GOVERNMENT OF INDIA
MINISTRY OF POWER

2024

DRAFT

ENERGY CONSERVATION & SUSTAINABLE BUILDING CODE (ECSBC)

(Commercial & Office Buildings)

For Comments of Stakeholders

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ऊर्जा दक्षता ब्यूरो
(भारत सरकार, विद्युत मंत्रालय)
BUREAU OF ENERGY EFFICIENCY
(Government of India, Ministry of Power)

आज़ादी का अमृत महोत्सव

F.No. BLDS-13/1/23-BEE / 6578

23rd January, 2024

Subject: Invitation for Feedback on Draft Energy Conservation and Sustainable Building Code (Commercial and Office Buildings)

Dear Madam/Sir,

In view of the amendment to Energy Conservation Act in December 2022, Energy Conservation and Building Code (ECBC) is under revision to Energy Conservation and Sustainable Building Code-Commercial and office Building for the inclusion of sustainability features.

Enclosed herewith is the draft of the Energy Conservation and Sustainable Building Code (Commercial and Office Buildings). We value your expertise and invite you to meticulously review and examine the document.

Doc. No.	Title
ECSBC.Version 1:2024	Draft Energy Conservation and Sustainable Building Code (Draft ECSBC) – Commercial and Office Buildings

Your valuable insights are crucial to ensuring the effectiveness of this code. We kindly request you to provide your comments and suggestions on the document. Your expertise will contribute significantly to the enhancement of industry standards.

Submission Details:

Please email your comments, using the prescribed format enclosed with this message, to ecsbcfeedback@gmail.com & sdiddi@beeindia.gov.in by **12th Feb 2024.**

Presumed Approval:

If no comments are received by the stipulated deadline, it will be presumed that the document requires no further corrections.

Review Process:

In the event of comments and suggestions, the competent authority will thoroughly review and consider each input before finalizing the document. Your contributions will play a pivotal role in shaping the code's success.

We have attached the specified format for your convenience. Kindly adhere to this format, as any deviation will not be entertained during the review process. Thank you for your commitment to sustainability, and we look forward to your constructive feedback.

Yours faithfully,

(Saurabh Diddi)
Director

Encl:
1. Draft ECSBC-Commercial and Ofiice Building
2. Feedback Format

BUREAU OF ENERGY EFFICIENCY
Government of India, Ministry of Power

FORMAT FOR FEEDBACK ON DRAFT ECSBC- COMMERCIAL AND OFFICE BUILDINGS

(Please use A4 size sheet of paper only and type within fields indicated. Comments on each clause/subclause/table/fig etc. be started on a fresh box. Information in column 7 should include reasons for the comments, and those in column 6 should include suggestions for modified wording of the clauses when the existing text is found not acceptable. Adherence to this format. Please e-mail your comments to: ecsbcfeedback@gmail.com & sdiddi@beeindia.gov.in by **12th Feb 2024.**

ECSBC Working Draft Chapter Name:
Name of Submitter :
Organization :
Email ID & Contact Number :
Date of Comment :
Last date of receipt of comment : 12th Feb 2024

Sr. No.	Clause/Sub-clause/Para No.	Line No.	Comment type Technical / Editorial	Comments /Suggestions	Modified Wordings of the Clause	Reasons/ Justifications for the Proposed Changes
(1)	(2)	(3)	(4)	(5)	(6)	(7)

DRAFT ENERGY CONSERVATION & SUSTAINABLE BUILDING CODE – 2024

(Commercial and Office Buildings)

Table of Contents

Section 1

ECSBC – PURPOSE

The focus on reducing energy consumption in buildings has increased worldwide. This is because the consumption of fossil fuels for the full-fledged operations of a building is as high as it is in other industries. Therefore, the adoption of energy efficiency techniques during the construction and operation of buildings would play a crucial role in the creation of sustainable cities in the future. This is also not just about the use of specific technologies or materials; but about a holistic approach to design and construction that considers the building's entire lifecycle. This includes considering the building's location, orientation, and layout, as well as the local climate and the building's intended use. It reduces household expenses and decreases carbon dioxide emissions.

The Energy Conservation and Sustainable Building Code in India was developed to provide minimum requirements for the energy-efficient design and construction of buildings. The Code provides two additional sets of incremental requirements over and above the minimum efficiency level for buildings to achieve enhanced levels of energy efficiency that go beyond the minimum requirements. It is expected that adoption of ECSBC code would also have an impact indoor air pollution as they provide cleaner and better ventilation than conventional buildings. As a result, the possibility of air pollution-related diseases can be avoided to greater extent.

Energy Conservation Building Code (ECBC) was first published in 2009 and subsequently revised in 2017. This second revision has been undertaken to align it with the latest development in the building sector and to take into account the sustainable building in cities. This second revision has also taken into consideration the energy efficiency improvement in buildings and revised energy efficiency requirements of equipment and appliances used in buildings for several application over the years. Other salient changes and addition in this revision are a) inclusion of new sections and b) changes in the requirements, methodology and addition of new definitions in the existing sections. The new sections which have been added in this second revisions are:

a) Sustainable site and planning
b) Water management and Controls
c) Waste Management
d) Indoor environmental Quality
e) Building Commissioning
f) IOT and Controls

Section – 2

SCOPE OF ECSBC

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 purposes.

Buildings intended for private residential purposes only are not covered by the Code.

Energy Efficiency Performance Levels

The code prescribes the following three levels of energy efficiency:

(a) Energy Conservation and Sustainable Building Code Compliant Building (ECSBC Building)
(b) Energy Conservation and Sustainable Building Code Plus Building (ECSBC+ Building)
(c) Super Energy Conservation and Sustainable Building Code Building (SuperECSBC Building)

Precedence

The following codes, programs, and policies will take precedence over the 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.

Building Classification

Any one or more building or part of a building with commercial 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) **Office/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 Office/Business – Daytime Office/Business and 24-hour Office/Business. Unless otherwise mentioned, Office/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-

i. Schools
ii. 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.

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.

Section 3

DEFINITIONS

General

Certain terms, abbreviations, and acronyms are defined in this section for the purposes of this code. These definitions are applicable to all sections of this code. Terms that are not defined shall have their ordinarily accepted meanings within the context in which they are used.

Definitions

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.

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

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.

Standard Design: a computer model of a hypothetical building, based on actual building design, that fulfils all the mandatory requirements and minimally complies with the prescriptive requirements of ECSBC.

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/cm² 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

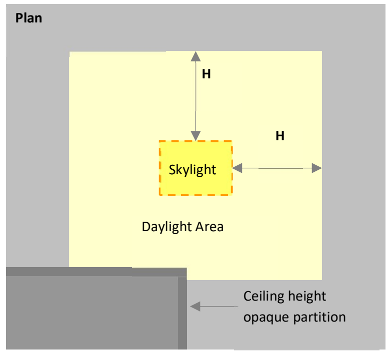
Cool roof: roof with top layer of material that has high solar reflectance and high thermal emittance properties. Cool roof surfaces are characterized by light colors so that heat can be rejected back to the environment.

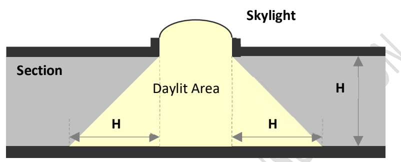
Cumulative design EPI: energy performance index for a building having two or more different functional uses and calculated based on the area weighted average (AWA) method

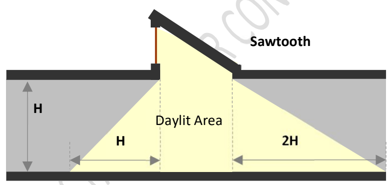
D

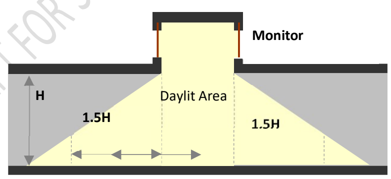
Daylight area: the daylight illuminated floor area under horizontal fenestration (skylight) or adjacent to vertical fenestration (window), described as follows:

(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.

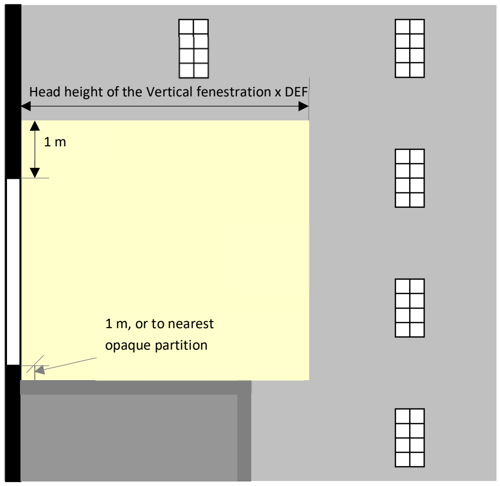








(b) Vertical Fenestration: the floor area adjacent to side apertures (vertical fenestration in walls) with an effective aperture greater than 0.06 (6%). The daylight area extends into the space perpendicular to the side aperture a distance equal to daylight extension factor (DEF) multiplied by the head 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

ECSBC Building: a building that complies with the mandatory requirements of §4A to §13 and also complies either with the prescriptive requirements stated under the ECSBC Building categories of §4A to §13, or, with the whole building performance compliance method of §14.

ECSBC+ Building: a building that complies with the mandatory requirements of §4A to §13 and also complies either with the prescriptive requirements stated under the ECSBC+ Building categories of §4A to §13, or, with the whole building performance compliance method of §14. This is a voluntary level of compliance with ECSBC.

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) Standard Building EPF: envelope performance factor calculated for the Standard Building using prescriptive 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

Energy Performance Index (EPI): of a building means its annual energy consumption in kilowatt-hours per square meter of the area of the building which shall be calculated in the existing or proposed building as per the formula below,

$$= \frac{annual\ energy\ consumption\ in\ kWh}{total\ built-up\ area\ (excluding\ storage\ area\ and\ the\ parking\ in\ the\ basement) in\ m^2}$$

EPI Ratio: of a building means the ratio of the EPI of the Proposed Building to the EPI of the Standard Building.

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.

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.

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.

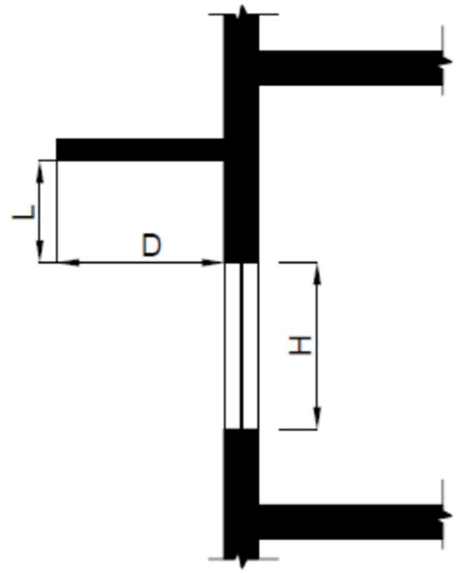
P&I Diagram: Piping & Instrument diagram is a detail diagram which shows all the piping together with the equipment's, instruments & control devices.

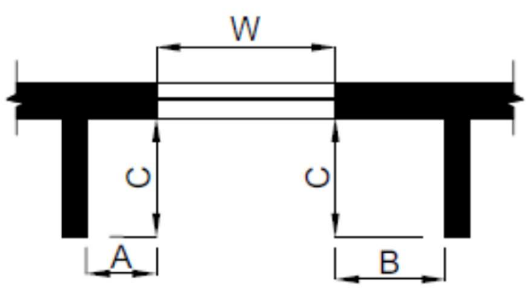
Potential daylit time: amount of time in a day when there is daylight to light a space adequately without using artificial lighting. Potential daylit time is fixed for 8 hours per day i.e. from 09:00 AM to 5:00 PM local time, resulting 2920 hours in total for all building types except for Type E-1 - 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, 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(PF_L)= C/(A+W) Projection factor Right Fin(PF_R)= 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 minimising 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.

Standard 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.

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.

Standard Building: a building that minimally complies with all the mandatory and prescriptive requirements of Energy Conservation Building Code and has same floor area, gross wall area, and gross roof area of the Proposed Building.

Standard Design: a computer model of a hypothetical building, based on actual building design, that fulfils all the mandatory requirements and minimally complies with the prescriptive 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).

SuperECSBC Building: a building that complies with the mandatory requirements of section §4 to §13 and also complies either with the prescriptive requirements stated under the SuperECSBC Building categories of §4 to §13, or, with the whole building performance compliance method of §14. This is a voluntary level of compliance with ECSBC.

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.

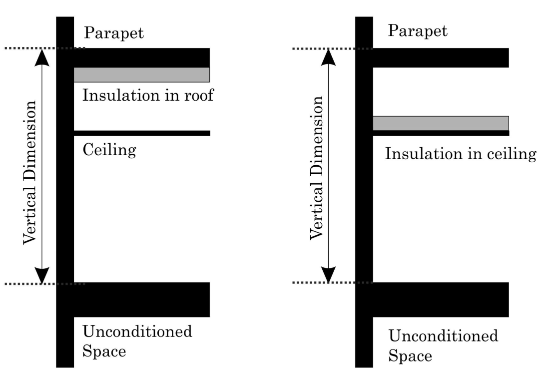
W

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.

3.1 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/ $l\text{-}s^{-1}$	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

3.2 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
$W/ l\text{-}s^{-1}$	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

Section 4 A

ECSBC – SUSTAINABLE SITES & PLANNING

SUSTAINABLE SITES & PLANNING

4.1 General Requirement

The Sustainable Sites and Planning section of the code is about preserving ecology and reducing environmental impacts due to construction activities. It focuses on restoring and preserving the biodiversity of the site caused or likely to cause due to development.

The buildings shall comply with the mandatory requirements as specified in 4.2.1 to 4.2.5. The prescriptive requirements are specified in 4.3.1 to 4.3.7. The compliance level for ECSBC, ECSBC plus and ECSBC Super shall be as per table 4.1. Relevant conformance documents shall be submitted for verification purposes as detailed in section 4.4.

Table 4.1: Compliance requirements for ECSBC, ECSBC + and Super ECSBC

Compliance Level	No of Prescriptive Measures Implemented
ECSBC	All Mandatory Requirements
ECSBC +	Mandatory Requirements and Prescriptive Measures - 4.3.1, 4.3.2, 4.3.3
Super ECSBC	Mandatory Requirements and Prescriptive Measures - 4.3.1 to 4.3.7

4.2 Mandatory Requirements

4.2.1 Topsoil Preservation

Top soil is a critical resource for the existence of species of all kinds. Soil erosion occurs due to storms and wind during construction and post-construction activities. The topsoil is nutrient rich and takes centuries to become fertile. Therefore, adequate steps need to be taken to preserve the top soil. Topsoil testing shall be carried out to verify and ensure the fertility of the soil as per Table 4.2 given below:

Table 4.2: Topsoil requirements

S.NO	PARAMETER	UNIT	NORMAL RANGE
1	pH	-	6.5 – 7.5
2	Available NITROGEN	Kg/ha	125-180 ppm
3	Available PHOSPHOROUS	Kg/ha	5-10 ppm
4	Available POTASSIUM	Kg/ha	62-125 m

Source: Paper published by Indian Institute of Horticultural Research (IIHR)

4.2.2 Selection of site

The site plan must comply with the local byelaws with regard to development plan and master plan and Urban Development Plans Formulation and Implementation (UDPFI) guidelines & regulations for eco-sensitive zones, coastal zones, heritage areas, water body zones, hazard-prone areas and others.

4.2.3 Design for Differently Abled

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 minimum width and minimum gradient requirements.

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.

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 floors 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.

4.2.4 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.

4.2.5 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 bye laws. Post remediation, the site shall be approved by local statutory body for its intended use.

4.3 Prescriptive Requirements

4.3.1 Topsoil preservation

Projects shall address the following topsoil preservation measures.

a) Pre-Construction Measures

Fertile topsoil shall be preserved for at least for0.15m to 0.2m and reused on site for landscaping or donated to a nursery.

b) During Construction Measures

A sedimentation basin shall be installed at the exit of storm water from site, to avoid topsoil erosion during construction.

4.3.2 Dedicated Parking for Differently Abled

Differently abled people should be provided with preferential parking as per NBC 2016 – Part 3, Annexure B-3.5:

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.

4.3.3 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:

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.

4.3.4 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 center / Gym

4.3.5 Access to Public Transportation

a) 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)
b) 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.

4.3.6 In-situ transit

If applicable, buildings in large campuses with total ground area above 1,00,000 sq m should 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.

4.3.7 Heat Island Reduction – Roof Areas

Urban Heat Island effect shall be minimized by providing cool roof or vegetation for 95% of the net exposed roof area as specified in chapter 4B (Building Envelope)

4.3.8 Heat Island Reduction – Non-Roof Areas

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 Documentation Requirements

Documents requirements to verify the compliance shall be as per table 4.5.1 and 4.5.2.

4.4.1 Documents requirement for mandatory requirements compliance

Table 4.5.1 Documents requirements for Mandatory sections compliance.

Section	Section Name	Documents to submit
4.2.1	Topsoil preservation	Submit Topsoil test report
4.2.2	Selection of site	Demonstrate that the design considered is as per local bye law /UDPFI guidelines.
4.2.3	Design for Differently Abled	Submit parking drawings and photographs Submit drawings, photographs and manufacturer datasheet of elevators Submit drawings and photographs of differently abled washroom
4.2.4	Heat Island Reduction – Non-Roof Areas	Submit calculations and site plan showing the paved areas
4.2.5	Brownfield Remediation	Submit documentation of remediation measures adopted and clearance certificate from local statutory body .

4.4.2 Documents requirement for prescriptive requirements compliance

Table 4.5.1 Documents requirements for Prescriptive sections compliance.

Section	Section Name	Documents to submit
4.3.1	Topsoil Preservation	Drawings and narratives highlighting topsoil preservation measures shall be submitted. Demonstrate through calculations, photographs & acknowledgement from the receiving beneficiary with regard to quantity of topsoil donated.
4.3.2	Dedicated Parking for Differently Abled	Submit parking drawings and photographs to demonstrate compliance.
4.3.3	Access for Differently Abled	Submit drawings highlighting the provisions for accessibility of differently abled.
4.3.4	Access to Amenities	Site map or drawing showing walking access to amenities shall be submitted.
4.3.5	Access to Public Transportation	Site map showing the access to amenities shall be submitted. Alternatively, letter indicating if contract would be in place for transportation services commuting shall be submitted.
4.3.6	In-Situ Transit	Site plan indicating the bicycle network and bicycle parking shall be submitted. Calculations for the number of bicycle parking provided.
4.3.7	Heat Island Reduction – Roof Areas	Submit roof plan demonstrating compliance. A test report from an NABL accredited lab shall be submitted for compliance to SRI value of the cool roof
4.3.8	Heat Island Reduction – Non Roof Areas	Site plan indicating the paved areas and measures adopted to reduce heat island reduction along with calculations shall be submitted. Manufacturer data sheets indicating the SRI value of the paving material shall be submitted or shall use type 1 eco-labelled products.

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Section 4 B

ECSBC – BUILDING ENVELOPE

4B BUILDING ENVELOPE

4B 1. GENERAL REQUIREMENTS

The building envelope shall comply with the mandatory requirements as specified in 4B 2, and the prescriptive criteria as specified in §4B 3.

4B 2. MANDATORY REQUIREMENTS

4B2.1 Fenestration

4B.2.1.1 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, and 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 10.

4B.2.1.2 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, and labelled or certified by the manufacturer.

Notes:
Exceptions to 4B.2.1.2:

(a) 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.

(b) Solar heat gain coefficient (SHGC) of the glass alone is an acceptable alternate for compliance with the SHGC requirements for the overall fenestration product.

4B.2.1.3 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, and 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.

4B 2.2 Opaque Construction

4B2.2.1 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.

4B2.2.2 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.

4B2.2.3 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.

4B 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 clause 4B 2.3.1 or through the Spatial Daylight Autonomy Part as defined in clause 4B 2.3.4. Compliance may also be demonstrated as per manual method in 4B.2.3.3. For Whole Building simulation, the standard building shall be modelled with daylight sensors located within 6m from the building periphery.

4B 2.3.1 Useful daylight illuminance

Above grade floor areas shall meet the useful daylight illuminance (UDI) area requirements listed in Table 4B-0-1 for 90% of the potential daylit time in a year.

Exceptions to 4B.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 4B-0-1.

Table 4B-0-1 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		

4B.2.3.2 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 4B-0-1 for at least 90% of the potential daylit time.

UDI>2000 lux will be used as a metric to evaluate glare impact in buildings. UDI>2000 lux shall be less than 5% of the floor area when UDI method of evaluation is used for Daylight compliance.

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:

a. 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 6 hours per day or working daylit hours (whichever is more), between 7:00 AM to 5:00 PM, resulting in maximum 2,920 hours in total for all building types.

b. 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.

c. Fenestration shall be modelled with actual visible light transmission (VLT) as per the details provided in the material specification sheet.

d. 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.

e. Interior surface reflectance shall be modelled based on the actual material specification. If material specification is not available, the default values in Table 4B-0- shall be used.

f. 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 4B-0-2 Default Values for Surface Reflectance

Surface Type	*Reflectance*
Wall or Vertical Internal Surfaces	50%
Ceiling	70%
Floor	20%

Furniture (permanent)	50%

4B.2.3.2

Spatial Daylight Autonomy (sDA) Method:

Above grade floor areas shall meet or exceed the Spatial Daylight Autonomy and listed in Table 4B-0-1 for occupied daytime hours (minimum 6 hours). Mixed-use buildings shall show compliance as per the criteria prescribed in §4B.2.3.2.1. Assembly buildings (auditoriums, community halls, museums etc.) and other buildings where daylighting will interfere with the functions or processes of 50% (or more) of the building floor area, are exempted from meeting the requirements listed in Table 4B-0-1. All values in the Table 4B-0-3 below are for ASE1000,250h**.

Note that annual sunlight exposure of 1000 lux,250hrs (ASE1000,250) shall be of no more than 10% of the space floor area.

Table 4B-0-3 SDA requirement

Building Category	*Percentage of above grade floor area meeting the SDA-requirement*		
	ECSBC	ECSBC+	Super ECSBC
Business, Educational	sDA300,40%.	sDA300,50%.	sDA300,60%
No Star Hotel Star Hotel Healthcare	sDA300,30%.	sDA300,40%.	sDA300,50%.
Resort	sDA300,45%.	sDA300,55%.	sDA300,65%.
Shopping Complex	sDA300,10%.	sDA300,15%.	sDA300,20%.
Assembly	Exempted		

NOTE*:*

1) The 'Illuminating Engineering Society' (IES) has developed the sDA which is defined in the standard IES LM-83-12

Spatial Daylight Autonomy (sDA) is a metric describing annual sufficiency of ambient daylight levels in interior environments. It is defined as the 'percent of an analysis area' (the area where calculations are performed -typically across an entire space) that meets a minimum daylight illuminance level for a specified fraction of the operating hours per year. E.g., The illuminance level and time fraction are included as subscripts, as in sDA300,50%.

2) ASE is defined by the IES LM-83-12 standard as a metric that describes the potential for visual discomfort in interior work environments. It is defined as the percent of an analysis area that exceeds a specified direct sunlight illuminance level more than a specified number of hours per year.

ASE is used in conjunction with sDA to determine the viability of daylighting. The recommended settings for ASE analysis determine the area exposed to more than 1000 lux of direct sunlight for more than 250 hours per year (ASE1000,250h), before any operable blinds or shades are deployed to block sunlight, considering the same min. 7 hour/day or working daylit hours analysis period as sDA and using comparable simulation methods.

4B.2.3.2.2 Spatial Daylight Autonomy Simulation Method

A software validated by an appropriate authority and approved by BEE shall be used to demonstrate compliance through the daylighting simulation method.

The geometry of the space which includes flooring walls, fenestration etc. must be accurately modelled, with respect to the true solar north. Any angles in the wall/roof etc. also need to be accurately modelled. The reflectance of the wall, floor and ceiling need to be accurately modelled.

4B.2.3.2.2.1 Analysis Area

sDA measures daylight sufficiency across a space based on point-by-point values and can be applied to an analysis grid of any size or shape. The output is presented as the percentage of analysis points that meet the stated criteria. Therefore, output can be interpreted space by space, accumulated across several spaces or addressed throughout an entire building.

To report results for an entire building at once, simply accumulate all measurement points for all defined analysis grids and report the area that meets the criteria.

Within the analysis areas measurement points shall be continuous, on a 1000 mm grid from the walls at a height of 750mm from the finished floor level. Grid points that fall within any opaque furniture such as cabinets may be excluded from the calculations.

4B.2.3.2.2.2 Period of Analysis:

Consider a time period of 6 hours or number of working daylit hours (which is more) from 8am to 6pm for this period.

4B.2.3.2.2.3 Blinds/Shades Operation:

All exterior windows should be modelled with interior blinds or shades that close in order to block direct sunlight on an hourly basis by “window group”, such that no more than a specified number of analysis points within an analysis area are ever in direct sunlight.

All exterior windows must be modelled with blinds unless:

a) Blinds are not be installed according to design documents.
b) The Annual Sunlight Exposure calculation for the analysis area associated with the window group meets or exceeds the recommended criteria for “nominally acceptable” (neutral) comfort.

4B.2.3.2.2.4 Blinds/Shades Optical Properties:

Use Bidirectional Scattering Distributing Function (BSDF) or geometric model data (e.g., of louver blinds) if available to define the specular and diffuse distribution of any blind or shade material. The angle of blinds, or the position of shades, shall be assumed to be set to block direct sunlight from the lowest solar angle experienced for that façade orientation for a given calendar month at that location, based on the nearest Typical meteorological year (TMY) weather file for the analysis period.

If BSDF data cannot be used, and the windows have fabric shades or curtains, model the shades using a combination of specular and diffuse transmittance

The specular transmittance should be equal to the openness factor of the fabric class 7, while the diffuse transmittance should be the total visible light transmission (VLT) minus the openness factor:

a) If VLT is known & the Openness factor is not known - Model the VLT with no specular Transmittance.

b) If the shade VLT is unknown - model the shade using 5 percentage diffuse VLT with no specular transmittance.
c) If BSDF data cannot be used, and the windows have white louver blinds (>80% reflectance - use a 20% VLT diffuse distribution for both sunlight and skylight

The VLT of darker blind colours shall be depreciated proportionally, to a lower limit of 10% diffuse VLT for black blinds (reflectance of 0%) for both sunlight and skylight. Blinds with 40% Reflectance to be modelled at 15% VLT and Blind with 60% Reflectance to be modelled ta 17.5% VLT.

4B.2.3.2.2.5 Exterior Obstructions

Exterior obstructions shall be modelled using at least the minimum level of detail described below.

(a) Model all buildings and opaque structures within at least 30m of the spaces under study, including any surfaces of the modeled building itself. Such exterior obstructions shall be modelled with at least a resolution of 3m increments in dimensions.

    i. More robust exterior obstruction modelling is permissible.
    ii. If the reflectance of surfaces is not known, assume 30% reflectance for all vertical surfaces.
    iii. If exterior obstructions are not known, assume adjacent buildings of equal height to the study building set on adjoining parcels, with a setback equal to the study building.

(b) Model trees as appropriately sized cones, spheres, or cylinders with 20% reflective component. More accurate shapes are allowable.

(c) Use actual surface reflectance values for ground surfaces within a minimum of 30m from the building perimeter. A default reflectance of 10% may be used if reflectance is unknown.

4B.2.3.2.2.6 Windows and Skylight Details

Window and skylight glazing shall be modelled with actual visible light transmittance (VLT), less a dirt depreciation factor.

Window openings should be modelled in three dimensions. When not known, other framing elements can be modelled as a percent reduction in glazing VLT relative to a rough opening area.

Skylight openings should be modelled in three dimensions, including at a minimum the vertical offset between skylight glazing and ceiling surface, otherwise known as the skylight well.

(a) Fenestration glazing VLT shall be based on site measured data for existing buildings, or manufacturer’s product information for new construction, to within 5% accuracy.

(b) Any window detail (sills, jambs, mullions, etc.) greater than 50mm in any dimension shall be modelled as such.

(c) All overhangs, light shelves, and other light redirecting elements shall be modelled with accurate geometry and material properties.

(d) All windows shall be modelled with actual wall thicknesses and sill and jamb reflectance.

(e) All skylights shall be modelled as three-dimensional elements, using actual dimensions, geometry, VLT and reflectance.

(f) The fenestration surfaces must be properly oriented with respect to vertical and true solar north within the model.

4B.2.3.2.2.7 Interior Surface Reflectance

Interior surface reflectance shall be modelled based on information from field measurements, construction specifications, or if not known, use Table 4B 02

4B.2.3.2.2.8 Furniture and Partitions

Furniture and opaque interior partitions shall be modelled.

4B.2.3.2.2.9 Documentation requirement to demonstrate compliance

a. Brief description of the project with location, number of stories, space types, hours of operation and software used.

b. 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.

c. Explanation of any significant modelling assumptions made.

d. Explanation of any error messages noted in the simulation program output.

e. Building floor plans, building elevations and sections, and site plan with surrounding building details (if modelled).

f. Details of building obstructions (if modelled).

g. Details of optical properties of exterior/interior blinds shades modelled.

h. Material reflectance, analysis grid size, total number of grid size/resolution, total number of grid points

4B.2.3.3 Manual Daylighting Compliance Method

All above grade floor areas shall meet or exceed the Daylight Factor requirements as described in section 4B 2.3.3.1 and;

All external Fenestrations should meet Shading requirements as described in Table 4B-0-4C 4B 2.3.1.2

4B.2.3.3.1 Daylight Factor Calculation

This method can be used for demonstrating compliance with daylighting requirements without simulation. Daylight factors (DF) shall be used for manually calculating percentage of above grade floor area meeting the daylight requirement as per Table 4B-0-4A. Spaces such as auditoriums, cinemas, where daylighting will interfere with the functions or processes can be exempted from the calculation of the building floor area. Utility spaces such as stores, AHUs, server rooms, toilets can also be exempted from the calculation of the building floor area.

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Table4B-0-4A Percentage of Total floor area meeting DF Requirement

Building Category	*Percentage of total floor area meeting DF requirements*		
	ECSBC	ECSBC+	SuperECSBC
Business, Educational	40%	50%	60%
No Star Hotel Star Hotel Healthcare	30%	40%	50%
Resort	45%	55%	65%
Shopping Complex	10%	15%	20%

Daylight factor (DF) is a measure of all the daylight reaching on an indoor reference point from the following sources:

(a) The direct sky visible from the point,
(b) External surfaces reflecting light directly to the point, and
(c) Internal surfaces reflecting and inter-reflecting light to the point.

Table 4B-0-4B Daylight Factors (DF) to be met in each space

Location	*Daylight factor (%)*
Schools	
Classroom	1.9
Lecture hall	2.0 to 2.5
Study hall	2.0 to 2.5
Labs	1.9 to 3.8
Offices	
General	1.9
Drawing	3.75

Enquiry	0.63 to 1.9
Hospitals	
General wards and inpatient rooms	1.25
Labs	2.54 to 3.75
Libraries	
Stack rooms	0.9 to 1.9
Reading rooms	1.9 to 3.75
Counter areas	2.5 to 3.75
Catalogue rooms	1.9 to 2.5
Hotels	
Bedrooms	0.625
Lobbies and Dining	1.9
Kitchen	2.5
Circulation	0.3

Source: (Bureau of Indian Standards, 1989)

Daylight Factor Calculations are as described in CIBSE Lighting Guide 10 (1999)

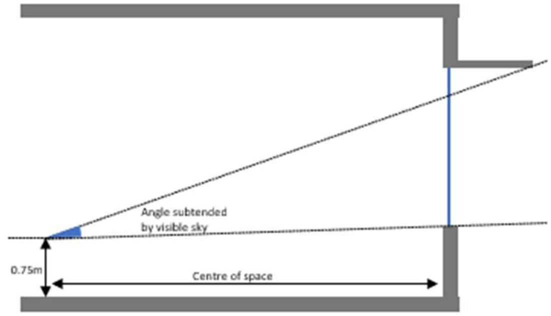
Example : An office building located in New Delhi, India is pursuing ECSBC compliance. Visible light transmission (VLT) of glazing in all orientations is 0.5. Windows have external shading devices with 0.45m along the North and 0.9mm along the south facade. Head height of fenestrations is 2.0 m with sill at 0.9m. Ceiling height is 3.5m.

Step 1: Calculate the floor area for each space.

Step 2: Note the glass transmittance for the window in each room

Step 3: Calculate the Net glazed area in the room.

Step 4: Calculated the angle subtended by the visible sky at the centre of the room at a height of 0.75m from the floor.



Step 4: Calculated the total surface area including the walls, floor, ceiling, and windows.

Step 5: Calculate the area weighted average reflectance for all surface.

Step 6: Calculate the Daylight factor with the formula: DF = (T*Aw*Q)/ (A{1-R^2}) and the percentage of total area that meets the DF requirement to meet Manual compliance.

4B 2.3.1.1. 4B2.3.3.2 Shading Requirement Calculation

Shading should be provided as per Table 4B-0-4C thereby avoiding direct solar ingress during the hottest part of the day.

Table 4B-0-4C Shading requirement

Latitude	*Shading extent on Sun path*
≥ 15°N	10am to 3pm from March to September for all orientations
< 15°N	10am to 3pm from February to November for all orientations

Shading to be demonstrated as per 4B.2.3.3.3 below

4B 2.3.1.2. 4B.2.3.3.3 Shading calculations using Sun path and Shading Protractor.

(a) Shading study may be carried out manually, using a shading protractor or may be carried out using a BEE approved simulation software

(b) The solar protractor with shading mask should be overlapped with the sun path to show the requirement of shading is met.

(c) Shading mask should be taken at the centre of the fenestration at the sill level (Point of reference) in case of simple shading geometry (Overhang and vertical fins). Multiple shading mask for a single fenestration should be provided at the centre and the corners of the fenestration at the sill level in case of complex shading geometry.

(d) Surrounding man-made or natural objects which will impact shading of the fenestration should be included in the Shading study.

(e) Documentation requirement:

i. A separate architectural plan shall be prepared with all areas meeting the daylight factor marked on the floor plans.

ii. A summary report shall be provided showing compliance.

iii. Report on the shading study compiled for each unique fenestration on each orientation.

4B.2.4 Building Envelope Sealing

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

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

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

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

(f) Site-built fenestration and doors

(g) Building assemblies used as ducts or plenums

(h) All other openings in the building envelope

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

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

Note 4B.1 Daylight Extent Factor and Useful Daylight Illuminance

Useful Daylight Illuminance (UDI) is defined as the annual occurrence of daylight between 100 lux to 2,000 lux on a work plane. This daylight is most useful to occupants, glare free and when available, eliminates the need for artificial lighting. Daylight extent factor provides a ratio of window sizes to floor area receiving UDI in accordance to window orientation.

Calculating Useful Daylight Illuminance (UDI)

An office building located in New Delhi, India is pursuing ECSBC compliance. Table 4B-0-1 lists the minimum daylight area requirements for compliance. The table specifies that for office buildings, minimum 40% of its floor area shall receive daylight in range of 100 – 2,000 lux for at least 90% of the year.

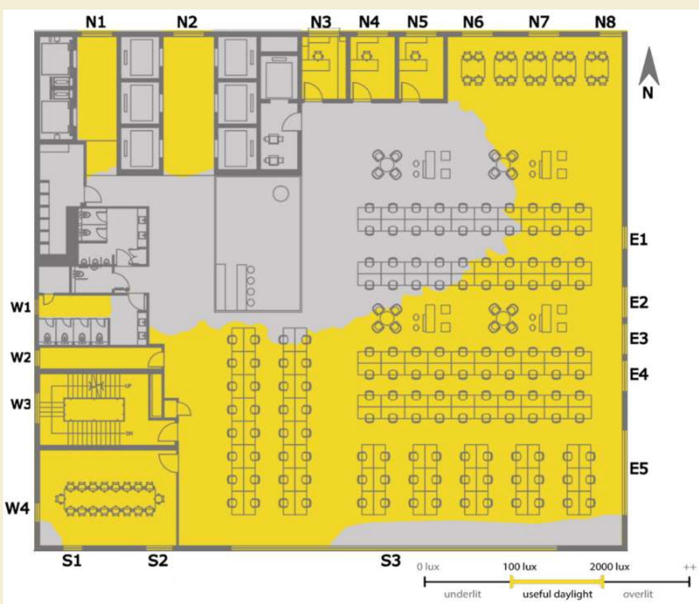
This typical floor has a rectangular layout (33 m x 38 m) of 1,254 m^2. Visible light transmission (VLT) of glazing in all orientations is 0.39. Windows have light shelves and external shading devices with Projection Factor (PF) ≥ 0.4. Head height of fenestrations is 3.0 m.

For compliance at least 502 m^2 (40% of 1,254 m^2) of floor area shall fulfil the UDI requirements. Daylit area should be indicated in floor plans submitted to code enforcement authorities. Design guidelines on daylighting stated in NBC (Part 8: Building Services, Section 1: Lighting and Natural Ventilation, Subsection 4.2: Daylighting) should also be referred to achieve the ECSBC, ECSBC+, or Super ECSBC requirement. Compliance with 4.2.3 Daylight Requirements can be checked for through two approaches.

(a) Analysis through software

If the whole building performance approach is used, compliance for daylighting requirements can be checked by analyzing the façade and floor plate design in an analytical software approved by BEE (3.4). The image below, developed through an approved software, specifies the lux levels and time-period of a year during which lighting levels would be available. With this information, designers can check if the required minimum area as per 4.2.3 has the required daylight levels

UDI Analysis with a Daylighting Analysis Software



4B.2.5 Shading calculations using Sunpath and Shading Protractor.

Calculation methodology

a. Shading mask study can be done manually over a solar shading protractor or can be done using any BEE certified simulation software.

b. The solar protractor with shading mask should be overlapped with the sun path to show the requirement of shading is met.

c. Shading mask should be taken at the centre of the fenestration (Point of reference) in case of simple shading geometry (Overhang and vertical fins). Multiple shading mask for a single fenestration should be provided at the centre and the corners of the fenestration in case of complex shading geometry.

d. Surrounding Man-made or natural objects which will impact shading of the fenestration should be included in the Shading mask study.

e. The Horizontal shading angle (HSA) is marked as horizontal shading angle of the shading device with the point of reference. Vertical shading angle (VSA) is marked as the angle made by the Shading device with the point of reference. Both should be marked on the Shading mask, whichever is applicable for the given case.

4B 3. Prescriptive Requirements

4B.3.1 Roof

Roofs may comply with the maximum assembly U-factors in Table 4B- 0- through Table 4B-0-. The roof insulation shall be applied externally as part of the roof assembly and not as a part of false ceiling.

Table 4B- 0-5 Roof Assembly U-factor (W/m^2.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 m^2 AGA	0.20	0.20	0.20	0.20	0.20

Table4B- 0-6 Roof Assembly U-factor (W/m^2.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 4B-0-7 Roof Assembly U-factor (W/m^2.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

4B3.1.1Vegetated 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.

(k) 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.

4B.3.2 Opaque External Wall

Opaque above grade external walls shall comply with the maximum assembly U-factors in Table 4B-0- through Table 4B- 0-8.

Table 4B-0-8 Opaque Assembly Maximum U-factor (W/m^2.K) Requirements for a 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 m^2 AGA	0.63	0.63	0.63	0.63	0.40
Business < 10,000 m^2 AGA	0.63	0.63	0.63	0.63	0.40
School <10,000 m^2 AGA	0.85	0.85	0.85	1.00	0.40

Table 4B- 0-9 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 4B- 0-10 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 §4B.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.

4B.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:

a. Maximum allowable Window Wall Ratio (WWR) is 40% (applicable to buildings showing compliance using the Prescriptive Method, including Building Envelope Trade-off Method)

b. Minimum allowable Visible light transmittance (VLT) is 0.27

c. 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 Table 4B-0- for ECSBC buildings and

Table 4B-0- for ECSBC+ buildings and 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 4B-0-11 Vertical Fenestration Assembly U-factor and SHGC Requirements for ECSBC Buildings

	Composite	*Hot and dry*	*Warm and humid*	*Temperate*	*Cold*
Maximum U-factor (W/m².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 4B-0-12 Vertical Fenestration U-factor and SHGC Requirements for ECSBC+ buildings

	Composite	*Hot and dry*	*Warm and humid*	*Temperate*	*Cold*
Maximum U-factor (W/m².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

Table 4B-0-13 Vertical Fenestration U-factor and SHGC Requirements for Super ECSBC buildings

	Composite	*Hot and dry*	*Warm and humid*	*Temperate*	*Cold*
Maximum U-factor (W/m².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

Exceptions to SHGC requirements in Table 4B-0- ,Table 4B-0-12 and Table 4B-013

(a) 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 4B-0- and Table 4B-0-12 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 9.

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 4B-0- and

v.

vi.

vii. Table 4B-0-.

viii. The maximum allowable SHGC is calculated by multiplying the prescriptive SHGC requirement for respective compliance level from Table 4B-0- and

ix.

x.

xi. Table 4B-0- with the SEF.

Table 4B-0-14 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 4B-0-15 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

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 4B-0-,Table 4B-0-12 and

Table 4B-0-, 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.

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 prescriptive approach?

Solution:

Table 4B-0- 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 prescriptive 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 prescriptive requirement of Table 4B-0-. 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 Table 4B-0-, as the latitude is greater than 15N.

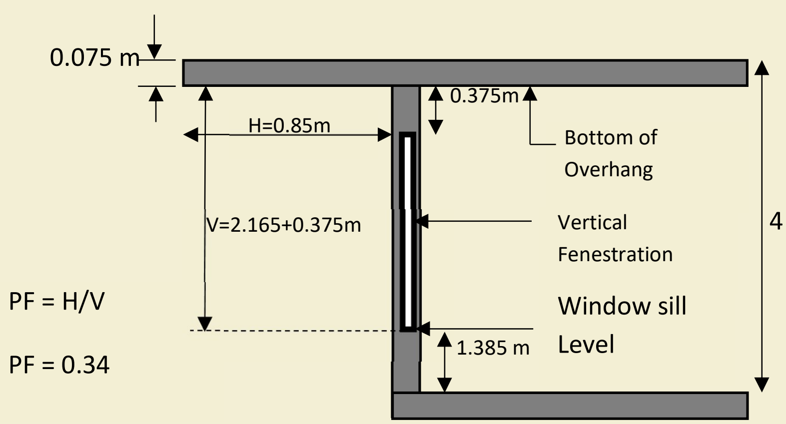
SEF for east for PF = 0.3 (as worst case) = 1.26

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



Exceptions to U-factor requirements in Table 4B-0-, Table 4B-0-12 and

Table 4B-0-:

Vertical fenestration on all unconditioned buildings or unconditioned spaces may have a maximum U-factor of 5 W/m^2.K provided they comply with all conditions mentioned in Table 4B-0-.

Table 4B-0-16 U-factor (W/m^2.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

4B.3.4 Skylights

Skylights shall comply with the maximum U-factor and maximum SHGC requirements of Table4B-0-. 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 Prescriptive Method for compliance.

Table4B-0-17 Skylight U-factor (W/m^2.K) and SHGC Requirements

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

Exception to §4B.3.4 Skylights in temporary roof coverings or awnings over unconditioned spaces

4B.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 prescriptive 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 4B.3.4. The envelope performance factor shall be calculated using the following equations.

Equation 0.1: $\boldsymbol{EPF}_{\boldsymbol{Total}} = \boldsymbol{EPF}_{\boldsymbol{Roof}} + \boldsymbol{EPF}_{\boldsymbol{Wall}} + \boldsymbol{EPF}_{\boldsymbol{Fenest}}$

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

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

$$EPF_{Fenest} = c_{1F\ ,Nor} \sum_{w=1}^{n} U_w A_w + c_{2Fenest,Nort} \sum_{w=1}^{n} \frac{SHGC_w}{SEF_w} A_w + c_{1Fenest,South} \sum_{w=1}^{n} U_w A_w$$

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

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

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

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 4B- 0- through Table 4B-0-3 for each class of construction.

Table 4B- 0-18 Envelope Performance Factor Coefficients – Composite Climate

	Daytime Business, Educational, Shopping Complex		*24-hour Business, Hospitality, Health Care, Assembly*	
	C factor $_{U\text{-}factor}$	C factor $_{SHGC}$	C factor $_{U\text{-}factor}$	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

Table4B- 0-1 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

1446 *Table4B-0-20 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

1447 *Table 4B-0-2 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 4B-0-3 Envelope Performance Factor Coefficients – Cold Climate

	Daytime Business, Educational, Shopping Complex		*24-hour Business, Hospitality, Health Care, Assembly*	
	C factor $_{U\text{-factor}}$	C factor $_{SHGC}$	C factor $_{U\text{-factor}}$	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

4B.3.5.1 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.

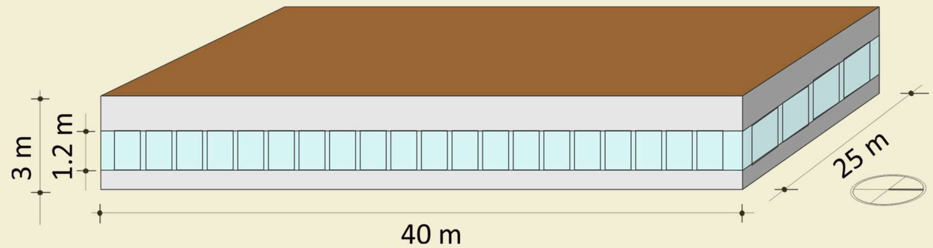
The U-factor of each envelope component shall be equal to the criteria from §4B.3 for each class of construction.

The SHGC of each window shall be equal to the criteria from §4B.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 m^2 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 prescriptive approach, U-factor, and SHGC must comply with requirements listed in Table 4B- 0-5, Table 4B-0-8, Table 4B-0- and VLT and window to wall ratio with requirements in § 4.3.3 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 prescriptive requirements for ECSBC complaint buildings.

Table 4-3-1 Prescriptive Requirements and Proposed Thermal Properties

	Prescriptive U-factor (W/m^2.K)			*Proposed U-factor (W/m^2.K)*			*Area (m^2)*
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

§4B.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$_{\text{North, South}}$ = 2 x (25m x 1.2m) = 60 m^2

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

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

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

Total Fenestration Area = 156 m^2, Total Wall Area = 390 m^2

WWR = 156/390= 0.4.

U-value of the roof of the proposed building, at 0.4 W/m².K does not fulfil prescriptive requirements.

Hence, this building will not be compliant if the prescriptive approach is followed. The compliance in prescriptive 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,

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

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

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

Standard Building EPF will be derived from U-factors, SHGCs and VLTs of walls, roofs and fenestration from Table 4B- 0-5, Table 4B-0-8, Table 4B-0-11 and § 4.3.3 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 4B-0-19. 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

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

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

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 $_{\textit{Standard Building}}$ ***from prescriptive 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.

4B 4. Alternative Compliance Path using Building Simulation

Compliance with the requirements of the envelope design may be demonstrated by using energy simulation to meeting the Peak Envelope Heat Gain Rate as defined in Table 4B-0-23, Table 4B-0-24, Table 4B-0-25 and Table 4B-0-26.

Peak Envelope Heat Gain Rate = Total Envelope Heat Gain(W)/ Total Envelope Area (m^2)

Where:
Total Envelope Heat Gain = Heat gain through the exterior walls+ Heat Gain through roof+ Heat gain through the fenestration
Total Envelope Area: Area of the exterior wall + area of the roof + area of the fenestration

Table 4B-0-23 - Peak Envelope Heat Gain Factor – Offices and all other Building types not covered below

Climatic Zone classification	ECSBC	ECSBC+	SuperECSBC
Hot-Dry	22 W/sqm	21.25 W/sqm	18.80 W/sqm
Warm Humid	18.85 W/sqm	18.37 W/sqm	15.96 W/sqm
Composite	24.59 W/sqm	23.74 W/sqm	20.95W/sqm
Temperate	22.89 W/sqm	21.78 W/sqm	17.85 W/sqm
Cold		N.A.	

Table4B-0-24 - Peak Envelope Heat Gain Factor – Educational Institutes

Climatic Zone classification	ECSBC	ECSBC+	SuperECSBC
Hot-Dry	13.19 W/sqm	12.10 W/sqm	10.57 W/sqm
Warm Humid	9.65 W/sqm	8.98 W/sqm	7.62 W/sqm
Composite	12.10 W/sqm	11.13 W/sqm	9.75 W/sqm
Temperate	10.13 W/sqm	9.78 W/sqm	7.85 W/sqm
Cold		N.A.	

Table4B-0-25 - Peak Envelope Heat Gain Factor – Shopping Malls

Climatic Zone classification	ECSBC	ECSBC+	SuperECSBC

Hot-Dry	12.97 W/sqm	12.50 W/sqm	10.99 W/sqm
Warm Humid	10.08 W/sqm	9.90 W/sqm	8.75 W/sqm
Composite	12.96 W/sqm	12.06 W/sqm	10.63 W/sqm
Temperate	12.68 W/sqm	10.66 W/sqm	8.75 W/sqm
Cold		N.A.	

Table4B-0-26 - Peak Envelope Heat Gain Factor – Hotels

Climatic Zone classification	ECSBC	ECSBC+	SuperECSBC
Hot-Dry	20.29 W/sqm	18.70 W/sqm	16.31 W/sqm
Warm Humid	12.80 W/sqm	11.78 W/sqm	10.77 W/sqm
Composite	17.06 W/sqm	15.71 W/sqm	13.14 W/sqm
Temperate	14.79 W/sqm	13.61 W/sqm	10.54 W/sqm
Cold		N.A.	

4B.4.1 Methodology – Energy Simulation

(a) The building envelope may be simulated with any BEE accepted whole building simulation software such as Energyplus, eQuest, VisDOE, Transys etc.

(b) The Simulation should be done for a peak day with the following parameters:

i. The simulation model must have the same geometry and zoning as per the architectural design.
ii. The simulation should consider the peak cooling demand day in the year, and the schedule should consider 24 hours occupancy.
iii. The indoor temperature set point should be $22^{O} \pm 2^{O}$
iv. All other parameters should be as per Chapter 9 whole building simulation baseline parameters.

(c) From the Simulation model, the heat gain through conduction for walls, roof and fenestration and solar- radiation heat gain through the glass in the fenestration may be obtained.

(d) The Peak Envelope heat gain may be obtained by adding the heat gain through the roof, wall and fenestration (in KW) and dividing the same by the total façade area + roof area, so that the Peak envelope Heat Gain can be obtained in **KW/sqm**.

Normative Reference:

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

The following Standards contain provisions which through reference in this text, constitute provisions of the standards. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the Standards indicated below:

Standard Number	***Title***
ISO-15099 (2003)	Thermal performance of windows, doors and shading devices -- Detailed calculations
ASTM E408-71 (2002)	Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
ASTM E903-96	Standard Test Method for Solar Absorbtance, Reflectance, and Transmittance of Materials Using Integrating Spheres.
SP 7: 2016	National Building Code of India 2016 (NBC 2016)
I.S. 2440 second revision	Indian Standards Guide for Daylighting of Buildings second revision
New CIBSE Lighting Guide 10	Daylighting- A guide for Designers: Lighting for the Built Environment.
IES LM-83-12	Approved Method: IES Spatial Daylight Autonomy (sDA) and Annual Sunlight Exposure
Eco-Niwas Samhita 2018	Energy Conservation and Building Code for Residential Buildings
ISHRAE 10001: 2019	Standard for Indoor Environment Quality
ISO 17772-1:2017	Energy performance of buildings- Indoor environmental quality — Part 1: Indoor environmental input parameters for the design and assessment of energy performance of buildings

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Section 5

ECSBC – COMFORT SYSTEM AND CONTROLS

5. Comfort Systems and Controls

5.1 General

All heating, ventilation, air conditioning (HVAC) equipment and systems contribute significantly to occupant comfort, productivity, health and well-being but simultaneously consume a major part of the energy consumed in the building.

Therefore, conserving the energy consumed by HVAC equipment and systems assumes a lot of importance.

Comfort systems and their controls shall comply with the mandatory provisions of Clause 5.2 and the prescriptive criteria detailed in Clause 5.3 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 Clause 5.3.11 or Clause 5.3.12 and relevant criteria of Clause 5.3 shall be complied.

5.2 Mandatory Requirements

5.2.1 Ventilation

All habitable spaces shall be ventilated with outdoor air in accordance with the requirements of Clause 5.2.1 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

Natural Ventilation Design Requirements

Naturally ventilated buildings shall meet the following requirements.

a) If the building has ceiling fans, they shall comply with the requirements of BEE 3-star rating at the minimum.
b) Air circulators, if provided, shall comply with IS 2997.
c) Exhaust fans, if provided, shall comply IS 2312 with minimum efficiency requirements of fans specified in Clause 5.3.1.

Mechanical Ventilation Air Quantity Design Requirements

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 than or equal to 600 m^2.

Demand Control Ventilation

Mechanical ventilation systems serving Air conditioning spaces shall have demand control ventilation if they provide outdoor air greater than 5400 m^3/hr to the conditioned space. Such outdoor air supply to the space shall be through:

An air side economizer, or

Automatic modulating control of the outdoor air damper actuated through CO_2 sensors mounted within the space. CO_2 sensors shall be mounted at breathing height level and shall be provided for any space in excess of 50 m^2.

Demand control ventilation 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.

Exceptions to 5.2.1.3

a) Any space that has processes or operations that generate dust, fumes, mists, vapors or gases and are provided with mechanical exhaust.

b) Systems with exhaust air energy recovery.

5.2.2 Space Conditioning Equipment

Chillers

a) For ECSBC Compliance minimum 2 Star rated chillers shall be installed.

b) 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 where the total cooling load to be catered to by the air cooled system is less than 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.

Unitary, Split, Packaged Air-Conditioners

Unitary (window), Split and Packaged air-conditioners shall meet or exceed the efficiency requirements given in **Error! Reference source not found.**1. Window and split air conditioners shall be BEE Star labelled. EER shall be as per IS 8148 for all Unitary, Split and Packaged air conditioners of capacity greater than 10.5 kWr.

Table 5.1 Minimum Requirements for Unitary, Split, Packaged Air Conditioners in ECSBC Building

Cooling Capacity (kWr) Cooled	Water	Air Cooled
≤ 10.5	NA	BEE 3 Star
> 10.5 EER	3.7	3.2 EER

Variable Refrigerant Flow (VRF air-conditioners)

Variable Refrigerant Flow (VRF) systems shall be of the minimum efficiency requirements as specified in Table 5-2 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 5-2: Minimum Efficiency Requirements for VRF Air conditioners for ECSBC Building (The ISEER and EER ratings calculation shall be as per BIS Standard as and when published)

		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

Air Conditioning and Condensing Units serving Computer Rooms and other special applications.

a) Air conditioning and condensing units serving computer rooms shall be of minimum energy efficiency as per the Table 5-3.

Table 5-3: Minimum Efficiency Requirements for Computer Room Air Conditioners

Equipment type	Net Sensible Cooling Capacity[a]	Minimum SCOP-127[b]	
		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)

b) In respect of 24-hour operational areas such as server/battery rooms in otherwise 8 or 12 hour occupancies separate air conditioning units shall be installed for such areas which can act as a stand by unit when the central system is operational but can take over when the central system is shut down. Similarly, where temperatures lower than those to be maintained in other areas of the building are required in certain areas (example : Operation theatres in hospitals) separate condensing units shall be installed for such areas so that the central system can work with higher efficiency.

Hot water production (For heating or reheat in HVAC Systems)

Hot water shall be produced through any one of the following methods:

Solar water heating. Solar water heating system shall comply with IS 12976 and shall be minimum BEE 3-star rated.

Heat recovery systems using waste heat from air/ water cooled condensers.

Air to water or water to water heat pumps

Note:

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 hot water is available for heating or reheat purposes.

For service water heating in the building, please refer to Section 8

5.2.3 Controls

To comply with the Code, buildings shall meet the requirements of Clause 5.2.3.1 through Clause 5.2.3.6.

Timeclock

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

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

Exceptions to Clause 5.2.3.1 :

Cooling and Heating systems of capacity less than 17.5 kWr.

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:

a) 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.
b) Where separate heating and cooling equipment serve the same temperature zone, temperature controls shall be interlocked to prevent simultaneous heating and cooling.
c) Separate temperature control shall be installed in each
    - Guest room of hotels and resorts,
    - Ii Individual zones in office buildings
    - Iii Air-conditioned classroom, lecture room, and computer room of educational institutions.
    - Iv In-patient rooms and wards in healthcare facilities

Occupancy Controls

Occupancy controls shall be installed at each zone level to de-energize or to throttle to reduce or minimize the fresh air ventilation and/or air conditioning systems when the building or part of the building or individual zones served by that system are not occupied.

Example: 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 27°C or higher for energy saving.

Cooling Tower Fan Controls.

Cooling towers in buildings with built up area greater than 20,000 m^2 and located in a place where the wet bulb temperature drops below 17°C shall have fan controls based on wet bulb logic capable to reduce fan speed up to 50 Percent of the rated full speed.

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 clause 5.2.3.5: Air handling units with capacity less than 5000 cmh .

Damper controls

Where multiple fans serve the same supply or exhaust system, automatic shutdown dampers shall be provided with input from pressure transducers.

Exception to Clause 5.2.3.6: Dampers shall not be provided in exhaust systems serving kitchen exhaust hoods.

5.2.4 Piping and Ductwork

Piping for heating, space conditioning, and service hot water systems shall meet the insulation requirements listed in Table 5-4 through Table 5-6. 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 5.4 through 5.6 shall be increased by 0.2.

Table 5-4 Insulation Requirements for Pipes in ECSBC Building

Operating Temperature (ºC)	Pipe size (mm)	
	<40	≥40
	Insulation R value (m^2.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 5-5 Insulation Requirements for Pipes in ECSBC+ Building

Operating Temperature (ºC)	Pipe size (mm)	
	< 40	≥40
	Insulation R value (m^2.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 5-6 Insulation Requirements for Pipes in Super ECSBC Buildings

Operating Temperature (ºC)	Pipe size (mm)	
	< 40	≥40
	Insulation R value (m^2.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

5.2.4.2 Ductwork and Plenum Insulation

Ductwork and plenum shall be insulated in accordance with Table 5-7.

Table 0-7 Ductwork Insulation (R value in m^2. 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

5.2.5 Commissioning of Systems

In respect of all occupancies specified in the code with built up area exceeding 5000 m^2 (excluding any non- air conditioned basements), the HVAC System shall be Commissioned as specified in Section 12 of this Code .

In addition to the above, system balancing shall be done for all air and water systems serving zones with a total conditioned area exceeding 500 m^2.

Air System Balancing

Air systems shall be balanced in a manner to first minimize throttling losses; then, for fans with fan system power greater than 0.75 kW, fan speed shall be adjusted to meet design flow conditions.

Hydronic System Balancing

Hydronic systems shall be proportionately balanced in a manner to first minimize throttling losses; then the pump impeller shall be trimmed, or pump speed shall be adjusted to meet design flow conditions.

5.2.6 Condenser Locations

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.

5.3 Prescriptive Requirements

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

5.3.1 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 5-8 through Table 5-

Exception to Clause 5.3.1: 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.
In respect of all Centrifugal and Axial Flow fans used in the Comfort system, Fan Energy Index (FEI) shall meet or exceed the requirements as below:

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

(i) For Centrifugal fans requiring shaft power 2.5KW or higher, the FEI shall be ≥ 1.1
(ii) For Axial flow fans requiring shaft power 2.5KW or higher, FEI shall be ≥ 1.

Table 5-8 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 5-9 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	70%	IE 4

Table 5-10 Mechanical and Motor Efficiency Requirements for Fans in Super ECSBC Buildings

System Type	Fan Type	Mechanical Efficiency	Motor Efficiency (As per IS 12615)
Air-handling unit	Supply, return and exhaust	75 %	IE 4

5.3.2 Chillers

Chillers shall be of minimum efficiency requirements as per Standards and Labelling Program of BEE for ECSBC, ECSBC+ and Super ECSBC buildings. BEE Star rating for ECSBC, ECSBC+ and Super ECSBC Buildings shall be as indicated in Table 5-1. Chillers shall be rated both at full load and at part load conditions in accordance with IS 16590

Table 5-14 Minimum Efficiency Requirements for Chillers for ECSBC, ECSBC+ and Super ECSBC Buildings

Building Category	Water Cooled	Air Cooled
ECSBC	2 Star	2 Star
ECSBC+	4 Star	4 Star
SUPER ECSBC	5 Star	5 Star

5.3.3 Pumps

Chilled Water and condenser water pumps shall meet or exceed the minimum energy efficiency requirements specified in Table 5-12 through

Table 5-16. Requirements for pumps in district cooling systems and hot water pumps for space heating are limited to the installed efficiency requirement of individual pump equipment only. To show compliance, calculate the total installed pump capacity in kilo watt and achieve the prescribed limits per kilo watt of refrigeration installed in the building .

Pumps used in HVAC Systems shall meet or exceed the minimum efficiency requirements as per Table 5.12 through 5.14.

Table 5-12 Pump Efficiency Requirements for ECSBC Building

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 5-15 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 5-16 Pump Efficiency Requirements for SuperECSBC Building

	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

5.3.4 Cooling Towers

Cooling towers shall be designed for an Approach not exceeding 3.9^{O}C in respect of ECSBC Buildings and 2.8^{O}C in respect of ECSBC+ and Super ECSBC Buildings. They shall meet fan efficiency requirements as specified in Table 5.15 through Table 5-17.

Table 5-17 Cooling Tower Fan Efficiency Requirements for ECSBC Buildings

Equipment type	Rating Condition	Efficiency
Open circuit cooling tower Fans	37.2°C entering water 31.6^{O}C leaving water 28.3 °C WB outdoor air	0.35 kW/(L/s)

Table 5-16 Cooling Tower fan Efficiency Requirements for ECSBC+ Buildings

Equipment type	Rating Condition	Efficiency
Open circuit cooling tower Fans for Chillers ≤530kWr	36.4°C entering water 30.8°C leaving water 28.3°C WB outdoor air	0.35 kW/(L/s)

Table 5-17 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/(L/s)

5.3.5 Economizers

Economizer for ECSBC, ECSBC+, and Super ECSBC Building

Each cooling fan system in buildings with built up area greater than 20,000 m^2, shall include at least one of the following:

(a) An air economizer capable of modulating outside-air and return-air dampers to supply 50% of the design supply air quantity as outside-air.
(b) A water economizer capable of providing 50% of the expected system cooling load at outside air temperatures of 10°C dry-bulb/7.2°C wet-bulb and below.

Exception to Clause 5.3.5.1:

(a) Projects in warm-humid climate zones.
(b) Projects with only daytime occupancy in the hot-dry climatic zone.
(c) Individual cooling or heating fan systems less than 11520 CMH

Partial Cooling .

Where required by Clause 5.3.5.1, economizers shall be capable of providing partial cooling even when additional mechanical cooling is required to meet the cooling load.

5.3.5.3 Economizer Controls.

Air side economizer shall be equipped with controls.

(a) That allow dampers to be sequenced with the mechanical cooling equipment and not be controlled by only mixed air temperature.
(b) Capable of automatically reducing outdoor air intake to the design minimum outdoor air quantity when outdoor air intake will no longer reduce cooling energy usage.
(c) Capable of high-limit shutoff at 24 °C dry bulb temperature.

Testing of Economizers.

Air side economizers shall be tested in the field following the requirements in Appendix 12 of ECBC to ensure proper operation.

Exception to clause 5.3.5.3 Air side economizers which is factory tested and calibrated as per procedures given in 12 of ECBC 2017 to ensure proper operation and duly certified by Authority Having Jurisdiction (AHJ)

5.3.6 Variable Flow Hydronic Systems

Variable Fluid Flow

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

(a) 50% of the design flow rate, or
(b) The minimum flow required by the equipment manufacturer for proper operation of the chillers .

Automatic shut off of Condenser water flow.

Water cooled air-conditioning or heat pump units with a circulation pump motor greater than or equal to 7.5 kW shall have two way automatic isolation valve or other control provisions on each water cooled air conditioning or heat pump circuit which are interlocked to the compressor to shut off water flow through the circuit as well as dedicated cooling tower fan when the respective compressor is not operating.

5.3.7 Unitary, Split, Packaged Air-Conditioners

Unitary (Window) 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 IS1391 Part 1 and Part 2 are shall meet or exceed the minimum efficiency requirements as under :

ECSBC + BEE 4 Star

Super ECSBC BEE 5 Star

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 5.18 for ECSBC + and Table 5.19 for Super ECSBC Buildings.

Table 5-18 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 5-19 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 5.18 and 5.19 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 4 Star for ECSBC + Buildings and 5 Star for Super ECSBC Buildings.

5.3.8 Variable Refrigerant Flow Air conditioners

Variable Refrigerant Flow (VRF) Air conditioners shall meet or exceed the efficiency requirements given in Table 5-20 through Table 5-22.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 – 5-20 Minimum Efficiency Requirements for VRF Air conditioners for ECSBC Buildings

	ECSBC
	ISEER
For <40kWr	5.4
For ≥ 40kWr and <70kWr	5.5
For ≥70kWr	5.6

Table – 5-21 Minimum Efficiency Requirements for VRF Air conditioners for ECSBC+ Buildings

	ECSBC+
	ISEER
For <40kWr	6.4
For ≥ 40kWr and <70kWr	6.5
For ≥70kWr	6.6

Table – 5-22 Minimum Efficiency Requirements for VRF Air conditioners for Super ECSBC Buildings

	Super ECSBC
	ISEER
For <40kWr	7.4
For ≥ 40kWr and <70kWr	7.5
For ≥70kWr	7.6

5.3.9 Controls for ECSBC+ Buildings

ECSBC+ rated building shall have automated control capability to achieve below requirements in addition to complying with requirements of Clause 5.2.3.

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 have the capability to optimize (reduce) the AHU fan static pressure, wherever the AHU serves multiple zones through "Zone temperature control devices " such as VAV boxes, auto -regulating diffusers etc. The control system shall have the capability to monitor such devices and optimize the dynamic set point of the fan static pressure sensor in the duct, thus controlling the fan speed while maintaining thermal comfort to the occupied zones.

c) Secondary pump energy optimisation: -

The Control system shall have the capability to optimize the pump speed requirement to feed different loops and equipment and optimise chilled water flow across AHUs and terminal units.

5.3.10 Controls for Super ECSBC Buildings

Super ECSBC Buildings shall comply with requirements of this clause in addition to complying with requirements of Clause 5.2.3 and Clause 5.3.9.

a) Zone Temperature Control

Heating and cooling set points of the Zone temperature controllers shall be checked at regular intervals. The users often modify these set points. A centralized system shall detect and correct extreme values of set points due to misunderstanding of users.

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 for combined benefits of reducing solar heat gain, harvesting natural sunlight and to 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.

Note: For recommended controls to meet the prescriptive requirements of the code to comply with ECSBC, ECSBC+ and Super ECSBC levels of certification, please refer to Table 13.1 in section 13 IoT and Controls and the Informative Annexure - A.

5.3.11 Energy Recovery

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

Exception to Clause 5.3.11: Energy recovery from Kitchen, Laundry and Laboratory exhaust systems.

5.3.12 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 prescriptive requirement. This alternate compliance approach is applicable for central chilled water plant side system in all building types. The total installed capacity per kilo-watt refrigeration load shall be less than or equal to maximum threshold requirements as specified in Table 5-23. Equipment that shall be included in central chilled water plant side system for this alternate approach are chillers, chilled water pumps, condenser water pumps, and cooling tower fan. Compliance check will be based on annual hourly simulation refer Table___________ for developing the proposed design.

Table 5-23 Maximum System Efficiency Threshold for ECSBC, ECSBC+, and Super ECSBC Buildings

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

5.3.12.1 Documentation Requirement

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

(c) 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.
(d) Brief description of the project with location, number of stories, space types, conditioned and unconditioned areas, hours of operation.
(e) List of the energy-related building features of the proposed design.
(f) List showing compliance with the mandatory requirements of this code.
(g) 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.
(h) Explanation of any significant modelling assumptions made.
(g) Explanation of any error messages noted in the simulation program output.

The total system efficiency shall be calculated as follows:

$$\text{Total System Efficiency} = \frac{\text{Annual Chiller plant Energy consumption(kWh)}}{\text{Annual Chilled water generation (kWrh)}}$$

5.3.13 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 Clause 5.2.2, but shall comply with all other applicable mandatory provisions of Clause 5.2 as applicable. Wherever applicable, requirements of Clause 5.3 and Clause 5.3.122 shall be complied with. The approved list of low energy comfort systems[1] is given below:

(i) Evaporative cooling
(j) Desiccant cooling system
(k) Solar air conditioning
(l) Tri-generation (waste-to-heat)
(m) Radiant cooling system
(n) Ground source heat pump
(o) Adiabatic cooling system
(p) 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 5.3.13.1..

5.3.13.1 Documentation Requirement

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

a) Brief details of the low- energy comfort system. type, capacity and efficiency.
b) Details of compliance with mandatory and prescriptive requirements other than those exempted in Clause 5.3.13.
c) 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.

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Section 6

ECSBC – LIGHTING AND CONTROLS

6. Lighting and Controls

6.1 General

Lighting systems and equipment shall comply with the mandatory provisions of 6.2 and the prescriptive criteria of 6.3. 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 6.1:

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.

6.2 Mandatory Requirements

6.2.1 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

6.2.2 Interior Lighting Control

6.2.2.1 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:

a) A scheduled basis at specific programmed times. An independent program schedule shall be provided for areas of up to and including 2,500 m^2 and not more than one floor, or,
b) 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 6.2.2.1:

1. Lighting required for 24/7 continuous operation.

2. Lighting in spaces where patient care is rendered.

3. General lighting and task lighting in spaces where automatic lighting shutoff would endanger the safety or the security of occupants in the space.

6.2.2.2 Space Control

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

   ii. offices greater than 30 m^2, shall have the following requirements:

      1. Control zones for general lighting shall be limited to 60 m^2.

2. Control zones for general lighting shall be permitted to automatically turn on, up to full power upon occupancy.
3. 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 6.2.2.1 for a maximum of 2 hours, and

v. be readily accessible and located so the occupants can see the control.

(b) Occupancy sensors shall be provided in

i. All habitable spaces less than 30 m^2, enclosed by walls or ceiling height partitions.
ii. All storage or utility spaces more than 15 m^2.
iii. Public toilets more than 25 m^2, 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 6.2.2.2 (a) 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.

6.2.2.3 Control in Daylight Areas

(a) Luminaires, installed within day lighting extent from the window as calculated in 4.2.3, 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:

i. Has a delay of minimum 5 minutes, and,
ii. 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.

6.2.3 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 6.2.3: Exterior Lighting systems designed for emergency and firefighting purposes.

6.2.4 Controls for ECSBC+ and Super ECSBC Buildings

ECSBC+ and Super ECSBC building(s) shall have centralized lighting control system with at least ~~one or more of the~~ following features –

a) Complete control of internal and external luminaires- switching on/off or dimming and scheduling of individual or group of luminaires
b) Space occupancy feedback from occupancy sensors
c) Luminaire failure feedback (individual/group) for maintenance
d) Energy monitoring (separately for internal and external lighting)
e) Interoperability with the BMS/BEMS

6.2.5 Additional Control

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 m^2 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 6.2.2.2.
(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.

6.2.6 Exit Signs

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

6.2.7 Lighting Power

(a) The Connected lighting power of exterior lighting applications shall not exceed the lighting power limits specified in section 6.3.5 for 'ECSBC Buildings' excluding the luminaires/application provided with exemptions in the section 6.3.5.
(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.

6.3 Prescriptive Requirements

6.3.2 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 6.3.4 and shall not exceed the interior lighting power allowance determined in accordance with either 6.3.2 or 6.3.3.

Exception to 6.3: 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.

6.3.3 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 6-1 for ECSBC Buildings, from Table 6-2 for ECSBC+ Buildings and from Table 6-3 for Super ECSBC Buildings.
(b) Calculate the gross illuminated ~~lighted~~ area for each building area type.
(c) The interior lighting power allowance is the sum of the products of the gross lighted floor area of each building area times the allowed lighting power density for that building area type.

Table 6-1 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	10.89	Museum	6.6
Hotels /Motel	6.27	Post office	7.48
Shopping Mall	9.24	Religious building	7.81
University and Schools	8.25	Sports arena	8.58
Library	9.9	Transportation	6.6
Dining: bar lounge/leisure	8.8	Warehouse	5.28
Dining: cafeteria/fast food	8.25	Performing arts theater	9.68
Dining: family	7.7	Police station	7.26
Dormitory	6.16	Workshop	10.23

Fire station	6.6	Automotive facility	8.69
Gymnasium	8.91	Convention center	7.48
Manufacturing facility	9.68	Parking garage	1.98

Table 6-2 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	9.9	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/fast food	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	7.9
Gymnasium	8.1	Convention centre	6.8
Manufacturing facility	8.8	Parking garage	1.8

Table 6-3 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	6.03	Motion picture theatre	4.14
Hospitals	8.91	Museum	5.4
Hotels /Motel	5.13	Post office	6.12
Shopping Mall	7.56	Religious building	6.39
University and Schools	6.75	Sports arena	7.02
Library	8.1	Transportation	5.4

Dining: bar lounge/leisure	7.2	Warehouse	4.32
Dining: cafeteria/fast food	6.75	Performing arts theatre	7.92
Dining: family	6.3	Police station	5.94
Dormitory	5.04	Workshop	8.37
Fire station	5.4	Automotive facility	7.11
Gymnasium	7.29	Convention centre	6.12
Manufacturing facility	7.92	Parking garage	1.62

6.3.4 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.

(b) Determine the appropriate building type and the allowed lighting power density from Table 6-4 for ECSBC Buildings, Table 6-5 for ECSBC+ Buildings and, Table 6-6 for SuperECSBC 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.

(e) Room Geometry Adjustment

When using the space-by-space Method, an adjustment of the space LPD allowance is permitted for individual spaces where room cavity ratio (RCR) calculated for the empty room is documented to be greater than the RCR threshold for that space type shown in interior lighting power allowance tables.

RCR = 2.5 × room cavity height × room perimeter length/room area

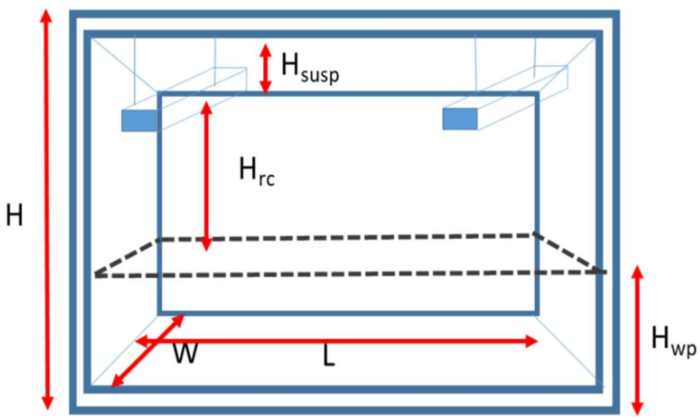
Where,

Room cavity height = luminaire mounting height – work plane height

For corridor/transition spaces, this adjustment is allowed when the corridor is less than 2.4 m wide, regardless of the RCR. The LPD allowance for these spaces may be increased which is determined using the following equation:

LPD Increase = Base Space LPD × 0.20

Note: RCR sample calculation for an enclosed office room example provided below



Sample calculation for Room Cavity Ratio for an Office Cabin

From the figure above

Room length (L) = 5m

Room breadth (W)= 3m

Room Height (H)= 4 m

Working Plane Height (H_{wp}) = 0.8m

Luminaire Suspension Height (H_{susp}) = 1 m

Room Cavity Height (H rc)

= Room Height- Luminaire Suspension Height- Working Plane Height

= (H –H wp – H susp)

= (4 -1 -0.8) m=2.2 m

Room perimeter length = 2 x (L +W) = 2 x (5+3) =16m

Room area = LXW= 5 x 3= 15 m^2

Room Cavity Ratio (RCR)= 2.5 x room cavity height x room perimeter length/room area

= (2.5 x 2.2 x 16) /15

= 5.87

As per table 6.2 for Enclosed Office < 13.9 $m^{2,}$, the reference RCR is 8 RCR. There is no additional LPD allowed for the example shown above

a) Allowance for tunable white lighting- If any regularly occupied space has got >80% of the lighting fixtures that can emit tunable white Light, then additional 10% of interior lighting power allowance on the base space LPD is allowed.

b) For spaces in which lighting is installed for the purpose of video conferencing, additional lighting power allowance of 5.38 W/m^2 is allowed.

Table 6-4 Interior Lighting Power for ECSBC Buildings – Space Function Method Base LPD without modifiers

Category	RCR	LPD (W/m^2)	Category	RCR	LPD (W/m^2)
Restrooms	8	8.8	Stairway		5.5
Storage	9 (<4.6 m^2)	5.72	Corridor/ Transition	Width <2.4 m	5.28
	6 (≥4.6 m^2)	4.18	Lobby	4	9.46
Conference/ Meeting	6	10.45	Driveways (covered/ basement)	4	1.65
Parking Bays (covered/ basement)	4	1.32	Driveways (covered/ basement) - Daylight transition zone	4	12.54
Electrical/ Mechanical	6	8.36	Workshop	6	10.41
Business					
Enclosed – Office < 13.9 m^2	8	8.69	Open Plan (Office >27.9 m^2)	4	6.6
Enclosed – Office >13.9 and <27.9 m^2	8	7.81	Service/Repair	8	5.5
Banking Activity Area	6	6.6			
Healthcare					
Emergency	8	15.73	Recovery	6	13.97
Exam/Treatment	8	15.73	Storage	9 (<4.6 m^2)	5.72
Nurses' Station	6	12.65		6 (≥4.6 m^2)	4.18
Operating Room	6	15.73	Laundry/Washing	4	6.05
Patient Room	6	9.24	Lounge/Recreation	6	9.13
Pharmacy	6	8.25	Medical Supply	6	6.6

Physical Therapy	6	9.68	Nursery	6	10.34
Radiology/Imaging	6	11.11	Corridor/Transition	width<2.4m	7.15
Hospitality					
Hotel Dining	4	6.16	Hotel Lobby	4	5.72
For Bar Lounge/ Dining	4	9.02	Motel Dining	4	4.29
For food preparation	6	11.44	Motel Guest Rooms	6	4.84
Hotel Guest Rooms	6	4.84			
Shopping Complex					
Mall Concourse	4	6.71	For Family Dining	4	6.16
Sales Area	6	10.01	For food preparation	6	11.44
Motion Picture Theatre (Audience Seating Area)	4	3.19	Bar Lounge/ Dining	4	9.02
Educational					
Classroom/Lecture	4	8.47	Card File and Cataloguing	4	8.25
For Classrooms			Stacks (Library)	4	13.97
Laboratory (in or as a classroom)	6	12.43	Reading Area (Library)	4	10.23
Assembly					
Dressing Room	6	4.62	Seating Area - Performing Arts Theatre	8	12.98
Exhibit Space – Convention Centre	4	5.94	Lobby - Performing Arts Theatre	6	14.3
Seating Area - Gymnasium	6	2.75	Seating Area – Convention Centre	6	6.6
Fitness Area - Gymnasium	4	9.68	Seating Religious Building	4	8.58

Museum – General Exhibition	6	3.63	Playing Area - Gymnasium	4	9.68
Museum – Restoration	4	14.74			

Table 6-5 Interior Lighting Power for ECSBC+ Buildings – Space Function Method base LPD without modifiers

Category	RCR	LPD (W/m^2)	Category	RCR	LPD (W/m^2)
Restrooms	8	8	Stairway		5
Storage	9 (<4.6 m^2)	5.2	Corridor/ Transition	Width <2.4m	4.8
	6 (≥4.6 m^2)	3.8	Lobby	4	8.6
Conference/ Meeting	6	9.5	Driveways (covered/ basement)	4	1.5
Parking Bays (covered/ basement)	4	1.2	Driveways (covered/ basement) - Daylight transition zone	4	11.4
Electrical/ Mechanical	6	7.6	Workshop	6	9.46
Business					
Enclosed: Office < 13.9 m^2	8	7.9	Open Plan (Office >27.9 m^2)	4	6
Enclosed: Office >13.9 and <27.9 m^2	8	7.1	Service/Repair	8	5
Banking Activity Area	6	6			
Healthcare					
Emergency	8	14.3	Recovery	6	12.7
Exam/Treatment	8	14.3	Storage	9 (<4.6 m^2)	5.2
Nurses' Station	6	11.5		6 (≥4.6 m^2)	3.8
Operating Room	6	14.3	Laundry/Washing	4	5.5

Patient Room	6	8.4	Lounge/Recreation	6	8.3
Pharmacy	6	7.5	Medical Supply	6	6
Physical Therapy	6	8.8	Nursery	6	9.4
Radiology/Imaging	6	10.1	Corridor/Transition	Width <2.4m	6.5
Hospitality					
Hotel Dining	4	5.6	Hotel Lobby	4	5.2
For Bar Lounge/ Dining	4	8.2	Motel Dining	4	3.9
For food preparation	6	10.4	Motel Guest Rooms	6	4.4
Hotel Guest Rooms	6	4.4			
Shopping Complex					
Mall Concourse	4	6.1	For Family Dining	4	5.6
Sales Area	6	9.1	For food preparation	6	10.4
Motion Picture Theatre (Audience Seating Area)	4	2.9	Bar Lounge/ Dining	4	8.2
Educational					
Classroom/Lecture	4	7.7	Card File and Cataloguing	4	7.5
For Classrooms			Stacks (Library)	4	12.7
Laboratory (in or as a classroom)	6	11.3	Reading Area (Library)	4	9.3
Assembly					
Dressing Room	6	4.2	Seating Area - Performing Arts Theatre	8	11.8
Exhibit Space – Convention Centre	4	5.4	Lobby - Performing Arts Theatre	6	13
Seating Area - Gymnasium	6	2.5	Seating Area – Convention Centre	6	6
Fitness Area - Gymnasium	4	8.8	Seating Religious Building	4	7.8

Museum – General Exhibition	6	3.3	Playing Area - Gymnasium	4	8.8
Museum – Restoration	4	13.4			

Table 6-6 Interior Lighting Power for SuperECSBC Buildings – Space Function Method base LPD without modifiers

<table>
<tr><th colspan="2">Category</th><th>RCR</th><th>LPD (W/m^2)</th><th>Category</th><th>RCR</th><th>LPD (W/m^2)</th></tr>
<tr><td colspan="2">Restrooms</td><td>8</td><td>7.2</td><td>Stairway</td><td></td><td>4.50</td></tr>
<tr><td colspan="2" rowspan="2">Storage</td><td>9 (<4.6 m^2)</td><td>4.68</td><td>Corridor/ Transition</td><td>Width <2.4m</td><td>4.32</td></tr>
<tr><td>6 (≥4.6 m^2)</td><td>3.42</td><td>Lobby</td><td>4</td><td>7.74</td></tr>
<tr><td colspan="2">Conference/ Meeting</td><td>6</td><td>8.55</td><td>Driveways (covered/ basement)</td><td>4</td><td>1.35</td></tr>
<tr><td colspan="2">Parking Bays (covered/ basement)</td><td>4</td><td>1.08</td><td>Driveways (covered/ basement) Daylight transition zone</td><td>4</td><td>10.26</td></tr>
<tr><td colspan="2">Electrical/Mechanical</td><td>6</td><td>6.84</td><td>Workshop</td><td>6</td><td>8.51</td></tr>
<tr><td colspan="7">Business</td></tr>
<tr><td rowspan="2">Enclosed</td><td>Office < 13.9 m^2</td><td>8</td><td>7.11</td><td>Open Plan (Office >27.9 m^2)</td><td>4</td><td>5.40</td></tr>
<tr><td>Office >13.9 and <27.9 m^2</td><td>8</td><td>6.39</td><td>Service/Repair</td><td>8</td><td>4.50</td></tr>
<tr><td colspan="2">Banking Activity Area</td><td>6</td><td>5.4</td><td></td><td></td><td></td></tr>
<tr><td colspan="7">Healthcare</td></tr>
<tr><td colspan="2">Emergency</td><td>8</td><td>12.87</td><td>Recovery</td><td>6</td><td>11.43</td></tr>
<tr><td colspan="2">Exam/Treatment</td><td>8</td><td>12.87</td><td rowspan="2">Storage</td><td>9 (<4.6 sqm)</td><td>4.68</td></tr>
<tr><td colspan="2">Nurses’ Station</td><td>6</td><td>10.35</td><td>6 (≥4.6 sqm)</td><td>3.42</td></tr>
<tr><td colspan="2">Operating Room</td><td>6</td><td>12.87</td><td>Laundry/Washing</td><td>4</td><td>4.95</td></tr>
<tr><td colspan="2">Patient Room</td><td>6</td><td>7.56</td><td>Lounge/Recreation</td><td>6</td><td>7.47</td></tr>
<tr><td colspan="2">Pharmacy</td><td>6</td><td>6.75</td><td>Medical Supply</td><td>6</td><td>5.40</td></tr>
</table>

Physical Therapy	6	7.92	Nursery	6	8.46
Radiology/ Imaging	6	9.09	Corridor/ Transition	Width <2.4m	5.85
Hospitality					
Hotel Dining	4	5.04	Hotel Lobby	4	4.68
For Bar Lounge/ Dining	4	7.38	Motel Dining	4	3.51
For food preparation	6	9.36	Motel Guest Rooms	6	3.96
Hotel Guest Rooms	6	3.96			
Shopping Complex					
Mall Concourse	4	5.49	For Family Dining	4	5.04
Sales Area	6	8.19	For food preparation	6	9.36
Motion Picture Theatre (Audience Seating Area)	4	2.61	Bar Lounge/ Dining	4	7.38
Educational					
Classroom/Lecture	4	6.93	Card File and Cataloguing	4	6.75
For Classrooms			Stacks (Library)	4	11.43
Laboratory (in or as a classroom)	6	10.17	Reading Area (Library)	4	8.37
Assembly					
Dressing Room	6	3.78	Seating Area - Performing Arts Theatre	8	10.62
Exhibit Space – Convention Centre	4	4.86	Lobby - Performing Arts Theatre	6	11.70
Seating Area - Gymnasium	6	2.25	Seating Area – Convention Centre	6	5.40
Fitness Area - Gymnasium	4	7.92	Seating Religious Building	4	7.02
Museum – General Exhibition	6	2.97	Playing Area - Gymnasium	4	7.92
Museum – Restoration	4	12.06			

NOTE 6-1 Calculating Interior Lighting Power – Space Function Method

A four-story building has retail on the ground floor and offices on the top three floors. Area is 3,598 m^2. Space types and their respective areas are mentioned below. Steps for calculating interior lighting power allowance using the space function method for a ECSBC building is described below.

For each of the space type, corresponding Lighting Power Density (LPD) values for Business and Shopping complex building type from Table 6-4 are used. Area is multiplied with the LPD values to estimate the lighting power allowance for the whole building. It is 34,003 W.

Table 6-1-1 Space Types, Areas and Corresponding LPDs

Space Function	LPD (W/ m^2)	Area (m^2)	Lighting Power Allowance (W)
Office			
Office – enclosed (>13.9m^2 and <27.9 m^2)	7.81	720	5,623
Office – open plan (>27.9m^2)	6.6	1,485	9,801
Meeting Rooms	10.45	120	1,254
Lobbies	9.46	93	880
Restrooms	8.8	51	449
Corridors	5.28	125	660
Electrical/ Mechanical	8.36	14	117
Staircase	5.5	84	462
Total			19,246
Retail			
General sales area	10.01	669	6,697
Offices – enclosed (<13.9m^2)	8.69	28	243
Restrooms	8.8	9	79
Corridors	5.28	79	417
Storage (≥4.6m^2)	4.18	93	389
Food preparation	11.4	28	319
Total			14,124
Building Total			34,003

6.3.5 Installed Interior Lighting Power

The installed interior lighting power calculated for compliance with §6.3 shall include total ~~all~~ power consumption of the luminaires, except the exemptions specified in §6.1.

Exception to §6.3.4: 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.

6.3.5.1 Luminaire Wattage

The wattage of lighting equipment, when used to calculate either installed interior lighting power or installed exterior lighting power, shall be determined in accordance with the following criteria:

a) The wattage of lighting equipment connected to supply voltage shall be the manufacturers' labelled rated wattage.
b) 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.
c) The wattage of all other miscellaneous luminaire types not described in (a) or (b) shall be the rated wattage marked on the luminaires and/or its packaging.
d) 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.

6.3.6 Exterior Lighting Power

Connected lighting power of exterior lighting applications shall not exceed the lighting power limits specified in Table 6-7 for ECSBC Buildings, Table 6-8 for ECSBC+ Buildings and Table 6-9 for Super ECSBC Buildings. Trade-offs between applications are not permitted.

Exception to exterior lighting power

a) Emergency lighting for hospitals including hospital signage.
b) Any signage which is mandatory by law /regulations

c) Lighting integral to equipment or instrumentation and installed by its manufacturer.
d) Theatrical purposes only comprising of performance, stage, film production, and video production.
e) Temporary lighting not permanently installed and can be removed or shifted whenever required.
f) 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.
g) Lighting for any monument of national importance, national flag, statue/sculpture etc.

Table 6-7 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 6-8 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 6-9 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

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Section 7

ECSBC – ELECTRICAL AND RENEWABLE ENRGY SYSTEMS

7.1 General

All electric, Vertical Transport and renewable energy equipment and systems shall comply with the mandatory requirements of §7.2.

7.2 Mandatory Requirements

7.2.1 Transformers

7.2.1.1 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 7.1

Compliance of Power distribution transformers shall be:

(a) ECSBC building – Conforming to BEE 3-star labelling requirement.

(b) ECSBC Plus building – Conforming to BEE 4-star labelling requirement.

(c) ECSBC Super building – Conforming to BEE 5-star labelling requirement.

Table 7-1 Dry Type Transformers

Rating (kVA)	*Impedance (%)*	*Max. Total Loss (W)*					
		ECBC Building		ECBC+ Building		SuperECBC 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	1,0750	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 classes 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.

a) The permissible loss value shall be superseded by the values as specified in the Indian standard whenever published.

b) EEL - Energy Efficiency Level

c) 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.

d) Total loss values given in table 7.1 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 above Table.

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.

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

7.2.1.2 Measurement and Reporting of Transformer Losses

All measurement of losses shall be carried out by using calibrated digital meters of class 0.5 or better accuracy and 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.

7.2.1.3 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.

7.2.2 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:

i. ECSBC Buildings shall have motors of minimum IE 3 (high efficiency) class
ii. ECSBC+ Buildings shall have motors of minimum IE 4 (premium efficiency)
iii. 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.

7.2.3 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.

7.2.4 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 7.2

(e) Submetering for specific building types s*h*all be as defined in Table 7.3.

7.2.4.1 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 7-2 and additional sub-metering for specific building types shall be as defined in Table 7.3

Table 7-2 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 7-3 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

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

7.2.4.3 Energy metering & monitoring system installed in the building shall be capable of catering to all the commissioning and measurement & verification (M&V) aspects related to various utilities in the building as described below.

a. Energy monitoring system with metering at LT panel with monitoring and control parameters available to take corrective action for the performance of the system, for ECSBC building.
b. Monitoring-based commissioning (MBCx) procedure with sub metering to measure, monitor and assess performance of all points of utility consumption, for ECSBC plus building.
c. MBCx + Advanced Measurement & Verification (M&V 2.0) infrastructure for ongoing energy performance evaluation, automated M&V, and predictive analysis capabilities, for super ECSBC building.

NOTE: commissioning and M&V related requirements shall be adopted as defined in Chapter 13 Controls & IoT section.

7.2.5 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

7.2.6 Power Quality

7.2.6.1 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 7.4.

b) Weekly 95th percentile short time (10 min) values shall be less than the values given in table 7.4.

Table 7.4 – 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

7.2.6.2 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 Table 7.5, Table 7.6 and Table 7.7
b) Weekly 99th percentile short time (10 min) harmonic currents shall be less than 1.5 times the value given in Table 7.5 and Table 7.6 and Table 7.7.
c) Weekly 95th percentile short time (10 min) harmonic currents shall be less than the values given in Table 7.5 and Table 7.6 and Table 7.7s.

Maximum allowable limit of current distortion for system design shall comply to Table 7.5

Table 7.5 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 $h \le 6$, even harmonics are limited to 50% of the harmonic limits 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.
where:
I_{sc} = maximum short-circuit current at PCC
I_L = maximum demand load current at PCC under normal load operating conditions

Table 7.6 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 $h \le 6$, even harmonics are limited to 50% of the harmonic limits 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.
where
I_{sc} = maximum short-circuit current at PCC
I_L = maximum demand load current at PCC under normal load operating conditions

Table 7.7- 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
≥ 50	3.0	1.5	1.15	0.45	0.22	3.75

[a] For $h \le 6$, even harmonics are limited to 50% of the harmonic limits 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.
where
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 A enclosed with this document to validate compliance to award

7.2.7 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

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

7.2.8 Uninterruptible Power Supply (UPS)

In all buildings, energy efficiency of UPS shall be equal to or higher than energy efficiency requirements defined in Table 7-8.

Table 7-8 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.

7.2.9 Renewable Energy Systems

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

7.2.9.1 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 ECSBC Super building shall fulfil the additional requirements listed in Table 7-9 and Table 7-10 respectively.

Table 7.9 Minimum Renewable Contribution towards meeting Contract Demand in ECSBC Plus Building

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

Star Hotel > 20,000 m² AGA Resort > 12,500 m² AGA University > 20,000 m² AGA Business >20,000 m² AGA	Minimum 7.5% of total Contract Demand

Table 7.10 Minimum Renewable Contribution towards meeting Contract Demand in Super ECSBC Building

Building Type	*Minimum Capacity to be Installed in REGZ*
All Building types except below	Minimum 15% of total Contract Demand
Star Hotel > 20,000 m² AGA Resort > 12,500 m² AGA University > 20,000 m² AGA Business >20,000 m² AGA	Minimum 15% of total Contract Demand

As an alternative compliance path, 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.

7.2.9.2 Main Electrical Service Panel

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

7.2.9.3 Demarcation on Documents

The following shall be indicated in design and construction documents:

a. Location for inverters and metering equipment

b. Pathway for routing of conduit from the REGZ to the point of interconnection with the electrical service

c. Routing of plumbing from the REGZ to the water-heating system and

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

7.2.9.4 Grid Harmonisation / Demand Response

All buildings should conform to

a) ECSBC -Minimum 5% Building Electricity Peak Demand load reduction capability

b) ECSBC Plus 7.5 % Building Electricity Peak Demand load reduction capability

c) Super ECSBC – 10 % Building Electricity Peak Demand load reduction Capability.

7.2.9.5 Recommendations on Electric Vehicle Charging Infrastructure and Parking Spaces

a) **EV Charging Infrastructure:**

Parking places in buildings shall be provided with EV Charging infrastructure as per ~~following~~ 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.

a) CEA Measures Relating to Safety and Electric Supply, Amendment Regulations, 2019
b) CEA Technical Standards for Connectivity of Distributed Generation Resources, Amendment Regulations, 2019
c) Ministry of Power Guidelines, Jan 2022
d) BIS standards (IS 17017 series)
e) Battery Safety and Vehicle Safety standards for EV as per regulations by Ministry of Heavy Industries.
f) 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

7.2.10 Vertical Transportation System

7.2.10.1 Mandatory requirement:

Vertical transportation shall comply to the standard in table 7.11:

Table 7.11: 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

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.

Energy efficiency class	Energy consumption per day (Wh)
A	$E_d \leq 0{,}72 \times Q \times n_d \times s_{av}/1\,000 + 50 \times t_{nr}$
B	$E_d \leq 1{,}08 \times Q \times n_d \times s_{av}/1\,000 + 100 \times t_{nr}$
C	$E_d \leq 1{,}62 \times Q \times n_d \times s_{av}/1\,000 + 200 \times t_{nr}$
D	$E_d \leq 2{,}43 \times Q \times n_d \times s_{av}/1\,000 + 400 \times t_{nr}$
E	$E_d \leq 3{,}65 \times Q \times n_d \times s_{av}/1\,000 + 800 \times t_{nr}$
F	$E_d \leq 5{,}47 \times Q \times n_d \times s_{av}/1\,000 + 1\,600 \times t_{nr}$
G	$E_d > 5{,}47 \times Q \times n_d \times s_{av}/1\,000 + 1\,600 \times t_{nr}$

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.

7.2.10.2 Prescriptive requirements:

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, and Internet of things for Predictive maintenance.

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, Internet of Things enabled controls for predictive maintenance. Regenerative Drives shall be provided to recycle energy. All signal/ signages used for these equipment’s shall be of LED fixtures.

Section 8

ECSBC – WATER MANAGEMENT AND CONTROLS

8.1 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.

All ECSBC compliant buildings shall conform to §8.2, §8.3, §8.4, §8.5 §8.6, §8.7 §8.8 and §8.9

8.1.1 Mandatory requirements

Following pre-requisites need to be followed for all building types:

8.1.1.1 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) Bought out potable water in tankers: when no other source is available or when municipal or well water is inadequate.

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

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

f) Desalination of water for potable & non-potable use shall be allowed after obtaining approval from concerned authorities.

Exception to 8.1.1.1 d: Reuse of reclaimed water in Hospital and Outpatient Health care is not recommended due to associated health hazards.

8.1.2 Water Efficiency Levels

The code prescribes the following three levels of water efficiency:

a) ECSBC compliant buildings shall conform to the mandatory and prescriptive requirements listed under ECSBC Compliant Building requirements as in §8.3.2.1, §8.4.2.1, §8.5.2.1 §8.5.6.1, §8.6.2 §8.6.4.1, §8.7.2, §8.8.2, and §8.9.2 or by following the provisions of the Whole Building Performance (WBP) Method as in §8.2.3.

b) ECSBC Plus Buildings shall conform to the mandatory and prescriptive requirements listed under ECSBC Plus Compliant Building requirements as in §8.3.3.1, §8.4.3.1, §8.5.3.1 §8.5.6.2, §8.5.7.1,§8.6.3.1, §8.6.4.2 §8.7.3.1, §8.8.3.1 and §8.9.3.1 or by following the provisions of the Whole Building Performance (WBP) Method as in §8.2.3.

c) ECSBC Super Buildings shall conform to the mandatory and prescriptive requirements listed under Super ECSBC Compliant Building requirements as in §8.3.3.2, §8.4.3.2, §8.5.3.2, §8.5.7.2, §8.6.3.2, §8.6.4.3, §8.7.3.2, §8.8.3.2 and §8.9.3.2 or by following the provisions of the Whole Building Performance (WBP) Method as in §8.2.3.

8.2 Water Efficiency

8.2.1 Water Efficiency Index (WEI):

Water

Efficiency Index (WEI) is the performance indicator for water efficiency and refers to the net annual fresh water used per business activity indicator. The business activity indicator will vary according to the nature of business. It will be represented either in form of Total Built up area occupied by the business activity or the total number of occupants using water in the business activity.

$$WEI = \frac{Annual\ fresh\ water\ demand\ in\ m^3}{Business\ activity\ indicator} \quad \text{Eq 8.1}$$

Where:

The Annual freshwater demand = {Total water demand per day – (reclaimed water per day + recycled water per day + harvested water per day + reused water per day)} X number of working days.

$$Builtup\ area = Total\ area - (basement\ area + parking\ area + electromechanical\ plan\ areas)$$

$$Business\ activity\ indicator = Total\ builtup\ area\ (OR)\ Total\ number\ of\ occupants\ in\ the\ business\ activity$$

Note:

a) Actual number of working days in a year shall be considered for arriving at annual water demand. Working days means actual number of days the person works in a week excluding Saturday (if 5day week,) Sundays and any other holidays.
b) WEI value shall be rounded off to two decimal places in accordance with IS 2: 1960 'Rules for rounding off numerical values'.

8.2.2 Water Efficiency Index Ratio (WEI Ratio):

Water efficiency ratio is the ratio of the WEI of proposed building to WEI of the Standard building and shall be calculated as in equation 8.2. WEI ratio shall be as below,

a) ECSBC Compliant building WEI Ratio ≤1
b) ECSBC Plus and ECSBC Super WEI ratio < 1

In addition, the building shall conform to mandatory requirements defined in sub-sections 8.3.2.1, §8.4.2.1, §8.5.2.1 §8.5.6.1, §8.6.2, §8.6.4.1, §8.7.2 §8.8.2 and §8.9.2

$$WEI\ Ratio = \frac{WEI\ of\ proposed\ building}{WEI\ of\ standard\ building} \text{ .... Eq. 8.2}$$

where

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

8.2.2.1 Prescriptive requirement:

Building shall use water efficient fixtures, recycled water, reuse of treated used water, and rain harvested water.

Table 8.2-1 Maximum Allowed WEI Ratios for Buildings

Building Type	Business Activity Indicator	ECSBC	ECSBC +	Super ECSBC
Hotel (No Star)	No of Guest nights	1	0.84	0.74
Hotel (Star)	No of Guest nights	1	0.80	0.70
Resort	No of Guest nights	1	0.80	0.70
Hospital	No of Beds	1	0.83	0.74
Office (Regular Use)	Total Built up area- m^2	1	0.78	0.58
Office (24Hours)	Total Built up area- m^2	1	0.80	0.62
Schools and University	Total No of Students	1	0.80	0.75
Shopping Mall	Total Built up area- m^2	1	0.82	0.68

8.2.3 Whole Building Performance Method (WBP)

The estimated annual water use for proposed building design shall be less than standard building design and complies to the mandatory requirements defined in §8.3 to §8.9. The compliance to prescriptive requirement defined in §8.3 to §8.9 is not mandatory for buildings conforming to WBP. WBPis

8.2.4 WEI ratio for Core and Shell Buildings

WEI for core and shell buildings shall be calculated for the entire building based on the final design of the wet areas and the relevant mandatory undertaking(s) for all the users including users of rental premises.

8.2.5 WEI Ratio for Mixed-use Development

The WEI ratio for mixed use building shall be as defined in Table 8.2.1. Each commercial part of a building shall be classified separately to calculate Net freshwater demand for each sub-classification as per Eq 8.1. The WEI Ratio of the proposed multipurpose use building shall be calculated based on area-*weighted average method. To calculate the reference maximum design WEI Ratio, listed in Table 8.2-1 applicable for the mixed-use building, each commercial part of mixed-use building shall be classified separately, and,

(a) If a part of the mixed-use building has different classification and is less than 10% of the Total Built-up Area, (excluding basements, parking & electro-mechanical plant areas), the WEI Ratio of the mixed-use Proposed Building shall be less than or equal to Maximum Allowed WEI ratio listed in Table 8.2-1 for the building sub-classification having highest percentage of total built-up area.

If a part of the mixed-use building has different classification and has more than 10% of the total built-up area, the WEI ratio of the mixed-use Proposed Building shall be less than or equal to Maximum Allowed WEI ratio for compliance calculated based on area weighted average method for all building sub-classifications listed in Table 8.2-1.

*Weighted Average Method is a calculation that takes into account the varying degrees of importance of the numbers in a data set. In calculating the weighted average, each number in a data set (say Area) is multiplied by its weight (WEI Ratio) and then summing these products. The sum of the products is divided by the sum of the areas to get the weighted average.

8.2.6 Compliance Documents

The following documents shall be submitted for compliance check.

(a) Flow rate/ volume of water for all Water Efficient plumbing fixtures, sanitary fittings and appliances.
(b) System type, equipment and performance parameters with Process& Instrumentation (P & I) diagram and reused water quantity for different application.
(c) details of catchment area, run-off co-efficient, intensity of rainfall, rainy days, storage and reuse for harvested rainwater.
(d) type of water metering system and monitoring of water supply from all sources and consumption.
(e) type of technology such as atmospheric water generator, desalination and any other system with their installed capacity, technical specifications for alternate sources of water
(f) Water Balance chart for water cycle in both dry and wet season on an annual basis.

8.2.7 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.

8.3 Water Quality

8.3.1 General

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

8.3.2 Mandatory requirement

8.3.2.1 ECSBC Building

a) Sources of water shall be as prescribed in Pre-requisites §8.1.2
b) Potable water quality shall comply with the requirements of IS 10500:2012, Drinking Water – Specification, as given in 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 issued by Ministry of Housing and Urban Affairs

Exception to 8.3.4.1(b): Not mandatory if the wastewater generation is less than 10 kld

8.3.3 Prescriptive requirement

8.3.3.1 ECSBC+ Buildings

a) 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.
b) Reclaimed used water from sewage treatment plants after adequate treatment can be used for domestic usages other than potable/drinking and culinary.
c) 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
d) Segregation and separate treatment to be offered for grey and black water for achieving the desired water quality for varied reuse applications.

8.3.3.2 Super ECSBC Buildings

Grey water to be segregated and treated separately and reused for potable drinking purposes.

8.4 Water Treatment

8.4.1 General

All types of water treatment systems shall comply with the mandatory provisions of §8.4.2 and the prescriptive criteria of §8.4.3 for the respective water and energy efficiency levels.

8.4.2 Mandatory requirements

8.4.2.1 ECSBC Buildings

(a) Representative samples of water from all sources shall be drawn, for laboratory testing of water quality as prescribed in IS 1622 and IS 3025. 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.

(b) Water Treatment shall be carried out as per guidelines by CPHEEO Manual on Water Supply and Treatment, May1999 to meet water quality for various applications as specified in §8.3.4.1. (b)

(c) 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%.

8.4.3 Prescriptive requirements

8.4.3.1 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.

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%

8.4.3.2 ECSBC Super Buildings

(a) 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.

(b) 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.

(c) R. O. reject water shall be reused after treatment or disposed off by authorized agencies where the Total Dissolved solids (TDS) content is more than 2100 mg/l.

8.5 Pumping System, Water Distribution and Metering

8.5.1 Pumping Systems

Water transfer pumps for domestic, wastewater and reclaimed water shall comply with energy efficiency values as defined in Table 8.5.1, Table 8.5.2 and Table 8.5.3.

8.5.2 Mandatory requirements

8.5.2.1 ECSBC Buildings

a) All pups shall be Selected with flow-head characteristics between 70% to 110% of flow at BEP (Best efficiency point) of the curve.

b) All non-submersible pumps shall be coupled with IE 3 and higher efficiency class motors

c) All submersible pumps shall be coupled with IE 2 and above efficiency class motors.

d) Pumps for other applications shall have minimum overall efficiency as per Table 8.5.1.

Table 8.5.1 Overall Efficiency of pump and motor Requirements for ECSBC Building

Equipment	Minimum Overall Efficiency (%)
a) Domestic water pumps	60
b) Flushing water pumps	60
c) Surface water pumps	60
d) Wastewater pumps (Solids – 10 to 20 mm size)	45
e) Sewage pumps (Solids – 40 to 50 mm size)	45
f) Hot Water circulation pumps	45

8.5.3 Prescriptive requirements

8.5.3.1 ECSBC + Buildings

a) All pumps shall comply with mandatory requirements defined in §8.5.2

b) All non-submersible pumps shall be coupled with minimum IE 3 and above efficiency class motors.

c) Pumps for other applications shall have minimum overall efficiency as per Table 8.5.2.

Table 8.5.2 Pump Overall Efficiency Requirements for ECSBC Plus Building

Equipment	Minimum Overall Efficiency (%)
a) Domestic water pumps	65
b) Flushing water pumps	65
c) Surface water pumps	65
d) Wastewater pumps (Solids – 10 to 20 mm size)	50
e) Sewage pumps (Solids – 40 to 50 mm size)	50
f) Hot Water circulation pumps	50

8.5.3.2 For Super ECSBC Buildings

a) All pumps shall be conform to §8.5.2 and §8.5.3

b) All non-submersible pumps shall be coupled with minimum IE 4 efficiency class motors or higher..

c) Pumps for other applications shall have minimum combined efficiency as per Table 8.5.3.

Table 8.5.3 Pump Efficiency Requirements for Super ECSBC Building

Equipment	Minimum Overall Efficiency (%)
a) Domestic water pumps	70
b) Flushing water pumps	70
c) Surface water pumps	70
d) Wastewater pumps (Solids – 10 to 20 mm size)	55
e) Sewage pumps (Solids – 40 to 50 mm size)	55
f) Hot Water circulation pumps	50

8.5.4 Piping Systems

Piping systems shall comply with the mandatory requirements of §8.5.4.1

8.5.4.1 Mandatory requirement

a) Piping systems shall comply with guidelines of NBC 2016 (Part 9, Section 1: Water Supply)

b) Hot water piping shall be provided with required insulation as per section 8.6. Table 8.6.3-1

8.5.5 Metering

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.

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.

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 §8.7.1.1(d) and §8.7.2.1(d).

8.5.6 Controls

8.5.6.1 Mandatory Requirement for ECSBC Buildings

a) All storage sumps/tanks shall be provided with float switch level controller for pumping system.
b) Hydro-pneumatic systems, if used, shall be provided with pressure switch to maintain consistent pressure both at suction and delivery manifolds.
c) Auto change overs are recommended for all the pumping systems when working and stand by pumps are installed as per emergency and any exigencies.
d) 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.

8.5.6.2 Prescriptive Requirement

For ECSBC+ Buildings

a) All storage sumps/tanks shall be provided with solenoid-based level controller with auto ON / OFF for pumping system to avoid overflow and wastages.
b) 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.
c) IoT based flow meters shall be provided on all water supply lines.
d) All pumping systems shall be controlled through PLC based system connected to BMS and data should be transmitted for remote management.

For Super ECSBC Buildings

a) All storage sumps/tanks shall be provided with Infra-Red level indicator, controller with auto ON / OFF and alarm for pumping system.

b) All pumping systems shall be controlled through PLC based system connected to BMS and data shall be transmitted for remote management.

8.6 Service Water Heating

8.6.1 General

Service Water Heating and equipment's shall comply with the Mandatory requirements and the Prescriptive criteria, as per §8.6.2 and §8.6.3 respectively.

8.6.2 Mandatory Requirements

8.6.2.1 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.

(a) Air source heat pumps shall meet or exceed minimum COP of 3.5.

(b) Water Source Heat Pumps shall meet or exceed minimum COP of 4.5

(c) Ground Source Heat Pumps shall meet or exceed minimum COP of 3.0

Exception to § 8.6.2.1:

(a) 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.

(b) Systems that use heat recovery (Condenser recovery from Chillers) to provide the hot water capacity required as per the building type and size.

(c) Buildings that install Solar PV cells of capacity 5% of Total Contractual Power Demand or 200 W/Sqm whichever is less.

8.6.2.2 Other Water Heating System - Supplementary heating system shall be designed to maximize the energy efficiency of the system and shall incorporate the following design features in cascade:

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

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

(c) Electric coil heaters

8.6.2.3 Heating Equipment Efficiency of Service water heating equipment shall comply or exceed the performance and minimum efficiency requirements presented in relevant Indian Standards;

(a) Solar water heater shall comply with the performance/ minimum efficiency level as mentioned in IS 13129 Part (1&2) IS 16368

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

(c) Electric water heater shall comply with the performance/ minimum efficiency level as mentioned in IS 2082 and shall be BEE star labelled.

(d) Electric coil heaters shall comply with IS 4149: 2021.

(e) 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.

8.6.2.4 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.

8.6.2.5 Piping Insulation for Supply & Return Lines – Piping for heating, space conditioning, and service hot water systems shall meet the insulation requirements listed in Table 8.6.3-1 through Table 8.6.3-3. 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.

Exceptions to §8.6.2.5:

(a) Reduction in insulation R value by 0.2 (compared to values in Table 8.6.3-1, Table 8.6.3-2 and Table 8.6.3-3) 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 8.6.3-1 for any pipe located in a partition outside a building with direct exposure to weather.

Table 8.6.3-1 Insulation Requirements for Pipes in ECSBC Building Insulation R Value (m^2.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 8.6.3-1

In case for Insulation if 'R' values as per Table 8.6.3-1 is not used the exception will be to use insulation material which will improve the performance by 85%.

8.6.2.5 Hot Water Tank Temperature to be maintained as per NBC 2016, Part 9, Clause 4.14.2.2

8.6.3 Prescriptive Requirements

8.6.3.1 ECSBC + Buildings

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 §8.6.3.1

Buildings that install Solar PV cells of capacity 7.5% of Total Contractual Power Demand or 300 W/ m^2 whichever is less.

Table 8.6.3-2: Insulation Requirements for Pipes in ECSBC Plus Building – Insulation R Value (m^2.K/W)

Operating Temperature	Pipe Size ≤ 40mm	Pipe Size ≥40mm
>60 Deg. C and <=94 Deg. C	0.8	0.8
>40 Deg. C and <=60 Deg. C	0.5	0.9

Exception to Table 8.6.3-2

In case for Insulation if 'R' values as per Table 8.6.3-2 is not used the exception will be to use insulation material which will improve the performance by 90%.

8.6.3.2 Super ECSBC Buildings

Hospitality and Healthcare in all climatic zones shall have solar water heating equipment installed to provide 00% of the total hot water design requirement.

Exception: Buildings that install Solar PV cells of capacity 10% of Total Contractual Power Demand or 400 W/ Sq. M whichever is less.

Table 8.6.3-3 Insulation Requirements for Pipes in Super ECSBC Building – Insulation R Value (m^2.K/W)

Operating Temperature	Pipe Size ≤ 40mm	Pipe Size ≥40mm
>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 8.6.3-3

In case for Insulation if 'R' values as per Table 8.6.3-3 is not used the exception will be to use insulation material which will improve the performance by 92%.

8.6.4 Water Heating Controls & Safety

8.6.4.1 For ECSBC Buildings

(a) 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.

(b) Heat Pumps: Controls shall be provided for the Heat Pump as follows:

1. Control for High / Low pressure Cut Off for Refrigerant Gas.
2. Control for Temperature Cut Off & Re Start – With provision of differential temperature setting.
3. Control for Chilled / Cooling Water Temperature Cut Off (In case of Water Source Heat Pumps)

(c) 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.

8.6.4.2 For ECSBC + Buildings

Heat pumps shall have PLC Based system panel, to give data to Central BMS of the building.

8.6.4.3 For Super ECSBC Buildings

Heat pumps shall have IOT based system, to have online data available to various concerned parties.

8.6.5 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 8.6.5-1 Energy consumption calculations. For various Hot water systems.

Table 8.6.5 – 1 Energy consumption calculation for various hot water system

Sample calculation to workout kW/litre/year

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

Sample calculation calculate power consumption per liter per year for hot water requirement of 10000 liters per day is given below.

Hot water requirement = 10000 liters per day

Ambient temperature = 15°C

Hot water temperature = 60°C

Heat load ‘Q’: ($Q = m \times C_p \times \Delta T$) = 450000

8.7 Water Balance:

8.7.1 General

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.)

Exception: 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.

8.7.2 Water Balancing

8.7.2.1 Mandatory Requirements

The buildings shall conform to the following –

(a) The population of the building shall be calculated as per Clause 4.1.b Section-1 Part 9 in NBC 2016. For building typologies which are not covered in NBC 2016, 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.

(b) 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.

(c) 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.

(d) Water Efficiency: The fixtures and sanitaryware shall follow the Star rating as per Table 1and Table 4, IS 17650 Part 1 and Part 2. An Extract of the table is given below for ready reference. The star rating to be followed for ECSBC, ECSBC+ & Super ECSBC will be as given in the relevant sections below.

Table – 8.7.2-1: Water Efficiency Rating Criteria for Sanitaryware

Sl. No	Unit	Water Consumption Unit	ECSBC	ECSBC +	Super ECSBC
1	Water closet	lpf full flush	≤6.0	≤4.8	≤4.0
		lpf reduced flush	≤3.0	≤2.8	≤2.0
2	Urinal	Lpf	≤3.0	≤2.0	≤1.0

Note: lpf - Litres per flush.

Table – 8.7.2-2: Water Efficiency Rating Criteria for Sanitary Fitting

Sl.	Unit	Unit	ECSBC	ECSBC +	Super ECSBC
1	Washbasin Metered Faucet	Litres/use	≤1.0	≤0.8	≤0.6
2	Urinal Metered Faucet	lpf	≤3.0	≤2.0	≤1.0
3	Washbasin tap	Lpm	≤8.0	≤6.0	≤3.0
4	Sink Faucet	Lpm	≤8.0	≤6.0	≤4.5
5	Overhead Shower	Lpm	≤10.0	≤8.0	≤6.8
6	Handheld Shower	Lpm	≤8.0	≤6.0	≤4.0
7	Handheld Ablution Spray	Lpm	≤6.0	≤5.0	≤4.0

Note: The flow rates are at maximum pressure of 4.2 kg/cm^2

8.7.3 Water Efficiency for ECSBC Buildings

a) The fixtures and sanitary ware should follow **1** star rating as per Table 1and Table 4, IS 17650 Part 1 and Part 2.
b) Treated recycled sewage will be used for, flushing, landscaping, cooling tower make-up.
c) Rainwater harvesting to be done in the form of rain water storage/recharge pits.
d) Analogy type water meters for supply line, flushing, landscaping, cooling tower make-up, inflow to and outflow from the STP and harvested rainwater.

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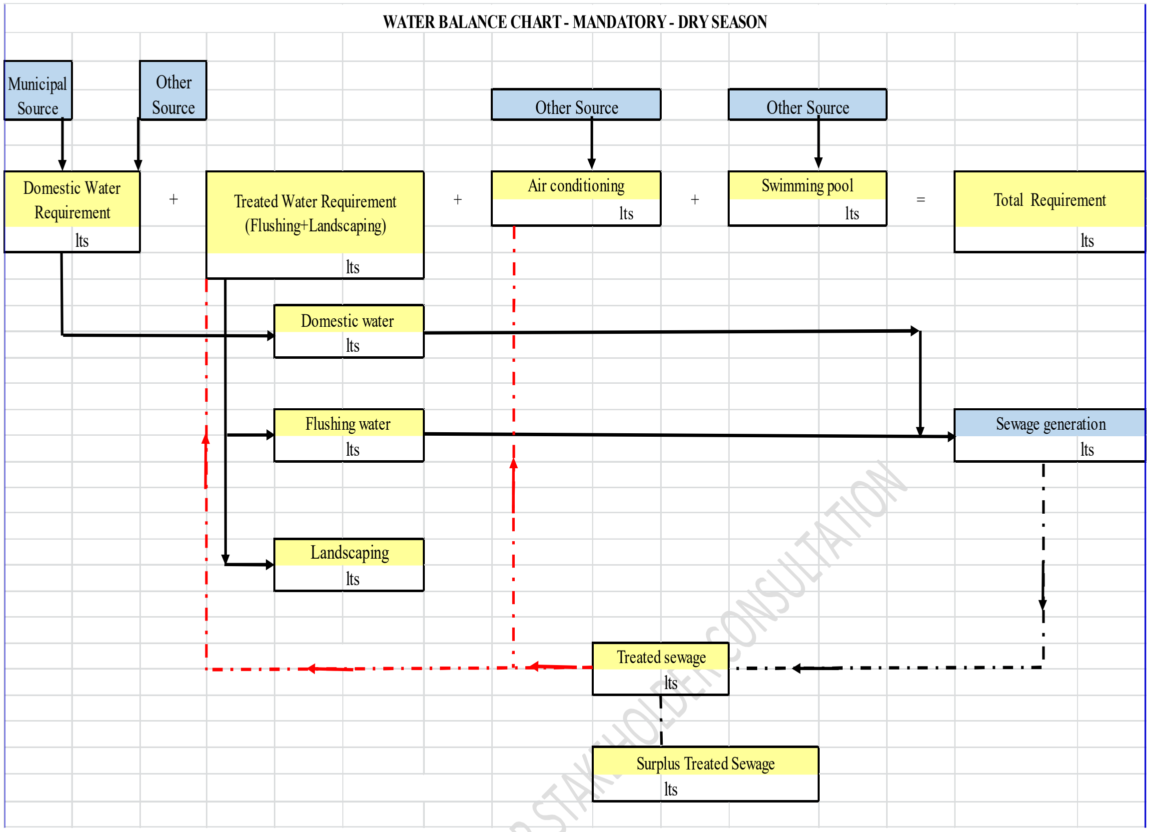
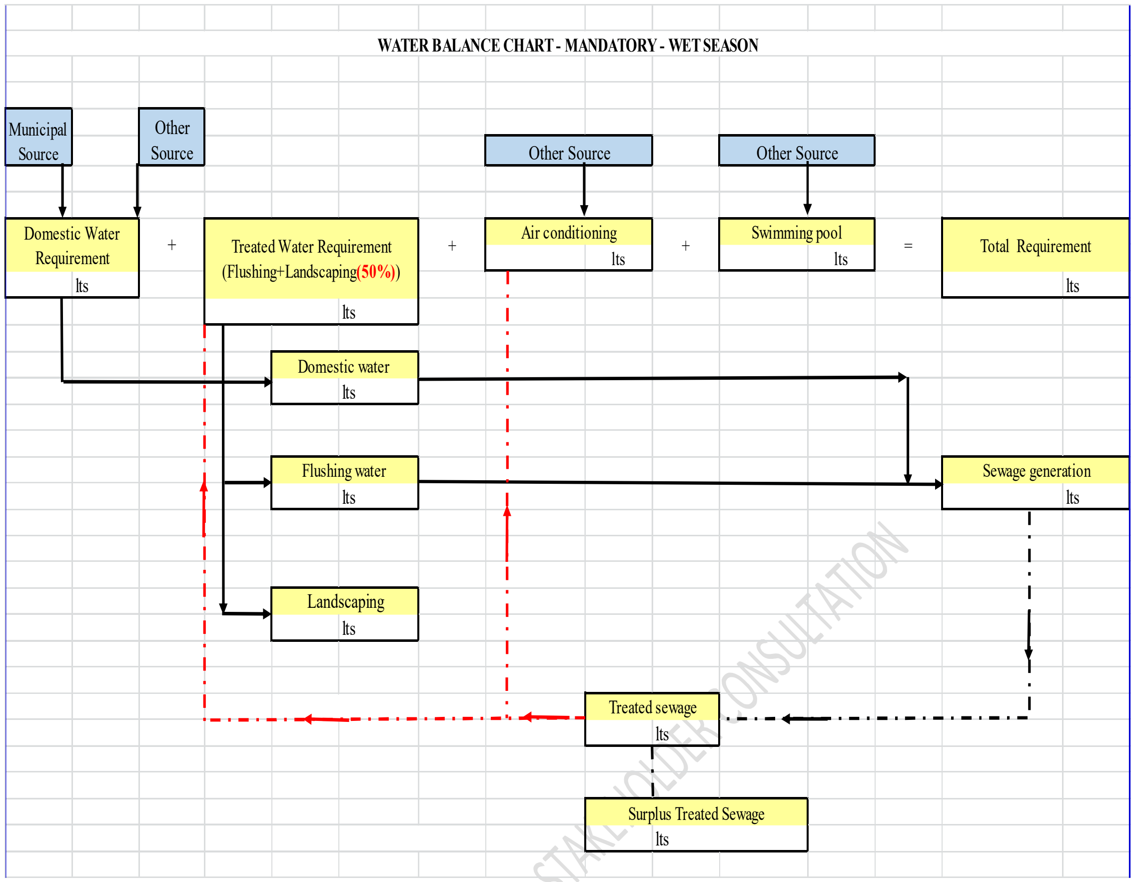


WATER BALANCE CHART - MANDATORY - DRY SEASON
Municipal Source
Other Source
Other Source
Other Source
Domestic Water Requirement
lts
+
Treated Water Requirement (Flushing+Landscaping)
lts
+
Air conditioning
lts
+
Swimming pool
lts
=
Total Requirement
lts
Domestic water
lts
Flushing water
lts
Sewage generation
lts
Landscaping
lts
Treated sewage
lts
Surplus Treated Sewage
lts

3043

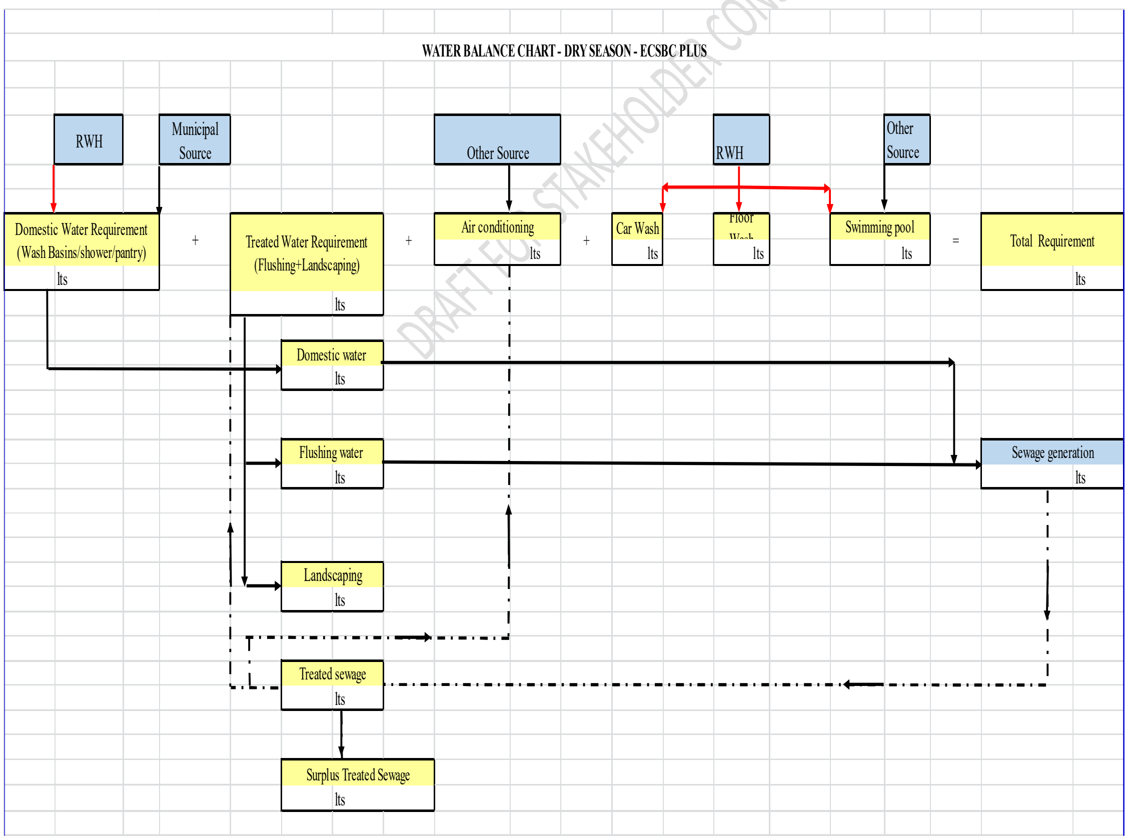

WATER BALANCE CHART - MANDATORY - WET SEASON
Municipal Source
Other Source
Other Source
Other Source
Domestic Water Requirement
lts
+
Treated Water Requirement (Flushing+Landscaping(50%))
lts
+
Air conditioning
lts
+
Swimming pool
lts
=
Total Requirement
lts
Domestic water
lts
Flushing water
lts
Sewage generation
lts
Landscaping
lts
Treated sewage
lts
Surplus Treated Sewage
lts

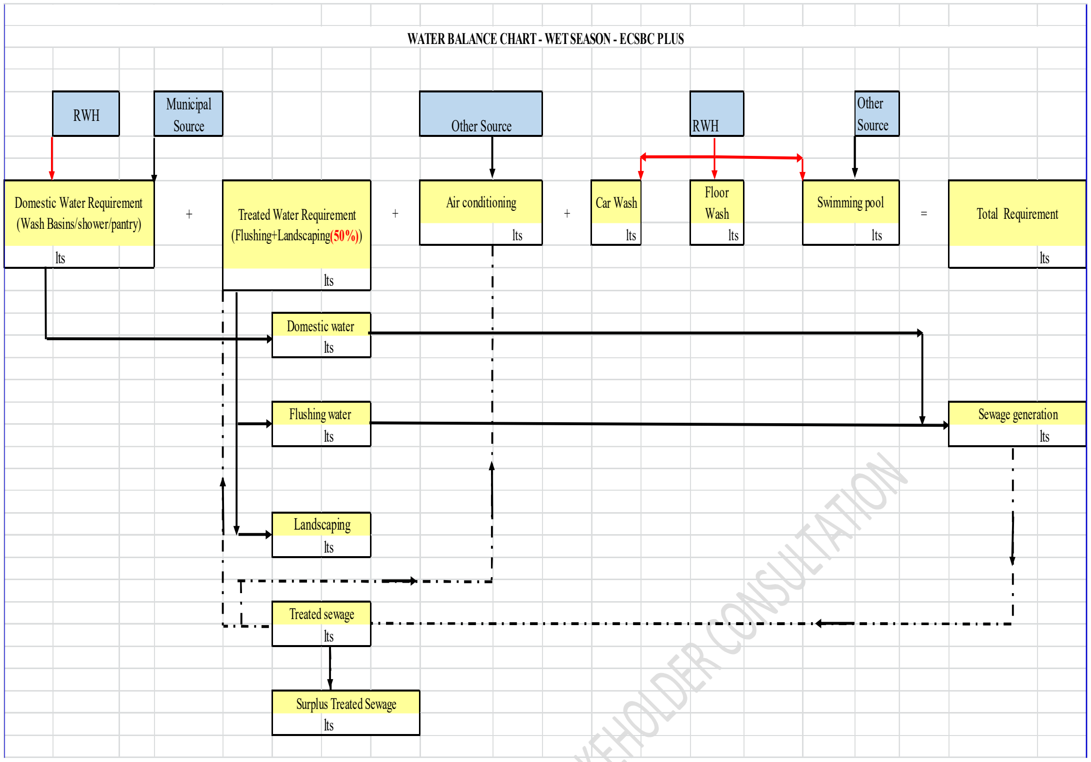
8.7.3 Prescriptive Requirements

Prescriptive buildings shall be defined as buildings which shall result in more water conservation than ECSBC mandated buildings. The requirements of Prescriptive buildings shall conform to all the requirements of Mandatory Buildings.

8.7.3.1 Water Efficiency for ECSBC+ Buildings:

(a) The fixtures and sanitary ware shall follow **2** star rating as per Table 1 and Table 4, IS 17650 Part 1 and Part 2.
(b) Reuse/Recycle of condensate water produced from air conditioning system.
(c) Rainwater harvesting water to be utilized for domestic (wash basins, shower, pantry), car wash, floor wash and swimming pool makeup water
(d) IOT based Smart water meter for all types of water as in §8.7.2(h)





8.7.3.2 Water Efficiency for ECSBC Super Buildings:

a) The fixtures and sanitary ware shall follow **3** star rating as per Table 1and Table 4, IS 17650 Part 1 and Part 2.

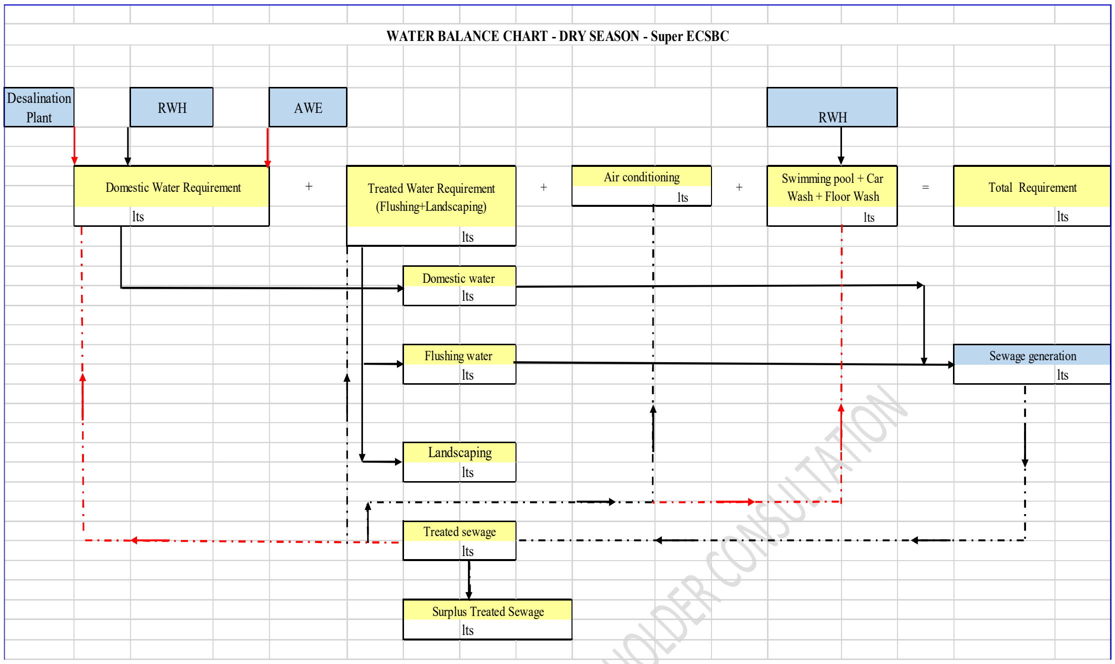
b) The treated recycled sewage will be used for domestic, drinking and swimming pool

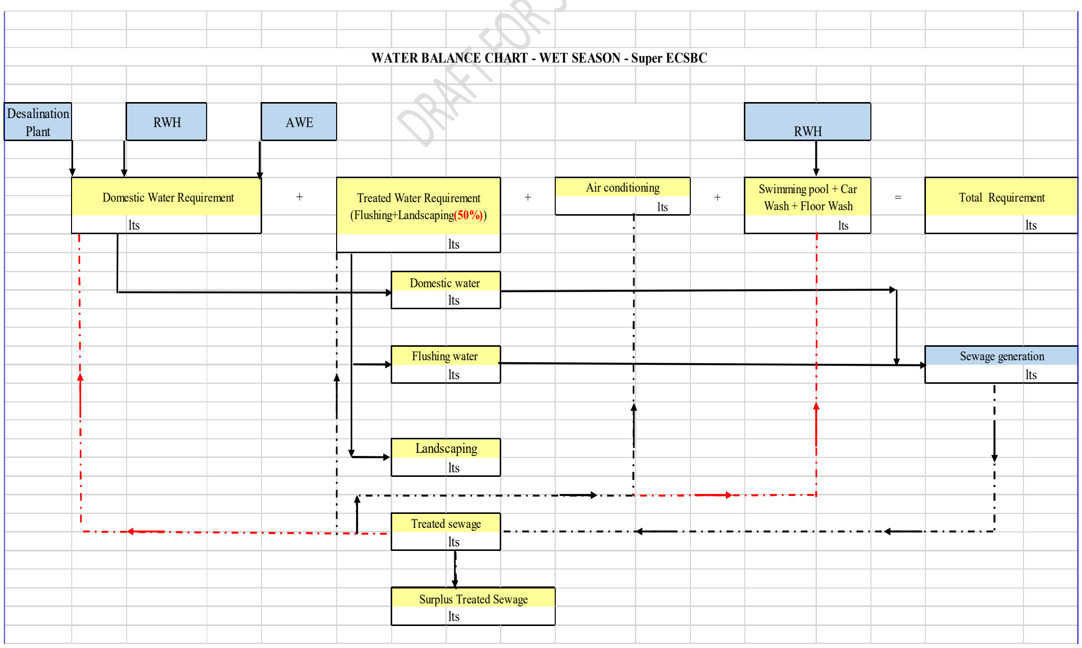
c) Sea water to be used for domestic consumption by means of desalination plant, if no other alternative source is available.

d) .

e) Reject water from RO filtration plants to be treated to acceptable standards before disposal as per §8.4.3.2(b)

f) Water metering as per §8.7.3.1(d)


WATER BALANCE CHART - DRY SEASON - Super ECSBC
Desalination Plant
RWH
AWE
RWH
Domestic Water Requirement
lts
+
Treated Water Requirement (Flushing+Landscaping)
lts
+
Air conditioning
lts
+
Swimming pool + Car Wash + Floor Wash
lts
=
Total Requirement
lts
Domestic water
lts
Flushing water
lts
Sewage generation
lts
Landscaping
lts
Treated sewage
lts
Surplus Treated Sewage
lts


WATER BALANCE CHART - WET SEASON - Super ECSBC
Desalination Plant
RWH
AWE
RWH
Domestic Water Requirement
lts
+
Treated Water Requirement (Flushing+Landscaping(50%))
lts
+
Air conditioning
lts
+
Swimming pool + Car Wash + Floor Wash
lts
=
Total Requirement
lts
Domestic water
lts
Flushing water
lts
Sewage generation
lts
Landscaping
lts
Treated sewage
lts
Surplus Treated Sewage
lts

8.8 Wastewater Treatment and Reclamation

8.8.1 General

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 to produce an environmentally safe fluid waste stream. 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.

8.8.2 Mandatory requirements

ECSBC Building

(a) 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.
(b) IoT based flowmeter shall be provided each at the inlet and outlet of the sewage treatment plant.
(c) 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.
(d) 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).
(e) 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).

8.8.3 Prescriptive requirements

8.8.3.1 ECSBC + Building

(a) Separate Grey water and Black water treatment shall be provided.

(b) 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)

(c) 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.

8.8.3.2 Super ECSBC Building

(a) All ECSBC + prescriptive requirement to be followed as mandatory requirement.

(b) 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.

8.9 Rainwater Harvesting and Reuse

8.9.1 General

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 the mandatory provisions of §8.19.2 and the prescriptive criteria of §8.9.3.

8.9.2 Mandatory requirements:

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.

8.9.3 Prescriptive Requirements:

8.9.3.1 ECSBC + Building

a. Entire roof top water storage shall be harvested with appropriate treatment and reuse for potable applications.
b. Recharge percolation pits as per soil suitability to be adopted.

8.9.3.2 SuperSECSBC Building

Compliance shall be demonstrated with full utilisation of annual potential of harvested rainwater such that there is zero dependency of fresh water.

Table: 8.9.4-1 Calculation of quantity of water to be Harvested

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"

Annual rainfall of any city	900 mm	
Height of rainfall	0.9m	
Area of Roof	1000 m^2	
Catchment volume (A)	900 m^3 (900000 litres)	
Calculation for Effectively harvested water from total rainfall		
Run off co-efficient for roof surface	0.85	
Co-efficient for evaporation, spillage and first flush wastage	0.8	
Effectively harvested water quantity	Rainwater endowment (A) x 0.8 x Run off co-efficient	
	= 900000 x 0.8 x 0.85	
	= 6,12,000 litres	
Calculations for water requirements for a typical office building		
Total occupants	500 person	
Per capita consumption	45 litres/p/day	
Drinking water per person/day	10 litres/p/d	
working days	240 days	
shift	1	
No of persons	500 (assumed)	
Total Annual drinking water requirement	500 x 10 x 240 = 1200000 litres/year	

Total Rainwater harvested = 6,12,000 litres

Total drinking water requirement = 12,00,000 litres

Thus over 50% of the annual drinking water can be serviced with Rainwater from Rooftop.

Section 9

WASTE MANAGEMENT

9. Waste Management

9.1 General Requirement

Waste management is applicable to all building typologies during construction, operation, and maintenance phases of the building project. All types of waste including solid, liquid, and gaseous waste are covered. Site area of the project is the boundary condition for managing all three types of waste.

i. Solid waste –solid waste being sent to landfill during construction, operation, and maintenance.
ii. Liquid waste –liquid waste other than wastewater. Refer Chapter 8 for wastewater management requirements. However, the local regulatory requirements shall apply in addition.
iii. Gaseous waste – gaseous waste examples as specified in table 9.2 to 9.5. However, the local regulatory requirements shall apply in addition.

A building project under construction phase complying to the code need to demonstrate meeting the requirements of all three types of waste management from the beginning of the construction to ready to occupy stage. If there is a need for demolition of an existing structure in the project site, the demolition waste needs to be addressed as per the requirements specified for waste management during construction phase.

A building complying to the ECSBC code shall meet all the three mandatory requirements. The number of prescriptive requirement shall be as defined in table below.

No of Prescriptive Measures Implemented	Compliance Level
4	ECSBC
7	ECSBC +
9	Super ECSBC

9.2 Mandatory requirements

9.2.1 Designated space for waste collection and Storage

The building project shall allocate a dedicated area for collecting and storing construction waste (solid waste) generated throughout the construction phase and post occupancy. For the construction phase, the designated space should be located on-site or adjacent to the project site within a maximum distance of 100 meters.

During construction phase, the designated waste collection and storage space should be at least 2% of the project site area. This space can be temporary, and the project has the flexibility to relocate it based on construction requirements.

During post occupancy, the designated waste collection area should be within the site. For a population of up to 50,000, the building shall provide 2 bins for the storage of wet and dry waste. These bins should have a capacity of minimum 60 litres each, and the wet waste storage bin should have a lid (as per CIPET specifications).

The project shall provide a centralized bin centre to store a minimum of 150 kg of waste per day. The bin centre must be adequately ventilated to ensure proper air circulation. The compliance shall be demonstrated with site plan highlighting the location of centralized bin centre.

9.2.2 Segregation of waste

The project team shall segregate the waste into minimum 4 categories as defined below during construction phase and store separately in the designated space.

a) Concrete waste
b) Broken bricks
c) Metal waste – steel, Aluminium, copper
d) Wood waste
e) Plastics
f) Tiles and ceramics
g) Masonry waste
h) Used paint tins / cans.
i) Granite / Marble
j) Glass

NOTE: The list is not exhaustive.

During post occupancy the waste generated shall be segregated into minimum of 2 categories: dry and wet/ biodegradable wastes.

List of Dry wastes:

a) Paper and plastic, all kinds
b) Cardboard and cartons

c) Containers of all kinds excluding those containing hazardous materials
d) Packaging of all kinds
e) Glass, all kinds
f) Metals, all kinds
g) Rags, rubber, wood
h) Foils, wrappings, pouches, sachets and tetra packs (rinsed)
i) Cassettes, computer diskettes, printer cartridges and electronic parts
j) Discarded clothing, furniture, and equipment.

List of Wet waste or biodegradable wastes

a) Food wastes of all kinds, cooked and uncooked, including eggshells, bones
b) Flower and fruit wastes including juice peels and house-plant wastes
c) House sweepings (not garden sweepings or yard waste: dispose on-site)
d) Household Inert (sweepings/ashes)

* The list is only illustrative.

The compliance shall be demonstrated in the site plan/ floor plan highlighting the space dedicated to segregate different types of waste during construction phase and post occupancy.

9.2.3 Monitoring

The project team shall quantify the waste generated category wise using the weighing machine and maintain the records. The monitoring of the waste generated shall be done once in a week during the construction phase and daily during post occupancy. The project team shall provide the monitoring plan as part of the design document.

9.3 Prescriptive requirements

9.3.1 Reduction of waste during construction phase

The waste generated during construction shall not exceed the limits as defined in Table 9.1 for material category.

Table 9.1 Allowable percentage of wastage

S No.	Waste material	% of waste generation
1	Cement	5-8%
2	Reinforcement Steel	10-15%

3	Concrete	3-5%
4	Sand	10-15%
5	Coarse Aggregate	5-8%
6	Bricks	5-10%
7	Wood	1-3%
8	Tiles	10-12%
9	Paint	3-4%
10	Glass	3-5%
11	Aluminum	3-5%

Estimation of % of waste generation

The percentage of waste generation shall be calculated based on the estimated quantity of waste generated in a particular category of material by the estimated total quantity procured of the respective category of material utilised in the project.

The details of respective quantity of material utilised in the project can be obtained from the inventory.

$$\text{\% of waste Generation} = \frac{\text{Estimated quantity of waste generated From use of a particular material X100}}{\text{Total quantity of the respective material that will be procured in the project.}}$$

9.3.2 Reuse of waste in construction phase

Minimum 2% of the waste material generated from the project shall be reused. Eg; utilization of the waste such as broken ceramic tiles in alternate place in projects.

The reuse of material in the project shall be calculated from equation shown below.

$$\% \text{ of waste reuse} = \frac{\text{Total quantity of waste reused within the project site}}{\text{Total quantity of waste Generation}} \times 100$$

9.3.3 Reuse of waste post occupancy

100% of wet, biodegradable and organic waste shall be processed onsite using organic waste composter (OWC), bio digestor or vermicomposting.

The manure produced after the waste processing shall be used for gardening purposes within the site or in any other site.

The compliance shall be demonstrated by,

a) Site plan highlighting the location of organic waste composter, bio digestor or vermicomposting.
b) Specifications of OWC and bio digestor indicating the capacity of waste that can be treated per day.

9.3.4 Recycling of waste

A state pollution control board or regulatory authority authorized recycling agency shall be appointed for recycling of the waste during construction phase and post occupancy phase.

The compliance shall be demonstrated by a valid agreement with authorised recycler for recycling of the waste materials.

9.3.5 Segregation of E- waste

For populations of up to 50,000, the provision of separate bins for E-waste segregation should be made. These bins should have a minimum capacity of 20 litres at the floor level and a minimum capacity of 60 litres at the site level.

List of some E- waste shall include:

a) Batteries from flashlights and button cells
b) Car batteries, oil filters and car care products and consumables
c) Light bulbs, tube-lights, and compact fluorescent lamps (CFL)

9.3.6 Segregation of Domestic hazardous waste

For populations of up to 50,000, the provision of separate bins for domestic hazardous waste should be provided. These bins should have a minimum capacity of 20 litres at the floor level and a minimum capacity of 60 litres at the site level.

List of Some Domestic Hazardous Wastes shall include:

(A)

a) Aerosol cans
b) Bleaches and household kitchen and drain cleaning agents
c) Chemicals and solvents and their empty containers
d) Cosmetic items, chemical-based
e) Insecticides and their empty containers
f) Paints, oils, lubricants, glues, thinners, and their empty containers
g) Pesticides and herbicides and their empty containers
h) Photographic chemicals
i) Styrofoam and soft foam packaging from new equipment
j) Thermometers
k) Mercury-containing products

(B)

a) Injection needles and syringes after destroying them both.
b) Discarded Medicines
c) Sanitary towels,
d) Disposable diapers and
e) Incontinence pads (duly packed in polythene bags before disposal)

9.3.7 Responsible disposal

The waste that cannot be reused or recycled within the site shall be handed over to the authorised Treatment, Storage and Disposal facility (TSDF) in the city.

The project team is required to maintain records and provide detailed information regarding the quantity of waste materials that have been responsibly disposed of.

9.3.8 Liquid waste

A building project complying to ESCBC code shall meet the requirements in terms of handling, storage and disposal of liquid hazardous waste generated during the construction phase and post occupancy.

Project site shall have a dedicated closed storage space for storing liquid hazardous waste generated during the construction such as used oil, oil sludge, paint, and paint sludge. The storage area must be locked and prevented from unauthorized entry.

The hazardous waste shall be stored in a container for a period of not more than 90 days at the site.

9.3.9 Gaseous waste

The building project shall comply to the requirements, by meeting the emission standards specified by the Central pollution control Board (CPCB) or state pollution control board as applicable.

Emission standards

The emission standards need to be met for the diesel fired earth moving equipment, material handling equipment and diesel power generators used within their construction site.

The emission limits for new engines used for power generating set (hereinafter referred to as Genset) applications up to 800 kW Gross Mechanical Power, namely:

a) Diesel engines.
b) Engines based on dedicated alternate fuels;
c) Engines based on Bi-fuels run either on Gasoline or on any one of the alternate fuels;
d) Engines based on Dual Fuel run on Diesel and any of the alternate fuels;
e) Portable Generator sets (PI engines below 19kW and up to 800 cc displacement) run on Gasoline fuel, dedicated alternate fuels and Bi-fuel run either on Gasoline or on any one of the alternate fuels

The emissions limits of the Genset is shown in Table 9.2 and Table 9.3. The emissions limit from the construction equipment is shown in Table 9.4 and Table 9.5

TABLE 9.2

Emission limits for Genset engines up to 800 kW Gross Mechanical Powered by All CI engines and PI engines > 800 cc engine displacement.

Power Category, kW	NOx	HC*/**	NOx +HC*/**	CO	PM		Smoke (light absorption coefficient)	
	CI/PI	CI/PI	CI/PI	CI/PI	CI	PI	CI	PI
	g/kWh						m-1	
P ≤ 8	-	-	7.5	3.5	0.30	-	0.7	-
8 < P ≤ 19	-	-	4.7	3.5	0.30	-	0.7	-
19 < P ≤ 56	-	-	4.7	3.5	0.03	-	0.7	-

56 < P ≤ 560	0.40	0.19		3.5	0.02	-	0.7	-
560 <P ≤ 800	0.67	0.19		3.5	0.03	-	0.7	-

TABLE 9.3

Emission limits for portable Genset up to 19 kW powered by PI engines (up to 800 cc engine displacement)

Category Engine Displacement (cc)	CO	NOx +HC */**
	g/kWh	
Up to 99	<250	<10
> 99 and up to 225	<250	<08
> 225 and upto 800	<250	<06

The Diesel fired construction equipment vehicles used with the project site should comply within the Ministry of Road Transport and Highways Notification, 2017 norms.

Table 9.4

Bharat Stage (CEV/TREM) -IV

Applicable emission limit for Non-Road Steady Cycle (NRSC) and Non-Road Transient Cycle (NRTC)test Cycle

	Applicable with effect from	CO	HC	NOx	PM	Test Cycle*
Category, kW		g/ kWh				
37 ≤P < 56	1st October, 2020	5.0	4.7 (HC+NOx)		0.025	NRSC & NRTC
56 ≤P < 130		5.0	0.19	0.4	0.025	
130≤P < 560		3.5	0.19	0.4	0.025	

*Test cycle as described in AIS: 137and as amended from time to time.

Table 9.5

Bharat Stage (CEV/TREM)- V

Applicable emission limit for Non Road Steady Cycle (NRSC) and Non Road Transient Cycle (NRTC)test cycle

	Applicable with the effect from	CO	HC	NOx	PM	PN	Test cycle
Category, kW		g/ kWh				#/kWh	
P<8	1st October, 2023	8.0	7.5 (HC+NOx)		0.4	-------	NRSC
8 ≤P < 19		6.6	7.5 (HC+NOx)		0.4	-------	NRSC and NRTC
19 ≤P < 37		5.0	4.7 (HC+NOx)		0.015	1×10^{12}	
37 ≤P < 56		5.0	4.7 (HC+NOx)		0.015	1×10^{12}	
56 ≤P < 130		5.0	0.19	0.4	0.015	1×10^{12}	
130 ≤P < 560		3.5	0.19	0.4	0.015	1×10^{12}	
P > 560		3.5	0.19	3.5	0.015	-------	NRSC

The abbreviations used in Table 1 and Table 2 are as follows:

a. NOx – Oxides of Nitrogen;
b. HC– Hydrocarbon;
c. CO – Carbon Monoxide;
d. PM – Particulate Matter;
e. CI-Compression Ignition engines;
f. PI- Positive Ignition engines;
g. * HC stands for THC for diesel and gasoline;

h. ** HC for alternate fuels shall be as defined in System and Procedure for Generator set.

9.4 Documentation Requirements

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

1. Brief description of the type of project with location, total area, number of occupants and operating hours.
2. Brief description of system in place of segregating and monitoring the waste generated within the project site.
3. Summary of various types of waste generated and their quantities. During construction phase provide the total quantity of waste generated for each type of waste and in case of operation and maintenance phase provide the quantity of waste generated for each type of waste on annual basis.
4. Brief description on the efforts taken to reduce, reuse and recycle the waste or meeting the norms in case of gaseous waste.
5. Details highlighting the compliance to mandatory and prescriptive requirements of the code.
6. Copy of the documents such as agreements with third party waste handlers / service providers, bills / vouchers for having handed over the waste for recycling.

9.5 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

The following Standards contain provisions which through reference in this text, constitute provisions of the standards. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the Standards indicated below:

Standard Number/Regulation	***Title***
SP 7: 2016	National Building Code of India 2016 (NBC 2016)
IGBC Net Zero waste Pilot Version	Indian Green Building Council Reference Guide on Net Zero Waste Rating systems
CPHEEO chapter 9	Storage Of Waste At Source
Municipal solid waste management manual: Part II	Manual on Municipal Solid Waste Management

Section 10
SUSTAINABLE MATERIALS

General

ECSBC requires the buildings to report the embodied carbon in $kgCO_2$-eq/Sqm. The reporting of the embodied carbon is limited to the A1-A3 life stage as defined in EN 15978.

1) 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.

2) 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.

3) Exclusions

a) 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.

4) 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)

5) **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.

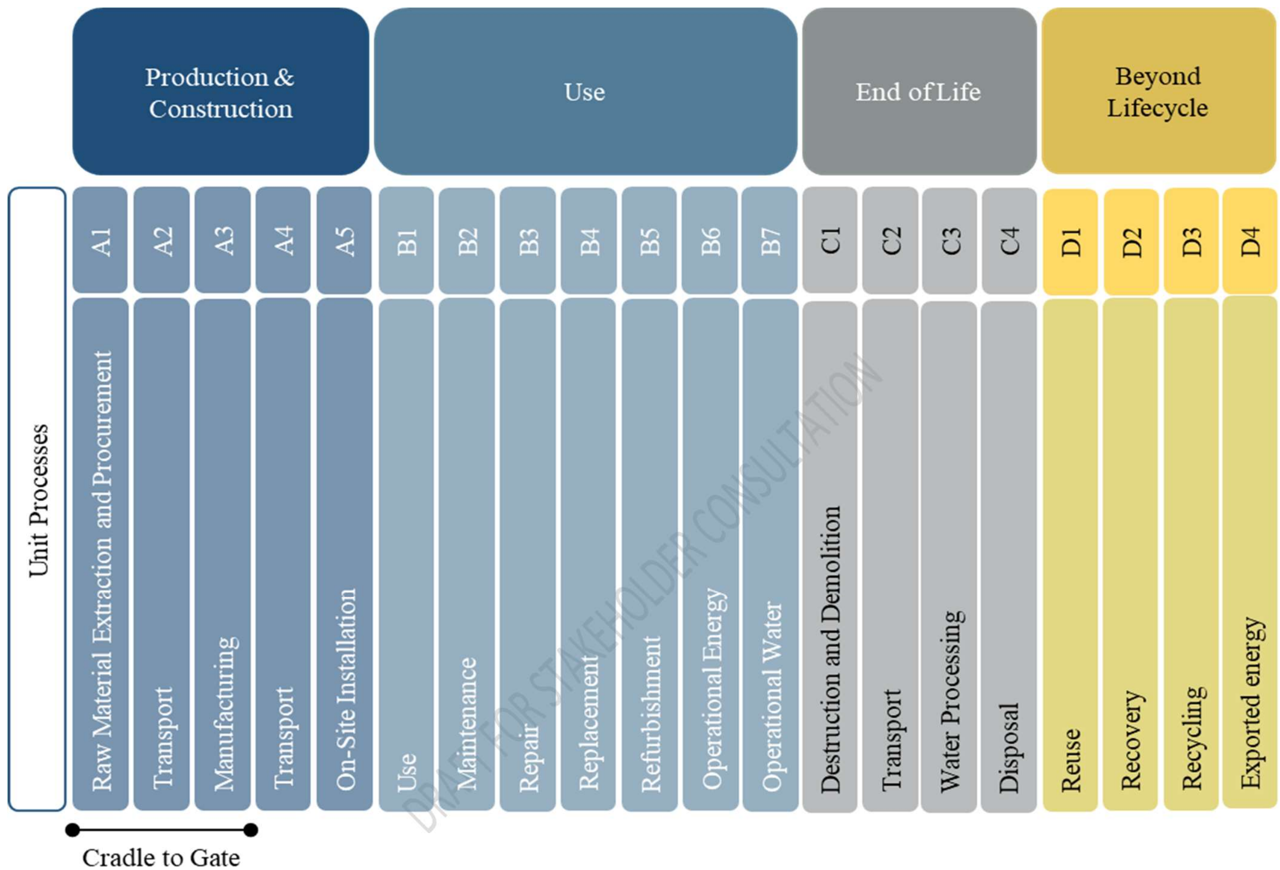
6) **Annexure:**

a) *Please refer attached Annexure-A*

Annexure-A

Table 1-1 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'.



The aim of this exercise is to obtain the embodied energy and/or carbon values for per Square Meter of the building.

Table 1-2 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 2 -1 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 2-2 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	Please mention all processes involved in Raw Material extraction and procurement. For example, cutting, hammering etc.	

	Extraction and Procurement		
	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 3 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)

Table 4 BoQ

Site	Sr. no.	1
S1_B1	Material	CONCRETE (includes concrete for
	Unit	
	Qty(a)	
	Raw Components	
	Unit	
	Qty(b)	
	Functional Unit (kg)	
S2_B1	Qty(c)	
	Material	CONCRETE
	Unit	
	Qty(a)	
	Raw Components	
	Unit	
	Qty(b)	
	Functional Unit (kg)	
S3	b	
	Material	CONCRETE
	Unit	
	Qty(a)	
	Raw Components	
	Unit	
	Qty(b)	
	Functional Unit (kg)	
S4	Qty(c)	
	Material	CONCRETE
	Unit	
	Qty(a)	
	Raw Components	
	Unit	
	Qty(b)	
	Functional Unit (kg)	
S5	Qty(c)	
	Material	CONCRETE
	Unit	
	Qty(a)	
	Raw Components	
	Unit	
	Qty(b)	
	Functional Unit (kg)	
	Qty(c)	

2	1.02	1.01
STEEL	Concrete (M30)	Concrete (M25)
		cum
STEEL	Concrete (M30)	Concrete (M25)
		cum
STEEL	Concrete (M30)	Concrete (M25)
		cum
STEEL	Concrete (M30)	Concrete (M25)
		cum
STEEL	Concrete (M30)	Concrete (M25)
		cum

3.01	3	2.01
Brick Masonry (Burnt Clay Bricks)	Walling Materials	Mild Steel (used as
		Mild Steel (used as
		kg
Brick Masonry (Burnt Clay Bricks)	Walling Materials	Mild Steel (used as
		Mild Steel (used as
		kg
Brick Masonry (Burnt Clay Bricks)	Walling Materials	Mild Steel (used as
		Mild Steel (used as
		kg
Brick Masonry (Burnt Clay Bricks)	Walling Materials	Mild Steel (used as
		Mild Steel (used as
		kg
Brick Masonry (Burnt Clay Bricks)	Walling Materials	Mild Steel (used as
		Mild Steel (used as
		kg

3.03	3.02
Block Masonry (Concrete Blocks)	Block Masonry (AAC Blocks)
Block Masonry (Concrete Blocks)	Block Masonry (AAC Blocks)
Block Masonry (Concrete Blocks)	Block Masonry (AAC Blocks)
Block Masonry (Concrete Blocks)	Block Masonry (AAC Blocks)
Block Masonry (Concrete Blocks)	Block Masonry (AAC Blocks)

3.03.03	3.03.02	3.03.01
Thermoinsulated Concrete Block (200 mm thk)	Sand	Cement
kg	kg	kg
Thermoinsulated Concrete Block (200 mm thk)	Sand	Cement
kg	kg	kg
Thermoinsulated Concrete Block (200 mm thk)	Sand	Cement
kg	kg	kg
Thermoinsulated Concrete Block (200 mm thk)	Sand	Cement
kg	kg	kg
Thermoinsulated Concrete Block (200 mm thk)	Sand	Cement
kg	kg	kg

3.04.03	3.04.02	3.04.01	3.04
	Shotcrete		EPS Core Walling System
Sand	Cement	EPS	
kg	kg	kg	
	Shotcrete		EPS Core Walling System
Sand	Cement	EPS	
kg	kg	kg	
	Shotcrete		EPS Core Walling System
Sand	Cement	EPS	
kg	kg	kg	
	Shotcrete		EPS Core Walling System
Sand	Cement	EPS	
kg	kg	kg	
	Shotcrete		EPS Core Walling System
Sand	Cement	EPS	
kg	kg	kg	

4	3.04.05	3.04.04
Plaster		
	Galvanized Iron Wires (for reinforcement)	Aggregate
	kg	kg
Plaster		
	Galvanized Iron Wires (for reinforcement)	Aggregate
	kg	kg
Plaster		
	Galvanized Iron Wires (for reinforcement)	Aggregate
	kg	kg
Plaster		
	Galvanized Iron Wires (for reinforcement)	Aggregate
	kg	kg
Plaster		
	Galvanized Iron Wires (for reinforcement)	Aggregate
	kg	kg

5	4.03	4.02	4.01
Paint	Ceiling Plaster	External Plaster	Internal Plaster
Paint	Ceiling Plaster	External Plaster	Internal Plaster
Paint	Ceiling Plaster	External Plaster	Internal Plaster
Paint	Ceiling Plaster	External Plaster	Internal Plaster
Paint	Ceiling Plaster	External Plaster	Internal Plaster

6.01	6
UPVC door (we are not counting hinges or any accessories)	Doors
nos	
1	
UPVC	
kg	
kg	
UPVC door (we are not counting hinges or any accessories)	Doors
nos	
1	
UPVC	
kg	
kg	
UPVC door (we are not counting hinges or any accessories)	Doors
nos	
1	
UPVC	
kg	
kg	
UPVC door (we are not counting hinges or any accessories)	Doors
nos	
1	
UPVC	
kg	
kg	
UPVC door (we are not counting hinges or any accessories)	Doors
nos	
1	
UPVC	
kg	
kg	

6.02	6.03	7	7.01	7.02
Steel Jali door (for security)	Wooden	Windows	UPVC	Steel
nos	nos			
1	1			
Cold-rolled steel-----drop down				
kg				
Steel Jali door	Wooden	Windows	UPVC	Steel
nos	nos			
1	1			
Cold-rolled steel				
kg				
Steel Jali door	Wooden	Windows	UPVC	Steel
nos	nos			
1	1			
Cold-rolled steel				
kg				
Steel Jali door	Wooden	Windows	UPVC	Steel
nos	nos			
1	1			
Cold-rolled steel				
kg				
Steel Jali door	Wooden	Windows	UPVC	Steel
nos	nos			
1	1			
Cold-rolled steel				
kg				

Table 5 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												

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3485 *Table 6 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 Category												
	Vehicle Capacity (tonnes)												
Vehicle 2	**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 Category												
	Vehicle Capacity (tonnes)												
	Vehicle Used: Make												
	Vehicle Used: Model												
Vehicle 5	**No. of trips**												
	Fuel Mix												
	Total Fuel Used												
	Unit (Fuel Use)												
	Embodied Carbon												
	Unit (EC)												

Table 7 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 for AAC block masonry)	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 Furnace (BAF)	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)																	

3490 *Table 8 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 AAC block masonry)	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 Furnace (BAF)	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 9 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 transport used?	Yes	No										
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

Section 11

INDOOR ENVIRONMENT QUALITY

11.1. General

The building shall comply with the mandatory provisions for all the four significant Indoor Environment Quality (IEQ) parameters – Indoor Air Quality (IAQ), Visual comfort, Thermal comfort and Acoustics as defined in clause 11.2.

Note:

Compliance to IEQ parameters through modifications in building components and systems, may have adverse impact on energy efficiency. Hence it is imperative to define threshold levels for indoor environment parameters to ensure that buildings attain multiple objectives of meeting the energy efficiency without compromising on good indoor environment for efficient functioning of activities and wellbeing of its occupants.

11.2. Mandatory requirements:

11.2.1. Indoor air quality (IAQ):

a) Source control for PM10 and PM2.5:

The HVAC system of all ECSBC, ESCBC+ and Super ECSBC buildings shall use air filter conforming to IS/ISO 16890 Part 1 to Part 4.

b) Source control for CO_2

1) The ECSBC compliant buildings shall be designed to operate their ventilation systems based on design ventilation rates for perceived air quality and shall conform to Section 5 – Clause 5.2.1 of this ECSBC code.
2) In addition, 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 section 5 – clause 5.2.1.3 of this ECSBC code.
3) In ECSBC Super compliant buildings, sensors shall be integrated with the control to continuously monitor and regulate the ventilation rate control to maintain comfort ventilation rates for non-residential buildings excluding healthcare and industrial buildings as defined clause 5.2.1.3 of in section 5 of this ECSBC code.

c) 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, 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) UL 2818 GREENGUARD Certification Program for Chemical Emissions 209or Building Materials, Finishes and Furnishings
4) UL 2819 GREENGUARD Certification Program for Chemical and Particle Emissions for Electronic Equipment
5) ANSI/BIFMA X7.1-2011(R2021) Standard for Formaldehyde and TVOC Emissions of Low-emitting Office Furniture and Seating

11.2.2. Thermal Comfort

Thermal conditions play a critical role in influencing occupant comfort and well-being. This sub-section specifies thermal environmental conditions that are suitable for healthy adults at:

a. Atmospheric pressure equivalent to altitudes up to mean sea level of 3000 m.
b. Indoor spaces designed for human occupancy for periods not less than 15 minutes.

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.

Table 11.1: Conditions for thermal comfort measurement

Air velocity	Weather condition	Level of activity	Reference table or Threshold Values
Up to 0.2m/s	Summer / winter	Met value ≤ 1.2	Table 11.2

Above 0.2m/s	Summer / winter	Met value ≤ 1.2	Table 11.2 + Figure 11.1
-	Summer	-	Relative humidity: 30 to 70%

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
Met >1 and up to 1.2	23.0 ± 3.0	19.0 ± 4.0
Met ≤1.0	24.5 ± 2.5	22.0 ± 3.0

Note:

a) Conditions for special purpose buildings such as Operation theatres, clean rooms shall be governed by norms prescribed by appropriate authorities.

b) Clothing insulation is expressed in **clo** units. The clo has the units as square metre kelvins per watt or $m^2 \cdot K/W$, used to describe insulation used in residential and commercial construction, — higher the value, the better the insulation performance.

c) 1 clo = 0.155 $K \cdot m^2 \cdot W^{-1}$. 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).

11.2.2.1 Prescriptive requirement:

a) ECSBC+ compliant buildings shall be designed to have relative humidity control within the range of 30% to 70% in summer.

b) Super ECSBC buildings shall also 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

11.2.2.3 Method of calculating operative temperature for air velocity up to 0.2 m/s

The operative temperature shall be calculated as below.

$$t_o = \frac{(t_{mr} + (t_a \times \sqrt{10}\ ))}{1+\sqrt{10\vartheta}} \text{ .... Eq. 11.1}$$

where,

ϑ = air velocity

t_a= air temperature

t_{mr} = mean radiant temperature

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.

$$t_o = \frac{(t_{mr} + t_a)}{2} \text{ .... Eq. 11.2}$$

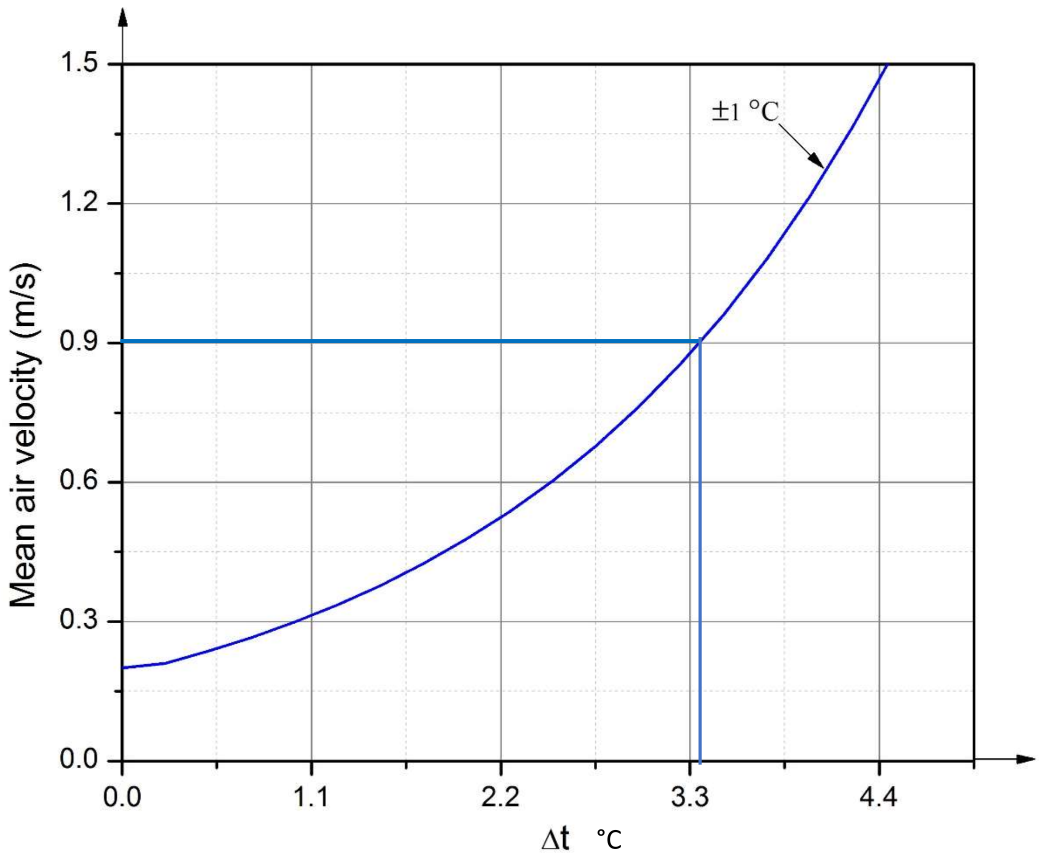


Figure 11.1. Required Air Speed to Offset Increased Operative Temperature (in Celsius)

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).

11.2.3. Visual Comfort

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) and IS 16017 (Par 1) for quality of luminaires for all application areas.

In addition, buildings shall meet the threshold values of parameters of lighting comfort as given below. Compliance shall be shown through lighting simulation under no daylight conditions.

a) 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.

b) Minimum uniformity of illuminance in task area shall be 0.7 as per NLC 2010 Part 5

c) Minimum uniformity of illuminance at immediate surrounding areas shall be 0.5 as per NLC 2010 Part 5.

d) Illuminance of the immediate surrounding areas shall be as per NLC 2010.

11.2.3.1 Prescriptive requirement:

Minimum 90% percent of the workstations shall meet the required illuminance at task plane for ECSBC and ECSBC Plus buildings, and 100% for Super ECSBC buildings.

11.2.4. Acoustics comfort

The controlling of noise in and around buildings is essential. The new buildings and the refurbished buildings shall demonstrate compliance through prescriptive method as defined below or through computer aided simulation tools.

11.2.4.1 Prescriptive requirements

Isolation between Building Elements depends upon the following factors:

a) Junction detail between the separating wall/floor
b) Mass of flanking elements
c) 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.

Table 11.4 Default sound insulation values of the different walls and Glazing.

Sl#	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 both sides	35-37
2	Metal stud partition, 50 mm studs 600 mm centres, clad both sides with 12.5 mm plasterboard of minimum density 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 both sides	38-40
4	Metal stud partition, 50 mm studs 600 mm centres, clad both sides with 12.5 mm plasterboard of minimum density 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 with 12mm 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 wool each side of a 70 mm metal stud	40-45
8	225 mm brickwork 215pprox.. density 440 kg/m2 with 12mm thick plaster on both sides	
9	Double Stud Metal stud partition, 70 mm studs placed 10mm apart and studs fixed at 600 mm centres, 2x12.5 mm plasterboard of minimum density 900Kg/m3 cavity filled with 2x 50mm thick mineral wool each side of a metal stud	45-50
10	200 mm block work 215pprox.. density 400Kg/m2 with 15mm thick plaster on both sides	
11	100 mm block (high density 200 kg/m2) with 12 mm plaster 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	
12	Double Stud Metal stud partition, 70 mm studs placed 10mm apart and studs fixed at 600 mm centres, 2x12.5 mm plasterboard of minimum density 990-1000Kg/m3 cavity filled with 2x 50mm thick mineral wool each side of a metal stud	50-55
	Glazing combinations	
13	4 mm single float (sealed)	25
14	6mmsingle float (sealed)	
15	4 mm glass/12 mm air gap/4 mm glass	28
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 seals around perimeter	Solid-core wood door [($24kg/m^2$)]; Magnetic seals around perimeter
STC		22	26	30
R_w				
Frequency Hz	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. Hallow-core Steel Doors

TL (Transmission loss), DB

Description		Hallow-core steel door,18ga. Steel faces[(26kg/m^2)]; no seals around perimeter	Hallow-core steel door,18ga. Steel faces (26kg/m^2)]; Foam type seals around perimeter	Hallow-core steel door,18ga. Steel faces (26kg/m^2)] Magnetic seals around perimeter
STC		17	28	32
R_w				
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

Transmission loss for Acoustical Louvers is defined in Table 11.6.

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

11.2.4.2 Calculating acoustical transmission loss:

Normalized transmission loss shall be calculated using the equation 11.7 and Random transmission loss using equation 11.8.

Normalized transmission loss, TL_N

$$TL_N = 10\,log\,\{1 + \left(\pi \times F\ \times \frac{S}{(S_O \times C_O)}\right)\}^2 \text{.. Eq. 11.3}$$

$\pi = \frac{22}{7}$

F = Center frequency

S= Surface density

$(\boldsymbol{S_o} \times \boldsymbol{C_o})$ = Characteristic impedance, 415 Rayls

Random transmission loss is then calculated using normalized transmission using the below mentioned formula,

$$TL_R = TL_N - (10\,log\,0.23\ \times TL_N) \text{ .... Eq. 11.8}$$

Table. 11.7: The threshold Noise isolation class depending on type of spaces

Sl. No.	Building	Type of space	Dw/NIC		
			Super ECSBC	ECSBC+	ECSBC
1	Office	Between two enclosed offices	45	40	40
		Between enclosed office and circulation area	40	35	30
		Between two meeting or conference rooms	50	45	45
		Between meeting or conference room and circulation area	40	35	30
		Between two training rooms	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 circulation area	40	40	35
		Between patient room and circulation area (with entrance)	35	30	25
		Between patient room and 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

Section 12

COMMISSIONING OF BUILDING SYSTEMS

12. Commissioning of Building Systems

12.1 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.

12.1.1 Applicability

The provisions of this section 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 5000m^2.

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.

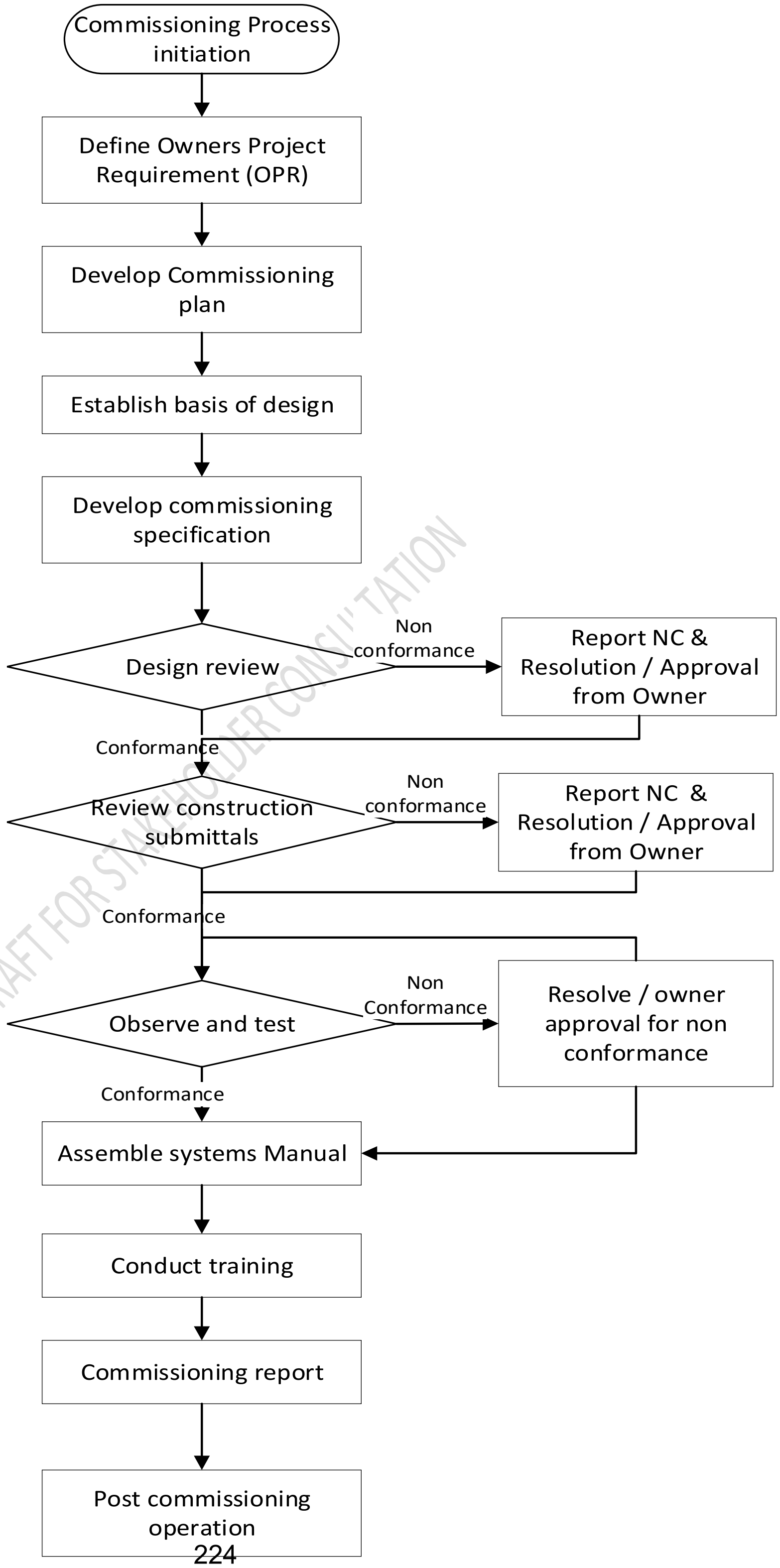
a) Building Envelope Systems.
b) Electrical systems including power receiving and distribution as well as Stand by Generation / On site generation systems.
c) On-site renewable energy systems.
d) Water supply and drainage systems including pumping systems and hot water generation/distribution systems.

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.

12.2 Mandatory requirements for ECSBC Buildings

12.2.1 A systematic approach as detailed in the flow chart (Figure 12.1) shall be followed for commissioning of each building system.



Commissioning Process initiation
Define Owners Project Requirement (OPR)
Develop Commissioning plan
Establish basis of design
Develop commissioning specification
Design review
Non conformance
Report NC & Resolution / Approval from Owner
Conformance
Review construction submittals
Non conformance
Report NC & Resolution / Approval from Owner
Conformance
Observe and test
Non Conformance
Resolve / owner approval for non conformance
Conformance
Assemble systems Manual
Conduct training
Commissioning report
Post commissioning operation

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Figure 12.1. Commissioning process flow chart

12.2.2 Owner shall designate a Commissioning Authority (CxA) right at the initiation of the building project. CxA shall either be an employee of the Owner or a member of the design team expressly designated for that purpose by Owner.He/She also may be a Third Party Commissioning agent appointed directly by the Owner.

12.2.3 Owners Project Requirements (OPR) shall be developed by the CxA with inputs from architects and all other members of the design team. OPR shall be approved by the Owner.

12.2.4 Based on the OPR and the scope of the building project, CxA shall develop the Commissioning Plan for each of the building systems applicable to the project. This commissioning plan duly accepted and signed by the Owner shall be submitted to the AHJ as part of code compliance requirements.

12.2.5 Commissioning plan, at a minimum, shall include the following in respect of each of the building systems.

a) Commissioning process overview
b) Appointment/engagement letter of CxA.
c) Documentation requirements including systems manual, commissioning report and training records (Note: These documents are not required at this stage)
d) Test and verification requirements.
e) Resolution process for non-compliance

12.3 Prescriptive Requirements of ECSBC Plus buildings

12.3.1 In addition to the requirements of the Commissioning Plan for ECSBC Compliant buildings, the following additional aspects shall be covered in the commissioning plan for ECSBC+ buildings.

a. Construction checklists for all equipment and subsystems.
b. Test procedures for each equipment, sub system and system
c. 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 CxA team for each test.
d. Seasonal and post occupancy testing requirement shall be part of the commissioning plan.
e. Owner shall provide an undertaking that the Commissioning Plan shall be in force for one year post occupancy and during this period, building performance with respect to energy and water consumption shall be monitored and recorded.
f. 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. Building owner shall be required to give an undertaking to this effect to the AHJ while applying for compliance with code.

12.4 Additional requirement for Super ECSBC buildings

12.4.1 In addition to the mandatory requirements under clause 12.2 and prescriptive requirements under clause 12.3, Super ECSBC Buildings shall comply with the following. CxA shall be a third party duly certified by an accredited agency.

12.4.2 CxA designated by the owner shall be either a member of the owner's organization or a Third party agency directly appointed by the owner. Members of the design or execution agencies shall not be the designated CxA.

12.4.3 The CxA appointment shall extend to the post occupancy stage and CxA shall be responsible for continuous commissioning of the systems for a minimum 3-year period post occupancy. Necessary undertaking by the building owner in this regard shall be submitted to AHJ. During this period, CxA shall be responsible for continuous monitoring of the building systems from energy and water consumption points of view and necessary records shall be maintained.

12.4.4 IoT enabled monitoring and data analytics for building systems shall be provided in the design. These shall cover monitoring and recording of and for energy and water usage.

12.4.5 IoT enabled system for preventive and predictive maintenance shall be included in the design.

12.5 Controls for Commissioning.

12.5.1 Installation of sensors, detectors, measuring devices and controls during construction stage is essential for proper commissioning of the system. These shall be clearly stated in the commissioning plan.

12.5.2 Control requirements for ECSBC, ECSBC+ and Super ECSBC buildings are detailed in Chapter 13.

12.6 Documentation requirements

12.6.1 Code Compliance shall be determined by the adequacy of the following documents to be submitted by the building owner to the approving authority.

12.6.2 Commissioning plan for all applicable building systems prepared by CxA and approved by the owner.

12.6.3 Particulars of CxA appointed/ designated by the owner to meet ECSBC/ECSBC+ or Super ECSBC requirements.

(Name, Organization, Qualification and Experience to be specified) Undertaking from owner for the post commissioning engagement of CxA for a period of three years in case of Super ECSBC Building.

12.6.4 Confirmation by Owner that commissioning requirement shall be incorporated in each of the contracts for supply/installation of equipment and systems.

Section 13

CONTROLS AND INTERNET OF THINGS

13.1 General

In today's era of rapid technological advancement, the integration of Control Systems **and Internet of Things (IoT**) has emerged as a transformative force in the realm of modern buildings. The convergence of these technologies 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 the~~ are covered in this section. Buildings shall comply with mandatory requirements as per Clause 13.2 and prescriptive requirements as per Clause 13.3 respectively.

13.2 Mandatory requirements

The compliance level for ECSBC, ECSBC+ and ECSBC Super shall be as defined in 13.2.1, 13.2.2 and 13.2.3.

13.2.1 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 section 6, section 7 and section 8 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 13.1 defines compliance requirement for significant components of building specified in Section 4b, 5, 6**,** section 7, section 8, section 9 and section 11.

TABLE 13.1

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/un occupancy mode data; based on based on which, VAVs to switch to occupied/unoc cupied modes
20	Electrical & Vertical Transportation	Equipment Level	Transformers, Breakers, VHT	-	-	Monitor healthy 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						

Table 13.2
Abbreviations used in Table 13.1

Abbreviations	Full form
DX IDU/ODU	Direct expansion Split Unit
DX VRF	Direct Expansion Variable Refrigerant Flow Unit

CHW FCU	Chilled Water Fan Coil Unit
CHW AHU	Chilled Water Air Handling Unit
CHW Pumping	Chilled Water Pumping
CT Level Control	Cooling Tower Level Control
PHE equipment	Public Health and Engineering equipment
VHT	Vertical and Horizontal Transportation

13.2.2. Protocols

All unit level and system level controls protocol shall conform to ASHRAE Standards 135 – BACnet, Specification for Data Communication Protocol for Building Automation and Control Networks. Other industry standard open and accepted Protocols like OPC (Open Platform Communications), MQTT (Message Queuing Telemetry Transport), Zigbee, Wi-Fi, MODBus, M-Bus (Meter-Bus), GSM/GPRS (Global System for Mobile communication/ General Packet Radio Services), Z-wave, DLMS (Device Language Message Specification) shall be used for connecting equipment and devices like, chillers, DG sets for captive power generation, energy meters, water meters, variable speed drives and others.

13.2.3 Controllers

For various applications, controllers with built-in logic or programmable control logic shall be used to achieve the desired design intents and controllers and shall meet the requirements of Clause 13.2.2 for protocol compliance.

13.3 Prescriptive Requirements

13.3.1 Controls for ECSBC and ECSBC Plus buildings

a. In addition to Table 13.1, critical parameters namely, temperature, pressure, voltage, current, energy, and others shall be recorded and monitored and shall be made available for the operations team for corrective action.

13.3.2. Controls for ECSBC Super

a. In addition to the various requirements as detailed for ECSBC and ECSBC+ building requirements, networked controls shall be carried out for ECSBC Super compliant buildings.
b. All networked controllers system shall comply with Clause 13.2.2 for protocols used.
c. Critical parameters namely, temperature, pressure, voltage, current, energy, and others shall be made available for effective monitoring and control of the system through networked centralized control system.

13.3.3 Internet of Things (IoT)

IoT devices and automation shall help optimize building performance by providing data on core building operational systems and enabling automatic control of the building's main operating functions. IoT devices shall be able to connect via standard building and industry protocols as mentioned in Section 13.2.2

For IoT devices to be accessed and configured on the field and / or remotely shall have hardware interface and software or wireless interface for remote configuration.

13.3.4 Cyber Security

Vulnerabilities in the IT based systems are diverse. Due to their physical location across all parts of a facility and connectivity with open protocols, systems are prone to technical and physical attacks at all architectural levels. System should take care of all aspects of Cyber Security. Refer to the enclosed INFORMATIVE ANNEXURE – Chapter 13.

13.3.5 Software

Software that brings in all the data and the graphics including all the functionalities to the operator workstation shall have the following options for buildings complying to ECSBC super.

a. Computer workstation software or Server based software for Super ECSBC buildings depending upon the number of data points for monitoring and control.
b. Optional server based – on-premise or remote for ECSBC Super buildings.
c. IoT & Cloud based system is optional for ECSBC Super buildings.

13.3.6 Integrators/Gateways

a. High level Integrators/Gateways shall be used to ensure conversion of various protocols mentioned under Section 13.2.2.
b. Protocol Conversion for equipment and devices integration of various equipment in a building shall happen when various equipment is connected through soft link to bring in the various parameters residing at the equipment to the BMS platform without installing any additional field devices. Conversion from one protocol to another protocol like,
    i. BACnet MSTP to BACnet/IP
    ii. MODBus RTU– BACnet/IP
    iii. MODBus TCP/IP - BACnet/IP
    iv. M-Bus to BACnet-IP
    v. MODBus – GSM / GPRS

13.3.7 Dashboard

a. High level parameters as specified in the informative AnnexureA of various sub systems shall be captured on the dashboard screen and customized based on the OPR (Owners Project Requirement).
    i. HVAC
    ii. Electrical
    iii. Energy Management – consumption, generation
    iv. Water Management – levels, volume, consumption
    v. Sewage Treatment Plant
    vi. Lighting management – power consumption, circuits status, luminaire fused status

vii. Fire – status of alarms / alerts
viii. IEQ
ix. Waste Management
x. Occupancy status
xi. UPS Management

b. Dashboards for ECSBC Super buildings shall capture parameters related to the following categories for trending and analysis.

i. Energy
ii. Environment
iii. Comfort Systems and Controls (HVAC)
iv. Lighting Control
v. Water Management System
vi. Electrical, VHT Systems

A suggested dashboard example of systems to be displayed is enclosed in the Informative Annex – A.

13.3.8 Commissioning and Measurement & Verification (M&V) aspects related to various utilities:

a. For ECSBC and ECSBC+ compliant buildings wherever stand alone and unit or equipment level controls have been provided, control and monitoring parameters shall be available for taking corrective action for the performance of the equipment and system.

b. IoT-based energy management system with software & advanced analytics for:

   i. For ECSBC+ Buildings monitoring-based commissioning (MBCx) procedure to be developed to measure, monitor and assess performance of all points of utility consumption like water, electricity, other energy sources including but not limited to gas, diesel, steam, compressed air and others.

   ii. For ECSBC Super buildings monitoring-based commissioning (MBCx) + Advanced Measurement & Verification (M&V 2.0) infrastructure for ongoing energy performance evaluation, automated M&V, and predictive analysis capabilities.

NOTE: All installed energy meters shall be at least Class 0.2 for building-level metering and Class 1 as defined in IS 13779 for sub-metering and have an active RS-485 port, with industry standard open protocols.

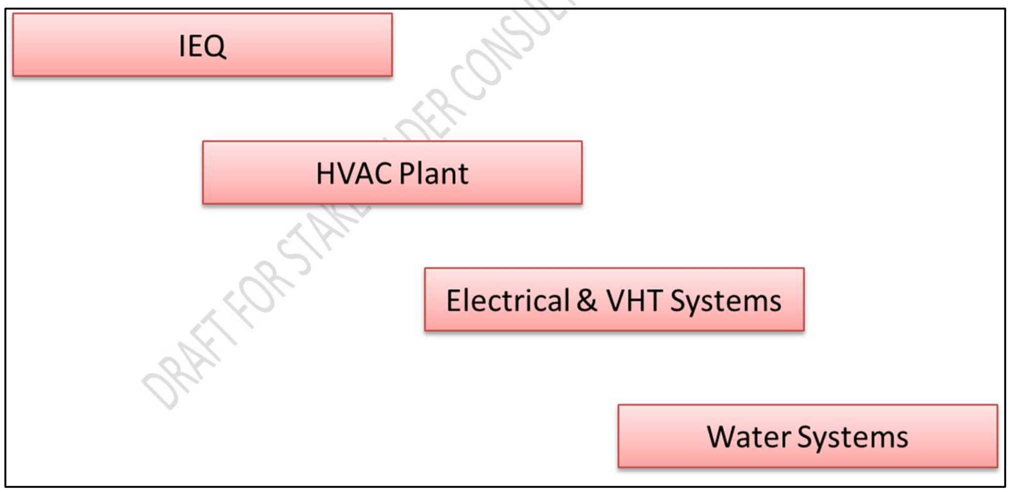
Annexure – A

(Informative)

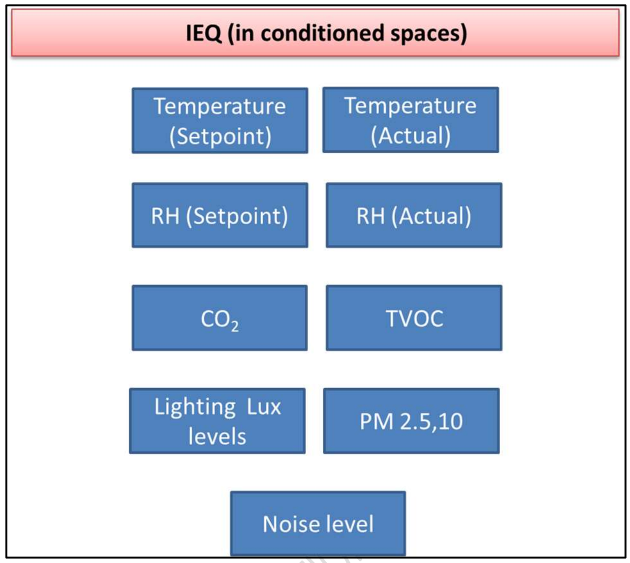
Dashboard for controls and monitoring

This informative annexure provides example of dashboard content. The dashboard can include any of the parameters as indicated in the example and as designed to monitor and control the performance of the equipment.

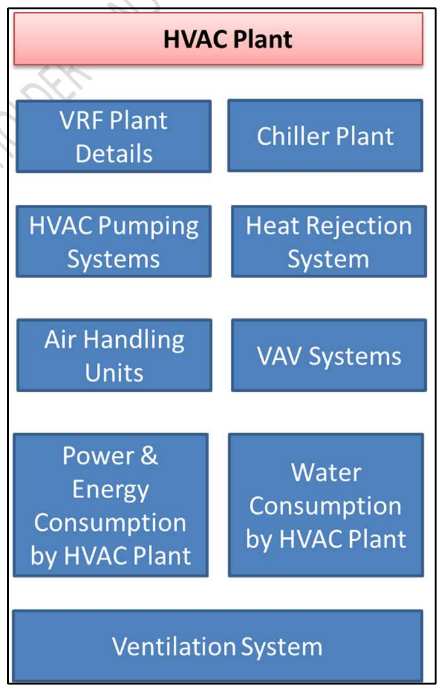
A1. Example of High-level controls and monitoring parameters.



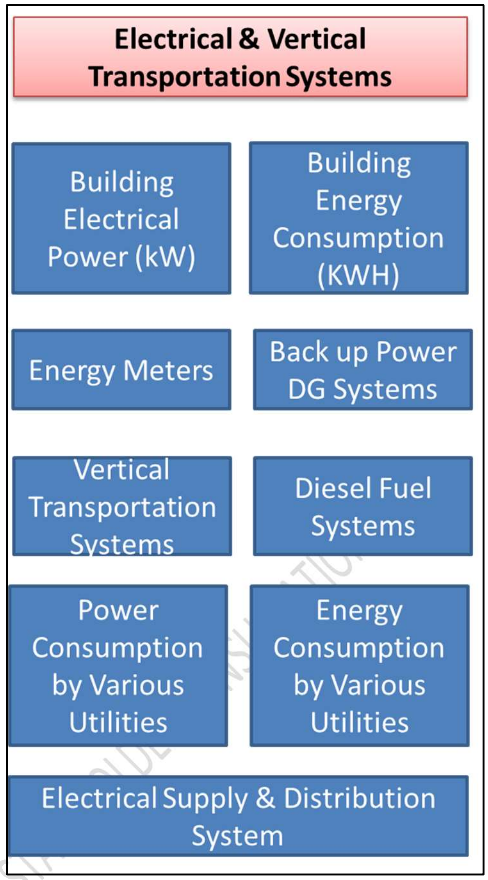
A2. Example of dashboard for IEQ controls and monitoring.



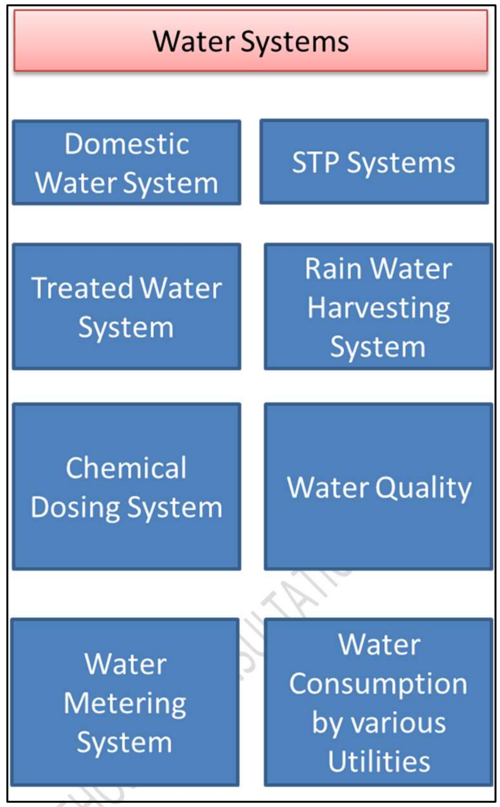
A3. Example of dashboard for HVAC equipment controls and monitoring.



A4. Example of dashboard for Electrical and vertical transportation systems equipment controls and monitoring.



A5. Example of dashboard for Electrical and vertical transportation systems equipment controls and monitoring.


Water Systems
Domestic Water System
STP Systems
Treated Water System
Rain Water Harvesting System
Chemical Dosing System
Water Quality
Water Metering System
Water Consumption by various Utilities

Section 14

WHOLE BUILDING PERFORMANCE

14.0 General

The Whole Building Performance Method is an alternative to the Prescriptive Method compliance path contained in 4 through 7 of this Code. It applies to all building types covered by the Code as mentioned in §2.5.

A building complies with the Code using the Whole Building Performance (WBP) Method, when the estimated EPI Ratio is equal to or less than 1, even though it may not comply with the specific provisions of the prescriptive requirements in 4 through 7. The mandatory requirements of 4 through 7 (4.2, 5.2, 6.2, and 7.2) shall be met when using the WBP Method.

14.1 Annual Energy consumption of the 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 9.3. 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 megajoule.

NOTE: The annual energy use calculation as per the Whole Building Performance Method is not a prediction of the actual energy use of the building 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.

14.1.1 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 Standard Design. Future improvements to the building shall comply with both the mandatory and prescriptive requirements of concurrent code.

14.1.2 Documentation Requirements

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

(a) Summary describing the results of the analysis, including the annual energy use for the Proposed Design and the Standard Design, and software used.
(b) Brief description of the project with location, number of stories, space types, conditioned and unconditioned areas, hours of operation.

(c) List of the energy-related building features of the Proposed Design. This list shall also document features different from the Standard Design.
(d) List showing compliance with the mandatory requirements of this code.
(e) 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 Standard Design.
(f) Explanation of any significant modelling assumptions made.
(g) Explanation of any error messages noted in the simulation program output.
(h) Building floor plans, building elevations, and site plan.

14.2 Mandatory Requirements

All requirements of 4.2, 5.2, 6.2, and 7.2 shall be met. These sections contain the mandatory provisions of the Code and are prerequisites for demonstrating compliance using the WBP Method.

14.3 Simulation Requirements

14.3.1 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:

(a) Energy flows on an hourly basis for all 8,760 hours of the year,
(b) 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,
(c) Thermal mass effects,
(d) Ten or more thermal zones,
(e) Part-load and temperature dependent performance of heating and cooling equipment,
(f) 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 Standard 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.

14.3.2 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.

14.3.3 Compliance Calculations

The Proposed Design and Standard Design shall be calculated using the following:

(a) Same simulation program,
(b) Same weather data, and
(c) 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.

14.4 Calculating Energy Consumption of Proposed Design and Standard Design

14.4.1 Energy Simulation Model

The simulation model for calculating the Proposed Design and the Standard Design shall be developed in accordance with the requirements in Table 14-1. The Standard Design is based on the mandatory and prescriptive requirements of the ECSBC compliant building. The Standard Design will be the same for all compliance levels (ECSBC, ECSBC+, Super ECSBC).

Table 14-1 Modelling Requirements for Calculating Proposed and Standard Design

Case	*Proposed Design*	*Standard 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 mandatory and prescriptive requirements of 4B.2, 5.2 ,6.2, and 7.2 and 4B.3, 5.3, and 6.3 respectively.	The Standard 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 modelled identically in the Standard Design and Proposed Design.
2. Space Use Classification	The building type or space type classifications shall be chosen in accordance with 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 §14.6. In case a schedule for an occupancy type is missing in §14.6, 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 modelled 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.

Case	*Proposed Design*	*Standard Design*
4. Building Envelope	All components of the building envelope in the Proposed Design shall be modelled 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 modelled in accordance with 4B.3.1.1. (d) Manually operated fenestration shading devices such as blinds or shades shall not be modelled. Permanent shading devices such as fins, overhangs, and light shelves shall be modelled. (e) The exterior roof surface shall be modelled 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 modelled as per ASTM E408-71 and ASTM E903-96 respectively. Where cool roof is not proposed, the exterior roof surfaces shall be modelled with a solar reflectance of 0.3 and a thermal emittance of 0.75.	The Standard 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 Standard 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 modelled so that it does not shade itself. (b) Opaque assemblies such as roof, floors, doors, and walls shall be modelled with the maximum U-factor allowed in 4B.3.1 and 4B.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 No shading projections are to be modelled; 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 modelled. 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 modelled using a solar reflectance of 0.70 and a thermal emittance of 0.75.as per 4B.3.1.1

Case	*Proposed Design*	*Standard Design*
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 6.3.4. Where no lighting exists, or is specified, lighting power shall be determined in accordance with the 6.3.2 or 6.3.3 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 modelled. Minimum Lighting controls, as per the ECSBC requirements of 6.2.1, shall be modelled in the Proposed case. Automatic daylighting controls shall be modelled 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 modelled directly in the software by adjusting the lighting power as per Table 14-3.	Interior lighting power in the Standard 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 6.3.2 or 6.3.3. Power for fixtures not included in the lighting power density calculation shall be modelled identically in the Proposed Design and Standard Design. Lighting controls shall be as per the ECSBC requirements of 6.2.1. Exterior lighting power in the standard design shall be set equal to the maximum allowed in 6.3.5

Case	*Proposed Design*	*Standard Design*
6. HVAC Thermal Zones	HVAC Zones Designed: Where HVAC zones are defined on design drawings, each HVAC zone shall be modelled 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 modelled 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 modelled for floors in contact with ground and for floors which have a ceiling/roof exposure to the ambient.	Same as Proposed Design

Case	*Proposed Design*	*Standard Design*
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 modelled in the Standard Design. (d) Where no cooling system has been specified, the cooling system and its characteristics shall be identical to the system modelled in the Standard Design. (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)	The HVAC system type shall be as per Table 14-2 and related performance parameters for the Standard Design shall be determined from requirements of 14.4.2. Equipment performance shall meet the requirements of 5 for code compliant building.

Case	*Proposed Design*	*Standard Design*
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 modelled.	The service water heating system shall be of the same type as the Proposed Design. For residential facilities, hotels and hospitals the Standard Design shall have a solar hot water system capable of meeting 20% of the hot water demand. Systems shall meet the efficiency requirements of 5.2.7.2.
9. Miscellaneous Loads	Receptacle, motor, and process loads shall be modelled 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 Standard Design and Proposed Design. All end-use load components within and associated with the building shall be modelled, 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 modelled the same as the Proposed Design.
10. Modelling 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. (c) Model the HVAC system components or systems using the HVAC system of the Standard Design in accordance with Section 6 of this table. Whichever method is selected, the component shall be modelled identically for both the Proposed Design and Standard Design models.	Same as Proposed Design.

Table 14-2 HVAC Systems Map for Standard Design

	Hotel/Motel, Hospital Patient Rooms, Hotel Guest Rooms, Resorts, Villas, Sleeping Quarters in Mixed-use Buildings, Schools, Classrooms/Lecture Rooms[1]	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 Type[2]	Split AC	VRF: Variable Refrigerant Flow	VAV: Central cooling plant with variable volume AHU[3]	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 Standard Design system type provided the non-predominant conditions apply to less than 1,000 m^2 of conditioned floor area. Use additional system type for non-predominant conditions if those conditions apply to more than 1,000 m^2 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 14-3 Power Adjustment Factors for Automatic Lighting Controls

Automatic Control Device	*Daytime occupancy and area <300 m^2*	*All Others*
Programmable Timing Control	10%	0%
Occupancy Sensor	10%	10%
Occupancy Sensor and Programmable Timing Control	15%	10%

14.4.2 HVAC Systems

The HVAC system type and related performance parameters for the Standard Design shall be determined from Table 14-2 and the following rules:

(a) Other components: Components and parameters not listed in Table 14-2 or otherwise specifically addressed in this subsection shall be identical to those in the Proposed Design.

Exception to 14.4.2(a): Where there are specific requirements in 5.2.2, the component efficiency in the Standard Design shall be adjusted to the lowest efficiency level allowed by the requirement for that component type.

(b) All HVAC and service water heating equipment in the Standard Design shall be modelled at the minimum efficiency levels, both part load and full load, in accordance with 5.2.2.

(c) 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 modelled separately.

(d) Minimum outdoor air ventilation rates shall be the same for both the Standard Design and the Proposed Design except for conditions specified in 9.4.2.1.

(e) The equipment capacity for the standard 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.

(f) Unmet load hours for the Proposed Design shall not differ from unmet load hours for the Standard Design by more than 50 hours. Maximum number of unmet hours shall not exceed 300 for either case.

14.4.2.1 Minimum Outdoor air rates

Minimum outdoor air rates shall be identical for both the Standard Design and Proposed Design, except

(a) when modelling demand-controlled ventilation (DCV) in the Proposed Design (DCV is not required in the Standard Design as per 5.2.1.3.

When the proposed design has a ventilation flow higher than the minimum required by the applicable code, the standard design shall be modelled as per the minimum ventilation rate required by the applicable code and the Proposed Design shall be modelled as per actual design (higher than standard design)

14.4.2.2 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.

14.4.2.3 Fan Power

(a) For Systems Types A, B and D,

P_{fan} = cmh x 0.176

Where P_{fan} = Standard Design fan power in watts

cmh = Standard Design supply airflow rate auto-sized by the simulation software

(b) For System B - VRF: Variable Refrigerant Flow system, the performance curve for Baseline shall be modelled using either equation 1 or table 2.

Equation 1

$$EIR(PLR) = 0.4628 - 1.0402 * PLR + 2.1749 * PLR^2 - 0.5975 * PLR^3$$

Table 2

Part load ratio (PLR)	EIR	Part load ratio (PLR)	EIR
0.1	0.3799	0.6	0.4926
0.2	0.3370	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

(c) For System Type C

Fan power shall be modelled as per efficiency limits specified in Table 5-9 using a static pressure of 622 Pa or the design static pressure, whichever is higher. The simulation software shall automatically calculate the Standard Design fan power based on the above inputs.

VAV system type C

supply fans shall have variable-speed drives, and their part-load performance characteristics shall be modelled using either Method 1 and Method 2 specified given below.

Method 1:

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* (PLR_{fan}) + 0.9506*(PLR_{fan})^2 - 0.0998*(PLR_{fan})^3

Where;

P_{fan} = fraction of full load fan power,

PLR_{fan} = Fan part-load ratio (Current L/s/Design L/s)

14.4.2.4 Design Airflow Rates

Design airflow rates for the Standard Design shall 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.

14.4.2.5 Economizers (airside and waterside)

Airside economizers shall be modelled in the Standard Design as per the requirements of 5.3.6.

Exception to 14.4.2.5: Airside economizer shall not be modelled for Standard Design HVAC System Type A.

14.4.2.6 Energy Recovery

Energy recovery shall be modelled in the Standard Design as per the requirements of 5.3**.**

14.4.2.7Chilled Water Design Supply Temperatures

Chilled water design supply temperature shall be modelled at 6.7°C and return temperature at 13.3°C.

14.4.2.8Chillers

Only electric chillers shall be modelled in the Standard Design for System C. Chillers shall meet the minimum efficiency requirements indicated in Table 14-4 and Table 14-5. Chillers in the Standard Design shall be selected as per Table 14.6 below:

Table 14-4 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	7.0

Table 14-5 Minimum Energy Efficiency Requirements for air cooled Chillers

Chiller Capacity (kW)	COP	IPLV
<260	2.8	*3.5*
≥260	3.0	*3.7*

Table 14-6 Types and Number of Chillers for Standard Design

Peak Building Cooling Load (kW)	*Chiller Type*
< 1,055	1 Water Cooled Screw Chiller
1,055 to 2,110	2 Water Cooled Screw Chillers equally sized
> 2,110	2 or more Water Cooled Centrifugal Chillers, equally sized such that no Chiller is greater than 2,813 kW$_r$

Exception to 14.4.2.8: Air cooled chillers are allowed to be modelled in the Standard Design if the Proposed Design has air cooled chillers. If the proposed building has a mix of air- and water-cooled chillers, then the Standard Design shall be modelled with a mix of air- and water-cooled chillers in the same proportion as in the Proposed Design.

14.4.2.9 Chilled Water Pumps

Chilled and condenser water pumps for the Standard Design shall be modelled as per power and efficiency limits specified in Table 5-12. Standard design chilled water pumps shall be modelled as primary-secondary with variable secondary flow.

14.4.2.10 Cooling Tower

Standard design cooling tower shall be modelled as an open circuit axial flow tower with power and efficiency as per 5.3.3. The fans shall be modelled 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.

14.4.2.11 Boiler

Standard Design boilers shall be modelled as natural draft boilers and shall use the same fuel as the Proposed Design. Boiler efficiency shall be modelled as per Table 5-4.

14.4.2.12 Hot Water Design Supply Temperatures

Hot water design supply temperature shall be modelled at 82°C and return temperature at 54°C.

14.4.2.13 Hot Water Pumps

The standard design hot water pumps shall be modelled with a minimum efficiency of 70% and a pump power of 300 $W/l\text{-}s^{-1}$.

Standard design hot water pumps shall be modelled as primary-secondary with variable secondary flow.

14.4.2.14 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 modelling campus/district cooling systems.

Option A

The cooling source shall be modelled as purchased chilled water in both the Standard Design and proposed design. For the standard design, Table 14-2, shall be modified as follows:

(a) For System Type C; purchased chilled water shall be modelled 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 standard design shall be modelled as per Table 9142 HVAC Systems Map.

For the proposed design, model a virtual onsite chilled water plant with Chiller, Pumps and cooling towers modelled at minimum efficiency levels as per 14.4.2.7 to 14.4.2.10. Airside/low side capacities shall be modelled as per design and the plant capacities shall be auto-sized by the software.

14.4.3 Compliance Thresholds for ECSBC compliant, ECSBC+ and SuperECSBC Buildings

For buildings to qualify as ECSBC+ and SuperECSBC Buildings, the WBP Method shall be followed for the standard design as detailed above. The proposed design for ECSBC+ and SuperECSBC buildings shall meet the mandatory provisions of 4.2, 5.2, 6.2, and 7.2.

The EPI Ratio for ECSBC+ and SuperECSBC Buildings shall be equal to or less than the EPI Ratios listed under the applicable climate zone in Table 14-7 through Table 14-11 of clause 14.5.

14.5 Maximum Allowed EPI Ratios

Table 14-7 Maximum Allowed EPI Ratios for Building in Composite Climate

Building Type	*Composite*		
	ECSBC	ECSBC+	SuperECSBC
Hotel (No Star and Star)	1	0.91	0.81
Resort	1	0.88	0.76
Hospital	1	0.85	0.77
Outpatient	1	0.85	0.75
Assembly	1	0.86	0.77
Office (Regular Use)	1	0.86	0.78
Office (24Hours)	1	0.88	0.76
Schools and University	1	0.77	0.66
Open Gallery Mall	1	0.85	0.76
Shopping Mall	1	0.86	0.74
Supermarket	1	0.81	0.70
Strip retail	1	0.82	0.68

Table 14-8 Maximum Allowed EPI Ratios for Buildings in Hot and Dry Climate

Building Type	*Hot and Dry*		
	ECSBC	ECSBC+	SuperECSBC
Hotel (No Star and Star)	1	0.90	0.81
Resort	1	0.88	0.76
Hospital	1	0.84	0.76
Outpatient	1	0.85	0.75
Assembly	1	0.86	0.78
Office (Regular Use)	1	0.86	0.78
Office (24Hours)	1	0.88	0.76
Schools and University	1	0.77	0.66
Open Gallery Mall	1	0.85	0.77
Shopping Mall	1	0.84	0.72
Supermarket	1	0.73	0.69
Strip retail	1	0.82	0.68

Table 14-9 Maximum Allowed EPI Ratios for Buildings in Temperate Climate

Building Type	*Temperate*		
	ECSBC	ECSBC+	SuperECSBC
Hotel (No Star and Star)	1	0.90	0.80
Resort	1	0.88	0.75
Hospital	1	0.82	0.73
Outpatient	1	0.85	0.75
Assembly	1	0.85	0.76
Office (Regular Use)	1	0.85	0.75
Office (24Hours)	1	0.87	0.74
Schools and University	1	0.77	0.66
Open Gallery Mall	1	0.83	0.74
Shopping Mall	1	0.84	0.71
Supermarket	1	0.81	0.69
Strip retail	1	0.81	0.67

Table 14-10 Maximum Allowed EPI Ratios for Buildings in Warm and Humid Climate

Building Type	*Warm and Humid*		
	ECSBC	ECSBC+	SuperECSBC
Hotel (No Star and Star)	1	0.91	0.81
Resort	1	0.88	0.75
Hospital	1	0.86	0.77
Outpatient	1	0.86	0.76
Assembly	1	0.88	0.80
Office (Regular Use)	1	0.86	0.76
Office (24Hours)	1	0.88	0.76
Schools and University	1	0.77	0.66
Open Gallery Mall	1	0.86	0.77
Shopping Mall	1	0.85	0.72
Supermarket	1	0.82	0.70
Strip retail	1	0.83	0.68

Table 14-11 Maximum Allowed EPI Ratios for Buildings in Cold Climate

Building Type	*Cold*		
	ECSBC	ECSBC+	SuperECSBC
Hotel (No Star and Star)	1	0.91	0.82
Resort	1	0.88	0.75
Hospital	1	0.88	0.80
Outpatient	1	0.85	0.75
Assembly	1	0.87	0.81
Office (Regular Use)	1	0.88	0.80
Office (24Hours)	1	0.87	0.75
Schools and University	1	0.85	0.73
Open Gallery Mall	1	0.82	0.73
Shopping Mall	1	0.96	0.93
Supermarket	1	0.80	0.68
Strip retail	1	0.80	0.66

14.6 Schedules

Table 14-12 Schedules for Business - Office Buildings

Business - Office							
Time Period	Elevator Schedules		External Lighting Schedule	Basement Ventilation		Basement Lighting	
	Day time 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 14-13: Schedules for Business - Office Building Daytime Business

Business – Office Daytime Business										
Time Period	Occupancy Schedule			Lighting Schedule			Equipment Schedule		HVAC Fan Schedule (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 14-14: Schedules for Business - Office Building 24-hours Business

Business – Office 24-hour Business									
Time Period	Occupancy Schedule			Lighting Schedule			Equipment Schedule		HVAC Fan Schedule (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

4325 *Table 14-15: 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 14-16: Schedules for Assembly Buildings (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 14-17: Schedules for Assembly Buildings (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 14-18: Schedules for Assembly Buildings (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 14-19: Schedules for Assembly Buildings (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 14-20: Schedules for Healthcare - Hospital Buildings (A)

Healthcare - Hospital											
Time Period	Occupancy Schedule				Lighting Schedule				Equipment Schedule		
	InPatient & ICU	Public Spaces	OPD & Offices	Diagnostic, emergency & OT	Public Spaces	InPatient & ICU	Diagnostic, emergency & OT	OPD & Offices	InPatient & 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	0.90	0.00	0.00	0.50	0.10	0.10	0.50	0.05	0.40	0.00	0.00
01:00-02:00	0.90	0.00	0.00	0.40	0.10	0.10	0.50	0.05	0.40	0.00	0.00
02:00-03:00	0.90	0.00	0.00	0.40	0.10	0.10	0.50	0.05	0.40	0.00	0.00
03:00-04:00	0.90	0.00	0.00	0.40	0.10	0.10	0.50	0.05	0.40	0.00	0.00
04:00-05:00	0.90	0.00	0.00	0.40	0.10	0.10	0.50	0.05	0.40	0.00	0.00
05:00-06:00	0.90	0.00	0.00	0.40	0.10	0.10	0.50	0.05	0.40	0.00	0.00
06:00-07:00	0.90	0.00	0.00	0.50	0.10	0.10	0.50	0.10	0.40	0.00	0.00
07:00-08:00	0.90	0.10	0.10	0.70	0.50	0.20	0.50	0.30	0.70	0.70	0.70
08:00-09:00	0.90	0.50	0.30	0.70	0.90	0.20	0.90	0.90	0.90	0.90	0.90
09:00-10:00	0.90	0.95	0.90	0.95	0.90	0.20	0.90	0.90	0.90	0.90	0.90
10:00-11:00	0.90	0.95	0.90	0.95	0.90	0.20	0.90	0.90	0.90	0.90	0.90
11:00-12:00	0.90	0.95	0.50	0.95	0.90	0.20	0.90	0.90	0.90	0.90	0.90
12:00-13:00	0.90	0.95	0.20	0.95	0.90	0.20	0.90	0.90	0.90	0.90	0.90
13:00-14:00	0.90	0.95	0.50	0.95	0.90	0.20	0.90	0.50	0.90	0.90	0.90
14:00-15:00	0.90	0.95	0.90	0.95	0.90	0.20	0.90	0.90	0.90	0.90	0.90
15:00-16:00	0.90	0.95	0.90	0.95	0.90	0.20	0.90	0.90	0.90	0.90	0.90
16:00-17:00	0.90	0.95	0.90	0.95	0.30	0.20	0.90	0.90	0.60	0.60	0.90
17:00-18:00	0.90	0.70	0.90	0.95	0.30	0.70	0.90	0.90	0.60	0.60	0.90
18:00-19:00	0.90	0.50	0.50	0.95	0.30	0.90	0.90	0.50	0.60	0.60	0.60
19:00-20:00	0.90	0.30	0.50	0.95	0.30	0.90	0.90	0.50	0.60	0.60	0.60
20:00-21:00	0.90	0.10	0.50	0.70	0.30	0.90	0.50	0.30	0.60	0.60	0.60
21:00-22:00	0.90	0.00	0.10	0.70	0.30	0.90	0.50	0.20	0.60	0.00	0.00
22:00-23:00	0.90	0.00	0.00	0.50	0.30	0.70	0.50	0.10	0.60	0.00	0.00
23:00-24:00	0.90	0.00	0.00	0.50	0.10	0.10	0.50	0.05	0.40	0.00	0.00

Table 14-21: Schedules for Healthcare - Hospital Buildings (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 14-22: Schedules for Healthcare – Out-patient Healthcare Buildings (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 9-23: Schedules for Healthcare – Out-patient Healthcare Buildings (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 14-24: 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 / wee k	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 14-25: Schedules for Educational - School Buildings (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 14-26: 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 14-27: Schedules for Educational - University Buildings (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 14-28: Schedules for Hospitality Buildings (A)

Hospitality									
Time Period	Elevator Schedule		External Lighting Schedule	Service Hot Water (SHW)				Basement Ventilation	Basement Lighting
				Guest rooms		Kitchen	Laundry		
	Week Days	Week ends	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 14-29: Schedules for Hospitality Buildings (B)

Hospitality - Occupancy												
Time Period	Occupancy Schedule											
	Guest Room		Lobby		Public Spaces		Restaurant		Back Office		Conference/ Banquet Room	Kitchen
	WeekDays	Weekends	WeekDay\s	Weekends	WeekDays	Weekends	WeekDays	Weekends	WeekDays	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 14-30: Schedules for Hospitality Buildings (C)

Hospitality – Lighting												
Time Period	Lighting Schedule											
	Guest Room		Lobby		Public Spaces		Restaurant		Back Office		Conference/Banquet Room	Kitchen
	WeekDays	Weekends	WeekDays	Weekends	WeekDays	Weekends	WeekDays	Weekends	WeekDays	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 14-31: Schedules for Hospitality Buildings (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	Week ends	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 14-32: Schedules for Hospitality Buildings (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 14-33: Schedules for Shopping Complexes Buildings (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 14-34: Schedules for Shopping Complexes Buildings (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

Table 14-35: Schedules for Shopping Complexes 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 14-36: Schedules for Shopping Complex- Strip Retail & Supermall Buildings

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