1. All non-submersible pumps shall be coupled with minimum IE 3 and above efficiency class motors.
2. Pumps for other applications shall have minimum overall efficiency as per Table 9.6.

Table 9.6: Pump Overall Efficiency Requirements for ECSBC Plus Building

Equipment	Minimum Overall Efficiency (%)
Domestic water pumps	65
Flushing water pumps	65
Surface water pumps	65
Wastewater pumps (Solids – 10 to 20 mm size)	50
Sewage pumps (Solids – 40 to 50 mm size)	50
Hot Water circulation pumps	50

b) Super ECSBC Building Requirement:

All pumps shall be conformed to section 9.3.3.-(b).

1. All non-submersible pumps shall be coupled with minimum IE 4 efficiency class motors or higher.
2. Pumps for other applications shall have minimum combined efficiency as per Table 9.7.

Table 9.7: Pump Efficiency Requirements for ECSBC Super Building

Equipment	Minimum Overall Efficiency (%)
Domestic water pumps	70
Flushing water pumps	70
Surface water pumps	70
Wastewater pumps (Solids – 10 to 20 mm size)	55
Sewage pumps (Solids – 40 to 50 mm size)	55
Hot Water circulation pumps	50

9.3.4 Controls

a) ECSBC Plus Building Requirement:

1. All storage sumps/tanks shall be provided with solenoid-based level controller with auto ON / OFF for pumping system to avoid overflow and wastages.
2. Hydro-pneumatic systems, if used, shall be provided with pressure transmitters to maintain consistent pressure both at suction and delivery manifolds to make sure dry running shall be avoided at suction side, to maintain and monitor the pressures on delivery side.

3. IoT based flow meters shall be provided on all water supply lines.
4. All pumping systems shall be controlled through PLC based system connected to BMS and data should be transmitted for remote management.

b) ECSBC Super Building Requirement:

1. All storage sumps/tanks shall be provided with Infra-Red level indicator, controller with auto ON / OFF and alarm for pumping system.
2. All pumping systems shall be controlled through PLC based system connected to BMS and data shall be transmitted for remote management.

9.3.5 Service Water Heating

a) ECSBC Plus Building Requirement:

Hospitality and Healthcare in all climatic zones shall have solar water heating equipment installed to provide at least 60% of the total hot water design requirement and balance 40% to be augmented by any other Hot Water generating systems.

Exception to 9.3.5. (a):

Buildings that install Solar PV cells of capacity 7.5% of Total Contractual Power Demand or 300 W/ m2 whichever is less.

Tabel 9.8: : Insulation Requirements for Pipes in ECSBC Plus Building – Insulation R Value (m2.K/W)

Operating Temperature	Pipe Size ≤40mm,mm	Pipe Size ≥40mm,mm
>60 Deg. C and ≤94 Deg. C	0.8	0.8
>40 Deg. C and ≤60 Deg. C	0.5	0.9

b) Table 9.8 ,Super ECSBC Building Requirement:

Hospitality and Healthcare in all climatic zones shall have solar water heating equipment installed to provide 100% of the total hot water design requirement.

Exception to section 9.3.5. (b):

Buildings that install Solar PV cells of capacity 10% of Total Contractual Power Demand or 400 W/ Sq. M whichever is less.

Tabel 9.9: Insulation Requirements for Pipes in ECSBC Super Building – Insulation R Value (m2.K/W)

Operating Temperature	Pipe Size ≤ 40mm,mm	Pipe Size ≥40mm,mm
>60 Deg. C and ≤ 94 Deg. C	1.0	1.3
>40 Deg. C and ≤ 60 Deg. C	0.7	1.1

Exception to Table 9.9:

In case for Insulation if 'R' values as per Table 9.9 is not used, the exception will be to use insulation material which will improve the performance by 92%.

9.3.6 Water Heating Controls and Safety

a) ECSBC Plus Building Requirement:

Heat pumps shall have PLC Based system panel, to give data to Central BMS of the building.

b) Super ECSBC Building Requirements:

Heat pumps shall have IOT based system, to have online data available to various concerned parties.

9.3.7 Water Efficiency

a) ECSBC Plus Building Requirement:

1. The fixtures and sanitary ware shall follow 2-star rating as per Table 1 and Table 4, IS 17650 Part 1 and Part 2 (Table & Table for ready reference).
2. Reuse/Recycle of condensate water produced from air conditioning system.
3. Rainwater harvesting water to be utilized for domestic (wash basins, shower, pantry), car wash, floor wash and swimming pool makeup water.

Table 9.10: Water Efficiency Rating Criteria for Sanitaryware for ECSBC Plus Compliant Building

Sl. No	Unit	Water Consumption Unit	ECSBC +
1	Water closet	lpf full flush	≤4.8
		lpf reduced flush	≤2.8
2	Urinal	Lpf	≤2.0

Table 9.11: Water Efficiency Rating Criteria for Sanitary Fitting for ECSBC Plus Compliant Building

Sl. No.	Unit	Unit	ECSBC +

1	Washbasin Metered Faucet	Litres/use	≤0.8
2	Urinal Metered Faucet	lpf	≤2.0
3	Washbasin tap	Lpm	≤6.0
4	Sink Faucet	Lpm	≤6.0
5	Overhead Shower	Lpm	≤8.0
6	Handheld Shower	Lpm	≤6.0
7	Handheld Ablution Spray	Lpm	≤5.0

b) ECSBC Super Building Requirement:

1. The fixtures and sanitary ware shall follow 3-star rating as per Table 1and Table 4, IS 17650 Part 1 and Part 2 (Table & Table for ready reference).
2. The treated recycled sewage will be used for domestic, drinking and swimming pool
3. Sea water to be used for domestic consumption by means of desalination plant, if no other alternative source is available.

Table 9.12: Water Efficiency Rating Criteria for Sanitaryware for ECSBC Super Compliant Building

Sl. No	Unit	Water Consumption Unit	Super ECSBC
1	Water closet	lpf full flush	≤4.0
		lpf reduced flush	≤2.0
2	Urinal	Lpf	≤1.0

Table 9.13: Water Efficiency Rating Criteria for Sanitary Fitting for ECSBC Super Compliant Building

Sl.	Unit	Unit	Super ECSBC
1	Washbasin Metered Faucet	Litres/use	≤0.6
2	Urinal Metered Faucet	lpf	≤1.0
3	Washbasin tap	Lpm	≤3.0
4	Sink Faucet	Lpm	≤4.5
5	Overhead Shower	Lpm	≤6.8
6	Handheld Shower	Lpm	≤4.0
7	Handheld Ablution Spray	Lpm	≤4.0

9.3.8 Waste Water Treatment and Reclamation

a) ECSBC Plus Building Requirement:

1. Separate Grey water and Black water treatment shall be provided.
2. Adequately treated grey water shall be reused for all potable purposes excluding drinking and culinary along with HVAC cooling tower make – up (If water cooled chillers are installed)
3. Treated Black water shall be reused for flushing and landscape irrigation. In case of deficit, treated grey water shall be used to augment the demand.

b) ECSBC Super Building Requirement:

1. All ECSBC + prescriptive requirement to be followed as mandatory requirement.
2. Grey water shall be treated to comply with IS 10500: 2012 drinking water standards and reused for non-potable purposes and HVAC cooling tower make-up if water cooled chillers are installed.

9.3.9 Rainwater Harvesting and Reuse

a) ECSBC Plus Building Requirement:

1. Entire roof top water storage shall be harvested with appropriate treatment and reuse for potable applications.
2. Recharge percolation pits as per soil suitability to be adopted.

b) ECSBC Super Building Requirement:

1. Compliance shall be demonstrated with full utilization of annual potential of harvested rainwater such that there is zero dependency of fresh water.
2. The total amount of water that is received in the form of rainfall over an area is called the rainwater endowment of that area. The rainwater that can be effectively harvested out of this amount is called the "Rainwater Harvesting Potential".

9.4 Compliance Documents requirement

1. Documentation for source of water being used for stable supply of water to building or all purposes.
2. Design and approval documents for rainwater harvesting systems.
3. Approval for desalination systems for high TDS water, if applicable.
4. Laboratory test reports confirming potable water meets IS 10500:2012 standards.

5. Test reports for treated sewage quality, conforming to CPHEEO Manual 2013 standards (if applicable).
6. Quantity of wastewater generation (calculation).
7. Laboratory water quality test reports from all applicable water sources.
8. Design and operational documentation for water treatment systems, including Reverse Osmosis (RO) treatment (if required).
9. Manufacturer's specifications for pumps, showing flow-head characteristics.
10. Documentation proving compliance with efficiency standards (IE 2/IE 3 motors).
11. Calculations and data demonstrating that pumps meet the minimum overall efficiency requirements.
12. Design documentation showing piping systems comply with NBC 2016 guidelines.
13. Installation plans and specifications for all water meters (inflow and outflow).
14. Compliance certification for water meters (conforming to IS-779, Electromagnetic, Ultrasonic, or IOT smart meters).
15. Design and installation details for float switch level controllers in storage tanks.
16. Documentation of auto-changeover mechanisms for pumping systems and Pressure switch specifications for hydro-pneumatic systems.
17. Heat pump specifications, showing compliance with COP requirements.
18. Solar water heating system, gas-fired heaters and evacuated tube collector's installation documents, if applicable/BOQ/Purchase.
19. Automation system specifications for temperature and timer controls.
20. Insulation materials specifications and compliance with required R-values.
21. Installation and control documentation for gas heaters, heat pumps, and solar systems.
22. Safety systems documentation, such as exhaust systems for CO emissions and thermostatic controls.
23. Detailed water balance diagram showing inflow and outflow for dry and wet seasons.
24. Population calculation as per NBC 2016, and water usage estimates for fixtures.
25. Water efficiency compliance documentation, including star ratings for fixtures
26. Fixture and sanitary ware documentation showing compliance with IS 17650 standards.
27. Design documents for rainwater harvesting systems and analogy-type water meters.
28. Design and installation documents for wastewater treatment plants.
29. Test reports showing treated water meets PCB norms.
30. IoT-based flowmeter and water quality monitoring system installation documentation.
31. Design documents showing compliance with CPWD, CPHEEO, and local bye-laws for rainwater harvesting.
32. Installation and operational documentation for storage tanks or recharge pits.

10. Waste Management

10.1 General Requirement

The chapter provides requirements to minimize the waste generated both during the construction phase and post-occupancy to divert any waste from reaching the landfills. The chapter consists of two parts – Construction Waste Management and Municipal Waste Management.

Documentation demonstrating compliance must be submitted for verification as prescribed in Section 10.4.

All ECSBC, ECSBC Plus, Super ECSBC compliant buildings shall conform to section 10.2. All ECSBC Plus and ECSBC Super compliant building shall confirm to section 10.3 in addition to section 10.2.

10.1.1 Classification of waste

1. Classification of construction waste

The waste generated during construction shall be classified but not limited to the following categories:

a. *Non-Hazardous waste:* Including but not limited to Excavated earth excluding 150-200 mm (6-8 inches) of the topsoil, Land clearing debris, Metals (Reinforcement bars, Metal beams/girders, Window/Door frames, nuts and bolts, wires, etc.), Cement and Concrete, Masonry materials (Bricks, AAC blocks, stone, any other masonry, etc.), Flooring, Ceiling, Roofing materials, Insulation materials, Cladding materials (Tiles, stones, gypsum, etc.), Glass, Wood, etc.

b. *Packaging waste:* Including but not limited to cement bags, Wooden crates and pallets, Cardboard boxes, Plastic wrapping and shrink wrap, Foam and bubble wrap, Strapping bands and steel wires, PE film or plastic sheeting, Plastic or metal drums/buckets/containers, Corrugated plastic sheets, specialized packaging etc.

c. *Construction Hazardous waste:* Including but not limited to lead, tars, adhesives, sealants, broken glass.

2. **Classification of post-occupancy waste:**

The waste generated post-construction shall be classified but not limited to the following categories:

a. *Dry waste:* Including but not limited to, plastic items (plastic bottles, containers, packaging, stationary items, etc.), paper items (newspapers, magazines, cardboard, packaging, etc.), metal items (aluminum cans, used aluminum foil paper/tray, steel containers, old metal utensils, pots, metal gardening accessories, etc.), glass items (glass bottles, jars, utensils, etc.), Electronics items (wires, computer accessories, fluorescents, lamps, other electronics, and electrical devices/appliances).

b. *Wet waste:* Including but not limited to, vegetable peels, used tea, fruits, food leftovers, horticulture waste, etc. These are biodegradable organic waste that can also be composted.

c. *Sanitary waste:* Including but not limited to, used diapers, sanitary pads, sweat pads, tampons, condoms, wipes, masks/ gloves, toilet paper, bandages, swabs, and other personal hygiene products etc.

d. *Hazardous waste:* Including but not limited to, expired medicines, used syringes/needles, chemical containers, broken glass, batteries, etc.

All ECSBC, ECSBC Plus, Super ECSBC compliant buildings shall conform to section 10.2. All ECSBC Plus and ECSBC Super compliant building shall confirm to section 10.3 in addition to section 10.2.

10.2 Additional Mandatory Requirements

10.2.1 Construction Waste Management

a) Segregation and Storage of Waste

Designated areas shall be provided within the site/adjacent site for collection, segregation, and storage of segregated waste as per the classification of waste mentioned in section 10.2of this code.

Note: No construction and demolition waste shall be littered or deposited to prevent obstruction to the

traffic or the public or drains. (C&D Waste Management Rules, 2016)

b) Minimization of Non-Hazardous Waste

At least 50% (by either weight or volume) of non-hazardous waste generated, shall have to be reused/repurposed/recycled/salvaged.

Note: Some types of construction waste can be reused/repurposed on-site as fill material for levelling uneven terrain, filling excavated areas, or creating embankments, as a base or subbase material for road construction, for erosion control measures, constructing retaining walls, as bedding and backfill material for utility pipelines, etc.

c) Recycling of Packaging Waste

100% of the packaging recyclable waste, shall be handed over to manufacturers/ authorized recyclers or municipal entities for appropriate management and disposal.

d) Divert Construction Waste from Landfill

Ensure that all (100%) the construction waste (by either weight or volume) generated during the construction process is either reused / repurposed/ salvaged on-site, diverted to recycling facilities, or safely handed over to municipalities. Diversion efforts shall be tracked throughout the construction process. For sample calculation refer to section number section 10.4 of this code.

10.2.2 Post Construction Waste Management

a) Waste Collection Segregation and Storage

A designated centralized waste collection area in each building shall be provided with at least four colour-coded waste bins from the categories (Dry Waste, Organic Waste, Sanitary Waste, Hazardous Waste, E-waste). For calculation of waste generation quantity and area required for storage, refer to section 10.4 of this code.

Note:

1. *A daily waste collection schedule should be developed to collect the segregated waste from each building and store at a designated centralized storage area in the premises until its transportation to respective recyclers.*
2. *Dry, sanitary, and hazardous waste shall be transported to/ collected by authorised recyclers/ Municipal Corporation.*

(b) Organic Waste Treatment

1. Projects having built up area ≥5000 sq.m, an onsite designated area shall be provided to compost (manually or mechanically) at least 50% of projected organic waste (kitchen & horticulture) generated on post-occupancy. The waste generation shall be calculated using the formula as given in section 10.4 of this code.
2. Projects having built up area <5000 sq.m, the project authority may hand over the segregated organic waste to the concerned local body if the municipality has a garbage pick-up mechanism in place. If such an arrangement is inadequate or unavailable, the project authority shall engage a professional waste management organisation to pick up the segregated organic waste, where there is no alternate arrangement for disposal of biodegradable waste, Organic waste composter/Vermiculture pit with a minimum capacity of 1.0 kg/150 sqm. of built-up area/day shall be installed & operated.

10.3 Additional Mandatory Requirements

10.3.1 Construction Waste Management

Non-hazardous construction waste generated shall have to be reused/repurposed /recycled/salvaged, to comply with the requirements below:

a) Requirements for ECSBC Plus Compliance

75%of non-hazardous waste generated is reused /repurposed /recycled /salvaged.

b) Requirements for Super ECSBC Compliance

95% of non-hazardous waste generated is reused /repurposed /recycled /salvaged.

10.3.2 Post Construction Waste Management

A designated area on the project site shall be provided to compost (manually or mechanically) to comply. The calculation shall be done to calculate the designated area as per section 10.4.

a) Requirements for ECSBC Plus Compliance

75% of organic waste generated post-occupancy is composted on-site.

b) Requirements for ECSBC Super Compliance

95% of organic waste generated post-occupancy is composted on-site.

10.4 Calculations and Formula

10.4.1 Example for Post Occupancy Waste Generation

An office building having plinth area 30000 sq.m, with an occupancy of 10 persons per 100 sqm. The recommended range of waste generation is between 0.1 to 0.2 kilograms per capita per day, comprises 40% organic waste and 60% inorganic waste.

Calculation for estimation of waste generation:

Step 1: Calculate the total number of occupants in the office building:

$$Total\ number\ of\ occupants = \frac{Plinth\ area\ (sqm) * \frac{person}{100} sqm}{100}$$

Total number of occupants = 3000 Nos.

Step 2: Calculate the total waste generation per day Considering the upper range of the NBC guidelines:

Total waste generation = Total number of occupants x waste generation per capita

Total waste generation = 600 kg/day

Step 3: Calculate the organic and inorganic waste generation:

Organic waste generation = Total waste generation x 40%

Organic Waste Generation = 240 kg/day

Inorganic waste generation = Total waste generation x Inorganic waste percentage

Inorganic waste generation = 360 kg/day

10.4.2 Calculation Of Area Requirement for Storing Organic Waste

The volume required to store 1 kg of organic waste depends on the density of the waste and how compacted it is. Organic waste's density can vary based on its composition, moisture content, and packing method.

Let's consider an example where the organic waste has a density of 0.5 kg/L. Remember that this is an approximate value, as organic waste density typically ranges from 0.2 kg/L to 0.8 kg/L, depending on the specific waste composition.

To calculate the volume required:

Volume = Mass / Density

Volume = 1 kg / 0.5 kg/L = 2 L

As a rule of thumb, 1000 litres require 1 cubic meter of volume

Then 2 L waste required = 0.002 m^3

(For a thumb rule, it is calculated that 1 kg waste required 0.002 $m^{3)}$

So, if the organic waste has a density of 0.5 kg/L, you would need approximately 2 liters of volume to store 1 kg of organic waste.

10.4.3 Organic Waste Calculation (Vermi Composting Method)

Table 10.1 : Organic waste calculation

Quantity of waste per day (Kg)	240	From section 4.5.1.
Volume required to store 1 Kg	0.002	
Retention time: days	60	
Worm density:	0.5 kg/m^2	
Vermi bed depth(m):	0.6	(Should not be more than 600mm for better

		efficiency)
Vermi bed width (m):	1.5	(Should not be more than 1500mm for easy turning and rotation)
Calculation:		
Calculate the total waste produced during the retention time:		
Total waste generated in 60 days = Daily waste generation x Retention time		
Total waste Kg	14400	
Calculate the volume of vermi beds required to handle this waste:		
Total vermi bed volume required = Total waste / Storage density		
Volume: m3	28.8	
Calculate the total area of vermi beds required:		
Vermi bed area = Vermi bed volume / Vermi bed depth	48.0	
Length of vermi beds = Vermi bed area / Vermi bed width=	32.0	
Hence, size of required pit/bed per cycle:	0.6m X 1.5m X 32m	
Number of beds	2	
Total area required for per day organic waste (m^2)	96	
Area (Sq.m) Required for Mandatory section 4.3.3	**50%**	**48**
Area (Sq.m) Required for Mandatory section 4.4.2 - a	**75%**	**72**
Area (Sq.m) Required for Mandatory section 4.4.2 - b	**95%**	**91.2**
Area provided on site for organic composting	93	
Meeting the requirement	100%	

10.4.4 Example for Construction Waste Diversion Estimation

Table 10.2 : Construction Waste Diversion Estimation

Classification of waste	Type of waste	Quantity (Kg)	% Of total waste[1]	Density(kg/m3)	Volume (m3)	Diverted from landfills (Kg)	Method of Diversion
As per CPCB 2016, new construction generates approx. 40-60 kg per sqm of built-up area							
Total Construction waste Quantity		**257621.5** (Considering 50 kg waste per sq.m of built-up area)					
Non-Hazardous	Soil, Sand and Gravel	66981.6	26%	1600	41.86	66981.6	Reused/ repurposed on site
	Brick & Masonry	82438.9	32%	1900	43.39	82438.9	Reused/ repurposed on site
	Concrete	72134.0	28%	1200	60.11	72134.0	Reused/ repurposed on site
	Metals	15457.3	6%	7850	2.0	15457.3	Sold to recycler
	Wood	7728.6	3%	400	19.3	7728.6	Sold to recycler
Packaging	Others	7728.6	3%			7728.6	Sold to recycler
Hazardous	Bitumen	5152.4	2%	1040	5.0	5152.4	Handover To municipal authority

Table 10.3 Construction waste calculation as per ECSBC Provisions

Classification of waste as per ECSBC Provisions	Quantity (Kg)	% Of diversion
Non-Hazardous	**244740.425**	
Sent to recycling units	23185.9	
Reused/ repurposed on site	221554.5	
Hazardous	**5152.43**	
To municipalities	5152.4	
Packaging	**7728.645**	
Sent to recycling units	7728.6	
Minimization of Non-Hazardous waste (reused on site, to recycling units)	**244740.4**	**100%**
Recycling of packaging waste	**7728.6**	**100%**
Total waste diverted from landfills (Kg)	**257621.5**	**100%**

10.4 Compliance documents requirement

1. Declaration for safe handling and disposing C&D waste as per CPCB guidelines/ (C & D Waste Management Rules, 2016).
2. An inventory of the waste generated during construction by either weight or volume, but not both shall be developed. The inventory shall classify the quantities of waste generated .
3. A waste management plan shall be developed which include:
    a) Estimate the quantum of waste generated daily
    b) Designate an area for collection of daily waste
    c) Site Logistics plan including; designated collection, segregation and storage areas for construction waste
    d) Detailed implementation plan for reuse of waste on site.
4. Site and Building floor plans, highlighted area for floor wise waste collection, with different color bins, organic waste composting location, type and catering capacity.

11. Indoor Environment Quality

11.1 General Requirement

The building shall comply with the mandatory requirements for all four key Indoor Environmental Quality (IEQ) parameters: Indoor Air Quality (IAQ), Visual Comfort, Thermal Comfort, and Acoustics, as outlined in clause 11.2. Documentation demonstrating compliance must be submitted for verification as prescribed in Section 11.4.

All ECSBC, ECSBC Plus, Super ECSBC compliant buildings shall conform to section 11.2. All ECSBC Plus and Super ECSBC compliant building shall confirm to section 11.3 in addition to section 11.2.

11.2 Mandatory Requirements

11.2.1 Indoor air quality (IAQ)

a) Source control for PM10 and PM2.5

The HVAC system of building shall use air filter conforming to IS/ISO 16890 Part 1 to Part 4

b) Source control for CO2

Buildings shall be designed to operate their ventilation systems according to design ventilation rates for perceived air quality, in accordance with Section 6.2.1

11.2.2 Thermal Comfort

In conditioned buildings, the values for quality of thermal environment parameters for representative occupant of a space shall be as specified in Table 11.1.

Note:

1. *Conditions for special purpose buildings such as Operation theatres, clean rooms shall be governed by norms prescribed by appropriate authorities.*
2. *Clothing insulation is expressed in clo units. The clo has the units as m2K/W, used to describe insulation used in residential and commercial construction, higher the value, the better the insulation performance.*
3. *1 clo = 0.155 K·m2·W^{-1}. One clo is the amount of insulation that allows a person at rest to maintain thermal equilibrium in an environment at 21°C in a normally ventilated room (0.1 m/s air movement).*

Table 11.1: Conditions for thermal comfort measurement

Air velocity	Weather condition	Level of activity	Reference table
Up to 0.2m/s	Summer / winter	Met value ≤ 1.2	Table 11.2

Table 11.2 Acceptable range of operative temperature with air velocity up to 0.2 m/s

Level of Activity	Operative Temperature (°C)	
	Summer (Cooling season) ~0.5 clo	Winter (Heating season) ~1.0 clo
1.0 <Met ≤ 1.2	23.0 ± 3.0	19.0 ± 4.0
Met ≤1.0	24.5 ± 2.5	22.0 ± 3.0

(a) Method of calculating operative temperature

For air velocity up to 0.2 m/s the operative temperature shall be calculated as below:

Operative temperature = $\frac{(T_r + (T_a \times \sqrt{10v}))}{(1+\sqrt{10v})}$

Where,

T_a = air temperature

T_r = mean radiant temperature (MRT)

v = air speed (m/s)

It is also acceptable to approximate this relationship for occupants engaged in near sedentary physical activity (with metabolic rates between 1.0 met and 1.3 met), not in direct sunlight, and not exposed to air velocities greater than 0.20 m/s.

Operative temperature = $(T_r + T_a) / 2$

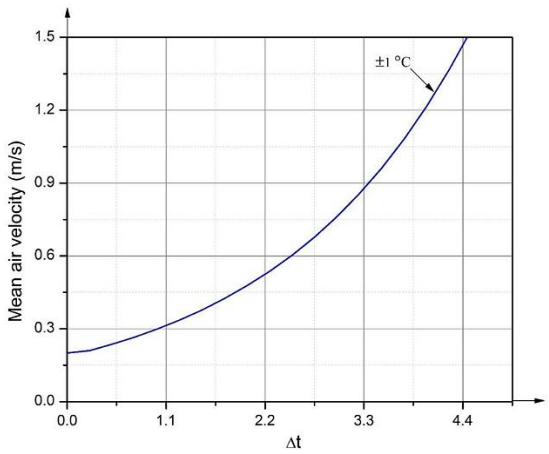


Figure 11.1: Required Air Speed to Offset Increased Operative Temperature (in Celsius)

Example: If in a given room, an occupant is involved in the moderate level of activity, air speed in room is 0.9 m/s and operative temperature is 27°C, then by using above mentioned graph, Δt is 3.3°C. It makes acceptable room air temperature of 27°C + 3.3°C.

For the purpose of showing compliance, representative sample locations shall be the locations where most extreme values of the thermal parameters are observed or likely to occur to occur (e.g. potentially occupied areas near windows, diffuser outlets, corners, and entry/exit).

Note:

When using the standardized compliance method (SCM) to achieve the required thermal comfort requirements as specified in Table 11.1 and Table 11.2, the Mean Radiant Temperature (MRT) shall be assumed to be equal to the air temperature.

When using the Integrative compliance method (ICM) to achieve the required thermal comfort requirements as specified in Table 11.1 and Table 11.2, operative temperature shall be determined through simulation program and shall conform to the reporting requirements as below:

1. Climate data file used.
2. Report demonstrating compliance with the thermal comfort criteria.
3. Submit a simulation report (input and output file) to demonstrate that thermal comfort conditions are met for the building.

11.2.3 Visual Comfort

There is following requirements shall me met:

(a) For all interior spaces, lighting quantity and quality parameters shall conform to IS 3646 (Part 1) for illumination level, glare index according to visual task and IS 10322 (Part 5/section 1 and 2).

(b) In addition, buildings shall meet the threshold values of parameters of lighting comfort as given below:

1. Compliance shall be shown through lighting simulation under no daylight conditions.
2. Illuminance level for all areas shall be as defined in Part 5, section 1 to 5 of NLC 2010 which describes the illumination level of interior illumination of hospital, educational, industrial, indoor public places and office lighting.
3. Minimum uniformity of illuminance in task area shall be 0.7 as per NLC 2010 Part 5.
4. Minimum uniformity of illuminance at immediate surrounding areas shall be 0.5 as per NLC 2010 Part 5.(Illuminance of the immediate surrounding areas shall be as per NLC 2010).

(c) Minimum 90% percent of the workstations shall meet the required illuminance at task plane for ECSBC.

11.3 Additional Mandatory Requirements

11.3.1 Indoor air quality (IAQ):

a) Source control for CO2

In addition to ECSBC requirements, the ECSBC+ compliant buildings shall install devices to measure and control HVAC equipment to regulate and maintain the ventilation rate for non-residential building excluding healthcare and industrial buildings as defined in Chapter 6 – section 6.2.1.(C) of the code.

In addition to ECSBC requirements, in super ECSBC compliant buildings, sensors shall be integrated with the controls to consistently monitor and regulate

ventilation rates, maintaining comfort levels in non-residential buildings (excluding healthcare & industrial buildings), as outlined in Clause 6.2.1-(c)

(b) Source control of Volatile Organic Compounds (VOCs) and Aldehydes emissions

All ECSBC Plus and Super ECSBC buildings, the construction materials like gypsum board, wood, paint, varnish, adhesives, furniture, carpet etc., shall be with low VOC emissions and shall comply to standards listed below:

1. The electronic equipment shall be tested as per ISO/IEC 28360 -1 or ISO/IEC 28360-2: Information technology — Determination of chemical emission rates from electronic equipment
2. The building material shall be tested as per ISO 16000-9: Determination of the emission of volatile organic compounds from building products and Furnishing-Emission test chamber method.
3. Building Materials, Finishes and Furnishings.
4. Emissions for Electronic Equipment.
5. ANSI/BIFMA X7.1-2011(R2021) Standard for Formaldehyde and TVOC
6. Emissions of Low-emitting office furniture and seating

11.3.2 Thermal Comfort

In addition to mandatory requirements of section 11.2.2, ECSBC + and super ECSBC building shell comply with following details:

ECSBC+ and super ECSBC compliant buildings shall be designed to have relative humidity control within the range of 30% to 70% in summer.

Super ECSBC buildings shall be designed to have relative humidity control within the range of 30-70% during summer as well as winter conditions. Super ECSBC buildings shall also meet the additional design conditions as given in Table-11.3.

Table 11.3. Additional requirements for thermal comfort in Super ECSBC buildings

Parameters	Units		Super ECSBC
Radiant Temperature Asymmetry	°C	Warm Ceiling	<7
		Cool Wall	<13
		Cool Ceiling	<18
		Warm Wall	<35
Vertical Air Temperature Difference	°C		4
Floor Surface Temperature (Only for floor-based cooling/heating)	°C		17 - 31

11.3.3 Visual Comfort

Minimum 90% percent of the workstations shall meet the required illuminance at task plane for ECSBC Plus buildings, and 100% for Super ECSBC buildings.

11.3.4 Acoustics comfort

The controlling of noise in and around buildings is essential. The new buildings and the refurbished buildings shall demonstrate compliance as defined below:

Isolation between Building elements depends upon the following factors:

1. Junction between the separating wall/floor
2. Mass of flanking elements
3. Transmission through floor voids, loft spaces, service ducts, mullions and similar paths.

The building material shall be selected based on acoustic insulation properties of the material as specified in table 11.4. The standard laboratory measurements of airborne sound insulation in accordance with BS EN ISO 10140-2 and impact sound insulation in accordance with BS EN ISO 10140-3 or any other equivalent standard should be considered as a guide to the performance of an element in the field.

In case of Super ECSBC, post building construction, field tests for sound insulation shall be conducted in

accordance with BS EN ISO 140-4 and BS EN ISO 140-7. From these measurements, single-number ratings can be calculated according to BS EN ISO 717-1, for airborne insulation, and BS EN ISO 717-2, for impact insulation.

The threshold Noise isolation class (NIC) depending on type of spaces shall be as per the table 11.7.

The Transmission loss of Wooden, Metal Doors along with acoustical louvers are defined in the Table 11.5

Transmission loss for Acoustical Louvers is defined in Table 11.6.

Table 11.4 Default sound insulation values of the different walls and Glazing.

Table 11.4 Default sound insulation values of the different walls and Glazing.

S.No.	Partition (Dry and Wet walls)	Rw/STC
1	100 mm thick low density block work 214pprox.. density 52 kg/m2) with 12mm thick plaster on bothsides	35-37
2	Metal stud partition, 50 mm studs 600 mm centres, clad both sides with 12.5 mm plasterboard of minimumdensity 750kg/m3 joints filled and perimeters sealed.	
3	100 mm thick medium density block work 214pprox..density 140 kg/m2 with 12mm thick plaster on bothsides	38-40
4	Metal stud partition, 50 mm studs 600 mm centres, clad both sides with 12.5 mm plasterboard of minimumdensity 750kg/m3, cavity filled with 50mm thick mineral wool & joints filled and perimeters sealed.	
5	100 mm thick medium density block work 214 approx.density 140 kg/m2 with 12mm thick plaster on both sides	
6	115 mm brickwork 214pprox.. density 190 kg/m2 with12mm thick plaster on both sides	
7.	Metal stud partition, 70 mm studs 600 mm centres, 2x12.5 mm plasterboard of minimum density 900Kg/m3 cavity filled with 50mm thick mineral wooleach side ,70 mm metal stud	40-45
8.	225 mm brickwork 215pprox.. density 440 kg/m2 with12mm thick plaster on both sides	45-50
9.	Double Stud Metal stud partition, 70 mm studs placed 10mm apart and studs fixed at 600 mm centres, 2x12.5mm plasterboard of minimum density 900Kg/m3 cavityfilled with 2x 50mm thick mineral wool each side of a metal stud	
10.	200 mm block work 215pprox.. density 400Kg/m2with 15mm thick plaster on both sides	
11.	100 mm block (high density 200 kg/m2) with 12 mmplaster on one side and 1x12.5 mm plasterboard on metal frame with a 50 mm cavity filled with glass fibre/mineral wool on other side	50-55
12.	Double Stud Metal stud partition, 70 mm studs placed 10mm apart and studs fixed at 600 mm centres, 2x12.5mm plasterboard of minimum density 990-1000Kg/m3 cavity filled with 2x 50mm thick mineral wool each sideof a metal stud	
	Glazing combinations	
13	4 mm single float (sealed)	25
14	6mmsingle float (sealed)	28
15	4 mm glass/12 mm air gap/4 mm glass	
16	10 mm single float (sealed)	30

17	6 mm glass/12 mm air gap/6 mm glass	
18	12 mm single float (sealed)	33
19	16 mm glass/12 mm air gap/8 mm glass	
20	10 mm laminated single float (sealed)	35
21	4 mm glass/12 mm air gap/10 mm glass	
22	12 mm laminated single float (sealed)	38
23	6 mm glass/12 mm air gap/10 mm glass	
24	19 mm laminated single float (sealed)	40
25	10 mm glass/12 mm air gap/6 mm laminated glass	
26	10 mm glass/50 mm air gap/6 mm glass	
27	10 mm glass/100 mm air gap/6 mm glass	43
28	12 mm laminated glass/12 mm air gap/10 mm glass	
29	17 mm laminated glass/12 mm air gap/10 mm glass	45

The Transmission loss of Wooden, Metal Doors along with acoustical louvers are defined in the Table 11.5

Table 11.5: Transmission loss of wooden, metal door along with acoustical louvers.

a. Solid-core Wood Doors				
TL (Transmission loss), DB				
Description		Solid-core wood door ($24kg/m^2$)]; no seals around perimeter	Solid-core wood door [($24kg/m^2$)]; Foam type sealsaround perimeter	Solid-core wood door [($24kg/m^2$)]; Magnetic seals around perimeter
STC		22	26	30
Rw				
Frequency H	63	16	18	20
	80	19	20	23
	100	16	19	22
	125	19	22	25
	160	20	24	26
	200	21	25	27
	250	22	25	29
	315	24	28	31
	400	25	28	30
	500	26	29	30
	630	26	29	30

	800	25	27	28
	1000	24	25	27
	1250	23	25	27
	1600	23	26	28
	2000	23	26	30
	2500	22	26	33
	3150	19	27	34
	4000	20	28	3
b. Hollow-Core Steel Doors				
TL (Transmission loss), DB				
Description		Hallow-core steel door,18ga. Steel faces[(26kg/m²)]; no seals around perimeter	Hallow-core steel door,18ga. Steel faces (26kg/m²)]; Foam type seals around perimeter	Hallow-core steeldoor,18ga. Steel faces (26kg/m²)] Magnetic seals around perimeter
STC		17	28	32
Rw				
Frequency Hz	63	12	21	21
	80	14	23	23
	100	11	21	22
	125	13	21	24
	160	14	24	24
	200	14	24	27
	250	15	25	28
	315	15	24	27
	400	16	25	29
	500	16	25	30
	630	17	26	31
	800	17	26	31
	1000	17	26	30

	1250	17	28	29
	1600	18	29	31
	2000	18	30	36
	2500	17	32	38
	3150	19	33	40
	4000	20	34	39

Table 11.6: Transmission loss for acoustical louvers

Depth of acoustical Louver Single Blade (mm)	63	125	250	500	1000	2000	4000	8000
100	5	4	5	6	9	13	14	13
150	6	6	8	10	14	18	16	15
300	6	7	10	12	18	18	14	13
600	7	9	12	24	31	33	29	30

Calculating acoustical transmission loss:

Normalized transmission loss shall be calculated using the equation 11.7 and Random transmission loss using equation 11.8.

Where, F = Center frequency, S= Surface density, $(\boldsymbol{S_o} \times \boldsymbol{C_o})$ = Characteristic impedance,

Normalized transmission loss TLn,

$$TLn = 10\log\{1 + (\pi \times F \times \frac{S}{So * Co})\}^2$$

Random transmission loss is then calculated using normalized transmission using the below mentioned formula,

$$TL_R = TL_N - (10\ log\ 0.23\ \times TL_N)$$

Table. 11.7: The threshold Noise isolation class depending on type of spaces

S. No.	Building	Type of space	Dw/NIC		
			SuperECSBC	ECSBC+	ECSBC
		Between two enclosedoffices	45	40	40
		Between enclosed office and circulation area	40	35	30
		Between two meeting or conference rooms	50	45	45

1	Office	Between meeting or conference room andcirculation area	40	35	30
		Between two trainingrooms	50	45	45
		Between training room and circulation area	40	35	30
2	Residential	Between water closets and noise sensitive room	45	40	35
3	Hospitality	Walls and floor between two guestrooms/suites	55	50	45
		Between guestrooms/suites and circulation area	40	40	40
		Walls and floor between banquet halls and guestrooms/suites	55	50	50
		Between banquet hall and circulation area or pre functions	45	40	40
4	Entertainment	Walls of cinemas, auditoriums, studios, pubs	60	55	50
5	Education	Between classrooms, labs,lecture halls	50	50	45
6	Hospital and Healthcare	Between two patient rooms and circulationarea	40	40	35
		Between patient room and circulation area (withentrance)	35	30	25
		Between patient roomand service area	50	45	45
		Between consultation room and patient room,public space	40	40	40
		Between consultation room and circulation area(with entrance)	35	30	25

11.5 Compliance Documents Requirement

1. design documents detailing the HVAC system, including air filters conforming to IS/ISO 16890 Part 1 to Part 4.
2. Submit design ventilation rates calculations, conforming to perceived air quality standards.
3. Submit an Indoor Air Quality Management Plan, including measures to prevent and control CO2 and VOCs.
4. Provide Material Safety Data Sheets (MSDS) for all construction materials, paints, adhesives, and finishes used, demonstrating low VOC emissions.
5. Submit post-construction IAQ testing reports confirming PM10, PM2.5, CO2 levels, and VOC emissions meet the prescribed standards.
6. Calculations and analysis of thermal comfort conditions, including operative temperature and humidity levels, for both summer and winter conditions.
7. Details of the building envelope design, including insulation materials, window-to-wall ratio, and solar heat gain calculations.
8. Submit a lighting design report including compliance with IS 3646 and IS 10322, detailing illuminance levels, glare control, and uniformity.
9. Provide simulation reports demonstrating compliance with visual comfort requirements under no daylight conditions.
10. Submit specifications of lighting fixtures used, confirming compliance with illumination and uniformity requirements.
11. Provide detailed design documents for building materials and partition assemblies used to achieve required sound insulation levels.
12. Submit simulation reports showing compliance with NIC and transmission loss requirements for different building areas.
13. Submit field testing reports (if applicable), conforming to BS EN ISO 140-4 and 140-7 for sound insulation, and calculations according to BS EN ISO 717-1 and 717-2.
14. Submit installation plans showing the placement and integration of air filters within the HVAC system.
15. Submit specifications and calibration certificates for CO_2 sensors installed.
16. Provide control logic diagrams demonstrating how ventilation rates are regulated in response to CO_2 levels.
17. Provide certifications from accredited laboratories verifying low VOC emissions of the materials used.
18. Provide design documents showing how relative humidity will be maintained within 30% to 70% during summer (and winter for Super ECSBC buildings).
19. Submit detailed plans demonstrating compliance with additional parameters in **Table 11.3**, including:
20. Radiant temperature asymmetry.
21. Vertical air temperature difference.
22. Floor surface temperature (for floor-based systems).
23. Describe control strategies and systems implemented to achieve and

monitor these additional thermal comfort requirements.

24. Provide data sheets for acoustic materials used, including walls, partitions, doors, and glazing,
25. Submit filed test report post building construction, for sound insulation conducted in accordance with BS EN ISO 140-4 and BS EN ISO 140-7, meeting threshold Noise isolation class.
26. Demonstrate that the Noise Isolation Class (NIC) meets the thresholds specified in **Table 11.7**, depending on the building type and space.

12. Whole Building Performance

12.1. General

The Whole Building Performance Method provides an alternative compliance path to the standardized requirements specified in Chapter 5 through 9 and Chapter 11 of this code. It applies to all building types covered by the Code as mentioned in Section 2.5.

A building complies with the Code using the Whole Building Performance (WBP) Method, when it conform to table3.1.

The mandatory requirements of chapter 5 through chapter 9 (5.2, 6.2, and 7.2, 8.2,9.2) and chapter 11.2 shall be met when using the WBP Method.

12.2. Annual Energy Consumption of a Building

Annual energy use for the purposes of the WBP Method shall be calculated in kilowatt-hours (kWh) of electricity use per year per unit area by using energy simulation program and climatic data as specified in section 12.4. Energy sources other than electricity that are used in the building shall be converted to kWh of electric energy at the rate of 0.75 kWh per mega-joule.

NOTE: The annual energy use calculation as per the Whole Building Performance Method and PES achieved for ECSBC + or Super ECSBC building is not a prediction of the actual energy use or saving of the building respectively, once it gets operational. Actual energy performance of a building depends on a number of factors like weather, occupant behaviour, equipment performance and maintenance, among others, which are not covered by this Code.

12.2.1. Trade-offs Limited to Building Permit

The WBP Method may be used for building permit applications that include less than the whole building; however, any design parameters that are not part of the building permit application shall be identical for both the Proposed Design and the Baseline design Future improvements to the building shall comply with both the mandatory and standardized requirements of concurrent code.

12.2.2. Documentation Required

Compliance shall be documented and shall be submitted to the authority having jurisdiction. The information submitted shall include, at a minimum, the following:

1. Summary describing the results of the analysis, including the annual energy use for the Proposed Design and the Baseline design, and software used.
2. Brief description of the project with location, number of stories, space types, conditioned and unconditioned areas, hours of operation.
3. List of the energy-related building features of the Proposed Design. This list shall also document features different from the Baseline design.
4. List showing compliance with the mandatory requirements of this code.
5. The input and output report(s) from the simulation program including a break up of energy usage by all the following components: lighting, internal equipment loads, service water heating equipment, space heating equipment, space cooling and heat rejection equipment, fans, and other HVAC equipment (such as pumps). The output reports shall also show the number of hours any loads which are not met by the HVAC system for both the Proposed Design and Baseline design.
6. Explanation of any significant modeling assumptions made.
7. Explanation of any error messages noted in the simulation program output.
8. Building floor plans, building elevations, and site plan.

12.3. Mandatory Requirement

All requirements of 5.2,6.2,7.2 and 8.2 , 9.2 and 11.2 shall be met. These sections contain the mandatory provisions of the Code and are prerequisites for demonstrating compliance using the WBP Method.

12.4. Simulation Requirements

12.4.1. Energy Simulation Program

The simulation software shall be a computer-based program for the analysis of energy consumption in buildings and be approved by the authority having jurisdiction. The simulation program shall, at a minimum, have the ability to model the following:

1. Energy flows on an hourly basis for all 8,760 hours of the year,
2. 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,
3. Thermal mass effects,
4. Ten or more thermal zones,
5. Part-load and temperature dependent performance of heating and cooling equipment,
6. Air-side and water-side economizers with integrated control.

In addition to the above, the simulation tool shall be able to produce hourly reports of energy use by energy source and shall have the capability to performing design load calculations to determine required HVAC equipment capacities, air, and water flow rates in accordance with 5 for both the proposed and baseline building designs.
The simulation program shall be tested according to ANSI/ASHRAE Standard 140 Method of Test for the Evaluation of Building Energy Analysis Computer Programs and the results shall be furnished by the software provider.

12.4.2. Climate Data

The simulation program shall use hourly values of climatic data, such as temperature and humidity, from representative climatic data for the city in which the Proposed Design is to be located. For cities or urban regions with several climate data entries, and for locations where weather data are not available, the designer shall select available weather data that best represent the climate at the construction site.

12.4.3. Compliance calculation

The Proposed Design and Baseline design shall be calculated using the following:

1. Same simulation program,
2. Same weather data, and
3. Identical building operation assumptions (thermostat set points, schedules, equipment and occupant loads, etc.) unless an exception is allowed by this Code or the authority having jurisdiction for a given category.

12.5. Energy Consumption calculation for Proposed Design and Baseline design

12.5.1. Energy Simulation Model

The simulation model for calculating the Proposed Design and the Baseline design shall be developed in accordance with the requirements in Table 12-1. The Baseline design is based on the mandatory and standardized requirements of the ECSBC compliant building. The Baseline design will be the same for all compliance levels (ECSBC, ECSBC+ and Super ECSBC).

Table 12-1 Modeling Requirements for calculating proposed and Baseline design

Case	Proposed Design	Baseline design
1. Design Model	(a) The simulation model of the Proposed Design shall be consistent with the design documents, including proper accounting of fenestration and opaque envelope types and area; interior lighting power and controls; HVAC system types, sizes, and controls; and service water heating systems and controls. (b) When the whole building performance method is applied to buildings in which energy-related features have not been designed yet (e.g., a lighting system), those yet-to-be-designed features shall be described in the Proposed Design so that they minimally comply with applicable	The Baseline design shall be developed by modifying the Proposed Design as described in this table. Unless specified in this table, all building systems and equipment shall be modeled identically in the Baseline design and Proposed Design.

	mandatory and Standardized requirements of 5.2 ,6.2, 7.2, 8.2 and 5.3, 6.3, 7.3,8.3 respectively.	
2. Space Use Classification	The building type or space type classifications shall be chosen in accordance with section 2.5. More than one building type category may be used in a building if it is a mixed-use facility.	Same as Proposed Design.
3. Schedules	Operational schedules (hourly variations in occupancy, lighting power, equipment power, HVAC equipment operation, etc.) suitable for the building and/or space type shall be modeled for showing compliance. Schedules must be modeled as per section 12.7. In case a schedule for an occupancy type is missing in section 12.7, appropriate schedule may be used. Temperature and humidity schedules and set points shall be identical in the Standard and Proposed Designs. Temperature control/thermostat throttling ranges shall also be modeled identically in both the Designs.	Same as Proposed Design. Exception: Schedules may be allowed to differ between the Standard and Proposed models wherever it is necessary to model nonstandard efficiency measures and/or measures which can be best approximated by a change in schedule. Measures that may warrant a change in operating schedules include but are not limited to automatic controls for lighting, natural ventilation, demand-controlled ventilation systems, controls for service water heating load reduction. Schedule change is not allowed for manual controls under any category. This is subject to approval by the authority having jurisdiction.
4. Building Envelope	All components of the building envelope in the Proposed Design shall be modeled as shown on architectural drawings or as installed for existing building envelopes. Exceptions: The following building elements are permitted to differ from architectural drawings. (a) Any envelope assembly that covers less than 5% of the total area of that assembly type (e.g., exterior walls) need not be separately described. If not separately described, the area of an envelope assembly must be added to the area of the adjacent assembly of that same type. (b) Exterior surfaces whose azimuth orientation and tilt differ by no more than 45 degrees and are otherwise the same may be described as either a single surface or by using multipliers. (c) For exterior roofs, other than roofs with ventilated attics, the reflectance and emittance of the roof surface shall be modeled in accordance with 5.3.1-(a) (d) Manually operated fenestration shading devices such as blinds or shades shall not be	The Baseline design shall have identical conditioned floor area and identical exterior dimensions and orientations as the Proposed Design, except as noted in (a), (b), (c), (d) and (e) below: (a) Orientation. The Baseline design performance shall be generated by simulating the building with its actual orientation and again after rotating the entire building 90, 180, 270 degrees, then averaging the results. The building shall be modeled so that it does not shade itself. (b) Opaque assemblies such as roof, floors, doors, and walls shall be modeled with the maximum U-factor allowed in 5.3.1 and 5.3.2. (c) Fenestration. Fenestration areas shall equal that in the Proposed Design or 40% of gross above grade wall area, whichever is smaller, and shall be distributed on each face in the same proportions as in the Proposed Design

	modeled. Permanent shading devices such as fins, overhangs, and light shelves shall be modeled. (e) The exterior roof surface shall be modeled using the solar reflectance in accordance with ASTM E903-96 and thermal emittance determined in accordance with ASTM E408-71. Where cool roof is proposed, emittance and reflectance shall be modeled as per ASTM E408-71 and ASTM E903-96 respectively. Where cool roof is not proposed, the exterior roof surfaces shall be modeled with a solar reflectance of 0.3 and a thermal emittance of 0.75.	No shading projections are to be modeled; fenestration shall be assumed to be flush with the exterior wall or roof. Manually operated fenestration shading devices such as blinds or shades shall not be modeled. Fenestration U-factor shall be the maximum allowed for the climate, and the solar heat gain coefficient shall be the maximum allowed for the climate and orientation. (d) Skylight areas shall equal that in the Proposed Design or 5% of gross roof area, whichever is smaller. (e) Roof Solar Reflectance and Thermal Emittance: The exterior roof surfaces shall be modeled using a solar reflectance of 0.70 and a thermal emittance of 0.75 as per 5.3.1-(a)
5. Lighting	Lighting power in the Proposed Design shall be determined as follows: Where a complete lighting system exists, the actual lighting power shall be used in the model. Where a lighting system has been designed, lighting power shall be determined in accordance with 7.3.3. Where no lighting exists, or is specified, lighting power shall be determined in accordance with the 7.3.1 or 7.3.2 for the appropriate building type. Lighting system power shall include all lighting system components shown or provided for on plans (including lamps, ballasts, task fixtures, and furniture-mounted fixtures). Lighting power for parking garages, exterior spaces and building facades shall be modeled. Minimum Lighting controls, as per the ECSBC requirements of 7.2.1, shall be modeled in the Proposed case. Automatic daylighting controls shall be modeled directly in the software or through schedule adjustments determined by a separate daylight analysis approved by the authority having jurisdiction. Other automatic lighting controls shall be modeled directly in the software by adjusting the lighting power as per Table 12.4.	Interior lighting power in the Baseline design shall be determined using the same categorization procedure (building area or space function) and categories as the Proposed Design with lighting power set equal to the maximum allowed for the corresponding method and category in either 7.3.1 or 7.3.2. Power for fixtures not included in the lighting power density calculation shall be modeled identically in the Proposed Design and Baseline design. Lighting controls shall be as per the ECSBC requirements of 7.2.1, Exterior lighting power in the Baseline design shall be set equal to the maximum allowed in 6.3.5
6. HVAC Thermal	HVAC Zones Designed: Where HVAC zones	Same as Proposed Design

Zones	are defined on design drawings, each HVAC zone shall be modeled as a separate thermal block. Exception: Identical zones (similar occupancy and usage, similar internal loads, similar set points and type of HVAC system, glazed exterior walls face the same orientation or vary by less than 45°) may be combined for simplicity. HVAC Zones Not Designed: Where HVAC zones are not defined on design drawings, HVAC zones shall be defined based on similar occupancy and usage, similar internal loads, similar set points and type of HVAC system, glazed exterior walls that face the same orientation or vary by less than 45° in combination with the following rules: Perimeter Core Zoning: Separate thermal block shall be modeled for perimeter and core spaces. Perimeter spaces are defined as spaces located within 5 meters of an exterior or semi exterior wall. Core spaces are defined as spaces located greater than 5 meters of an exterior or semi exterior wall. Separate thermal blocks shall be modeled for floors in contact with ground and for floors which have a ceiling/roof exposure to the ambient.	
7. HVAC Systems	The HVAC system type and all related performance parameters, such as equipment capacities and efficiencies, in the Proposed Design shall be determined as follows: (a) Where a complete HVAC system exists, the model shall reflect the actual system type using actual component capacities and efficiencies. (b) Where an HVAC system has been designed, the HVAC model shall be consistent with design documents. Mechanical equipment efficiencies shall be adjusted from actual design conditions to the rating conditions specified in 5, if required by the simulation model. (c) Where no heating system has been specified, the heating system shall be assumed to be electric. The system characteristics shall be identical to the system modeled in the Baseline design. (d) Where no cooling system has been specified, the cooling system and its characteristics shall be identical to the system modeled in the Baseline design.	The HVAC system type shall be as per Table 12.3 and related performance parameters for the Baseline design shall be determined from requirements of 12.5.2 Equipment performance shall meet the requirements of Chapter 6 for code compliant building.

	(e) For projects, which shall have VRF systems in proposed design, project team shall have to submit following performance curves of proposed VRF systems: 1. EIR vs PLR (Part Load Ratio) 2. Total Capacity; f (evaporator entering wet bulb temperature, condenser entering dry bulb temperature) 3. Electric Input Ratio; f (evaporator entering wet bulb temperature, condenser entering dry bulb temperature)	
8. Service Hot Water	The service hot water system type and all related performance parameters, such as equipment capacities and efficiencies, in the Proposed Design shall be determined as follows: (a) Where a complete service hot water system exists, the model shall reflect the actual system type using actual component capacities and efficiencies. (b) Where a service hot water system has been designed, the service hot water model shall be consistent with design documents. (c) Where no service hot water system exists, or is specified, no service hot water heating shall be modeled.	The service water heating system shall be of the same type as the Proposed Design. For residential facilities, hotels and hospitals the Baseline design shall have a solar hot water system capable of meeting 20% of the hot water demand. Systems shall meet the efficiency requirements of 9.2.8
9. Miscellaneous Loads	Receptacle, motor, and process loads shall be modeled and estimated based on the building type or space type category. These loads shall be included in simulations of the building and shall be included when calculating the Baseline design and Proposed Design. All end-use load components within and associated with the building shall be modeled, unless specifically excluded by this Table, but not limited to, exhaust fans, parking garage ventilation fans, exterior building lighting, swimming pool heaters and pumps, elevators and escalators, refrigeration equipment, and cooking equipment.	Receptacle, motor and process loads shall be modeled the same as the Proposed Design.
10. Modeling Limitations to the Simulation Program	If the simulation program cannot model a component or system included in the Proposed Design, one of the following methods shall be used with the approval of the authority having jurisdiction: (a) Ignore the component if the energy impact on the trade-offs being considered is not significant. (b) Model the component substituting a thermodynamically similar component model.	Same as Proposed Design.

	(c) Model the HVAC system components or systems using the HVAC system of the Baseline design in accordance with Section 6 of this table. Whichever method is selected, the component shall be modeled identically for both the Proposed Design and Baseline design models.	
11. Thermal Comfort	Operative temperature shall be determined using simulation program as specified in section 11.2.2.	Same as Proposed Design

Table 12.2 HVAC Systems Map for Baseline design

	Hotel/Motel, Hospital Patient Rooms, Hotel Guest Rooms, Resorts, Villas, Sleeping Quarters in Mixed-use Buildings, Schools, Classrooms/Lecture Rooms1	Buildings with Less than or Equal to 12,500 m^2 of Conditioned Area	Buildings with More than 12,500 m^2 of Conditioned Area	Data Centre/ Server/Computer Rooms
Name	**System A**	**System B**	**System C**	**System D**
System Type2	Split AC	Variable Refrigerant Flow (VRF)	Central cooling plant with variable volume AHU (VAV)	Computer Room air conditioners
Fan Control	Constant Volume	Constant volume	Variable volume	Constant volume
Cooling Type	Direct expansion with air cooled condenser	Direct expansion with air cooled condenser	Chilled Water with water cooled condenser	Direct expansion with air cooled condenser
Heating Type	1. Heat Pump: Where no heating system has been specified or where an electric heating system has been specified in the Proposed Design 2. Fossil Fuel Boiler, Fossil/Electric Hybrid: Where a heating system exists and a fossil fuel hot water boiler has been specified in the Proposed Design	1. Heat Pump: Where no heating system has been specified or where an electric heating system has been specified in the Proposed Design 2. Fossil Fuel Boiler Fossil/Electric Hybrid: Where a heating system exists and a fossil fuel hot water boiler has been specified in the Proposed Design	1. Electric resistance: Where no heating system has been specified or where an electric heating system has been specified in the Proposed Design 2. Fossil Fuel Boiler Fossil/Electric Hybrid: Where a heating system exists and a fossil fuel hot water boiler has been specified in the Proposed Design	NA
Notes: 1. Buildings of the listed occupancy types or spaces in Mixed-use Buildings with the listed occupancy types. 2. Where attributes make a building eligible for more than one system type; use the predominant condition to determine the Baseline design system type provided the non-predominant conditions apply to less than 1,000 m2				

of conditioned floor area. Use additional system type for non-predominant conditions if those conditions apply to more than 1,000 m2 of conditioned floor area. Use additional system type for any space which has a substantial difference in peak loads and/or operational hours compared to the predominant space type. Such spaces may include but are not limited to computer/server rooms, retail areas in residential, or office buildings. 3. One AHU per floor at a minimum.

Table 12-3 Power adjustment factors for automatic lighting controls

Automatic Control Device	Daytime occupancy and area <300 m²	All Others
Programmable Timing Control	10%	0%
Occupancy Sensor	10%	10%
Occupancy Sensor and Programmable Timing Control	15%	10%

12.5.2 HVAC System

The HVAC system type and related performance parameters for the Baseline design shall be determined from Table 12.2 and the following rules:

1. Other components: Components and parameters not listed in Table 12.2 or otherwise specifically addressed in this subsection shall be identical to those in the Proposed Design.

2. Exception to 12.5.2(a): Where there are specific requirements in 6.2.2, the component efficiency in the Baseline design shall be adjusted to the lowest efficiency level allowed by the requirement for that component type.

3. All HVAC and service water heating equipment in the Baseline design shall be modeled at the minimum efficiency levels, both part load and full load, in accordance with 6.2.2.
4. Where efficiency ratings, such as EER and COP, include fan energy, the descriptor shall be broken down into its components so that supply fan energy can be modeled separately.
5. Minimum outdoor air ventilation rates shall be the same for both the Baseline design and the Proposed Design except for conditions specified in 12.5.2-(a).
6. The equipment capacity for the Baseline design shall be based on sizing runs for each orientation and shall be oversized by 15% for cooling and 25% for heating, i.e., the ratio between the capacities determined by the sizing runs shall be 1.15 for cooling and 1.25 for heating.
7. Unmet load hours for the Proposed Design shall not differ from unmet load hours for the Baseline designby more than 50 hours. Maximum number of unmet hours shall not exceed 300 for either case.

a) Minimum outdoor rates

Minimum outdoor air rates shall be identical for both the Baseline design and Proposed Design, except

1. when modeling demand-controlled ventilation (DCV) in the Proposed Design (DCV is not required in the Baseline design as per 6.2.1-(c)
2. When the proposed design has a ventilation flow higher than the minimum required by the applicable code, the Baseline design shall be modeled as per the minimum ventilation rate required by the applicable code and the Proposed Design shall be modeled as per actual design (higher than Baseline design)

b) Fan Schedules

Supply and return fans shall operate continuously whenever the spaces are occupied and shall be cycled to meet heating and cooling loads during unoccupied hours.

c) Fan Power

1. For Systems Types A, B and D,

P_{fan} = cmh x 0.176

Where P_{fan} = Baseline design fan power in watts

cmh = Baseline design supply airflow rate auto-sized by the simulation software

2. For System B - VRF: Variable Refrigerant Flow system, the performance curve for Baseline shall be modeled using either Equation 1 or table 12-4.

Equation 1

$$EIR(PLR) = 0.4628 - 1.0402 \times PLR + \{2.1749 \times PLR^2\} - \{0.5975 \times PLR^3\}$$

Table 12.4 Performance curve reference for VRF flow system

Part Load Ratio (PLR)	EIR	Part Load Ratio (PLR)	EIR
0.1	0.3799	0.6	0.4926
0.2	0.337	0.7	0.5954
0.3	0.3304	0.8	0.7167
0.4	0.3565	0.9	0.8527
0.5	0.4117	1	1

3. For System Type C

Fan power shall be modeled as per efficiency limits specified in section 6.3.1 using a static pressure of 622 Pa or the design static pressure, whichever is higher. The simulation software shall automatically

calculate the Baseline design fan power based on the above inputs.

Note:

For VAV system under type C:

Supply fans shall have variable-speed drives, and their part-load performance characteristics shall be modeled using either Method 1 and Method 2 specified given below.

Method 1:

Table 12.5 Part Load Fan Power Data

Fan Part-Load Ratio	Fraction of Full-Load Power
0	0
0.1	0.03
0.2	0.07
0.3	0.13
0.4	0.21
0.5	0.3
0.6	0.41
0.7	0.54
0.8	0.68
0.9	0.83
1	1

Method 2:

$P_{fan} = 0.0013 + \{0.1470 \times (PLR_{fan})\} + \{0.9506 \times (PLR_{fan})^2\} - \{0.0998 \times (PLR_{fan})^3\}$

Where;

P_{fan} = fraction of full load fan power,

PLR_{fan} = Fan part-load ratio (Current L/s/Design L/s)

d) Design Air Flow Rates

Design airflow rates for the Baseline designshall be sized based on a supply air to room air temperature difference of 11 °C for cooling and 18°C for heating. The Proposed Design airflow rates shall be as per design.

e) Economizer (airside and waterside)

Airside economizers shall be modeled in the Baseline designas per the requirements of 6.3.5

Exception to 12.5.2-(e): Airside economizer shall not be modeled for Baseline design HVAC System Type A.

f) Energy Recovery

Energy recovery shall be modeled in the Baseline design as per the requirements of 5.3

g) Chilled Water Design Supply Temperatures

Chilled water design supply temperature shall be modeled at 6.7°C and return temperature at 13.3°C.

h) Chillers

Only electric chillers shall be modeled in the Baseline design for System C. Chillers shall meet the minimum efficiency requirements indicated in Table 12-4 and Table 12-5. Chillers in the Baseline designs hall be selected as per Table 12-6 below:

Table 12-4 Minimum energy efficiency requirements for water-cooled chillers

Chiller Capacity (kW)	COP	IPLV
< 260	4.7	5.8
≥ 260 & < 530	4.9	5.9
≥ 530 & < 1,050	5.4	6.5
≥ 1,050 & < 1,580	5.8	6.8
≥ 1,580	6.3	7

Table 12-5 Minimum energy efficiency requirements for air-cooled chillers

Chiller Capacity (kW)	COP	IPLV
<260	2.8	*3.5*
≥260	3.0	*3.7*

Table 12-6 Type and Numbers of Chillers for Baseline design

Chiller Capacity (kW)	Chiller Type
<1055	*1 Water Cooled Screw Chiller*
1055 to 2110	*2 Water Cooled Screw Chiller equally Sized*
> 2110	*2 or More Water Cooled Centrifugal Chillers, equally sized such that no chiller is greater than 2813 kW_r*

Exception to 12.5.2-(h): Air cooled chillers are allowed to be modeled in the Baseline design if proposed design has air cooled chillers. If the proposed building has a mix of air and water cooled chillers, then the Baseline design shall be modeled with a mix of air and water cooled chillers in the same proportion as in the proposed design.

i) Chilled Water Pumps

Chilled and condenser water pumps for the Baseline design shall be modeled as per power and efficiency limits specified in Table 6.13. Baseline design chilled water pumps shall be modeled as primary-secondary with variable secondary flow.

j) Cooling Tower

Baseline design cooling tower shall be modeled as an open circuit axial flow tower with power and efficiency as per 6.3.3. The fans shall be modeled as two speed.

Condenser water design supply temperature shall be 29.4°C or 5.6°C approach to wet bulb temperature, whichever is lower, with a design temperature rise of 5.6°C.

k) Boiler

Baseline design boilers shall be modeled as natural draft boilers and shall use the same fuel as the Proposed Design. Boiler efficiency shall be modeled as per Table 6.4.

l) Hot Water Design Supply Temperatures

Hot water design supply temperature shall be modeled at 82°C and return temperature at 54°C.

m) Hot Water Pumps

The Baseline design hot water pumps shall be modeled with a minimum efficiency of 70% and a pump power of 300 W/ltr-sec.

Baseline design hot water pumps shall be modeled as primary-secondary with variable secondary flow.

n) Campus/District Cooling Systems

All district cooling plants shall be assumed to be on grid electricity, unless otherwise specified and supported through pertinent documents. New district plants shall comply with the mandatory requirements of ECSBC irrespective of who owns and/or operates the district plant.

Projects may choose either option A or option B given below for modeling campus/district cooling systems.

Option A

The cooling source shall be modeled as purchased chilled water in both the Baseline design and proposed design. For the Baseline design, Table 12.2, shall be modified as follows:

(a) For System Type C; purchased chilled water shall be modeled as the cooling source.

(b) System Types A and B shall be replaced with a two-pipe fan coil system with purchased chilled water as the cooling source.

The chilled water/thermal energy consumption simulated by the software shall be converted to units of kWh and added to the overall building energy consumption. The following conversion factors shall be used to convert chilled water/thermal energy consumption to units of kWh.

1 ton hour = 0.85 kWh

1 MBtu = 1,000,000 Btu = 293 kWh

Option B

The Baseline design shall be modeled as per Table 12.2 HVAC Systems Map.

For the proposed design, model a virtual onsite chilled water plant with Chiller, Pumps and cooling towers modeled at minimum efficiency levels as per 12.5.2-(g) to 12.5.2-(j) . Airside/low side capacities shall be modeled as per design and the plant capacities shall be auto-sized by the software.

12.5.3 Compliance Thresholds for ECSBC compliant, ECSBC+ and Super ECSBC Buildings

For buildings to qualify as ECSBC+ and SuperECSBC Buildings, the WBP Method shall be followed for the Baseline design as detailed above. The proposed design for ECSBC+ and Super ECSBC buildings shall meet the mandatory provisions of 5.2, 6.2, 7.2 and 8.2 and 9.2

The PES for ECSBC+ and SuperECSBC Buildings shall be equal to or greater than the PES listed under the applicable climate zone in Table 12-7 through Table 12-11 of section 12.6.

12.6 Minimum required Percentage Energy Savings

Table 12.7 Minimum required Percentage Energy Savings (PES) respect to Energy Savings of ECSBC building in Composite Climate.

Composite Climate		
Building Type	**ECSBC+**	**SuperECSBC**
Hotel (No Star and Star)	9%	19%
Resort	12%	24%
Hospital	15%	23%
Outpatient	15%	25%
Assembly	14%	23%
Office (Regular Use)	14%	22%
Office (24 Hours)	12%	24%
Schools and University	23%	34%
Open Gallery Mall	15%	24%
Shopping Mall	14%	26%
Supermarket	19%	30%
Strip retail	18%	32%

Table 12.8 Minimum required Percentage Energy Savings (PES) respect to Energy Savings of ECSBC building in Hot and Dry Climate

Hot and Dry Climate		
Building Type	ECBC+	Super ECBC
Hotel (No Star and Star)	10%	19%
Resort	12%	24%
Hospital	16%	24%
Outpatient	15%	25%
Assembly	14%	22%
Office (Regular Use)	14%	22%

Office (24Hours)	12%	24%
Schools and University	23%	34%
Open Gallery Mall	15%	23%
Shopping Mall	16%	28%
Supermarket	27%	31%
Strip retail	18%	32%

Table 12-9 Minimum required Percentage Energy Savings (PES) respect to Energy Savings of ECSBC building in Temperate Climate

Temperate Climate		
Building Type	ECBC+	Super ECBC
Hotel (No Star and Star)	10%	20%
Resort	12%	25%
Hospital	18%	27%
Outpatient	15%	25%
Assembly	15%	24%
Office (Regular Use)	15%	25%
Office (24Hours)	13%	26%
Schools and University	23%	34%
Open Gallery Mall	17%	26%
Shopping Mall	16%	29%
Supermarket	19%	31%
Strip retail	19%	33%

Table 12-10 Minimum required Percentage Energy Savings (PES) respect to Energy Savings of ECSBC building in Warm and Humid climate.

Warm and Humid Climate		
Buildilng type	ECBC+	SuperECBC
Hotel (No Star and Star)	9%	19%
Resort	12%	25%
Hospital	14%	23%
Outpatient	14%	24%
Assembly	12%	20%
Office (Regular Use)	14%	24%
Office (24Hours)	12%	24%
Schools and University	23%	34%
Open Gallery Mall	14%	23%
Shopping Mall	15%	28%
Supermarket	18%	30%
Strip retail	17%	32%

Table 12-11 Minimum required Percentage Energy Savings (PES) respect to Energy Savings of ECSBC building in Cold Climate.

Cold Climate		
Buildign type	ECBC+	SuperECBC
Hotel (No Star and Star)	9%	18%
Resort	12%	25%
Hospital	12%	20%
Outpatient	15%	25%
Assembly	13%	19%
Office (Regular Use)	12%	20%

Office (24Hours)	13%	25%
Schools and University	15%	27%
Open Gallery Mall	18%	27%
Shopping Mall	4%	7%
Supermarket	20%	32%
Strip retail	20%	34%

12.7 Schedules

Table 12.12 Schedules for Business - Office Buildings

Business - Office							
Time Period	Elevator Schedules		External Lighting Schedule	Basement Ventilation		Basement Lighting	
	Daytime Business	24 Hours Business	7 Days/ week	Daytime Business	24 Hours Business	Daytime Business	24 Hours Business
00:00-01 00	0.05	0.55	0.80	0.00	1.00	0.05	1.00
01:00-02:00	0.05	0.25	0.80	0.00	1.00	0.05	1.00
02:00-03:00	0.05	0.25	0.80	0.00	1.00	0.05	1.00
03:00-04:00	0.05	0.15	0.80	0.00	1.00	0.05	1.00
04:00-05:00	0.05	0.35	0.80	0.00	1.00	0.05	1.00
05:00-06:00	0.05	0.50	0.80	0.00	1.00	0.05	1.00
06:00-07:00	0.20	0.20	0.00	0.00	1.00	0.05	1.00
07:00-08:00	0.40	0.40	0.00	0.00	1.00	0.05	1.00
08:00-09:00	0.80	0.80	0.00	1.00	1.00	1.00	1.00
09:00-10:00	0.80	0.80	0.00	1.00	1.00	1.00	1.00
10:00-11:00	0.55	0.55	0.00	1.00	1.00	1.00	1.00
11:00-12:00	0.35	0.35	0.00	1.00	1.00	1.00	1.00
12:00-13:00	0.25	0.25	0.00	1.00	1.00	1.00	1.00
13:00-14:00	0.95	0.95	0.00	1.00	1.00	1.00	1.00
14:00-15:00	0.95	0.95	0.00	1.00	1.00	1.00	1.00
15:00-16:00	0.35	0.35	0.00	1.00	1.00	1.00	1.00
16:00-17:00	0.15	0.35	0.00	1.00	1.00	1.00	1.00
17:00-18:00	0.75	0.70	0.00	1.00	1.00	1.00	1.00
18:00-19:00	0.95	0.95	0.80	1.00	1.00	1.00	1.00
19:00-20:00	0.50	0.50	0.80	1.00	1.00	1.00	1.00

20:00-21:00	0.30	0.35	0.80	1.00	1.00	1.00	1.00
21:00-22:00	0.20	0.25	0.80	0.00	1.00	0.05	1.00
22:00-23:00	0.05	0.25	0.80	0.00	1.00	0.05	1.00
23:00-24:00	0.05	0.55	0.80	0.00	1.00	0.05	1.00

Table 12.13 Schedules for Business - Office Buildings daytime business

Business – Office Daytime Business										
Time Period	Occupancy Schedule			Lighting Schedule			Equipment Schedule		HVAC FanSchedule (On/Off)	
	Office	Corridor/ Lobby	Conference/ Meeting	Office	Corridor/ Lobby	Conference/ Meeting	Office	Conference/ Meeting Room	Office/ Corridor/ Lobby	Conference/ Meeting
00:00-01:00	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0	0
01:00-02:00	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0	0
02:00-03:00	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0	0
03:00-04:00	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0	0
04:00-05:00	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0	0
05:00-06:00	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0	0
06:00-07:00	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0	0
07:00-08:00	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.00	1	0
08:00-09:00	0.20	0.70	0.00	0.90	0.90	0.00	0.10	0.00	1	1
09:00-10:00	0.95	0.80	0.00	0.90	0.90	0.00	0.90	0.00	1	1
10:00-11:00	0.95	0.70	0.75	0.90	0.90	0.90	0.90	0.90	1	1
11:00-12:00	0.95	0.30	0.75	0.90	0.90	0.90	0.90	0.90	1	1
12:00-13:00	0.95	0.30	0.75	0.90	0.90	0.90	0.90	0.90	1	1
13:00-14:00	0.50	0.80	0.5	0.50	0.90	0.50	0.80	0.50	1	1
14:00-15:00	0.95	0.50	0.75	0.90	0.90	0.90	0.90	0.90	1	1
15:00-16:00	0.95	0.30	0.75	0.90	0.90	0.90	0.90	0.90	1	1
16:00-17:00	0.95	0.30	0.75	0.90	0.90	0.90	0.90	0.90	1	1
17:00-18:00	0.95	0.80	0.75	0.95	0.90	0.90	0.90	0.90	1	1
18:00-19:00	0.30	0.70	0.50	0.50	0.90	0.90	0.50	0.90	1	1
19:00-20:00	0.00	0.30	0.00	0.30	0.90	0.00	0.10	0.00	1	0
20:00-21:00	0.00	0.00	0.00	0.10	0.10	0.00	0.10	0.00	1	0
21:00-22:00	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0	0
22:00-23:00	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0	0
23:00-24:00	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0	0

Table 12.14 Schedules for Business - Office Buildings 24 hr business

Business – Office 24-hour Business									
Time Period	Occupancy Schedule			Lighting Schedule			Equipment Schedule		HVAC FanSchedule (On/Off)
	Office	Corridor/ Lobby	Conference/ Meeting	Office	Corridor/ Lobby	Conference/ Meeting	Office	Conference/ Meeting	Office/ Corridor/ Lobby/ Conference/ Meeting
00:00-01:00	0.90	0.20	0.00	0.90	0.90	0.00	0.95	0.00	1
01:00-02:00	0.90	0.50	0.00	0.90	0.90	0.00	0.95	0.00	1
02:00-03:00	0.90	0.20	0.00	0.90	0.90	0.00	0.95	0.00	1
03:00-04:00	0.90	0.20	0.00	0.90	0.90	0.00	0.95	0.00	1
04:00-05:00	0.50	0.20	0.50	0.50	0.90	0.50	0.00	0.90	1
05:00-06:00	0.20	0.50	0.50	0.05	0.90	0.50	0.00	0.90	1
06:00-07:00	0.10	0.50	0.50	0.05	0.50	0.50	0.00	0.90	1
07:00-08:00	0.10	0.50	0.00	0.90	0.50	0.00	0.95	0.00	1
08:00-09:00	0.90	0.70	0.00	0.90	0.90	0.00	0.95	0.00	1
09:00-10:00	0.90	0.80	0.50	0.90	0.90	0.50	0.95	0.90	1
10:00-11:00	0.90	0.70	0.75	0.90	0.90	0.90	0.95	0.90	1
11:00-12:00	0.90	0.30	0.75	0.90	0.90	0.90	0.95	0.90	1
12:00-13:00	0.90	0.30	0.75	0.90	0.90	0.90	0.95	0.90	1
13:00-14:00	0.20	0.80	0.25	0.50	0.50	0.50	0.20	0.50	1
14:00-15:00	0.90	0.50	0.75	0.90	0.90	0.90	0.95	0.90	1
15:00-16:00	0.90	0.30	0.75	0.90	0.90	0.90	0.95	0.90	1
16:00-17:00	0.90	0.30	0.75	0.90	0.90	0.90	0.95	0.90	1
17:00-18:00	0.90	0.80	0.75	0.90	0.90	0.90	0.95	0.90	1
18:00-19:00	0.90	0.70	0.50	0.90	0.90	0.90	0.20	0.90	1
19:00-20:00	0.20	0.30	0.00	0.90	0.90	0.00	0.95	0.00	1
20:00-21:00	0.90	0.20	0.00	0.90	0.90	0.00	0.95	0.00	1
21:00-22:00	0.90	0.20	0.50	0.90	0.90	0.50	0.95	0.90	1
22:00-23:00	0.90	0.20	0.50	0.90	0.90	0.50	0.95	0.90	1
23:00-24:00	0.90	0.20	0.50	0.90	0.90	0.50	0.20	0.90	1

Table 12.15 Schedules for Business – Server Room

Business Building - Server Room						
Time Period	Occupancy Schedule		Lighting Schedule		Equipment Schedule	**HVAC Fan** Schedule (ON/OFF)
	Daytime Business	24-hour business	Daytime Business	24-hour business	All time running	
00:00-01:00	0.00	0.00	0.10	0.10	1.00	1
01:00-02:00	0.00	0.00	0.10	0.10	1.00	1
02:00-03:00	0.00	0.00	0.10	0.10	1.00	1
03:00-04:00	0.00	0.00	0.10	0.10	1.00	1
04:00-05:00	0.00	0.00	0.10	0.10	1.00	1
05:00-06:00	0.00	1.00	0.10	0.10	1.00	1
06:00-07:00	0.00	1.00	0.10	0.10	1.00	1
07:00-08:00	0.00	1.00	0.10	0.10	1.00	1
08:00-09:00	1.00	1.00	0.10	0.10	1.00	1
09:00-10:00	1.00	1.00	0.50	0.50	1.00	1
10:00-11:00	1.00	1.00	0.50	0.50	1.00	1
11:00-12:00	1.00	1.00	0.50	0.50	1.00	1
12:00-13:00	1.00	1.00	0.50	0.50	1.00	1
13:00-14:00	1.00	1.00	0.50	0.50	1.00	1
14:00-15:00	1.00	1.00	0.50	0.50	1.00	1
15:00-16:00	1.00	1.00	0.50	0.50	1.00	1
16:00-17:00	1.00	1.00	0.50	0.50	1.00	1
17:00-18:00	1.00	1.00	0.50	0.50	1.00	1
18:00-19:00	0.00	1.00	0.10	0.50	1.00	1
19:00-20:00	0.00	1.00	0.10	0.50	1.00	1
20:00-21:00	0.00	1.00	0.10	0.50	1.00	1
21:00-22:00	0.00	1.00	0.10	0.50	1.00	1
22:00-23:00	0.00	0.00	0.10	0.10	1.00	1
23:00-24:00	0.00	0.00	0.10	0.10	1.00	1

Table 12.16 Schedules for Assembly building (A)

Assembly Buildings – Common Areas							
Time Period	Elevator Schedule	HVAC Fan Schedule (On/Off)			External Lighting Schedule	Basement Ventilation	Basement Lighting
		Seating/ Public Space	Exhibit Space	Meeting/ Conference Room			
00:00-01:00	0.00	0	0	0	0.80	0.00	0.05
01:00-02:00	0.00	0	0	0	0.80	0.00	0.05
02:00-03:00	0.00	0	0	0	0.80	0.00	0.05
03:00-04:00	0.00	0	0	0	0.80	0.00	0.05

04:00-05:00	0.00	0	0	0	0.80	0.00	0.05
05:00-06:00	0.00	0	0	0	0.80	0.00	0.05
06:00-07:00	0.00	0	0	1	0.00	0.00	0.05
07:00-08:00	0.00	1	1	1	0.00	0.00	0.05
08:00-09:00	0.20	1	1	1	0.00	1.00	1.00
09:00-10:00	0.50	1	1	1	0.00	1.00	1.00
10:00-11:00	0.50	1	1	1	0.00	1.00	1.00
11:00-12:00	0.50	1	1	1	0.00	1.00	1.00
12:00-13:00	0.50	1	1	1	0.00	1.00	1.00
13:00-14:00	0.50	1	1	1	0.00	1.00	1.00
14:00-15:00	0.50	0	1	1	0.00	1.00	1.00
15:00-16:00	0.50	0	1	0	0.00	1.00	1.00
16:00-17:00	0.50	0	1	0	0.00	1.00	1.00
17:00-18:00	0.50	0	0	0	0.00	1.00	0.50
18:00-19:00	0.50	0	0	0	0.80	0.00	0.05
19:00-20:00	0.40	0	0	0	0.80	0.00	0.05
20:00-21:00	0.20	0	0	0	0.80	0.00	0.05
21:00-22:00	0.20	0	0	0	0.80	0.00	0.05
22:00-23:00	0.00	0	0	0	0.80	0.00	0.05
23:00-24:00	0.00	0	0	0	0.80	0.00	0.05

Table 12.17 Schedules for Assembly building (B)

Assembly Buildings								
Time Period	Occupancy Schedule			Lighting Schedule			Equipment Schedule	
	Seating/Public Space	Exhibit Space	Meeting/ Conference	Seating/Public Space	Exhibit Space	Meeting/ Conference	Exhibit Space	Meeting/ Conference
00:00-01:00	0.00	0.00	0.00	0.10	0.10	0.10	0.00	0.00
01:00-02:00	0.00	0.00	0.00	0.10	0.10	0.10	0.00	0.00
02:00-03:00	0.00	0.00	0.00	0.10	0.10	0.10	0.00	0.00
03:00-04:00	0.00	0.00	0.00	0.10	0.10	0.10	0.00	0.00
04:00-05:00	0.00	0.00	0.00	0.10	0.10	0.10	0.00	0.00
05:00-06:00	0.00	0.00	0.00	0.10	0.10	0.10	0.00	0.00
06:00-07:00	0.00	0.00	0.00	0.10	0.10	0.10	0.00	0.00
07:00-08:00	0.00	0.00	0.00	0.10	0.10	0.10	0.00	0.00
08:00-09:00	0.50	0.50	0.00	0.90	0.90	0.10	0.00	0.00
09:00-10:00	0.60	0.50	0.50	0.90	0.90	0.90	0.90	0.80
10:00-11:00	0.70	0.80	0.75	0.90	0.90	0.90	0.90	0.80
11:00-12:00	0.70	0.80	0.75	0.90	0.90	0.90	0.90	0.80

12:00-13:00	0.70	0.80	0.75	0.90	0.90	0.90	0.90	0.80
13:00-14:00	0.90	0.25	0.50	0.90	0.50	0.50	0.50	0.50
14:00-15:00	0.90	0.25	0.75	0.90	0.50	0.90	0.90	0.80
15:00-16:00	0.70	0.80	0.75	0.90	0.90	0.90	0.90	0.80
16:00-17:00	0.70	0.80	0.75	0.90	0.90	0.90	0.90	0.80
17:00-18:00	0.70	0.80	0.75	0.90	0.90	0.90	0.90	0.80
18:00-19:00	0.80	0.50	0.50	0.90	0.90	0.50	0.00	0.00
19:00-20:00	0.80	0.00	0.00	0.90	0.10	0.10	0.00	0.00
20:00-21:00	0.80	0.00	0.00	0.90	0.10	0.10	0.00	0.00
21:00-22:00	0.70	0.00	0.00	0.90	0.10	0.10	0.00	0.00
22:00-23:00	0.60	0.00	0.00	0.90	0.10	0.10	0.00	0.00
23:00-24:00	0.50	0.00	0.00	0.90	0.10	0.10	0.00	0.00

Table 12.18 Schedules for Assembly building (C)

Assembly Buildings - Museum								
Time Period	Occupancy Schedule		Lighting Schedule	Equipment Schedule			HVAC Fan Schedule(ON/OFF)	
	Museum Exhibition	Museum Restoration	Museum Exhibition	Museum Restoration	Museum Exhibition	Museum Restoration	Museum Exhibition	Museum Restoration
00:00-01:00	0.00	0.00	0.10	0.10	0.00	0.00	0	0
01:00-02:00	0.00	0.00	0.10	0.10	0.00	0.00	0	0
02:00-03:00	0.00	0.00	0.10	0.10	0.00	0.00	0	0
03:00-04:00	0.00	0.00	0.10	0.10	0.00	0.00	0	0
04:00-05:00	0.00	0.00	0.10	0.10	0.00	0.00	0	0
05:00-06:00	0.00	0.00	0.10	0.10	0.00	0.00	0	0
06:00-07:00	0.00	0.00	0.10	0.10	0.00	0.00	0	0
07:00-08:00	0.00	0.00	0.10	0.10	0.00	0.00	1	1
08:00-09:00	0.50	0.80	0.90	0.90	0.00	0.90	1	1
09:00-10:00	0.50	0.25	0.90	0.50	0.90	0.25	1	1
10:00-11:00	0.80	0.25	0.90	0.50	0.90	0.25	1	1
11:00-12:00	0.80	0.25	0.90	0.50	0.90	0.25	1	1
12:00-13:00	0.80	0.25	0.90	0.50	0.90	0.25	1	1
13:00-14:00	0.25	0.80	0.50	0.90	0.50	0.90	1	1
14:00-15:00	0.25	0.80	0.50	0.90	0.90	0.90	1	1
15:00-16:00	0.80	0.25	0.90	0.50	0.90	0.25	1	1
16:00-17:00	0.80	0.25	0.90	0.50	0.90	0.25	1	1
17:00-18:00	0.80	0.25	0.90	0.50	0.90	0.25	1	1
18:00-19:00	0.25	0.80	0.90	0.90	0.00	0.90	1	1
19:00-20:00	0.00	0.00	0.10	0.10	0.00	0.00	1	1

20:00-21:00	0.00	0.00	0.10	0.10	0.00	0.00	0	0
21:00-22:00	0.00	0.00	0.10	0.10	0.00	0.00	0	0
22:00-23:00	0.00	0.00	0.10	0.10	0.00	0.00	0	0
23:00-24:00	0.00	0.00	0.10	0.10	0.00	0.00	0	0

Table 12.19 Schedules for Assembly building (D)

Assembly Buildings – Gym and Transport								
Time Period	Occupancy Schedule		Lighting Schedule		Equipment Schedule		HVAC Fan Schedule (ON/OFF)	
	Gym	Transport Buildings	Gym	Transport Buildings	Gym	Transport Buildings	Gym	Transport Buildings
00:00-01:00	0.00	0.00	0.00	0.00	0.00	0.80	0	1
01:00-02:00	0.00	0.00	0.00	0.00	0.00	0.80	0	1
02:00-03:00	0.00	0.00	0.00	0.00	0.00	0.80	0	1
03:00-04:00	0.00	0.00	0.00	0.00	0.00	0.80	0	1
04:00-05:00	0.00	0.50	0.50	0.50	0.50	0.80	1	1
05:00-06:00	0.60	0.90	0.90	0.75	0.75	0.90	1	1
06:00-07:00	0.90	0.90	0.90	0.75	0.75	0.90	1	1
07:00-08:00	0.90	0.90	0.90	0.75	0.75	0.90	1	1
08:00-09:00	0.90	0.90	0.90	0.75	0.75	0.90	1	1
09:00-10:00	0.60	0.90	0.90	0.50	0.50	0.90	1	1
10:00-11:00	0.20	0.50	0.50	0.20	0.20	0.90	1	1
11:00-12:00	0.00	0.00	0.00	0.00	0.00	0.90	1	1
12:00-13:00	0.00	0.00	0.00	0.00	0.00	0.90	1	1
13:00-14:00	0.00	0.00	0.00	0.00	0.00	0.50	1	1
14:00-15:00	0.00	0.00	0.00	0.00	0.00	0.90	1	1
15:00-16:00	0.00	0.00	0.00	0.00	0.00	0.90	1	1
16:00-17:00	0.00	0.00	0.00	0.00	0.00	0.90	1	1
17:00-18:00	0.60	0.75	0.75	0.50	0.50	0.90	1	1
18:00-19:00	0.90	0.90	0.90	0.75	0.75	0.90	1	1
19:00-20:00	0.90	0.90	0.90	0.75	0.75	0.90	1	1
20:00-21:00	0.60	0.90	0.90	0.75	0.75	0.90	1	1
21:00-22:00	0.20	0.75	0.75	0.50	0.50	0.50	1	1
22:00-23:00	0.00	0.00	0.00	0.00	0.00	0.90	0	1
23:00-24:00	0.00	0.00	0.00	0.00	0.00	0.90	0	1

Table 12.20 Schedules for Health care and hospital Building (A)

Healthcare - Hospital											
Time Period	Occupancy Schedule				Lighting Schedule				Equipment Schedule		
	In Patient & ICU	Public Spaces	OPD & Offices	Diagnostic, emergency & OT	Public Spaces	In Patient & ICU	Diagnostic, emergency & OT	OPD & Offices	In Patient & ICU	Diagnostic, emergency & OT	OPD & Offices
	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week
00:00-01:00	0.9	0	0	0.5	0.1	0.1	0.5	0.05	0.4	0	0
01:00-02:00	0.9	0	0	0.4	0.1	0.1	0.5	0.05	0.4	0	0
02:00-03:00	0.9	0	0	0.4	0.1	0.1	0.5	0.05	0.4	0	0
03:00-04:00	0.9	0	0	0.4	0.1	0.1	0.5	0.05	0.4	0	0
04:00-05:00	0.9	0	0	0.4	0.1	0.1	0.5	0.05	0.4	0	0
05:00-06:00	0.9	0	0	0.4	0.1	0.1	0.5	0.05	0.4	0	0
06:00-07:00	0.9	0	0	0.5	0.1	0.1	0.5	0.1	0.4	0	0
07:00-08:00	0.9	0.1	0.1	0.7	0.5	0.2	0.5	0.3	0.7	0.7	0.7
08:00-09:00	0.9	0.5	0.3	0.7	0.9	0.2	0.9	0.9	0.9	0.9	0.9
09:00-10:00	0.9	0.95	0.9	0.95	0.9	0.2	0.9	0.9	0.9	0.9	0.9
10:00-11:00	0.9	0.95	0.9	0.95	0.9	0.2	0.9	0.9	0.9	0.9	0.9
11:00-12:00	0.9	0.95	0.5	0.95	0.9	0.2	0.9	0.9	0.9	0.9	0.9
12:00-13:00	0.9	0.95	0.2	0.95	0.9	0.2	0.9	0.9	0.9	0.9	0.9
13:00-14:00	0.9	0.95	0.5	0.95	0.9	0.2	0.9	0.5	0.9	0.9	0.9
14:00-15:00	0.9	0.95	0.9	0.95	0.9	0.2	0.9	0.9	0.9	0.9	0.9
15:00-16:00	0.9	0.95	0.9	0.95	0.9	0.2	0.9	0.9	0.9	0.9	0.9
16:00-17:00	0.9	0.95	0.9	0.95	0.3	0.2	0.9	0.9	0.6	0.6	0.9
17:00-18:00	0.9	0.7	0.9	0.95	0.3	0.7	0.9	0.9	0.6	0.6	0.9
18:00-19:00	0.9	0.5	0.5	0.95	0.3	0.9	0.9	0.5	0.6	0.6	0.6
19:00-20:00	0.9	0.3	0.5	0.95	0.3	0.9	0.9	0.5	0.6	0.6	0.6
20:00-21:00	0.9	0.1	0.5	0.7	0.3	0.9	0.5	0.3	0.6	0.6	0.6
21:00-22:00	0.9	0	0.1	0.7	0.3	0.9	0.5	0.2	0.6	0	0
22:00-23:00	0.9	0	0	0.5	0.3	0.7	0.5	0.1	0.6	0	0
23:00-24:00	0.9	0	0	0.5	0.1	0.1	0.5	0.05	0.4	0	0

Table 12.21 Schedules for Health care and hospital Building (B)

Healthcare - Hospital										
Time Period	HVAC Fan Schedule (On/Off)				External Lighting Schedule	Elevators	Service Hot Water		Basement Ventilation	Basement Lighting
	Public Spaces	Beds & ICU	Diagn, emerg, & OT	OPD & Offices			Building Summer	Building Winters		
	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week
00:00-01:00	0	1	1	0	1.00	0.20	0.00	0.30	0.50	0.50
01:00-02:00	0	1	1	0	1.00	0.20	0.00	0.30	0.50	0.50
02:00-03:00	0	1	1	0	1.00	0.20	0.00	0.30	0.50	0.50
03:00-04:00	0	1	1	0	1.00	0.20	0.00	0.30	0.50	0.50
04:00-05:00	0	1	1	0	1.00	0.20	0.00	0.30	0.50	0.50
05:00-06:00	0	1	1	0	1.00	0.20	0.00	0.30	0.50	0.50
06:00-07:00	0	1	1	0	0.00	0.20	0.00	0.30	0.50	0.50
07:00-08:00	1	1	1	0	0.00	0.50	0.00	0.20	0.50	0.50
08:00-09:00	1	1	1	1	0.00	0.75	0.20	0.60	1.00	1.00
09:00-10:00	1	1	1	1	0.00	1.00	0.30	0.60	1.00	1.00
10:00-11:00	1	1	1	1	0.00	1.00	0.30	0.80	1.00	1.00
11:00-12:00	1	1	1	1	0.00	1.00	0.30	0.80	1.00	1.00
12:00-13:00	1	1	1	1	0.00	0.75	0.25	0.70	1.00	1.00
13:00-14:00	1	1	1	1	0.00	1.00	0.25	0.80	1.00	1.00
14:00-15:00	1	1	1	1	0.00	1.00	0.25	0.80	1.00	1.00
15:00-16:00	1	1	1	1	0.00	1.00	0.25	0.70	1.00	1.00
16:00-17:00	1	1	1	1	0.00	1.00	0.25	0.70	1.00	1.00
17:00-18:00	1	1	1	1	0.00	1.00	0.10	0.50	1.00	1.00
18:00-19:00	1	1	1	1	1.00	0.50	0.00	0.35	1.00	1.00
19:00-20:00	1	1	1	1	1.00	0.50	0.00	0.35	1.00	1.00
20:00-21:00	1	1	1	1	1.00	0.50	0.00	0.35	1.00	1.00
21:00-22:00	1	1	1	0	1.00	0.30	0.00	0.30	0.50	0.50
22:00-23:00	0	1	1	0	1.00	0.20	0.00	0.30	0.50	0.50
23:00-24:00	0	1	1	0	1.00	0.20	0.00	0.30	0.50	0.50

Table 12-22 Schedules for Health -Out Patient Health Care Building (A)

Healthcare – Out-patient Healthcare							
Time Period	Occupancy Schedule			Lighting Schedule		Equipment Schedule	
	Lobby	Diagnostic & Emergency	OPD & Back Office	Diagnostic & Emergency	OPD & Back Office	Diagnostic & Emergency	OPD & Back Office
	6 days/ week	6 days/ week	6 days/ week	6 days/ week	6 days/ week	6 days/ week	6 days/ week
00:00-01:00	0.00	0.00	0.00	0.10	0.00	0.00	0.00
01:00-02:00	0.00	0.00	0.00	0.10	0.00	0.00	0.00
02:00-03:00	0.00	0.00	0.00	0.10	0.00	0.00	0.00
03:00-04:00	0.00	0.00	0.00	0.10	0.00	0.00	0.00
04:00-05:00	0.00	0.00	0.00	0.10	0.00	0.00	0.00
05:00-06:00	0.00	0.00	0.00	0.10	0.00	0.00	0.00
06:00-07:00	0.00	0.20	0.20	0.10	0.10	0.00	0.00
07:00-08:00	0.10	0.20	0.20	0.50	0.30	0.50	0.00
08:00-09:00	0.50	0.30	0.20	0.90	0.90	0.95	0.95
09:00-10:00	0.80	0.90	0.90	0.90	0.90	0.95	0.95
10:00-11:00	0.80	0.90	0.90	0.90	0.90	0.95	0.95
11:00-12:00	0.80	0.90	0.90	0.90	0.90	0.95	0.95
12:00-13:00	0.80	0.90	0.50	0.90	0.90	0.95	0.95
13:00-14:00	0.80	0.90	0.20	0.90	0.50	0.95	0.95
14:00-15:00	0.80	0.90	0.50	0.90	0.90	0.95	0.95
15:00-16:00	0.80	0.90	0.90	0.90	0.90	0.95	0.95
16:00-17:00	0.80	0.90	0.90	0.90	0.90	0.95	0.95
17:00-18:00	0.80	0.90	0.90	0.90	0.95	0.95	0.95
18:00-19:00	0.80	0.90	0.50	0.90	0.95	0.95	0.95
19:00-20:00	0.80	0.90	0.50	0.90	0.30	0.95	0.95
20:00-21:00	0.20	0.65	0.20	0.90	0.30	0.80	0.80
21:00-22:00	0.20	0.20	0.20	0.50	0.20	0.00	0.00
22:00-23:00	0.00	0.00	0.00	0.30	0.00	0.00	0.00
23:00-24:00	0.00	0.00	0.00	0.10	0.00	0.00	0.00

Table 12.23 Schedules for Health -Out Patient Health Care Building (B)

Healthcare - Out-patient Healthcare							
Time Period	Elevator Schedule	HVAC Fan Schedule (On/Off)	External Lighting Schedule	Service Hot Water (SHW)		Basement Ventilation	Basement Lighting
		All Spaces		Building Summer	Building Winters		
	6 days/ week	6 days/ week	7 Days/ week	6 days/ week	6 days/ week	6 days/ week	6 days/ week
00:00-01:00	0.05	0	0.20	0.00	0.00	0.00	0.00
01:00-02:00	0.05	0	0.20	0.00	0.00	0.00	0.00
02:00-03:00	0.05	0	0.20	0.00	0.00	0.00	0.00
03:00-04:00	0.05	0	0.20	0.00	0.00	0.00	0.00
04:00-05:00	0.05	0	0.20	0.00	0.00	0.00	0.00
05:00-06:00	0.05	0	0.20	0.00	0.00	0.00	0.00
06:00-07:00	0.05	0	0.00	0.00	0.00	0.00	0.00
07:00-08:00	0.50	0	0.00	0.00	0.20	0.00	0.00
08:00-09:00	0.75	1	0.00	0.20	0.60	1.00	1.00
09:00-10:00	1.00	1	0.00	0.30	0.60	1.00	1.00
10:00-11:00	1.00	1	0.00	0.30	0.80	1.00	1.00
11:00-12:00	1.00	1	0.00	0.30	0.80	1.00	1.00
12:00-13:00	0.75	1	0.00	0.25	0.70	1.00	1.00
13:00-14:00	1.00	1	0.00	0.25	0.80	1.00	1.00
14:00-15:00	1.00	1	0.00	0.25	0.80	1.00	1.00
15:00-16:00	1.00	1	0.00	0.25	0.70	1.00	1.00
16:00-17:00	1.00	1	0.00	0.25	0.70	1.00	1.00
17:00-18:00	1.00	1	0.00	0.10	0.50	1.00	1.00
18:00-19:00	0.50	1	0.50	0.01	0.20	1.00	1.00
19:00-20:00	0.50	1	0.50	0.01	0.20	1.00	1.00
20:00-21:00	0.50	1	0.50	0.01	0.20	1.00	1.00
21:00-22:00	0.30	0	0.50	0.01	0.10	1.00	1.00
22:00-23:00	0.05	0	0.20	0.01	0.01	0.00	0.00
23:00-24:00	0.05	0	0.20	0.01	0.01	0.00	0.00

Table 12.24 Schedules for Educational School building (A)

Educational – School Building							
Time Period	Elevator Schedule	HVAC Fan Schedule (On/Off)			External Lighting Schedule	Basement Ventilation	Basement Lighting
		Student Area	Back Office	Corridor/ Lobby			
	7 Days/ week	5 Days/ week	5 Days/ week	5 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week
00:00-01:00	0.00	0	0	0	0.80	0.00	0.05
01:00-02:00	0.00	0	0	0	0.80	0.00	0.05
02:00-03:00	0.00	0	0	0	0.80	0.00	0.05
03:00-04:00	0.00	0	0	0	0.80	0.00	0.05
04:00-05:00	0.00	0	0	0	0.80	0.00	0.05
05:00-06:00	0.00	0	0	0	0.80	0.00	0.05
06:00-07:00	0.05	0	0	1	0.00	0.00	0.05
07:00-08:00	0.80	1	1	1	0.00	0.00	0.05
08:00-09:00	0.80	1	1	1	0.00	1.00	1.00
09:00-10:00	0.25	1	1	1	0.00	1.00	1.00
10:00-11:00	0.25	1	1	1	0.00	1.00	1.00
11:00-12:00	0.25	1	1	1	0.00	1.00	1.00
12:00-13:00	0.25	1	1	1	0.00	1.00	1.00
13:00-14:00	0.90	1	1	1	0.00	1.00	1.00
14:00-15:00	0.60	0	1	1	0.00	1.00	1.00
15:00-16:00	0.20	0	1	0	0.00	1.00	1.00
16:00-17:00	0.30	0	1	0	0.00	1.00	1.00
17:00-18:00	0.40	0	0	0	0.00	1.00	0.50
18:00-19:00	0.00	0	0	0	0.80	0.00	0.05
19:00-20:00	0.00	0	0	0	0.80	0.00	0.05
20:00-21:00	0.00	0	0	0	0.80	0.00	0.05
21:00-22:00	0.00	0	0	0	0.80	0.00	0.05
22:00-23:00	0.00	0	0	0	0.80	0.00	0.05
23:00-24:00	0.00	0	0	0	0.80	0.00	0.05

Table 12.25 Schedules for Educational School building (B)

Educational – School Buildings								
Time Period	Occupancy Schedule			Lighting Schedule			Equipment Schedule	
	Student Zone	Back Office	Corridor/ Lobby	Student Zone	Back Office	Corridor/ Lobby	Student Zone	Back Office
00:00-01:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01:00-02:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02:00-03:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03:00-04:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04:00-05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05:00-06:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06:00-07:00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00
07:00-08:00	0.70	0.00	0.90	0.90	0.70	0.90	0.35	0.35
08:00-09:00	0.90	0.90	0.20	0.90	0.90	0.50	0.95	0.95
09:00-10:00	0.90	0.90	0.20	0.90	0.90	0.50	0.95	0.95
10:00-11:00	0.90	0.90	0.20	0.90	0.90	0.50	0.95	0.95
11:00-12:00	0.20	0.90	0.90	0.20	0.90	0.90	0.20	0.95
12:00-13:00	0.90	0.90	0.20	0.90	0.90	0.50	0.95	0.95
13:00-14:00	0.90	0.20	0.50	0.90	0.30	0.50	0.95	0.40
14:00-15:00	0.00	0.90	0.90	0.00	0.90	0.90	0.00	0.95
15:00-16:00	0.00	0.90	0.50	0.00	0.90	0.90	0.00	0.95
16:00-17:00	0.00	0.90	0.50	0.00	0.90	0.50	0.00	0.95
17:00-18:00	0.00	0.50	0.00	0.00	0.30	0.00	0.00	0.25
18:00-19:00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00
19:00-20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20:00-21:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21:00-22:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22:00-23:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23:00-24:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 12.26 Schedules for Educational University building (A)

Educational – University Buildings									
Time Period	Elevator Schedule		HVAC Fan Schedule (On/Off)				External Lighting Schedule	Basement Ventilation	Basement Lighting
	Library & Comp. Centre	Student and Back office	Student Area	Back Office	Library & Comp. Centre	Corridor/ Lobby			
	7 days/ week	7 days/ week	5 days/ week	5 days/ week	7 days/ week	5 days/ week	7 days/ week	7 days/ week	7 days/ week
00:00-01:00	0.00	0.00	0	0	0	0	0.80	0.00	0.05
01:00-02:00	0.00	0.00	0	0	0	0	0.80	0.00	0.05
02:00-03:00	0.00	0.00	0	0	0	0	0.80	0.00	0.05
03:00-04:00	0.00	0.00	0	0	0	0	0.80	0.00	0.05
04:00-05:00	0.00	0.00	0	0	0	0	0.80	0.00	0.05
05:00-06:00	0.00	0.00	0	0	0	0	0.80	0.00	0.05
06:00-07:00	0.00	0.05	0	0	0	0	0.00	0.00	0.05
07:00-08:00	0.00	0.25	1	1	1	1	0.00	0.00	0.05
08:00-09:00	0.50	0.85	1	1	1	1	0.00	1.00	1.00
09:00-10:00	0.50	0.25	1	1	1	1	0.00	1.00	1.00
10:00-11:00	0.30	0.25	1	1	1	1	0.00	1.00	1.00
11:00-12:00	0.20	0.25	1	1	1	1	0.00	1.00	1.00
12:00-13:00	0.20	0.25	1	1	1	1	0.00	1.00	1.00
13:00-14:00	0.40	0.90	1	1	1	1	0.00	1.00	1.00
14:00-15:00	0.30	0.60	1	1	1	1	0.00	1.00	1.00
15:00-16:00	0.30	0.25	1	1	1	1	0.00	1.00	1.00
16:00-17:00	0.30	0.25	1	1	1	1	0.00	1.00	1.00
17:00-18:00	0.50	0.90	1	0	1	1	0.00	1.00	1.00
18:00-19:00	0.50	0.15	0	0	1	1	0.80	1.00	1.00
19:00-20:00	0.50	0.05	0	0	1	0	0.80	1.00	1.00
20:00-21:00	0.50	0.00	0	0	1	0	0.80	0.00	0.50
21:00-22:00	0.50	0.00	0	0	1	0	0.80	0.00	0.05
22:00-23:00	0.50	0.00	0	0	1	0	0.80	0.00	0.05
23:00-24:00	0.00	0.00	0	0	0	0	0.80	0.00	0.05

Table 12.27 Schedules for Educational University building (B)

Educational – University Buildings											
Time Period	Occupancy Schedule				Lighting Schedule				Equipment Schedule		
	Student Zone	Back Office	Library & Computer Centre	Corridor/ Lobby	Student Zone	Back Office	Library & Computer Centre	Corridor/ Lobby	Student Zone	Back Office	Library & Computer Centre
	5 Days/ week	5 Days/ week	7Days/ week	5 Days/ week	5 Days/ week	5 Days/ week	7 Days/ week	5 Days/ week	5 Days/ week	5 Days/ week	7 Days/ week
00:00-01:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10
01:00-02:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10
02:00-03:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10
03:00-04:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10
04:00-05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10
05:00-06:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10
06:00-07:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10
07:00-08:00	0.40	0.00	0.00	0.00	0.90	0.00	0.00	0.00	0.35	0.35	0.10
08:00-09:00	0.90	0.90	0.30	0.90	0.90	0.90	0.90	0.90	0.95	0.95	0.70
09:00-10:00	0.90	0.90	0.40	0.30	0.90	0.90	0.90	0.50	0.95	0.95	0.70
10:00-11:00	0.90	0.90	0.50	0.30	0.90	0.90	0.90	0.50	0.95	0.95	0.70
11:00-12:00	0.90	0.90	0.50	0.30	0.90	0.90	0.90	0.50	0.95	0.95	0.70
12:00-13:00	0.90	0.90	0.50	0.90	0.90	0.90	0.90	0.90	0.95	0.95	0.70
13:00-14:00	0.10	0.20	0.20	0.50	0.60	0.30	0.20	0.90	0.20	0.40	0.70
14:00-15:00	0.90	0.90	0.50	0.30	0.90	0.90	0.90	0.50	0.95	0.95	0.70
15:00-16:00	0.90	0.90	0.50	0.30	0.90	0.90	0.90	0.50	0.95	0.95	0.70
16:00-17:00	0.90	0.90	0.50	0.70	0.90	0.90	0.90	0.50	0.95	0.95	0.70
17:00-18:00	0.40	0.00	0.50	0.90	0.90	0.50	0.90	0.90	0.95	0.10	0.80
18:00-19:00	0.00	0.00	0.60	0.00	0.00	0.00	0.90	0.00	0.00	0.10	0.80
19:00-20:00	0.00	0.00	0.60	0.00	0.00	0.00	0.90	0.00	0.00	0.10	0.80
20:00-21:00	0.00	0.00	0.60	0.00	0.00	0.00	0.90	0.00	0.00	0.10	0.80
21:00-22:00	0.00	0.00	0.60	0.00	0.00	0.00	0.90	0.00	0.00	0.10	0.80
22:00-23:00	0.00	0.00	0.60	0.00	0.00	0.00	0.90	0.00	0.00	0.10	0.80
23:00-24:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00

Table 12.28 Schedules for Hospitality building (A)

Hospitality									
Time Period	Elevator Schedule		External Lighting Schedule	Service Hot Water (SHW)				Basement Ventilation	Basement Lighting
				Guest rooms		Kitchen	Laundry		
	Week Days	Weekends	7 Days/ week	Week Days	Weekends	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week
00:00-01:00	0.10	0.10	1.00	0.01	0.01	0.00	0.00	0.50	0.50
01:00-02:00	0.10	0.10	1.00	0.01	0.01	0.00	0.00	0.50	0.50
02:00-03:00	0.10	0.10	1.00	0.01	0.01	0.00	0.00	0.50	0.50
03:00-04:00	0.10	0.10	1.00	0.01	0.01	0.00	0.00	0.50	0.50
04:00-05:00	0.10	0.10	1.00	0.01	0.01	0.00	0.00	0.50	0.50
05:00-06:00	0.20	0.20	1.00	0.01	0.01	0.00	0.00	0.50	0.50
06:00-07:00	0.40	0.50	0.00	0.50	0.70	0.60	0.00	0.50	0.50
07:00-08:00	0.50	0.60	0.00	0.50	0.70	0.80	0.00	0.50	0.50
08:00-09:00	0.50	0.60	0.00	0.30	0.50	0.80	1.00	1.00	1.00
09:00-10:00	0.35	0.40	0.00	0.15	0.30	0.60	1.00	1.00	1.00
10:00-11:00	0.15	0.20	0.00	0.15	0.20	0.60	1.00	1.00	1.00
11:00-12:00	0.15	0.20	0.00	0.15	0.20	0.80	1.00	1.00	1.00
12:00-13:00	0.15	0.20	0.00	0.15	0.20	0.80	1.00	1.00	1.00
13:00-14:00	0.15	0.20	0.00	0.15	0.20	0.80	1.00	1.00	1.00
14:00-15:00	0.15	0.20	0.00	0.15	0.20	0.60	1.00	1.00	1.00
15:00-16:00	0.15	0.20	0.00	0.15	0.20	0.60	1.00	1.00	1.00
16:00-17:00	0.35	0.40	0.00	0.15	0.20	0.60	0.00	1.00	1.00
17:00-18:00	0.50	0.60	0.00	0.30	0.30	0.80	0.00	1.00	1.00
18:00-19:00	0.50	0.60	1.00	0.50	0.50	0.80	0.00	1.00	1.00
19:00-20:00	0.50	0.60	1.00	0.50	0.70	0.80	0.00	1.00	1.00
20:00-21:00	0.50	0.60	1.00	0.65	0.70	0.80	0.00	1.00	1.00
21:00-22:00	0.30	0.40	1.00	0.65	0.90	0.80	0.00	0.50	0.50
22:00-23:00	0.20	0.30	1.00	0.01	0.01	0.60	0.00	0.50	0.50
23:00-24:00	0.10	0.10	1.00	0.01	0.01	0.60	0.00	0.50	0.50

Table 12.29 Schedules for Hospitality building (B)

Hospitality - Occupancy												
Time Period	Occupancy Schedule											
	Guest Room		Lobby		Public Spaces		Restaurant		Back Office		Conference/ Banquet Room	Kitchen
	Week Days	Weekends	Week Days	Weekends	Week Days	Weekends	Week Days	Weekends	Week Days	Weekends	7 Days/ week	7 Days/ week
00:00-01:00	0.65	0.90	0.10	0.10	0.00	0.00	0.00	0.00	0.20	0.20	0.00	0.00
01:00-02:00	0.65	0.90	0.10	0.10	0.00	0.00	0.00	0.00	0.20	0.20	0.00	0.00
02:00-03:00	0.65	0.90	0.10	0.10	0.00	0.00	0.00	0.00	0.20	0.20	0.00	0.00
03:00-04:00	0.65	0.90	0.10	0.10	0.00	0.00	0.00	0.00	0.20	0.20	0.00	0.00
04:00-05:00	0.65	0.90	0.10	0.10	0.00	0.00	0.00	0.00	0.20	0.20	0.00	0.00
05:00-06:00	0.65	0.90	0.10	0.10	0.20	0.50	0.00	0.00	0.20	0.20	0.00	0.00
06:00-07:00	0.50	0.70	0.20	0.20	0.40	0.70	0.00	0.00	0.20	0.20	0.00	0.50
07:00-08:00	0.50	0.70	0.30	0.40	0.40	0.70	0.30	0.30	0.20	0.20	0.00	0.80
08:00-09:00	0.30	0.50	0.40	0.70	0.40	0.70	0.30	0.30	0.20	0.20	0.20	0.80
09:00-10:00	0.15	0.30	0.40	0.70	0.40	0.70	0.30	0.30	0.95	0.50	0.50	0.50
10:00-11:00	0.15	0.20	0.40	0.70	0.40	0.70	0.30	0.30	0.95	0.50	0.90	0.50
11:00-12:00	0.15	0.20	0.40	0.70	0.20	0.30	0.30	0.30	0.95	0.50	0.90	0.80
12:00-13:00	0.15	0.20	0.40	0.70	0.20	0.30	0.80	0.80	0.95	0.50	0.90	0.80
13:00-14:00	0.15	0.20	0.20	0.20	0.20	0.30	0.80	0.80	0.50	0.30	0.90	0.80
14:00-15:00	0.15	0.20	0.20	0.20	0.20	0.30	0.80	0.80	0.95	0.50	0.90	0.50
15:00-16:00	0.15	0.20	0.20	0.20	0.40	0.70	0.30	0.30	0.95	0.50	0.90	0.50
16:00-17:00	0.15	0.20	0.20	0.20	0.40	0.70	0.30	0.30	0.95	0.50	0.90	0.50
17:00-18:00	0.30	0.30	0.40	0.40	0.40	0.70	0.30	0.30	0.95	0.50	0.50	0.80
18:00-19:00	0.50	0.50	0.40	0.40	0.50	0.70	0.50	0.50	0.30	0.30	0.20	0.80
19:00-20:00	0.50	0.70	0.40	0.40	0.80	0.70	0.80	0.90	0.20	0.20	0.20	0.80
20:00-21:00	0.65	0.70	0.30	0.30	0.90	0.70	0.80	0.90	0.20	0.20	0.00	0.80
21:00-22:00	0.65	0.90	0.20	0.20	0.80	0.70	0.80	0.90	0.20	0.20	0.00	0.80
22:00-23:00	0.65	0.90	0.10	0.10	0.60	0.60	0.80	0.90	0.20	0.20	0.00	0.50
23:00-24:00	0.65	0.90	0.10	0.10	0.30	0.30	0.50	0.90	0.20	0.20	0.00	0.50

Table 12.30 Schedules for Hospitality building (C)

Hospitality – Lighting												
Time Period	Lighting Schedule											
	Guest Room		Lobby		Public Spaces		Restaurant		Back Office		Conference/ Banquet Room	Kitchen
	Week Days	Weekends	Week Days	Weekends	Week Days	Weekends	Week Days	Weekends	Week Days	Weekends	7 Days/ week	7 Days/ week
00:00-01:00	0.20	0.30	0.30	0.30	0.20	0.20	0.50	0.50	0.05	0.05	0.00	0.50
01:00-02:00	0.20	0.25	0.30	0.30	0.15	0.20	0.10	0.10	0.05	0.05	0.00	0.05
02:00-03:00	0.10	0.10	0.30	0.30	0.10	0.10	0.10	0.10	0.05	0.05	0.00	0.05
03:00-04:00	0.10	0.10	0.30	0.30	0.10	0.10	0.10	0.10	0.05	0.05	0.00	0.05
04:00-05:00	0.10	0.10	0.30	0.30	0.10	0.10	0.10	0.10	0.05	0.05	0.00	0.05
05:00-06:00	0.20	0.10	0.30	0.30	0.20	0.10	0.10	0.10	0.05	0.05	0.00	0.05
06:00-07:00	0.45	0.40	0.40	0.40	0.40	0.30	0.10	0.10	0.10	0.10	0.00	0.10
07:00-08:00	0.55	0.40	0.30	0.40	0.50	0.30	0.50	0.50	0.30	0.30	0.00	0.30
08:00-09:00	0.45	0.55	0.40	0.70	0.40	0.40	0.50	0.50	0.90	0.60	0.50	0.90
09:00-10:00	0.20	0.20	0.40	0.70	0.20	0.40	0.50	0.50	0.90	0.60	0.80	0.90
10:00-11:00	0.20	0.20	0.40	0.70	0.20	0.40	0.50	0.50	0.90	0.60	0.90	0.90
11:00-12:00	0.20	0.20	0.40	0.70	0.20	0.40	0.50	0.50	0.90	0.60	0.90	0.90
12:00-13:00	0.20	0.20	0.40	0.70	0.20	0.40	0.90	0.90	0.90	0.60	0.90	0.90
13:00-14:00	0.20	0.20	0.40	0.40	0.20	0.40	0.90	0.90	0.50	0.50	0.90	0.50
14:00-15:00	0.20	0.20	0.40	0.40	0.20	0.40	0.90	0.90	0.90	0.60	0.90	0.90
15:00-16:00	0.20	0.20	0.40	0.40	0.20	0.40	0.50	0.50	0.90	0.60	0.90	0.90
16:00-17:00	0.20	0.20	0.40	0.40	0.20	0.40	0.50	0.50	0.90	0.60	0.90	0.90
17:00-18:00	0.30	0.30	0.40	0.40	0.25	0.40	0.50	0.50	0.95	0.60	0.50	0.95
18:00-19:00	0.70	0.85	0.40	0.40	0.60	0.60	0.90	0.90	0.50	0.50	0.50	0.95
19:00-20:00	0.90	1.00	0.40	0.40	0.80	0.70	0.90	0.90	0.30	0.30	0.50	0.95
20:00-21:00	1.00	1.00	0.30	0.30	0.90	0.70	0.90	0.90	0.30	0.30	0.00	0.95
21:00-22:00	0.90	1.00	0.40	0.40	0.80	0.70	0.90	0.90	0.20	0.20	0.00	0.95
22:00-23:00	0.70	0.85	0.30	0.30	0.60	0.60	0.90	0.90	0.10	0.10	0.00	0.95
23:00-24:00	0.30	0.40	0.30	0.30	0.30	0.30	0.90	0.90	0.05	0.05	0.00	0.95

Table 12.30 Schedules for Hospitality building (D)

Hospitality – Equipment									
Time Period	Equipment Schedule								
	Guest Room		Public Spaces	Restaurant		Back Office		Conference/ Banquet Room	Kitchen
	Week Days	Weekends	7 Days/ week	Week Days	Weekends	Week Days	Weekends	7 Days/ week	7 Days/ week
00:00-01:00	0.20	0.20	0.30	0.50	0.50	0.05	0.05	0.00	0.30
01:00-02:00	0.20	0.20	0.20	0.00	0.00	0.05	0.05	0.00	0.10
02:00-03:00	0.20	0.20	0.20	0.00	0.00	0.05	0.05	0.00	0.10
03:00-04:00	0.20	0.20	0.20	0.00	0.00	0.05	0.05	0.00	0.10
04:00-05:00	0.20	0.20	0.20	0.00	0.00	0.05	0.05	0.00	0.10
05:00-06:00	0.20	0.20	0.30	0.00	0.00	0.05	0.05	0.00	0.10
06:00-07:00	0.30	0.30	0.50	0.00	0.00	0.05	0.05	0.00	0.30
07:00-08:00	0.40	0.60	0.50	0.60	0.60	0.10	0.10	0.00	0.30
08:00-09:00	0.70	0.90	0.50	0.60	0.60	0.30	0.30	0.50	0.30
09:00-10:00	0.20	0.20	0.50	0.60	0.60	0.95	0.70	0.50	0.30
10:00-11:00	0.20	0.20	0.35	0.60	0.60	0.95	0.70	0.90	0.30
11:00-12:00	0.20	0.20	0.35	0.60	0.60	0.95	0.70	0.90	0.30
12:00-13:00	0.20	0.20	0.35	0.80	0.80	0.95	0.70	0.90	0.30
13:00-14:00	0.20	0.20	0.35	0.80	0.80	0.50	0.70	0.90	0.30
14:00-15:00	0.20	0.20	0.35	0.80	0.80	0.95	0.70	0.90	0.30
15:00-16:00	0.20	0.20	0.35	0.60	0.60	0.95	0.70	0.90	0.30
16:00-17:00	0.20	0.20	0.35	0.60	0.60	0.95	0.70	0.90	0.30
17:00-18:00	0.30	0.30	0.35	0.60	0.60	0.95	0.70	0.50	0.30
18:00-19:00	0.50	0.50	0.70	0.80	0.80	0.30	0.30	0.50	0.30
19:00-20:00	0.50	0.50	0.90	0.80	0.90	0.10	0.10	0.50	0.30
20:00-21:00	0.50	0.70	0.90	0.80	0.90	0.10	0.10	0.00	0.30
21:00-22:00	0.70	0.70	0.90	0.80	0.90	0.10	0.10	0.00	0.30
22:00-23:00	0.40	0.40	0.70	0.80	0.90	0.05	0.05	0.00	0.30
23:00-24:00	0.20	0.20	0.40	0.80	0.90	0.05	0.05	0.00	0.30

Table 12.31 Schedules for Hospitality building (E)

Hospitality –HVAC Fan Schedules							
Time Period	HVAC Fan Schedule						
	Guest Room	Lobby	Public Spaces	Restaurants	Back Office	Conference/ Banquet Room	Kitchen
	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week
00:00-01:00	1	0	0	0	0	0	0
01:00-02:00	1	0	0	0	0	0	0
02:00-03:00	1	0	0	0	0	0	0
03:00-04:00	1	0	0	0	0	0	0
04:00-05:00	1	0	0	0	0	0	0
05:00-06:00	1	1	1	0	0	0	1
06:00-07:00	1	1	1	1	0	0	1
07:00-08:00	1	1	1	1	0	0	1
08:00-09:00	1	1	1	1	1	1	1
09:00-10:00	1	1	1	1	1	1	1
10:00-11:00	1	1	1	1	1	1	1
11:00-12:00	1	1	1	1	1	1	1
12:00-13:00	1	1	1	1	1	1	1
13:00-14:00	1	1	1	1	1	1	1
14:00-15:00	1	1	1	1	1	1	1
15:00-16:00	1	1	1	1	1	1	1
16:00-17:00	1	1	1	1	1	1	1
17:00-18:00	1	1	1	1	1	1	1
18:00-19:00	1	1	1	1	1	1	1
19:00-20:00	1	1	1	1	0	1	1
20:00-21:00	1	1	1	1	0	1	1
21:00-22:00	1	1	1	1	0	0	1
22:00-23:00	1	0	1	1	0	0	1
23:00-24:00	1	0	1	1	0	0	1

Table 12.32 Schedules for Shopping Complex building (A)

Shopping Complex								
Time Period	HVAC Fan Schedule (ON/OFF)			External Lighting Schedule	Basement Ventilation	Basement Lighting	Elevator Schedule	
	Retail	Corridor & Atrium	Special Zones					
	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	Weekdays	Weekends
00:00-01:00	0	0	0	1.00	1.00	1.00	0.20	0.20
01:00-02:00	0	0	0	0.50	0.00	0.05	0.05	0.20
02:00-03:00	0	0	0	0.50	0.00	0.05	0.05	0.05
03:00-04:00	0	0	0	0.50	0.00	0.05	0.05	0.05
04:00-05:00	0	0	0	0.50	0.00	0.05	0.05	0.05
05:00-06:00	0	0	0	0.50	0.00	0.05	0.05	0.05
06:00-07:00	0	0	0	0.00	0.00	0.05	0.05	0.05
07:00-08:00	0	0	0	0.00	0.00	0.05	0.10	0.10
08:00-09:00	0	0	0	0.00	0.00	0.05	0.10	0.10
09:00-10:00	0	1	1	0.00	1.00	1.00	0.20	0.20
10:00-11:00	1	1	1	0.00	1.00	1.00	0.40	0.40
11:00-12:00	1	1	1	0.00	1.00	1.00	0.70	0.70
12:00-13:00	1	1	1	0.00	1.00	1.00	0.70	0.80
13:00-14:00	1	1	1	0.00	1.00	1.00	0.70	0.95
14:00-15:00	1	1	1	0.00	1.00	1.00	0.70	0.95
15:00-16:00	1	1	1	0.00	1.00	1.00	0.70	0.95
16:00-17:00	1	1	1	0.00	1.00	1.00	0.70	0.95
17:00-18:00	1	1	1	0.00	1.00	1.00	0.80	0.95
18:00-19:00	1	1	1	1.00	1.00	1.00	0.80	0.95
19:00-20:00	1	1	1	1.00	1.00	1.00	0.80	0.95
20:00-21:00	1	1	1	1.00	1.00	1.00	0.80	0.95
21:00-22:00	0	1	1	1.00	1.00	1.00	0.80	0.80
22:00-23:00	0	1	1	1.00	1.00	1.00	0.50	0.60
23:00-24:00	0	1	1	1.00	1.00	1.00	0.30	0.40

Table 12.33 Schedules for Shopping Complex building (B)

Shopping Complex											
Time Period	Occupancy Schedule						Lighting Schedule			Equipment Schedule	
	Retail		Corridors & Atrium		Special Zone		Retail	Corridors & Atrium	Special Zone	Retail	Special Zone
	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week
00:00-01:00	0.00	0.00	0.00	0.10	0.00	0.00	0.05	0.05	0.05	0.05	0.05
01:00-02:00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.05	0.05	0.05
02:00-03:00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.05	0.05	0.05
03:00-04:00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.05	0.05	0.05
04:00-05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.05	0.05	0.05
05:00-06:00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.05	0.05	0.05
06:00-07:00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.05	0.05	0.05
07:00-08:00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.05	0.05	0.05
08:00-09:00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.05	0.05	0.50
09:00-10:00	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.05	0.50
10:00-11:00	0.40	0.40	0.40	0.40	0.20	0.20	0.50	0.50	0.40	0.90	0.90
11:00-12:00	0.60	0.60	0.60	0.60	0.30	0.50	0.95	0.50	0.60	0.90	0.90
12:00-13:00	0.60	0.70	0.60	0.70	0.50	0.70	0.95	0.50	0.60	0.90	0.90
13:00-14:00	0.60	0.90	0.60	0.90	0.50	0.70	0.95	0.50	0.60	0.90	0.90
14:00-15:00	0.70	0.90	0.70	0.90	0.50	0.70	0.95	0.50	0.60	0.90	0.90
15:00-16:00	0.70	0.90	0.70	0.90	0.50	0.80	0.95	0.50	0.40	0.90	0.90
16:00-17:00	0.70	0.90	0.70	0.90	0.50	0.80	0.95	0.70	0.40	0.90	0.90
17:00-18:00	0.70	0.90	0.70	0.90	0.50	0.80	0.95	0.95	0.40	0.90	0.90
18:00-19:00	0.90	0.95	0.90	0.95	0.60	0.95	0.95	0.95	0.80	0.90	0.90
19:00-20:00	0.90	0.95	0.90	0.95	0.60	0.95	0.95	0.95	0.80	0.90	0.90
20:00-21:00	0.90	0.95	0.90	0.95	0.60	0.95	0.95	0.95	0.80	0.50	0.90
21:00-22:00	0.00	0.00	0.40	0.40	0.60	0.95	0.05	0.50	0.80	0.05	0.90
22:00-23:00	0.00	0.00	0.30	0.30	0.60	0.95	0.05	0.30	0.80	0.05	0.90
23:00-24:00	0.00	0.00	0.10	0.10	0.30	0.95	0.05	0.30	0.80	0.05	0.90

12.34 Schedules for Shopping Complex buildings- Food court

Shopping Complex - Food Court												
Time Period	Occupancy Schedule			Lighting Schedule			Equipment Schedule			HVAC Fan Schedule		
	Family Dining	Food Preparation	Bar Lounge	Family Dining	Food Preparation	Bar Lounge	Family Dining	Food Preparation	Bar Lounge	Family Dining	Food Preparation	Bar Lounge
00:00-01:00	0.00	0.50	0.70	0.50	0.70	0.70	0.50	0.60	0.70	1	0	1
01:00-02:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
02:00-03:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
03:00-04:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
04:00-05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
05:00-06:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
06:00-07:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
07:00-08:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
08:00-09:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
09:00-10:00	0.00	0.20	0.00	0.00	0.50	0.00	0.00	0.60	0.00	0	0	0
10:00-11:00	0.20	0.50	0.00	0.50	0.70	0.00	0.60	0.70	0.00	0	1	0
11:00-12:00	0.20	0.80	0.00	0.50	0.90	0.00	0.60	0.70	0.00	1	1	0
12:00-13:00	0.70	0.80	0.00	0.90	0.90	0.00	0.80	0.70	0.00	1	1	0
13:00-14:00	0.70	0.80	0.00	0.90	0.90	0.00	0.80	0.70	0.00	1	1	0
14:00-15:00	0.70	0.80	0.00	0.90	0.90	0.00	0.80	0.70	0.00	1	1	0
15:00-16:00	0.20	0.50	0.00	0.50	0.70	0.00	0.60	0.40	0.00	1	1	0
16:00-17:00	0.20	0.30	0.00	0.50	0.50	0.00	0.60	0.40	0.00	1	1	1
17:00-18:00	0.20	0.30	0.50	0.50	0.50	0.70	0.60	0.40	0.70	1	1	1
18:00-19:00	0.50	0.50	0.70	0.90	0.70	0.80	0.80	0.40	0.70	1	1	1
19:00-20:00	0.80	0.90	0.80	0.90	0.90	0.80	0.80	0.70	0.70	1	1	1
20:00-21:00	0.80	0.90	0.80	0.90	0.90	0.80	0.80	0.70	0.70	1	1	1
21:00-22:00	0.80	0.90	0.80	0.90	0.90	0.80	0.80	0.70	0.70	1	1	1
22:00-23:00	0.80	0.90	0.80	0.90	0.90	0.80	0.80	0.70	0.70	1	1	1
23:00-24:00	0.50	0.50	0.80	0.90	0.90	0.80	0.80	0.40	0.70	1	1	1

Table 12.35 Schedules for Shopping Complex – strip reatial & Supermall Building

Strip Retail & Supermall										
Time Period	Occupancy Schedule		Lighting Schedule	Equipment Schedule	HVAC Fan Schedule (On/Off)	Elevator Schedule		External Lighting Schedule	Basement Ventilation	Basement Lighting
	Retail & Circulation		All Spaces	All Spaces						
	Weekdays	Weekends	7 Days/ week	7 Days/ week	7 Days/ week	Weekdays	Weekends	7 Days/ week	7 Days/ week	7 Days/ week
00:00-01:00	0.00	0.00	0.05	0.05	0	0.00	0.00	0.20	0.00	0.05
01:00-02:00	0.00	0.00	0.05	0.05	0	0.00	0.00	0.20	0.00	0.05
02:00-03:00	0.00	0.00	0.05	0.05	0	0.00	0.00	0.20	0.00	0.05
03:00-04:00	0.00	0.00	0.05	0.05	0	0.00	0.00	0.20	0.00	0.05
04:00-05:00	0.00	0.00	0.05	0.05	0	0.00	0.00	0.20	0.00	0.05
05:00-06:00	0.00	0.00	0.05	0.05	0	0.00	0.00	0.20	0.00	0.05
06:00-07:00	0.00	0.00	0.05	0.05	0	0.00	0.00	0.00	0.00	0.05
07:00-08:00	0.00	0.00	0.05	0.05	0	0.10	0.10	0.00	0.00	0.05
08:00-09:00	0.00	0.00	0.05	0.05	0	0.10	0.10	0.00	0.00	0.05
09:00-10:00	0.20	0.20	0.20	0.05	1	0.20	0.20	0.00	1.00	1.00
10:00-11:00	0.40	0.40	0.50	0.90	1	0.40	0.40	0.00	1.00	1.00
11:00-12:00	0.60	0.60	0.95	0.90	1	0.70	0.70	0.00	1.00	1.00
12:00-13:00	0.60	0.70	0.95	0.90	1	0.70	0.80	0.00	1.00	1.00
13:00-14:00	0.60	0.90	0.95	0.90	1	0.70	0.95	0.00	1.00	1.00
14:00-15:00	0.70	0.90	0.95	0.90	1	0.70	0.95	0.00	1.00	1.00
15:00-16:00	0.70	0.90	0.95	0.90	1	0.70	0.95	0.00	1.00	1.00
16:00-17:00	0.70	0.90	0.95	0.90	1	0.70	0.95	0.00	1.00	1.00
17:00-18:00	0.70	0.90	0.95	0.90	1	0.80	0.95	0.00	1.00	1.00
18:00-19:00	0.90	0.95	0.95	0.90	1	0.80	0.95	1.00	1.00	1.00
19:00-20:00	0.90	0.95	0.95	0.90	1	0.80	0.95	1.00	1.00	1.00
20:00-21:00	0.90	0.95	0.95	0.50	1	0.80	0.95	1.00	1.00	1.00
21:00-22:00	0.00	0.00	0.05	0.05	0	0.00	0.00	1.00	0.20	0.50
22:00-23:00	0.00	0.00	0.05	0.05	0	0.00	0.00	0.20	0.00	0.05
23:00-24:00	0.00	0.00	0.05	0.05	0	0.00	0.00	0.20	0.00	0.05

Appendix 1

A1. Default Values for Typical Constructions

A1.1 Procedure for Determining Fenestration Product U-factor and Solar Heat Gain Coefficient

Section 5.2.1-(a) and Section 5.2.1-(b) require that U-factors and solar heat gain coefficients (SHGC) be determined for the overall fenestration product (including the sash and frame) in accordance with ISO 15099.

In several cases, ISO 15099 suggests that individual national standards will need to be more specific and in other cases the ISO document gives users the choice of two options. This section clarifies these specific issues as they are to be implemented for this code:

(a) Section 4.1 of ISO 15099: For calculating the overall U-factor, ISO 15099 offers a choice between the linear thermal transmittance (4.1.2) and the area weighted method (4.1.3). The area weighted method (4.1.3) shall be used.

(b) Section 4.2.2 of ISO 15099: Frame and divider SHGC's shall be calculated in accordance with Section 4.2.2. The alternate approach in Section 8.6 shall not be used.

(c) Section 6.4 of ISO 15099 refers the issue of material properties to national standards. Material conductivities and emissivity shall be determined in accordance with Indian standards.

(d) Section 7 of ISO 15099 on shading systems is currently excluded.

(e) Section 8.2 of ISO 15099 addresses environmental conditions. The following are defined for India:

For U-factor calculations:

T_{in} = 24 °C
T_{out} = 32 °C
V = 3.35 m/s
$T_{rm,out}=T_{out}$
$T_{rm,in}=T_{in}$
I_s=0 W/m²
For SHGC calculations:
T_{in} = 24 °C
T_{out} = 32 °C
V = 2.75 m/s
$T_{rm,out}=T_{out}$
$T_{rm,in}=T_{in}$
I_s=783 W/m²

(f) Section 8.3 of ISO 15099 addresses convective film coefficients on the interior and exterior of the window product. In Section 8.3.1 of ISO 15099, simulations shall use the heat transfer coefficient based on the center of glass temperature and the entire window height; this film coefficient shall be used on all indoor surfaces, including frame sections. In Section 8.3.2 of ISO 15099, the formula from this section shall be applied to all outdoor exposed surfaces.

(g) Section 8.4.2 of ISO 15099 presents two possible approaches for incorporating the impacts of self-viewing surfaces on interior radiative heat transfer calculations. Products shall use the method in Section 8.4.2.1 of ISO 15099 (Two-Dimensional Element to Element View Factor Based Radiation Heat Transfer Calculation). The alternate approach in Section 8.4.3 of ISO 15099 shall not be used.

A1.2 Default U-factors, Visible Light Transmittance and Solar Heat Gain Coefficients for Unrated Fenestration Products

All fenestration with U-factors, SHGC, or visible light transmittance determined, certified, and labeled in accordance ISO 15099 shall be assigned those values.

A1.2.1 Unrated Vertical Fenestration.

For unrated vertical fenestration, both operable and fixed, the glass VLT reported by manufacturer must meet or exceed 0.37 (as it accounts for framing). The SHGC values reported by glass manufacturer must meet or exceed the Standardized requirements in Table 5-9, Table 5-10 and Table 5-11 for compliance.

U-factors for unrated vertical fenestration, both operable and fixed, shall be assigned as per Table A1.1.

Table A1.1: Defaults for Unrated Fenestration (Overall Assembly including the Sash and Frame)

Frame Type	*Glazing Type*	*U-Factor (W/m².K)*
All frame types	Single Glazing	7.1
Wood, vinyl, or fiberglass frame or metal frame with thermal break	Double Glazing (COG U value >1.6 W/m².K)	3.4
Wood, vinyl, or fiberglass frame or metal frame with thermal break	Double Glazing (COG U value <1.6 W/m².K)	3.0
Metal and other frame type	Double Glazing	5.1

A1.3 Typical Roof Constructions

For calculating the overall U-factor of a typical roof construction, the U-factors from the typical wall construction type and effective U-factor for insulation shall be combined according to the following equation:

$$U_{TotalRoof} = \frac{1}{\frac{1}{U_{TypicalRoof}} + \frac{1}{U_{TyipcalInsulation}}}$$

where

$U_{TotalRoof}$ Total U-factor of the roof with insulation

$U_{Typical\ Roof}$ U-factor of the roof

$U_{Typical\ Insulation}$ U-factor of the effective insulation

A1.4 Typical Wall Constructions

For calculating the overall U-factor of a typical wall construction, the U-factors from the typical wall construction type and effective U-factor for insulation shall be combined according to the following equation:

$$U_{TotalWall} = \frac{1}{\frac{1}{U_{TypicalWall}} + \frac{1}{U_{TyipcalInsulation}}}$$

where

$U_{TotalWall}$ Total U-factor of the wall with insulation

$U_{Typical\ Wall}$ U-factor of the wall

$U_{Typical\ Insulation}$ U-factor of the effective insulation

Table A1.2: Typical Thermal Properties of Common Building and Insulating Materials

Description	Density	Conductivity[b] k,	Resistance R,	Specific Heat,
	kg/m3	W/(m·K)	(m^2·K)/W	kJ/(kg·K)
Building Board and Siding				
Board				
Asbestos/cement board	1900	0.57	-	1
Cement board	1150	0.25	-	0.84
Fiber/cement board	1400	0.25	-	0.84
	1000	0.19	-	0.84
	400	0.07	-	1.88
	300	0.06	-	1.88
Gypsum or plaster board	640	0.16	-	1.15
Oriented strand board (OSB) 9 to 11 mm	650	-	0.11	1.88
Oriented strand board (OSB) 12.7 mm	650	-	0.12	1.88
Plywood (douglas fir) 12.7 mm	460	-	0.14	1.88
Plywood (douglas fir) 15.9 mm	540	-	0.15	1.88
Plywood/wood panels 19.0 mm	550	-	0.19	1.88
Vegetable fiber board				-
Sheathing, regular density[e] 12.7 mm	290	-	0.23	1.3
Intermediate density[e] .. 12.7 mm	350	-	0.19	1.3
Nail-base sheathing[e] 12.7 mm	400	-	0.19	1.3
Shingle backer 9.5 mm	290	-	0.17	1.3
Sound deadening board. 12.7 mm	240	-	0.24	1.26
Tile and lay-in panels, plain or acoustic	290	0.058	-	0.59
Laminated paperboard	480	0.072	-	1.38
Homogeneous board from repulped paper	480	0.072	-	1.17
Hardboard[e]				
Medium density	800	0.105	-	1.3
High density, service-tempered	880	0.12	-	1.34
Grade and service grade				
High density, standard-tempered grade	1010	0.144	-	1.34
Particleboard[e]				
Low density	590	0.102	-	1.3
Medium density	800	0.135	-	1.3
High density	1000	0.18	-	-
Underlayment 15.9 mm	640	-	1.22	1.21
Waferboard	700	0.072	-	1.88
Shingles				
Asbestos/cement	1900	-	0.37	-
Wood, 400 mm, 190 mm exposure	-	-	0.015	1.3
Wood, double, 400 mm, 300 mm exposure	-	-	0.21	1.17
Wood, plus ins. backer board 8 mm	-	-	0.25	1.3

Siding	-	-	-	-
Asbestos/cement, lapped 6.4 mm	-	-	0.037	1.01
Asphalt roll siding	-	-	0.026	1.47
Siding				
Asphalt insulating siding (12.7 mm bed)	-	-	0.26	1.47
Hardboard siding 11 mm	-	-	0.12	1.17
Wood, drop, 200 mm 25 mm	-	-	0.14	1.17
Wood, bevel 200 mm, lapped13 mm	-	-	0.14	1.17
Wood, bevel 250 mm, lapped19 mm	-	-	0.18	1.17
Wood, plywood, lapped 9.5 mm	-	-	0.1	1.22
Aluminum, steel, or vinyl,[j,k] over sheathing Hollow-backed	-	-	0.11	1.22
Aluminum, steel, or vinyl,[j,k] over sheathing Insulating-board-backed 9.5 mm	-	-	0.32	1.34
Aluminum, steel, or vinyl,[j,k] over sheathing Foil-backed 9.5 mm	-	-	0.52	-
Architectural (soda-lime float) glass	2500	1	-	0.84
Building Membrane				
Vapor-permeable felt	-	-	0.011	-
Vapor: seal, 2 layers of mopped 0.73 kg/m^2 felt	-	-	0.21	-
Vapor: seal, plastic film	-	-	Negligible	-
Finish Flooring Materials				
Carpet and rebounded urethane pad 19 mm	110	-	0.42	-
Carpet and rubber pad (one-piece) 9.5 mm	320	-	0.12	-
Pile carpet with rubber pad 9.5 to 12.7 mm	290	-	0.28	-
Linoleum/cork tile 6.4 mm	465	-	0.09	-
PVC/Rubber floor covering	-	0.4	-	-
Rubber tile 25 mm	1900	-	0.06	-
Terrazzo 25 mm	-	-	0.014	0.8
Insulating Materials				
Blanket and batt[c,d]				
Glass-fiber batts 85 to 90 mm	10 to 14	0.043	-	0.84
Glass-fiber batts 50 mm	8 to 13	0.045 to 0.048	-	0.84
Mineral fiber 140 mm	30	0.036	-	0.84
Mineral wool, felted	16 to 48	0.04	-	-
	65 to 130	0.035	-	-
Slag wool .	50 to 190	0.038	-	-
	255	0.04	-	-
	305	0.043	-	-
	350	0.048	-	-
	400	0.05	-	-
Board and slabs				
Cellular glass.	130	0.048	-	0.75
Cement fiber slabs, shredded wood with Portland cement binder	400 to 430	0.072 to 0.076	-	-
			-	
Cement fiber slabs, shredded wood with magnesia oxysulfide binder	350	0.082	-	1.3
Glass fiber board	160	0.032 to 0.040	-	0.84
Expanded rubber (rigid)	70	0.032	-	1.67
Expanded polystyrene extruded (smooth skin)	25 to 40	0.022 to 0.030	-	1.47

Expanded polystyrene, molded beads	15 to 25	0.032 to 0.039	-	1.47
Mineral fiberboard, wet felted	160	0.038	-	0.84
Mineral fiberboard, core or roof insulation	255 to 270	0.049	-	-
Mineral fiberboard, acoustical tile[g]	290	0.05	-	0.8
	335	0.053	-	-
Mineral fiberboard, wet-molded, acoustical tile.	370	0.061	-	0.59
Perlite board	160	0.052	-	-
Polyisocyanurate, aged unfaced	25 to 35	0.020 to 0.027	-	-
Polyisocyanurate, aged with facers	65	0.019	-	1.47
Phenolic foam board with facers, aged	65	0.019	-	-
Loose fill				
Cellulosic (milled paper or wood pulp)	35 to 50	0.039 to 0.045	-	1.38
Perlite, expanded	30 to 65	0.039 to 0.046	-	1.09
	65 to 120	0.045 to 0.052	-	-
	120 to 180	0.052 to 0.061	-	-
Mineral fiber (rock, slag, or glass)[d] approx. 95 to 130 mm	10 to 30	-	1.92	0.71
Mineral fiber (rock, slag, or glass)[d] approx. 170 to 220 mm	11 to 30	-	3.33	-
Mineral fiber (rock, slag, or glass)[d] approx. 190 to 250 mm	12 to 30	-	3.85	-
Mineral fiber (rock, slag, or glass)[d] approx. 260 to 350 mm	13 to 30	-	5.26	-
Mineral fiber (rock, slag, or glass)[d] 90 mm (closed sidewall application)	30 to 55	-	2.1 to 2.5	-
Vermiculite, exfoliated	110 to 130	0.068	-	1.34
	64 to 96	0.063	-	-
Spray-applied				
Cellulosic fiber	55 to 95	0.042 to 0.049	-	-
Glass fiber	55 to 70	0.038 to 0.039	-	-
Polyurethane foam (low density)	6 to 8	0.042	-	1.47
	40	0.026	-	1.47
Polyurethane foam (low density) aged and dry 40 mm	30	-	1.6	1.47
Polyurethane foam (low density) 50 mm	55	-	1.92	1.47
Polyurethane foam (low density) 120 mm	30	-	3.69	-
Ureaformaldehyde foam, dry	8 to 20	0.030 to 0.032	-	-
Roofing				
Asbestos/cement shingles	1120	-	0.037	1
Asphalt (bitumen with inert fill)	1600	0.43	-	-
	1900	0.58	-	-
	2300	1.15	-	-
Asphalt roll roofing	920	-	0.027	1.51
Asphalt shingles	920	-	0.078	1.26
Built-up roofing	920	-	0.059	1.47
Mastic asphalt (heavy, 20% grit)	950	0.19	-	-
Reed thatch	270	0.09	-	-
Roofing felt	2250	1.2	-	-
Slate 13 mm	-	-	0.009	1.26
Straw thatch	240	0.07	-	-
Wood shingles, plain and plastic-film-faced	-	-	0.166	1.3
Plastering Materials				
Cement plaster, sand aggregate	1860	0.72	-	0.84

Sand aggregate 10 mm	-	-	0.013	0.84
Sand aggregate 20 mm	-	-	0.026	0.84
Gypsum plaster	1120	0.38	-	-
	1280	0.46	-	-
Lightweight aggregate	720	-	0.056	-
Lightweight aggregate	720	-	0.066	-
Lightweight aggregate	-	-	0.083	-
Perlite aggregate	720	0.22	-	1.34
Sand aggregate	1680	0.81	-	0.84
Sand aggregate on metal lath 19 mm	-	-	0.023	-
Vermiculite aggregate	480	0.14	-	-
	600	0.2	-	-
	720	0.25	-	-
	840	0.26	-	-
	960	0.3	-	-
Perlite plaster	400	0.08	-	-
	600	0.19	-	-
Pulpboard or paper plaster	600	0.07	-	-
Sand/cement plaster, conditioned	1560	0.63	-	-
Sand/cement/lime plaster, conditioned	1440	0.48	-	-
Sand/gypsum (3:1) plaster, conditioned	1550	0.65	-	-
Masonry Materials				
Masonry units				
Brick, fired clay	2400	1.21 to 1.47	-	-
	2240	1.07 to 1.30	-	-
	2080	0.92 to 1.12	-	-
	1920	0.81 to 0.98	-	0.8
	1760	0.71 to 0.85	-	-
	1600	0.61 to 0.74	-	-
	1440	0.52 to 0.62	-	-
	1280	0.43 to 0.53	-	-
	1120	0.36 to 0.45	-	-
Clay tile, hollow 1 cell deep 75 mm	-	-	0.14	0.88
Clay tile, hollow 1 cell deep 100 mm	-	-	0.2	-
Clay tile, hollow 2 cells deep 150 mm	-	-	0.27	-
Clay tile, hollow 2 cells deep 200 mm	-	-	0.33	-
Clay tile, hollow 2 cells deep 250 mm	-	-	0.39	-
Clay tile, hollow 3 cells deep 300 mm	-	-	0.44	-
Lightweight brick	800	0.2	-	-
	770	0.22	-	-
Concrete blocks[h,i] Limestone aggregate ~200 mm, 16.3 kg, 2200 kg/m^3 concrete, 2 cores ..	-	-	-	-
Concrete blocks[h,i] Limestone aggregate ~200 mm, 16.3 kg, 2200 kg/m^3 concrete with perlite-filled cores	-	-	0.37	-
Concrete blocks[h,i] Limestone aggregate ~300 mm, 25 kg, 2200 kg/m^3 concrete, 2 cores	-		-	-
Normal-weight aggregate (sand and gravel)~200 mm, 16 kg, 2100 kg/m^3 concrete, 2 or 3 cores ..	-	-	0.20 to 0.17	0.92
Normal-weight aggregate (sand and gravel)~200 mm, 16 kg, 2100 kg/m^3 with perlite-filled cores	-	-	0.35	-

Normal-weight aggregate (sand and gravel)~200 mm, 16 kg, 2100 kg/m^3 with vermiculite-filled cores	-	-	0.34 to 0.24	-
Normal-weight aggregate (sand and gravel)~200 mm, 16 kg, 2100 kg/m^3 ~300 mm, 22.7 kg, 2000 kg/m^3 concrete, 2 cores ..	-	-	0.217	0.92
Medium-weight aggregate (combinations of normal and lightweight aggregate) ~200 mm, 13 kg, 1550 to 1800 kg/m^3 concrete, 2 or 3 cores	-	-	0.30 to 0.22	-
Medium-weight aggregate (combinations of normal and lightweight aggregate) ~200 mm, 13 kg, 1550 to 1800 kg/m^3 with perlite-filled cores	-	-	0.65 to 0.41	-
Medium-weight aggregate (combinations of normal and lightweight aggregate) ~200 mm, 13 kg, 1550 to 1800 kg/m^3 with vermiculite-filled cores	-	-	0.58	-
Medium-weight aggregate (combinations of normal and lightweight aggregate) ~200 mm, 13 kg, 1550 to 1800 kg/m^3 with molded-EPS-filled (beads) cores	-	-	0.56	-
Medium-weight aggregate (combinations of normal and lightweight aggregate) ~200 mm, 13 kg, 1550 to 1800 kg/m^3 with molded EPS inserts in cores	-	-	0.47	-
Low-mass aggregate (expanded shale, clay, slate or slag, pumice) ~150 mm, 7 1/2 kg, 1400 kg/m^{2}concrete, 2 or 3 cores	-	-	0.34 to 0.29	-
Low-mass aggregate (expanded shale, clay, slate or slag, pumice) ~150 mm, 7 1/2 kg, 1400 kg/m^{2}with perlite-filled cores	-	-	0.74	-
Low-mass aggregate (expanded shale, clay, slate or slag, pumice) ~150 mm, 7 1/2 kg, 1400 kg/m^{2}with vermiculite-filled cores	-	-	0.53	-
Low-mass aggregate (expanded shale, clay, slate or slag, pumice) 200 mm, 8 to 10 kg, 1150 to 1380 kg/m^2 concrete	-	-	0.56 to 0.33	0.88
Low-mass aggregate (expanded shale, clay, slate or slag, pumice) 200 mm, 8 to 10 kg, 1150 to 1380 kg/m^2 concrete with perlite-filled cores	-	-	1.20 to 0.77	-
Low-mass aggregate (expanded shale, clay, slate or slag, pumice) 200 mm, 8 to 10 kg, 1150 to 1380 kg/m^2 concrete with vermiculite-filled cores	-	-	0.93 to 0.69	-
Low-mass aggregate (expanded shale, clay, slate or slag, pumice) 200 mm, 8 to 10 kg, 1150 to 1380 kg/m^2 concrete with molded-EPS-filled (beads) cores	-	-	0.85	-
Low-mass aggregate (expanded shale, clay, slate or slag, pumice) 200 mm, 8 to 10 kg, 1150 to 1380 kg/m^2 concrete with UF foam-filled cores	-	-	0.79	-
Low-mass aggregate (expanded shale, clay, slate or slag, pumice) 200 mm, 8 to 10 kg, 1150 to 1380 kg/m^2 concrete with molded EPS inserts in cores	-	-	0.62	-
Low-mass aggregate (expanded shale, clay, slate or slag, pumice) 300 mm, 16 kg, 1400 kg/m^3,concrete, 2 or 3 cores	-	-	0.46 to 0.40	-
Low-mass aggregate (expanded shale, clay, slate or slag, pumice) 300 mm, 16 kg, 1400 kg/m^3,with perlite-filled cores	-	-	1.6 to 1.1	-
Low-mass aggregate (expanded shale, clay, slate or slag, pumice) 300 mm, 16 kg, 1400 kg/m^3,with vermiculite-filled cores	-	-	1	-
Stone, lime, or sand	2800	10.4	-	-
Quartzitic and sandstone	2560	6.2	-	-
	2240	3.46	-	-
	1920	1.88	-	0.88
Calcitic, dolomitic, limestone, marble, and granite	2880	4.33	-	-
	2560	3.17	-	-
	2240	2.31	-	-
	1920	1.59	-	0.88
	1600	1.15	-	-
Gypsum partition tile .75 by 300 by 760 mm, solid	-	-	0.222	0.79

Gypsum partition tile .4 cells	-	-	0.238	-
Gypsum partition tile .100 by 300 by 760 mm, 3 cells	-	-	0.294	-
Limestone	2400	0.57	-	0.84
	2600	0.93	-	0.84
Concretes				
Sand and gravel or stone aggregate concretes (concretes with >50% quartz or quartzite sand have conductivities in higher end of range)	2400	1.4 to 2.9	-	-
	2240	1.3 to 2.6	-	0.80 to 1.00
	2080	1.0 to 1.9	-	-
Low-mass aggregate or limestone concretes	1920	0.9 to 1.3	-	-
Low-mass aggregate or limestone concretes Expanded shale, clay, or slate; expanded slags ;cinders; pumice (with density up to 1600 kg/m^3); scoria (sanded concretes have conductivities in higher end of range)	1600	0.68 to 0.89	-	0.84
	1280	0.48 to 0.59	-	0.84
	960	0.30 to 0.36	-	-
	640	0.18	-	-
Gypsum/fiber concrete (87.5% gypsum, 12.5% wood chips)	800	0.24	-	0.84
Cement/lime, mortar, and stucco	1920	1.4	-	-
	1600	0.97	-	-
	1280	0.65	-	-
Perlite, vermiculite, and polystyrene beads	800	0.26 to 0.27	-	-
	640	0.20 to 0.22	-	0.63 to 0.96
	480	0.16	-	-
	320	0.12	-	-
Foam concretes	1920	0.75	-	-
	1600	0.6	-	-
	1280	0.44	-	-
	1120	0.36	-	-
Foam concretes and cellular concretes	960	0.3	-	-
	640	0.2	-	-
	320	0.12	-	-
Aerated concrete (oven-dried)	430 to 800	0.2	-	0.84
Polystyrene concrete (oven-dried)	255 to 800	0.37	-	0.84
Polymer concrete	1950	1.64	-	-
	2200	1.03	-	-
Polymer cement	1870	0.78	-	-
Slag concrete	960	0.22	-	-
	1280	0.32	-	-
	1600	0.43	-	-
	2000	1.23	-	-
Woods (12% moisture content)				
Hardwoods	-	-	-	1.63
Oak	660 to 750	0.16 to 0.18	-	-
Birch	680 to 725	0.17 to 0.18	-	-
Maple	635 to 700	0.16 to 0.17	-	-
Ash	615 to 670	0.15 to 0.16	-	-
Softwoods	-	-	-	1.63
Southern pine	570 to 660	0.14 to 0.16	-	-
Southern yellow pine	500	0.13	-	-
Eastern white pine	400	0.1	-	-

Douglas fir/larch	535 to 580	0.14 to 0.15	-	-
Southern cypress	500 to 515	0.13	-	-
Hem/fir, spruce/pine/fir	390 to 500	0.11 to 0.13	-	-
Spruce	400	0.09	-	-
Western red cedar	350	0.09	-	-
West coast woods, cedars	350 to 500	0.10 to 0.13	-	-
Eastern white cedar	360	0.1	-	-
California redwood	390 to 450	0.11 to 0.12	-	-
Pine (oven-dried)	370	0.092	-	1.88
Spruce (oven-dried)	395	0.1	-	1.88

[a]Values are for mean temperature of 24°C. Representative values for dry materials are intended as design (not specification) values for materials in normal use. Thermal values of insulating materials may differ from design values depending on in-situ properties (e.g., density and moisture content, orientation, etc.) and manufacturing variability. For properties of specific product, use values supplied by manufacturer or unbiased tests.
[b]Symbol λ also used to represent thermal conductivity.
[c]Does not include paper backing and facing, if any. Where insulation forms boundary (reflective or otherwise) of airspace
[d]Conductivity varies with fiber diameter. Batt, blanket, and loose-fill mineral fiber insulations are manufactured to achieve specified R-values, the most common of which are listed in the table. Because of differences in manufacturing processes and materials, the product thicknesses, densities, and thermal conductivities vary over considerable ranges for a specified R-value.
[e]Values are for aged products with gas-impermeable facers on the two major surfaces. An aluminum foil facer of 25 μm thickness or greater is generally considered impermeable to gases. For change in conductivity with age of expanded polyisocyanurate.
[f]Cellular phenolic insulation may no longer be manufactured. Thermal conductivity and resistance values do not represent aged insulation, which may have higher thermal conductivity and lower thermal resistance.
[g]Insulating values of acoustical tile vary, depending on density of board and on type, size, and depth of perforations.
[h]Values for fully grouted block may be approximated using values for concrete with similar unit density.
[i]Values for concrete block and concrete are at moisture contents representative of normal use.
[j]Values for metal or vinyl siding applied over flat surfaces vary widely, depending on ventilation of the airspace beneath the siding; whether airspace is reflective or nonreflective; and on thickness, type, and application of insulating backing-board used. Values are averages for use as design guides, and were obtained from several guarded hot box tests (ASTM *Standard* C236) or calibrated hot box (ASTM *Standard* C976) on hollow-backed types and types made using backing of wood fiber, foamed plastic, and glass fiber. Departures of ±50% or more from these values may occur.
[k]Vinyl specific heat = 1.0 kJ/(kg·K)
[l]See Adams (1971), MacLean (1941), and Wilkes (1979). Conductivity values listed are for heat transfer across the grain. Thermal conductivity of wood varies linearly with density, and density ranges listed are those normally found for wood species given. If density of wood species is not known, use mean conductivity value. For extrapolation to other moisture contents, the following empirical equation developed by Wilkes (1979) may be used:

$$k = 0.1791 + \frac{(1.874 \times 10^{-2} + 5.733 \times 10^{-4} M)\rho}{1 + 0.01 M}$$

where ρ is density of moist wood in kg/m3, and M is moisture content in percent.
[m]From Wilkes (1979), an empirical equation for specific heat of moist wood at 24°C is as follows:

$$C_p = \frac{(0.299 + 0.01 M)}{(1 + 0.01 M)} + \Delta C_p$$

where Δc_p accounts for heat of sorption and is denoted by

$$\Delta C_p = M(1.921 \times 10^{-3} - 3.168 \times 10^{-5} M)$$

where M is moisture content in percent by mass.
[n]Blank space in reference column indicates historical values from previous volumes of *ASHRAE Handbook*. Source of information could not be determined.

Appendix 2

A2. Climate Zone Map of India

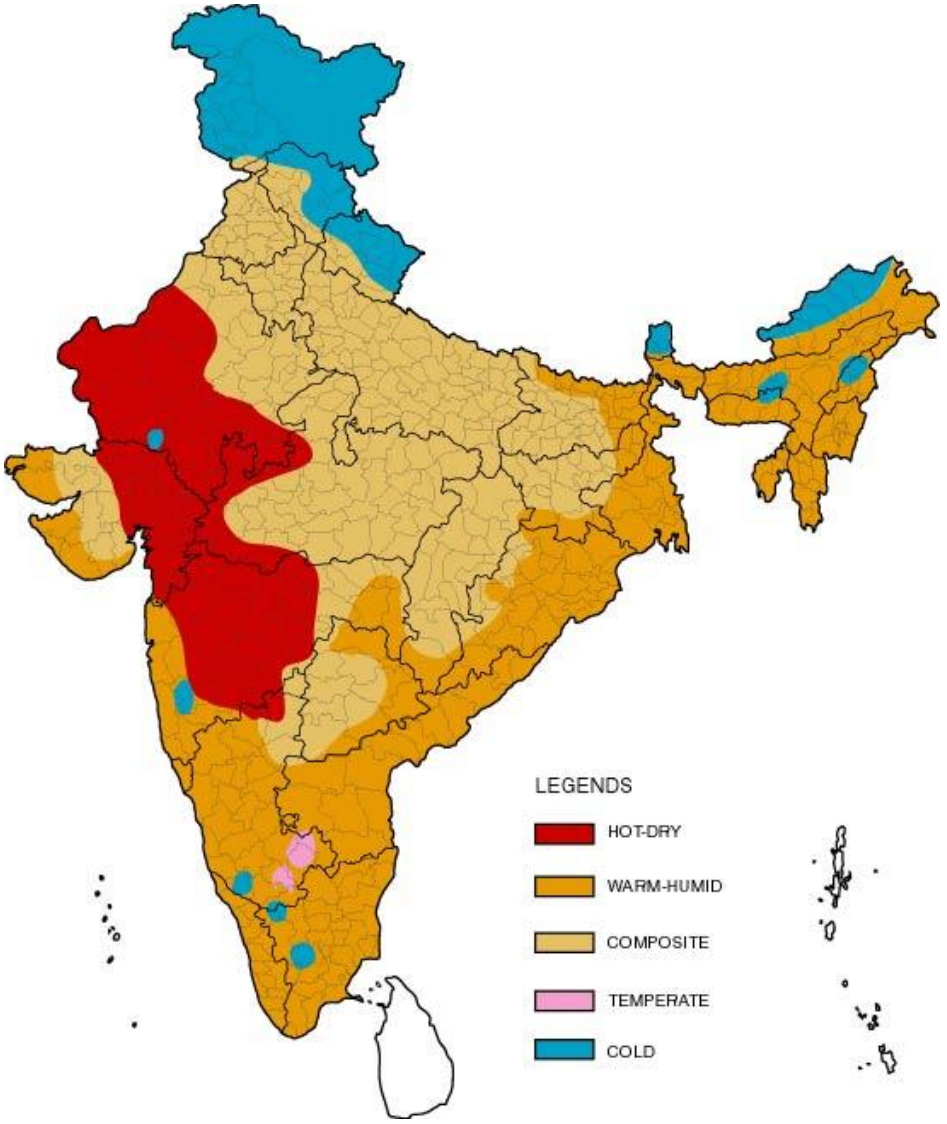


Table A2.1 Climate Zone for Major Indian Cities

City	Climate Type	City	Climate Type
Ahmedabad	Hot & Dry	Kurnool	Warm & Humid
Allahabad	Composite	Leh	Cold
Amritsar	Composite	Lucknow	Composite
Aurangabad	Hot & Dry	Ludhiana	Composite
Bangalore	Temperate	Chennai	Warm & Humid
Barmer	Hot & Dry	Manali	Cold
Belgaum	Warm & Humid	Mangalore	Warm & Humid
Bhagalpur	Warm & Humid	Mumbai	Warm & Humid
Bhopal	Composite	Nagpur	Composite
Bhubaneshwar	Warm & Humid	Nellore	Warm & Humid
Bikaner	Hot & Dry	New Delhi	Composite
Chandigarh	Composite	Panjim	Warm & Humid
Chitradurga	Warm & Humid	Patna	Composite
Dehradun	Composite	Pune	Warm & Humid
Dibrugarh	Warm & Humid	Raipur	Composite
Guwahati	Warm & Humid	Rajkot	Composite
Gorakhpur	Composite	Ramgundam	Warm & Humid
Gwalior	Composite	Ranchi	Composite
Hissar	Composite	Ratnagiri	Warm & Humid
Hyderabad	Composite	Raxaul	Warm & Humid
Imphal	Warm & Humid	Saharanpur	Composite
Indore	Composite	Shillong	Cold
Jabalpur	Composite	Sholapur	Hot & Dry
Jagdelpur	Warm & Humid	Srinagar	Cold
Jaipur	Composite	Sundernagar	Cold
Jaisalmer	Hot & Dry	Surat	Hot & Dry
Jalandhar	Composite	Tezpur	Warm & Humid
Jamnagar	Warm & Humid	Tiruchirappalli	Warm & Humid
Jodhpur	Hot & Dry	Trivandrum	Warm & Humid
Jorhat	Warm & Humid	Tuticorin	Warm & Humid
Kochi	Warm & Humid	Udhagamandalam	Cold
Kolkata	Warm & Humid	Vadodara	Hot & Dry
Kota	Hot & Dry	Veraval	Warm & Humid
Kullu	Cold	Vishakhapatnam	Warm & Humid

Appendix 3

A3. Air-Side Economizer Acceptance Procedures

A3.1 Construction Inspection

Prior to Performance Testing, verify and document the following:

a. System controls are wired correctly to ensure economizer is fully integrated (i.e. economizer will operate when mechanical cooling is enabled).
b. Economizer lockout control sensor location is adequate (open to air but not exposed to direct sunlight nor in an enclosure; away from sources of building exhaust; at least 8 meters away from cooling towers).
c. System is provided with barometric relief, relief fan or return fan to control building pressure.

A3.2 Equipment Testing

Step 1: Simulate a cooling load and enable the economizer by adjusting the lockout control set point. Verify and document the following:

a. Economizer damper modulates opens to 100% outside air.
b. Return air damper modulates closed and is completely closed when economizer damper is 100% open.
c. Economizer damper is 100% open before mechanical cooling is enabled.
d. Relief fan or return fan (if applicable) is operating or barometric relief dampers freely swing open.

Step 2: Continue from Step 1 and disable the economizer by adjusting the lockout control set point. Verify and document the following:

a. Economizer damper closes to minimum ventilation position.
b. Return air damper opens to at or near 100%.
c. Relief fan (if applicable) shuts off or barometric relief dampers close. Return fan (if applicable) may still operate even when economizer is disabled.

Appendix 4

A4. Controls And Internet of Things

A4.1 General Requirement

Internet of Things (IoT) offers a wide array of benefits, ranging from improved energy efficiency and sustainability, enhanced occupant comfort, predictive maintenance and asset management, safety and security, and data driven decision making. Various ways in which Control Systems and IoT can revolutionize buildings, making them smarter, more efficient, and ultimately, more liveable are covered in this section. Buildings shall comply with mandatory requirements as per Clause A4.2 and prescriptive requirements as per Clause 13.3 respectively.

A4.2 Mandatory Requirements

The compliance level for ECSBC, ECSBC+ and ECSBC Super shall be as defined in A4.2.1, A4.2.2 and A4.2.3.

A4.2.1 Controls requirements at Equipment level and System Level

To comply with the code, ECSBC and ECSBC+ Compliant buildings shall meet the requirements of a) to c) as given below:

a. *Equipment Level* stand-alone control and monitoring shall be provided for the equipment as specified in clause 5.2.3.1 to 5.2.3.6 of Section 5 on Comfort & Controls. Basement ventilation system and demand control ventilation system shall also comply with clause 5.2.1.2 and 5.2.1.3 of chapter 5.
b. *Equipment level* stand-alone monitoring of lighting, energy and water parameters shall be provided for all utilities. (Refer to chapter 7, chapter 8 and chapter 9 respectively).
c. *System Level* stand-alone control and monitoring shall be provided for groups of chilled water pumps, supply and extract fans with pressure sensor varying the speed of the equipment.

In addition to meeting the requirements of ECSBC & ECSBC+ buildings, ECSBC Super compliant buildings shall have networked controllers to enable use the control and monitoring parameters from a computer workstation or Server for system improvements. Table A4.1 defines compliance requirement for significant components of building.

Table A4-1: Controls compliance requirement for significant components of building

Sl. No	Application	Control & Monitoring Level	Equipment / System	Control / Monitoring for ECSBC	Control / Monitoring for ECSBC +	Control / Monitoring for ECSBC Super
1	Comfort & Controls	Equipment Level	DX IDU/ODU	Stand Alone	Stand Alone	Stand Alone
2	Comfort & Controls	Equipment Level	DX VRF	Stand Alone	Stand Alone	Provide networked controllers
3	Comfort & Controls	Equipment Level	CHW FCU	Stand Alone	Individual Timeclock Control using Controller	Provide networked controllers
4	Comfort & Controls	Equipment Level	CHW AHU	Stand Alone	Individual Timeclock Control using Programmable Controller	Provide networked controllers
5	Comfort & Controls	Equipment Level	CHW Pumping	Stand Alone	Provide group controls for all the pumps	Provide networked controllers

6	Comfort & Controls	Equipment Level	Cooling Tower Fan	Stand Alone	Stand Alone - as per Chapter 5	Provide networked controllers
7	Comfort & Controls	Equipment Level	Extract Fan	Stand Alone	Stand Alone	Provide networked controllers
8	Comfort & Controls	Equipment Level	Pressure Control (Air side)	Stand Alone	Stand Alone	Provide networked controllers
9	Comfort & Controls	Equipment Level	CT Level Control	Stand Alone	Stand Alone	Provide networked controllers
10	Comfort & Controls	Equipment Level	Basement Ventilation	Stand Alone - as per Chapter 5	Stand Alone - as per Chapter 5	Provide networked controllers with all monitoring points in the dashboard screens
11	Comfort & Controls	Equipment Level	Energy Recovery (Airside)	Stand Alone - as per Chapter 5	Stand Alone - as per Chapter 5	Provide networked controllers
12	Comfort & Controls	System Level	CHW Pumping	Stand Alone	Stand Alone	Provide networked controllers
13	Comfort & Controls	System Level	Variable Air Volume	Stand Alone	Stand Alone	Provide networked controllers
14	Comfort & Controls	System Level	Pressure Control	Stand Alone	Stand-alone	Provide networked controllers
15	Comfort & Controls	System Level	Demand Control Ventilation	Stand Alone as detailed in Chapter 5	Stand Alone as detailed in Chapter 5	Provide networked controllers
16	Comfort & Controls	System Level	Economizer	Provide controls as per Chapter 5	Provide controls as per Chapter 5	Provide networked controllers
17	Comfort & Controls	System Level	Chillers & Chiller Plant Control	Chiller Plant Control as per Chapter 5 details	Chiller Plant Control as per Chapter 5 details	Provide networked controllers with data for analysis
18	Lighting	Equipment Level	Lux level control	as per details given in Section 6	as per details given in section 6	as per details given in section 6
19	Lighting	System Level	Lighting Management System (LMS)	-	-	Integrate LMS with BMS; share occupancy/unoccupancy mode data; based on based on which, VAVs to switch to occupied/unoccupied modes
20	Electrical &	Equipment Level	Transformer	-	-	Monitor healthy

	Vertical Transportation		s, Breakers, VHT			status of the equipment
21	Electrical & Vertical Transportation	Equipment Level	Energy Meters	Record energy value at all meters for monitoring purposes for all utilities	Digitally connect all utility energy meters; track energy consumption for analysis	Digitally connect all utility energy meters; track power and energy consumption data for analysis
22	Electrical & Vertical Transportation	System Level	Building Level	-	Comply as per Clause 13.3.9.b.i	Comply as per Clause 13.3.9.b.ii
23	Water Management	Unit/Equipment Level	PHE Equipment	Provide stand-alone control for equipment functioning as per Section 8 on Water Management	Provide stand-alone control for equipment functioning as per Section 8 on Water Management	Track parameters at the dashboards
24	Water Management	Equipment Level	STP System	Stand-alone control	Stand-alone control	Track parameters at the dashboards
25	Water Management	Equipment Level	Water Meters	Recording of Water Consumption data;	Recording of Water Consumption data;	Recording and trending of water consumption data
NOTE: DETAILS OF FOR ABBREVIATIONS MENTIONED IN COLUMN UNDER EQUIPMENT/SYSTEM ARE PROVIDED IN TABLE 13.2						

Appendix 5

A5 Commissioning of Building Systems

A5.1 General

Structured methodology for Commissioning of various systems in a building Systems is essential to ensure that all systems, sub systems and equipment perform optimally to meet the design requirements and necessary documentation is provided and adequate training on operation and maintenance is imparted to the designated personnel.

NOTE: This section does not define:

a) Equipment or system performance levels
b) Specific technical requirement of commissioning of each building system or equipment.
c) Scope of commissioning of a specific building may vary depending on the project size, complexity, specific requirements of the owner/end user or the local regulatory Authority Having Jurisdiction (AHJ). However, this code defines the process which has to be followed in each and every case.

A5.1.1 Applicability

The provisions of this section are voluntary and shall apply to all building typologies covered by the code and across all climatic zones whose built up area (excluding any non-air-conditioned basements) exceed 5000m2.

The following building systems, if present in the specific building under consideration) shall require to follow the commissioning process as set out in this section.

a) Building Envelope Systems.
b) Electrical systems including power receiving and distribution as well as Stand by Generation / On site generation systems.
c) On-site renewable energy systems.
d) Water supply and drainage systems including pumping systems and hot water generation/distribution systems.
e) Water and Sewage water treatment and recycling systems.
f) Heating, ventilation and Air Conditioning systems.
g) Vertical transportation systems.
h) Solid waste handling, management and disposal systems.
i) Building management and Building Automation Systems.
j) Lighting systems (both internal and external) including dimming systems

NOTE: The fire, life safety and disaster management requirements shall conform the local regulations.

A5.2 Requirements for ECSBC Buildings

The compliance level for ECSBC, ECSBC+ and Super ECSBC shall be as defined in A5.2.1, A5.2.2 and A5.2.3.

A5.2.1 Owner Project Requirements (OPR) shall be developed by the owner with inputs from architects and all other members of the design team.

A5.2.2 Based on the OPR and the scope of the building project, owner shall develop the Commissioning Plan for each of the building systems applicable to the project.

A5.2.3 Commissioning plan, at a minimum, shall include the following in respect of each of the building systems:

a) Commissioning process overview
b) Construction checklists for all equipment and subsystems
c) Test procedures for each equipment, sub system and system
d) The Commissioning Plan shall assign clear responsibility to the agency who will perform each test and record the result as well as the agency who will approve the test result as satisfactory. for test procedure shall assign clear responsibility of the team for each test.
e) Building shall have a Building Management System which will bring all parameters regarding power and water consumption to a common dashboard to enable monitoring and control.

Appendix 6

A6. Sustainable Materials

A6.1 General

ECSBC requires the buildings to report the embodied carbon in kgCO2-eq/Sqm. The reporting of the embodied carbon is limited to the A1-A3 life stage as defined in EN 15978.

A6. 2 Purpose

The purpose of reporting embodied carbon as part of the Energy Conservation and Sustainable Building Code is to disclose the initial embodied carbon emissions from the building construction materials used in commercial buildings in India.

NOTE: This provision is voluntary disclosure of embodied carbon emissions.

A6.3 Scope

a. Applicable to all buildings under the purview of ECSBC
b. Applicable to building materials used in structural systems and building envelop systems namely all kinds of foundations, retaining walls, substructure as part of the structural system, superstructure such as but not limited to beams, columns, sheer walls, opaque and non-opaque structural and non-structural external walls, structure for mezzanine floors and loft floors, floors, ceilings, roofs, staircases and ramps, fenestration such windows, skylights and ventilation openings.

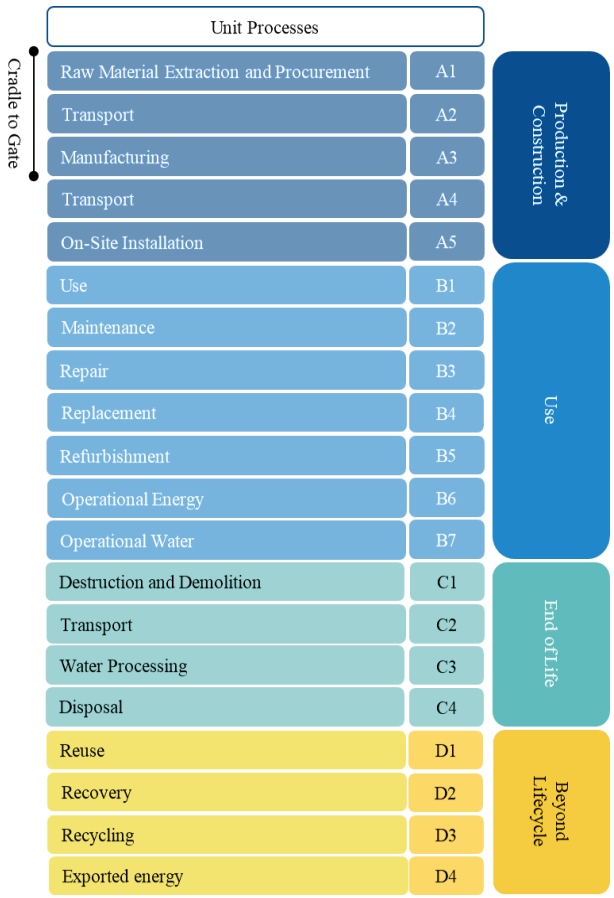
A6.4 Exclusions

The approach does not include materials used in electro-mechanical systems, plumbing systems, firefighting systems, elevators, finishing materials including wall, floor and ceiling finishes, or any other kind of non-structural elements such as railings, parapet walls, or built-in furniture.

A6.5 Definition

Please refer to EN 15978 for the definitions.
Stages of assessment (as per EN 15978) CEN 2011.

Product (A1-A3): The boundary for modules A1 to A3 covers the 'cradle to gate' processes for materials used in the building. These numbers are typically declared as a sum of A1 to A3 by the manufacturers. Building developers can ask for these numbers when choosing a building material. These numbers should be in accordance with EN 15804. (CEN, 2019)



A6.6 Method of calculation

Annexure-A contains the Comma Separated Value (CSV) Spreadsheet format. The fulfilment of

Annexure-A requirements should be demonstrated by reporting all the data required in the format.	Please refer attached Tables.

Table A6.1 Introduction

For Embodied Energy Data Collection:
Applicable to building materials used in structural systems and building envelop systems, namely all kinds of foundations, retaining walls, substructures as part of the structural system, super structures such as but not limited to beams, columns, sheer walls, opaque and non-opaque structural and non-structural external walls, structure for mezzanine floors and loft floors, floors, ceilings, roofs, staircases and ramps, fenestration such windows, skylights and ventilation openings.
The project for ECSBC compliance shall gather primary data for embodied energy of construction materials including but not limited to the ones mentioned in the sheets. The system boundary is Cradle to Gate, i.e., unit processes A1 to A3. The data for the same is required to be entered in sheets 'A1',' A2', and 'A3'.

Table A6.2 Introduction

For Site Selection:
Site: refers to a Project/Site. It may comprise one or more buildings.
Building: refers to an individual building block of the Site.
The availability of Bill of Quantities (BoQ) and material supplier details is a must.
This annual projected electricity data as reported for ECSBC Compliance.

Table A6.3 Details

Sheet Name	Description
Building Information	Sheet that contains background details of the selected building(s). An example has been presented in the sheet.
BoQ	Bill of Quantities: Sheet meant for recording quantities of construction materials. In this sheet, the BoQ of multiple Sites may be entered in adjacent columns. For example, BoQ details of S1_B1 can be added in columns B to I, and S2_B1 can be added in columns J to Q and so on.
A1 Extraction and Procurement	Sheet for entering embodied energy/carbon attributed to 'Raw material extraction and procurement'
A2 Transport	Sheet for entering embodied energy/carbon attributed to 'Transport to manufacturing plant'
A3 Manufacturing	Sheet for entering embodied energy/carbon attributed to 'Manufacturing'
Sum of A1 to A3	Sheet for presenting total embodied energy/carbon for stages A1 to A3. This sheet contains tow categories of resultant embodied energy/carbon: a) it may be calculated using the data gathered in sheets A1 to A3 if data of that granularity is available), b) it may be directly obtained from the manufacturer (if data of individual unit process granularity is not available).
Building_ELE_CON	Sheet for recording the annual electricity consumption of the building
Prominent Manufacturers	Sheet for recording the dominant companies/manufacturers in that region. This may help when the material source is unknown and it is safe to assume that it may be from the companies having the highest market penetration.
Validation Tables	Sheet contains background information used for creating drop downs for certain columns

Table A6.4 Details

Concerned Sheet	Column Headers	Description	Data Type
All		**Site**: refers to an Affordable Housing Project/Site. It may comprise one or more buildings	
All		**Building**: refers to an individual building block of the Site	
Building Information	Address	Refers to the Address of the selected Building and Site	
	Nomenclature	Refers to the alphanumeric nomenclature assigned to the selected Building. It is in the format "XYZ_S1_B1", "XYZ_S2_B1", where XYZ is the Airport code / nearest Airport code, S1 indicates the Site ID, and B1 refers to the selected building from that Site. As of now, we are targeting one Building from each Site. In case of design variations across different Buildings belonging to the same Site, more than one buildings may be selected	
	Latitude	Refers to the latitude of the selected Site	
	Longitude	Refers to the longitude of the selected Site	
	No. of floors in the building	Indicates the number of floors in the building. If the building has: a) only ground floor, please enter G b) more than one floor, and there are built up spaces on the ground floor, please enter G+ no of floors c) more than one floor on top of a stilt parking, please enter S+ no of floors	
	Bill of Quantity (BoQ) Available	Indicates the availability of Bill of Quantities data. Data for this column shall be selected from the drop down. If the BoQ of all the materials within the study's scope is available, then please select "Yes-Fully Available"; if the data for any material(s) is unavailable then select "Yes-Partly Available"; and if no BoQ data is available then select "Not Available"	
	BoQ data source	Indicates the source from which the BoQ data has been obtained. Please select from the available options mentioned in the drop down: Material Supplier Contractor/Designer Owner (refers to the owner of the building) Tender Document Government DPR Architectural Drawings	
	Make and Model Details Available	Indicates the availability of Make and Model related data of construction materials. Here, Make refers to the material manufacturer and Model refers to the specific product details. Data for this column shall be selected from the drop down. If the details of all the materials within the study's	

		scope are available, then please select "Yes-Fully Available"; if the data for any material(s) is unavailable then select "Yes-Partly Available"; and if no BoQ data is available then select "Not Available"	
	Make and Model data Source	Indicates the source from which the material-related data has been obtained. Please select from the available options mentioned in the drop down: Material Supplier Contractor/Designer Owner Tender Document Government DPR Architectural Drawings	
	Building Drawings	Indicates the availability of architectural drawings for the Building. Data shall be selected from the drop down list having the following options: Yes-Fully Available Yes-Partly Available Not Available	
	Building Layout (file)	This cell contains the link to the digital file of architectural drawings of the selected Building. The file may be ".dwg" or in image format. Please upload image/cad file of layout over Gdrive folder and paste link here	
	Built up area (sq. m)	Indicates the built up area of the building. In case more than one building configurations exist in the same site, please add its built up area in the next column.	
	Sr. no.	For this sheet, the materials have been segregated into Concrete, Steel, Walling Materials and so on, and have been numbered from 1 to 7. Update this sheet with more material, in their respective categories, as and when information of Sites becomes available.	
BoQ	Material	Provides the list of construction materials that are formed by one or more 'Raw Components'. For example, concrete is a material which is made up of cement, sand, and aggregate.	
	Unit	Refers to the measurement unit as mentioned in the BoQ	
	Qty(a)	Refers to the quantity of the 'Material' as mentioned in the BoQ	
	Raw Components	Breaks down composite construction 'Materials' into their 'Raw Materials'.Can add any new 'Raw Materials' here, as and when information from Sites is collected.	Primary
	Unit	Refers to the measurement units of 'Raw Materials'.	Primary
	Qty(b)	Mentions the calculated quantities of 'Raw Materials'	Primary

	Functional Unit (kg)	Refers to the functional unit-kg, followed in this study. All calculated quantities must be converted to this unit	Primary
	Qty(c)	Refers to the 'Raw Material' quantities mentioned in kg	Primary
	Qty of Raw Material Extracted and Procured	Refers to the quantity of the Raw Materials to be extracted and procured for producing, say, 1 MT (1 unit) of the finished construction material. Many manufacturers calculate the embodied energy/carbon in reference to a certain qty of final product. For example, in their annual sustainability reports, cement manufacturers mention the embodied carbon values per MT of cement.	Calculated
A1_Extraction and Procurement, A2_Transport, and A3_Manufacturing	Unit (RM)	Refers to the measurement unit of Raw Materials	Primary
	Reference Qty of finished construction material	Refers to the quantity of finished Construction Material for which the embodied energy data is being collected. For example, the manufacturer might provide the MJ of energy used in production of 1 MT cement. Thus, the "qty of finishes construction material" would be 1 MT.	Primary
	Unit (FCM)	Refers to the measurement unit of finished construction material	Primary
	Fuel Mix	Refers to types of fuels used in the extraction and procurement processes	Primary
	Embodied Energy	Refers to the energy consumed during the extraction and procurement processes	Primary
	Unit (EE)	Indicates the unit in which embodied energy is reported. Units shall be selected from the following drop down options: MJ kWh	Primary
	Embodied Carbon	Refers to the carbon released during the extraction and procurement processes	Primary
	Unit (EC)	Indicates the unit in which embodied energy is reported. Units shall be selected from the following drop down options: kg CO2 (assuming the emissions of rest of the GHG as 0) kg CO2e (includes the emissions of other GHG like CH4 and N2O)	Primary
	Source of Data	Refers to the source of the embodied energy/carbon associated with raw material extraction and procurement data. This data may be sourced from: Material supplier Estimated from machine readings Contractor/Designer EPD Company Annual Reports	Primary

	Data Type	Refers to the type of data - Measured, Derived, or Calculated Measured data - refers to the data that the manufacturer/supplier has measured Derived data - refers to data that has been derived using some kind of conversion factors. For example, if embodied energy is available in MJ/cum and the density is available, then it can be used to derive embodied energy in MJ/kg Calculated data - refers to the data which is calculated/estimated through indirect means. For example, if the total weight of coal used is not available, but the generator capacity and the amount of time for which the generator was running, and in how much time does the generator exhaust all the coal is available. Then, the amount of coal used can be calculated by multiplying the time taken for all the coal to be exhausted and the generator capacity, and dividing it by the time for which the generator was running.	
	Please Note: In the A1_Extraction and Procurement sheet - a) if embodied energy/carbon data at the process-level granularity is available, then the data must be entered in columns C through U b) if the combined embodied energy/carbon data of extraction and procurement is available, then data must be entered in columns V to AC		
A1 Extraction and Procurement	Supplier/Manufacturer	Refers to the Manufacturer/Supplier of the Construction Materials	
	Process: Raw Material Extraction	This refers to the processes involved in mining the Raw Components of Construction Materials	Primary
	Process: Raw Material Procurement	Refers to the processes involved in Raw Component procurement. The difference between raw material extraction and procurement can be understood by the following example. To manufacture plywood panels, first the tress need to be felled. The process of cutting tress would be included in 'Raw Material Extraction', and any processes involved in taking those felled tree barks from the point of mining to the point from where they would be transported shall be included in 'Raw Material Procurement'	
	Processes involved in Raw Material Extraction and Procurement	Please mention all processes involved in Raw Material extraction and procurement. For example, cutting, hammering etc.	

	Raw Material	Refers to the raw materials used up for producing the Construction Materials. May add raw materials for each of the construction materials, and number them in the following format: 1.1, 1.2, etc. where 1 is the sr. no. of the Construction Material.	Primary
	Calculated: Embodied Energy	Refers to the resultant embodied energy calculated by summing the values mentioned for raw material extraction and procurement	
	Calculated: Embodied Carbon	Refers to the resultant embodied carbon calculated by summing the values mentioned for raw material extraction and procurement	Calculated
	Distance between Extraction Site and Manufacturing Plant	Indicates the distance between the raw material extraction site and manufacturing plant	Calculated
A2_Transport	Were more than one vehicle involved in transport	Yes/No type of question. In case more than one vehicles were used, the vehicle capacity, fuel mix, total fuel used for each of the cases must be added in columns underneath 'Vehicle 1', 'Vehicle 2' etc.	Primary
	Vehicle Category	Refers to the category of vehicle, i.e., Light Duty Vehicle (LDV), Medium Duty Vehicle (MDV), or Heavy-Duty Vehicle (HDV)	Primary
	Vehicle Capacity (Tonne)	Indicates the vehicles's capacity in tonnes	Primary
	Vehicle Used: Make	Indicates the manufacturer of the vehicle used	Primary
	Vehicle Used: Model	Indicates the product/model of vehicle used	Primary
	No. of trips	This shall be calculated on the basis of total material required divided by the distance between the raw material extraction point and manufacturing plant	Primary
	Fuel Mix	Indicates the fuel used for transportation. Data shall be chosen from the following drop-down options: Petrol Diesel Coal	Calculated
	Total Fuel Used	Indicates the total fuel consumed	Primary
	Unit (Fuel Use)	Refers to the measurement unit used to express the used fuel. For example, litres of petrol, MT of coal etc.	Primary
	Sub-level	Refers to the alphabetic categorization assigned to various production methods/technolologies available for Construction Materials.	Primary
A3_Manufacturing	Variation in Method/Technology	Indicates the various production technologies/methods for manufacturing a Construction Material	
	Please Note: In the Sum of A1 to A3 sheet: a) if granular data was available and filled up in the previous sheets, then that very data would be linked and displayed in columns H to S b) if the combined embodied energy for A1, A2, and A3 is directly available from		

	the manufacturer, then it must be entered in columns T to AC Also, the details in columns B to G must be entered .		
Sum of A1 to A3	Address	Column where the building address must be entered	
Building ELE_CON	Nomenclature	This is our nomenclature or identification given to the building, in the format Airport Code_S1_B1.	Primary
	Annual Electricity Consumption (unit: kWh)	This is the sum of electricity consumed across the year in kWh (of the building)	Primary
	Year of data	Indicates the year for which electricity data is presented	Primary
	Bimonthly Electricity Consumption	This is the electricity consumed across two consecutive months in kWh (of the building). This data may be entered in the respective month's column.	Primary
	Address	Column where the Building address must be entered	Primary
Prominent Manufacturer			Primary

Table A6.5 Building Information

Sr. No.	Address	Nomenclature	Latitude	Longitude	No. of floors in the building	Bill of Quantity (BoQ) Available	BoQ data source	Make and Model Details Available	Make and Model Data Source	Building Drawings	Building Layout (file)	Built up Area (sq. m)	Built up Area (sq. m)

1.02	1.01	1	Sr. no.	Site
Concret	Concrete (M25)	CONCRETE (includes concrete for slabs, columns, beams, staircases, roofs)	Material	S1_B1
	cum		Unit	
			Qty(a)	
			Raw Components	
			Unit	
			Qty(b)	
			Functional Unit	
			Qty(c)	S2_B1
Concret	Concrete (M25)	CONCRETE	Material	
	cum		Unit	
			Qty(a)	
			Raw Components	
			Unit	
			Qty(b)	
			Functional Unit	
			b	S3
Concret	Concrete (M25)	CONCRETE	Material	
	cum		Unit	
			Qty(a)	
			Raw Components	
			Unit	
			Qty(b)	
			Functional Unit	
			Qty(c)	S4
Concret	Concrete (M25)	CONCRETE	Material	
	cum		Unit	
			Qty(a)	
			Raw Components	
			Unit	
			Qty(b)	
			Functional Unit	
			Qty(c)	S5
Concret	Concrete (M25)	CONCRETE	Material	
	cum		Unit	
			Qty(a)	
			Raw Components	
			Unit	
			Qty(b)	
			Functional Unit	
			Qty(c)	

Table A6.6 BoQ

3.03.02	3.03.01	3.03	3.02	3.01	3	2.01	2
		Block Masonry (Concrete	Block Masonry (AAC Blocks)	Brick Masonry (Burnt Clay Bricks)	Walling Materials	Mild Steel (used as reinforcement in RCC)	STEEL
Sand	Cement					Mild Steel (used as reinforcement in RCC)	
kg	kg					kg	
		Block Masonry (Concrete	Block Masonry (AAC Blocks)	Brick Masonry (Burnt Clay Bricks)	Walling Materials	Mild Steel (used as reinforcement in RCC)	STEEL
Sand	Cement					Mild Steel (used as reinforcement in RCC)	
kg	kg					kg	
		Block Masonry (Concrete	Block Masonry (AAC Blocks)	Brick Masonry (Burnt Clay Bricks)	Walling Materials	Mild Steel (used as reinforcement in RCC)	STEEL
Sand	Cement					Mild Steel (used as reinforcement in RCC)	
kg	kg					kg	
		Block Masonry (Concrete	Block Masonry (AAC Blocks)	Brick Masonry (Burnt Clay Bricks)	Walling Materials	Mild Steel (used as reinforcement in RCC)	STEEL
Sand	Cement					Mild Steel (used as reinforcement in RCC)	
kg	kg					kg	
		Block Masonry (Concrete	Block Masonry (AAC Blocks)	Brick Masonry (Burnt Clay Bricks)	Walling Materials	Mild Steel (used as reinforcement in RCC)	STEEL
Sand	Cement					Mild Steel (used as reinforcement in RCC)	
kg	kg					kg	

4.02	4.01	4	3.04.05	3.04.04	3.04.03	3.04.02	3.04.01	3.04	3.03.03
External Plaster	Internal Plaster	Plaster				Shotcrete		EPS Core Walling	
			Galvanized Iron Wires (for reinforcement)	Aggregate	Sand	Cement	EPS (mention thk)		Thermoinsulated Concrete Block (200 mm thk)
			kg	kg	kg	kg	kg		kg
External Plaster	Internal Plaster	Plaster				Shotcrete		EPS Core Walling	
			Galvanized Iron Wires (for reinforcement)	Aggregate	Sand	Cement	EPS (mention thk)		Thermoinsulated Concrete Block (200 mm thk)
			kg	kg	kg	kg	kg		kg
External Plaster	Internal Plaster	Plaster				Shotcrete		EPS Core Walling	
			Galvanized Iron Wires (for reinforcement)	Aggregate	Sand	Cement	EPS (mention thk)		Thermoinsulated Concrete Block (200 mm thk)
			kg	kg	kg	kg	kg		kg
External Plaster	Internal Plaster	Plaster				Shotcrete		EPS Core Walling	
			Galvanized Iron Wires (for reinforcement)	Aggregate	Sand	Cement	EPS (mention thk)		Thermoinsulated Concrete Block (200 mm thk)
			kg	kg	kg	kg	kg		kg
External Plaster	Internal Plaster	Plaster				Shotcrete		EPS Core Walling	
			Galvanized Iron Wires (for reinforcement)	Aggregate	Sand	Cement	EPS (mention thk)		Thermoinsulated Concrete Block (200 mm thk)
			kg	kg	kg	kg	kg		kg

7.02	7.01	7	6.03	6.02	6.01	6	5	4.03
Steel frame casement	UPVC windows	Windows	Wooden door	Steel Jali door (for security)	UPVC door (we are not counting hinges or any accessories)	Doors	Paint	Ceiling Plaster
			nos	nos	nos			
			1	1	1			
				Cold-rolled steel-----drop	UPVC			
					kg			
				kg	kg			
Steel frame casement	UPVC windows	Windows	Wooden door	Steel Jali door	UPVC door (we are not counting hinges or any accessories)	Doors	Paint	Ceiling Plaster
			nos	nos	nos			
			1	1	1			
				Cold-rolled steel	UPVC			
					kg			
				kg	kg			
Steel frame casement	UPVC windows	Windows	Wooden door	Steel Jali door	UPVC door (we are not counting hinges or any accessories)	Doors	Paint	Ceiling Plaster
			nos	nos	nos			
			1	1	1			
				Cold-rolled steel	UPVC			
					kg			
				kg	kg			
Steel frame casement	UPVC windows	Windows	Wooden door	Steel Jali door	UPVC door (we are not counting hinges or any accessories)	Doors	Paint	Ceiling Plaster
			nos	nos	nos			
			1	1	1			
				Cold-rolled steel	UPVC			
					kg			
				kg	kg			
Steel frame casement	UPVC windows	Windows	Wooden door	Steel Jali door	UPVC door (we are not counting hinges or any accessories)	Doors	Paint	Ceiling Plaster
			nos	nos	nos			
			1	1	1			
				Cold-rolled steel	UPVC			
					kg			
				kg	kg			

Table A6.7 A1 Extraction and Procurement

Sr. No.	1	2	3	4	5	6	7	8	9	10	11	12

Construction Materials		AAC Blocks	Aggregate	Bonding Agent/Polymer (used for AAC block masonry)	Burnt Clay Bricks	Cement	EPS	Galvanised Iron	Glass	Mild Steel (for reinforcement)	Sand	Thermoinsulated Concrete Blocks	UPVC
Supplier/Manufacturer													
Processes involved in Raw Material Extraction and Procurement													
Raw Material													
Qty of Raw Material Extracted and Procured													
Unit (RM)													
Reference Qty of finished construction material													
Unit (FCM)													
Process: Raw Material Extraction (A1.1)	**Fuel Mix**												
	Embodied Energy												
	Unit (EE)												
	Embodied Carbon												
	Unit (EC)												
	Source of Data												
	Data Type												
Process: Raw Material Procurement (A1.2)	**Fuel Mix**												
	Embodied Energy												
	Unit (EE)												
	Embodied Carbon												
	Unit (EC)												
	Source of Data												
	Data Type												

Calculated	***Total Embodied Energy (A1)***												
	Unit (EE)												
Calculated	***Total Embodied Carbon***												
	Unit (EC)												
Supplier/Manufacturer													
Processes involved in Raw Material Extraction and Procurement													
Raw Material													
Qty of Raw Material Extracted and Procured													
Unit (RM)													
Qty of finished construction material for which data is available													
Unit (FCM)													
Processes: Raw Material Extraction and Procurement	**Fuel Mix**												
	Embodied Energy												
	Unit (EE)												
	Embodied Carbon												
	Unit (EC)												
	Source of Data												
	Data Type												

Table A6.8: A2 Transport

	Sr. No.	1	2	3	4	5	6	7	8	9	10	11	12

	Construction Materials	AAC Blocks	Aggregate	Bonding Agent/Polymer (used for AAC block masonry)	Burnt Clay Bricks	Cement	EPS	Galvanised Iron	Glass	Mild Steel (for reinforcement)	Sand	Thermoinsulated Concrete Blocks	UPVC
	Reference Qty of final Construction Material for which data is collected												
	Unit (FCM)												
	Raw Materials												
	Qty of Raw Material (1)												
	Unit (RM)												
	Distance between Extraction Site and Manufacturing Plant (km)												

	Were more than one mode of transport used?												
	Source of Data												
	Data Type												
Vehicle 1	Vehicle Category												
	Vehicle Capacity (tonnes)												
	Vehicle Used: Make												
	Vehicle Used: Model												
	No. of trips												
	Fuel Mix												
	Total Fuel Used												
	Unit (Fuel Use)												
	Embodied Carbon												
	Unit (EC)												
Vehicle 2	Vehicle Category												
	Vehicle Capacity (tonnes)												
	Vehicle Used: Make												

	Vehicle Used: Model												
	No. of trips												
	Fuel Mix												
	Total Fuel Used												
	Unit (Fuel Use)												
	Embodied Carbon												
	Unit (EC)												
Vehicle 3	Vehicle Category												
	Vehicle Capacity (tonnes)												
	Vehicle Used: Make												
	Vehicle Used: Model												
	No. of trips												
	Fuel Mix												
	Total Fuel Used												
	Unit (Fuel Use)												
	Embodied Carbon												
	Unit (EC)												
Vehicle 4	Vehicle Category												

	Vehicle Capacity (tonnes)												
	Vehicle Used: Make												
	Vehicle Used: Model												
	No. of trips												
	Fuel Mix												
	Total Fuel Used												
	Unit (Fuel Use)												
	Embodied Carbon												
	Unit (EC)												
Vehicle 5	**Vehicle Category**												
	Vehicle Capacity (tonnes)												
	Vehicle Used: Make												
	Vehicle Used: Model												
	No. of trips												
	Fuel Mix												
	Total Fuel Used												
	Unit (Fuel Use)												

	Embodied Carbon												
	Unit (EC)												

Table A6.9: A3 Manufacturing

Sr. No.		1	2	3	4				5		6	7	8	9		10	11	12
Raw Components		AAC Blocks	Aggregate	Bonding Agent/Polymer (used	Burnt Clay Bricks						EPS	Galvanised Iron	Glass	Mild Steel (for reinforcement)		Sand	Thermoinsulated Concrete	UPVC
Sub-level					a	b	c	d	a	b				a	b			
Variation in Method/Technology					Fixed Chimney Bull's Trench Kiln	Zig-Zag Kiln	Vertical Shaft Brick Kiln	Down-Draught Kiln	Wet Process	Dry Process				Blast Furnace/Basic Oxygen	Electric Arc Furnace (EAF)			
Manufacturer																		
Reference Qty of final Construction Material																		
Unit (FCM)																		
Source of Data																		
Data Type																		
Process: Manufacturing	**Fuel Mix**																	
	amount of fuel used																	

	Unit (Fuel Use)																
	Embodied Energy																
	Unit (EE)																
	Embodied Carbon																
	Unit (EC)																

Table A6.10: Sum of A1 to A3

Sr. No.		1	2	3	4				5		6	7	8	9		10	11	12
Material		AAC Blocks	Aggregate	Bonding Agent/Polymer (used for)	Burnt Clay Bricks				Cement		EPS	Galvanised Iron	Glass	Mild Steel (for reinforcement)		Sand	Thermoinsulated Concrete Blocks	UPVC
Sub-level					a	b	c	d	a	b				a	b			
Variation in Method/Technology					Fixed Chimney Bull's Trench Kiln	Zig-Zag Kiln	Vertical Shaft Brick Kiln	Down-Draught Kiln	Wet Process	Dry Process				Blast Furnace/Basic Oxygen	Electric Arc Furnace (EAF)			
Manufacturer																		
Source of Data																		
Data Type																		
Reference Qty of final Construction Material																		
Unit (FCM)																		
Embodied Energy	**A1**																	
	A2																	

	A3																	
	Sum of A1 to A3																	
	Unit (EE)																	
Embodied Carbon	A1																	
	A2																	
	A3																	
	Sum of A1 to A3																	
	Unit (EC)																	
Manufacturer																		
Source of Data																		
Data Age																		
Data Type																		
Reference Qty of final Construction Material																		
Unit (FCM)																		
Combined values for unit processes A1 to A3	Embodied Energy																	
	Unit (EE)																	
	Embodied Carbon																	
	Unit (EC)																	

Table A6.11: Validation Tables

Bill of Quantity (BoQ) Available	Yes - Fully Available	Yes - Partly Available	Not Available									
BoQ data source	Material Supplier	Contractor/Designer	Owner	Tender Document	Government DPR	Architectural Drawings						
Make and Model Details Available	Yes - Fully Available	Yes - Partly Available	Not Available									
Make and Model Data Source	Material Supplier	Contractor/Designer	Owner	Tender Document	Government DPR	Architectural Drawings						
Building Layout	Yes - Fully Available	Yes - Partly Available	Not Available									
Fuel Mix (A1)	Electricity	Coal	Solar Energy	Wind Energy	Hydro Energy	Petrol	Diesel					
Unit (EE)	MJ	kWh										
Unit (EC)	kg CO2	kg CO2e										
Source of Data	Supplier/Manufacturer	Estimated from machine readings	Contractor /Designer	EPD	Company Sustainability Report							
Data Type	Measured	Calculated	Derived									
Unit (RM)	MT	kg	cum	nos.								
Unit (FCM)	MT	kg	cum	nos.								
Were more than one mode of transpo	Yes	No										

rt used?												
Vehicle Category	LDV	MDV	HDV									
Fuel Mix	Petrol	Diesel	Coal									
Unit (Fuel Use)	Litres	kg	MT									
Source of Data	Supplier/Manufacturer	Estimated from machine readings	Contractor /Designer	EPD	Company Sustainability Report							
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Appendix 7

A7. Power Quality

A7. 1 level of compliance

Please mark the level of compliance attempting for the project		
Sl.No	**Description**	**Mark**
1	ECSBC	
2	ECSBC Plus	
3	Super ECSBC	

A7.2 Voltage Distortion

At the main metering level of the building, utilities and/or distribution system operators shall limit line-to-neutral voltage harmonics as follows:

a) Daily 99th percentile very short time (3s) values shall be less than 1.5 times the values given in table A7.1

b) Weekly 95th percentile short time (10 min) values shall be less than the values given in table A7.1

Table A7.1 – Voltage Distortion Limits

Description	**Design**	**Actual**	**Design**	**Actual**	**Technology Implemented to meet the ECSBC compliance**	**Remarks**
Bus voltage V at PCC	Individual harmonic (%) h ≤ 50	Individual harmonic (%) h ≤ 50	Total harmonic distortion THD (%)	Total harmonic distortion THD (%)		
V ≤ 1.0 kV	5		8			
1 kV < V ≤ 69 kV	3		5			
69 kV < V ≤ 161 kV	1.5		2.5			
161 kV < V	1		1.5*			

Note: High-voltage systems are allowed to have up to 2.0% THD where the cause is an HVDC terminal whose effects are found to be attenuated at points in the network where future users may be connected.

A7.3 Current Distortion

The limits in this sub clause shall be applicable to users connected to systems with the rated voltage at the PCC is from 120 V to above 161 kV. For individual nonlinear load, these limits are not applicable. At the PCC (Point of Common Coupling), users shall limit their harmonic currents as specified.:

a) Daily 99th percentile very short time (3 s) harmonic currents shall be less than 2.0 times the values given in Tables A7.2, Table A7.3 and Table A7.4

b) Weekly 99th percentile short time (10 min) harmonic currents shall be less than 1.5 times the value given in Tables A7.2, Table A7.3 and Table A7.4

c) Weekly 95th percentile short time (10 min) harmonic currents shall be less than the values given in Table Tables A7.2, Table A7.3 and Table A7.4

Maximum allowable limit of current distortion for system design shall comply to Table A7.2

Table A7.2Current distortion limits for systems rated 120V through 69kV

Maximum harmonic current distortion in percent of IL														
Individual harmonic order														
Description	**Design**	**Actual**	**Design**	**Actual**	**Design**	**Actual**	**Design**	**Actual**	**Design**	**Actual**	**Design**	**Actual**	**Tech. Implemented**	**Remarks**
ISC/IL	**2≤ h<11a**	**2≤ h<11a**	**11≤ h<17**	**11≤ h<17**	**17≤ h<23**	**17≤ h<23**	**23≤ h<35**	**23≤ h<35**	**35≤ h≤50**	**35≤ h≤50**	**TDD**	**TDD**		
<20C	4.0		2.0		1.5		0.6		0.3		5.0			
20<50	7.0		3.5		2.5		1.0		0.5		8.0			
50<100	10.0		4.5		4.0		1.5		0.7		12.0			
100<1000	12.0		5.5		5.0		2.0		1.0		15.0			
>1000	15.0		7.0		6.0		2.5		1.4		20.0			

a For h≤6 even harmonics are limited to 50% of the harmonic limits shown in the table.

b Current distortion the result in dc offset e.g. half wave converters are not allowed.

Power generation facilities are limited to these values of current distortion. Regardless of actual ISC/IL unless covered by other standards with applicable scope.

Where

ISC= maximum short circuit current at PCC

IL= maximum demand load current at PCC under normal load operating conditions.

Table A7.3: Current distortion limits for systems rated above 69 kV through 161kV

Maximum harmonic current distortion in percent of IL
Individual harmonic order

Description	Design	Actual	Design	Actual	Design	Actual	Design	Actual	Design	Actual	Design	Actual	Technolog	Remarks
ISC/IL	2≤ h<11a	2≤ h<11a	11≤ h<17	11≤ h<17	17≤ h<23	17≤ h<23	23≤ h<35	23≤ h<35	35≤ h≤50	35≤ h≤50	TDD	TDD		
<20C	2.0		1.00		0.75		0.30		0.15		2.50			
20<50	3.5		1.75		1.25		0.50		0.25		4.00			
50<100	5.0		2.25		2.00		0.75		0.35		6.00			
100<1000	6.0		2.75		2.50		1.00		0.50		7.50			
>1000	7.5		3.50		3.00		1.25		0.70		10.00			

a For h≤6 even harmonics are limited to 50% of the harmonic limits shown in the table.

b Current distortion the result in dc offset e.g. half wave converters are not allowed.

Power generation facilities are limited to these values of current distortion. Regardless of actual ISC/IL unless covered by other standards with applicable scope.

Where

ISC= maximum short circuit current at PCC

IL= maximum demand load current at PCC under normal load operating conditions.

Table A7.4- Current distortion limits for systems rated > 161 kV

Maximum harmonic current distortion in percent of IL														
Individual harmonic order														
Description	Design	Actual	Design	Actual	Design	Actual	Design	Actual	Design	Actual	Design	Actual	Technolog	Remarks
ISC/IL	2≤ h<11a	2≤ h<11a	11≤ h<17	11≤ h<17	17≤ h<23	17≤ h<23	23≤ h<35	23≤ h<35	35≤ h≤50	35≤ h≤50	TDD	TDD		
<25C	1.0		0.50		0.38		0.15		0.10		1.50			
25<50	2.0		1.00		0.75		0.30		0.15		2.50			
≥50	3.0		1.50		1.15		0.45		0.22		3.75			