Building and Construction Authority

An MND Statutory Board

Our Ref: APPBCA-2021-16 Environmental Sustainability Group

1 Sep 2021

See Distribution List

Dear Sir/Madam

AMENDMENTS TO THE BUILDING CONTROL (ENVIRONMENTAL SUSTAINABILITY) REGULATIONS 2008 AND ADOPTION OF THE CODE FOR ENVIRONMENTAL SUSTAINABILITY OF BUILDINGS (EDITION 4.0) AND CODE ON ENVIRONMENTAL SUSTAINABILITY MEASURES FOR EXISTING BUILDINGS (EDITION 3.0)

Objective

1. This circular is to inform the industry of the following:

   (A) amendments to the Building Control (Environmental Sustainability) Regulations 2008 (the "**ES Regulations 2008**")[1] to exempt building works involving a Gross Floor Area ("**GFA**") of less than 5000 m^2 from complying with the ES Regulations 2008;

   (B) adoption of the Code for Environmental Sustainability of Buildings (Edition 4.0) under the ES Regulations 2008; and

   (C) adoption of the Code on Environmental Sustainability Measures for Existing Buildings (Edition 3.0) under the Building Control (Environmental Sustainability Measures for Existing Buildings) Regulations 2013 (the **"ESM Regulations 2013**")[2].

Background

2. Legislation on Environmental Sustainability was first introduced in 2008 as part of the key initiatives under the earlier Green Building Masterplans to advance sustainable building development. Under the latest Singapore Green Building Masterplan, more ambitious targets to implement sustainable building development in the Built Environment ("**BE**") sector have been set to mitigate the effects of climate change. On this, BCA has worked in collaboration with our industry stakeholders to enhance the Environmental Sustainability requirements to drive better building energy efficiency and carbon reduction potential to support the transition to a more sustainable and low carbon BE sector .

3. Going forward, the Environmental Sustainability requirements in the Code for Environmental Sustainability of Buildings (Edition 4.0) and the Code on Environmental Sustainability

[1] Under the Building Control (Environmental Sustainability) Regulations 2008, building works are to be designed and constructed to meet the minimum environmental sustainability standard. These requirements apply to new building developments and existing buildings with major A & As/ retrofits. The compliance forms part of the building plan approval and TOP/CSC clearance.

[2] Under the Building Control (Environmental Sustainability Measures for Existing Buildings) Regulations 2013, the compliance with the minimum environmental sustainability standard is required for which a major energy-use change is proposed for prescribed existing buildings. Design submission is required for approval before work commencement.

Measures for Existing Buildings (Edition 3.0) (collectively the "**Codes**") will focus on building energy efficiency and carbon reduction measures. One of the key changes to the Environmental Sustainability requirements will include raising the minimum energy performance standards to ensure energy efficiency improvements of 50% over the 2005 baseline for new buildings and 40% over the 2005 baseline for existing buildings which have undergone major retrofit. To help lower the overall carbon footprint of our buildings, a further key change will be the introduction of a new requirement to implement at least two (2) of seven (7) sustainable construction practices.

4. Other than the enhancements to the Environmental Sustainability requirements in the Codes, BCA has also reviewed and streamlined the regulatory measures for building works involving a GFA of less than 5000 m^2 as well as requirements under the Codes as part of our on-going efforts to streamline requirements and reduce the regulatory burden across the BE sector.

5. Currently, various energy-consuming systems such as air-conditioners (including but not limited to Variable Refrigerant Flow systems) and lighting and electrical appliances are regulated to meet the minimum energy performance standards under the Energy Conservation ("**EC**") Act. Based on our assessment, these standards help tackle inefficient building systems at source and supply end, particularly for smaller projects (i.e. involving a GFA of less than 5000 m^2). Considering that the bulk of carbon reduction can be attained under the EC Act, BCA will exempt such projects involving a GFA of less than 5000 m^2 from the need to comply with the ES Regulations 2008.

6. In March 2021, BCA issued an industry circular to call for comments from the industry on the proposed changes to the Environmental Sustainability requirements for new building developments and existing buildings. Taking into consideration the feedback received, the finalised changes have been incorporated in the Codes, which are now ready for implementation.

(A) Amendments to the ES Regulations 2008 to exempt building works involving a GFA of less than 5000 m^2 from complying with the ES Regulations 2008

7. The amended ES Regulations 2008 will apply to any of the following building works where planning permission is first submitted to the Urban Redevelopment Authority on or after 1 December 2021:

   i) building works which involve a GFA of 5,000 m^2 or more;

   ii) building works which involve increasing the GFA of an existing building by 5,000 m^2 or more;

   iii) building works relating to an existing building which involve a GFA of 5000 m^2 or more, and which involve the provision, extension or substantial alteration of the building envelope and building services in or in connection with an existing building.

(B) Adoption of the Code for Environmental Sustainability of Buildings (Edition 4.0) under the ES Regulations 2008

8. The Code for Environmental Sustainability of Buildings (Edition 4.0) will apply to any of the building works described in paragraph 7 above where planning permission is first submitted to the Urban Redevelopment Authority (URA) on or after 1 December 2021.

9. The Code for Environmental Sustainability of Buildings (Edition 4.0) is available at https://go.gov.sg/esreg-for-nd. The summary of key changes is available in **Annex A**.

(C) Adoption of the Code on Environmental Sustainability Measures for Existing Buildings (Edition 3.0) under the ESM Regulations 2013

10. The Code on Environmental Sustainability Measures for Existing Buildings (Edition 3.0) will apply to all prescribed buildings with a GFA of 5000 m^2 or more (as set out in Regulation 3 of the ESM Regulations 2013) for which a major energy-use change is proposed, and where the design score for the proposed major energy-use change is submitted on or after 1 June 2022, except for the following buildings for Type A use or Type B use:

Buildings for Type A Use	Buildings for Type B Use
Data centres	Industrial buildings, industrial retail buildings, light industrial buildings or special industrial buildings
Religious buildings	Railway premises
Residential buildings (other than serviced apartments)	Port services and facilities
Utility buildings	Airport services and facilities

11. The Code on Environmental Sustainability Measures for Existing Buildings (Edition 3.0) is available at https://go.gov.sg/esreg-for-eb. The summary of key changes is available in **Annex B**.

Registration of Interest for Briefing

12. If you are interested to attending a briefing on the revised Codes, please register your interest at https://go.gov.sg/es-briefing-interest. Further details on the proposed briefing will be provided to interested parties once the arrangements are finalised.

For Clarification

13. We would appreciate if you could convey the contents of this circular to members of your organisation. For clarification, please submit your enquiry through BCA's Online Feedback Form or call us at 1800 342 5222.

Yours faithfully

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Summary of Key Changes to the Requirements under the Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document (Section I – Energy Efficiency)

ANNEX A

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
	General The minimum Green Mark Score of 50 points and the stipulated pre-requisite requirements The criteria comprise 5 environmental impact categories namely Part 1 – Energy Efficiency Part 2 – Water Efficiency Part 3 – Environmental Protection Part 4 – Indoor Environmental Quality Part 5 – Other Green Features The score is the total of all the numerical scores assigned based on the degree of compliance with the applicable criteria listed under the 5 categories.		**General** The environmental sustainability compliance framework was simplified and streamlined to complement the sustainability requirements regulated by other agencies. It is broadly grouped into two sections namely the Base Requirements and Carbon reduction measures. The Base Requirements will cover sustainability indicators relating to passive and active strategies, which have a direct impact on building energy efficiency standards and are mandatory, where applicable. The section on Carbon Reduction Measures covers sustainability indicators that will help drive a low carbon future by way of sustainable design, construction practices and technologies. The minimum environmental sustainability standard shall have a level of environmental performance that meets all relevant base requirements and a selected number of sustainability indicators provided under Carbon Reduction Measures in order to meet 50 points as required. The Carbon Reduction Measures are broadly grouped in 3 Sections namely Section 1 – Sustainable Design Strategies Section 2 – Sustainable Construction Section 3 – Sustainable Technologies

<table>
<tr><th>Criteria Ref</th><th>Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document</th><th>Criteria Ref</th><th>Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)</th></tr>
<tr><td></td><td></td><td></td><td>In summary,
<table>
<tr><th>Residential Buildings</th><th>Non-Residential Buildings</th></tr>
<tr><td>▪ All Base Requirements listed in Table 4.1(a), where applicable.
▪ A selection of four (4) Carbon Reduction Measures in total as listed in Table 4.2(a) including a minimum of two (2) measures from Section 2 - Sustainable Construction.</td><td>▪ All Base Requirements, listed in Table 4.1(b), where applicable.
▪ A selection of four (4) Carbon Reduction Measures in total as listed in Table 4.2(b) including a minimum of two (2) measures from Section 2 - Sustainable Construction.</td></tr>
</table>

For building works that involve only the erection of simple structures and buildings that are solely use for special functions only the Base Requirements will be applicable. Examples, link ways, underground passes, open sheds, standalone substation, lift upgrading, farm structures, temporary workers' dormitories, treatment plants, transport facilities. However, note that this does not apply to building works that form part of the residential and non-residential building developments.</td></tr>
<tr><td colspan="4">For Residential Building Development</td></tr>
<tr><td colspan="2">Part 1 – Energy Efficiency</td><td colspan="2">Part 1 – Base Requirements</td></tr>
<tr><td>RB1-1</td><td>Thermal Performance of building Envelope (RETV)

Based on every reduction of 1W/m^2 from baseline of 25 W/m^2

Note that under Approved Document – Maximum permissible RETV is 25 W/m^2 .</td><td>RB 01</td><td>Envelope and Roof Thermal Transfer

Maximum permissible RETV will be 22 W/m^2 in accordance with the methodology stated under the Code on Envelope Thermal Performance of Buildings

Note: This requirement is enhanced to further reduce heat gain thru' building envelope</td></tr>
</table>

<table>
<tr><th>Criteria Ref</th><th>Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document</th><th>Criteria Ref</th><th>Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)</th></tr>
<tr><td></td><td></td><td></td><td>The building envelope designed is deemed to have satisfied the performance requirement if it meets the following criteria

<table><tr><th>Window to Wall Ratio (WWR)</th><th>Shading Coefficients of Glass (SC_{glass})</th></tr><tr><td>< 0.30</td><td>≤ 0.67</td></tr><tr><td>0.30 to < 0.35</td><td>≤ 0.59</td></tr><tr><td>0.35 to < 0.40</td><td>≤ 0.52</td></tr><tr><td>0.40 to < 0.45</td><td>≤ 0.48</td></tr><tr><td>0.45 to ≤ 0.50</td><td>≤ 0.43</td></tr></table></td></tr>
<tr><td>RB 1-2 (a) (ii)</td><td>Provision of air-conditioning system

Based on provision of air-conditioning system with 3 ticks or 4 ticks rating for 80% of total number of dwelling units.</td><td>RB02-1</td><td>Air-Conditioning System

Minimum 5-tick or 3-tick rated based on type of air-conditioners for 80% of total number of dwelling units and common facilities.

<table><tr><th colspan="2">Minimum Energy Performance Standard</th></tr><tr><td>Single/ Multi Spilt System</td><td>5-tick rated</td></tr><tr><td>Variable Refrigerant Flow (VRF) system</td><td>3-tick rated</td></tr></table></td></tr>
<tr><td>RB 1-4</td><td>Artificial lighting

Based on percentage improvement over maximum lighting power budget stated in SS 530</td><td>RB 02-2</td><td>Lighting System for Common Areas and Facilities

Minimum 40% improvement over maximum lighting power budget stated in SS 530</td></tr>
<tr><td>RB1-5</td><td>Ventilation in Car parks

Based on mode of ventilation – NV, MV with and without fume extracts – with CO sensors</td><td>RB 02-3</td><td>Mechanical Ventilation System in Car parks

MV car parks – to be equipped with CO sensor control with VSDs</td></tr>
</table>

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
Part 1 – Energy Efficiency		**Part 2 – Carbon Reduction Measures – Sustainable Design Strategies**	
RB 1-1	**Thermal Performance of Building Envelope** Based on every reduction of 1W/m^2 from baseline of 25 W/m^2	RBE01-1	**Enhanced Building Envelope Performance** (a) RETV of not more than 20 W/m^2 (b) Application of cool materials on external wall or roof areas (c) provision of innovative façade technology
RB 1-2	**Naturally Ventilated Design** Based on extent of coverage in the following areas (a) Ventilation Simulation Modelling and Analysis OR (b) Ventilation Design - Building layout design & Dwelling unit design (c) Naturally Ventilated in common areas • Lift lobbies and corridors • Staircases	RBE01-2	**Naturally Ventilated Building Design** (a) Building layout design with 30% of all units with prevailing wind condition (b) Dwelling unit design with 25% of habitable spaces with good cross ventilation (c) Passive design considerations for dwelling unit indoor comfort and design for natural ventilation with minimum coverage of 80% in at least two(2) of the following areas • Toilets/bathrooms of dwelling units • Lift lobbies and corridors • Staircases • Car parks • Common facilities
RB 1-3	**Daylighting** Based on extent of coverage via (a) Daylight and Glare simulation analysis for dwelling units (b) Daylight for common areas	RBE01-3	**Effective Daylighting** (a) Habitable Spaces : Daylighting provision for 25% of the total number of residential units that meets the desired lighting level of $DA_{200lx,\ 50\%}$ in 60% of applicable areas (namely bedrooms, living room, family room and study room) based on daylight availability table provided. (b) Non-Habitable Spaces: Provision of daylighting with minimum coverage of 80% in at least two (2) of the following areas : • Toilets/bathrooms of dwelling units • Lift lobbies and Corridors • Staircases • Car parks *Note: No daylight simulation required for item (a)*

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
Part 3 - Environmental Protection		**Part 2 – Carbon Reduction Measures – Sustainable Construction (at least two measures)**	
RB3-1	**Sustainable Construction** (b) Concrete Usage Index (CUI) Encourage designs with efficient use of concrete for building components – Points accorded for a range of CUI from 0.7 to 0.35	RBE02-1	**Resource Efficiency Measures** (a) Existing building structures with more than 50% of the floor and/or wall areas conserved for adaptive reuse. (b) Design with Concrete Usage Index (CUI) of not more than 0.48. (c) Embodied carbon reporting to account for the upfront carbon emissions of three (3) key construction materials namely, concrete, steel, and glass used in building developments. *Note:* *(1) Item (a) is similar to the requirement under Green Features and Innovation of Current Code.* *(2) Item (b) – the methodology will be the same as current Code with a low CUI stipulated to encourage efficient concrete usage* *(3) Item (c) – A new requirement incorporated to encourage carbon accounting for three key construction materials*
	3-1 (a) Based on extent of use for (a) green cements (b) Recycled concrete aggregate (RCA) (c) Washed Copper Slag (WCS)	RBE02-2	**Low Carbon Concrete** Enhance carbon reduction with the use of following sustainable materials in building construction. (a) Use of concrete with eco-friendly cementitious materials that are classified under CEM II to V types for at least 80% of the super-structural works by volume. (b) Use of recycled concrete aggregate (RCA) and/or washed copper slag (WCS) from approved sources that meet the minimum usage requirement (that is 1.5% x GFA for RCA and/or 0.75 x GFA for WCS) (c) Alternative construction materials that can be used as a replacement for standard building materials for non-structural application. *Note : These requirements are generally similar to current Code but are enhanced with stipulated standard and have included new materials for construction such as granite fines.*

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
RB3-2	**Sustainable Products** Based on extent of coverage, environmentally friendliness, areas of application. Minimum 1 tick rated (Good) from an approved local product certification body	RBE02-3	**Sustainable Products** Minimum three (3) sustainable products with EPDs or minimum 2 ticks (Very good) rated from an approved local product certification body *Note : This requirement is enhanced to encourage the use of building products with lower embodied carbon. Only products with EPDs or minimum 2 tick rating can be considered.*
Part 1 - Energy Efficiency		**Part 3 – Carbon Reduction Measures – Sustainable Technologies**	
RB1-8	**Renewable Energy** Based on extent of provision with minimum 1 % replacement (exclude household's usage)	RBE03-1	**Renewable Energy System** Recognition given for on-site renewable energy systems with a minimum capacity installation of 15% roof coverage of the residential blocks within the development. *Note : This requirement is enhanced to consider spatial requirement which is more direct in assessing the potential to adopt PV system. The placement of the system is not restricted to roof space of residential blocks to provide flexibility in design.*
	No mention	RBE 03-2	**Smart Technology Solutions** Recognition given to the adoption of smart solutions and technologies which help facilitate resource usage monitoring and reduce overall energy consumption. Examples of solutions or technologies that can be considered are as follows : • Energy dashboard, web-based or mobile application or equivalent to provide useful and timely information on utilities consumption and breakdown for homeowners and/or facility manager • Energy recovery system • Lifts with regenerative function • Occupancy sensors/controls for lighting in private lift lobbies, staircases or common facilities • Others (to be evaluated on a case-to-case basis)

<table>
<tr><th>Criteria Ref</th><th>Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document</th><th>Criteria Ref</th><th>Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)</th></tr>
<tr><td colspan="4">For Non-Residential Building Development</td></tr>
<tr><td colspan="2">Part 1 – Energy Efficiency</td><td colspan="2">Part 1 – Base Requirements</td></tr>
<tr><td>NRB1-1</td><td>Thermal Performance of building Envelope (ETTV)

Based on every reduction of 1W/m^2 from baseline of 50 W/m^2

Note that under Approved Document – Maximum permissible ETTV is 50 W/m^2 .</td><td>NRB01</td><td>Envelope and Roof Thermal Transfer
Maximum permissible ETTV will be 45 W/m^2 in accordance with the methodology stated under the Code on Envelope Thermal Performance of Buildings

The building envelope designed is deemed to have satisfied the performance requirement if it meets the following criteria
<table><tr><th>Window to Wall Ratio (WWR)</th><th>Shading Coefficients of Glass (SC_{glass})</th></tr><tr><td>< 0.20</td><td>≤ 0.51</td></tr><tr><td>0.20 to < 0.25</td><td>≤ 0.41</td></tr><tr><td>0.25 to < 0.30</td><td>≤ 0.35</td></tr><tr><td>0.30 to < 0.35</td><td>≤ 0.30</td></tr><tr><td>0.35 to < 0.40</td><td>≤ 0.27</td></tr><tr><td>0.40 to ≤ 0.50</td><td>≤ 0.22</td></tr></table></td></tr>
<tr><td></td><td>Source : Approved Document

Roof with skylight : Maximum permissible RTTV is 50 W/m^2 in accordance with the methodology stated under the Code on Envelope Thermal Performance of Buildings

Roof without skylight
<table><tr><th>Roof Weight Group</th><th>Weight Range (kg/m^2)</th><th>Maximum U- value (W/m^{2}k)</th></tr><tr><td>Light</td><td><50</td><td>0.5</td></tr><tr><td>Medium</td><td>50 to 230</td><td>0.8</td></tr><tr><td>Heavy</td><td>>230</td><td>1.2(air-con)
1.5 (non air-con)</td></tr></table></td><td>NRB01-2</td><td>Roof

Roof with skylight : Maximum permissible RTTV at 50 W/m^2 in accordance with the methodology stated under the Code on Envelope Thermal Performance of Buildings

Roof without skylight
<table><tr><th>Roof Weight Group</th><th>Weight Range (kg/m^2)</th><th>Maximum U- value (W/m^{2}k)</th></tr><tr><td>Light</td><td><50</td><td>0.5</td></tr><tr><td>Medium</td><td>50 to 230</td><td>0.8</td></tr><tr><td>Heavy</td><td>>230</td><td>1.2</td></tr></table></td></tr>
</table>

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
	Source : Approved Document **I.3.4. Air-Tightness and Leakage** All windows on the building envelope shall not exceed the air leakage rates specified in SS 212 Where the door opening of any commercial unit is located along the perimeter of the building envelope, that unit shall be completely separated from the other parts of the buildings and has its air-conditioning system separated from and independent of the central system	NRB02	**Air-Tightness and Leakage** All windows and curtain walls shall be designed to ensure that the airleakage rates do not exceed the limits specified in SS 212 and SS654 respectively Building entrances and door openings to building exterior or non air-conditioned spaces and the like, shall (a) be provided with doors that are equipped with automated technology or self-closing devices. Where door opening of any commercial units are located along the perimeter of the building envelope, that unit shall be equipped with addition of pressure independent control valve and energy meter to measure the consumption of fan coiled units (FCUs) within the unit; and (b) be equipped with enclosed vestibules or other appropriate measures for doorway with high pedestrian traffic flow*. In the case of vestibules, the interior door and exterior door must have a minimum distance of not less than 2.5 m apart and should be interlocked to avoid being opened at the same time. * Doorway with high pedestrian traffic flow refers to main entrances and those leading to transport nodes or other commercial buildings
	Note : Compliance with specific energy savings requirement and approach using energy modelling simulation are not included in current Code	NRB03 NRB03-1	**Building Energy Performance** The compliance with the energy performance that meet minimum energy *improvements of 50% over 2005 baseline by way of energy modelling simulation OR the respective performance standards set out below.* **Whole building approach via Energy Modelling** Demonstration of energy saving requirements 30% over prevailing Singapore Standard and baseline based on Energy Modelling Methodology and requirements. The limits set for Total System Efficiency (TSE) of respective building cooling system shall apply.

<table>
<tr><th>Criteria Ref</th><th>Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document</th><th>Criteria Ref</th><th>Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)</th></tr>
<tr>
<td>NRB 1-2</td>
<td>
Air Conditioning System
(a) Water-Cooled Chilled-Water Plant :

Water-Cooled Chiller
Chilled-Water Pump
Condenser Water Pump
Cooling Tower

<table>
<tr><th rowspan="2">Baseline</th><th colspan="2">Peak Building Cooling Load</th></tr>
<tr><th>≥ 500 RT</th><th>< 500 RT</th></tr>
<tr><td>Prerequisite Requirements

Minimum Design System Efficiency (DSE) for central chilled-water plant</td><td>0.70 kW/RT</td><td>0.80 kW/RT</td></tr>
</table>
(b) Air-Cooled Chilled-Water Plant /Unitary Air-Conditioners

Air-Cooled Chilled- Water Plant

Air-Cooled Chiller
Chilled Water Pump

Unitary Air-Conditioners

Variable Refrigerant Flow (VRF) system
Single – Spilt Units
Multi-Spilt Units

<table>
<tr><th rowspan="2">Baseline</th><th colspan="2">Peak Building Cooling Load</th></tr>
<tr><th>≥ 500 RT</th><th>< 500 RT</th></tr>
<tr><td>Prerequisite Requirements

Minimum Design System Efficiency (DSE) for air cooled chilled-water plant or unitary conditioners</td><td>0.80 kW/RT</td><td>0.90 kW/RT</td></tr>
</table>
</td>
<td>NRB03-2(a)</td>
<td>
Air-Conditioning System
(i) Water-Cooled Building Cooling System

Water-Cooled Chiller;
Chilled-Water Pump;
Condenser Water Pump;
Cooling Tower; and
Air-Distribution System

<table>
<tr><th colspan="2">Total System Efficiency (TSE) for Water-Cooled Building Cooling System</th></tr>
<tr><td>New Buildings</td><td>Existing Buildings with New Extension and Major Retrofits</td></tr>
<tr><td>0.85 kW/RT</td><td>0.9 kW/RT</td></tr>
</table>
(ii) Air-Cooled Building Cooling System

Unitary Air-Conditioners (Single or combination of systems)

Variable Refrigerant Flow (VRF) system
Single – Spilt Units
Multi-Spilt Units
Air-Distribution System

Air-Cooled Chilled-Water System can be adopted in relation to existing building development with inherent constraints and with peak building cooling load of not more than 500 RT

Air-Cooled Chiller
Chilled Water Pump
Air-Distribution System

<table>
<tr><th>Total System Efficiency (TSE) for Air-Cooled Building Cooling System</th></tr>
<tr><td>New and Existing Buildings with New Extension or Major Retrofits</td></tr>
<tr><td>1.0 kW/RT</td></tr>
</table>
</td>
</tr>
</table>

<table>
<tr><th>Criteria Ref</th><th>Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document</th><th>Criteria Ref</th><th>Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)</th></tr>
<tr><td></td><td></td><td></td><td>
where TSE refers to the combined design system efficiency of the chiller plant or condenser units and air-distribution systems.

Note (1) Unlike the current Code, the minimum energy performance standard is pegged based on the Total Design System Efficiency which comprises both the water-side system and air-side system efficiency. In other words, it is a requirement to consider the air-distribution system efficiency in meeting the TSE. Noted that there will be minimum standards required for water cooled chilled water plant, air-cooled chilled water plant and unitary air conditioners – condensers and as follows :

<u>Water-Cooled Building Cooling System</u>
<table>
<tr><td colspan="8">Minimum Water-Cooled Chilled Water Plant Efficiency η_c</td></tr>
<tr><td rowspan="2">New Commercial Buildings</td><td colspan="7">Other Building Developments</td></tr>
<tr><td>Chilled Water Supply Temp (°C)</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td rowspan="2">For chilled water supply temp above 10°C, the threshold will be adjusted from 0.64 kW/RT by 0.01 kW/RT for every 1 °C increase in chilled water supply temperature</td></tr>
<tr><td>0.63 kW/RT</td><td>Water-Cooled Chiller System Efficiency (kW/RT)</td><td>0.68</td><td>0.67</td><td>0.66</td><td>0.65</td><td>0.64</td></tr>
</table>
For buildings with cooling provision that tap on District Cooling System (DCS), the TSE requirement does not apply but the air-distribution system efficiency must meet the minimum energy performance standard of 0.25 kW/RT.
</td></tr>
</table>

<table>
<tr><th>Criteria Ref</th><th>Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document</th><th>Criteria Ref</th><th>Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)</th></tr>
<tr><td></td><td></td><td></td><td>Air- Cooled Building Cooling System

<table>
<tr><th colspan="2">Minimum Air-Conditioning System Efficiency η_c</th></tr>
<tr><th>Unitary System (Outdoor Condenser Units)</th><th>Air-Cooled Chilled Water Plant</th></tr>
<tr><td>All Buildings</td><td>Applicable to only Existing Buildings with New Extension or Major Retrofits</td></tr>
<tr><td>0.78 kW/RT (inclusive site deration factor)</td><td>0.85 kW/RT</td></tr>
</table>

The provision of air-cooled chilled water plant can only be considered for existing buildings with new extension or major retrofits.

Note (2) The air-distribution system efficiency can be adjusted to allow for pressure drop adjustments for fan system where there is a need for more allowance due to functionality and activities as per recommended by SS 553 – Table 2b.

Note(3) Where there is a combination of water cooled and air-cooled building cooling system, the respective TSEs are to be complied with.</td></tr>
<tr><td>NRB 1-4
RB 1-4</td><td>Artificial Lighting

Based on percentage improvement over maximum lighting power budget stated in SS 530</td><td>NRB01-2(b)
RB01-2</td><td>Lighting System

The lighting provision shall be at least 40% more energy efficient than the prescribed lighting power budget stated in SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment.</td></tr>
<tr><td>NRB 1-4 (b)</td><td>Mechanical Ventilation

Based on percentage improvement in mechanical ventilation system efficiency over the baseline stipulated in SS 553.</td><td>NRB01-2(c)</td><td>Mechanical Ventilation System</td></tr>
</table>

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
			Provision of mechanical ventilation system of at least 10% more energy efficient than the prescribed standard stated in SS 553 for normally occupied spaces that utilise mechanical ventilation as the preferred ventilation mode. Provision of CO detection sensor control with VSD to regulate demand for mechanical ventilation in car parks *Note : There is a minimum energy improvement of 10% over baseline stipulated in SS 553 which is applicable only to the normally occupied spaces and car parks.*
NRB 1-2 (d)	**Measurement and Instrumentation Requirements for water cooled chilled water air conditioning system** (d) *Prerequisite Requirements :* Provision of permanent measuring instruments for monitoring of water-cooled chilled-water plant efficiency. The installed instrumentation shall have the capability to calculate a resultant plant efficiency (i.e. kW/RT) within 5 % of its true value and in accordance with ASHRAE Guide 22 and AHRI Standard 550/590. The following instrumentation and installation are also required to be complied with : (i) Location and installation of the measuring devices to meet the manufacturer's recommendation. (ii) Data acquisition system with a minimum resolution of 16 bit. (iii) All data logging with capability to trend at 1 minute sampling time interval. (iv) Flow meters are to be provided for chilled-water and condenser water loop and shall be of ultrasonic / full bore magnetic type or equivalent. (v) Temperature sensors are to be provided for chilled water and condenser water loop and shall have an end-to-end	NRB04 NRB 04-1	**Measurement and Verification (M & V) Instrumentation** **Instrumentation for Chilled Water Air-Conditioning System** Provision of permanent measuring instruments for monitoring of the energy performance of the chilled water plants and air distribution systems. The installed instrumentation must have the capability to calculate the resultant system efficiency within 5% of its true value in accordance with SS 591. Each measurement system shall include sensors, any signal conditioning, data acquisition system and the wiring connecting these components. The permanent measuring instruments and devices are to be accessible and must not be located directly above the chillers, to facilitate verification and maintenance. They must be installed in accordance with the manufacturers' recommendation and SS 591. The measurement systems provided shall also comply with the following requirement: (a) All data logging with capability to trend at 1-minute sampling time interval, and recorded to the 3rd decimal digit; (b) Building management system (BMS), standalone energy monitoring system (EMS) or local sequential controller (LSC) shall have capability to compute and display of key indicators including total system energy efficiency and its component (water-side and air-side efficiency) as well as the calculated heat balance of the chilled water system.

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
NRB 1-2 (d) – cont'd	measurement uncertainty not exceeding ± 0.05 °C over the entire measurement or calibration range. All thermo-wells shall be installed in a manner that ensures that the sensors can be in direct contact with fluid flow. Provisions shall be made for each temperature measurement location to have two spare thermo-wells located at both side of the temperature sensor for verification of measurement accuracy. (vi) Dedicated power meters are to be provided for each of the following groups of equipment : chillers, chilled water pumps, condenser water pumps and cooling towers.	NRB 04-1 – cont'd	(c) Magnetic in-line flow meter, with 1% uncertainty and capable of electronic in-situ verification to within ±2% of its original factory calibration. If installation of magnetic in-line meters is not possible, ultrasonic flow meters or other flow meters that can meet the indicated performance may be used; (d) Temperature sensors are to be provided for chilled water and condenser water loop and shall have a measurement uncertainly within ±0.05°C over the entire measurement range. Each temperature measurement location shall have test plugs or additional thermowells located before and after each temperature sensor along the chilled water and condenser water lines for verification of measurement accuracy. All thermo-wells shall be installed in a manner that enables the sensors to be in direct contact with fluid flow; and (e) Dedicated power meters (of IEC Class 1 or better) and metering current transformers (of Class 1 or better) where applicable, are to be provided for each of the following groups of equipment where applicable: chillers, chilled water pumps, condenser water pumps, cooling towers, air-distribution sub-system (i.e. AHUs, PAHUs, FCUs). *Note (1) : This requirement Is extended to cover air-cooled chilled water plant* *Note (2) : Added requirements on the manner and location of the permanent instruments and devices as well as the functionality and capability of data loggers and energy monitoring system for better monitoring as highlighted in blue.* *Note (3) : Provision of calibrated magnetic in-line flow meters for better measurement accuracy is preferred.* *Note (4) : It is a new requirement to have dedicated power meters to be provided for air-distribution sub-systems (that is AHUs, PAHUs, FCUs). In the case of FCUs, if submetering cannot be provided, the evidences of way of nameplate motors can be considered.*

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
	Note : No requirement on VRF system under Current Code	NRB04-2	**Instrumentation for Variable Refrigerant Flow (VRF) system** Provision of permanent measuring instruments for monitoring of the energy performance of the Variable Refrigerant Flow (VRF) condensing units and air-distribution systems. The installed instrumentation must have the capability to calculate the resultant system efficiency within 10% uncertainty. Each measurement system shall include sensors, any signal conditioning, data acquisition system and the wiring connecting these components. The measurement systems provided shall also comply with the following requirement: (a) All data logging with capability to trend at 5-minute sampling time interval, and preferably recorded to the 3rd decimal digit; (b) Building management system (BMS), standalone energy monitoring system (EMS) shall have capability to compute and display of the overall system energy efficiency and to facilitate data extraction for verification purpose; and (c) Dedicated power meters (of IEC Class 1 or better) and metering current transformers (of Class 1 or better) where applicable, are to be provided for all condensing units of the VRF system and air-distribution sub-systems (i.e. AHUs, PAHUs, FCUs). *Note :* *(1) This is a new requirement to cover instrumentation for VRF system for better energy monitoring. It is only applicable if the VRF system serve an aggregate conditioned floor areas of **2000 m^2 or more**.* *(2) Requirement for dedicated power meters to be provided for air-distribution sub-systems (that is AHUs, PAHUs, FCUs). In the case of FCUs, if*

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
			submetering cannot be provided, the evidences of way of nameplate motors can be considered. *(3) Suppliers' proprietary system can be used to determine the system efficiency of the condensing units.*
	Note : No requirement on service clearances under Current Code	NRB06	**Maintenance of Building Cooling System Performance** Ensure adequate service clearances so that the building cooling system performance can be maintained during operation as designed. *Service clearances are to be provided as per manufacturers' specification or prescribed standards stated in the following clauses, whichever governs.* This is applicable to Chillers, Pump Systems, Cooling Towers, Air-Distribution System – AHUs only *Note : This is a new requirement to ensure that the building cooling system performance can be maintained during building operation.*
Part 1 – Energy Efficiency		**Part 2 – Elective Options under Section 1 : Sustainable Design Strategies**	
NRB 1-5	**Daylighting** Encourage design that optimises the use of effective daylighting to reduce energy use for artificial lighting. (a) Use of daylight and glare simulation analysis to verify the adequacy of ambient lighting levels in all dwelling unit's living and dining areas. The ambient lighting levels should meet the illuminance level and Unified Glare Rating (UGR) stated in SS CP 38 – Code of Practice for Artificial lighting in Buildings.	NRBE01-3	**Effective Daylighting** (a) Normally Occupied Spaces : Daylighting provision with desired lighting level and specific Daylight Autonomy (DA) requirements as outlined in the following table for a minimum 15% of total occupied areas with integration of daylighting controls.

<table>
<tr><th>Criteria Ref</th><th>Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document</th><th>Criteria Ref</th><th>Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)</th></tr>
<tr>
<td></td>
<td>(b) Daylighting in the following common areas

(i) Staircases
(ii) Corridors
(iii) Lift lobbies
(iv) Atriums
(v) Car parks

Extent of coverage : 80% - with integration with daylight control</td>
<td></td>
<td>
<table>
<tr><th>S/N</th><th>Minimum Lighting Level Based on Space Occupancy Type</th><th>Daylight Autonomy requirement per unit area of space</th></tr>
<tr><td>1</td><td>Offices and Institutional spaces where lux requirement is 500 lux</td><td>DA_{500lx}, 50%</td></tr>
<tr><td>2</td><td>Industrial, sports facilities, retail areas where lux requirement is 300 lux</td><td>DA_{300lx}, 50%</td></tr>
<tr><td>3</td><td>Hotel, resort-like and service apartment where lux requirement is 200 lux</td><td>DA_{200lx}, 50%</td></tr>
</table>

Note : Daylight availability tables will be made available for use to simplify the compliance with daylighting requirement. Daylight simulation is not required.

(c) Common areas : Daylighting provision with integrated daylight controls for minimum coverage of 80% in at least two(2) of the following areas
• Lift lobbies
• Corridors
• Staircases
• Car parks
• Atriums
• Toilets</td>
</tr>
</table>

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
Part 3 – Environmental Protection		**Part 2 – Elective Options – Section 2: Sustainable Construction**	
NRB 3-1	**Sustainable Construction** (b) Concrete Usage Index (CUI) Encourage designs with efficient use of concrete for building components – Points accorded for a range of CUI from 0.7 to 0.35	NRBE02-1	**Resource Efficiency Measures** (d) Existing building structures with more than 50% of the floor and/or wall areas conserved for adaptive reuse. (e) Design with Concrete Usage Index (CUI) of not more than 0.48. (f) Embodied carbon reporting to account for the upfront carbon emissions of three (3) key construction materials namely, concrete, steel, and glass used in building developments. *Note:* *(1) Item (a) is similar to the requirement under Green Features and Innovation of Current Code.* *(2) Item (b) – the methodology will be the same as current Code with a low CUI stipulated to encourage efficient concrete usage* *(3) Item (c) – A new requirement incorporated to encourage carbon accounting for three key construction materials*
	(a) Use of Sustainable and Recycled Materials (i) Green Cements with approved industrial by-product (such as Ground Granulated Blastfurnace Slag (GGBS), silica fume, fly ash) to replace Ordinary Portland Cement (OPC) by at least 10% by mass for superstructural works. (ii) Recycled Concrete Aggregates (RCA) and Washed Copper Slag (WCS) from approved sources to replace coarse and fine aggregates for concrete production of main building elements	NRBE02-2	**Low Carbon Concrete** Enhance carbon reduction with the use of following sustainable materials in building construction. (a) Use of concrete with eco-friendly cementitious materials that are classified under CEM II to V types for at least 80% of the super-structural works by volume. (b) Use of recycled concrete aggregate (RCA) and/or washed copper slag (WCS) from approved sources that meet the minimum usage requirement (that is 1.5% x GFA for RCA and/or 0.75 x GFA for WCS) (c) Alternative construction materials that can be used as a replacement for standard building materials for non-structural application.

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
			Note : These requirements are generally similar to current Code but are enhanced with stipulated standard and have included new materials for construction such as granite fines.
NRB 3-2	**Sustainable Products** Promote the use of environmentally friendly products that are certified by approved local certification body. Points accorded based on weightage and extent of coverage. Applicable for building products	NRBE02-3	**Sustainable Products** Encourage the specification and use of environmentally friendly products that are certified with Environmental Product Declaration (EPD) requirements or two-ticks rating by an approved local certification body. The provision shall include at least three (3) products for 80% of applicable areas or building components. Applicable for building products, M & E products *Note : This requirement is enhanced to encourage the use of building products with lower embodied carbon.*
Part 1 – Energy Efficiency		**Part 2 – Elective Options – Section 3: Sustainable Technologies**	
NRB1-11	**Renewable Energy** Encourage the use of renewable energy sources – Points can be accorded based on the % replacement of building electricity consumption.	NRB03-1	**Renewable Energy System** Encourage the use of on-site renewable energy sources to reduce the use of electricity by • at least 1% of the expected total building electricity consumption
	Note : No requirement under Current Code	NRB03-2	**Smart Building Solutions** Minimum two (2) building solutions which facilitates some form of automation and controls over building systems for better energy management and thermal comfort as listed below. • Use of BACnet, Modbus or any other open protocol as the network backbone of the building management system where data points can be used to facilitate communication and integration with other building systems. • Energy portal and dashboard that help building owners and/or tenants to better manage their energy consumption in an intuitive manner. It

Criteria Ref	Current Code for Environmental Sustainability of Buildings (3rd Edition) and Approved Document	Criteria Ref	Requirements to be incorporated in upcoming Code for Environmental Sustainability of Buildings (4th Edition)
			should comprise display metered data, trending of energy consumption (historical data) on monthly basis of tenants/spaces within buildings and relevant parameters. • Real time remote monitoring of chiller plant system performance and operation such as BCA Chiller Efficiency Smart Portal • Demand controlled ventilation system such as carbon dioxide sensors or devices to regulate the fresh air intake and ventilation based on occupants' need. • Timer sensors/controls for lighting and/or ventilation systems in common areas and facilities. • Smart building sensors that are equipped with sensing capability, microprocessors and communication technology that can help facilitate some form of monitoring or automation. • Differential pressure switches for Air Handling Units (AHUs) that are linked to a building management system (BMS) or suitable means that can monitor the air filter condition. • Others (to be evaluated on a case to case basis)

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	Note : No requirement under Current Code	NRB03-3	**Green Building Technologies** Low-carbon solutions and technologies which help reduce energy consumption. Examples of solutions that can be considered are as follows : • Energy recovery systems for building applications • Lifts with regenerative function • Passive Displacement ventilation system • Dedicated outdoor air system • Others (to be evaluated on a case-to-case basis) *Note : Some criteria under Part 5 – Green Features and Innovation under current Code are incorporated. New requirements are included to encourage the use of smart technologies and solutions to minimise building energy consumption.*

Summary of Key Changes to the Requirements under the Current Code on Environmental Sustainability Measures for Existing Buildings (2nd Edition)

ANNEX B

Criteria Ref	Current Code on Environmental Sustainability Measures for Existing Buildings (2nd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code on Environmental Sustainability Measures for Existing Buildings (3rd Edition)
	General The minimum environmental sustainability standard can be met by meeting the stipulated requirements which is deemed to meet 50 points as required. There is a total of seven requirements/conditions covering that need to be fulfilled for regulatory compliance and as follows. P1 – Energy Consumption Monitoring P2 – Air Conditioning System Minimum Operating Efficiency P3 – Energy Improvement on Lighting System P4 – Water Consumption Monitoring P5 – Chiller Plant Measurement and Verification (M&V) Instrument P6 – Indoor Temperature P7 – Indoor Air Quality (IAQ) Surveillance Audit		**General** The environmental sustainability compliance framework was simplified and broadly grouped into two sections namely the Base Requirements and Carbon reduction measures. The Base Requirements will cover sustainability indicators relating to passive and active strategies, which have a direct impact on building energy efficiency standards and are mandatory, where applicable. The section on Carbon Reduction Measures covers sustainability indicators that will help drive a low carbon future by way of sustainable features, operation and management practices and technologies. The minimum environmental sustainability standard shall have a level of environmental performance that meets all relevant base requirements and a selected number of sustainability indicators provided under Carbon Reduction Measures in order to meet 50 points as required. The Carbon Reduction Measures are broadly grouped in 3 Sections namely Section 1 – Sustainable Features Section 2 – Sustainable Operation and Management Section 3 – Sustainable Technologies NON-RESIDENTIAL BUILDINGS All Base Requirements listed in Table 4.1, where relevant. A selection of three (3) Carbon reduction measures from Table 4.2 with at least one(1) measure from Sustainable Operation and Management.

<table>
<tr><th>Criteria Ref</th><th>Current Code on Environmental Sustainability Measures for Existing Buildings (2nd Edition)</th><th>Criteria Ref</th><th>Requirements to be incorporated in upcoming Code on Environmental Sustainability Measures for Existing Buildings (3rd Edition)</th></tr>
<tr><td></td><td></td><td></td><td>Note that there are sub-clauses under the Base Requirements for non-residential buildings - 6 sub-clauses that are to be complied with, where relevant.</td></tr>
<tr><td colspan="2">Code requirements</td><td colspan="2">Part 1 – Base Requirements</td></tr>
<tr><td>P2</td><td>Air Conditioning System Minimum Operating Efficiency

(i) For Buildings using Water-cooled Chilled-water Plant
• Water-Cooled Chiller
• Chiller-Water Pump
• Condenser Water Pump
• Cooling Tower

<table><tr><th rowspan="2">Baseline</th><th colspan="2">Building Cooling Load (RT)</th></tr><tr><th>< 500</th><th>≥500</th></tr><tr><th colspan="3">Minimum Efficiency (kW/RT)</th></tr><tr><td>Minimum Design System Efficiency (DSE) for central chilled-water plant</td><td>0.8</td><td>0.75</td></tr></table>
(ii) For Buildings using Air-cooled Chilled-water Plant or Unitary Air-Conditioner
• Air-Cooled Chiller
i. Air-Cooled Chiller
ii. Chilled Water Pump
• Unitary Air-Conditioners
i. Variable Refrigerant Flow (VRF) system
ii. Single-Split Units
iii. Multi-Split Units</td><td>ENRB01-2(a)</td><td>Building Energy Performance
The compliance with the energy performance that meet minimum energy improvements of 40% over 2005 baseline by way of energy audit methodology or the respective performance standards set out below.

Air-Conditioning System
(i) Water-Cooled Building Cooling System
• Water-Cooled Chiller;
• Chilled-Water Pump;
• Condenser Water Pump;
• Cooling Tower; and
• Air-Distribution System

<table><tr><th>Total System Efficiency (TSE) for Water-Cooled Building Cooling System</th></tr><tr><td>Existing Buildings with Major Energy Use Change</td></tr><tr><td>0.9 kW/RT</td></tr></table>
where TSE refers to combined system efficiency of the chiller plant and air distribution systems and the minimum requirement on water-side component efficiency will be based on the chilled water supply temperature and as follows :

Table A4 : Minimum Water-Cooled Chilled Water Plant Efficiency η_c
<table><tr><td>Chilled Water Supply Temp (°C)</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td rowspan="2">For chilled water supply temp above 10°C, the threshold will be adjusted from 0.64 kW/RT by 0.01 kW/RT for every 1 °C increase in chilled water supply temperature</td></tr><tr><td>Water-Cooled Chiller System Efficiency (kW/RT)</td><td>0.68</td><td>0.67</td><td>0.66</td><td>0.65</td><td>0.64</td></tr></table></td></tr>
</table>

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<tr>
<td></td>
<td>
<table>
<tr><th rowspan="2">Baseline</th><th colspan="2">Building Cooling Load (RT)</th></tr>
<tr><th>< 500</th><th>≥500</th></tr>
<tr><th colspan="3">Minimum Efficiency (kW/RT)</th></tr>
<tr><td>Pre-requisite Requirement

Minimum Design System Efficiency (DSE) for</td><td>1.1</td><td>1.0</td></tr>
</table>
</td>
<td></td>
<td>
(ii) Air-Cooled Building Cooling System

Unitary Air-Conditioners (Single or combination of systems)

Variable Refrigerant Flow (VRF) system
Single – Spilt Units
Multi-Spilt Units
Air-Distribution System

Air-Cooled Chilled-Water System can be adopted in relation to existing building development with inherent constraints and with peak building cooling load of not more than 500 RT

Air-Cooled Chiller
Chilled Water Pump
Air-Distribution System

<table>
<tr><th>Total System Efficiency (TSE) for Air-Cooled Building Cooling System</th></tr>
<tr><td>1.0 kW/RT</td></tr>
</table>
where minimum energy performance standards for different building cooling systems are as follows :
<table>
<tr><th colspan="2">Minimum Air-Conditioning System Efficiency η_c</th></tr>
<tr><th>Unitary System (Outdoor Condenser Units)</th><th>Air-Cooled Chilled Water Plant</th></tr>
<tr><td>0.78 kW/RT (inclusive of 20% site deration factor)</td><td>0.85 kW/RT</td></tr>
</table>
Note (1) Total System Efficiency (TSE) refers to combined design system efficiency of the chiller plant or condenser units and air distribution systems.
</td>
</tr>
</table>

Criteria Ref	Current Code on Environmental Sustainability Measures for Existing Buildings (2nd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code on Environmental Sustainability Measures for Existing Buildings (3rd Edition)
			Note (2) The TSE can be adjusted to allow for pressure drop adjustments for fan system where there is a need for more allowance due to functionality and activities as per recommended by SS 553 – Table 2b. *Note (3) Where there is a combination of water cooled and air-cooled building cooling system, the respective TSEs are to be complied with.* *Note (4) Energy Audit Approach can be used as the methodology used for compliance. It will entail the need to establish the average EUI for past three years before retrofits begin. The expected EUI could be derived by considering the potential energy savings from the retrofits. For compliance, the expected EUI is required to meet the stipulated EUI for the same building category and the air-conditioning provision shall have a minimum total system efficiency TSE of 0.9 kW/RT during operation.*

<table>
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<tr><td>P3</td><td>Artificial Lighting

To encourage the use of energy efficient lighting to minimise energy consumption from lighting usage while maintaining proper lighting level.

To demonstrate at least 20% improvement in the lighting power budget for common areas over the baseline stated in the table below.

<table>
<tr><th>Type of Usage</th><th>Maximum Lighting Power Budget (W/m²)</th></tr>
<tr><td>Offices</td><td>15</td></tr>
<tr><td>Classrooms</td><td>15</td></tr>
<tr><td>Hotel guest room</td><td>15</td></tr>
<tr><td>Lecture theatres</td><td>15</td></tr>
<tr><td>Auditoriums / Concert halls</td><td>10</td></tr>
<tr><td>Shops / Supermarkets / Departmental stores (including general, accent & display lighting)</td><td>25</td></tr>
<tr><td>Restaurants</td><td>15</td></tr>
<tr><td>Lobbies / Atrium / Concourse</td><td>10</td></tr>
<tr><td>Stairs</td><td>6</td></tr>
<tr><td>Corridors</td><td>10</td></tr>
<tr><td>Toilets</td><td>15</td></tr>
<tr><td>Car parks</td><td>5</td></tr>
<tr><td>Electronic Manufacturing and fine detail / Assembly industries</td><td>20</td></tr>
<tr><td>Medium and heavy industries</td><td>15</td></tr>
<tr><td>Warehouses / Storage areas</td><td>10</td></tr>
</table></td><td>ENRB01-2(b)</td><td>Lighting System

Reduce energy required to illuminate interior spaces with proper lighting level. The lighting provision shall be at least 40% more energy efficient than the prescribed lighting power budget stated in SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment.

Note: The energy improvements will be accounted based on SS 530 instead of the prescribed standard shown in current Code.</td></tr>
</table>

Criteria Ref	Current Code on Environmental Sustainability Measures for Existing Buildings (2nd Edition)	Criteria Ref	Requirements to be incorporated in upcoming Code on Environmental Sustainability Measures for Existing Buildings (3rd Edition)
	Note : No requirement on mechanical ventilation under Current Code	ENRB01-2(c)	**Mechanical Ventilation System** Reduce energy required to supply and distribute fresh air within the space by having energy efficient mechanical ventilation system and controls. (i) Provision of mechanical ventilation system of at least 10% more energy efficient than the prescribed standard stated in SS 553 for normally occupied spaces that utilise mechanical ventilation as the preferred ventilation mode (ii) Provision of Carbon Monoxide (CO) detection sensor control with Variable Speed Drive (VSD) to regulate demand for mechanical ventilation in carpark areas. *Note:* *(1) There is a minimum energy improvement of 10% over baseline stipulated in SS 553 which is applicable only to the normally occupied spaces and carpark areas.* *(2) Only applicable if there is a replacement of the mechanical ventilation system.*
	Note : No requirement on vertical transportation system under Current Code	ENRB 01-2(d)	**Vertical Transportation System** Reduce energy consumption by providing energy efficient vertical transportation systems that are equipped with variable voltage variable frequency (VVVF) drives and sleep mode features. *Note: Only applicable if there is a replacement of the lift and escalator*
P5	**Measurement and Instrumentation Requirements for water cooled chilled water air conditioning system** To provide permanent measuring instruments for monitoring of chilled water system operating efficiency. The installed instrumentation shall have the capability to calculate the resultant operating system efficiency (i.e. kW/RT) within 5% of its true value	ENRB02-1	**Measurement and Verification (M & V) Instrumentation** **Instrumentation for Chilled Water Air-Conditioning System** Provision of permanent measuring instruments for monitoring of the energy performance of the chilled water plants and air distribution systems.

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	and in accordance with SS 591. Each measurement system shall include the sensor(s), any signal conditioning, the data acquisition system and wiring connecting these components.		The installed instrumentation must have the capability to calculate the resultant system efficiency within 5% of its true value in accordance with SS 591. Each measurement system shall include sensors, any signal conditioning, data acquisition system and the wiring connecting these components. The permanent measuring instruments and devices are to be accessible[see note (5)] and should not be located directly above the chillers, to facilitate verification and maintenance. They must be installed in accordance with the manufacturers' recommendation and SS 591. The measurement systems provided shall also comply with the following requirement: (a) All data logging with capability to trend at 1-minute sampling time interval, and recorded to the 3rd decimal digit; (b) Building management system (BMS), standalone energy monitoring system (EMS) shall have capability to compute and display of key indicators including total system energy efficiency and its component (water-side and air-side efficiency) as well as the calculated heat balance of the chilled water system; (c) Magnetic in-line flow meter, with 1% uncertainty and capable of electronic in-situ verification to within ±2% of its original factory calibration. If installation of magnetic in-line meters is not possible, ultrasonic flow meters or other flow meters that can meet the indicated performance may be used; (d) Temperature sensors are to be provided for chilled water and condenser water loop and shall have a measurement uncertainly within ±0.05°C over the entire measurement range. Each temperature measurement location shall have test plugs or additional thermowells located before and after each temperature sensor along the chilled water and condenser water lines for verification of measurement accuracy. All thermo-wells shall be

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			installed in a manner that enables the sensors to be in direct contact with fluid flow; and (e) Dedicated power meters (of IEC Class 1 or better) and metering current transformers (of Class 1 or better) where applicable, are to be provided for each of the following groups of equipment where applicable: chillers, chilled water pumps, condenser water pumps, cooling towers, air-distribution sub-system (i.e. AHUs, PAHUs, FCUs). (f) A heat balance substantiating test for the chilled water system is to be computed in accordance to SS 591 for verification of the accuracy of the M & V instrumentation. To meet the accuracy requirement, more than 80% of the heat balance (%) derived over the entire normal operating hours is to be within 5% for a period of one (1) week. *Note (1) : The temperature sensors are best placed in an accessible location with mounting height of not more than 3m, where possible. Otherwise, there should be evidence of provision for access by way of mobile platform or other suitable form.* *Note(2) : It is a new requirement to have dedicated power meters to be provided for air-distribution sub-systems (that is AHUs, PAHUs, FCUs). In the case of FCUs, if submetering cannot be provided, the evidences of way of nameplate motors can be considered.*

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	Note : No requirement on VRF system under Current Code	ENRB02-2	**Instrumentation for Variable Refrigerant Flow (VRF) system** Provision of permanent measuring instruments for monitoring of the energy performance of the Variable Refrigerant Flow (VRF) condensing units and air-distribution systems. The installed instrumentation must have the capability to calculate the resultant system efficiency within 10% uncertainty. Each measurement system shall include sensors, any signal conditioning, data acquisition system and the wiring connecting these components. The measurement systems provided shall also comply with the following requirement: (a) All data logging with capability to trend at 5-minute sampling time interval, and recorded to the 3rd decimal digit; (b) Building management system (BMS), standalone energy monitoring system (EMS) shall have capability to compute and display of the overall system energy efficiency and to facilitate data extraction for verification purpose; and (c) Dedicated power meters (of IEC Class 1 or better) and metering current transformers (of Class 1 or better) where applicable, are to be provided for all condensing units of the VRF system and air-distribution sub-systems (i.e. AHUs, PAHUs, FCUs). *Note : This is a new requirement to cover instrumentation for VRF system for better energy monitoring. It is only applicable if the VRF system serve an aggregate conditioned floor areas of 2000 m^2 or more.*

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	Note: No requirement on real time remote monitoring of chiller plant system operation	ENRB03	**Real Time Remote Monitoring of Chiller Plant System Operation** Facilitate real time diagnostic and monitoring of chiller plant system operation with the provision of web-based control system with remote access functionality (such as BCA Chiller Efficiency Smart Portal) to monitor the chiller system operation and efficiency with diagnostic alerts.
P1	**Energy Consumption Monitoring** To compute and monitor the building's Energy Use Intensity (EUI) for the past 3 years and review its energy efficiency improvement plan, where necessary	ENRB04	**Energy Utilisation Reporting** Encourage monitoring of building energy consumption trend over the past 3 years and review of energy efficiency improvement plan and measures. *Note: This is similar to current Code*
P6	**Indoor Temperature** To maintain the indoor dry-bulb temperature at 23°C and above to prevent overcooling	ENRB05	**Indoor Temperature** Minimise incidences of overcooling and energy wastage by ensuring that the normal dry-bulb temperature for indoor spaces is maintained at 23°C and above. *Note: This is the same as current Code*
P7	**Indoor Air Quality (IAQ) Surveillance Audit** To conduct an IAQ surveillance audit once every 3 years. The audit shall be conducted by an accredited laboratory under Singapore Accreditation Council with respect to the recommended IAQ parameters and acceptable limits stated in Table 1 of *SS554: 2016 Code of Practice for Indoor Air Quality for Air-Conditioned Buildings* or in Annex E of NEA's *Guidelines for Good Indoor Air Quality in Office Premises.*	ENRB06	**Indoor Air Quality (IAQ) Audit** Facilitate improvement on indoor environmental quality by way of a post-retrofit IAQ audit. The audit shall be conducted by an accredited laboratory under Singapore Accreditation Council with respect to the recommended IAQ parameters and acceptable limits stated in Table 1 of *SS554: 2016 Code of Practice for Indoor Air Quality for Air-Conditioned Buildings* or in Annex E of NEA's *Guidelines for Good Indoor Air Quality in Office Premises* *Note: This is the same as current Code*

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		Part 2 – Elective Options Under Section 1 : Sustainable Design Strategies	
	Note : No requirement on Building Envelope Enhancement under current Code	ENRBE01-1	**Building Envelope Enhancement** Enhance building envelope performance to minimise heat gain to internal spaces for better indoor thermal comfort with any of the following provisions : (a) Façade design with Envelope Thermal Transmittance Value (ETTV) of no more than 40 W/m^2. (b) Application of cool paints that are certified by an approved local product certification body for 80% of the east and west facing external wall and/or roof areas. Note (1) The selected paint system must meet the allowable limits set for daylight reflectance as required under the Approved Document. (c) Provision of innovative façade technology or solutions such as the use of electrochromic glass, integration of photovoltaic modules, film technology, parametric façade and so on for at least 20% of the fenestration areas.
	Note : No requirement on Natural Ventilation Strategies under current Code	ENRBE01-2	**Natural Ventilation Strategies** Reduce energy demand for cooling and ventilation by way of enhanced provision of naturally ventilated spaces by at least 5% of the applicable areas. *Note: Applicable to occupied spaces and common areas*

<table>
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<tr><td></td><td>Note : No requirement on Sustainable Products under current Code</td><td>ENRBE01-3</td><td>Sustainable Products

Encourage the specification and use of environmentally friendly products that are certified with Environmental Product Declaration (EPD) requirements or two-ticks rating by an approved local certification body.

The provision shall include at least five (5) products for 80% of applicable areas or building components.

Note: Applicable to building products / Mechanical and Electrical products</td></tr>
<tr><td colspan="2"></td><td colspan="2">Part 2 – Elective Options Under Section 2 : Sustainable Operation and Management</td></tr>
<tr><td></td><td>Note : No requirement on Electrical Sub-Metering for Major Energy Use under current Code</td><td>ENRBE02-1</td><td>Electrical Sub-Metering for Major Energy Use

Facilitate measurement and monitoring of major energy end uses for energy management and audit. Separate sub-meters shall be provided and linked to a monitoring system that can measure and trend energy consumption data of the following systems:

<table>
<tr><th colspan="2">Sub-System for Metering</th></tr>
<tr><td>Lifts and escalators</td><td>More than 5 numbers or sets or with sum of all feeders > 50 kVA.</td></tr>
<tr><td>Mechanical Ventilation Systems</td><td>Total subsystem’s load > 15 kW
Sub-metering applicable to individual fan system motors that are more than 1.5 kW in the following areas
• Normally Occupied Spaces
• M & E Plant Rooms
• Carparks</td></tr>
<tr><td>Centralised hot water supply system</td><td>> 50 kW thermal heating capacity</td></tr>
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<tr><td></td><td></td><td></td><td>
<table>
<tr><td>General power supply and lighting systems for tenancy areas and owners' premises</td><td>Sub-metering for tenancy areas and owners' premises are to be separated. The sub-circuits serving these areas can be provided based on sub-system basis and /or per floor level.</td></tr>
<tr><td colspan="2">If there is a need to cater to high plug loads or process loads exceeding 50 kVA in areas such as manufacturing, carpark, data centre, EV charging stations, please provide separate sub-metering for these specific areas to better manage the energy consumption, where relevant.</td></tr>
</table>
</td></tr>
<tr><td></td><td>Note : No requirement on maintainability provision under current Code</td><td>ENRBE02-2</td><td>Maintenance of Building Cooling System Performance

Ensure adequate service clearances so that the building cooling system performance can be maintained after system upgrade.

Service clearances are to be provided as per manufacturers' specification or prescribed standards stated in the following clauses, whichever governs.

Access space provisions are as follows:

1. Chillers
a. Clear space of 2 m or more at the front of chiller unit piping section for tube maintenance and cleaning, repair and replacement of bigger components;
b. Clearance of 1.2 m or more between the chillers measured from plinth to plinth for regular maintenance; and
c. Overhead service clearance of 1.5 m or more above the chiller for overhaul maintenance.</td></tr>
</table>

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			2. Pump systems a. Except for the areas where the pipes are connected, a clearance of 0.6 m or more is to be provided round the pump for regular maintenance; and b. Clear head room space of 1 m or more above the pump and motor to facilitate overhaul maintenance or replacement. 3. Cooling Towers a. Provision of maintenance platform, stairs and catwalks of 600 mm width or more with handrails around the cooling towers and access to the level for periodic maintenance, inspection of water basin and fill media; and b. Clear space of 2 m or more from the top of cooling towers to location of the trellis, where applicable. 4. Air handling units (AHU) of cooling capacity greater than 35kW shall be floor mounted as stipulated in SS 553 a. AHU access – Provide minimum 1m clear space from the AHU room door entrance to the AHU for general maintenance ; b. Cooling coil pipe and filter access – Provide minimum 800 mm clear space after pipe connection to facilitate cooling coil cleaning and filter access; c. Fan access – Provide minimum 800 mm clear space for fan/motor access and maintenance (if the access is not from cooling coil connection side); and d. AHU side and back clearance – Provide minimum 600 mm clear space for general access and maintenance.

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	Note : No requirement on user engagement plan under current Code	ENRBE02-3	**User Engagement Plan** Encourage the provision of user engagement plan and strategies that facilitate users' involvement and contribution in reducing the overall carbon footprint. It should have a combination of minimum two strategic approaches such as sustainability related activities, educational programmes, green fit-out guidelines, green lease or incentives for tenants meeting measurable outcome. *Note: Users' involvement is required.*
			Part 2 – Elective Options Under Section 3 : Sustainable Technologies
	Note : No requirement on renewable energy system under current Code	ENRBE03-1	**Renewable Energy System** Encourage the use of on-site renewable energy sources to reduce the use of electricity by at least 1% of the expected total building electricity consumption
	Note : No requirement on smart building solutions under current Code	ENRBE03-2	**Smart Building Solutions** Encourage the provision of minimum two (2) building solutions which facilitates some form of automation and controls over building systems for better energy management and thermal comfort as listed below. (a) Use of BACnet, Modbus or any other open protocol as the network backbone of the building management system where data points can be used to facilitate communication and integration with other building systems. (b) Energy management system, applications and dashboard that help building owners and/or tenants to better manage their energy consumption in an intuitive manner (c) Demand controlled ventilation system such as carbon dioxide sensors or devices to regulate the fresh air intake and ventilation based on occupants' need.

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			(d) Timer sensors/controls for lighting and ventilation systems in common areas and facilities (e) Differential pressure monitoring equipment in Air Handling Units (AHUs) (f) Others (to be evaluated on a case to case basis)
	Note : No requirement on green building technologies under current Code	ENRBE03-3	**Green Building Technologies** Encourage the adoption of low-carbon solutions and technologies which help minimise energy consumption. Examples of the systems that can be considered are as follows : • Energy recovery system • Lifts with regenerative function • Passive displacement ventilation system • Hybrid cooling system • Smart sensor and control technologies • Dedicated outdoor air system • Others (to be evaluated on a case to case basis)