Building and Construction Authority

Code for Environmental Sustainability Of Buildings

Version 1.0

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Building and Construction Authority

Contents

CODE FOR ENVIRONMENTAL SUSTAINABILITY OF BUILDINGS

ANNEX

INTRODUCTION

The intent of this Code for Environmental Sustainability of Buildings (referred to as “this Code”) is to establish environmentally friendly practices for the planning, design and construction of buildings, which would help to mitigate the environmental impact of built structures.

This Code sets out the minimum environmental sustainability standard for buildings and the administrative requirements. It has largely adopted the BCA Green Mark’s criteria as the compliance method in assessing the environmental performance of a building development.

This Code is not intended to abridge safety, health, environmental or related requirements contained in other applicable laws, codes or policies administered by relevant authorities. Where there is a conflict between a requirement of this Code and such other laws affecting the design and construction of the building, precedence shall be determined by the relevant authorities.

If you need clarification on any aspect of this Code, please contact the Building and Construction Authority, Singapore.

1 SCOPE

This Code sets out the minimum environmental sustainability standard for buildings and the administrative requirements. It includes the compliance method for determining the level of environmental performance of a building development.

The provisions of this Code shall apply to :

a. All new building works which involve a gross floor area of 2,000 m^2 or more;

b. Additions or extensions to existing buildings which involve increasing the gross floor area of the existing buildings by 2,000 m^2 or more;

c. Building works which involve major retrofitting to existing buildings with gross floor area of 2,000 m^2 or more.

The referenced codes, standards and other documents referred in this Code shall be considered part of the requirements of this Code to the extent as prescribed.

2 DEFINITIONS

For the purpose of this Code, the following definitions shall apply:

Dwelling unit	A unit within residential development that provides complete, independent living facilities for one or more person.
Green Mark Score	The score for environmental performance of buildings computed in accordance with the criteria and the scoring methodology set out in this code.
Gross Floor Area	The gross floor area is calculated using the definition by the Urban Redevelopment Authority (URA).
Major Retrofitting	The provision, extension or substantial alteration of the building envelope and building services in or in connection with an existing building.
Minimum Green Mark Score	The lowest Green Mark score that would meet the minimum environmental performance required for buildings.

In instances where terms are not expressly stated in this Code and are defined in other referenced documents, such terms shall have the meanings as determined in those documents.

3 STATUTORY REQUIREMENTS

3.1 Act and Regulations

The following Act and Regulations have relevance:

a. The Building Control Act

b. The Building Control Regulations

c. The Building Control (Environmental Sustainability) Regulations

3.2 Referenced Codes and Standards

The following codes and standards have relevance:

a. Code on Envelope Thermal Performance for Buildings

b. SS 530 - Code of Practice for Energy Efficiency Standard for Building Services and Equipment

c. SS CP 13 - Code of Practice for Mechanical Ventilation and Air-Conditioning in Buildings

d. SS CP 38 - Code of Practice for Artificial Lighting in Buildings

e. SS 531-1 - Code of Practice for Lighting of Work Places - Indoor

3.3 Responsibility

The developer or building owner shall engage the appropriate practitioners which include the qualified person (QP) to ensure that the building works are designed with physical features or amenities, and may be carried out using methods and materials to meet the minimum environmental sustainability standard stipulated in Building Control (Environmental Sustainability) Regulations.

The QP who submits the building plan shall be overall responsible for ensuring that the minimum environmental sustainability standard is met. The QP together with the other appropriate practitioners (i.e. PE (Mechanical) and PE (Electrical)) shall be responsible for assessing and scoring the building works under their charge. The areas of responsibility are as prescribed in Annex A of this Code.

3.4 Minimum Environmental Sustainability Standard

3.4.1 The minimum environmental sustainability standard of building works shall have a level of environmental performance that meets the minimum Green Mark score.

3.4.2 The minimum Green Mark score for building works related to a residential building is 50 points. Similarly, the minimum Green Mark score for building works related to a non-residential building is also 50 points.

3.4.3 For mixed-use buildings consisting of residential and non-residential buildings, the Green Mark score will be based on the compliance with both residential and non-residential building criteria. The Green Mark scores for the respective building categories should meet at least 50 points. For smaller projects where the GFA of either building category is less than 2000 m^2, the computation of the Green Mark score can be based solely on the appropriate assessment criteria for the one with larger applicable GFA as summarised in Table 3.4.3.

Table 3.4.3 : Applicable Criteria for Mixed-Use Building with GFA ≥ 2000 m^2

Project Type	Total New GFA Residential (m^2)	Total New GFA Non-Residential (m^2)	GM Score Residential Applicable	GM Score Non-Residential Applicable
Mixed-Use Building	≥ 2000	≥ 2000	Yes	Yes
	≥ 2000	< 2000	Yes	No
	< 2000	≥ 2000	No	Yes
	< 2000	< GFA for Residential	Yes	No
	< GFA for Non-Residential	< 2000	No	Yes

3.4.4 The building works shall also meet all the relevant mandatory requirements regulated under Part IV of the Building Control Regulations 2003 (refer to Annex B for details).

4 COMPLIANCE METHOD

4.1 Environmental Sustainability Standard

4.1.1 The environmental sustainability standard of building development shall be determined by the level of environmental performance and the numerical scores (i.e Green Mark points) achieved in accordance with the degree of compliance with the applicable criteria using the scoring methodology as specified in this Code. There are basically two sets of criteria namely the Residential Building Criteria and Non-Residential Building Criteria. The framework and point allocations for the respective assessment criteria are as illustrated in Table 4.1.1(a) and (b).

4.1.2 The criteria consist of five(5) environmental impact categories namely :

(a) *Part 1 – Energy Efficiency :* This category focuses on the approach that can be used in the building design and system selection to optimise the energy efficiency of buildings.

(b) *Part 2 – Water Efficiency :* This category focuses on the selection of water use efficiency during construction and building operations.

(c) *Part 3 – Environmental Protection :* This category focuses on the design, practices and selection of materials and resources that would reduce the environmental impacts of built structures.

(d) *Part 4 – Indoor Environmental Quality* : This category focuses on the design strategies that would enhance the indoor environmental quality which includes air quality, thermal comfort, acoustic control and daylighting.

(e) *Part 5 – Other Green Features* : This category focuses on the adoption of green practices and new technologies that are innovative and have potential environmental benefits.

4.1.3 These environmental impact categories are broadly classified under two main groupings namely (I) Energy Related Requirements and (II) Other Green Requirements.

Table 4.1.1(a) : Framework and Point Allocations for Residential Building Criteria

Category			Point Allocations
(I)	**Energy Related Requirements**		
Maximum Cap of 50 points	Minimum 30 points	**Part 1 : Energy Efficiency**	
		RB 1-1 Building Envelope – RETV	15
		RB 1-2 Dwelling Unit Indoor Comfort	16
		RB 1-3 Natural Ventilation in Common Areas	2
		RB 1-4 Lighting	15
		RB 1-5 Ventilation in Carparks	8
		RB 1-6 Lifts	2
		RB 1-7 Energy Efficient Features	7
		Category Score for Part 1 – Energy Efficiency (Exclude Bonus Points)	**65**
Bonus 20 points		RB 1-8 Renewable Energy (Bonus Points)	20
(II)	**Other Green Requirements**		
Maximum Cap of 50 points	Minimum 20 points	**Part 2 : Water Efficiency**	
		RB 2-1 Water Efficient Fittings	10
		RB 2-2 Water Usage	1
		RB 2-3 Irrigation System	2
		Category Score for Part 2 – Water Efficiency	**13**
		Part 3 : Environmental Protection	
		RB 3-1 Sustainable Construction	12
		RB 3-2 Greenery	6
		RB 3-3 Environmental Management Practice	9
		RB 3-4 Public Transport Accessibility	2
		Category Score for Part 3 – Environmental Protection	**29**
		Part 4 : Indoor Environmental Quality	
		RB 4-1 Noise Level	1
		RB 4-2 Indoor Air Pollutants	3
		RB 4-3 Waste Disposal	1
		RB 4-4 Indoor Air Quality in Wet Areas	1
		Category Score for Part 4 – Indoor Environmental Quality	**6**
		Part 5 : Other Green Features	
		RB 5-1 Green Features & Innovations	7
		Category Score for Part 5 – Other Green Features	**7**
		Total Points Allocated :	**120**
		Total Point Allocated (Include BONUS points):	**140**
		Green Mark Score (Max) :	**100 + Bonus 20 points**

4.1.4 Energy Related Requirements consist of Part 1- Energy Efficiency where points are allocated for the various energy efficient designs, practices and features used. A minimum of 30 points must be obtained from this group to meet the minimum environmental sustainability standard. The number of points achievable for this group is capped at 50 points (exclude 20 bonus points that are obtainable under RB 1-8 and NRB 1-10 - Renewable Energy).

4.1.5 Other Green Requirements consist of Part 2 – Water Efficiency, Part 3 – Environmental Protection, Part 4 – Indoor Environmental Quality and Part 5 – Other Green Features. Points are allocated for the water efficient features, environmentally friendly design practices and innovative green features used. A minimum of 20 points must be obtained from this grouping to comply with the

minimum environmental sustainability standard. The number of points achievable for this group is also capped at 50 points.

Table 4.1.1(b) : Framework and Point Allocations for Non-Residential Building Criteria

		Category		Point Allocations
(I)	**Energy Related Requirements**			
Maximum Cap of 50 points	Minimum 30 points	**Part 1 : Energy Efficiency**		
		NRB 1-1 Building Envelope – ETTV NRB 1-2 Air-Conditioning System	Section (A) Applicable to air-con areas	15 27
		Sub-Total (A) - NRB 1-1 to 1-2		42
		NRB 1-3 Building Envelope – Design/Thermal Parameters NRB 1-4 Natural Ventilation (exclude carparks)	Section (B) Applicable to non air-con areas	29 13
		Sub-Total (B) - NRB 1-3 to 1-4		42
		NRB 1-5 Artificial Lighting NRB 1-6 Ventilation in Carparks NRB 1-7 Ventilation in Common Areas NRB 1-8 Lifts and Escalators NRB 1-9 Energy Efficient Practices & Features	Section (C) Generally applicable to all areas	12 5 5 3 12
		Sub-Total (C) - NRB 1-5 to 1-9		37
		Category Score for Part 1 – Energy Efficiency (Exclude Bonus Points) Prorate Subtotal (A) + Prorate Subtotal (B) + Subtotal (C)		**79**
Bonus 20 points		NRB 1-10 Renewable Energy *(Bonus Points)*		20
(III)	**Other Green Requirements**			
Maximum Cap of 50 points	Minimum 20 points	**Part 2 : Water Efficiency**		
		NRB 2-1 Water Efficient Fittings		8
		NRB 2-2 Water Usage and Leak Detection		2
		NRB 2-3 Irrigation System		2
		NRB 2-4 Water Consumption of Cooling Tower		2
		Category Score for Part 2 – Water Efficiency		**14**
		Part 3 : Environmental Protection		
		NRB 3-1 Sustainable Construction		14
		NRB 3-2 Greenery		6
		NRB 3-3 Environmental Management Practice		8
		NRB 3-4 Public Transport Accessibility		2
		NRB 3-5 Refrigerants		2
		Category Score for Part 3 – Environmental Protection		**32**
		Part 4 : Indoor Environmental Quality		
		NRB 4-1 Thermal Comfort		2
		NRB 4-2 Noise Level		2
		NRB 4-3 Indoor Air Pollutants		2
		NRB 4-4 High Frequency Ballasts		2
		Category Score for Part 4 – Indoor Environmental Quality		**8**
		Part 5 : Other Green Features		
		NRB 5-1 Green Features & Innovations		7
		Category Score for Part 5 – Other Green Features		**7**
			Total Points Allocated :	**140**
			Total Point Allocated (Include BONUS points):	**160**
			Green Mark Score (Max) :	**100 + Bonus 20 points**

4.1.6 The maximum Green Mark score achievable for a project is capped at 100 points and this does not include 20 bonus points that are obtainable under Energy Related Requirements if a project uses renewable energy sources.

4.1.7 The Green Mark score of the building design is the total of all the numerical scores (i.e. Green Mark points) assigned based on the degree of compliance with the applicable criteria listed in Table 4.1.7(a) and (b) and the scoring methodology stated in Annex C and D.

4.1.8 Under the non-residential building criteria, the environmental impact category Part 1 – Energy Efficiency applies to both air-conditioned and non air-conditioned spaces. Where there is a combination of air-conditioned and non air-conditioned spaces, the points allocated are to be prorated in accordance with the respective floor areas. For simplicity, points applicable to air-conditioned areas are accounted only if the aggregate air-conditioned areas exceed 500 m^2. Similarly, points applicable to non air-conditioned areas are accounted only if the aggregate non air-conditioned areas are more than 10% of the total floor areas excluding carparks.

Table 4.1.7(a) : Residential Building Criteria

Part 1 - Energy Efficiency	Green Mark Points
RB 1-1 Building Envelope – RETV Enhance the overall thermal performance of building envelope to minimise heat gain thus reducing the overall cooling load when required. Baseline : Maximum Permissible RETV = 25 W/m^2	3 points for every reduction of 1 W/m^2 in RETV from the baseline Points scored = 75 – [3 x (RETV)] where RETV ≤ 25 W/m^2 (Up to 15 points)
RB 1-2 Dwelling Unit Indoor Comfort Enhance dwelling unit indoor comfort either through the provision of better efficient air-conditioners or good natural ventilation design. (a)(i) Use of energy efficient air-conditioners that are certified under the Singapore Energy Labelling Scheme. OR (a)(ii) Design for natural ventilation (applicable to development where air-conditioners are not provided). • Building layout design : Proper design of building layout that utilises prevailing wind conditions to achieve adequate cross ventilation. • Dwelling unit design : Good ventilation in indoor units through sufficient openings. (b) Use of ventilation simulation software to identify the most effective building design and layout to achieve good natural ventilation.	Extent of Coverage : At least 90% of the air-conditioners used in all dwelling units Air-conditioners labelled with : Two Ticks – 2 points Three Ticks – 6 points Four Ticks – 12 points OR 0.6 point for every 10% of units with window openings facing north and south directions Points scored = 0.6 x (% of units/10) (Up to 6 points) 0.6 point for every 10 % of living rooms and bedrooms designed with true cross ventilation Points scored = 0.6 x (% rooms /10) (Up to 6 points) Points can only be scored if the recommendations from ventilation simulations are implemented 4 points
RB 1-3 Natural Ventilation in Common Areas Design for natural ventilation in following common areas : (a) Lift lobbies and corridors (b) Staircases	Extent of Coverage : All applicable areas 1 point 1 point

Part 1 - Energy Efficiency	Green Mark Points
RB 1-4 Lighting Encourage the use of better efficient lighting and daylighting in common areas to minimise energy consumption from lighting usage while maintaining proper lighting level. (a) Artificial lighting in common areas. Baseline = Maximum lighting power budget stated in SS 530 (b) Daylighting in the following areas : (i) Lift lobbies and corridors (ii) Staircases (iii) Carparks	0.3 point for every percentage improvement in the lighting power budget Points scored = 0.3 x (% improvement) (Up to 12 points) 1 point 1 point 1 point
RB 1-5 Ventilation in Carparks Encourage the use of energy efficient design and control of ventilation systems in carparks. (a) Carparks designed with natural ventilation. (b) CO sensors are used to regulate the demand for mechanical ventilation (MV). Note (1) : Where there is a combination of different ventilation modes adopted for carpark design, the points obtained will be prorated accordingly.	Naturally ventilated carparks - 8 points Points scored based on the mode of mechanical ventilation provided Fume extract – 6 points MV with or without supply - 4 points
RB 1-6 Lifts Encourage the use of lifts with the following energy efficient features : (a) AC variable voltage and variable frequency (VVVF) motor drive or equivalent. (b) Sleep mode features or equivalent.	Extent of Coverage : All lifts 1 point 1 point
RB 1-7 Energy Efficient Features Encourage the use of energy efficient features which are innovative and have positive environmental impact. Examples : ▪ Heat recovery devices ▪ Cool paints ▪ Motion sensors at staircase half landing ▪ Heat elevators ▪ Gas heaters ▪ Sun pipes ▪ etc	2 points for high impact item 1 point for medium impact item 0.5 point for low impact item (Up to 7 points)
Sub-Total (A) :	Sum of Green Mark Points obtained from RB 1-1 to 1-7

Part 1 - Energy Efficiency	Green Mark Points
RB 1-8 Renewable Energy Encourage the application of renewable energy sources in buildings. (a) Solar energy (b) Other renewable energy	***(Bonus points)*** 1 point for every 3 kWp of solar energy 1 point for every 1% replacement of electricity (exclude household's usage) by renewable energy (Up to 20 points)
PART 1 – ENERGY EFFICIENCY CATEGORY SCORE :	Sub-total (A) + Bonus points (RB 1-8) where Sub-Total (A) = Sum of Green Mark Points obtained from RB 1-1 to 1-7

<table>
<tr><th>Part 2 – Water Efficiency</th><th colspan="4">Green Mark Points</th></tr>
<tr><td rowspan="3"><u>RB 2-1 Water Efficient Fittings</u>

Encourage the use of water efficient fittings that are certified under the Water Efficiency Labelling Scheme (WELS).

(a) Basin taps and mixers
(b) Flushing cisterns
(c) Showerheads, taps and mixers
(d) Sink/Bib taps and mixers
(e) All other water fittings</td><td colspan="3">Rating based on Water Efficiency Labelling Scheme (WELS)</td><td rowspan="3">Extent of coverage :

At least 90% of the fitting type used

(Up to 10 points)</td></tr>
<tr><td>Good</td><td>V Good</td><td>Excellent</td></tr>
<tr><td>0.5 point</td><td>1 point</td><td>2 points</td></tr>
<tr><td><u>RB 2-2 Water Usage</u>

Provision of sub-meters to monitor the major water usage such as irrigation, swimming pools and other water features.</td><td colspan="4">1 point</td></tr>
<tr><td><u>RB 2-3 Irrigation System</u>

Provision of suitable systems that utilise rainwater or recycled water for landscape irrigation to reduce potable water consumption.

(a) Use of non potable water including rainwater for landscape irrigation.

(b) Use of water efficient irrigation system.</td><td colspan="4">1 point

Extent of Coverage : At least 50% of the landscape areas are served by the system

1 point</td></tr>
<tr><td>PART 2 – WATER EFFICIENCY CATEGORY SCORE :</td><td colspan="4">Sum of Green Mark Points obtained from RB 2-1 to 2-3</td></tr>
</table>

Part 3 – Environmental Protection	Green Mark Points
RB 3-1 Sustainable Construction Encourage the adoption of building designs, construction practices and materials that are environmentally friendly and sustainable.	
(a) More efficient concrete usage for building components.	0.1 point for every percentage reduction in the prescribed Concrete Usage Index (CUI) limit for residential buildings *(refer to page 60 for CUI limit)* (Up to 4 points)
(b) Conservation of existing building structure. Applicable to existing structural elements or building envelope.	Extent of Coverage : Conserve at least 50 % of the existing structural elements or building envelope (by area) 2 points
(c) Use of sustainable materials and products in building construction such as :	
(i) Environmental friendly products that are certified under the Singapore Green Labelling Scheme (SGLS).	1 point for high impact item 0.5 point for low impact item (Cap at 3 points)
(ii) Products with at least 30% recycled content by weight or volume (applicable only to non-structural elements). Note (2) : For products that are certified under SGLS and with at least 30% recycled contents, points can only be scored either from RB 3-1(c)(i) or (c)(ii).	1 point for high impact item 0.5 point for low impact item (Cap at 3 points) (Up to 6 points)
RB 3-2 Greenery Encourage greater use of greenery, restoration of trees to reduce heat island effect.	
(a) Greenery Provision (GnP) is calculated by considering the 3D volume covered by plants using the following Green Area Index (GAI) : Grass GAI = 1 ; Shrubs GAI = 3; Palms Trees GAI = 4; Trees GAI = 6	GnP = 2.0 to < 3.0 – 1 point GnP = 3.0 to < 3.5 – 2 points GnP = 3.5 to < 4.0 – 3 points GnP ≥ 4.0 – 4 points
(b) Restoration of trees on site, conserving or relocating of existing trees on site.	1 point
(c) Use of compost recycled from horticulture waste.	1 point

Part 3 – Environmental Protection	Green Mark Points
RB 3-3 Environmental Management Practice Encourage the adoption of environmental friendly practices during construction and building operation.	
(a) Implement effective environmental management programmes including monitoring and setting of targets to minimise energy use, water use and construction waste.	1 point
(b) Building quality assessed under the Construction Quality Assessment System (CONQUAS) and Quality Mark Scheme.	1 point each (Up to 2 points)
(c) Developer, main builder, M & E consultant and architect that are ISO 14000 certified.	0.25 point for each firm (Up to 1 point)
(d) Project team comprises one Certified Green Mark Manager (GMM) and/or one Certified Green Mark Professional (GMP).	1 point for GMM / 2 points for GMP (Up to 3 points)
(e) Provision of building users' guide including details of the environmental friendly facilities and features within the building and their uses in achieving the intended environmental performance during building operation.	1 point
(f) Provision of facilities or recycling bins for collection and storage of different recyclable waste such as paper, glass, plastic etc.	1 point
RB 3-4 Public Transport Accessibility Promote the use of public transport or bicycles to reduce pollution from individual car use with the following provision :	
(a) Good access to nearest MRT/LRT stations or bus stops.	1 point
(b) Adequate bicycle parking lots.	1 point
PART 3 – ENVIRONMENTAL PROTECTION CATEGORY SCORE :	Sum of Green Mark Points obtained from RB 3-1 to 3-4

Part 4 – Indoor Environmental Quality	Green Mark Points
RB 4-1 Noise Level Building design to achieve ambient internal noise level as specified : 55 dB (6am-10pm) LeqA 45 dB (10pm-6 am) LeqA	1 point
RB 4-2 Indoor Air Pollutants Minimise airborne contaminants, mainly from inside sources to promote a healthy indoor environment. (a) Use of low volatile organic compounds (VOC) paints certified under the Singapore Green Labelling Scheme (SGLS). (b) Use of adhesives certified under the Singapore Green Labelling Scheme (SGLS) for composite wood products.	Extent of Coverage : At least 90% of the total internal wall areas 2 points 1 point
RB 4-3 Waste Disposal Minimise airborne contaminants from waste by locating refuse chutes at open ventilation areas such as service balconies or common corridors.	1 point
RB 4-4 Indoor Air Quality in Wet Areas Provision of adequate natural ventilation and daylighting in wet areas such as kitchens, bathrooms and toilets.	Extent of Coverage : At least 90% of all applicable areas 1 point
PART 4 – INDOOR ENVIRONMENTAL QUALITY CATEGORY SCORE :	Sum of Green Mark Points obtained from RB 4-1 to 4-4

Part 5 – Other Green Features	Green Mark Points
RB 5-1 Green Features and Innovations Encourage the use of other green features which are innovative and have positive environmental impact. Examples : ▪ Pneumatic waste collection system ▪ Dual chute system ▪ Self cleaning façade system ▪ Infiltration trenches ▪ Integrated storm water retention/treatment into landscaping ▪ etc	2 points for high impact item 1 point for medium impact item 0.5 point for low impact item (Up to 7 points)
PART 5 – OTHER GREEN FEATURES CATEGORY SCORE :	Sum of Green Mark Points obtained from RB 5-1

Green Mark Score (Residential)

Green Mark Score (Res) = ∑Category Score [(Part 1 – Energy Efficiency) +
(Part 2 – Water Efficiency) +
(Part 3 – Environmental Protection) +
(Part 4 – Indoor Environmental Quality) +
(Part 5 – Other Green Features)]

where Category Score for Part 1 ≥ 30 points and
∑Category Score for Part 2, 3, 4 & 5 ≥ 20 points

Table 5.1.7(b) : Non-Residential Building Criteria

Part 1 – Energy Efficiency	Green Mark Points
(A) Applicable to Air-Conditioned Building Areas (with an aggregate air-conditioned areas > 500 m^2)	
NRB 1-1 Building Envelope – ETTV Enhance the overall thermal performance of building envelope to minimise heat gain thus reducing the overall cooling load requirement. Baseline : Maximum Permissible ETTV = 50 W/m^2	2 points for every reduction of 1 W/m^2 in ETTV from the baseline Points scored = 100 – [2 x (ETTV)] where ETTV ≤ 50 W/m^2 (Up to 15 points)
NRB 1-2 Air-Conditioning System Encourage the use of better efficient air-conditioned equipment to minimise energy consumption. Baseline : Minimum efficiency requirement of the air-conditioning system stated in SS 530 & SS CP 13. The systems to be considered are as follows - (a)(i) Air-Conditioned Plant : • Chiller • Chilled-water pump • Condenser water pump • Cooling tower (a)(ii) Air Distribution System : • Air Handling Units (AHUs) • Fan Coil Units (FCUs) Note (1) : For buildings using district cooling system, there is no need to compute the plant efficiency under NRB 1-2 (a)(i). The points obtained will be pro-rated based on the air distribution system efficiency under NRB 1-2(a)(ii). OR (b) Unitary Air-Conditioners/Condensing Units : • Single-Spilt Unit • Multi-Spilt Unit • Variable Refrigerant Volume (VRV) System Note (2) : Where there is a combination of centralised air-con system with unitary air-conditioned system, the computation for the points scored will only be based on the air-conditioning system with a larger aggregate capacity. (c) Sensors or similar automatic control devices are used to regulate outdoor air flow rate to maintain the concentration of carbon dioxide below 1000ppm	(a)(i) Air-Conditioned Plant 1.45 points for every percentage improvement in the efficiency of chiller, chilled-water pump and condenser water pump. Points scored = 1.45 x (% improvement) 0.05 point for every percentage improvement in the performance required for cooling tower. Points scored = 0.05 x (% improvement) (Up to 20 points) (a)(ii) Air Distribution System 0.5 points for every percentage improvement in the air distribution system efficiency. Points scored = 0.5 x (% improvement) (Up to 5 points) OR (b) Unitary Air-Conditioners/Condensing Units 1.5 points for every percentage (average) improvement in the efficiency of all unitary air-conditioners/ condensing units. Points scored = 1.5 x (% improvement) (Up to 25 points) 2 points
Sub-Total (A) :	Sum of Green Mark Points obtained from NRB 1-1 to 1-2

Part 1 – Energy Efficiency	Green Mark Points
(B) Applicable to Non Air-Conditioned Building Areas (with an aggregate non air-conditioned areas > 10 % of total floor area excluding carparks)	
NRB 1-3 Building Envelope – Design / Thermal Parameters Enhance the overall thermal performance of building envelope to minimise heat gain which would improve indoor thermal comfort and encourage natural ventilation.	
(a) Minimum direct west facing façade through building design orientation. Note (3) : Orientation of façade that falls within the range of 22.5° N of W and 22.5° S of W will be defined as west facing facade. Core walls for lifts or staircases and toilets that are located within this range are exempted in computation.	Points scored = 10 – [0.2 x (% of west facing facade areas over total façade areas)] (Up to 10 points) Where there is no west facing façade, the total points scored for this item will be 24 points; the NRB 1-3 b(i), b(ii) and (c) as listed below will not be applicable.
(b)(i) Minimum west facing window openings.	Points scored = 10 – [0.1 x (% of west facing window areas over total west facing façade areas)]
(b)(ii) Effective sunshading provision for windows on the west façade with minimum shading of 30%.	Points scored = 0.1 x (% of west facing window areas with sunshading devices over total west facing façade areas) (Up to 10 points for NRB 1-3b(i) & b(ii))
(c) Better thermal transmittance (U-value) of external west facing walls. The U-value of external west facing walls should be equal or less than 2 W/m^2K.	Points scored = 0.04 x (% of the external west facing walls areas with U value of 2 W/m^2K or less over total west facing facades areas) (Up to 4 points)
(d) Better thermal transmittance (U-value) of roof. Baseline: U-value for roof stated below depending on the weight range of roof structure: Weight Group / Weight range (kg/m^2) / Maximum Thermal Transmittance (W/m^2K) Light / Under 50 / 0.8 Medium / 50 to 230 / 1.1 Heavy / Over 230 / 1.5	2 points for every 0.1 W/m^2K reduction (Up to 5 points)

Part 1 – Energy Efficiency	Green Mark Points
(B) Applicable to Non Air-Conditioned Building Areas (with an aggregate non air-conditioned areas > 10 % of total floor area excluding carparks)	
NRB 1-4 Natural Ventilation (exclude carparks) Enhance building design to achieve good natural ventilation. (a) Proper design of building layout that utilizes prevailing wind conditions to achieve adequate cross ventilation.	0.8 point for every 10% of units/rooms with window openings facing north and south directions Points scored = 0.8 x (% of units/10) (Up to 8 points)
(b) Use of ventilation simulation software or wind tunnel testing to identify the most effective building design and layout to achieve good natural ventilation.	Points can only be scored if the recommendations from ventilation simulations are implemented (5 points)
Exception : For existing buildings, NRB 1-3(a) may be excluded in computation, the total Green Mark Points for Sub-Total (B) under Part 1 will be prorated accordingly.	
Sub-Total (B) :	Sum of Green Mark Points obtained from NRB 1-3 to 1-4

Part 1 - Energy Efficiency	Green Mark Points
(C) General	
NRB 1-5 Artificial Lighting Encourage the use of better efficient lighting to minimise energy consumption from lighting usage while maintaining proper lighting level. Baseline = Maximum lighting power budget stated in SS 530	0.5 point for every percentage improvement in lighting power budget Points scored = 0.5 x (% improvement) (Including tenant lighting provision) (Up to 12 points) (Excluding tenant lighting provision) (Up to 5 points)
NRB 1-6 Ventilation in Carparks Encourage the use of energy efficient design and control of ventilation systems in carparks. (a) Carparks designed with natural ventilation. (b) CO sensors are used to regulate the demand for mechanical ventilation (MV). Note (4) : Where there is a combination of different ventilation modes adopted for carpark design, the points obtained will be prorated accordingly.	Naturally ventilated carparks – 5 points Points scored based on the mode of mechanical ventilation provided Fume extract – 4 points MV with or without supply - 3 points (Up to 5 points)

Part 1 – Energy Efficiency	Green Mark Points
(C) General	
NRB 1-7 Ventilation in Common Areas Encourage the use of energy efficient design and control of ventilation systems in the following common areas : (a) Toilets (b) Staircases (c) Corridors (d) Lift lobbies (e) Atriums	Extent of Coverage : At least 90 % of each applicable area Points scored based on the mode of ventilation provided in the applicable areas Natural ventilation – 1.5 points for each area Mechanical ventilation – 0.5 point for each area (Up to 5 points)
NRB 1-8 Lifts and Escalators Encourage the use of efficient lifts and escalators. (a) Lifts with the following energy efficient features : (i) AC variable voltage and variable frequency (VVVF) motor drive or equivalent. (ii) Sleep mode features or equivalent. (b) Escalators with energy efficient features such as motion sensors.	Extent of Coverage : All lifts and/or escalators 1 point 1 point 1 point
NRB 1-9 Energy Efficient Practices & Features Encourage the use of energy efficient practices and features which are innovative and have positive environmental impact. (a) Computation of energy consumption based on design load in the form of energy efficiency index (EEI). (b) Use of energy efficient features : Examples: ▪ Heat recovery system ▪ Motion sensors for staircase half landing ▪ Ductless fan for basement ventilation ▪ Sun pipes ▪ etc	1 point 3 points for every 1% energy saving over the total building energy consumption (Up to 11 points)
Sub-Total (C) :	Sum of Green Mark Points obtained from NRB 1-5 to 1-9

Part 1 – Energy Efficiency	Green Mark Points
(C) General	
NRB 1-10 Renewable Energy Encourage the application of renewable energy sources in buildings.	***(Bonus Points)*** 5 points for every 1% replacement of electricity (based on the total electricity consumption including tenant's usage) by renewable energy OR 3 points for every 1% replacement of electricity (based on the total electricity consumption excluding tenant's usage) by renewable energy (Up to 20 points)
PART 1 – ENERGY EFFICIENCY CATEGORY SCORE :	Sub-Total (A) X Air-Conditioned Building Floor Area / Total Floor Area + Sub-Total (B) X Non Air-Conditioned Building Floor Area / Total Floor Area + Sub-Total (C) + Bonus points (NRB 1-10) where Sub-Total (A) = Sum of Green Mark Points obtained under Section (A) that is NRB 1-1 to 1-2 Sub-Total (B) = Sum of Green Mark Points obtained under Section (B) that is NRB 1-3 to 1-4 Sub-Total (C) = Sum of Green Mark Points obtained under Section (C) that is NRB 1-5 to 1-9 If either Section (A) or Section (B) is not applicable, no prorating of areas is required for the score computation.

<table>
<tr><th>Part 2 – Water Efficiency</th><th colspan="4">Green Mark Points</th></tr>
<tr><td rowspan="4"><u>NRB 2-1 Water Efficient Fittings</u>
Encourage the use of water efficient fittings that are certified under the Water Efficiency Labelling Scheme (WELS).</td><td colspan="3">Rating based on Water Efficiency Labelling Scheme (WELS)</td><td rowspan="4">Points scored based on the number and water efficiency rating of the fitting type used

(Up to 8 points)</td></tr>
<tr><td>Good</td><td>V Good</td><td>Excellent</td></tr>
<tr><td colspan="3">Weightage</td></tr>
<tr><td>4</td><td>6</td><td>8</td></tr>
<tr><td><u>NRB 2-2 Water Usage and Leak Detection</u>
Promote the use of sub-metering and leak detection system for better control and monitoring.

(a) Provision of sub-meters for major water uses which includes irrigation, cooling tower and tenants' usage.

(b) Linking all sub-meters to the Building Management System (BMS) for leak detection.</td><td colspan="4">1 point

1 point</td></tr>
<tr><td><u>NRB 2-3 Irrigation System</u>
Provision of suitable systems that utilise rainwater or recycled water for landscape irrigation to reduce potable water consumption.

(a) Use of non potable water including rainwater for landscape irrigation.

(b) Use of water efficient irrigation system.</td><td colspan="4">1 point

Extent of Coverage : At least 50% of the landscape areas are served by the system
1 point</td></tr>
<tr><td><u>NRB 2-4 Water Consumption of Cooling Tower</u>
Reduce potable water use for cooling purpose.

(a) Use of cooling tower water treatment system which can achieve 6 or better cycles of concentration at acceptable water quality.

(b) Use of NEWater or on-site and recycled water from approved sources.</td><td colspan="4">1 point

1 point</td></tr>
<tr><td>PART 2 – WATER EFFICIENCY CATEGORY SCORE :</td><td colspan="4">Sum of Green Mark Points obtained from NRB 2-1 to 2-4</td></tr>
</table>

Part 3 – Environmental Protection	Green Mark Points
NRB 3-1 Sustainable Construction Encourage the adoption of building designs, construction practices and materials that are environmentally friendly and sustainable.	
(a) More efficient concrete usage for building components.	0.1 point for every percentage reduction in the prescribed Concrete Usage Index (CUI) limit for non-residential buildings *(refer to page 115 for CUI limit)* (Up to 4 points)
(b) Conservation of existing building structure Applicable to existing structural elements or building envelope.	Extent of Coverage : Conserve at least 50 % of the existing structural elements or building envelope (by area) 2 points
(c) Use of sustainable materials and products in building construction such as :	
(i) Environmental friendly products that are certified under the Singapore Green Labelling Scheme (SGLS).	1 point for high impact item 0.5 point for low impact item (Cap at 4 points)
(ii) Products with at least 30% by weight or volume (applicable only to non-structural elements).	1 point for high impact item 0.5 point for low impact item (Cap at 4 points)
Note (5) : For products that are certified under SGLS and with at least 30% recycled contents, points can only be scored either from NRB 3-1(c)(i) or (c)(ii).	(Up to 8 points)
NRB 3-2 Greenery Encourage greater use of greenery, restoration of trees to reduce heat island effect.	
(a) Greenery Provision (GnP) is calculated by considering the 3D volume covered by plants using the following Green Area Index (GAI) : Grass GAI = 1 ; Shrubs GAI = 3; Palms Trees GAI = 4; Trees GAI = 6	GnP = 0.5 to < 1.0 – 1 point GnP = 1.0 to < 1.5 – 2 points GnP = 1.5 to < 3.0 – 3 points GnP ≥ 3.0 – 4 points
(b) Restoration of trees on site, conserving or relocating of existing trees on site.	1 point
(c) Use of compost recycled from horticulture waste.	1 point

Part 3 – Environmental Protection	Green Mark Points
NRB 3-3 Environmental Management Practice Encourage the adoption of environmental friendly practices during construction and building operation.	
(a) Implement effective environmental friendly programmes including monitoring and setting targets to minimise energy use, water use and construction waste.	1 point
(b) Building quality assessed under the Construction Quality Assessment System (CONQUAS).	1 point
(c) Developer, main builder, M & E consultant and architect that are ISO 14000 certified.	0.25 point for each firm (Up to 1 point)
(d) Project team comprises one Certified Green Mark Manager (GMM) and/or one Certified Green Mark Professional (GMP).	1 point for GMM / 2 points for GMP (Up to 3 points)
(e) Provision of building users' guide including details of the environmental friendly facilities and features within the building and their uses in achieving the intended environmental performance during building operation.	1 point
(f) Provision of facilities or recycling bins for collection and storage of different recyclable waste such as paper, glass, plastic etc.	1 point
NRB 3-4 Public Transport Accessibility Promote the use of public transport or bicycles to reduce pollution from individual car use with the following provision :	
(a) Good access to nearest MRT/LRT stations or bus stops.	1 point
(b) Adequate bicycle parking lots.	1 point
NRB 3-5 Refrigerants Reduce the potential damage to the ozone layer and the increase in global warming through the release of ozone depleting substances and greenhouse gases.	
(a) Refrigerants with ozone depletion potential (ODP) of zero or with global warming potential (GWP) of less than 100.	1 point
(b) Use of refrigerant leak detection system at critical areas of plant rooms containing chillers and other equipments with refrigerants.	1 point
PART 3 – ENVIRONMENTAL PROTECTION CATEGORY SCORE :	Sum of Green Mark Points obtained from NRB 3-1 to 3-5

Part 4 – Indoor Environmental Quality	Green Mark Points
NRB 4-1 Thermal Comfort Air-conditioning system is designed to allow for cooling load variations due to fluctuations in ambient air temperature to ensure consistent indoor conditions for thermal comfort. Indoor temp between 22.5 to 25.5 °C Relative Humidity < 70%	2 points
NRB 4-2 Noise Level Occupied spaces in buildings are designed with good ambient sound levels as recommended in SS CP 13.	2 points
NRB 4-3 Indoor Air Pollutants Minimise airborne contaminants, mainly from inside sources to promote a healthy indoor environment. (a) Use of low volatile organic compounds (VOC) paints certified under the Singapore Green Labelling Scheme (SGLS). (b) Use of adhesives certified under the Singapore Green Labelling Scheme (SGLS) for composite wood products.	Extent of Coverage : At least 90% of the total internal wall areas 1 point 1 point
NRB 4-4 High Frequency Ballasts *Applicable to offices, classrooms and the like* Improve workplace lighting quality by avoiding low frequency flicker associated with fluorescent lighting with the use of high frequency ballasts in the fluorescent luminaries.	Extent of Coverage : At least 90% of all applicable areas that are served by fluorescent luminaries 2 points
PART 4 – INDOOR ENVIRONMENTAL QUALITY CATEGORY SCORE :	Sum of Green Mark Points obtained from NRB 4-1 to 4-4

Part 5 – Other Green Features	Green Mark Points
NRB 5-1 Green Features and Innovations Encourage the use of other green features which are innovative and have positive environmental impact. Examples : ▪ Pneumatic waste collection system ▪ Rainwater harvesting ▪ Dual chute system ▪ Self cleaning façade system ▪ Infiltration trenches ▪ Integrated storm water retention/treatment into landscaping ▪ etc	2 points for high impact item 1 point for medium impact item 0.5 point for low impact item (Up to 7 points)
PART 5 – OTHER GREEN FEATURES CATEGORY SCORE :	Sum of Green Mark Points obtained from NRB 5-1

Green Mark Score (Non-Residential)

Green Mark Score (Non-Res) = ∑Category Score [(Part 1 – Energy Efficiency) +
(Part 2 – Water Efficiency) +
(Part 3 – Environmental Protection) +
(Part 4 – Indoor Environmental Quality) +
(Part 5 – Other Green Features)]

where Category Score for Part 1 ≥ 30 points and
∑Category Score for Part 2, 3, 4 & 5 ≥ 20 points

5 SUBMISSION PROCEDURES

5.1 General

The submission of the Green Mark score will be one of the requirements for Building Plan (BP) approval. The BP will not be approved if the submitted Green Mark score is lower than the stipulated minimum of 50 points. The Green Mark score is to be submitted by QP(BP) at the following stages:

- BP stage
- Before Temporary Occupation Permit (TOP) or Certificate of Statutory Completion (CSC) stage (if there is no TOP application).

5.2 Submission at BP Stage

The QP shall indicate in Form BPD_BP03 (Application for Approval of Building Plans) whether the submission of Green Mark score is applicable for the proposed building works. If applicable, the Green Mark score is to be submitted together with the BP submission using the prescribed forms and calculation sheets generated from the Green Mark (GM) e-Filing system. The Green Mark score for the proposed building works and the numerical scores assigned to those building works are to be declared by the QP and the other appropriate practitioners.

5.3 Submission before TOP or CSC Stage (if there is no TOP application)

5.3.1 Upon completion of the building works, the as-built Green Mark score and the numerical scores assigned to those completed building works are to be declared by the QP and the other appropriate practitioners. QP shall submit the as-built Green Mark score using the prescribed forms and calculation sheets generated from the Green Mark e-Filing system. This submission is to be made before a temporary occupation permit or in a case where no such permit is earlier applied for, a certificate of statutory completion can be granted.

5.3.2 BCA may conduct site checks during the construction stage and TOP inspection.

5.4 Documentary Evidences

5.4.1 The QP and the other appropriate practitioners shall ensure that the following documents and records are available as evidences to demonstrate compliance with the environmental sustainability standard and criteria :

- Extracts of the tender specifications and other form of documentary proof showing the pertinent details of the proposed green practices or features adopted;
- Relevant plan layouts, elevations and sectional drawings showing the applicable areas, locations or types of green features adopted;
- Summary sheets listing the detailed breakdown and the extent of implementation; and
- Calculations, worksheets or other data in the prescribed format as shown in Annex C and D.

5.4.2 Details of the documentary evidences required can be found in Annex C and D for compliance.

5.4.3 Submittal of the documentary evidences may be required and shall be made in such manner and be in such form as the Commissioner of Building Control requires upon request.

Annex A

AREAS OF RESPONSIBILITY

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

Residential Building Criteria	Responsibility
Part 1 - Energy Efficiency	
RB 1-1 Building Envelope - RETV	QP (BP)[1]
RB 1-2 Dwelling Unit Indoor Comfort	
• Use of energy efficient conditioners	PE (Mechanical)[2]
• Design for Natural Ventilation	QP (BP)
RB 1-3 Natural Ventilation in Common Areas	QP(BP)
RB 1-4 Lighting	
• Artificial Lighting in common areas	PE (Electrical)
• Daylighting	QP(BP)
RB 1-5 Ventilation in Carparks	PE (Mechanical)
RB 1-6 Lifts	PE (Electrical)
RB 1-7 Energy Efficient Features	
• Heat Recovery Devices	PE (Mechanical)
• Motion Sensors /Photo Sensors	PE (Electrical)
• Others	Appropriate Practitioners[3]
RB 1-8 Renewable Energy	PE (Electrical)
Part 2 – Water Efficiency	
RB 2-1 Water Efficient Fittings	QP(BP)
RB 2-2 Water Usage	PE (Mechanical)
RB 2-3 Irrigation System	QP(BP)
Part 3 – Environmental Protection	
RB 3-1 Sustainable Construction	Appropriate Practitioners
RB 3-2 Greenery	QP(BP)
RB 3-3 Environmental Management Practice	QP(BP)
RB 3-4 Public Transport Accessibility	QP(BP)
Part 4 – Indoor Environmental Quality	
RB 4-1 Noise Level	QP(BP)
RB 4-2 Indoor Air Pollutants	QP(BP)
RB 4-3 Waste Disposal	QP(BP)
RB 4-4 Indoor Air Quality in Wet Areas	QP(BP)
Part 5 – Other Green Features	
RB 5-1 Green Features and Innovations	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.*

[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
Part 1 - Energy Efficiency	
NRB 1-1 Building Envelope - ETTV	QP (BP)
NRB 1-2 Air-Conditioning System	PE (Mechanical)
NRB 1-3 Building Envelope – Design/ Thermal Parameters	QP (BP)
NRB 1-4 Natural Ventilation (exclude carparks)	QP (BP)
NRB 1-5 Artificial Lighting	PE (Electrical)
NRB 1-6 Ventilation in Carparks	PE (Mechanical)
NRB 1.7 Ventilation in Common Areas	PE (Mechanical)
NRB 1-8 Lift and Escalator	PE (Electrical)
NRB 1-9 Energy Efficient Practices / Features • Heat Recovery System • Auto Condenser Tube Cleaning System • Energy Efficiency Index Computation • Motion Sensors /Photo Sensors • Others	 PE (Mechanical) PE (Mechanical) PE (Electrical) PE (Electrical) Appropriate Practitioners
NRB 1-10 Renewable Energy	PE (Electrical)
Part 2 – Water Efficiency	
NRB 2-1 Water Efficient Fittings	QP (BP)
NRB 2-2 Water Usage and Leak Detection	PE (Mechanical)
NRB 2-3 Irrigation System	QP (BP)
NRB 2-4 Water Consumption of Cooling Tower	PE (Mechanical)
Part 3 – Environmental Protection	
NRB 3-1 Sustainable Construction	Appropriate Practitioners
NRB 3-2 Greenery	QP (BP)
NRB 3-3 Environmental Management Practice	QP (BP)
NRB 3-4 Public Transport Accessibility	QP (BP)
NRB 3-5 Refrigerants	PE (Mechanical)
Part 4 – Indoor Environmental Quality	
NRB 4-1 Thermal Comfort	PE (Mechanical)
NRB 4-2 Noise Level	QP (BP)
NRB 4-3 Indoor Air Pollutants	QP (BP)
NRB 4-4 High Frequency Ballast	PE (Electrical)
Part 5 – Other Green Features	
NRB 5-1 Green Features and Innovations	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.*

Annex B

MANDATORY REQUIREMENTS

Source : Part IV of Building Control Regulations 2003 and Approved Document

Table B-1 : Mandatory Requirements for Residential Buildings

M1 Building Envelope – RETV

The residential envelope thermal 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.

M2 Roof – U Value

In respect of roofs without skylight, the average thermal transmittance (U-value) for the gross area of the roof shall not exceed the limit prescribed in the following Table 2-1 for the corresponding weight group.

Table 2-1 – Maximum Thermal Transmittance for Roof of Non Air-Conditioned Building

Weight Group	Weight range (kg/m^2)	Maximum Thermal Transmittance (W/m^2K)
Light	Under 50	0.8
Medium	50 to 230	1.1
Heavy	Over 230	1.5

This requirement does not apply to building with an aggregate floor area not exceeding 500 m^2, open sided sheds, covered walkways and linkways, store rooms and utility rooms or plants and equipment rooms.

M3 Air-Conditioning System

(a) 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.

(b) Air-conditioning system shall be equipped with manual switches, timers or automatic controllers for shutting off part of the air-conditioning system to reduce energy use whenever conditions permit.

M4 Air Tightness and Leakage

All windows on the building envelope shall not exceed the air leakage rates specified in SS 212 – Specification for Aluminium Alloy Windows.

M5 Artificial Lighting

(a) The maximum lighting power budget in a building shall comply with SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment.

(b) Lighting control for artificial lighting shall be provided in accordance with SS 530.

M6 Ventilation

Ventilation shall be adequately provided in a building for its intended occupancy.

(a) Where natural ventilation is applicable, it shall be provided by means of openable windows or other openings with an aggregate area of not less than –

  (i) 5% of the floor area of the room or space required to be ventilated; and
  (ii) 15% of the floor area of the aboveground car parking area required to be ventilated.

(b) Where mechanical ventilation or air-conditioning systems are used, the ventilation rates of these systems shall comply with SS CP 13 – Code of Practice for Mechanical Ventilation and Air-Conditioning in Buildings.

M7 Electrical Sub-Metering

Provision of sub-metering to monitor energy consumption of key building services and energy usage of end users or tenants.

M8 Luminance Level

Building lighting is maintained at luminance level as stated in SS CP 38 – Code of Practice for Artificial Lighting in Buildings for various types of occupancy.

Source: Building Control Regulations /Approved Document

Table B-2 : Mandatory Requirements for Non-Residential Buildings

M1 Building Envelope – ETTV

The envelope thermal transfer value (ETTV) 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 50 W/m^2.

M2 Roof – RTTV

In respect of roofs with skylight, the roof thermal transfer value (RTTV) 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 50 W/m^2.

M3 Roof – U Value

In respect of roofs without skylight, the average thermal transmittance (U-value) for the gross area of the roof shall not exceed the limit prescribed in the following Table 3-1 and Table 3-2 for the corresponding weight group.

Table 3-1 – Maximum Thermal Transmittance for Roof of Air-Conditioned Building

Weight Group	Weight range (kg/m^2)	Maximum Thermal Transmittance (W/m^{2}K)
Light	Under 50	0.5
Medium	50 to 230	0.8
Heavy	Over 230	1.2

Table 3-2 – Maximum Thermal Transmittance for Roof of Non Air-Conditioned Building

Weight Group	Weight range (kg/m^2)	Maximum Thermal Transmittance (W/m^{2}K)
Light	Under 50	0.8
Medium	50 to 230	1.1
Heavy	Over 230	1.5

This requirement does not apply to building with an aggregate floor area not exceeding 500 m^2, open sided sheds, covered walkways and linkways, store rooms and utility rooms or plants and equipment rooms.

M4 Air-Conditioning System

(a) 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.

(b) Air-conditioning system shall be equipped with manual switches, timers or automatic controllers for shutting off part of the air-conditioning system to reduce energy use whenever conditions permit.

(c) In any hotel building, control devices shall be installed in every guestroom such that the power to the air-conditioning required in a guestroom would automatically be turned off when the occupant is not in the room.

M5 Air Tightness and Leakage

(a) All windows on the building envelope shall not exceed the air leakage rates specified in SS 212 – Specification for Aluminium Alloy Windows.

(b) Where the door opening of any commercial unit is located along the perimeter of the building envelope or leading to an exterior open space, external corridor, passageway or pedestrian walkway, that unit shall –

(i) be completely separated from the other parts of the building; and
(ii) has its air-conditioning system separated from and independent of the central system.

M6 Artificial Lighting

(a) The maximum lighting power budget in a building shall comply with SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment.

(b) Lighting control for artificial lighting shall be provided in accordance with SS 530.

(c) In any hotel building, control devices shall be installed in every guestroom such that the power to the lights in a guestroom would automatically be turned off when the occupant is not in the room.

M7 Ventilation

Ventilation shall be adequately provided in a building for its intended occupancy.

(c) Where natural ventilation is applicable, it shall be provided by means of openable windows or other openings with an aggregate area of not less than –

  (i) 5% of the floor area of the room or space required to be ventilated; and
  (ii) 15% of the floor area of the aboveground car parking area required to be ventilated.

(d) Where mechanical ventilation or air-conditioning systems are used, the ventilation rates of these systems shall comply with SS CP 13 – Code of Practice for Mechanical Ventilation and Air-Conditioning in Buildings.

M8 Electrical Sub-Metering

Provision of sub-metering to monitor energy consumption of key building services and energy usage of end users or tenants.

M9 Luminance Level

Building lighting is maintained at luminance level as stated in SS CP 38 – Code of Practice for Artificial Lighting in Buildings for various types of occupancy and in SS 531:Part 1 : 2006 – Code of Practice for Lighting of Work Places where appropriate.

Source: Building Control Regulations /Approved Document

Annex C

SCORING METHODOLOGY & DOCUMENTATION

Residential Building Criteria

(I) Energy Related Requirements

RB 1-1 BUILDING ENVELOPE - RETV

Objectives	Enhance overall thermal performance of building envelope to minimise heat gain thus reducing the overall cooling load requirement.
Applicability	Applicable to residential buildings with GFA of 2000 m^2.
Baseline Standard	Maximum permissible RETV = 25 W/m^2 RETV stands for Residential Envelope Transmittance Value. The computation of RETV shall be based on the methodology specified in the Code on Envelope Thermal Performance for Buildings issued by BCA.
Requirements	Up to 15 points can be scored for building envelope with better thermal performance than the baseline standard : 3 points for every reduction of 1 W/m^2 in RETV from the baseline. Points scored = 75 – [3 x (RETV)] where RETV ≤ 25 W/m^2 For developments consisting of more than one residential building, the weighted average of the RETVs based on the façade areas of these buildings shall be used as the basis for point allocation. That is $RETV_{\text{Weighted average}} = \sum (RETV_{bldg} \times A_{bldg}) / A_{devt}$ where $RETV_{bldg}$ = RETV for a residential building (W/m^2) A_{bldg} = Summation of all facade areas that enclose all living rooms, dining rooms, study rooms and bedrooms of a residential building (m^2) A_{devt} = Summation of total applicable facade areas of all residential buildings within the development (m^2) (i.e. $\sum A_{bldg}$)
Documentary Evidences	• Architectural elevation drawings showing the composition of the different façade or wall systems that are relevant for the computation of RETV; • Architectural plan layouts and elevations showing the living rooms, dining rooms, study rooms and bedrooms; • Extracts of the tender specification or material schedules showing the salient data of the material properties that are to be used for the façade or external wall system; and • RETV calculation.
References	Code on Envelope Thermal Performance for Buildings issued by BCA.

Worked Example 1-1	Example 1 RETV = 22 W/m^2 Points scored = 75 – [3 x (RETV)] = 75 – [3x (22)] = 9 points Example 2 RETV = 19 W/m^2 Points scored = 75 – [3 x (RETV)] = 75 – [3 x (19)] = 18 points > 15 points (max) Therefore, points scored should be 15 points (Max) Example 3 A proposed building development comprises three residential building blocks. The individual RETV of the each residential building computed are as follows : $RETV_{bldg1}$ = 20 W/m^2 A_{bldg} = 4000 m^2 $RETV_{bldg2}$ = 25 W/m^2 A_{bldg} = 3600 m^2 $RETV_{bldg3}$ = 19 W/m^2 A_{bldg} = 5000 m^2 A_{devt} = 4000 +3600 +5000 = 12600 m^2 Therefore $RETV_{\text{Weighted average}} = \sum (RETV_{bldg} \times A_{bldg}) / A_{devt}$ $= \frac{(RETV_{bldg1} \times A_{bldg1}) + (RETV_{bldg2} \times A_{bldg2}) + (RETV_{bldg3} \times A_{bldg3})}{(A_{devt})}$ $= \frac{(20 \times 4000) + (25 \times 3600) + (19 \times 5000)}{12600}$ = 21.03 W/m^2 Points scored = 75 – [3 x (RETV)] = 75 – [3 x (21.03)] = 11.91 points Note : Refer to the Code on Envelope Thermal Performance for Buildings for more detailed examples on how to compute the RETV.

RB 1-2 DWELLING UNIT INDOOR COMFORT

<table>
<tr><td>Objectives</td><td>Enhance building design to achieve good natural ventilation for better indoor comfort or through the use of better efficient air-conditioners if needed.</td></tr>
<tr><td>Applicability</td><td>Applicable to all dwelling units within the development.</td></tr>
<tr><td>Baseline Standard</td><td>As specified under the Singapore Energy Labelling Scheme for air-conditioners.</td></tr>
<tr><td>Requirements</td><td>
<u>For development with provision of air-conditioners</u>
1-2 (a)(i) Up to 12 points can be scored for the use of the air-conditioners that are certified under the Singapore Energy Labelling Scheme based on the following rating.
<table>
<tr><th>Rating</th><th>Point Allocation</th></tr>
<tr><td>✓✓</td><td>2</td></tr>
<tr><td>✓✓✓</td><td>6</td></tr>
<tr><td>✓✓✓✓</td><td>12</td></tr>
</table>
Extent of coverage : At least 90% of air-conditioners used in all dwelling units are energy labelled
OR
<u>For developments where air-conditioners are not provided</u>
1-2 (a)(ii) Up to 12 points can be scored for the following design :
• Building layout design that utilises prevailing wind conditions to achieve adequate cross ventilation. (Up to 6 points).
0.6 point for every 10% of units with window openings facing north and south directions
Points scored = 0.6 x (% of units/10)
• Dwelling unit design that allows for true cross ventilation in the living rooms and bedrooms of the dwelling units (Up to 6 points).
0.6 point for every 10 % of living rooms and bedrooms designed with true cross ventilation
Points scored = 0.6 x (% rooms /10)
Note: In Singapore, the prevailing wind comes from two predominant directions; that is the north to north-east during the Northeast monsoon season and south to south-east during the South-west monsoon season. Hence, buildings designed with window openings facing the north and south directions have the advantage of the prevailing wind conditions which would enhance indoor thermal comfort. Meteorological data on the more precise wind direction and velocity of the site location can also be used as the basis for the design.
It is not necessary for the window openings to be located perpendicularly to the prevailing wind direction. An oblique angle is considered acceptable (see illustrations next page).
</td></tr>
</table>

Illustrations on building layout design that facilitate cross ventilation

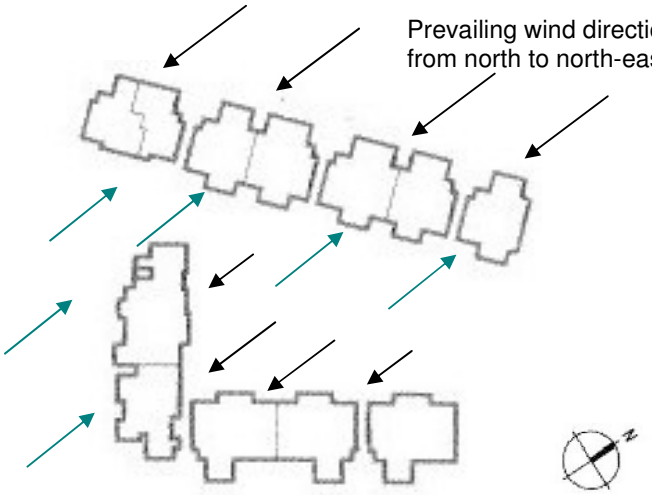


Illustration 1 – Building layout showing all dwelling units with window openings facing the north and south direction. In this instance, all units can be considered meeting the requirement 1-2(a)(ii)

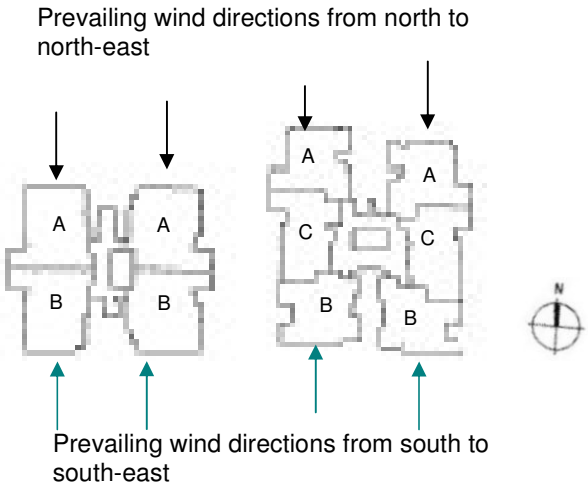
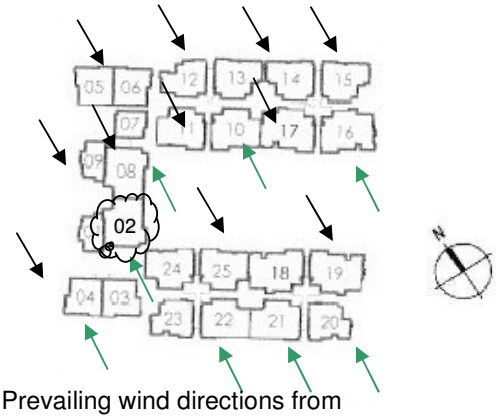


Illustration 2 – Building layout showing all dwelling unit Type A and B with window openings facing either the north or south direction. The dwelling unit Type C has no window openings in the north and south directions. In this instance, no unit can be considered meeting the requirement 1-2(a)(ii)

Prevailing wind directions from north to north-east

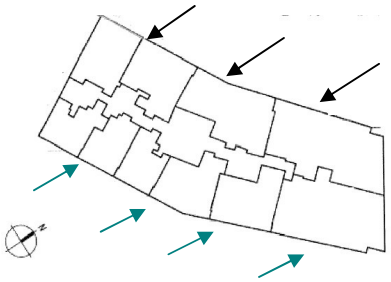


Prevailing wind directions from south to south-east

Illustration 3 – Building layout showing the window openings of all dwelling units facing the north and south direction except dwelling unit 02. Dwelling 02 has window openings facing only the south direction and hence it is not considered meeting the requirement 1-2(a)(ii)

Illustration 4 – Building layout showing the window openings of all dwelling units facing either the north or south direction and hence they are not considered meeting the requirement 1-2(a)(ii)

Prevailing wind directions from north to north-east



Prevailing wind directions from south to south-east

Illustrations on dwelling unit design that facilitates true cross ventilation

Dwelling unit design is considered to have true cross ventilation when there is a reasonably unobstructed air flow path between the windows or vents on opposite sides of the building. For this requirement, the main entrance of the dwelling units is assumed to be closed and all the windows / internal doors are assumed to be open.

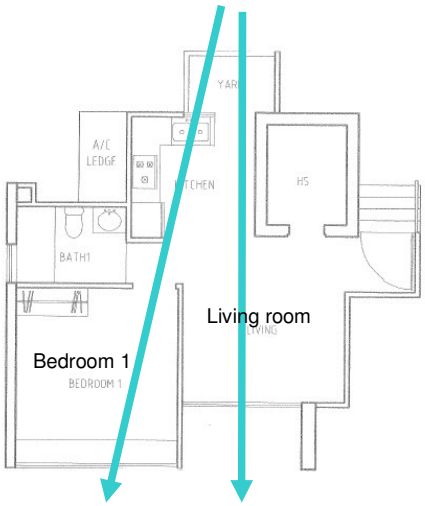


Illustration 5 – Dwelling unit layout showing that both living room and bedroom 1 are considered to have true cross ventilation and meet the requirement 1-2(a)(ii)

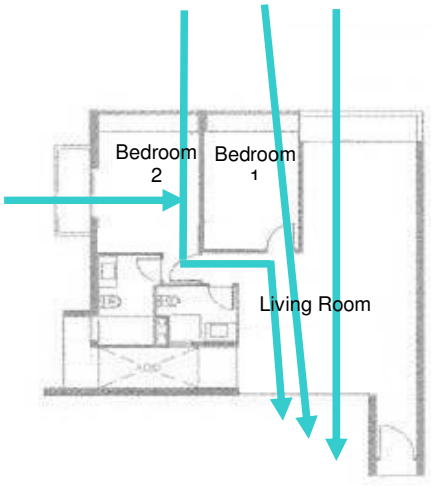
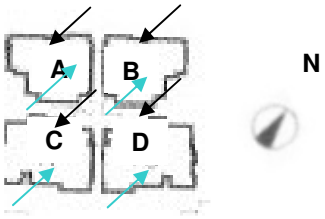


Illustration 6 – Dwelling unit layout showing only living room and bedroom 1 are considered to have true cross ventilation. Bedroom 2 is not considered meeting the requirement 1-2(a)(ii)

	1-2 (b) 4 points for the use of ventilation simulation software or wind tunnel testing to identify the most effective building design and layout in achieving good natural ventilation. The design should provide an average wind velocity within the space of at least 0.6 m/s or more. Points can only be scored if the recommendations from the ventilation simulation or wind tunnel testing are implemented. The ventilation simulation shall be carried out with the following conditions: ▪ Assumed wind velocity of 2m/s in the north and south directions or based on meteorological data on precise wind direction and velocity of the proposed site location for the month of December and June. ▪ Characteristics of the surroundings and buildings which have significant impact on the wind pattern and indoor air velocity to be included in the modeling and simulation.
Documentary Evidences	<u>For 1-2(a)(i) – For dwelling units with provision of air-conditioners</u> • Extracts of the tender specification showing the provision of the types of air-conditioners for the dwelling units of the development; • Schedule of air-conditioners showing the numbers, types and the approved rating from the Singapore Energy Labelling Scheme; and • Technical product information of the air-conditioners and approved rating. <u>For 1-2(a)(ii) – For development where air-conditioners are not provided</u> • Floor plan of all the unit types with highlights of those with window openings facing the north and south directions and/or with true cross ventilation; • Schedules showing the total number of units in the development and those with window openings facing the north and south direction. • Schedules showing the total number of living rooms and bedrooms in the development and those with true cross ventilation. • Calculation showing the percentage of living rooms and bedrooms of dwelling units with true cross ventilation in the prescribed tabulated format as shown in the worked example 1-2(a)(ii). <u>For 1-2(b) – Ventilation Simulation</u> • Ventilation simulation or wind tunnel testing reports summarizing the analysis and modelling results for each typical space as well as the recommendations for design.
References	-
Worked Example 1-2(a)(i)	A residential development with one block of 18-storey apartments comprises 108 units in total. There are 36 two-bedroom unit type and 68 three-bedroom unit type and 4 penthouses. All dwelling units are provided with air-conditioners. All the two-bedroom and three-bedroom unit types are provided with spilt unit wall mounted air-conditioners with 4-tick energy label. The four penthouses are provided with ducted air-conditioning system with no energy label. Total no. of units = 108 No. of units with air-conditioners with 4-tick energy label = 36 +68 = 104 Percentage of units with air-conditioners = 104/108 x 100 = 96% > 90% ok Points scored for 1-2(a)(i) = 12 points

Worked Example 1-2(a)(ii)

Proposed residential development with one block of 10 storey apartment comprises 40 units. Each dwelling comes with a living room and two bedrooms. There are four different unit types for this development as illustrated below.

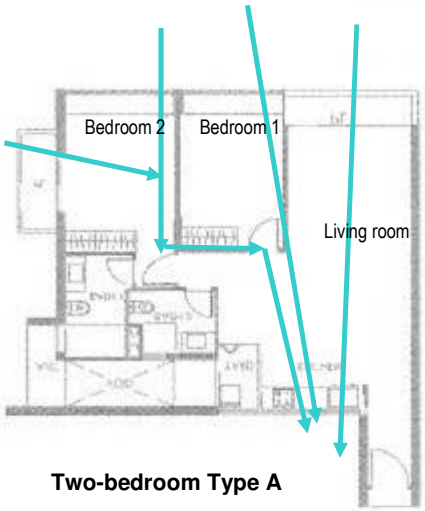


<u>Building Layout Design</u>
Total no. of units in the developments = 40

Total units with all window openings facing north and south directions = 40

% of units with window openings facing north and south directions = 40/40 x 100 = 100%

Points scored = 0.6 x (% unit/10)
= 0.6 x (100/10) = 6 points

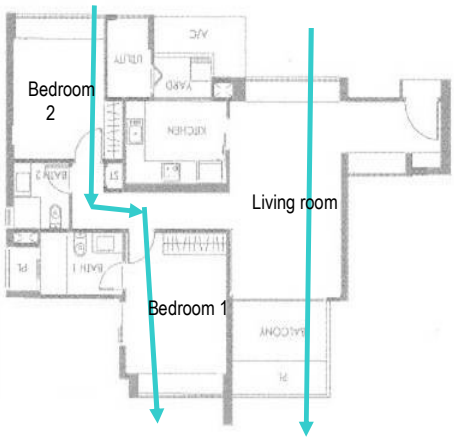


Two-bedroom Type A

Both living room and bedroom 1 are considered to have true cross ventilation. Bedroom 2 does not meet the requirement.

Two-bedroom Type B

Both living room and bedroom 1 are considered to have true cross ventilation. Bedroom 2 does not meet the requirement.



Two-bedroom Type C

Only living room is considered to have true cross ventilation. Both bedroom 1 & 2 do not meet the requirement.

Two-bedroom Type D

Only living room is considered to have true cross ventilation. Both bedroom 1 & 2 do not meet the requirement.

Dwelling Unit Design

Table 1-2(a)(ii) : Percentage of rooms with true cross ventilation

Type of dwelling unit	No of units (a)	For each unit		Total living rooms and bedrooms with true cross ventilation (b + c) x a
		Living room with true cross ventilation (b)	Bedrooms with true cross ventilation (c)	
2-bedroom Type A	10	1	1	20
2-bedroom Type B	10	1	1	20
2-bedroom Type C	10	1	0	10
2-bedroom Type D	10	1	0	10
			Total	60

Total no. of living rooms and bedrooms = 3 x 40 units = 120

Total no. of living rooms and bedrooms with true cross ventilation = 60

Percentage of living rooms and bedrooms with true cross ventilation = 60/120 x 100
= 50%

Points scored = 0.6 x (% rooms/10) = 0.6 x (50/10) = 3 points

Total points scored for 1-2(a)(ii) = 6 + 3 = 9 points

RB 1-3 NATURAL VENTILATION IN COMMON AREAS

Objectives	Enhance building design to achieve good natural ventilation in common areas.
Applicability	Applicable to the following common areas of the development. ▪ Lobbies and Corridors ▪ Staircases
Baseline Standard	-
Requirements	1-3(a) 1 point can be scored if all the lift lobbies (including private lift lobbies) and corridors are designed to be naturally ventilated. 1-3(b) 1 point can be scored if all the staircases are designed to be naturally ventilated.
Documentary Evidences	<u>For 1-3(a) and (b)</u> • Plan layouts showing the applicable common areas and confirmation that they are designed to be naturally ventilated.
References	-
Worked Example 1-3(a) and (b)	Proposed development has the following provision : All lift lobbies and corridors are designed to be naturally ventilated except for two private lobbies of the penthouses units which are designed with air-conditioning system. All staircases are designed to be naturally ventilated No point for 1-3(a) as not all the lift lobbies are naturally ventilated. 1 point for 1-3(b) for staircases that are all designed to be naturally ventilated. Therefore, points scored for 1-3 = 1 point

RB 1-4 LIGHTING

Objectives	Encourage the use of better efficient lighting and daylighting in common areas to minimise energy consumption from lighting usage while maintaining proper lighting level.
Applicability	Applicable to lighting provisions for the type of usage specified in the SS 530 Clause 7 – Lighting power budget pertaining to common areas and facilities within the residential developments such as staircases, lobbies, corridors, indoor carparks and landscape areas . It is not applicable to lighting provisions for dwelling units.
Baseline Standard	Maximum lighting power budget stated in SS 530 - Code of Practice for Energy Efficiency Standard for Building Services and Equipment.
Requirements	1-4 (a) Up to 12 points can be scored for the improvement in the lighting power budget in common areas : 0.3 point for every percentage improvement in the lighting provisions over the baseline standard. That is Points scored = 0.3 x (% improvement) Display lighting and specialised lighting are to be included in the calculation of lighting power budget. The design service illuminance, lamp efficacies and the light output ratios of luminaries shall be in accordance with SS CP 38 – Code of Practice for Artificial Lighting in Buildings where applicable. 1-4(b)(i) 1 point for provision of daylighting for lift lobbies and corridors. 1-4(b)(ii) 1 point for provision of daylighting for staircases. 1-4(b)(iii) 1 point for provision of daylighting for carparks.
Documentary Evidences	<u>For 1-4(a)</u> • Lighting layout plan; • Lighting schedules showing the numbers, locations and types of luminaries used; • Calculation of the proposed lighting power budget and the percentage; improvement in the prescribed tabulated format as shown in the worked example 1-4(a); and • Technical product information of the lighting luminaries used. <u>For 1-4(b)</u> • Extracts of the tender specification or drawings showing the use of daylighting for lift lobbies and corridors, staircases and carparks where applicable.

References	SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment.
Worked Example 1-4 (a)	(1) Determine the total power consumption based on the lighting layout design for each area and light fitting types used (2) Calculate the total power consumption based on the maximum lighting power budget stated in SS 530. (3) Calculate the percentage improvement in the total power consumption.

Table 1-4(a)-1 : Total power consumption based on each fitting type

Description	Areas (m^2) (A)	Light Fitting Type (B)	Power Consumption per fitting (W) (C)	Ballast Loss (W) (D)	No. of Fittings (E)	Total power consumption based on fitting type [(C+D) x (E)]
Corridors	580	T5	1x28	3	70	2170
Staircase	420	T5	1x28	3	35	1085
Carparks	1500	T5	1x28	3	130	4030
Exterior Lighting	200	LED bollard	4x 1	3	20	140
		Floodlight CDM-TC	1x 35	4	15	585
					Total :	8010

Table 1-4(a)-2 : Total power consumption based on design and SS 530 requirements

Description	Areas (m^2) (A)	Design Data		SS 530 Requirements	
		Total Power Consumption (by area)(W) (F)	Design Lighting Power Budget (W/m^2) (F/A)	Reference Lighting Power Budget (W/m^2) (H)	Reference Total Power Consumption (by area) (W) (H x A)
Corridors	580	2170	3.74	10	5800
Staircase	420	1085	2.85	6	2520
Carparks	1500	4030	2.69	5	7500
Exterior Lighting	200	725	3.63	5	1000
Total :		8010			16820

Therefore

% improvement in the lighting power budget $= [\Sigma(HxA) - \Sigma(F)] / \Sigma(HxA) \times 100$

$= (16820 - 8010)/16820 \times 100$

$= 52.38\%$

Points scored $= 0.3 \times 52.38\% = 15.7$ points > 12 points (max)

Therefore, points scored for 1-4(a) should be 12 points (max)

Worked Example 1-4 (b)	Residential development with the following provision : All lift lobbies (including private lift lobbies), corridors and staircases are designed to have daylighting where artifical lighting is not required during the day time. Majority of the carpark areas have daylighting provision except for one area where artificial lighting is needed during day time to maintain proper lighting level. 1 point for lift lobbies with daylighting provisions. 1 point for staircase with daylighting provisions. No point for carpark as one area requires artifical lighting. Therefore, points scored for 1-4(b) = 2 points

RB 1-5 VENTILATION IN CARPARKS

Objectives	Encourage the use of energy efficient design and control of ventilation systems in carparks.
Applicability	Applicable to all carpark spaces in the development.
Baseline Standard	-
Requirements	1-5(a) 8 points can be scored for carpark spaces that are fully naturally ventilated. 1-5(b) For carparks that have to be mechanically ventilated, points can be scored for the use of carbon monoxide (CO) sensors in regulating such demand based on the mode of mechanical ventilation (MV) used; 6 points for carparks using fume extract system and 4 points for those with MV with or without supply. Note : Where there is a combination of different ventilation modes adopted for carpark design, the points scored under this requirement will be prorated accordingly.
Documentary Evidences	For 1-5 (a) and (b) • Plan layouts showing all carpark provisions for the development with highlights of the carpark spaces that are designed to be naturally ventilated and/or mechanical ventilated; • Plan layouts indicating the locations of CO sensors and the mode of ventilation adopted for the design; and • Calculation showing the points allocation if there is a combination of different ventilation mode adopted for the carpark design.
References	SS CP 13 – Code of Practice for Mechanical Ventilation and Air-Conditioning in Buildings.
Worked Example 1-5	Proposed development has two levels of basement carparks. Level 1 basement carpark (B1) is designed with more than 20% openings for natural ventilation and fume extract system. Level 2 basement carpark (B2) is fully mechancially ventilated. CO sensors are installed to control the ventilation system for both carpark levels. Areas of basement capark – B1 = 700 m^2 Areas of basement carpark– B2 = 500 m^2 Total areas = 1200 m^2 Points scored for 1-5 = (700/1200) x 6 + (500/1200) x 4 = 5.17 points

RB 1-6 LIFTS

Objectives	Encourage the use of energy efficient lifts.
Applicability	Applicable to all lifts in the development.
Baseline Standard	-
Requirements	1 point can be scored for the use of lifts with energy efficient features such as AC variable voltage and variable frequency (VVVF) motor drive or equivalent 1 point can be scored for the use of lifts with sleep mode features.
Documentary Evidences	Extracts of the tender specification indicating the types of lifts and related features used.
References	-
Worked Example 1-6	Proposed development has the following provision: All lifts are gearless traction machine with sleep mode features 1 point for the use of gearless traction machine. 1 point for sleep mode operation. Therefore, points scored for 1-6 = 2 points

RB 1-7 ENERGY EFFICIENT FEATURES

Objectives	Encourage the use of energy efficient features which are innovative and have positive environmental impact in terms of energy saving.
Applicability	Applicable to practices and features that are not listed in the requirements under Part 1 – Energy Efficiency.
Baseline Standard	-
Requirements	Up to 7 points can be scored for the use of the following approved energy efficient features based on their potential environmental benefits and the extent of coverage. (i) Use of heat recovery devices • 2 points for more than 50% of all dwelling units • 1 point for at least 25% of all dwelling units • 0.5 point for club house or other common facilities (ii) Use of thermal insulation or cool paints on the east and west facing external walls • 2 points for window to wall ratio (WWR) of less than 0.5 • 1 point for WWR that is between 0.5 to 0.75 • 0.5 point for WWR of more than 0.75 (iii) Use of motion sensors for private lift lobbies, staircases, common toilets • 1 point for at least 50 motion sensors installed • 0.5 point for less than 50 motion sensors installed (iv) 1 point for the use of heat elevator in at least 90% of all dwelling units' water heater systems. (v) 1 point for the use of gas water heaters in at least 90% of all dwelling units. (vi) Use of software analysis and simulation to optimise the capacity and sizing of the air-conditioning system of dwelling units to achieve energy savings (as compared with the SS 530 requirements). • 1 point for at least 30% energy savings • 0.5 point for at least 15% energy savings (vii) 1 point for the provision of clothes drying facilities and open spaces for at least 90% of the dwelling units. (viii) Use of sun pipes for natural lighting. • 1 point for more than 10 sun pipes • 0.5 point for at least 5 sun pipes (ix) 0.5 point for the provision of ductless fans for basement ventilation. (x) 0.5 point for the computation of Energy Efficiency Index (EEI) for common facilities of the development.

Calculation of EEI for Common Facilities :

EEI = (TEC / GFA) x 365 days

where:

(a) TEC : Total electricity consumption for common facilities (kWh/day)
(b) GFA : Gross floor area of development (m^2)

The common facilities and the daily usage hours of these facilities are pre-determined for consistency as shown in Table 1-7. They are to be used in the computation for EEI. Other common facilities that are not listed should be included under 'Others' and the operation hours can be estimated based on the likely usage pattern.

Table 1-7 : Common Facilities and Daily Usage Pattern

	Description	Daily Usage (hr)
A)	**Mechanical Load**	
	MV fan (plant room)	9
	Car park fan	4
	A/C for club house	12
	A/C for lobbies	12
	A/C for guard house	24
	Domestic pump	2
	Ejector pump	2
	Booster pump	3
	Sump pumps	0.5
B)	**Lift Load**	
	Passenger lifts	2
	Service lift	2
C)	**General lighting**	
	Car park lighting - 24 hours operation	24
	Car park lighting - 5 hours operation	5
	Guard house lighting	12
	Facade lighting	5
	Landscape lighting - 12 hours operation	12
	Landscape lighting - 5 hours operation	5
	Lift lobbies, corridors & staircase lighting - 12 hours operation	12
	Lift lobbies, corridors & staircase lighting - 5 hours operation	5
D)	**Club Facilities**	
	Club house interior lighting	12
	Power to Gym equipment, SPA, etc	6
	Swimming pool filtration	12
	Water features	8
E)	**Others**	
	Facilities A	To estimate
	Facilities B	To estimate

Important notes : *For features that are not listed in RB 1-7(i) to (x) above, the QP is required to submit the details showing the positive environmental impacts and potential energy savings of the proposed features to BCA for assessment before the submittal of Green Mark Score.*

Documentary Evidences	• Extracts of the tender specification showing the provision of the proposed energy efficient features and the extent of implementation where applicable; • Technical product information on the energy efficient features used; and • Calculation of the potential energy savings that could be reaped from the use of these features. • Calculation of the Energy Efficiency Index (EEI) using the pre-determined daily usage pattern as in Table 1-7 and in the prescribed tabulated format as shown in the worked example 1-7(x).
References	-

Worked Example 1-7(x)

Background info :

Proposed residential development with the following estimated electricity consumption for common facilities.

Table 1-7(x) : Estimated electricity consumption for common facilities

	Description	Estimated Load (KW)	Daily Usage (hr)	Load per day (KWh)
A)	**Mechanical Load**			
	MV fan (plant room)	9	9	81
	Carpark fan	320	4	1280
	A/C for club house	8	12	96
	A/C for lobbies (1st sty & Basement)	0	12	0
	A/C for guard house	2	24	48
	Domestic pump	70	2	140
	Ejector pump	13	2	26
	Booster pump	28	3	84
	Sump Pumps	12	0.5	6
B)	**Lift Load**			
	Passenger Lifts	470	2	940
	Service Lifts	0	2	0
C)	**General lighting**			
	Carpark lighting – 24 hours operation	23	24	552
	Carpark lighting - 5 hours operation	23	5	115
	Guard house lighting	0.3	12	3.6
	Facade lighting	0	5	0
	Landscape lighting - 12 hours operation	30	12	360
	Landscape lighting - 5 hours operation	28	5	140
	Lift lobbies, corridor& staircase Lighting - 12 hours operation	20	12	240
	Lift lobbies, corridor& staircase lighting - 5 hours operation	19	5	95
D)	**Club Facilities**			
	Club house interior lighting	12	12	144
	Power to Gym equipment, SPA, etc	85	6	510
	Swimming Pool Filtration	50	12	600
	Water Feature	25	8	200
	Total kWh per day			**5660.60**

Calculation of EEI for Common Facilities :

Total electricity consumption per day = 5660.60 kWh/day

EEI = (TEC / GFA) x 365 days
= (5660.60 / 40 000) x 365
= 51.65 kWh/m^2/yr

Points scored for 1-7(x) = 0.5 point

RB 1-8 RENEWABLE ENERGY

Objectives	Encourage the use of renewable energy sources in buildings.
Applicability	Includes all renewable energy sources
Baseline Standard	-
Requirements	Up to 20 *Bonus* points can be scored based on the percentage replacement of electricity by the renewable energy source : For solar energy : 1 point for every 3 kWp of solar energy Points scored = (kWp of the solar energy) / 3 For other renewable energy sources : 1 point for every 1% replacement of electricity (based on annual electricity consumption exclude household's usage) by renewable energy
Documentary Evidences	• Extracts of the tender specification and plans showing the location of the renewable energy system and the extent of implementation; • Technical product information on the salient features of the renewable energy system and the expected renewable energy generated; and • Calculation of the percentage replacement of electricity and the total annual electricity consumption of the development.
References	-
Worked Example 1-8	A residential development with the following provision : Installation of 5.15 KWp solar array on the roof of its open car park. Points scored for 1-8 = 1 point for every 3 kWp of solar energy = (5.15) / 3 = 1.72 points

(II) Other Green Requirements

RB 2-1 WATER EFFICIENT FITTINGS

<table>
<tr><td>Objectives</td><td>Reduce the use of potable water by using water efficient fittings covered under the Water Efficiency Labelling Scheme (WELS).</td></tr>
<tr><td>Applicability</td><td>Applicable to the water fittings covered by the WELS and used in dwelling units :
Basin taps and mixers
Flushing cistern
Sink/bib taps and mixers
Showerheads, taps and mixers
All other water fittings</td></tr>
<tr><td>Baseline Standard</td><td>As specified under Water Efficiency Labelling Scheme (WELS).</td></tr>
<tr><td>Requirements</td><td>Up to 10 points can be scored based on the number and water efficiency rating of the fitting type used for dwelling units.

<table><tr><th>WELS Rating</th><th>Water Efficiency</th><th>Point Allocation</th></tr><tr><td>✓</td><td>Good</td><td>0.5</td></tr><tr><td>✓✓</td><td>Very Good</td><td>1</td></tr><tr><td>✓✓✓</td><td>Excellent</td><td>2</td></tr></table>
Extent of coverage : At least 90% of each fitting type used.</td></tr>
<tr><td>Documentary Evidences</td><td>Extracts of the tender specification showing all the water fitting provisions for the development;
Water fitting schedules showing the numbers, types and the approved rating of the proposed fittings in the prescribed tabulated format shown in the worked example; and
Calculation showing the percentage of proposed water fittings that are approved under WELS.</td></tr>
<tr><td>References</td><td>For more information about WELS, refer to

Inspectorate Branch
Water Demand Management & Inspectorate Division
Water Supply (Network Department)
PUB</td></tr>
</table>

Worked Example 2-1	Example 1 All dwelling units are provided with dual flushing cisterns, basin taps and sink taps that are certified with good rating under WELS. The showerheads provided are not certified under WELS. 0.5 point for dual flushing cistern with good rating 0.5 point for basin taps with good rating 0.5 point for sink taps with good rating Points scored = 0.5 +0.5 +0.5 = 1.5 points Example 2 All dwelling units are provided with dual flushing cisterns, basin taps, showerheads and sink taps that are certified with good rating under WELS. Club house toilets are provided with dual flushing cisterns, basin taps are certified with excellent rating under WELS. 0.5 point for dual flushing cistern with good rating 0.5 point for basin taps with good rating 0.5 point for showerheads with good rating 0.5 point for sink taps with good rating Points scored = 0.5 +0.5 +0.5 + 0.5 points = 2.0 points No point can be scored for the dual flushing cisterns, basin taps with excellent rating used in common facilities such as clubhouse toilets as the requirement is meant for water fittings used in dwelling units.

RB 2-2 WATER USAGE

Objectives	Promote the use of sub-metering for better control and monitoring of major water usage.
Applicability	Applicable to sub-metering provisions for major water uses of the building developments.
Baseline Standard	-
Requirements	1 point can be scored if sub-meters are provided for all major water uses i.e. irrigation system, swimming pools and other water features where applicable.
Documentary Evidences	• Extracts from the tender specification stating the locations and provision of sub-metering for all major water uses. • Schematic drawings of cold water distribution system showing the location of the sub-metering provided.
References	-

RB 2-3 IRRIGATION SYSTEM

Objectives	Reduce potable water consumption by provision of suitable systems that utilise rainwater or recycled water for landscape irrigation.
Applicability	Applicable to residential development with landscaping provision.
Baseline Standard	-
Requirements	2-3(a) 1 point can be scored for the use of non-potable water including rainwater for landscape irrigation. 2-3(b) 1 point can be scored if more than 50% of the landscape areas are served by water efficient irrigation system with features such as automatic sub-soil drip irrigation system with rain sensor control.
Documentary Evidences	<u>For 2-3(a)</u> • Extracts of the tender specification showing how the non-potable water source is to be provided; • Relevant drawings showing the location and design of the non-potable water source; and • For rainwater harvesting and storage system, approval letter from PUB is to be provided. <u>For 2-3(b)</u> • Extracts of the tender specification showing the provision and details of water efficient irrigation system; • Relevant layout plans showing the overall landscape areas and the areas that would be served using the system; and • Calculation showing the percentage of the landscape areas that would be served using the system.
References	-

(II) Other Green Requirements

RB 3-1 SUSTAINABLE CONSTRUCTION

<table>
<tr><td>Objectives</td><td>Encourage the adoption of building designs, construction practices and materials that are environmentally friendly and sustainable.</td></tr>
<tr><td>Applicability</td><td>Generally applicable to all building developments.</td></tr>
<tr><td>Baseline Standard</td><td>-</td></tr>
<tr><td>Requirements</td><td>
3-1(a) Up to 4 points are allocated to encourage more efficient concrete usage for building components based on the percentage reduction in the prescribed Concrete Usage Index (CUI) limit.

Note : Concrete Usage Index (CUI) is an indicator of the amount of concrete used to construct the superstructure which includes both the structural and non-structural elements. CUI does not include the concrete used for external works and sub-structural works such as basements and foundations. CUI is defined as the volume of concrete in cubic metres needed to cast a square metre of constructed floor area. It is expressed as:

$$\text{Concrete Usage Index} = \frac{\text{Concrete Volume in m}^3}{\text{Constructed Floor Area in m}^2}$$
Table 3-1(a) CUI Limit for Residential Building
<table>
<tr><th>CATEGORY</th><th>Concrete Usage Index (CUI) limit (m^3/m^2)</th></tr>
<tr><td>Residential (15 storey & below)</td><td>0.55</td></tr>
<tr><td>Residential (above 15 storey)</td><td>0.60</td></tr>
</table>
3-1(b) Up to 2 points can be scored if more than 50% of the existing structural elements or building envelopes (by areas) are conserved during redevelopment. Structural elements refer to slabs, columns, beams and load bearing walls.

3-1(c) Up to 6 points are allocated to encourage the use of sustainable materials and products in building construction such as :

(i) Up to 3 points for the use of environmental friendly products that are certified under the Singapore Green Labelling Scheme (SGLS) where 1 point for each high impact item and 0.5 point for each low impact item.

(ii) Up to 3 points for the use of products (applicable only for non-structural elements) with at least 30% recycled content by weight or volume where 1 point for each high impact item and 0.5 point for each low impact item

Note (1) : The use of environmental friendly products or recycled materials used for all dwelling units of the development are considered as high impact. Items that are used in common areas, external works and communal facilities are considered as low impact.

Note (2) : The point allocated for low volatile organic compound (VOC) paints and adhesives certified under SGLS can be found in RB 4-2 and hence shall not be included in the scoring for RB 3-1(c)(i) and (ii).
</td></tr>
</table>

Documentary Evidences

For 3-1(a)

- Architectural and structural plan layout, elevation and sectional plans showing the type of wall system used, the dimensions and sizes of all the building and structural elements; and
- Calculation showing the quantity of concrete for each floor level in the prescribed tabulated format shown in worked example 3-1(a). The calculation should include all the building elements as listed in the worked example.

For 3-1(b)

- Architectural and structural plan layout, elevation and sectional plans of the proposed building showing the areas of the existing building envelope or structural elements that are to be conserved;
- A summary sheet listing each area of the existing building envelope or structural elements that are to be conserved;
- Calculation showing that the percentage of building envelope or structural elements being conserved; and
- Extracts from the tender specification and documents indicating the portion of existing building envelope or structural elements to be conserved.

For 3-1(c)

- Extracts from the tender specification showing the requirements to incorporate the environmental friendly products that are certified with SGLS.
- Extracts from the tender specification showing the requirements to incorporate the use of recycled products
- Technical product information on the recycled products and their recycled contents by weight or volume.

References

-

Worked Example 3-1(a)

Proposed development comprises a 15 storey residential block with a basement carpark and the following details :

Concrete usage for the superstructure	**Constructed floor areas**
For 1st storey = 587 m^3 From 2nd to 15th storey = 5400 m^3 (including roof level)	For 1st storey = 1000 m^2 From 2nd to 15th storey = 14000 m^2 (including roof level)
Therefore, Total concrete usage = 5987 m^3	Therefore, Total constructed floor area = 15000m^2

Note : The concrete usage for foundation and two basements are not required to be included.

Concrete Usage Index CUI = $\frac{5987}{15000}$ = 0.4 m^3/m^2

Refer to the following Table 3-1(a) for more details

For residential buildings ≤ 15 storey, the CUI limit = 0.55

% reduction in CUI = (0.55-0.4)/(0.55) = 27 %

Points scored = 0.1 x (27%)= 2.7 points

Worked Example 3-1(a) – Cont'd

Table 3-1(a) – Concrete Usage Index

COMPUTATION OF CONCRETE USAGE INDEX				RESIDENTIAL BLDG
Project Reference No.: AXXXX-00001-2007		Total no. of storey for the project: 15		
Block No : A				
	Structural System	Thickness (mm) or size (mm x mm)	Volume of concrete (m^3)	Remark *
1	1st storey			
	1.1 Columns	200x400, 200x200	72	Precast
	1.2 Beams	200x400, 200x500	145	Precast
	1.3 Slabs	150,200	265	Post – tensioned
	1.4 Staircases	150	30	Precast
	1.5 Suspended structures like planter boxes, bay windows, ledges etc	150	10	Precast
	1.6 Parapets	150	5	RC
	1.7 External walls - loadbearing walls	Nil	0	–
	1.8 External walls – non-loadbearing walls	125	15	RC
	1.9 Internal walls – loadbearing walls	200	40	RC
	1.10 Internal walls – non-loadbearing walls	Nil	0	Light weight concrete
	1.11 Others (kerbs, ramps, services risers, etc)	Not required	5	RC
	Total volume of concrete for this storey (m^3)		587	
	Total constructed floor area for this storey (m^2)		1000	
2	Typical floor layout			
	2.1 Columns	200x400, 200x200	55	Precast
	2.2 Beams	200x400, 200x500	45	Precast
	2.3 Slabs	150,200	160	Post – tensioned
	2.4 Staircases	150	30	Precast
	2.5 Suspended structures like planter boxes, bay windows, ledges etc	150	10	Precast
	2.6 Parapets	150	5	RC
	2.7 External walls - loadbearing walls	Nil	0	–
	2.8 External walls – non-loadbearing walls	125	15	RC

Worked Example 3-1(a) – Cont'd

COMPUTATION OF CONCRETE USAGE INDEX RESIDENTIAL BLDG

Project Reference No.: AXXXX-00001-2007 **Total no. of storey for the project: 15**

Block No : A

	Structural System	Thickness (mm) or size (mm x mm)	Volume of concrete (m^3)	Remark *
2	**2nd storey to 30th storey (Typical floor layout)**			
	2.9 Internal walls – loadbearing walls	200	40	RC
	2.10.Internal walls – non-loadbearing walls	Nil	0	–
	2.11 Others (kerbs, ramps, services risers etc)	Nil	0	–
	Volume of concrete for one storey (m^3)		360	
	Constructed floor area for one storey		933.3	
	Total volume of concrete for 2nd to 15th storey (including roof level)		360 X 15 = 5400	
	Total constructed floor area for 2nd to 15th storey (m^2) (including roof level)		933.3 x 15 = 14000	
	Total volume of concrete for this project (m^3)		5987	
	Total constructed floor area for this project (m^2)		15000	
	Concrete Usage Index (CUI in m^3/m^2)		0.4	

* To indicate if the structural elements is of precast concrete, post-tensioned concrete, high strength concrete (> Grade 60) or reinforced concrete (RC) under the 'Remarks' column

Important notes : *The quantities of the concrete for all the structural and non-structural elements for each floor level are computed. All the elements listed in the table such as columns, beams, slabs, suspended structures (like planter boxes, bay windows and ledges etc) , parapets, walls and others (service risers, kerbs, ramps etc) are to be included. The concrete usages for foundation and basement works are excluded in CUI computation.*

Worked Example 3-1(b)

Proposed residential redevelopment has conserved more than 50% of the façade of the existing building.

Check

Building System	Area to be conserved (m^2)	Total Wall Area (m^3)
1. Façade Type A	500	1000
2. Façade Type B	2000	3000
Total :	2500	4000
% area of existing building envelope being conserved		2500/4000 x 100 = 62.5% > 50% ok
Points scored :		2 points

Worked Example 3-1(c)(i)	1. Determine if the environmental friendly products selected are certified under SGLS as GreenLabel products. 2. Check if products are used in every dwelling units of the development to be considered as high impact. Products that are meant for common areas and external works such as toilets, lobbies and landscaping areas are considered as low impact. Example of a proposed residential development with the following provision: (a) Use of GreenLabel waterproofing coating or membrane for all dwelling units' toilets : 1 point (b) Use of GreenLabel wooden doors for all dwelling units : 1 point (c) Use of GreenLabel roof waterproofing coating for roof : 0.5 point Points scored for 3-1(c)(i) = 1 + 1 + 0.5 = 2.5 points
Worked Example 3-1(c)(ii)	1. Determine if the recycled products used in non-structural elements and have at least 30% recycled content by weight or volume. 2. Check if products are used in every dwelling unit of the development to be considered as high impact. Products that are meant for common areas and external works such as toilets, lobbies and landscaping areas are considered as low impact. 3. For products that are already scored under 3-1(c)(i) are to be excluded. The same residential development in example 3-1(c)(i) also has the following provision: (a) Use of medium density fibre board that made with 80% recycled materials for all the dwelling units' wardrobes : 1.0 point (b) Use of floor finishes with recycled rubber (100%) for playground areas : 0.5 point Points scored for 3-1(c)(ii) = 1.5 point Therefore, total points scored for 3-1(c) = 2.5 +1.5 = 4 points

RB 3-2 GREENERY

Objectives	Encourage greater use of greenery and restoration of existing trees to reduce heat island effect.
Applicability	Applicable to building developments with landscaping areas.
Baseline Standard	-
Requirements	3-2(a) Up to 4 points can be scored for the provision of greenery within the developments including roof top/ sky garden and green roof. Greenery Provision (GnP) is calculated by considering the 3D volume covered by plants using the following Green Area Index (GAI) : Grass GAI = 1 ; Shrubs GAI = 3; Palms Trees GAI = 4; Trees GAI = 6 Greenery Provision (GnP) = total green area / site area GnP = 2.0 to < 3.0 – 1 point GnP = 3.0 to < 3.5 – 2 points GnP = 3.5 to < 4.0 – 3 points GnP ≥ 4.0 – 4 points 3-2(b) 1 point for restoration of trees on site, conserving or relocating of existing trees on site. 3-2(c) 1 point for the use of compost recycled from horticulture waste.
Documentary Evidences	<u>For 3-2(a)</u> • Plan layouts showing the greenery provision and site areas ; and • Calculation showing the extent of the greenery provision in the prescribed tabulated format as in worked example 3-2(a). <u>For 3-2(b)</u> • Site layouts showing the existing and final locations (where applicable) and number of the trees to be restored or conserved or relocated. <u>For 3-2(c)</u> • Extracts of the tender specification showing the requirements to use compost recycled from horticulture waste.
References	-

Worked Example 3-2(a)

(1) Determine the number of trees, palms and the areas for shrub and other greenery areas.

(2) The canopy, radius and Green Area Index are predetermined design parameters applicable for all developments.

(3) Compute the green areas as shown in the Table 3-2(a).

Table 3-2(a) – Calculation of the Greenery Provision

Description	Qty (A)	Canopy area (B)	Radius (C)	Green Area Index GAI	Green Area (A)x(B)x(C^2)xGAI
Trees (Nos)	20	3.14	3.5	6	4615.8
Palms (Nos)	20	3.14	1	4	251.2
Shrubs (m^2)	20	NA	NA	3	60
Landscape area + roof garden area + vertical greening (m^2)	100	NA	NA	1	100
				Total Green Area :	**5027**

Assume site area is 2000m^2

Greenery Provision (GnP) = 5027 / 2000 = 2.51 < 3.0

where GnP = 2.0 to < 3.0 – 1 point

Therefore, points scored for 3-2(a) = 1 point

RB 3-3 ENVIRONMENTAL MANAGEMENT PRACTICE

Objectives	Encourage the adoption of environmental friendly practices during construction and building operation.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
Requirements	3-3(a) 1 point can be scored if effective implementation of environmental friendly programmes including monitoring and setting targets to minimise energy use, water use and construction waste are in place. 3-3(b) 1 point can be scored if the building quality is assessed under the Construction Quality Assessment System (CONQUAS) and an additional one (1) point can be scored if the project is assessed under Quality Mark. 3-3(c) Up to 1 point if the developer, main builder, M & E consultant and architect are ISO 14000 certified. 0.25 point is allocated for each firm that is certified. 3-3(d) Up to 3 points where 1 point can be scored if the project team comprises one Certified Green Mark Manager (GMM) and 2 points can be scored if the team has one Certified Green Mark Professional (GMP). 3-3(e) 1 point can be scored for the provision of building users' guide including details of the environmental friendly facilities and features within the building and their uses in achieving the intended environment performance during the building operation. 3-3(f) 1 point can be scored for the provision of facilities or recycling bins for collection and storage of different recyclable waste such as paper, glass, plastic etc.
Documentary Evidences	<u>For 3-3(a)</u> • Extracts of the tender specification showing the requirements for builder to provide and implement environmental friendly programmes to minimise energy use, water use and construction waste; and • Details of the environmental friendly programmes implemented. <u>For 3-3(b)</u> • Extracts of the tender specification showing the requirement to adopt CONQUAS. <u>For 3-3(c)</u> • A certified true copy of the ISO 14000 certificate of developer, main contractor, M & E consultant and architect where applicable. <u>For 3-3(d)</u> • A certified true copy of the certificate of Green Mark manager and Green Mark professional where applicable and a confirmation of their involvement in the project.

Documentary Evidences – Cont'd	<u>For 3-3(e)</u> • A copy of the building users' guide containing the details of the environmental friendly facilities and features within the building and their uses in achieving the intended environment performance during the building operation. <u>For 3-3(f)</u> • Plan layout showing the location of the recycling bins for collection and storage of different recyclable waste.
References	-

RB 3-4 PUBLIC TRANSPORT ACCESSIBILITY

Objectives	Promote the use of public transport or bicycles to reduce pollution from individual car use.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
Requirements	3-4(a) 1 point can be scored for design that provides good access (< 500m) to public transport networks such as MRT/LRT stations and bus stops. 3-4(b) 1 point can be scored for the provision of adequate bicycles parking lots.
Documentary Evidences	For 3-4(a) • Site layout plan in the context of the surrounding area showing the location of the development site and the location of the MRT/LRT stations and bus stops. For 3-4(b) • Extracts of the tender specification showing the requirement to provide bicycles parking lots for the development.
References	-
Worked Example 3-4	The main entrance of the residential development is about 200 m away from the nearest bus stop and the provision of bicycle parking lots is specified in the tender drawings and specification 1 point for good access to the bus stop 1 point for the provision of bicycle parking lots Points scored for 3-4 = 2 points

(II) Other Green Requirements

Part 4 – Indoor Environmental Quality	**RB4-1**	**Noise Level**
	RB4-2	**Indoor Air Pollutants**
	RB4-3	**Waste Disposal**
	RB4-4	**Indoor Air Quality in Wet Areas**

RB 4-1 NOISE LEVEL

Objectives	Recognise buildings that are designed to consider the potential noise levels within the dwelling units are maintained at an appropriate level.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
Requirements	1 point can be scored if the building is designed to achieve ambient internal noise level as specified : • 55 dB (6am-10 pm) LeqA • 45 dB (10 pm-6 am) LeqA For developments that are in close proximity to road with heavy traffic, flyover or highway, it is necessary to have a detailed analysis conducted by the acoustic consultant. Points can only be scored if the recommendations from the acoustic consultant are implemented.
Documentary Evidences	• Extracts of the tender specification showing the requirement to design the occupied space with the ambient sound levels; and • A report of the detailed analysis and recommendations from acoustic consultant on how the designed ambient sound levels can be met where applicable.
References	-

RB 4-2 INDOOR AIR POLLUTANTS

Objectives	Minimise airborne contaminants, mainly from inside sources to promote a healthy indoor environment.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
Requirements	4-2(a) 2 points can be scored for the use of low volatile organic compounds (VOC) paints certified under the Singapore Green Labelling Scheme (SGLS) for at least 90% of the internal wall areas. 4-2(b) 1 point can be scored for the use of adhesives certified under the Singapore Green Labelling Scheme (SGLS) in all composite wood products used for the development.
Documentary Evidences	<u>For 4-2(a)</u> • Extracts of the tender specification showing the requirement to use low VOC paints that are certified under SGLS. <u>For 4-2(b)</u> • Extracts of the tender specification showing the requirement to use adhesive with low emission formaldehyde and are certified under SGLS for all composite wood products used.
References	-

RB 4-3 WASTE DISPOSAL

Objectives	Minimise airborne contaminants from waste.
Applicability	Generally applicable to all developments.
Baseline Standard	-
Requirements	1 point can be scored if the refuse chutes are located at open ventilation areas such as service balconies or common corridors
Documentary Evidences	• Plan layouts showing the location of the refuse chutes for all typical dwelling units.
References	-

RB 4-4 INDOOR AIR QUALITY IN WET AREAS

Objectives	Encourage provision of adequate natural ventilation and daylighting in wet areas.
Applicability	Generally applicable to all wet areas such as kitchens, bathrooms and toilets of the developments.
Baseline Standard	-
Requirements	1 point can be scored if there is provision for adequate natural ventilation and daylighting in wet areas i.e. kitchens, bathrooms and toilets. Extent of coverage : At least 90% of all applicable areas.
Documentary Evidences	• Plan layouts showing the location of the window openings of the kitchens, bathrooms and toilets for all typical dwelling units.
References	-

(II) Other Green Requirements

Part 5 –	**Other Green Features**	**RB5-1**	**Green Features and Innovations**

RB 5-1 OTHER GREEN FEATURES

Objectives	Encourage the use of green features which are innovative and have positive environmental impact on water efficiency, environmental protection and indoor environmental quality of the buildings.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
Requirements	Up to 7 points can be scored for the use of the following green features depending on their potential environmental benefits and the extent of coverage. <u>Water Efficiency</u> (i) Use of self cleaning façade system : • 2 points for more than 75% of the external walls • 1 point for more than 50% of the external walls • 0.5 points for at least 25% of the external walls (ii) Use of integrated basin/cistern pedestal system : • 2 points for more than 50% of all dwelling units' flushing cisterns • 1 point for more than 25% of all dwelling units' flushing cisterns • 0.5 point for at least 10% of all dwelling units' flushing cisterns (iii) Use of grey water recycling system : • 2 points for all blocks of the development. • 1 point for at least one block of the development. (iv) 0.5 point for the use of membrane filtration system to recycle water during construction. <u>Environmental Protection</u> (i) Use of precast toilets : • 2 points for more than 75% of all toilets • 1 point for more than 50% of all toilets • 0.5 point for at least 25% of all toilets (ii) Provision of green roof and roof top garden : • 1 point for more than 50% of the roof areas • 0.5 point for at least 25% of the roof areas. (iii) Provision of vertical greening : • 1 point for more than 50% of the external wall areas • 0.5 point for at least 25% of the external wall areas (iv) 1 point for the provision of double refuse chutes for separating recyclable from non-recyclable waste (v) 0.5 point for the use of non-chemical termite treatment system such as termite baiting system, anti-termite mesh.

	(vi) 0.5 point for the provision of at least 5 nos. of compost bins to recycle organic waste. (vii) 0.5 point for the use of non-chemical water treatment system for swimming pools. (viii) Up to 1 point if at least 10% of the fine and/or coarse aggregate used for concrete production of structural application are replaced with recycled products from approved sources. 0.5 point for each recycled product used. Points can only be scored if the extent of implementation covers at least 50% of all concrete structural elements of the superstructures (by volume). <u>Indoor Air Quality</u> (i) Use of Titanium Dioxide solutions to remove odour in toilets : • 2 points for more than 50% of all toilets • 1 point for more than 25% of all toilets • 0.5 point for at least 10% of all toilets (ii) 1 point for the use of pneumatic waste collection system. <u>Others</u> (i) Provision of landscape drainage and infiltration trenches : • 1 point for at least 25% of the landscape areas • 0.5 point for less than 25% of the landscape areas (ii) Provision of system to recycle surface runoff from the vertical green wall and sky garden : • 1 point for at least 25% of the green areas • 0.5 point for less than 25% of the green areas (iii) 0.5 point for the use of siphonic rainwater discharge system at roof. (iv) 0.5 point for the provision of eco-pond. ***Important notes :*** *For features that are not listed above, the QP is required to submit the details showing the positive environmental impacts, possible savings and benefits of the proposed features to BCA for assessment before the submittal of Green Mark Score.*
Documentary Evidences	• Extracts of the tender specification showing the provision of the specific green features used and the extent of implementation where applicable; • Technical product information (including drawings and supporting documents) of the green features; • A summary sheet listing the breakdown and the extent of implementation as well as the total requirements for the same intended purpose for the specific green features used; and • Quantified evidences on the potential environmental benefits that the features can bring to the development.
References	-

Annex D

SCORING METHODOLOGY & DOCUMENTATION
Non-Residential Building Criteria

(I) Energy Related Requirements

Part 1 – Energy Efficiency

NRB 1-1 BUILDING ENVELOPE - ETTV

Objectives	Enhance overall thermal performance of building envelope to minimise heat gain thus reducing the overall cooling load requirement.
Applicability	Applicable to air-conditioned building spaces with aggregate areas > 500 m^2.
Baseline Standard	Maximum permissible ETTV = 50 W/m^2 ETTV stands for Envelope Thermal Transfer Value. The computation of ETTV shall be based on the methodology specified in the Code on Envelope Thermal Performance for Buildings issued by BCA.
Requirements	Up to 15 points can be scored for building envelope with better thermal performance than the baseline standard : 2 points for every reduction of 1 W/m^2 in ETTV from the baseline. Points scored = 100 – [2 x (ETTV)] where ETTV ≤ 50 W/m^2 For developments consisting of more than one building, the weighted average of the ETTVs based on the façade areas of these buildings shall be used as the basis for point allocation. That is $ETTV_{\text{Weighted average}} = \sum (ETTV_{bldg} \times A_{bldg}) / A_{devt}$ where $ETTV_{bldg}$ = ETTV for a building (W/m^2) A_{bldg} = Summation of all facade areas that enclose all the air-conditioning areas (m^2) in a building A_{devt} = Summation of total applicable facade areas of all buildings within the development (m^2) (i.e. $\sum A_{bldg}$)
Documentary Evidences	• Architectural elevation drawings showing the composition of the different façade or wall systems that are relevant for the computation of ETTV; • Architectural plan layouts and elevations showing all the air-conditioning areas; • Extracts of the tender specification or material schedules showing the salient data of the material properties that are to be used for the façade or external wall system; and • ETTV calculation.
References	Code on Envelope Thermal Performance for Buildings issued by BCA

Worked Example 1-1	Example 1 ETTV = 45 W/m^2 Points scored = 100 – [2 x (ETTV)] = 100 – [2 x (45)] = 10 points Example 2 ETTV = 35 W/m^2 Points scored = 100 – [2 x (ETTV)] = 100 – [2 x (35)] = 30 points > 15 points Therefore, points scored should be 15 points (max) Example 3 A proposed building development comprises three building blocks. The individual ETTV of the each building computed are as follows : $ETTV_{bldg1}$ = 35 W/m^2 A_{bldg} = 5000 m^2 $ETTV_{bldg2}$ = 45 W/m^2 A_{bldg} = 6800 m^2 $ETTV_{bldg3}$ = 50 W/m^2 A_{bldg} = 7500 m^2 A_{devt} = 5000+6800+7500 = 19300 m^2 Therefore $ETTV_{\text{Weighted average}} = \sum (ETTV_{bldg} \times A_{bldg}) / A_{devt}$ $= \frac{(ETTV_{bldg1} \times A_{bldg1}) + (ETTV_{bldg2} \times A_{bldg2}) + (ETTV_{bldg3} \times A_{bldg3})}{(A_{devt})}$ $= \frac{(35 \times 5000) + (45 \times 6800) + (50 \times 7500)}{19300}$ = 44.35 W/m^2 Points scored = 100 – [2 x (ETTV)] = 100 – [2 x (44.35)] = 11.3 points Note : Refer to the Code on Envelope Thermal Performance for Buildings for more detailed examples on how to compute the ETTV.

NRB 1-2 AIR-CONDITIONING SYSTEM

Objectives	Encourage the use of better efficient air-conditioned equipments to minimise energy consumption.
Applicability	Applicable to air-conditioned building areas where its aggregate air-conditioned areas > 500 m^2. Scope covers all air-conditioned equipments for the buildings as listed: ▪ Chillers ▪ Chilled water pumps ▪ Condenser water pumps ▪ Cooling Towers ▪ Air Handling Units (AHUs) ▪ Fan Coil Units (FCU) ▪ Unitary Air-Conditioners/ Condensing Units which include single-split units, multi-spilt units and variable refrigerant units (VRV) system
Baseline Standard	Minimum efficiency requirement of the air-conditioning system stated in SS 530 and SS CP 13. <u>1-2(a)(i) Air-Conditioned Plant</u> • Chiller - Refer Table 2 of SS 530. • Chiller and condenser water pump efficiency - Refer to Clause 7.11.6 in CP 13 which states that the water transport factor shall not be less than 30 for chiller water and 40 for the condensing water circuit. Chilled water pump efficiency ≤ 1kW / (30kW/3.5172) tons ≤ 1kW / 8.53 tons ≤ 0.117 kW/ tons Condenser water pump efficiency ≤ 1kW / (40kW/3.5172) tons ≤ 1kW / 11.37 tons ≤ 0.088 kW/ tons • Cooling tower performance at the <u>rating condition</u> stated in Table 3 of SS530. Rating condition is as follows : 35℃ Entering water 29℃ Leaving water 24℃ wb Outdoor air <u>Propeller and axial fan cooling tower :</u> With heat rejected from every 3.23 L/s of condenser water per 1 kW of fan power rating : Cooling tower performance ≤ 1kW / 3.23 L/s ≤ 0.310 kW/ L/s <u>Centrifugal fan cooling tower :</u> With heat rejected from every 1.7 L/s of condenser water per 1 kW of fan power rating : Cooling tower performance ≤ 1kW/1.7 L/s ≤ 0.588 kW/ L/s <u>1-2(a)(ii) Air Distribution System</u> – Refer to Clause 7.11.5 in CP 13. <u>1-2(b) Unitary Air-Conditioners/ Condensing Units</u> - Refer Table 1 of SS 530.

Requirements	<u>1-2 (a)(i) Air-Conditioned Plant (Up to 20 points)</u> 1.45 points for every percentage improvement in the efficiency of chiller, chilled-water pump and condenser water pump. Points scored = 1.45 x (% improvement) 0.05 point for every percentage improvement in the performance of cooling tower at rating condition. Points scored = 0.05 x (% improvement) <u>1-2 (a)(ii) Air Distribution System (Up to 5 points)</u> 0.5 points for every percentage improvement in the air distribution system efficiency above the baseline. Points scored = 0.5 x (% improvement) Note (1) : For buildings using district cooling system, there is no need to compute the plant efficiency under item (a)(i). The points obtained will be pro-rated based on the air distribution system efficiency under NRB 1-2(a)(ii). OR <u>1-2 (b) Unitary Air-Conditioners/Condensing Units (Up to 25 points)</u> 1.5 points for every average percentage improvement in the efficiency of unitary air-conditioners/ condensing units above the baseline. Points scored = 1.5 x (% improvement) Note (2) : Where there is a combination of centralised air-con system with unitary air-conditioned system, the computation for the points scored will only be based on the air-conditioning system with a larger aggregate capacity. <u>1-2 (c) Sensors or similar automatic control devices (2 points)</u> 2 points can be scored if sensors or similar automatic control devices are used to regulate outdoor air flow rate to maintain the concentration of carbon dioxide (CO_2) below 1000ppm.
Documentary Evidences	<u>For 1-2 (a) and 1-2(b)</u> • Detailed calculations of the overall improvement in equipment efficiency of the air-conditioning plants/ units and air distribution system in the prescribed tabulated formats as shown in the worked examples 1-2(a)(i), 1-2(a)(ii), 1-2(b); • Calculation and technical data of the designed system efficiency of chillers at <u>part load condition</u> ; and • Technical product information of all air-conditioning units and system. <u>For 1-2 (c)</u> • Extracts of the tender specification showing the requirements to incorporate these control devices; and • Plan layouts showing the locations and the types of control devices used to regulate fresh air intake.
References	(a) SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment. (a) SS CP 13 – Code of Practice for Mechanical Ventilation and Air-Conditioning in Buildings.

Worked Example 1-2(a)(i)

For Water-Cooled Chillers and Plant

<u>Calculation of System Efficiency of Air-Conditioned Plant (using Centrifugal Water-Cooled Chillers)</u>

<u>Background info</u>
Air conditioned area = 311550 m^2
Designed total cooling capacity = 1950 ton

Based on contract or suppliers' specification, we have

1. <u>Centrifugal water cooled chillers :</u>
   (a) 3 nos of chillers with identical cooling load of 800 ton
   (b) Coefficient of Performance (COP) on full load = 6.4 kW/kW
   = (1/6.4)(3.5172)= 0.55kW/ton
2. <u>Chiller water pumps:</u>
   (a) 3 nos of identical water pumps
   (b) Water flow rate per pump = 121 L/s
   (c) Operating static = 30.5 m
   (d) Pump efficiency = 85%
   (e) Motor efficiency = 92%

Power per pump (kW) = $\frac{(Q)(\rho)(g)(h)}{(10^6)(\eta_p)(\eta_m)}$

where Q=water flow rate in L/s
ρ=density of water in kg/m^3
g=gravitational acceleration in m/s^2
h=static pressure head m
η_p= pump efficiency
η_m=motor efficiency

Power per pump (kW) = $\frac{(121)(1000)(9.81)(30.5)}{(10^6)(0.85)(0.92)}$ = 46.3 kW

Total pump (kW) = 46.3 x 3 = 138.9 kW
Total cooling capacity = 800 x 3 = 2400 ton
The pump performance = 138.9/ 2400 = 0.058 kW/ton

3. <u>Condenser water pumps:</u>
   (a) 3 nos of identical water pumps
   (b) Water flow rate per pump = 151.5 L/s
   (c) Operating static = 22.9 m
   (d) Pump efficiency = 85%
   (e) Motor efficiency = 92%

Power per pump (kW) = $\frac{(151.5)(1000)(9.81)(22.9)}{(10^6)(0.85)(0.92)}$ = 43.5 kW

Total pump (kW) = 43.5 x 3 nos = 130.5 kW
Total cooling capacity = 800 x 3 nos = 2400 ton
The pump performance = 130.5/ 2400 = 0.054 kW/ton

4. <u>Cooling towers with axial fans:</u>
   (a) 3 nos of identical cooling towers
   (b) Condenser water flow rate per cooling tower = 151.5 L/s
   (c) Fan motor rating per cooling tower = 43 kW

Total condenser water flow rate = 151.5 x 3 nos = 454.5 L/s
Total fan motor rating = 43 x 3 nos = 129 kW
Cooling tower performance at rating condition = 129/454.5 = 0.28 kW/L/s

Worked Example 1-2(a)(i) – Cont'd

For Water-Cooled Chillers and Plant

Table 1-2(a)(i)-1 : Equipment Efficiency (Chillers & Pumps)

Equipment Type	Proposed design based on specs (kW/ton)	Design based on code requirements (kW/ton)	Design Code
Chillers (e.g. greater than 300 tons)	0.55	0.577	SS 530
Chilled Water Pumps	0.058	0.117	CP13
Condenser Water Pumps	0.054	0.088	CP13
Total:	**0.662**	**0.782**	

% Improvement in Equipment Efficiency for Chillers & Pumps = $\frac{0.782-0.662}{0.782} \times 100 = 15.34\%$

Points scored = 1.45 pts x (% improvement) = 1.45 (15.34) = 22.34 points

Table 1-2(a)(i)-2 : Equipment Performance (Cooling Tower)

Equipment Type	Design based on SS 530 (kW/L/s)	Proposed design based on Specs (kW/L/s)
Cooling Tower (eg. axial fan type)	0.31	0.28

% Improvement in Equipment Performance for Cooling Tower = $\frac{0.31-0.28}{0.31} \times 100$

= 9.68%

Points scored = 0.05 x (% improvement) = 0.05 x 9.68 = 0.48 points

Total points scored for 1-2(a)(i) = 22.24 +0.48 = 22.72 > 20 points (max)

Therefore, points scored 1-2 (a)(i) should be 20 points (max)

Worked Example 1-2(a)(i)

For Air-Cooled Chillers and Plant

<u>Calculation of System Efficiency of Air-Conditioned Plant (using Air-Cooled Chillers)</u>

<u>Background info</u>
Air conditioned area = 81500 m^2
Designed total cooling capacity = 500 ton

Based on contract or suppliers' specification, we have

1. <u>Air-cooled chillers :</u>
   (a) 3 nos of chillers with identical cooling load of 200 ton
   (b) Coefficient of Performance (COP) on full load = 3.2 kW/kW
   = (1/3.2)(3.5172)= 1.10 kW/ton
2. <u>Chiller water pumps:</u>
   (a) 3 nos of identical water pumps
   (b) Water flow rate per pump = 78 L/s
   (c) Operating static = 16 m
   (d) Pump efficiency = 85%
   (e) Motor efficiency = 92%

Power per pump (kW) = : $\frac{(Q)(\rho)(g)(h)}{(10^6)(\eta_p)(\eta_m)}$ where Q=water flow rate in L/s
ρ=density of water in kg/m^3
g=gravitational acceleration in m/s^2
h=static pressure head m
η_p= pump efficiency
η_m=motor efficiency

Worked Example 1-2(a)(i) – Cont'd

For Air-Cooled Chillers and Plant

Power per pump (kW) = $\frac{(78)(1000)(9.81)(16)}{(10^6)(0.85)(0.92)}$ = 15.66 kW

Total pump (kW) = 15.66 x 3 = 46.98 kW
Total cooling capacity = 200 x 3 = 600 ton
The pump performance = 46.98/ 600 = 0.078 kW/ton

Table 1-2(a)(i)-1 : Equipment Efficiency (Chillers & Pumps)

Equipment Type	Proposed design based on specs (kW/ton)	Design based on code requirements (kW/ton)	Design Code
Air-Cooled Chillers	1.10	1.13	SS 530
Chilled Water Pumps	0.078	0.117	CP13
Total:	**1.178**	**1.247**	

% Improvement in Equipment Efficiency for Chillers & Pumps = $\frac{1.247-1.178}{1.247} \times 100$ = 5.53 %

Points scored = 1.45 pts x (% improvement) = 1.45 (5.53) = 8.02 points

Worked Example 1-2(a)(ii)

Calculation of Efficiency for Air Distribution Equipment

Background info
Based on contract or suppliers' specification, we have

1. AHUs (VAV system):
   a. Total fan power consumption = 293.2 kW = 293200 W
   b. Total air volume flow rate = 409212 CMH
   Equipment efficiency = 293200/409212 = 0.716 W/CMH

2. AHUs (CAV system):
   a. Total fan power consumption = 275.2 kW = 275200 W
   b. Total air volume flow rate = 678520 CMH
   Equipment efficiency = 275200/678520 = 0.406 W/CMH

3. FCUs
   a. Total fan power consumption = 411.52 kW = 411520 W
   b. Total air volume flow rate = 979805 CMH
   Equipment efficiency = 411520/979805 = 0.420 W/CMH

4. Overall required air distribution system efficiency specified under CP13

   = $\frac{(0.74)(409212)+(0.47)(678520)+(0.47)(979805)}{(409212+678520+979805)}$ = 0.523 W/CMH

5. Overall required air distribution system efficiency based on suppliers' specs/contract specs = (293200+275200+411520)/(409212+678520+979805)
   = 979920/2067537 W/CMH
   = 0.474 W/CMH

Worked Example 1-2(a)(ii) – Cont'd

Table 1-2(a)(ii) : Equipment Efficiency (Air-Distribution System)

Equipment Type	From Specs		Power Required by the motor based on design code CP 13 (W/CMH)	Power Required by the motor at design condition (W/CMH)
	Total air flow (CMH)	Total motor power rating (W)		
1. AHUs (VAV)	409212	293200	0.74	0.716
2. AHUs (CAV)	678520	275200	0.47	0.406
3. FCUs	979805	411520	0.47	0.420
Total	**2067537**	**979920**	**0.523**	**0.474**

see working (4) above

See working (5) above

% Improvement in Efficiency for Air Distribution Equipment $= \frac{0.523-0.474}{0.523} \times 100$

$= 9.37\%$

Points scored = 0.5 x (% improvement) = 0.5 x (9.37) = 4.69 points

Worked Example 1-2(b)

Calculation of Efficiency for Unitary Air Conditioners/Condensing Units

(1) Determine the design cooling capacities required for the different block, level and areas served.

(2) Determine the power input required based on design and SS 530 requirements.

Table 1-2(b)-1 : Summary of the design cooling capacity requirement

Block	Floor Level	Area served	Type of Air-Conditioners	Floor Areas (m^2)	Design Cooling Capacity	
					Indoor Unit (kW)	Outdoor Unit (kW)
Blk A	1st Sty	Meeting Room 1	VRV system 1	33	2.8	63.3
		Meeting Room 2		27	2.8	
		Seminar Room (3 nos)		198	14 x 3	
		Principal's Office		29.6	4.5	
		Officer's Room (4 nos)		12	4x2.8	
	2nd Sty	Staff Room	VRV system 2	652	5.6 x 14	78.4
Blk B	1st Sty	Computer Lab (4 nos)	VRV system 3	270	7.1 x 6 units	78.6
		IT Resource Room		30	9.0 x 4 units	

Worked Example 1-2(b) – Cont'd

Therefore, average % improvement in the efficiency of VRV systems is as follows:

Table 1-2(b)-2 : Efficiency for Unitary Air Conditioners/Condensing Units

Equipment Type	Design Cooling Capacity (kW) (a)	Minimum Efficiency based on SS 530 (b)	Design System efficiency from specs (c)	System Power Input based on SS 530 (kW) (a)/(b)	Design Power Input (kW) (a)/(c)
VRV system 1	63.3	2.84 COP	2.91 COP	22.29	21.75
VRV system 2	78.4	2.78 COP	2.89 COP	28.20	27.13
VRV system 3	78.6	2.78 COP	2.89 COP	28.27	27.20
			Total Power Input (kW)	78.76	76.08

$$\% \text{ average percentage improvement} = \frac{78.76 - 76.08}{78.76} \times 100 = 3.40\%$$

Points scored = 1.5 (% improvement) = 5.10 points

NRB 1-3 BUILDING ENVELOPE – DESIGN / THERMAL PARAMETERS

Objectives

Enhance the overall thermal performance of building envelope to minimise heat gain which would improve indoor thermal comfort and encourage natural ventilation.

Applicability

Applicable to non air-conditioned building spaces with aggregate areas > 10% of the total floor areas excluding carparks.

Baseline Standard

Baseline standard for 1-3(d) - U value for roof :

Weight Group	Weight range (kg/m^2)	Maximum Thermal Transmittance (W/m^{2}K)
Light	Under 50	0.8
Medium	50 to 230	1.1
Heavy	Over 230	1.5

Requirements

1-3(a) Up to 10 points can be scored if the building envelope is designed with minimum direct west facing façade by having better building orientation. Where there is no west facing façade, the points scored will be 24 points and the requirements under 1-3(b)(i), b(ii) and (c) will not be applicable for scoring.

Points scored = 10 – [0.2 x (% of west facing facade areas over total façade areas)]

Note : Orientation of façade that falls within the range of 22.5° N of W and 22.5° S of W will be defined as west facing façade (see illustrations below). Core walls for lifts or staircases and toilets that are located within this range are exempted in computation.

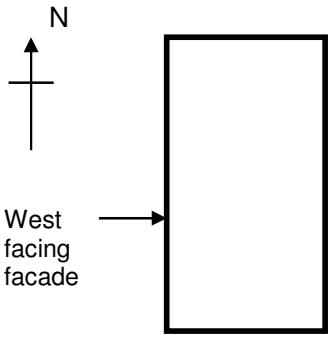


Illustration 1
An example of direct west facing facade

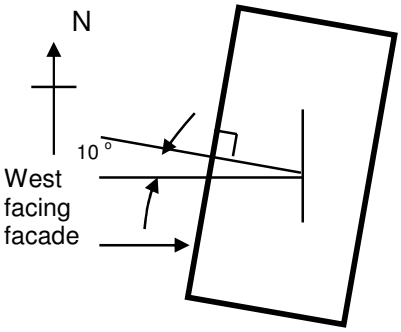


Illustration 2
The block is orientated 10°N of W which is less than of 22.5° N of W. In this instance, the façade is defined as 'west facing façade'.

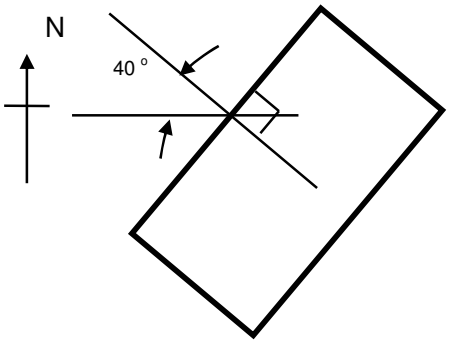


Illustration 3
The block is orientated 40°N of W which exceeds 22.5°N of W and hence the façade is not considered as 'west facing façade' in the computation.

Exception : For existing buildings, the requirement NRB 1-3(a) may be excluded in the computation. The total score obtained from NRB 1-3 and NRB 1-4 under Part 1 – Energy Efficiency will be prorated accordingly.

1-3(b) Up to 10 points can be scored for design with (i) minimum west facing window openings and/or (ii) having effective sunshading provision for windows with minimum shading of 30% on the west façade.

For 1-3 (b)(i) Points scored = 10 – [0.1 x (% of west facing window areas over total west facing façade areas)]

For 1-3 (b)(ii) Points scored = 0.1 x (% of west facing window areas with sunshading devices over total west facing façade areas)

Important notes *: For 1-3 (b)(ii) Points can only be scored if the sunshading devices meet at least a shading of 30% as tabulated in Table 1-3(b) below :*

Table 1-3(b) : Minimum Requirement on Shading Devices for West Facade

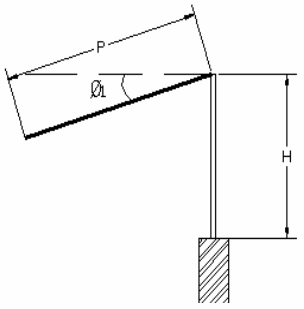
Types of Sunshading Devices	Angle of Inclination	Desired Shading			
		30%	40%	50%	60%
Horizontal Shading (R_1)	0°	0.6	0.9	1.5	
	20°	0.4	0.6	0.9	1.8
	40°	0.4	0.5	0.7	1.1
Vertical Shading (R_2)	0°	2.1			
	20°	1.1	1.7	2.5	
	40°	0.7	1	1.4	
	50°	0.6	0.9	1.1	2.8

where

Horizontal Shading/Projections (R_1)

$$R_1 = \frac{P}{H}$$

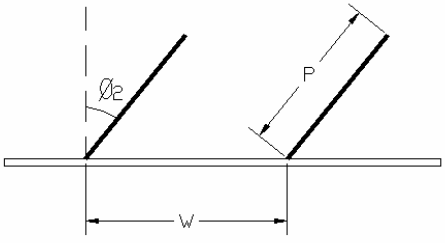
ϕ_1 = Angle of inclination



Vertical Shading/Projections (R_2)

$$R_2 = \frac{P}{W}$$

ϕ_2 = Angle of inclination



1.3(c) Up to 4 points can be scored for external west facing wall that are designed with better thermal transmittance that is a U-value of wall equal or less than 2 W/m^{2}K.

Points scored = 0.04 x (% of the external west facing walls areas with U-value of 2 W/m^{2}K or less over the total west facing façade areas)

	1.3(d) Up to 5 points can be scored for roof design with better thermal transmittance that is a lower U value of roof than the baseline standard. Points scored = 2 points for every 0.1 W/m^2K reduction from the baseline.
Documentary Evidences	<u>For 1-3(a)</u> • Architectural plan layouts and elevation drawings of the façades of all blocks. Highlight those areas that are considered as west facing façade ; and • Calculation showing the percentage of west facing façade areas in the prescribed tabulated format as shown in the worked example 1-3(a). <u>For 1-3(b)(i) and (ii)</u> • Architectural plan layouts and elevation drawings of west facing façade and window openings; • Sectional drawings showing the details of the sunshading devices. Highlight those sunshading devices that meet the 30% shading requirement ; • Window schedules or drawings showing the areas of the west facing windows; and • Calculation showing the percentage of west facing window areas in the prescribed tabulated format as shown in worked example 1-3(b). <u>For 1-3(c)</u> • Architectural drawings highlighting the material types and wall areas which are of better thermal transmittance (U-value); • Detailed sectional drawings showing the wall composition and the respective U-values; • Extracts of the tender specification which states the thermal transmittance properties to be adopted for west facing walls; and • Technical product information and relevant calculation on the U-value of the wall materials used. <u>For 1-3(d)</u> • Plan layout and sectional details of the different roof types of the development; • Extracts of the tender specification which states the thermal transmittance properties of roof ; • Detailed sectional drawings showing the roof composition and the respective U-values; and • Technical product information and relevant calculation of the U-value of the roof.
References	-
Worked Example 1-3(a)	(1) Determine the total areas of external façade. (2) Identify the façade areas that are within the range of 22.5° N of W and 22.5° S of W as west facing facades <u>Background info</u> Block 1: Total façade areas = 6000 m^2 West facing façade areas = 1500 m^2 Block 2 : Total façade areas = 8000 m^2 West facing façade areas = 1500 m^2 Block 3 : Total façade areas = 3000 m^2 West facing façade areas = 1000 m^2 (These wall areas are envelope of core wall for lifts and staircases)

Worked Example 1-3(a) – Cont'd

Table 1-3(a) Minimum direct west facing external facade

	Area of west facing external façade (m^2) (a)	Total area of external facade (b)	% of west facing external facade
Block 1	1500	6000	Σ (a)/ Σ (b) x100
Block 2	1500	8000	
Block 3	Exempted	3000	
Total	3000	17000	

Points scored for 1-3(a) = 10 – [0.2 x (Σ (a)/ Σ (b)) x100)]
= 10 – [0.2 x (3000/17000) x 100] = 6.47 points

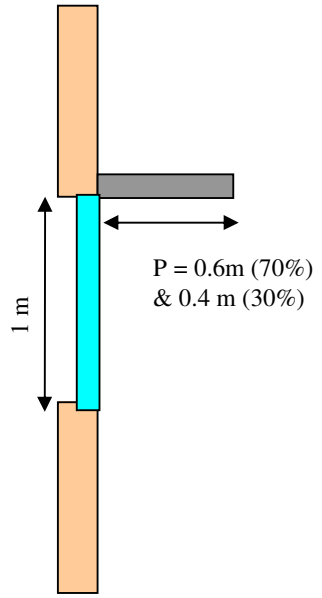
Worked Example 1-3(b)

(1) Identify the façade areas that are within the range of 22.5° N of W and 22.5° S of W as west facing façade.
(2) Determine the window areas on these facades.
(3) Determine if the sunshading provisions meet the minimum 30% shading.

Background info
Block 1 : West facing façade areas = 1500 m^2
Window areas = 600 m^2

There are two types of sunshading devices; 70% of the units have sunshading devices with horizontal projection (P) of 0.6 m and the rest of the 30% have sunshading devices with projection of 0.4 m.

Illustration 1 : Sectional detail of horizontal sunshading devices



Check

To determine if the sunshading provisions (i.e. horizontal projection (P)) meet the minimum 30% shading.

Refer to Table 1-3(b) *(as in page 90)*

Angle of inclination – 0°

R_1 = 0.6 / 1.0 = 0.6

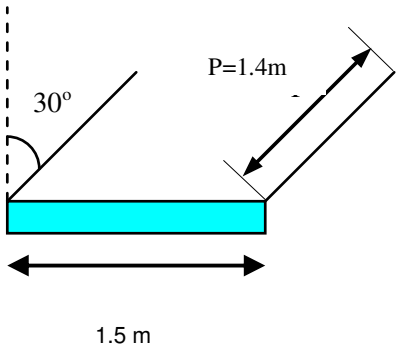
Min horizontal projection P = R_1 x H
= 0.6 x 1
= 0.6 m

Therefore sunshading devices with horizontal projection of 0.4 m will not be considered as effective.

Worked Example 1-3(b) – Cont'd

Block 2 : West facing façade areas = 1500 m^2
Window areas = 1000 m^2

Illustration 2 : Plan view of vertical sunshading devices



Check

To determine if the sunshading provisions meet (i.e. vertical projection (P)) the minimum 30% shading.

Refer to Table 1-3(b) *(as in page 90)*

Tilted Angle – 30°

R_2 = (1.1+0.7) / 2 =0.9 (interpolation)

Min vertical projection P = R_2 x W
= 0.9 x 1.5
= 1.35 m

Therefore, sunshading devices with vertical projection of 1.4 m ok.

Block 3 : West facing façade areas = 1000 m^2 (These wall areas are envelope of core wall for lifts and staircases)
Window areas = 0 m^2

Points scored for 1-3(b)(i) and 1-3(b)(ii) are as follows:

Table 1-3(b)(i) : Minimum west facing windows openings

Description	Area of west facing window area (m^2) (a)	Total area of west facing external façade (m^2) (b)	% of west facing window areas over total west facing external façade areas
Block 1	600	1500	Σ (a)/ Σ (b) x100
Block 2	1000	1500	
Block 3	0	1000	
Total	1600	4000	

Points scored for 1-3(b)(i) = 10 – [0.1 x ((Σ (a)/ Σ (b)) x 100)]
= 10 – [0.1 x (1600/4000) x 100)] = 6 points

Table 1-3(b)(ii) : Effective sunshading provisions for west facing window with minimum 30% shading

Description	Area of west facing window with effective sunshading provision (m^2) (a)	Total area of west facing external façade (m^2) (b)	% of west facing window areas over total west facing external façade areas
Block 1	420 (70% of 600)	1500	Σ (a)/ Σ (b) x100
Block 2	1000	1500	
Block 3	0	1000	
Total	1420	4000	

Points scored for 1-3(b)(ii) = 0.1 x [(Σ (a)/ Σ (b)) x100]
= 0.1 x [(1420 / 4000) x 100] = 3.55 pts

Therefore, points scored for 1-3(b) = 6 + 3.55 = 9.55 points

Worked Example 1-3(c)

Background info

Block 1 : West facing façade areas = 1500 m^2

Window areas = 600 m^2
Wall areas = 900 m^2

U-value of west facing wall areas is 2.0 W/ m^2K

Block 2 : West facing façade areas = 1500 m^2

Window areas = 1000 m^2
Wall areas = 500 m^2

Window areas = 1000 m^2

U-value of west facing walls is 2.5 W/ m^2K > 2.0 W/ m^2K not ok

Block 3 : West facing façade areas = 1000 m^2

Window areas = 0 m^2
Wall areas = 1000 m^2

U-value of external west facing walls is 2 W/ m^2K

Table 1-3(c): Better thermal transmittance of external west facing walls

Description	**Area of external west facing walls with U-value of 2W/m^2K or less (m^2) (a)**	**Total area of west facing external façade (m^2) (b)**	**% of west facing window areas over total west facing external façade areas**
Block 1	900	1500	$\sum$ (a)/ $\sum$ (b) x100%
Block 2	0	1500	
Block 3	1000	1000	
Total	1900	4000	

Points scored = 0.04 x [($\sum$ (a)/ $\sum$ (b)) x100)]

= 0.04 x [(1900/4000) x 100] = 1.9 pts < 4 points (max)

Worked Example 1-3(d)

Background info

Proposed development has 3 roof types with the designed U value of the roof as tabulated in the table below

Table 1-3(d): Better thermal transmittance of roof

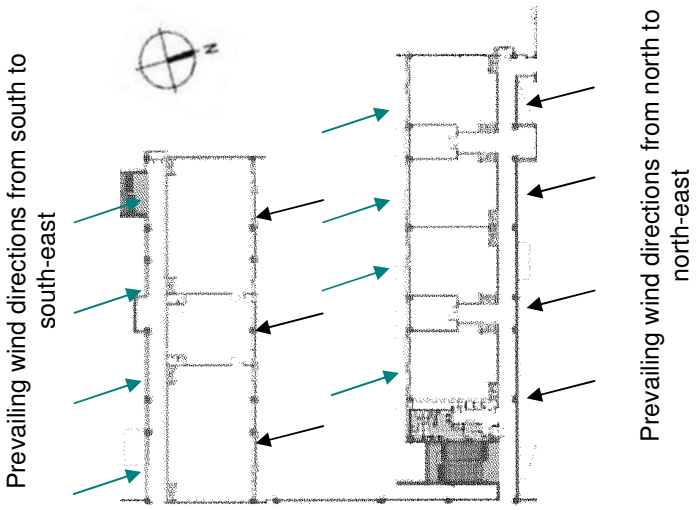
Roof Type	**Weight Group**	**Weight range (kg/m^2)**	**Maximum Thermal Transmittance (W/m^2K)**	**Designed U-value (W/m^2K)**	**Reduction (W/m^2K)**
Roof 1	Light	Under 50	0.8	0.6	0.2
Roof 2	Medium	50 to 230	1.1	0.8	0.3
Roof 3	Heavy	Over 230	1.5	1.0	0.5

Average reduction = (0.2 + 0.3 + 0.5) / 3 = 0.33

Points scored = (0.33 / 0.1) x 2 = 6.67 pts > 5 points (max)

Therefore, points scored should be 5 points (max)

NRB 1-4 NATURAL VENTILATION (EXCLUDE CARPARKS)

Objectives	Enhance building design to achieve good natural ventilation.
Applicability	Applicable to non air-conditioned building spaces with aggregate areas > 10% of the total floor areas excluding carparks.
Baseline Standard	-
Requirements	1-4 (a) Up to 8 points can be scored for building design that utilises prevailing wind conditions to achieve adequate cross ventilation. 0.8 point for every 10% of units/rooms with window openings facing north and south directions Points scored = 0.8 x (% of units / 10) Note: In Singapore, the prevailing wind comes from two predominant directions; that is the north to north-east during the Northeast monsoon season and south to south-east during the South-west monsoon season. Hence, buildings designed with window openings facing the north and south directions have the advantage of the prevailing wind conditions which would enhance indoor thermal comfort. Meteorological data on the more precise wind direction and velocity of the site location can also be used as the basis for the design. It is not necessary for the window openings to be located perpendicularly to the prevailing wind direction. An oblique angle is considered acceptable (see illustrations below).  Illustration 1 - Building layout shows all rooms with window openings facing the north and south directions.

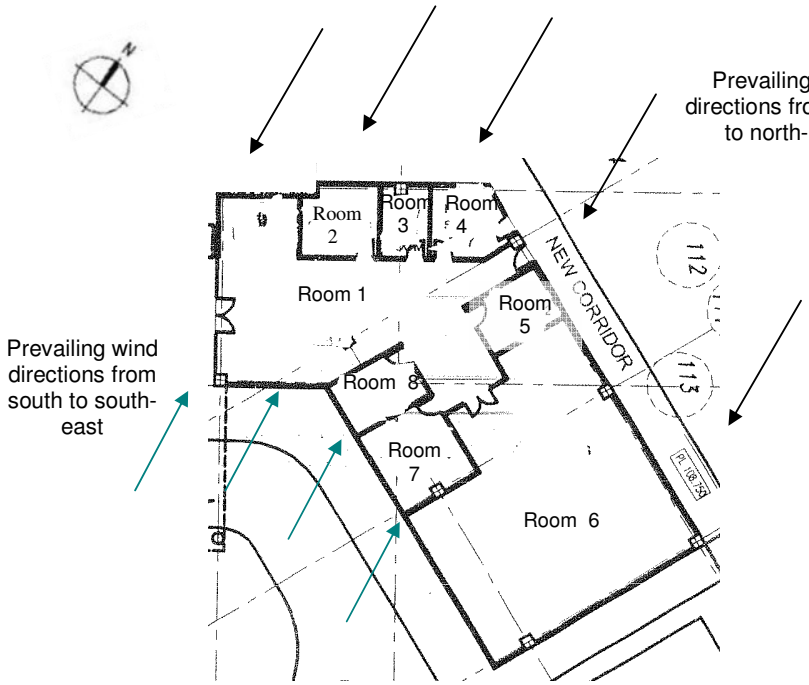


Illustration 2 - Building layout shows not all rooms with window openings facing the north and south directions. Room 2 to Room 5 would only have prevailing wind in one direction. Only Room 1 and 6 can be considered meeting the requirement 1-4 (a)

Alternative compliance : The application of ventilation simulation can be used to prove that the building layout utilises prevailing wind conditions and could achieve adequate cross ventilation within the indoor units through sufficient window openings. The ventilation simulation should be carried out in the same conditions outlined in para 1-4(b) below. Points should only be scored if the recommendations from the simulation are implemented.

1-4 (b) 5 points for the use of ventilation simulation software or wind tunnel testing to identify the most effective building design and layout in achieving good natural ventilation. The design should provide an average wind velocity within the space of at least 0.6 m/s or more. Points can only be scored if the recommendations from the ventilation simulation or wind tunnel testing are implemented.

The ventilation simulation shall be carried out with the following conditions:

- Assumed wind velocity of 2m/s in the north and south directions or based on meteorological data on precise wind direction and velocity of the proposed site location for the month of December and June.
- Characteristics of the surroundings and buildings which have significant impact on the wind pattern and indoor air velocity to be included in the modeling and simulation.

<table>
<tr><td>Documentary Evidences</td><td>
<u>For 1-4(a)</u>
• Architectural plan layouts showing the units / rooms of all blocks with highlights of those with window openings in the N-S direction and/or with air-conditioned systems;
• Calculation showing the percentage of units or rooms with window openings facing north and south directions in the prescribed tabulated format as shown in the worked example 1-4(a).

<u>For 1-4(b)</u>
• Ventilation simulation or wind tunnel testing reports summarising the analysis and simulation results for each typical space as well as the recommendations for design.
</td></tr>
<tr><td>References</td><td>-</td></tr>
<tr><td>Worked Example 1-4(a)</td><td>
<u>Background info</u>
A school development comprises two 3-storey classroom block A and A1 with majority of the window openings facing the N-S direction, a 4 storey classroom Block B with window opening in the E-W direction and three blocks of office, meeting rooms and computer rooms which are air-conditioned.
<table>
<tr><th>Ref</th><th>Description</th><th>Units/Rooms with window openings in the N-S direction
(a)</th><th>Total no. of naturally ventilated units/room
(b)</th><th>% of units/rooms with window openings in N-S direction</th></tr>
<tr><td>1</td><td>Classroom Blk A & A1</td><td>40</td><td>60</td><td rowspan="4">∑ (a)/ ∑ (b) x100</td></tr>
<tr><td>2</td><td>Classroom Blk B</td><td>0</td><td>40</td></tr>
<tr><td>3</td><td>Offices, meeting rooms and computer rooms with air-conditioning</td><td>NA</td><td>NA</td></tr>
<tr><td colspan="2">Total :</td><td>40</td><td>100</td></tr>
</table>
Points scored = 0.8x (% of units / 10)
= 0.8 x [(∑ (a)/ ∑ (b) x100) /10]
= 0.8 x [(40/100 x 100) / 10] = 3.2 pts < 8 points (max)
</td></tr>
</table>

NRB 1-5 ARTIFICIAL LIGHTING

Objectives	Encourage the use of better efficient lighting to minimise energy consumption from lighting usage while maintaining proper lighting level.
Applicability	Applicable to lighting provisions for the type of usage specified in the SS 530 Clause 7 – Lighting power budget.
Baseline Standard	Maximum lighting power budget stated in SS 530 - Code of Practice for Energy Efficiency Standard for Building Services and Equipment.
Requirements	Up to 12 points if tenants' light is provided OR Up to 5 points if tenants' light is excluded for the improvement in the lighting power consumption. 0.5 point for every percentage improvement in the lighting provisions over the baseline standard. That is Points scored = 0.5 x (% improvement) Display lighting and specialised lighting are to be included in the calculation of lighting power budget. The design service illuminance, lamp efficacies and the light output ratios of luminaries shall be in accordance with SS 531 : Part 1 – Code of Practice for Lighting of Work Places - Indoor
Documentary Evidences	• Lighting layout plan; • Lighting schedules showing the numbers, locations and types of lighting luminaries used; • Calculation of the proposed lighting power budget and the percentage improvement in the prescribed tabulated format as shown in the worked example 1-5; and • Technical product information of the lighting luminaries used.
References	SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment. SS 531 : Part 1 – Code of Practice for Lighting of Work Places - Indoor
Worked Example 1-5	(1) Determine the total power consumption based on the lighting layout design for each area and light fitting types used. (2) Calculate the total power consumption based on the maximum lighting power budget stated in SS 530. (3) Calculate the percentage improvement in the total power consumption.

Worked Example 1-5 – Cont'd

Table 1-5-1: Total power consumption based on each fitting type

Description	Areas (m^2) (A)	Light Fitting Type (B)	Power Consumption per fitting (W) (C)	Ballast Loss (W) (D)	No. of Fittings (E)	Total power consumption based on fitting type [(C+D) x (E)]
Office Space Type 1	1500	T5	2x28	3	245	14455
Office Space Type 2	1250	T5	2x 28	3	210	12390
Meeting Room	75	T8	1x36	3	15	585
		Surface downlight	2x26	0	8	416
Corridors Type 1	150	T5	2x28	3	15	885
Corridors Type 2	205	T5	2x28	3	15	885
		Surface downlight	1x70	0	9	630
Atrium	850	T8	2x36	3	87	6525
		Surface downlight	1x150	0	10	1500
Carparks	7500	T5	2x28	3	436	25724
Staircase	300	T5	2x28	3	20	1180
					Total :	65175

Table 1-5-2 : Total power consumption based on design and SS 530 requirements

Description	Areas (m^2) (A)	Design Data		SS 530 Requirements	
		Total Power Consumption (by area)(W) (F)	Design Lighting Power Budget (W/m^2) (F/A)	Reference Lighting Power Budget (W/m^2) (H)	Reference Total Power Consumption (by area) (W) (H x A)
Office Space Type 1	1500	14455	9.64	15	22500
Office Space Type 2	1250	12390	9.91	15	18750
Meeting Room	75	1001	13.35	15	1125
Corridors Type 1	150	885	5.90	10	1500
Corridors Type 2	205	1515	7.39	10	2050
Atrium	850	8025	9.44	10	8500
Carparks	7500	25724	3.43	5	37500
Staircase	300	1180	3.93	6	1800
Total :		65175			93725

Worked Example 1-5 – Cont'd	Therefore % improvement in the lighting power consumption = [Σ (HxA) - Σ (F)] /Σ (HxA) x 100 = (93725-65175)/93725 x 100 = 30.46% Points scored = 0.5 x 30.46% = 15.23 points > 5 points (max) or 12 points (max) Therefore, points scored should be 12 points (max) if tenant's lighting is included or 5 points (max) if tenant's lighting is not included

NRB 1-6 VENTILATION IN CARPARKS

Objectives	Encourage the use of energy efficient design and control of ventilation systems in carparks.
Applicability	Applicable to all carpark spaces in the development.
Baseline Standard	-
Requirements	1-6(a) 5 points can be scored if the carparks spaces that are fully naturally ventilated. 1-6(b) For carparks that have to be mechanically ventilated, points can be scored for the use of carbon monoxide (CO) sensors in regulating such demand based on the mode of mechanical ventilation (MV) used; 4 points for carparks using fume extract system and 3 points for those with MV with or without supply. Note : Where there is a combination of different ventilation mode adopted for carpark design, the points scored under this requirement will be prorated accordingly.
Documentary Evidences	<u>For 1-6 (a) and (b)</u> • Plan layouts showing all carpark provisions for the development with highlights of the carpark spaces that are designed to be naturally ventilated and/or mechanical ventilated; • Plan layouts indicating the locations of CO sensors and the mode of ventilation adopted for the design; and • Calculation showing the points allocation if there is a combination of different ventilation modes adopted for the carpark design.
References	SS CP 13 – Code of Practice for Mechanical Ventilation and Air-Conditioning in Buildings.
Worked Example 1-6	Proposed development has a 6-storey naturally ventilated carparks and one level of mechanically ventilated basement carparks with CO sensors to be installed to regulate MV. Areas of naturally ventilated carparks = 6 x 600 = 3600 m^2 Areas of basement carparks = 600 m^2 Total areas = 4200 m^2 Points scored for 1-6 = (3600/4200) x 5 + (600/4200) x 3 = 4.71 points

NRB 1-7 VENTILATION IN COMMON AREAS

Objectives	Encourage the use of energy efficient design and control of ventilation systems in common areas.
Applicability	Applicable to the following common areas of the development. ▪ Toilets ▪ Staircases ▪ Corridors ▪ Lift Lobbies ▪ Atriums
Baseline Standard	-
Requirements	Up to 5 points can be scored for the use of natural ventilation as an effective passive cooling design strategy to reduce the energy used by air-conditioning systems in these common areas. Extent of coverage : At least 90% of each applicable area (by numbers). Points are scored based on the mode of ventilation provided in these applicable areas. Natural ventilation – 1.5 points for each area Mechanical ventilation – 0.5 points for each area
Documentary Evidences	• Plan layouts showing the applicable areas and the respective modes of ventilation; and • Schedules showing the numbers, locations of the applicable areas and the modes of ventilation used.
References	SS CP 13 – Code of Practice for Mechanical Ventilation and Air-Conditioning in Buildings.
Worked Example 1-7	Proposed development has the following details : No. of toilets = 45 ; where 10 units are designed with air-conditioning % of toilet units with natural ventilation = (45-10)/45 = 77.8 % < 90% and hence no point for this item No. of staircases = 100 ; all are mechanical ventilated – 0.5 points No. of lift lobbies = 22 ; all are naturally ventilated – 1.5 points Points scored for 1-7 = 0.5 +1.5 = 2 points < 5 points(max)

NRB 1-8 LIFTS AND ESCALATORS

Objectives	Encourage the use of energy efficient lifts and escalators.
Applicability	Applicable to all lifts and/or escalators in the development.
Baseline Standard	-
Requirements	1 point can be scored for the use of lifts with energy efficient features such as AC variable voltage and variable frequency (VVVF) motor drive or equivalent. 1 point can be scored for the use of lifts with sleep mode features. 1 point can be scored for the use of escalators with motion sensors to regulate usage.
Documentary Evidences	Extracts of the tender specification indicating the types of lifts, escalators and related features.
References	-
Worked Example 1-8	Proposed development has the following provision : Two lift types : Type L1 with VVVF motor drive Type L2 with sleep mode features Two escalator types : Type E1 with motion sensors Type E2 without motion sensors 2 points for the use of lifts with VVVF and sleep mode features. No point for escalators as not all escalators are designed with motion sensors Points scored for 1-8 = 2 points

NRB 1-9 ENERGY EFFICIENT PRACTICES & FEATURES

Objectives	Encourage the use of energy efficient practices and features which are innovative and have positive environmental impact in terms of energy saving.
Applicability	Applicable to practices and features that are not listed in the requirements under Part 1 – Energy Efficiency.
Baseline Standard	-
Requirements	1-9 (a) 1 point can be scored for the practice of using Energy Efficiency Index (EEI) as a building performance indicator to measure the building's unit area energy consumption for future monitoring and improvements. Calculation of EEI : EEI = [(TBEC - DCEC) / (GFA – DCA)] x (NF/OH) *where:* (a) TBEC : Total building energy consumption (kWh/year) (b) DCEC : Data centre energy consumption (kWh/year) (d) GFA : Gross floor area (exclude car park area) (m^2) (e) DCA : Data centre area (m^2) (f) NF : Normalising factor based on a typical weekly operating hours that is 55 hrs/week (g) OH : Weighted weekly operating hours (hrs/week) Note : (1) EEI is based on 100% occupancy rate for consistency. (2) All major energy consumption equipments are to be included in the estimation of total building energy consumption. (3) For industrial buildings, process load should be excluded. 1-9(b) Up to 11 points can be scored for the use of the following approved energy efficient features depending on the potential energy saving. ▪ Thermal storage system ▪ Heat recovery devices ▪ Light shelves ▪ Motion sensors for staircases half landing and toilets ▪ Sun pipes for natural lighting ▪ Ductless fans for basement ventilation ▪ Auto-condenser tube cleaning system ▪ Photo sensors to maximize the use of daylighting ***Important notes :*** *For features that are not listed NRB 1-9(b) above, the QP is required to submit the details showing the positive environmental impacts and potential energy savings of the proposed features to BCA for assessment before the submittal of Green Mark Score.*

Documentary Evidences

For 1-9(a)

- Calculation of the Energy Efficiency Index (EEI) in the prescribed tabulated format as shown in the worked example 1-9(a).

For 1-9(b)

- Extracts of the tender specification showing the provision of the proposed energy efficient features and the extent of implementation where applicable;
- Technical product information on the energy efficient features used; and
- Calculation of the potential energy savings that could be reaped from the use of these features.

References

NUS Centre for Total Building Performance:
http://www.bdg.nus.edu.sg/buildingenergy/e_energy/audit_results.html

Worked Example 1-9(a)

(1) Determine the total annual building electricity consumption (TBEC) based on the estimated electricity consumption and usage pattern in term of operation hours of all the major energy consumption systems and equipments.
(2) Compute the Energy Efficiency Index of the building .

Background info :

Assume a proposed development with GFA of 86 000 m^2, operational hours per week is 55 hours at 100% occupancy rate. No data centre in the building.

Table 1-9(a) : Total Building Electricity Consumption (TBEC) per year

System/ Equipment	Total Annual Building Electricity Consumption (KWh)/year
Lighting – (Air-Conditioned Space)	3094380
Lighting- (Non Air-Conditioned Space)	236321
Exterior Lighting	405800
Air-Conditioned Plant	7924425
Air System Fans	632293
Mechanical Ventilation Fans	207571
Lifts	792966
Escalators	45865
Receptacle Equipment * (@16W/m^2)	3936517
Domestic Water Pump Systems	226088
Hot Water Systems	93789
Others	-
Total :	17596015

*For tenant receptacle load, the nominal values shown in the following table can be adopted.

Receptacle Loads	Nominal Values
Computer intensive offices	22 W/m^2
General office areas	16 W/m^2
Large conference areas	11 W/m^2
Server/Computer rooms	540 W/m^2

Source: ASHRAE STD 90.1:1999

Total annual building electricity consumption (TBEC) = 17596015 kWh/year

Therefore, the Energy Efficiency Index (EEI) of the building is as follows:

EEI = (TBEC/GFA) X (NF/ OH) *where NF is assumed to be 55 hrs/week and the operation hours is 55 hrs/week*

= (17596015 / 86000) x (55/55)

= 204.6 kWh/m^2 /yr

Points scored for 1-9(a) = 1 point

Worked Example 1-9(b)

The same proposed development has included the use of motion sensors for all staircases and toilets.

(i) Toilets

Total light fittings to be controlled by motion sensors = 2 x 350 nos.

Power consumption by light fitting = 2 x 350 x 36 W = 25200 W

Assume 5 hours per day that the light fittings are off when it is not occupied.

Electricity saving = 25200 W x 5 hours = 126 kWh

Annual electricity saving = 126 x 365 = 45990 kWh

(ii) Staircases

Total light fittings to be controlled by motion sensors = 2 x 180 nos.

Power consumption by light fitting = 2 x 180 x 18 W = 6480 W

Assume 10 hours per day that the light fittings are off when it is not used

Electricity saving = 6480 W x 10 hours = 64.8 kWh

Annual electricity saving = 64.8 x 365 = 23652kWh

Total annual electricity saving using motion sensors = 45990 +23652
= 69642 kWh

% energy savings = 69642/17596015 = 0.396 %

Points scored for 1-9(b) = 3 points for every 1 % energy saving

= 3 x 0.396 = 1.19 points

NRB 1-10 RENEWABLE ENERGY

Objectives	Encourage the use of renewable energy sources in buildings.
Applicability	Includes all renewable energy sources
Baseline Standard	-
Requirements	Up to 20 *Bonus* points can be scored based on the percentage replacement of electricity by the renewable energy source : 5 points for every 1% replacement of electricity (based on total electricity consumption) by renewable energy OR 3 points for every 1% replacement of electricity (exclude tenant's usage) by renewable energy
Documentary Evidences	• Extracts of the tender specification and plans showing the location of the renewable energy system and the extent of implementation; • Technical product information on the salient features of the renewable energy system and the expected renewable energy generated; and • Calculation of the percentage replacement of electricity and the total annual electricity consumption of the development.
References	-

(II) Other Green Requirements

Part 2 – Water Efficiency

NRB 2-1 WATER EFFICIENT FITTINGS

<table>
<tr><td>Objectives</td><td>Reduce the use of potable water by using water efficient fittings covered under the Water Efficiency Labelling Scheme (WELS).</td></tr>
<tr><td>Applicability</td><td>Applicable to all water fittings covered by the WELS as follows:
Basin taps and mixers
Sink/bib taps and mixers
Shower taps and mixers
Showerheads
Dual-Flush Low Capacity Flushing Cisterns
Urinals and Urinal Flush Valves</td></tr>
<tr><td>Baseline Standard</td><td>As specified under Water Efficiency Labelling Scheme (WELS).</td></tr>
<tr><td>Requirements</td><td>Up to 8 points can be scored based on the number and water efficiency rating of the fitting type used.<table><tr><th>WELS Rating</th><th>Water Efficiency</th><th>Weightage for Point Allocation</th></tr><tr><td>✓</td><td>Good</td><td>4</td></tr><tr><td>✓✓</td><td>Very Good</td><td>6</td></tr><tr><td>✓✓✓</td><td>Excellent</td><td>8</td></tr></table></td></tr>
<tr><td>Documentary Evidences</td><td>Extracts of the tender specification showing all the water fitting provisions for the development;
Water fitting schedules showing the numbers, types and the approved rating of the proposed fittings in the prescribed tabulated format shown in the worked example; and
Calculation showing the percentage of proposed water fittings that are approved under WELS.</td></tr>
<tr><td>References</td><td>For more information about WELS, refer to

Inspectorate Branch
Water Demand Management & Inspectorate Division
Water Supply (Network Department)
PUB</td></tr>
</table>

Worked Examples

Example of a water fitting schedule showing the numbers, types and the approved rating of the proposed fittings.

Table 2-1 –Computation of the percentage of water fittings under WELS

Ref.	Water Fitting Type	WELS rating			No approved rating	Total no. based on fitting type
		Excellent	Very Good	Good		
1	Shower taps and mixers	0	30	0	30	60
2	Showerheads	0	30	0	30	60
3	Basin taps and mixers	100	10	0	100	210
4	Sink/bib taps and mixers	0	0	30	0	30
5	Dual-flush low capacity flushing cisterns	0	80	0	0	80
6	Urinals and urinal flush valves	50	0	0	0	50
Total no. based on rating (A)		150	150	30	160	∑A =490
Weightage (B)		8	6	4	0	0
Total (AXB)		1200	900	120	0	∑(AxB) =2220

Points scored = ∑(AxB) / ∑A

= 2220/490

= 4.53 points

NRB 2-2 WATER USAGE AND LEAK DETECTION

Objectives	Promote the use of sub-metering and leak detection system for better control and monitoring of water usage.
Applicability	Applicable to sub-metering provisions for major water uses of the building developments.
Baseline Standard	-
Requirements	2-2(a) 1 point can be scored if sub-meters are provided for all major water uses i.e. irrigation system, cooling towers and tenant's usage where applicable. 2-2(b) 1 point can be scored if all sub-meters are linked to the Building Management System (BMS) for monitoring and leak detection. The BMS should have specific alert features that can be set and triggered to detect the possibility of water leakage during operation.
Documentary Evidences	For 2-2(a) • Extracts from the tender specification stating the provision of sub-metering for all major water uses. • Schematic drawings of cold water distribution system showing the location of the sub-metering provided. For 2-2(b) • Extracts from the tender specification and schematic drawings showing the location of sub-metering and its linkage to the BMS.
References	-

NRB 2-3 IRRIGATION SYSTEM

Objectives	Reduce potable water consumption by provision of suitable systems that utilise rainwater or recycled water for landscape irrigation.
Applicability	Applicable to development with landscaping provision.
Baseline Standard	-
Requirements	2-3(a) 1 point can be scored for the use of non-potable water including rainwater for landscape irrigation. 2-3(b) 1 point can be scored if more than 50% of the landscape areas are served by water efficient irrigation system with features such as automatic sub-soil drip irrigation system with rain sensor control.
Documentary Evidences	<u>For 2-3(a)</u> • Extracts of the tender specification showing how the non-potable water source is to be provided; • Relevant drawings showing the location and design of the non-potable water source; and • For rainwater harvesting and storage system, approval letter from PUB is to be provided. <u>For 2-3(b)</u> • Extracts of the tender specification showing the provision and details of water efficient irrigation system; • Relevant layout plans showing the overall landscape areas and the areas that would be served using the system; and • Calculation showing the percentage of the landscape areas that would be served using the system.
References	-

NRB 2-4 WATER CONSUMPTION OF COOLING TOWER

Objectives	Reduce potable water consumption for cooling purpose.
Applicability	Applicable to building developments with water-cooled central chillers systems and water cooled package units.
Baseline Standard	-
Requirements	2-4(a) 1 point can be scored for the use of cooling tower water treatment system which can achieve 6 or better cycles of concentration at acceptable water quality. 2-4(b) 1 point can be scored for the use of NEwater or on-site and recycled water from approved sources to meet the water demand for cooling purpose.
Documentary Evidences	<u>For 2-4(a)</u> • Extracts of the tender specification showing the requirements to incorporate with the cooling tower designs to achieve six cycles of concentration; • Details showing how the cooling towers have been designed to achieve at least six cycles of concentration; and • Relevant drawings showing the location of the cooling towers and other supporting systems that are required to achieve the designed concentration. <u>For 2-4(b)</u> • Extracts of the tender specification showing how the Newater or other recycled water source is to be provided.
References	-

(II) Other Green Requirements

NRB 3-1 SUSTAINABLE CONSTRUCTION

Objectives	Encourage the adoption of building designs, construction practices and materials that are environmentally friendly and sustainable.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
Requirements	3-1(a) Up to 4 points are allocated to encourage more efficient concrete usage for building components based on the percentage reduction in the prescribed Concrete Usage Index (CUI) limit.

Note : *Concrete Usage Index* (CUI) is an indicator of the amount of concrete used to construct the superstructure which includes both the structural and non-structural elements. CUI does not include the concrete used for external works and sub-structural works such as basements and foundations. CUI is defined as the volume of concrete in cubic metres needed to cast a square metre of constructed floor area. It is expressed as:

$$\text{Concrete Usage Index} = \frac{\text{Concrete Volume in m}^3}{\text{Constructed Floor Area in m}^2}$$

Table 3-1(a) CUI Limit for Non-Residential Building

CATEGORY	Concrete Usage Index (CUI) limit (m^3/m^2)
Non-Residential (15 storey & below)	0.50
Non-Residential (above 15 storey)	0.55

3-1(b) Up to 2 points can be scored if more than 50% of the existing structural elements or building envelopes (by areas) are conserved during redevelopment. Structural elements refer to slabs, columns, beams and load bearing walls.

3-1(c) Up to 8 points are allocated to encourage the use of sustainable materials and products in building construction such as :

(i) Up to 4 points for the use of environmental friendly products that are certified under the Singapore Green Labelling Scheme (SGLS) where 1 point for each high impact item and 0.5 point for each low impact item.

(ii) Up to 4 points for the use of products (applicable only for non-structural elements) with at least 30% recycled content by weight or volume where 1 point for each high impact item and 0.5 point for each low impact item

Note (1) : The use of environmental friendly products or recycled products used for the main building elements or functional spaces will be considered as high impact if the quantities used by percentage is more than 50% as compared to the total amount of materials used for same intended purpose.

Note (2) : The point allocated for low volatile organic compound (VOC) paints and adhesives certified under SGLS can be found in NRB 4-3 and hence shall not be included in the scoring for NRB 3-1(c)(i) and (ii).

Documentary Evidences

For 3-1(a)

- Architectural and structural plan layout, elevation and sectional plans showing the type of wall system used, the dimensions and sizes of all the building and structural elements; and
- Calculation showing the quantity of concrete for each floor level in the prescribed tabulated format shown in worked example 3-1(a). The calculation should include all the building elements as listed in the worked example.

For 3-1(b)

- Architectural and structural plan layout, elevation and sectional plans of the proposed building showing the areas of the existing building envelope or structural elements that are to be conserved;
- Calculation showing that the percentage of building envelope or structural elements being conserved; and
- Extracts from the tender specification and documents indicating the portion of existing building envelope or structural elements to be conserved.

For 3-1(c)

- Extracts from the tender specification showing the requirements to incorporate the environmental friendly products that are certified with SGLS.
- Extracts from the tender specification showing the requirements to incorporate the use of recycled products
- Technical product information on the recycled products and their recycled contents by weight or volume.

References

-

Worked Example 3-1(a)

Proposed development comprises a 30 storey office block with two basement carparks and the following details :

Concrete usage for the superstructure	**Constructed floor areas**
For 1st storey = 1035.5 m^3 From 2nd to 30th storey = 27 060 m^3 (including roof level)	For 1st storey = 2200 m^2 From 2nd to 30th storey = 57798 m^2 (including roof level)
Therefore, Total concrete usage = 28 095.5 m^3	Therefore, Total constructed floor areas = 59998m^2

Note : The concrete usage for foundation and two basements are not required to be included.

Concrete Usage Index CUI = $\frac{28095.5}{59998}$ = 0.47 m^3/m^2

For non-residential buildings > 15 storey, the CUI limit = 0.55

% reduction in CUI = (0.55-0.47)/(0.55) = 14.5 %

Points scored = 0.1 x (14.5%)= 1.45 points

Refer to the following Table 3-1(a) for more details

Worked Example 3-1(a) – Cont'd

Table 3-1(a) – Concrete Usage Index

COMPUTATION OF CONCRETE USAGE INDEX				NON-RESIDENTIAL BLDG
Project Reference No.: AXXXX-00001-2007			Total no. of storey for the project: 30	
Block No : A				
	Structural System	Thickness (mm) or size (mm x mm)	Volume of concrete (m^3)	Remark *
1	1st storey			
	1.1 Columns	300x300, 400x400	120	Precast
	1.2 Beams	300x500, 200x500	320	Precast
	1.3 Slabs	200,225,250	400	Post – tensioned
	1.4 Staircases	175	93.5	Precast
	1.5 Suspended structures like planter boxes, bay windows, ledges etc	–	0	–
	1.6 Parapets	–	0	–
	1.7 External walls - loadbearing walls	Nil	0	–
	1.8 External walls – non-loadbearing walls	125	22	RC
	1.9 Internal walls – loadbearing walls	200	55	RC
	1.10 Internal walls – non-loadbearing walls	100	10	Light weight concrete
	1.11 Others (kerbs, ramps, services risers, etc)	Not required	15	RC
	Total volume of concrete for this storey (m^3)		1035.5	
	Total constructed floor area for this storey (m^2)		2200	
2	Typical floor layout			
	2.1 Columns	300x300, 400x400	115	Precast
	2.2 Beams	300x500, 200x500	301.5	Precast
	2.3 Slabs	200,225,250	320	Post – tensioned
	2.4 Staircases	175	93.5	Precast
	2.5 Suspended structures like planter boxes, bay windows, ledges etc	Nil	0	–
	2.6 Parapets	Nil	0	–
	2.7 External walls - loadbearing walls	Nil	0	–
	2.8 External walls – non-loadbearing walls	125	22	RC

Worked Example 3-1(a) – Cont'd

COMPUTATION OF CONCRETE USAGE INDEX — **NON-RESIDENTIAL BLDG**

Project Reference No.: AXXXX-00001-2007 — **Total no. of storey for the project: 30**

Block No : A

	Structural System	Thickness (mm) or size (mm x mm)	Volume of concrete (m^3)	Remark *
2	**2nd storey to 30th storey (Typical floor layout)**			
	2.9 Internal walls – loadbearing walls	250,300	50	RC
	2.10.Internal walls – non-loadbearing walls	Nil	0	–
	2.11 Others (kerbs, ramps, services risers etc)	Nil	0	–
	Volume of concrete for one storey (m^3)		902	
	Constructed floor area for one storey		1926.6	
	Total volume of concrete for 2nd to 30th storey (including roof level)		902 X 30 = 27060	
	Total constructed floor area for 2nd to 30th storey (m^2) (including roof level)		1926.6 x 30 = 57798	
	Total volume of concrete for this project (m^3)		28095.5	
	Total constructed floor area for this project (m^2)		59998	
	Concrete Usage Index (CUI in m^3/m^2)		0.47	

*To indicate if the structural elements is of precast concrete, post-tensioned concrete, high strength concrete (> Grade 60) or reinforced concrete (RC) under the 'Remarks' column

Important notes : *The quantities of the concrete for all the structural and non-structural elements for each floor level are computed. All the elements listed in the table such as columns, beams, slabs, suspended structures (like planter boxes, bay windows and ledges etc) , parapets, walls and others (service risers, kerbs, ramps etc) are to be included. The concrete usage for foundation and basement works are excluded in CUI computation.*

Worked Example 3-1(b)

Proposed redevelopment has conserved more than 50% of the floor slabs of an existing two-storey shop house to the new building design.

Check

Structural System	Area to be conserved (m^2)	Total Floor Area (m^3)
1. 1st storey floor slab	150	200
2. 2nd storey floor slab	70	200
Total :	220	400
% area of existing structural elements being conserved		220/400 x 100 = 55% > 50% ok
Points scored :		2 points

Worked Example 3-1(c)(i)	1. Determine if the environmental friendly products selected are certified under SGLS as GreenLabel products. 2. Check if the products used are meant for main building elements or functional spaces and can be considered as high impact. Examples are internal drywall partitions in every functional space unit, carpets for office spaces, compact fluorescent lighting etc. Products that are meant for common areas and external works such as toilets, lobbies and landscaping areas are considered as low impact. 3. If the selected products are potential high impact items, then determine the quantities used for these products as compared to the total quantities required for the same intended purpose. If the quantities of the products are more than 50% of the total requirement, it is considered as high impact. If it is less than 50% of the total requirement then it should be considered as low impact. Example of a proposed development with the following provision: (a) Use of carpets that are GreenLabel for all the office spaces - 1 point (b) Use of GreenLabel panel boards as internal partitions for 50% of the office spaces - 1 point (c) Use of precast concrete road kerbs - 0.5 point Points scored for 3-1(c)(i) = 1+1+0.5 = 2.5 points
Worked Example 3-1(c)(ii)	1. Determine if the recycled products used in non-structural elements and have at at least 30% recycled content by weight or volume. 2. Same as above. *Check if the products used are meant for main building elements or functional spaces and can be considered as high impact. Examples are internal drywall partitions in every functional space unit, carpets for office spaces, compact fluorescent lighting etc. Products that are meant for common areas and external works such as toilets, lobbies and landscaping areas are considered as low impact.* 3. Same as above. *If the selected products are potential high impact items, then determine the quantities used for these products as compared to the total quantities required for the same intended purpose. If the quantities of the products are more than 50% of the total requirement, it is considered as high impact. If it is less than 50% of the total requirement then it should be considered as low impact.* 4. For products that are already scored under 3-1(c)(i) are to be excluded. The same proposed development in example 3-1(c)(i) also has the following provision: (a) Use of panel boards with 40% recycled content (but not GreenLabel) as internal partitions for the other 50% of the office spaces. No point can be scored as the same product type has already been considered in the above scenario in example 3-1(c)(i). (b) Use of concrete pavers that are not GreenLabel but with 40% recycled content - 0.5 point Points scored for 3-1(c)(ii) = 0.5 point Therefore, total points scored for 3-1(c) = 2.5 +0.5 = 3 points

NRB 3-2 GREENERY

Objectives	Encourage greater use of greenery and restoration of existing trees to reduce heat island effect.
Applicability	Applicable to building developments with landscaping areas.
Baseline Standard	-
Requirements	3-2(a) Up to 4 points can be scored for the provision of greenery within the developments including roof top/ sky garden and green roof. Greenery Provision (GnP) is calculated by considering the 3D volume covered by plants using the following Green Area Index (GAI) : Grass GAI = 1 ; Shrubs GAI = 3; Palms Trees GAI = 4; Trees GAI = 6 Greenery Provision (GnP) = total green area / site area GnP = 0.5 to < 1.0 – 1 point GnP = 1.0 to < 1.5 – 2 points GnP = 1.5 to < 3.0 – 3 points GnP ≥ 3.0 – 4 points 3-2(b) 1 point for restoration of trees on site, conserving or relocating of existing trees on site. 3-2(c) 1 point for the use of compost recycled from horticulture waste.
Documentary Evidences	<u>For 3-2(a)</u> • Plan layouts showing the greenery provision and site areas ; and • Calculation showing the extent of the greenery provision in the prescribed tabulated format as in worked example 3-2(a). <u>For 3-2(b)</u> • Site layouts showing the existing and final locations (where applicable) and number of the trees to be restored or conserved or relocated. <u>For 3-2(c)</u> • Extracts of the tender specification showing the requirements to use compost recycled from horticulture waste.
References	-

Worked Example 3-2(a)

(1) Determine the number of trees, palms and the areas for shrub and other greenery areas.

(2) The canopy, radius and Green Area Index are predetermined design parameters applicable for all developments.

(3) Compute the green areas as shown in the Table 3-2(a).

Table 3-2(a) – Calculation of the Greenery Provision

Description	Qty (A)	Canopy area (B)	Radius (C)	Green Area Index GAI	Green Area (A)x(B)x(C^2)xGAI
Trees (Nos)	20	3.14	3.5	6	4615.8
Palms (Nos)	20	3.14	1	4	251.2
Shrubs (m^2)	20	NA	NA	3	60
Landscape area + roof garden area + vertical greening (m^2)	100	NA	NA	1	100
				Total Green Area :	**5027**

Assume site area is 4000m^2

Greenery Provision (GnP) = 5027 / 4000 = 1.26

where GnP = 1.0 to < 1.5 – 2 points

Therefore,

Points scored for 3-2(a) = 2 points

NRB 3-3 ENVIRONMENTAL MANAGEMENT PRACTICE

Objectives	Encourage the adoption of environmental friendly practices during construction and building operation.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
Requirements	3-3(a) 1 point can be scored if effective implementation of environmental friendly programmes including monitoring and setting targets to minimise energy use, water use and construction waste are in place. 3-3(b) 1 point can be scored if the building quality is assessed under the Construction Quality Assessment System (CONQUAS). 3-3(c) Up to 1 point if the developer, main builder, M & E consultant and architect are ISO 14000 certified. 0.25 point is allocated for each firm that is certified. 3-3(d) Up to 3 points where 1 point can be scored if the project team comprises one Certified Green Mark Manager (GMM) and 2 points can be scored if the team has one Certified Green Mark Professional (GMP). 3-3(e) 1 point can be scored for the provision of building users' guide including details of the environmental friendly facilities and features within the building and their uses in achieving the intended environment performance during the building operation. 3-3(f) 1 point can be scored for the provision of facilities or recycling bins for collection and storage of different recyclable waste such as paper, glass, plastic etc.
Documentary Evidences	<u>For 3-3(a)</u> • Extracts of the tender specification showing the requirements for builder to provide and implement environmental friendly programmes to minimise energy use, water use and construction waste; and • Details of the environmental friendly programmes implemented. <u>For 3-3(b)</u> • Extracts of the tender specification showing the requirement to adopt CONQUAS. <u>For 3-3(c)</u> • A certified true copy of the ISO 14000 certificate of developer, main contractor, M & E consultant and architect where applicable. <u>For 3-3(d)</u> • A certified true copy of the certificate of Green Mark manager and Green Mark professional where applicable and a confirmation of their involvement in the project.

Documentary Evidences – Cont'd	<u>For 3-3(e)</u> • A copy of the building users' guide containing the details of the environmental friendly facilities and features within the building and their uses in achieving the intended environment performance during the building operation. <u>For 3-3(f)</u> • Plan layout showing the location of the recycling bins for collection and storage of different recyclable waste.
References	-

NRB 3-4 PUBLIC TRANSPORT ACCESSIBILITY

Objectives	Promote the use of public transport or bicycles to reduce pollution from individual car use.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
Requirements	3-4(a) 1 point can be scored for design that provides good access (< 500m) to public transport networks such as MRT/LRT stations and bus stops. 3-4(b) 1 point can be scored for the provision of adequate bicycles parking lots.
Documentary Evidences	<u>For 3-4(a)</u> • Site layout plan in the context of the surrounding area showing the location of the development site and the location of the MRT/LRT stations and bus stops. <u>For 3-4(b)</u> • Extracts of the tender specification showing the requirement to provide bicycles parking lots for the development.
References	-

NRB 3-5 REFRIGERANTS

Objectives	Reduce the potential damage to the ozone layer and the increase in global warming through the release of ozone depleting substances and greenhouse gases.
Applicability	Generally applicable to all building developments with air-conditioning systems.
Baseline Standard	-
Requirements	3-5(a) 1 point can be scored for the use of refrigerants with ozone depleting potential(ODP) of zero or with global warming potential (GWP) of less than 100. 3-5(b) 1 point can be scored for the use of refrigerant leak detection system at critical areas of plant rooms containing chillers and other equipments with refrigerants.
Documentary Evidences	For 3-5(a) • Extracts from the tender specification showing the requirement for all refrigerants to have an ODP of zero or GWP of less than 100. For 3-5(b) • Extracts from tender specification showing the requirement to incorporate a refrigerant leak detection system.
References	-

(II) Other Green Requirements

Part 4 –	**Indoor Environmental Quality**	**NRB 4-1**	**Thermal Comfort**
		NRB 4-2	**Noise Level**
		NRB 4-3	**Indoor Air Pollutants**
		NRB 4-4	**High Frequency Ballasts**

NRB 4-1 THERMAL COMFORT

Objectives	Recognise buildings that are designed with good thermal comfort.
Applicability	Generally applicable to all building developments with air-conditioning systems.
Baseline Standard	-
Requirements	2 points can be scored if the air-conditioning systems are designed to allow for cooling load variations due to fluctuations in ambient air temperature to ensure consistent indoor conditions for thermal comfort. Indoor temp between 22.5 to 25.5 °C Relative Humidity < 70%
Documentary Evidences	Extracts of the tender specification showing the requirement to design the air-conditioning systems which would provide consistent indoor conditions for thermal comfort as stated in the above requirement.
References	-

NRB 4-2 NOISE LEVEL

Objectives	Recognise buildings that are designed to control and keep the background noise in occupied spaces at levels appropriate to the intended use of the spaces.
Applicability	Generally applicable to all building developments.
Baseline Standard	SS CP 13 – Code of Practice for Mechanical Ventilation and Air-Conditioning in Buildings.
Requirements	2 points can be scored if the occupied spaces in buildings are designed with the recommended ambient sound levels stated in SS CP 13.
Documentary Evidences	• Extracts of the tender specification showing the requirement to design the occupied space with the ambient sound levels to the recommendation stated in SS CP 13 ; and • Detailed analysis, calculations and/or measurements to ensure that the designed ambient sound levels are met.
References	-

NRB 4-3 INDOOR AIR POLLUTANTS

Objectives	Minimise airborne contaminants, mainly from inside sources to promote a healthy indoor environment.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
Requirements	4-3(a) 1 point can be scored for the use of low volatile organic compounds (VOC) paints certified under the Singapore Green Labelling Scheme (SGLS) for at least 90% of the internal wall areas. 4-3(b) 1 point can be scored for the use of adhesives certified under the Singapore Green Labelling Scheme (SGLS) in all composite wood products used for the development.
Documentary Evidences	<u>For 4-3(a)</u> • Extracts of the tender specification showing the requirement to use low VOC paints that are certified under SGLS. <u>For 4-3(b)</u> • Extracts of the tender specification showing the requirement to use adhesive with low emission formaldehyde and are certified under SGLS for all composite wood products used.
References	-

NRB 4-4 HIGH FREQUENCY BALLASTS

Objectives	Encourage the use of high frequency ballasts in fluorescent luminaries to improve the workplace lighting quality.
Applicability	Generally applicable to workplace such as offices, classrooms and training rooms and the like.
Baseline Standard	-
Requirements	2 points can be scored for the use of high frequency ballasts in the fluorescent luminaries if it is adopted in at least 90% of the applicable areas that are served by fluorescent luminaries.
Documentary Evidences	• A summary sheet listing all fluorescent luminaries used for the developments and those with high frequency ballasts; and • Extracts of the tender specification showing the requirement to have high frequency ballasts are to be used in all fluorescent luminaries listed.
References	-

(II) Other Green Requirements

Part 5 – Other Green Features

NRB 5-1 Green Features and Innovations

NRB 5-1 OTHER GREEN FEATURES

Objectives	Encourage the use of green features which are innovative and have positive environmental impact on water efficiency, environmental protection and indoor environmental quality of the buildings.
Applicability	Generally applicable to all building developments.
Baseline Standard	-
Requirements	Up to 7 points are awarded for the use of the following green features depending on their potential environmental benefits or reduced environmental impacts. <u>Water Efficiency</u> (i) Use of self cleaning façade system • 2 points for more than 75% of the external walls. • 1 point for more than 50% of the external walls. • 0.5 point for at least 25% of the external walls. (ii) Use of grey water recycling system • 2 points for all blocks of the development. • 1 point for at least one block of the development. (iii) Recycling of AHU condensate • 1 point for more than 75% of the AHU condensate. • 0.5 point for at least 50% of the AHU condensate. (iv) 0.5 point for the use of membrane filtration system to recycle water during construction. (v) 0.5 point for the use of non-chemical water treatment for cooling tower. <u>Environmental Protection</u> (i) Provision of green roof and roof top garden • 1 point for more than 50% of the roof areas • 0.5 point for at least 25% of the roof areas (ii) Provision of vertical greening • 1 point for more than 50% of the external wall areas • 0.5 point for at least 25% of the external wall areas (iii) 1 point for the provision of double refuse chutes for separating recyclable from non-recyclable waste (iv) 0.5 point for the use of non-chemical termite treatment system such as termite baiting system, anti-termite mesh. (v) 0.5 point for the provision of at least 5 nos. of compost bins to recycle organic waste.

	(vi) 0.5 point for the use of non-chemical water treatment system for swimming pools. (vii) Up to 1 point if at least 10% of the fine and/or coarse aggregate used for concrete production of structural application are replaced with recycled products from approved sources. 0.5 point for each recycled product used. Points can only be scored if the extent of implementation covers at least 50% of all concrete structural elements of the superstructures (by volume). <u>Indoor Air Quality</u> (i) Use of Titanium Dioxide solutions to remove odour in toilets : • 1 point for more than 50% of all toilets • 0.5 point for at least 25% of all toilets (ii) 1 point for the use of pneumatic waste collection system. (iii) 0.5 point for the use of Ultraviolet light-C band (UV) emitters in <u>all</u> air handling units (AHUs) to improve indoor air quality. <u>Others</u> (i) Provision of landscape drainage and infiltration trenches : • 1 point for at least 25% of the landscape areas • 0.5 point for less than 25% of the landscape areas (ii) Provision of system to recycle surface runoff from the vertical green wall and sky garden : • 1 point for at least 25% of the green areas • 0.5 point for less than 25% of the green areas (iii) 0.5 point for the use of siphonic rainwater discharge system at roof. (iv) 0.5 point for the provision of eco-pond. (v) 0.5 point for the provision of carpark guidance system. ***Important notes :*** *For features that are not listed above, the QP is required to submit the details showing the positive environmental impacts, possible savings and benefits of the proposed features to BCA for assessment before the submittal of Green Mark Score.*
Documentary Evidences	• Extracts of the tender specification showing the provision of the specific green features used and the extent of implementation where applicable; • Technical product information (including drawings and supporting documents) of the green features; • A summary sheet listing the breakdown and the extent of implementation as well as the total requirements for the same intended purpose for the specific green features used; and • Quantified evidences on the potential environmental benefits that the features can bring to the development.
References	-