BCA GREEN MARK

Annex A

Summary of the Main Changes

Green Mark for New Residential Building Criteria
Green Mark for New Non-Residential Building Criteria

Criteria / Requirements	Green Mark Version RB 4.0	Green Mark Version RB 4.1
1. VENTILATION SIMULATION METHODOLOGY Pre-requisite Requirement RB 1-2 APPENDIX C	1.1 To be eligible for Green Mark Platinum rating, it is a requirement to use ventilation simulation modeling and analysis to identify the most effective building design and layout. A minimum 80% of the selected typical dwelling units should have a weighted average wind velocity of 0.60 m/s. 1.2 The ventilation simulation modelling to be conducted based on the four prevailing wind directions for the building development namely North, North-East, South and South-East.	1.1 A minimum 70% of the selected typical dwelling units will be required in considering the weighted average wind velocity. 1.2 The ventilation simulation modelling can be conducted based on the two best prevailing wind directions for the building development that is North or North-East (N or NE) and South or South-East (S or SE).
Criteria / Requirements	**Green Mark Version NRB 4.0**	**Green Mark Version NRB 4.1**
2. AIR CONDITIONING SYSTEM SCORING AND METHODOLOGY NRB 1-2 (a) – Water Cooled Chilled-Water Plant	2.1 Scoring methodology was based on the cooling load profile for a design peak day, building operating hours specified and the chilled water plant efficiency at full load condition or part load condition	2.1 Scoring methodology was revised to consider the building cooling load profile for a typical week and building operating hours specified. The Design System Efficiency (DSE) of the proposed air-conditioning system will be based on the total average cooling load and total power inputs of the various system components. For potential Green Mark Gold^{Plus} and Platinum projects, the scoring will be based on the Design System Efficiency (DSE) derived using the energy modeling framework set out in Appendix E.

<table>
<tr><th>Criteria / Requirements</th><th>Green Mark Version NRB 4.0</th><th>Green Mark Version NRB 4.1</th></tr>
<tr><td>2. AIR CONDITIONING SYSTEM SCORING AND METHODOLOGY
Cont'd

NRB 1-2 (c) – Air Distribution System</td><td>2.2 No baseline and consideration for fan systems with power of ≤ 4kW in SS 553

2.3 The baseline standard adopted for fan system was only based on allowable motor nameplate as shown below.

Baseline : SS553:2009 Table 2 – Fan power limitation in air-conditioning systems

<table>
<tr><th colspan="2">Allowable nameplate motor power</th></tr>
<tr><td>Constant volume</td><td>Variable volume</td></tr>
<tr><td>1.7 kW/m^3/s</td><td>2.4 kW/m^3/s</td></tr>
</table></td><td>2.2 A baseline was established and set at 0.17 W/CMH or 0.6 kW/m^3/s

2.3 The baseline standard using fan system input power was introduced as Option 2.

Option 2 – Fan System Input Power

Baseline : ASHRAE 90.1:2010 Clause 6.5.3.1 and as prescribed below :

<table>
<tr><th rowspan="2">Baseline
Air Distribution System Type</th><th colspan="2">Allowable Fan System Input Power*</th></tr>
<tr><th>(kW/m^3/s)</th><th>(W/CMH)</th></tr>
<tr><td>AHUs/FCUs ≥ 4kW (Constant Volume)</td><td>1.5</td><td>0.42</td></tr>
<tr><td>AHUs ≥ 4kW (Variable Volume)</td><td>2.1</td><td>0.58</td></tr>
<tr><td>Fan systems with nameplate motor power < 4 kW</td><td>0.6</td><td>0.17</td></tr>
<tr><td colspan="3">* Applicable pressure drop adjustments can be considered based on ASHRAE 90.1 Table 6.5.3.1.1B and are subject to BCA's evaluation</td></tr>
</table></td></tr>
<tr><td>NRB 1-2 (d) – Instrumentation for Monitoring Central Water Cooled Chilled Water Plant Efficiency</td><td>2.4 No specific mention</td><td>2.4 To include the provision for dedicated power meters for each of the following groups of equipment: chillers, chilled water pumps, condenser water pumps and cooling towers under NRB 1-2(d)(vi).</td></tr>
</table>

<table>
<tr><th>Criteria / Requirements</th><th>Green Mark Version NRB 4.0</th><th>Green Mark Version NRB 4.1</th></tr>
<tr><td>3. MECHANICAL VENTILATION FAN SYSTEM SCORING

NRB 1-4 Mechanical Ventilation</td><td>The baseline standard adopted for fan system was only based on allowable motor nameplate as shown below.

Baseline: SS553:2009 Table 8 – Fan power limitation in mechanical ventilation systems

<table>
<tr><th colspan="2">Allowable nameplate motor power</th></tr>
<tr><td>Constant volume</td><td>Variable volume</td></tr>
<tr><td>1.7 kW/m^3/s</td><td>2.4 kW/m^3/s</td></tr>
</table></td><td>The baseline standard using fan system input power was introduced as Option 2.

Option 2 – Fan System Input Power

Baseline : ASHRAE 90.1 : 2010 Clause 6.5.3.1 and as prescribed below :

<table>
<tr><th rowspan="2">Baseline
Air Distribution System Type</th><th colspan="2">Allowable Fan System Input Power *</th></tr>
<tr><th>(kW/m^3/s)</th><th>(W/CMH)</th></tr>
<tr><td>AHUs/FCUs ≥ 4kW (Constant Volume)</td><td>1.5</td><td>0.42</td></tr>
<tr><td>Fan systems with nameplate motor power < 4 kW</td><td>0.6</td><td>0.17</td></tr>
<tr><td colspan="3">* Applicable pressure drop adjustments can be considered based on ASHRAE 90.1 Table 6.5.3.1.1B and are subject to BCA's evaluation</td></tr>
</table></td></tr>
<tr><td>4. ENERGY MODELLING FRAMEWORK

Under Table E3 – Baseline Standard

Item No. 2.5 –

Air-Conditioning Fan Systems</td><td>4.1 The baseline standard adopted for air-conditioning fan system under Table E3 was based on allowable name plate motor power where the ratio of fan system power to the supply fan air flow rate (main fan) of each air air-conditioning system at design conditions shall not exceed allowable fan system power stated below

Constant Volume shall not exceed 1.7 kW/m^3/s of supply air

Variable Volume shall not exceed 2.4 kW/m^3/s of supply air</td><td>4.1 The baseline standard adopted for air-conditioning fan system under Table E3 was based on allowable fan system input power.

For fan system having a motor nameplate power exceeding 4 kW, the fan power limitation in air-conditioning system that is the allowable fan system input power shall be as follows :

(i) Constant volume shall not exceed 1.5 kW/m^3/s (or 0.42 W/CMH) of supply air

(ii) Variable volume shall not exceed 2.1 kW/m^3/s (or 0.58 W/CMH) of supply air

(b) For fan system having a motor nameplate power not exceeding 4 kW, the allowable fan system input power shall not exceed 0.6 kW/m^3/s (or 0.17 W/CMH) of supply air.</td></tr>
</table>

<table>
<tr><th>Criteria / Requirements</th><th>Green Mark Version NRB 4.0</th><th>Green Mark Version NRB 4.1</th></tr>
<tr><td>4. ENERGY MODELLING FRAMEWORK
Cont'd
Item No. 2.6 –
Mechanical Ventilation Fan Systems</td><td>4.2 The ratio of fan system to the supply fan air flow rate (main fan) of each mechanical ventilation system at design conditions shall not exceed allowable fan system power.
Fan power limitation in mechanical ventilation system – Allowable nameplate motor power
(i) Constant volume shall not exceed 1.7 kW/m^3/s of supply air
(ii) Variable volume shall not exceed 2.4 kW/m^3/s of supply air</td><td>4.2 The ratio of fan system to the supply fan air flow rate (main fan) of each mechanical ventilation system at design conditions shall not exceed allowable fan system power.
Fan system design criteria
(a) For fan system having a motor nameplate power exceeding 4 kW, the fan power limitation in air-conditioning system that is the allowable fan system input power shall not exceed 1.5 kW/m^3/s (or 0.42 W/CMH) of supply air
(b) For fan system having a motor nameplate power not exceeding 4 kW, fan system input power shall not exceed 0.6 kW/m^3/s (or 0.17 W/CMH) of supply air.</td></tr>
<tr><td>Item No. 2.7 –
Lighting Systems</td><td>4.3 The baseline standard for lighting systems – SS 530 – Code of Practice for Energy Efficiency Standard for Building Services and Equipment</td><td>4.3 Lighting power budgets for common areas were specified for use. The allowable lighting power density stated in ASHRAE 90.1 can be considered if the lighting power budget for the types of usage are not made available in SS 530</td></tr>
<tr><td>New Item No. 3.7</td><td>4.3 No Provision</td><td>4.3 For projects that demonstrate considerable efforts to reduce air-conditioned space and hence greater energy savings, a cap of 2% additional energy savings over its reference model can be considered for such efforts.
Note: Provision does not apply to areas that would normally be non air-conditioned space.</td></tr>
<tr><td>Paragraph E4.5</td><td>4.4 No specific mention</td><td>4.4 The basis for deriving the overall energy consumption and potential energy savings must be made clear and justifiable for consideration. Notwithstanding this, the cap on the potential energy savings for the following systems/devices may be imposed based on the following norm :
<table><tr><th>List of Systems/Devices</th><th></th><th>Energy savings Cap</th></tr><tr><td>Escalator</td><td></td><td>30%</td></tr><tr><td>Lifts</td><td>With VVVF and Sleep mode</td><td>10%</td></tr><tr><td></td><td>Regenerative features</td><td>18%</td></tr><tr><td>CO sensors</td><td></td><td>15%</td></tr><tr><td>Occupancy Sensors</td><td></td><td>15%</td></tr><tr><td>Photo Sensors</td><td></td><td>15%</td></tr></table></td></tr>
</table>

<table>
<tr><th>Criteria / Requirements</th><th>Green Mark Version NRB 4.0</th><th>Green Mark Version NRB 4.1</th></tr>
<tr><td>5. PRE-REQUISITE REQUIREMENT PERTAINING TO ENERGY MODELLING AND VENTILATION SIMULATION</td><td>No Provision</td><td>NEW PREQUISITE
<u>Building Developments with more than 30% Non Air-Conditioned Spaces</u>
Prerequisite requirement for building developments with a combination of ventilation mode and with aggregate non-air-conditioned spaces of more than 30% of the total constructed floor areas (excluding carparks and common areas) are as follows :
<table><tr><th>Aggregate Non Air-Conditioned Spaces (m^2)</th><th>Aggregate Air-Conditioned Spaces (m^2)</th><th>Ventilation Simulation Requirement</th><th>Energy Modeling Requirement</th><th>Justification on Energy Savings</th></tr><tr><td>≥ 2000</td><td>≥ 5000</td><td>Yes</td><td>Yes</td><td>No</td></tr><tr><td>< 2000</td><td>≥ 5000</td><td>No</td><td>Yes</td><td>No</td></tr><tr><td>≥ 2000</td><td>< 5000</td><td>Yes</td><td>No</td><td>Yes</td></tr><tr><td>< 2000</td><td>< 5000</td><td>No</td><td>No</td><td>Yes</td></tr></table></td></tr>
<tr><th>Criteria / Requirements</th><th>Green Mark Version RB 4.0 and NRB 4.0</th><th>Green Mark Version RB 4.1 and NRB 4.1</th></tr>
<tr><td>6. ENERGY EFFICIENT PRODUCTS OR EQUIPMENT
RB 1-7
NRB 1-10</td><td>No Provision</td><td>NEW CRITERIA UNDER RB 1-7 AND NRB 1-10
Use of energy efficient equipment or product that are certified by approved local certification body
Extent of Coverage : 90% of the applicable equipment type or product
0.5 point for each eligible certified equipment or products (Up to 2 points)</td></tr>
</table>

<table>
<tr><th>Criteria / Requirements</th><th>Green Mark Version RB 4.0 and NRB 4.0</th><th>Green Mark Version RB 4.1 and NRB 4.1</th></tr>
<tr><td>7. SUSTAINABLE CONSTRUCTION
RB 3-1(a)(ii)
NRB 3-1(a)(ii)</td><td>Extent of Coverage : The total quantity used (in tonnage) for replacement of the coarse or fine aggregates must not be less than the minimum usage requirement that is [0.03 x Gross Floor Area (GFA in m^2)]

2 points for the use of RCA to replace coarse aggregates
2 points for the use of WCS to replace fine aggregates

Where the total quantity used (in tonnage) for replacement of coarse or fine aggregates is at least two times (2x) that of the minimum usage requirement.

4 points for the use of RCA
4 points for the use of WCS</td><td>The point scoring will be based on the quantity used (in tonnage) as illustrated below :

1 point for every incremental of 0.5 times (0.5x) of the Usage Requirement. (Up to 2x)

<table><tr><th>Quantity of RCA /WCS</th><th>Points Allocation</th></tr><tr><td>≥ 0.5 x Usage Requirement</td><td>1 point</td></tr><tr><td>≥ 1.0 x Usage Requirement</td><td>2 points</td></tr><tr><td>≥ 1.5 x Usage Requirement</td><td>3 points</td></tr><tr><td>≥ 2.0 x Usage Requirement</td><td>4 points</td></tr></table>
where Usage Requirement = 0.03 x Gross Floor Area (GFA in m^2)</td></tr>
<tr><td>8. SUSTAINABLE PRODUCTS
RB 3-2
NRB 3-2</td><td>The weightages given will be based on the extent of environmental friendliness as determined by the approved local certification body and are subject to BCA's evaluation were as follows.

<table><tr><th>Extent of Environmental Friendliness of Products</th><th>Weightage for Point Allocation</th></tr><tr><td>Good</td><td>1</td></tr><tr><td>Very Good</td><td>1.5</td></tr><tr><td>Excellent</td><td>2</td></tr></table></td><td>The weightage given for the 'Good' rating was reduced to 0.5 instead of 1 as illustrated in the following table :

<table><tr><th>Extent of Environmental Friendliness of Products</th><th>Weightage for Point Allocation</th></tr><tr><td>Good</td><td>0.5</td></tr><tr><td>Very Good</td><td>1.5</td></tr><tr><td>Excellent</td><td>2</td></tr></table>
Note: There is a new pre-requisite requirement for higher GM rating projects

Minimum score under RB 3-2 and NRB 3-2 Sustainable Products
Green Mark Gold^{Plus} ≥ 3 points
Green Mark Platinum ≥ 4 points</td></tr>
</table>

<table>
<tr><th>Criteria / Requirements</th><th>Green Mark Version RB 4.0 and NRB 4.0</th><th>Green Mark Version RB 4.1 and NRB 4.1</th></tr>
<tr><td>9. GREENERY PROVISION
RB 3-3
NRB 3-3</td><td>No mention</td><td><u>EXCEPTION CLAUSE INCLUDED</u>

<u>Trees and Palms Spacing (Centre to Centre)</u>
(a) If the selected trees and palms are to be planted at ≤ 2m from trunk-to-trunk as illustrated below, the leaf area should be calculated as the product of LAI value and planted area (in m^2).

<u>Columnar Trees</u>
(b) For trees that have tight, columnar crowns, the canopy area of 12 m^2 is to be adopted for calculation of leaf area.</td></tr>
<tr><td>10. GREEN TRANSPORT
RB 3-5(c)
NRB 3-5(c)</td><td>No specific mention on the extent of coverage for the provision of electric vehicle charging stations and priority parking lots within the development.</td><td><u>For RB 3-5(c)</u>

Extent of Coverage : Minimum 1 number of electric vehicle charging station for every 100 carpark lots (Cap at 5)

1 point

<u>For NRB 3-5(c)</u>

Extent of Coverage : Minimum 1 number of electric vehicle charging station and priority parking lot for every 100 carpark lots (Cap at 5)

1 point</td></tr>
<tr><td>11. OTHER GREEN FEATURES
RB 5-1
NRB 5-1</td><td>No Provision</td><td><u>NEW CRITERIA UNDER RB 5-1 and NRB 5-1</u>

1 point allocated for the computation of concrete usage index of the development</td></tr>
<tr><td>12. PRE-REQUISITE REQUIREMENT PERTAINING TO THE USE OF SUSTAINABLE PRODUCTS</td><td>No Provision</td><td><u>NEW PREQUISITE</u>

Minimum score under RB 3-2 and NRB 3-2 Sustainable Products
Green Mark Gold^{Plus} ≥ 3 points
Green Mark Platinum ≥ 4 points</td></tr>
</table>