

Our Ref: APPBCA-2019-03

Environmental Sustainability Group

24 Apr 2019

See Distribution List

Dear Sir/Madam

CALL FOR INDUSTRY COMMENTS ON PROPOSED CHANGES TO THE COMPLIANCE FRAMEWORK UNDER THE CODE FOR ENVIRONMENTAL SUSTAINABILITY OF BUILDINGS

Objective

The Building and Construction Authority (BCA) would like to seek industry comments on the proposed changes to the compliance framework under the Code for Environmental Sustainability of Buildings.

Background

2. The Code for Environmental Sustainability of Buildings sets out the minimum environmental sustainability standard for buildings for regulatory compliance. It has largely adopted the BCA Green Mark (GM) criteria as the compliance method in assessing the environmental performance of a building development.

3. With the recent revamp of the Green Mark criteria for new buildings, we have reviewed and are proposing to align the compliance framework for regulatory submission with the key sustainability indicators of the revised GM criteria. We intend to also integrate all energy efficiency requirements under Section I of the Approved Document, to form part of the compliance framework under this Code. These changes will help make the regulatory process more streamlined and provide greater clarity to the industry.

Industry Consultation

4. As part of our reviews on environmental sustainability requirements, we have earlier conducted several rounds of industry and stakeholder consultations to seek feedback on the keys areas of improvement.



5. We would like to disseminate the proposed changes to building professionals and members of various Trade Associations and Chambers (TACs) for further inputs and comments before finalising the Code requirements.

Proposed Changes to the Code

6. Please see Annex A on the proposed compliance framework and summary of the changes for further feedback.

Consultation Details

7. Building professionals and members of TACs can send their views and inputs using the [feedback form](#) or email to bca_gm_efiling@bca.gov.sg by **23 May 2019**.

8. Separately, we will also arrange an industry consultation session as shown below.

Consultation Session	
Date	8 May 2019
Time	10.00 am to 12.30 pm
Venue	BCAA Lecture Theatre Blk C3-3

9. For those who are interested to attend, please register with BCA through [online registration form](#) by **3 May 2019**. The registration is based on first-come, first-served basis. In view of limited seating capacity, the number of representatives per organisation/association may be capped to 2 pax.

For Clarification

10. We would appreciate it if you could convey the contents of this circular to the 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



DR EDWARD ANG
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for COMMISSIONER OF BUILDING CONTROL



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Annex A-1

Proposed Compliance Framework in meeting the Minimum Environmental Sustainability Standard

Under the Code for Environmental Sustainability of Buildings
BC (Environmental Sustainability) Regulations 2008

For Industry Consultation

1. OVERVIEW OF COMPLIANCE FRAMEWORK

1.1 MINIMUM ENVIRONMENTAL SUSTAINABILITY STANDARD

The minimum environmental sustainability standard of building works shall have a level of environmental performance that meets all relevant Base Requirements and a suite of sustainability indicators provided under the Elective Options.



1.2 SPECIFIC REQUIREMENTS FOR DIFFERENT BUILDING TYPES

The required level of environmental performance will depend on the building works in relation to building types and as follows:

RESIDENTIAL BUILDINGS

5 Base Requirements (where relevant)
10 Elective Options

NON-RESIDENTIAL BUILDINGS

7 Base Requirements (where relevant)
10 Elective Options*

** for building works that only involve the erection of simple structures such as link ways, underground passes, open sheds, substations, lift upgrading and the like, only the base requirements will apply.*

MIXED USE BUILDINGS

Each part of the buildings works in relation to the residential and non-residential buildings shall be regarded as separate building works. The level of environmental performance shall be in accordance with the requirement set for each part of the building works.

Note : Alternative solutions for compliance that meet the intent of the sustainability objectives can be considered on a case-to-case basis.

2. BASE REQUIREMENTS

2.1 SUSTAINABILITY ATTRIBUTES

The Base Requirements comprises sustainability attributes that are to be complied with, where applicable. The details are provided in the following Table 2.1.1 and Table 2.2.2 for the respective building types.

TABLE 2.1.1 – BASE REQUIREMENTS FOR RESIDENTIAL BUILDINGS

SUSTAINABILITY ATTRIBUTES		APPLICABILITY & SCOPE												
RB 01	<p>Envelope and Roof Thermal Transfer</p> <p>Minimise heat gain through building envelope and roof to enhance thermal comfort and to reduce the energy needed to condition the indoor environment. The following thermal performance indicators are to be met.</p> <p>(a) Maximum Residential Envelope Transmittance Value (RETV) of 25 W/m²</p> <p>(b) The average thermal transmittance (U-Value) of roof shall not exceed the prescribed limits as stated below :</p> <table border="1"> <thead> <tr> <th>Roof Weight Group</th> <th>Weight Range (kg/m²)</th> <th>Maximum U-value (W/m²k)</th> </tr> </thead> <tbody> <tr> <td>Light</td> <td><50</td> <td>0.8</td> </tr> <tr> <td>Medium</td> <td>50 to 230</td> <td>1.1</td> </tr> <tr> <td>Heavy</td> <td>>230</td> <td>1.5</td> </tr> </tbody> </table> <p>The RETV is to be computed based on the methodology stated in the Code on Envelope Thermal Performance for Buildings</p>	Roof Weight Group	Weight Range (kg/m ²)	Maximum U-value (W/m ² k)	Light	<50	0.8	Medium	50 to 230	1.1	Heavy	>230	1.5	<p>Building facades and roofs</p>
Roof Weight Group	Weight Range (kg/m ²)	Maximum U-value (W/m ² k)												
Light	<50	0.8												
Medium	50 to 230	1.1												
Heavy	>230	1.5												
RB 02	<p>Air-tightness and Leakage</p> <p>Minimise air infiltration through building envelope by having effective means of weather-stripping of windows and curtain walls to ensure that the air leakage rates do not exceed the limits specified in the following standards.</p> <p>(a) SS 212 – Specification for Aluminium Alloy Windows</p> <p>(b) SS 381 – Material and Performance Tests for Aluminium Curtain Walls</p>	<p>Windows and curtain walls</p>												
RB 03	<p>Air-Conditioning System Efficiency</p> <p>Reduce energy required to provide and distribute conditioned air within the space by having energy efficient air-conditioning systems that are certified with the following energy performance standard.</p> <table border="1"> <thead> <tr> <th>Coefficient of Performance (COP) range</th> </tr> </thead> <tbody> <tr> <td>COP_{100%} ≥ 3.34</td> </tr> <tr> <td>Weighted COP ≥ 3.78</td> </tr> </tbody> </table>	Coefficient of Performance (COP) range	COP _{100%} ≥ 3.34	Weighted COP ≥ 3.78	<p>Air-conditioning system and cooling provisions</p>									
Coefficient of Performance (COP) range														
COP _{100%} ≥ 3.34														
Weighted COP ≥ 3.78														

TABLE 2.1.1 – BASE REQUIREMENTS FOR RESIDENTIAL BUILDINGS – CONT'D

RB 04	Lighting Efficiency	Lighting Provision
<p>Reduce energy required to illuminate a space with the provision of energy efficient lighting system. The lighting provision must be at least 10% 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.</p>		
RB 05	Vertical Transportation Efficiency	Lifts
<p>Reduce energy consumption by installing energy efficient vertical transportation systems that are equipped with variable voltage variable frequency (VVVF) drives and sleep mode features.</p>		

DRAFT

TABLE 2.1.2 – BASE REQUIREMENTS FOR NON-RESIDENTIAL BUILDINGS

SUSTAINABILITY ATTRIBUTES		APPLICABILITY & SCOPE											
NRB 01	Envelope and Roof Thermal Transfer	Building facades and roofs											
<p>Minimise heat gain through building envelope and roof to enhance thermal comfort and to reduce the energy needed to condition the indoor environment. The following thermal performance indicators are to be met.</p> <p>(a) Maximum Envelope Thermal Transfer Value (ETTV) of 50 W/m²</p> <p>(b) For roof with skylights, the maximum Roof Thermal Transfer Value (RTTV) of 50 W/m²</p> <p>(c) For roof without skylights, the average thermal transmittance (U-Value) of roof shall not exceed the prescribed limits as stated below :</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Roof Weight Group</th> <th>Weight Range (kg/m²)</th> <th>Maximum U-value (W/m²k)</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>The ETTV and RTTV are to be computed based on the methodology stated in the Code on Envelope Thermal Performance for Buildings.</p>			Roof Weight Group	Weight Range (kg/m ²)	Maximum U-value (W/m ² k)	Light	<50	0.5	Medium	50 to 230	0.8	Heavy	>230
Roof Weight Group	Weight Range (kg/m ²)	Maximum U-value (W/m ² k)											
Light	<50	0.5											
Medium	50 to 230	0.8											
Heavy	>230	1.2											
NRB 02	Air-tightness and Leakage	Windows, curtain walls & door openings to building exterior or non-air conditioned space											
<p>Minimise air infiltration through building envelope with the following:</p> <p>(a) Effective means of weather-stripping of windows and curtain walls to ensure that the air leakage rates do not exceed the limits specified in the following standards.</p> <p>(i) SS 212 – Specification for Aluminium Alloy Windows</p> <p>(ii) SS 381 – Material and Performance Tests for Aluminium Curtain Walls</p> <p>(b) Conditioned air is to be well confined to minimise heat gain due to warmer infiltration of air into the space with appropriate mitigation measures.</p> <p>Building entrances and door openings to building exterior or non air-conditioned spaces and the like, shall</p> <p>(i) be provided with doors that are equipped with automated technology or self-closing devices;</p> <p>(ii) be equipped with enclosed vestibules or air lock rooms for doorway with high pedestrian traffic flow. The interior door and exterior door should have a minimum distance of not less than 2.5 m apart.</p>													

TABLE 2.1.2 – BASE REQUIREMENTS FOR NON-RESIDENTIAL BUILDINGS - CONT'D

SUSTAINABILITY ATTRIBUTES		APPLICABILITY & SCOPE																									
NRB 03	Air-Conditioning System Efficiency and Controls	Air-conditioning system and cooling provision Including existing air-conditioning system and district cooling system that serve new buildings or floor areas																									
<p>Reduce energy required to provide and distribute conditioned air within the space by having energy efficient air-conditioning system and controls.</p> <p>(a) Provision of air-conditioning system that meet the following energy performance standard.</p> <table border="1" style="margin-left: 20px;"> <tr> <td colspan="3" style="text-align: center;">Water-Cooled Chilled-Water Plant for New Buildings</td> </tr> <tr> <td style="width: 20%;">Minimum Design System Efficiency (DSE)</td> <td colspan="2" style="text-align: center;">0.67 kW/RT</td> </tr> </table> <table border="1" style="margin-left: 20px;"> <tr> <td colspan="3" style="text-align: center;">Water-Cooled Chilled-Water Plant for Existing Buildings with New Extension or Major Retrofitting</td> </tr> <tr> <td rowspan="3" style="width: 20%;">Minimum Design System Efficiency (DSE)</td> <td colspan="2" style="text-align: center;">Peak Building Cooling Load</td> </tr> <tr> <td style="width: 20%; text-align: center;">≥ 500RT</td> <td style="width: 20%; text-align: center;">< 500 RT</td> </tr> <tr> <td style="text-align: center;">0.70 kW/RT</td> <td style="text-align: center;">0.80 kW/RT</td> </tr> </table> <table border="1" style="margin-left: 20px;"> <tr> <td colspan="3" style="text-align: center;">Air-Cooled Chilled-Water Plant/ Unitary Air-Conditioners</td> </tr> <tr> <td rowspan="3" style="width: 20%;">Minimum Design System Efficiency (DSE)</td> <td colspan="2" style="text-align: center;">Peak Building Cooling Load</td> </tr> <tr> <td style="width: 20%; text-align: center;">≥ 500RT</td> <td style="width: 20%; text-align: center;">< 500 RT</td> </tr> <tr> <td style="text-align: center;">0.8 kW/RT</td> <td style="text-align: center;">0.9 kW/RT</td> </tr> </table> <p>(b) For hotel buildings, a control device shall be installed in every guestroom to automatically reduce the air-conditioning provision when the room is not occupied.</p>			Water-Cooled Chilled-Water Plant for New Buildings			Minimum Design System Efficiency (DSE)	0.67 kW/RT		Water-Cooled Chilled-Water Plant for Existing Buildings with New Extension or Major Retrofitting			Minimum Design System Efficiency (DSE)	Peak Building Cooling Load		≥ 500RT	< 500 RT	0.70 kW/RT	0.80 kW/RT	Air-Cooled Chilled-Water Plant/ Unitary Air-Conditioners			Minimum Design System Efficiency (DSE)	Peak Building Cooling Load		≥ 500RT	< 500 RT	0.8 kW/RT
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NRB 04	Lighting Efficiency and Controls	Lighting provision																									
<p>Reduce energy required to illuminate a space with the provision of energy efficient lighting system and controls :</p> <p>(a) Lighting provision of at least 10% 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.</p> <p>(b) For hotel buildings, a control device shall be installed in every guestroom to ensure lightings are automatically switch off when the room is not occupied.</p>																											

TABLE 2.1.2 – BASE REQUIREMENTS FOR NON-RESIDENTIAL BUILDINGS - CONT'D

SUSTAINABILITY ATTRIBUTES		APPLICABILITY & SCOPE
NRB 05	Vertical Transportation Efficiency	Lifts and escalators
<p>Reduce energy consumption by installing energy efficient vertical transportation systems that are equipped with variable voltage variable frequency (VVVF) drives and sleep mode features.</p>		
NRB 06	Measurement and Instrumentation Requirements	Water Cooled and Air Cooled Chilled Water air-conditioning system provision
<p>Facilitate energy management and monitoring of chilled water air-conditioning system operating efficiency with the provision of permanent instrumentation.</p> <p>The instrumentation must have the capability to calculate the resultant efficiency within 5% of its true value in accordance with SS 591: 2013. Each measurement system shall include sensors, any signal conditioning, data acquisition system and the wiring connecting these components.</p> <p>The measuring instruments and devices are to be located within reach to facilitate verification and maintenance. They must be installed in accordance with the manufacturers' recommendation and SS 591: 2013. The measurement systems provided shall also comply with the following requirement:</p> <ul style="list-style-type: none"> • All data logging with capability to trend at 1-minute sampling time interval, and recorded to the 3rd decimal digit; • 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 overall system energy efficiency and calculated heat balance of the chilled water system; • Magnetic in-line flow meter, with 1% uncertainty and capable of electronic in-situ verification to within $\pm 2\%$ 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; • Temperature sensors are to be provided for chilled water and condenser water loop and shall have an end-to-end measurement uncertainty within $\pm 0.05^\circ\text{C}$ over the entire measurement range. Each temperature measurement location shall have 2 spare thermo-wells located in close proximity of the temperature sensor (with minimum flow interference differential) for verification of measurement accuracy. Thermo-wells shall be installed in a manner that enables the sensors to be in direct contact with fluid flow; and • Dedicated power meters (of IEC Class 1 or better) and metering current transformers, where applicable, of Class 1 or better, are to be provided for each of the following groups of equipment where applicable: chillers, chilled water pumps, condenser water pumps and cooling towers. 		

TABLE 2.1.2 – BASE REQUIREMENTS FOR NON-RESIDENTIAL BUILDINGS - CONT'D

SUSTAINABILITY ATTRIBUTES		APPLICABILITY & SCOPE
NRB 07	Electrical Sub-Metering & Monitoring	Applicable to only projects with GFA of 5000 m ² or more.
<p>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:</p> <ul style="list-style-type: none"> (a) Variable Refrigerant Flow (VRF) systems. (b) Lifts & Escalators if there are more than 5 numbers or the sum of all feeders > 50 kVA, whichever is applicable. (c) Mechanical Ventilation Systems with a total subsystem's load > 15 kW and individual fan system motors are more than 1.5 kW. (d) Centralised hot water supply system with more than 50 kW thermal heating capacity (e) General power supply and lighting systems for each floor level <p>Note :</p> <ul style="list-style-type: none"> (1) The provision of sub-metering for chiller plant systems is covered in NRB 07. (2) The submetering provision for general power supply & lighting systems can be based on per floor or sub-system basis. 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, please provide separate sub-metering for these specific areas to better manage the energy consumption where relevant. 		

3. ELECTIVE OPTIONS

Elective Options comprises a suite of sustainability indicators that are classified under the following four sections.

SECTION 1 – CLIMATIC RESPONSIVE DESIGN

This section encourages the use of contextual, integrative design process with due consideration on the conservation of ecological systems. It takes into account climatic parameters which have direct influence on indoor thermal comfort and building energy consumption.

SECTION 2 – BUILDING ENERGY PERFORMANCE

This section focuses on how building energy systems can be designed and optimised through energy efficiency, effectiveness and replacement strategies to reduce environmental impact.

SECTION 3 – RESOURCE STEWARDSHIP

This section promotes the adoption of sustainable practices, material procurement and design to inculcate responsible use and conservation of resources during construction and building operation.

SECTION 4 – SMART AND HEALTHY BUILDING

This section encourages the provision of smart controls and systems that could adapt to the users' requirement for better building performance management. It also covers provisions that enhance the indoor environmental quality which brings health benefits to occupants.

The selection of the elective options should be appropriate for the building development. The details are provided in the following Table 3.1.1 and Table 3.2.2 for the respective building types.

TABLE 3.1.1 – ELECTIVE OPTIONS FOR RESIDENTIAL BUILDINGS

Section 1 – Climatic Responsive Design		
ENVIRONMENTAL SUSTAINABILITY INDICATORS		APPLICABILITY & SCOPE
RBE 1-1	<p>Environmental Credentials of Project Team</p> <p>Recognise contributions from key project team members with green credentials and their efforts in delivering sustainable building developments</p> <p>Project team comprises at least one certified green specialist with another three (3) team members who are either certified green specialists or from green companies.</p> <p>Note :</p> <p>(1) Green Specialists refers to certified Green Mark Manager (GMM), Green Mark Facilities Manager (GMFM) with valid Refresher Course Certificate, certified Green Mark Professional (GMP), Green Mark Facilities Professional (GMFP)</p> <p>(2) Green Companies refers to firms of developer, main builder, architect, M & E engineers, C & S Engineers, ESD consultants that are either ISO 14001 certified, SGBC Green Services Certified or certified under the Green and Gracious Builder Scheme.</p>	Generally Applicable
RBE 1-2	<p>Integrative Design Process</p> <p>Promote collaborative efforts among key stakeholders to optimise opportunities for design and system synergies so as to create better integrated, cost-effective sustainability outcome and building performance.</p> <p>(a) Integrated approach to building design (b) Maintainability design considerations (c) Collaborative BIM (d) Green BIM</p>	Generally Applicable
RBE 1-3	<p>User Engagement</p> <p>Raise environmental awareness on sustainable design strategies and green features through the provision of building user guide.</p>	Generally Applicable
RBE 1-4	<p>Integrated Landscape</p> <p>Incorporate accessible verdant landscape within building development to create better quality living and support biodiversity.</p> <p>(a) Greenery provision with GPR of more than 3.0 (b) Tree conservation by way of preserving existing trees or replanting equivalent number of trees with same or higher Leaf Area Index (LAI).</p>	Buildings with landscape provision

TABLE 3.1.1 – ELECTIVE OPTIONS FOR RESIDENTIAL BUILDINGS – CONT'D

RBE 1-5	Tropical Façade Performance	Building envelope
<p>Enhance façade performance to minimise heat gain to the building for better indoor thermal comfort by meeting the Residential Envelope Transmittance Value (RETV) of no more than 22 W/m².</p>		
RBE 1-6	Naturally Ventilated Design	Naturally ventilated occupied spaces and common areas
<p>Enhance indoor thermal comfort through the provision of building and unit layout design, which facilitate good natural ventilation.</p> <p>(a) Building layout design comprises 40% of all units with window openings facing prevailing wind directions</p> <p>(b) Dwelling unit design comprises 30% of living rooms and bedrooms designed with effective inlet and outlet openings on either opposite or adjacent wall to facilitate good cross ventilation.</p> <p>(c) Use of in depth analytical tools to identify the most effective building design and layout for the development that can enhance thermal comfort and meet the following requirements :</p> <ul style="list-style-type: none"> • Minimum 70% of the selected units with weighted average velocity of 0.6 m/s using the ventilation simulation modelling and analysis; or • Minimum 70% of the selected units with weighted average velocity of 0.2 m/s and thermal comfort threshold using predicted mean vote equation that meet $-0.5 < PMV < 0.5$ range along with provision of mechanically assisted ventilation where applicable. <p>(d) Design for natural ventilation for at least 80% of one common area that is lift lobbies and corridors or staircases.</p>		

TABLE 3.1.1 – ELECTIVE OPTIONS FOR RESIDENTIAL BUILDINGS – CONT'D

Section 2 – Building Energy Performance					
ENVIRONMENTAL SUSTAINABILITY INDICATORS		APPLICABILITY & SCOPE			
RBE 2-1	Enhanced Air-Conditioning System Efficiency	Air-conditioning system provision			
Provision of better energy efficient air-conditioners that are certified with the following minimum energy performance standard <table border="1" style="margin-left: 40px; margin-top: 10px;"> <tr> <td style="padding: 5px;">Coefficient of Performance (COP) range</td> </tr> <tr> <td style="padding: 5px;">Weighted COP \geq 5.50</td> </tr> <tr> <td style="padding: 5px;">COP_{100%} \geq 4.86</td> </tr> </table>		Coefficient of Performance (COP) range	Weighted COP \geq 5.50	COP _{100%} \geq 4.86	
Coefficient of Performance (COP) range					
Weighted COP \geq 5.50					
COP _{100%} \geq 4.86					
RBE 2-2	Energy Efficient Products and Features	Generally Applicable			
Encourage the use of energy efficient products and design features (maximum of 3 features) that have positive environmental impact in term of energy saving. <ul style="list-style-type: none"> (i) Naturally ventilated carpark design (ii) Provision of CO sensors to regulate demand for mechanical ventilation in carparks (iii) Heat recovery system (iv) Lifts with regenerative function (v) Open spaces with clothes drying facilities (vi) Provision of bi-level motion sensors for lighting systems in at least 50% of the common areas (by number) (vii) Timer sensors/controls for lighting and ventilation systems in community spaces such as function rooms, club house, community halls (viii) Energy labelled appliances with excellent energy efficient rating 					
RBE 2-3	Solar Energy Feasibility Study	Generally Applicable			
Conduct of feasibility study to assess the building's potential to incorporate solar photovoltaic systems.					
RBE 2-4	Adoption of Renewable Energy	Provision of on-site renewable energy			
Encourage the use of renewable energy sources to reduce the use of electricity by at least 1% of the expected total building electricity consumption of common facilities and areas.					

TABLE 3.1.1 – ELECTIVE OPTIONS FOR RESIDENTIAL BUILDINGS – CONT'D

Section 3 – Resource Stewardship		
ENVIRONMENTAL SUSTAINABILITY INDICATORS		APPLICABILITY & SCOPE
RBE 3-1	Water Efficiency Measures	Generally Applicable
<p>Reduce potable water consumption through the provision of water efficient fittings and systems.</p> <ul style="list-style-type: none"> (a) Provision of at least one (1) water fitting types with 3 ticks WELs rating for dwelling units (b) Provision of at least two (2) water fitting types with 3 ticks WELs rating for common facilities (c) Provision of water efficient automated irrigation systems or drought tolerant plant for at least 50% of landscape areas 		
RBE 3-2	Water Usage Monitoring	Generally Applicable
<p>Facilitate setting of water consumption reduction targets and monitoring of major water uses with the provision of private meters.</p>		
RBE 3-3	Alternative Water Sources	Generally Applicable
<p>Encourage the use of alternative water sources for general application to reduce potable water consumption.</p> <ul style="list-style-type: none"> (a) NEWater Supply (b) On-site recycled water (c) Rainwater harvested 		
RBE 3-4	Sustainable Construction	Structural and non-structural components constituting building superstructure
<p>Promote the adoption of building designs, materials and practices that are environmentally friendly and sustainable.</p> <ul style="list-style-type: none"> (a) Conservation and Resource Recovery <ul style="list-style-type: none"> (i) Existing structures are conserved for reuse (ii) Adopting demolition protocol to maximise resource recovery of demolition materials for reuse or recycling based on S557: Code of Practice for Demolition. (b) Resource Efficient Building Design with Concrete Usage Index (CUI) of not more than 0.5 (c) Low Carbon Concrete <ul style="list-style-type: none"> (i) Use of concrete (up to grade C50/60) with clinker content of less than 400 kg/m² or SGBC– certified concrete for 80% of the super-structural works. (ii) 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) 		

TABLE 3.1.1 – ELECTIVE OPTIONS FOR RESIDENTIAL BUILDINGS – CONT'D

RBE 3-4	Sustainable Construction – cont'd	Non-structural or architectural related building components
<p>(d) Adoption of Sustainable Building Systems with minimum coverage of 50% of the constructed floor areas (CFA). The systems that can be considered are as listed :</p> <ul style="list-style-type: none"> • Pre-stressed or precast concrete elements • Light Weight Concrete Elements • High Strength Concrete Elements with concrete grade >60 MPa • Structural Steel Elements • Composite Structural Elements • Engineering Timber Elements • Prefabricated Prefinished Volumetric Construction Units (PPVC) • Leave in formwork 		
RBE 3-5	Sustainable Products	Non-structural or architectural related building components
<p>Encourage the specification and use of resource efficient and environmentally friendly products that are certified by an approved local certification body.</p> <p>The provision shall include for at least six (6) products or one functional system (including its finishes where applicable) with two (2) other products in at least 80% of applicable areas or building components.</p>		
RBE 3-6	Environmental Construction Management Plan	Generally Applicable
<p>Encourage effective implementation of environmental management plan to facilitate tracking of specific sustainability targets, monitoring of energy, water and construction waste.</p>		
RBE 3-7	Operational Waste Management	Generally Applicable
<p>Facilitate segregation of recyclable consumer waste with appropriate collection and recycling provision.</p> <p>(a) Facilities for collection and storage of different recyclables such as paper glass, metal and plastic in commingled or sorted form.</p> <p>(b) Facilities or systems for the placement of horticultural or wood waste for recycling</p>		

TABLE 3.1.1 – ELECTIVE OPTIONS FOR RESIDENTIAL BUILDINGS – CONT'D

Section 4 – Smart & Healthy Building		
ENVIRONMENTAL SUSTAINABILITY INDICATORS		APPLICABILITY & SCOPE
RBE 4-1	Indoor Air Quality	Generally Applicable
<p>Minimise airborne contaminants, mainly from inside sources to create a better healthy indoor environment.</p> <p>(a) Use of low VOC paint systems that are certified by an approved local certification body for 90% of the total painted internal wall areas.</p> <p>(b) Use of low VOC emitting interior finishes, site applied adhesives and sealants that are certified by approved local certification bodies in at least 80% of applicable areas.</p> <p>(c) Provision of good natural ventilation and daylighting for at least 80% of all wet areas such as kitchens, bathrooms and toilets.</p>		
RBE 4-2	Effective Daylighting	Generally Applicable
<p>Encourage design that optimise the use of effective natural lighting for better visual comfort.</p> <p>(a) Dwelling units : Daylighting provision for 25% of the total number of residential units that meets the desired lighting level of DA 200lux, 50% in 60% of applicable areas (namely bedrooms, living room, family room and study room).</p> <p>(b) Common areas: Provision of daylighting with minimum coverage of 80% (by number) in at least two (2) of the following areas :</p> <ul style="list-style-type: none"> • Staircases • Corridors and lift lobbies • Carparks 		
RBE 4-3	Biophilic Design	
<p>Integration of biophilic elements as part of design strategies to reinforce the attributes and experience of nature which would help enhance user's environment and overall wellbeing. The provisions can come in the form of the following attributes:</p> <p>(a) Direct experience of nature by having extensive greenery within buildings, natural landscapes and/or water features</p> <p>(b) Indirect experience of nature in building design that can come in the form of naturalistic materials, colours, shape, geometry, biomimicry concepts</p> <p>(c) Dedicated common spaces that promote healthy lifestyle and wellbeing</p>		

TABLE 3.1.1 – ELECTIVE OPTIONS FOR RESIDENTIAL BUILDINGS – CONT'D

RBE 4-4	Energy and Water Usage Monitoring	Generally Applicable
<p>Encourage the provision of suitable means that would help users to better manage their energy and/or water consumption such as</p> <ul style="list-style-type: none"> (a) Appropriate smart metering for electricity, water or gas (b) Web-based or mobile application to provide useful and timely information on utilities consumption and breakdown for <ul style="list-style-type: none"> • Homeowners • Facilities management team 		
RBE 4-5	Low Environmental Impact Refrigerant	Air-conditioning system provision
<p>Encourage the provision of air-conditioning systems containing low environmental impact refrigerants of Zero Ozone Depleting Potential (ODP) and Low Global Warming Potential (GWP) of less than 750</p>		

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TABLE 3.1.2 – ELECTIVE OPTIONS FOR NON-RESIDENTIAL BUILDINGS

Section 1 – Climatic Responsive Design		
ENVIRONMENTAL SUSTAINABILITY INDICATORS		APPLICABILITY & SCOPE
NRBE 1-1	Environmental Credentials of Project Team	Generally Applicable
<p>Recognise contributions from key project team members with green credentials and their efforts in delivering sustainable building developments</p> <p>Project team comprises at least one certified green specialist with another three (3) team members who are either certified green specialists or from green companies.</p> <p>Note :</p> <p>(i) Green Specialists refers to certified Green Mark Manager (GMM), Green Mark Facilities Manager (GMFM) with valid Refresher Course Certificate, certified Green Mark Professional (GMP), Green Mark Facilities Professional (GMFP)</p> <p>(ii) Green Companies refers to firms of developer, main builder, architect, M & E engineers, C & S Engineers, ESD consultants that are either ISO 14001 certified, SGBC Green Services Certified or certified under the Green and Gracious Builder Scheme.</p>		
NRBE 1-2	Integrative Design Process	Generally Applicable
<p>Promote collaborative efforts among key stakeholders to optimise, opportunities for design and system synergies so as to create better integrated, cost-effective sustainability outcome and building performance.</p> <p>(a) Integrated approach to building design</p> <p>(b) Maintainability design considerations</p> <p>(c) Collaborative BIM</p> <p>(d) Green BIM</p>		
NRBE 1-3	User Engagement	Generally Applicable
<p>Raise environmental awareness on sustainable design strategies and green features through the provision of building user guide.</p>		
NRBE 1-4	Integrated Landscape	Buildings with landscape provision
<p>Incorporate accessible verdant landscape within building development to create better quality living and support biodiversity.</p> <p>(a) Greenery provision with GPR of more than 1.0</p> <p>(b) Tree conservation by way of preserving existing trees or replanting equivalent number of trees with same or higher Leaf Area Index (LAI)</p>		

TABLE 3.1.2 – ELECTIVE OPTIONS FOR NON-RESIDENTIAL BUILDINGS

NRBE 1-5	Tropical Façade Performance	Building envelope
<p>Enhance façade performance to minimise heat gain to the building for better indoor thermal comfort by meeting the Envelope Thermal Transfer Value (ETTV) of no more than 45 W/m²</p>		
NRBE 1-6	Naturally Ventilated Design	Naturally ventilated occupied spaces and common areas
<p>Enhance indoor thermal comfort through the provision of building layout designs which facilitate good natural ventilation.</p> <p>(a) Proper design of building layout that utilises prevailing wind conditions and comprises at least 40% of all units with window openings facing prevailing wind directions</p> <p>(b) Use of in depth analytical tools to effectively design the naturally ventilated functional spaces that can enhance thermal comfort and meet the following requirements :</p> <ul style="list-style-type: none"> • Minimum 70% of the naturally ventilated occupied spaces with weighted average velocity of 0.6 m/s using the ventilation simulation modelling and analysis; or • Minimum 70% of the naturally ventilated occupied spaces with weighted average velocity of 0.2 m/s and thermal comfort threshold using predicted mean vote equation that meet $-1.0 < PMV < 1.0$ range along with provision of mechanically assisted ventilation where applicable. <p>(c) Design for natural ventilation for at least 80% at least one common area such as lift lobbies and corridors, staircases or atriums. Design for natural ventilation for at least 80% of one common areas that is lift lobbies and corridors or staircases.</p>		

TABLE 3.1.2 – ELECTIVE OPTIONS FOR NON-RESIDENTIAL BUILDINGS – CONT'D

Section 2 – Building Energy Performance											
ENVIRONMENTAL SUSTAINABILITY INDICATORS		APPLICABILITY & SCOPE									
NRBE 2-1	Air-Conditioning Total System Efficiency Provision of better energy efficient air-conditioning systems that meet the overall energy performance standard which includes that of the air-distribution system and as stated below.	Air-conditioning system provision									
<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="3">Water-Cooled Chilled-Water Plant</th> </tr> <tr> <th rowspan="3">Total Design System Efficiency (TDSE)</th> <th colspan="2">Peak Building Cooling Load</th> </tr> <tr> <th>≥ 500RT</th> <th>< 500 RT</th> </tr> <tr> <th>1.08 kW/RT</th> <th>0.98 kW/RT</th> </tr> </thead> </table>			Water-Cooled Chilled-Water Plant			Total Design System Efficiency (TDSE)	Peak Building Cooling Load		≥ 500RT	< 500 RT	1.08 kW/RT
Water-Cooled Chilled-Water Plant											
Total Design System Efficiency (TDSE)	Peak Building Cooling Load										
	≥ 500RT	< 500 RT									
	1.08 kW/RT	0.98 kW/RT									
NRBE 2-2	Mechanical Ventilation System Efficiency Encourage the use of energy efficient mechanical ventilation systems for normally occupied spaces. The overall efficiency standard is to be at least 20% more energy efficient than the prescribed fan power limitation set in SS 553.	Generally Applicable									
NRBE 2-3	Solar Energy Feasibility Study Conduct of feasibility study to assess the building's potential to incorporate solar photovoltaic systems.	Generally Applicable									
NRBE 2-4	Adoption of Renewable Energy Encourage the use of renewable energy sources to reduce the use of electricity by at least 1% of the expected total building electricity consumption of common facilities and areas.	Provision of on-site renewable energy									

TABLE 3.1.2 – ELECTIVE OPTIONS FOR NON-RESIDENTIAL BUILDINGS – CONT'D

Section 3 – Resource Stewardship		
ENVIRONMENTAL SUSTAINABILITY INDICATORS		APPLICABILITY & SCOPE
NRBE 3-1	Water Efficient Systems	Generally Applicable
<p>Reduce potable water consumption through the design and provision of water efficient fittings and mechanical systems:</p> <ul style="list-style-type: none"> (a) Provision of at least one (1) water fitting types with 3 ticks WELs rating for public use (b) Provision of water efficient automated irrigation systems for at least 50% of the landscape areas (c) Provision of cooling tower water treatment with effective basin filtration system that helps increase the solubility of water and facilitates at least 7 cycles of concentration with acceptable water quality 		
NRBE 3-2	Water Usage Monitoring	Generally Applicable
<p>Facilitate setting of water consumption reduction targets and monitoring of major water uses with the provision of private meters.</p>		
NRBE 3-3	Alternative Water Sources	Generally Applicable
<p>Encourage the use of alternative water sources for general application which help reduce potable water consumption.</p> <ul style="list-style-type: none"> (a) NEWater Supply (b) On-site recycled water (c) Rainwater harvested 		
NRBE 3-4	Sustainable Construction	Structural and non-structural components constituting building superstructure
<p>Promote the adoption of building designs, materials and practices that are environmentally friendly and sustainable.</p> <ul style="list-style-type: none"> (a) Conservation and Resource Recovery <ul style="list-style-type: none"> (i) Existing structures are conserved for reuse (ii) Adopting demolition protocol to maximise resource recovery of demolition materials for reuse or recycling based on S557: Code of Practice for Demolition. (b) Resource Efficient Building Design with Concrete Usage Index (CUI) of not more than 0.5 (c) Low Carbon Concrete <ul style="list-style-type: none"> (i) Use of concrete (up to grade C50/60) with clinker content of less than 400 kg/m² or SGBC– certified concrete for 80% of the super-structural works. (ii) 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) 		

TABLE 3.1.2 – ELECTIVE OPTIONS FOR NON-RESIDENTIAL BUILDINGS – CONT'D

NRBE 3-5	Sustainable Products	Non-structural or architectural related building components
<p>Encourage the specification and use of resource efficient and environmentally friendly products that are certified by an approved local certification body.</p> <p>The provision shall include for at least six (6) products or one functional system (including its finishes where applicable) with two (2) other products in at least 80% of applicable areas or building components.</p>		
NRBE 3-6	Environmental Construction Management Plan	Generally Applicable
<p>Encourage effective implementation of environmental management plan to facilitate tracking of specific sustainability targets, monitoring of energy, water and construction waste.</p>		
NRBE 3-7	Operational Waste Management	Generally Applicable
<p>Facilitate segregation of recyclable consumer waste with appropriate collection and recycling provisions.</p> <ul style="list-style-type: none"> (a) Facilities for collection and storage of different recyclables such as paper glass, metal and plastic in commingled or sorted form. (b) Facilities or systems for food waste to be treated and recycled (c) Facilities or systems for the placement of horticultural or wood waste for recycling 		

TABLE 3.1.2 – ELECTIVE OPTIONS FOR NON- RESIDENTIAL BUILDINGS – CONT'D

Section 4 – Smart & Healthy Building														
ENVIRONMENTAL SUSTAINABILITY INDICATORS		APPLICABILITY & SCOPE												
NRBE 4-1	Indoor Air Quality	Generally Applicable												
<p>Minimise the build-up of airborne contaminants to create a better healthy indoor environment.</p> <ul style="list-style-type: none"> (a) Use of low VOC paint systems that are certified by an approved local certification body for 90% of the total painted internal wall areas (b) Use of low VOC emitting interior finishes, site applied adhesives and sealants that are certified by an approved local certification body for at least 80% of applicable areas. (c) Use of demand control ventilation strategies such as carbon dioxide sensors to regulate the fresh air intake (d) Provision of enhanced filtration media (e) Provision of Ultraviolet Germicidal Irradiation (UVGI) system (f) Provision of dedicated outdoor air system 														
NRBE 4-2	Lighting Quality	Generally Applicable												
<p>Encourage the provision of enhanced lighting attributes and effective natural lighting to maximise visual comfort.</p> <ul style="list-style-type: none"> (a) 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 border="1" data-bbox="316 1123 1026 1579"> <thead> <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> </thead> <tbody> <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> </tbody> </table>		S/N	Minimum Lighting Level Based on Space Occupancy Type	Daylight Autonomy requirement per unit area of space	1	Offices and Institutional spaces where lux requirement is 500 lux	DA _{500lx} , 50%	2	Industrial, sports facilities, retail areas where lux requirement is 300 lux	DA _{300lx} , 50%	3	Hotel, resort-like and service apartment where lux requirement is 200 lux	DA _{200lx} , 50%	
S/N	Minimum Lighting Level Based on Space Occupancy Type	Daylight Autonomy requirement per unit area of space												
1	Offices and Institutional spaces where lux requirement is 500 lux	DA _{500lx} , 50%												
2	Industrial, sports facilities, retail areas where lux requirement is 300 lux	DA _{300lx} , 50%												
3	Hotel, resort-like and service apartment where lux requirement is 200 lux	DA _{200lx} , 50%												

TABLE 3.1.2 – ELECTIVE OPTIONS FOR NON-RESIDENTIAL BUILDINGS – CONT'D

Section 4 – Smart & Healthy Building		
ENVIRONMENTAL SUSTAINABILITY INDICATORS		APPLICABILITY & SCOPE
NRBE 4-2	Lighting Quality - Cont'd	Generally Applicable
<p>(b) Common areas : To have no less than 80% of the applicable spaces to be daylighted and integrated with daylighting controls.</p> <p>(c) Provision of relevant luminaires with any of the following attributes for 90% of applicable functional areas.</p> <p>(i) Lighting designed to avoid flicker and stroboscopic effects, by using high frequency ballasts (frequency > 20 kHz) for fluorescent luminaires and LED lighting with output frequency < 200 Hz and <30% flicker or equivalent performance characteristics provided by LED drivers</p> <p>(ii) Minimum colour rendering index (Ra or CRI) in Clause 5 of SS 531 – 1 : 2006 (2013) – Code of Practice for Lighting of Workplaces</p> <p>(iii) LED Luminaires certified under SGBP scheme</p>		
NRBE 4-3	Biophilic Design	Generally Applicable
<p>Integration of biophilic elements as part of design strategies to reinforce the attributes and experience of nature to nurture the human-nature relationship. This would help enhance the user's environment and overall wellbeing. The provisions can come with the following attributes:</p> <p>(a) Direct experience of nature by having extensive greenery within buildings, natural landscapes and/or water features</p> <p>(b) Indirect experience of nature in building design that can come in the form of naturalistic materials, colours, shape, geometry, biomimicry concepts</p>		
NRBE 4-4	Energy and Water Usage Monitoring	Generally Applicable
<p>Encourage the provision of suitable means that would help users to better manage their energy and/or water consumption.</p> <p>(a) Web-based or mobile application to provide useful and timely information on utilities consumption and breakdown for</p> <ul style="list-style-type: none"> • Users or tenants • Facilities management team <p>(b) Use of BACnet, Modbus or any other open protocol as the network backbone of the building management system (BMS) where data points can be extracted to commonly used file formats for monitoring and verification purpose.</p>		

TABLE 3.1.2 – ELECTIVE OPTIONS FOR NON-RESIDENTIAL BUILDINGS – CONT'D

NRBE 4-5	Low Environmental Impact Refrigerant	Air-conditioning system provision
Encourage the provision of air-conditioning systems containing low environmental impact refrigerants of Zero Ozone Depleting Potential (ODP) and Low Global Warming Potential (GWP) of less than 750		
NRBE 4-6	System Handover and Documentation	Generally Applicable
<p>Encourage proper handover and documentation so that the designed building system performance can be attained and maintained. The documentation shall include the following :</p> <ul style="list-style-type: none"> • Details of the basis and performance requirements of air and hydronic systems and building control systems. • Evidences on the verification and acceptance of the functional performance of air and hydronic systems and building control systems. • Details of the building controls for system operations, control actions and strategies including logic diagrams, network schematic of the BMS network, showing device locations and description of BMS point list. • Technical training manuals and user guides. 		

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Annex A-2

Areas of Responsibility

Under the Code for Environmental Sustainability of Buildings
Building Control (Environmental Sustainability) Regulations 2008

For Industry Consultation

Table A-1. Areas of Responsibility under Residential Building Criteria

Residential Building Criteria	Responsibility
Base Requirement	
RB 01 Envelope and Roof Thermal Transfer	QP (BP) ¹
RB 02 Air-Tightness and Leakage	QP (BP)
RB 03 Air Conditioning System Efficiency	PE (Mechanical) ²
RB 04 Lighting Efficiency	PE (Electrical) ²
RB 05 Vertical Transportation Efficiency	PE (Electrical)
Elective Requirement	
Section 1 – Climatic Responsive Design	
RBE 1-1 Environmental Credentials of Project Team	QP (BP)
RBE 1-2 Integrative Design Process	QP (BP)
RBE 1-3 User Engagement	QP (BP)
RBE 1-4 Integrated Landscape	QP (BP)
RBE 1-5 Tropical Façade Performance	QP (BP)
RBE 1-6 Naturally Ventilated Design	QP (BP)
Section 2 – Building Energy Performance	
RBE 2-1 Enhanced Air-Conditioning System Efficiency	PE (Mechanical)
RBE 2-2 Energy Efficient Products and Features	Appropriate Practitioners ³
RBE 2-3 Solar Feasibility Study	Appropriate Practitioners
RBE 2-4 Adoption of Renewable Energy	PE (Electrical)
Section 3 – Resource Stewardship	
RBE 3-1 Water Efficiency Measures	QP (BP)
RBE 3-2 Water Usage Monitoring	QP (BP)
RBE 3-3 Alternative Water Sources	QP (BP)
RBE 3-4 Sustainable Construction	QP (BP)
RBE 3-5 Sustainable Products	QP (BP)
RBE 3-6 Environmental Construction Management Plan	QP (BP)
RBE 3-7 Operational Waste Management	QP (BP)
Section 4 – Smart and Healthy Buildings	
RBE 4-1 Indoor Air Quality	QP (BP)
RBE 4-2 Effective Daylighting	QP (BP)
RBE 4-3 Biophilic Design	QP (BP)
RBE 4-4 Energy and Water Usage Monitoring	QP (BP)
RBE 4-5 Low Environmental Impact Refrigerant	QP (BP)

¹ QP(BP) refers to Qualified Person who submits building plan.

² PE (Mechanical) or PE(Electrical) refers to a professional engineer registered under the Professional Engineers Act (Cap 253) in the branch of mechanical engineering or electrical engineering

³ Appropriate practitioners refer to QP (BP), PE(Mechanical) or PE(Electrical)

Table A-2. Areas of Responsibility under Non-Residential Building Criteria

Non-Residential Building Criteria	Responsibility
Base Requirement	
NRB 01 Envelope and Roof Thermal Transfer	QP (BP)
NRB 02 Air-Tightness and Leakage	QP (BP)
NRB 03 Air Conditioning System Efficiency and Controls	PE (Mechanical)
NRB 04 Lighting Efficiency and Controls	PE (Electrical)
NRB 05 Vertical Transportation Efficiency	PE (Electrical)
NRB 06 Measurement and Instrumentation Requirements	PE (Mechanical)
NRB 07 Electrical Sub-Metering and Monitoring	PE (Electrical)
Elective Requirement	
Section 1 – Climatic Responsive Design	
NRBE 1-1 Environmental Credentials of Project Team	QP (BP)
NRBE 1-2 Integrative Design Process	QP (BP)
NRBE 1-3 User Engagement	QP (BP)
NRBE 1-4 Integrated Landscape	QP (BP)
NRBE 1-5 Tropical Façade Performance	QP (BP)
NRBE 1-6 Naturally Ventilated Design	QP (BP)
Section 2 – Building Energy Performance	
NRBE 2-1 Air-Conditioning Total System Efficiency	PE (Mechanical)
NRBE 2-2 Mechanical Ventilation System Efficiency	PE (Mechanical)
NRBE 2-3 Solar Feasibility Study	Appropriate Practitioners
NRBE 2-4 Adoption of Renewable Energy	PE (Electrical)
Section 3 – Resource Stewardship	
NRBE 3-1 Water Efficiency Measures	QP (BP)
NRBE 3-2 Water Usage Monitoring	QP (BP)
NRBE 3-3 Alternative Water Sources	QP (BP)
NRBE 3-4 Sustainable Construction	QP (BP)
NRBE 3-5 Sustainable Products	QP (BP)
NRBE 3-6 Environmental Construction Management Plan	QP (BP)
NRBE 3-7 Operational Waste Management	QP (BP)
Section 4 – Smart and Healthy Buildings	
NRBE 4-1 Indoor Air Quality	QP (BP)
NRBE 4-2 Lighting Quality	QP (BP)
NRBE 4-3 Biophilic Design	QP (BP)
NRBE 4-4 Energy and Water Usage Monitoring	QP (BP)
NRBE 4-5 Low Environmental Impact Refrigerant	QP (BP)
NRBE 4-6 System Handover and Documentation	Appropriate Practitioners

Note : Documentary evidences prepared by the domain experts or specialists such as acoustic consultant, landscape architect etc may be used to demonstrate compliance with the criteria where applicable.

Integrating Energy Efficiency Requirements under Section I of the Approved Document to form part of the compliance framework under Environmental Sustainability Requirements

Summary of Key Changes to the Requirements under the Current Code for Environmental Sustainability of Buildings (3rd Edition)

Clause Ref	Approved Document Section I on Energy Efficiency	Criteria Ref	Requirements to be incorporated in Upcoming Code for Environmental Sustainability of Buildings 4 th Edition Base Requirements
I.3.2	Air-conditioned building	RB 01	<p>Same requirement incorporated in Base requirements for Residential Buildings under RB 01 – Envelope and Roof Thermal Transfer Value</p> <p>The deemed to satisfy requirement under Clause I.3.2.2 will be incorporated as part of the acceptable methodology in the Code with the proposed modifications.</p> <p> $WWR_{Bldg} < 0.3$ and $SC_{glass} \leq 0.73$ $0.30 < WWR_{Bldg} \leq 0.35$ and $SC_{glass} \leq 0.63$ $0.35 < WWR_{Bldg} \leq 0.4$ and $SC_{glass} < 0.56$ $0.40 < WWR_{Bldg} \leq 0.45$ and $SC_{glass} < 0.51$ $0.45 < WWR_{Bldg} \leq 0.50$ and $SC_{glass} < 0.46$ </p> <p>Where: WWR :Window to wall ratio SC : Shading coefficient of glass</p>
I.3.2.1	For all residential buildings with a gross floor areas of 2000 m ² or more, the Residential Envelope Transmittance Value (RETV) of the building, as determined in accordance with the formula set out in the “Code on Envelope Thermal Performance for Buildings” issued by the Commissioner of Building Control, shall not exceed 25 W/m ²		
I.3.2.2	<p>The requirements in paragraphs I.3.2.1 are deemed to be satisfied if a residential building with external walls consisting of masonry construction, satisfies the criteria below :</p> <p> $WWR_{Bldg} < 0.3$ and $SC_{façade} < 0.7$ $WWR_{Bldg} < 0.4$ and $SC_{façade} < 0.5$ $WWR_{Bldg} < 0.5$ and $SC_{façade} < 0.43$ </p> <p>Where: WWR :Window to wall ratio SC : Shading coefficient of fenestration = $SC_{glass} \times SC_{shading\ device}$</p>		

Clause Ref	Approved Document Section I on Energy Efficiency	Criteria Ref	Requirements to be incorporated in Upcoming Code for Environmental Sustainability of Buildings 4 th Edition Base Requirements												
I.3.3	Non air-conditioned building	NRB 01	Same requirement incorporated in Base requirements for Non-Residential Buildings under NRB01 – Envelope and Roof Thermal Transfer Value												
I.3.3.1	<p>The thermal transmittance (U value) of the roof, as determined in accordance with the formula set out in the “Code on Envelope Thermal Performance for Buildings” issued by the Commissioner of Building Control, shall not exceed the limits specified in Table I2 for the corresponding weight group.</p> <p>TABLE I2 Maximum thermal transmittance for roof of air-conditioned building</p> <table border="1" data-bbox="191 630 863 829"> <thead> <tr> <th>Roof Weight Group</th> <th>Weight Range (kg/m²)</th> <th>Maximum U-value (W/m²k)</th> </tr> </thead> <tbody> <tr> <td>Light</td> <td>Under 50</td> <td>0.5</td> </tr> <tr> <td>Medium</td> <td>50 to 230</td> <td>1.1</td> </tr> <tr> <td>Heavy</td> <td>Over 230</td> <td>1.5</td> </tr> </tbody> </table> <p><i>Note (1) : The requirement in paragraph I.3.3.1 does not apply to the following</i></p> <ul style="list-style-type: none"> (a) buildings with a gross floor area not exceeding 500 m²; (b) open sided sheds; (c) linkways; (d) covered walkways; (e) store rooms and utility rooms; and (f) plants and equipment rooms. <p><i>Note (2) : Where a building is partially air-conditioned and the aggregate air-conditioned area is less than 500 m², the requirement in paragraph I.3.3.1 shall apply if the total gross floor area of the building exceeds 500 m²</i></p>	Roof Weight Group	Weight Range (kg/m ²)	Maximum U-value (W/m ² k)	Light	Under 50	0.5	Medium	50 to 230	1.1	Heavy	Over 230	1.5		
Roof Weight Group	Weight Range (kg/m ²)	Maximum U-value (W/m ² k)													
Light	Under 50	0.5													
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Heavy	Over 230	1.5													

Clause Ref	Approved Document Section I on Energy Efficiency	Criteria Ref	Requirements to be incorporated in Upcoming Code for Environmental Sustainability of Buildings 4 th Edition Base Requirements
I.3.4	Air tightness and leakage	RB 02	Same requirement incorporated in Base requirements for residential and non-residential buildings under RB 02 and NRB 02
I.3.4.1	All windows on the building envelope shall not exceed the air leakage rates specified in SS 212 – Specification for Aluminium Alloy Windows.	NRB 02	– Air-tightness and Leakage with inclusion of test requirement under SS 381 - Material and Performance Test for Aluminum Curtain Walls
I.3.4.2	<p>Where the door opening of any commercial unit is located along the perimeter of the building envelope, that unit shall –</p> <p><i>(a) be completely separated from the other parts of the building; and</i></p> <p><i>(b) has its air-conditioning system separated from and independent of the central systems.</i></p> <p><i>Note (1) : The requirements in paragraph I.3.4.1 and I.3.4.2 do not apply to non air-conditioned buildings</i></p> <p><i>Note (2) : The requirement in paragraph I.3.4.2 also applies to commercial units , the doors of which open to an exterior open space, external corridor, passageway or pedestrian walkway.</i></p>		<p>The requirement under Clause I.3.4.2 is enhanced to be more generic to cover other scenarios that are stated in Note (2) and as follows.</p> <p>NRB 02 (b)Conditioned air is to be well confined to minimise heat gain due to warmer infiltration of air into the space with appropriate mitigation measures.</p> <p>Building entrances and door openings to building exterior or non air-conditioned spaces and the like, shall</p> <p>(i) be provided with doors that are equipped with automated technology or self-closing devices;</p> <p>(ii) be equipped with enclosed vestibules or air lock rooms for doorway with high pedestrian traffic flow. The interior door and exterior door should have a minimum distance of not less than 2.5 m apart.</p>
I.3.5	Air-conditioning system	RB 03	Better energy efficiency standard of at least 10% over the SS 530
I.3.5.1	Where the cooling capacity of any air-conditioning system exceeds 30 kW, the equipment shall comply with the relevant provisions of SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment	NRB 03	standard is set for the air-conditioning system provision as in the current Code.
I.3.6	Artificial Lighting	RB 04	

Clause Ref	Approved Document Section I on Energy Efficiency	Criteria Ref	Requirements to be incorporated in Upcoming Code for Environmental Sustainability of Buildings 4 th Edition Base Requirements
I.3.6.1	The maximum lighting power budget in a building shall comply with the SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment	NRB 04	Better energy efficiency standard of at least 10% over the Approved Document / SS 530 standard is set for the lighting provision.
I.3.7	Switching control	NRB 03 NRB 04	The provision under Clause I.3.7.1 is excluded as it is already an industry norm for air-conditioning system to be equipped with these features. Same requirement is included in Base requirements for non-residential buildings under NRB 03 – Air-Conditioning system and Control and NRB 04 – Lighting Efficiency and Controls.
I.3.7.1	Air-conditioning system shall be equipped with manual switches, timers, or automatic controllers for shutting off part of the air conditioning system during periods of non-use or reduced heat load.		
I.3.7.2	Lighting control for artificial lighting shall be provided in accordance with SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment.		
I.3.7.3	In any hotel building, a control device acceptable to the Commissioner of Building Control, shall be installed in every guestroom for the purpose of automatically switching off the lighting and reducing the air-conditioning when a guestroom is not occupied.		
I.3.8	Energy Auditing	NRB 08	Similar requirement is included in Base requirements for non-residential buildings under NRB 08 – Electrical Sub-Metering & Monitoring, with simplification to allow sub-circuits to serve both the general power and lighting supply.
I.3.8.1	For buildings used as offices, hospitals, hotels or a combination thereof, suitable means for the monitoring of energy consumption shall be provided to all incoming power supply to a building and the sub-circuits serving – <ul style="list-style-type: none"> (a) a central air-conditioning system; (b) a major mechanical ventilation system; (c) a vertical transportation system; (d) a water pumping system; (e) the general power supply to tenancy areas; (f) the general lighting power supply to tenancy areas; (g) the general power supply to owner's premises; and (h) the general lighting supply to owner's premises. 		

Clause Ref	Approved Document Section I on Energy Efficiency		Criteria Ref	Requirements to be incorporated in Upcoming Code for Environmental Sustainability of Buildings 4 th Edition Base Requirements
				<p>Note :</p> <p>(1) The provision of sub-metering for chiller plant systems is covered in NRB 07.</p> <p>(2) The submetering provision for general power supply & lighting systems can be based on per floor or sub-system basis. 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, please provide separate sub-metering for these specific areas to better manage the energy consumption where relevant.</p>

Summary of Key Changes to the Requirements under the Current Code for Environmental Sustainability of Buildings (3rd Edition)

Criteria Ref	Code for Environmental Sustainability of Buildings (3 rd Edition)	Criteria Ref	Requirements to be incorporated in Upcoming Code for Environmental Sustainability of Buildings 4 th Edition					
<p>General</p> <p>The minimum Green Mark Score of 50 points and the stipulated pre-requisite requirements</p> <p>The criteria comprise 5 environmental impact categories namely</p> <p>Part 1 – Energy Efficiency Part 2 – Water Efficiency Part 3 – Environmental Protection Part 4 – Indoor Environmental Quality Part 5 – Other Green Features</p> <p>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</p>		<p>General</p> <p>The minimum environmental sustainability standard (equivalent 50 points) shall have a level of environmental performance that meets all relevant base requirements and a suite of sustainability indicators provided under Elective Option</p> <p>The criteria comprise 4 Sections namely</p> <p>Section 1 – Climatic Responsive Design Section 2 – Building Energy Performance Section 3 – Resource Stewardship Section 4 – Smart & Healthy Buildings</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; border-bottom: 1px solid black;">RESIDENTIAL BUILDINGS</th> <th style="text-align: left; border-bottom: 1px solid black;">NON-RESIDENTIAL BUILDINGS</th> </tr> </thead> <tbody> <tr> <td style="border-bottom: 1px solid black;">5 Base Requirements (where relevant) 10 Elective Options</td> <td style="border-bottom: 1px solid black;">7 Base Requirements (where relevant) 10 Elective Options*</td> </tr> <tr> <td></td> <td style="vertical-align: top;"> <p><i>* for building works that only involve the erection of simple structures such as link ways, underground passes, open sheds, substations, lift upgrading and the like, only the base requirements will apply.</i></p> </td> </tr> </tbody> </table>	RESIDENTIAL BUILDINGS	NON-RESIDENTIAL BUILDINGS	5 Base Requirements (where relevant) 10 Elective Options	7 Base Requirements (where relevant) 10 Elective Options*		<p><i>* for building works that only involve the erection of simple structures such as link ways, underground passes, open sheds, substations, lift upgrading and the like, only the base requirements will apply.</i></p>
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Part 1 – Energy Efficiency																	
<p>NRB 1-2</p>	<p>Air Conditioning System (a) Water-Cooled Chilled-Water Plant :</p> <ul style="list-style-type: none"> • Water-Cooled Chiller • Chilled-Water Pump • Condenser Water Pump • Cooling Tower <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2" style="text-align: left;">Baseline</th> <th colspan="2" style="text-align: center;">Peak Building Cooling Load</th> </tr> <tr> <th style="text-align: center;">≥ 500 RT</th> <th style="text-align: center;">< 500 RT</th> </tr> </thead> <tbody> <tr> <td style="text-align: left;">Prerequisite Requirements</td> <td style="text-align: center;">0.70 kW/RT</td> <td style="text-align: center;">0.80 kW/RT</td> </tr> <tr> <td style="text-align: left;">Minimum Design System Efficiency (DSE) for central chilled-water plant</td> <td style="text-align: center;">0.70 kW/RT</td> <td style="text-align: center;">0.80 kW/RT</td> </tr> </tbody> </table>	Baseline	Peak Building Cooling Load		≥ 500 RT	< 500 RT	Prerequisite Requirements	0.70 kW/RT	0.80 kW/RT	Minimum Design System Efficiency (DSE) for central chilled-water plant	0.70 kW/RT	0.80 kW/RT					
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<p>NRB 01</p>	<p>Air-Conditioning System Efficiency and Controls (a) Water-Cooled Chilled-Water Plant :</p> <p>Provision of air-conditioning system that meet the following energy performance standard.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="3" style="text-align: center;">Water-Cooled Chilled-Water Plant for New Buildings</th> </tr> </thead> <tbody> <tr> <td style="text-align: left;">Minimum Design System Efficiency (DSE)</td> <td colspan="2" style="text-align: center;">0.67 kW/RT</td> </tr> </tbody> </table> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="3" style="text-align: center;">Water-Cooled Chilled-Water Plant for Existing Buildings with New Extension or Major Retrofitting</th> </tr> </thead> <tbody> <tr> <td rowspan="3" style="text-align: left;">Minimum Design System Efficiency (DSE)</td> <th colspan="2" style="text-align: center;">Peak Building Cooling Load</th> </tr> <tr> <th style="text-align: center;">≥ 500RT</th> <th style="text-align: center;">< 500 RT</th> </tr> <tr> <td style="text-align: center;">0.70 kW/RT</td> <td style="text-align: center;">0.80 kW/RT</td> </tr> </tbody> </table>	Water-Cooled Chilled-Water Plant for New Buildings			Minimum Design System Efficiency (DSE)	0.67 kW/RT		Water-Cooled Chilled-Water Plant for Existing Buildings with New Extension or Major Retrofitting			Minimum Design System Efficiency (DSE)	Peak Building Cooling Load		≥ 500RT	< 500 RT	0.70 kW/RT	0.80 kW/RT
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<p>NRB 1-2 (d)</p>	<p>Measurement and Instrumentation Requirements for water cooled chilled water air conditioning system</p> <p>(d) <i>Prerequisite Requirements</i> : 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.</p> <p>The following instrumentation and installation are also required to be complied with :</p> <ul style="list-style-type: none"> (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 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. 	<p>NRB07</p>	<p>Measurement and Instrumentation Requirements applicable for chilled water air conditioning system</p> <p>The instrumentation must have the capability to calculate the resultant efficiency within 5% of its true value in accordance with SS 591: 2013. Each measurement system shall include sensors, any signal conditioning, data acquisition system and the wiring connecting these components.</p> <p>The measuring instruments and devices are to be located within reach to facilitate verification and maintenance. They must be installed in accordance with the manufacturers’ recommendation and SS 591: 2013. The measurement systems provided shall also comply with the following requirement:</p> <ul style="list-style-type: none"> • All data logging with capability to trend at 1-minute sampling time interval, and recorded to the 3rd decimal digit; • 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 overall system energy efficiency and calculated heat balance of the chilled water system; • Magnetic in-line flow meter, with 1% uncertainty and capable of electronic in-situ verification to within $\pm 2\%$ 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; • Temperature sensors are to be provided for chilled water and condenser water loop and shall have an end-to-end measurement uncertainty within ± 0.05°C over the entire measurement range. Each temperature measurement location shall have 2 spare thermo-wells located in close proximity of the temperature sensor (with minimum flow interference differential) for verification of measurement accuracy. Thermo-wells shall be installed in a manner that enables the sensors to be in direct contact with fluid flow.
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	<p>(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.</p>		<ul style="list-style-type: none">• Dedicated power meters (of IEC Class 1 or better) and metering current transformers, where applicable, of Class 1 or better, are to be provided for each of the following groups of equipment where applicable: chillers, chilled water pumps, condenser water pumps and cooling towers
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<p>RB1-5</p>	<p>Daylighting Encourage design that optimises the use of effective daylighting to reduce energy use for artificial lighting.</p> <p>(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.</p>	<p>RBE4-2</p>	<p>Daylighting Encourage design that optimise the use of effective natural lighting for better visual comfort.</p> <p>(a) Dwelling units : Daylighting provision for 25% of the total number of residential units that meets the desired lighting level of DA 200lux, 50% in 60% of applicable areas (namely bedrooms, living room, family room and study room).</p>												
<p>NRB 1-5</p>	<p>(a) Use of daylighting and glare simulation analysis to verify the adequacy of ambient lighting levels in meeting the illuminance level and Unified Glare Rating (UGR) stated in SS 531:Part 1:2006 – Code of Practice for Lighting of Work Places.</p>	<p>NRBE4-2</p>	<p>(a) 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.</p> <table border="1" data-bbox="1306 727 2016 1185"> <thead> <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> </thead> <tbody> <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> </tbody> </table>	S/N	Minimum Lighting Level Based on Space Occupancy Type	Daylight Autonomy requirement per unit area of space	1	Offices and Institutional spaces where lux requirement is 500 lux	DA _{500lx} , 50%	2	Industrial, sports facilities, retail areas where lux requirement is 300 lux	DA _{300lx} , 50%	3	Hotel, resort-like and service apartment where lux requirement is 200 lux	DA _{200lx} , 50%
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New sustainability indicators under Elective Options that are not currently in the Code 3 rd Edition	
Criteria Ref	Requirements to be incorporated in Upcoming Code for Environmental Sustainability of Buildings 4 th Edition
RBE 1-2 & NRBE 1-2	<p>Integrative Design Process</p> <p>To maximize opportunities for integrated, cost-effective adoption of green design and construction strategies which help optimize the project outcome and building performance</p> <ul style="list-style-type: none"> <li style="display: inline-block; width: 45%; vertical-align: top;">➤ Integrated approach to building design <li style="display: inline-block; width: 45%; vertical-align: top;">➤ Maintainability design considerations <li style="display: inline-block; width: 45%; vertical-align: top;">➤ Collaborative BIM <li style="display: inline-block; width: 45%; vertical-align: top;">➤ Green BIM
RBE 2-3 & NRBE 2-3	<p>Solar Feasibility Study</p> <p>Conduct of feasibility study to assess the building’s potential to incorporate solar photovoltaic systems.</p>
NRBE 2-1	<p>Air-Conditioning Total System Efficiency</p> <p>Provision of better energy efficiency air-conditioning systems that meet the overall energy performance standard which includes that of the air-conditioning systems.</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p>Air-conditioning total system efficiency = chiller plant efficiency kW/RT + air side efficiency kW/RT</p> <p>where air side efficiency includes that of fan-coil unit (FCU), air handling unit (AHU), pre-cooled air handling unit (PAHU)</p> </div>
RBE 4-3 & NRBE 4-3	<p>Biophilic Design</p> <p>Integration of biophilic elements as part of design strategies to reinforce the attributes and experience of nature to enhance user’s environment and overall wellbeing</p>