



BCA Green Mark for Laboratories
GM Lab: 2017

Green Mark Laboratories: 2017 Revision Log

Revision	Description	Date Effective
R0	Pilot-testing	01/12/2016
R1	Official Launch	13/06/2017

This criteria was developed by Building and Construction Authority with support from Singapore Sustainable Laboratories Group, led by Energy Research Institute @NTU, at Sustainable Energy Association of Singapore (SEAS).

Framework and Point Allocations for GM Lab: 2017

S/N	Item	Points
1. Sustainable Design		25
1.1	Leadership	3
1.1a	Organisation Governance	3
1.2	Design and Operation	17
1.2a	Sustainable Laboratory Design	3
1.2b	Sustainable Laboratory Operation	6
1.2c	Environmental Credentials of Project Team	6
1.2d	User Engagement	2
1.3	Urban Harmony	5
1.3a	Sustainable Commuting	3
1.3b	Greenery provision	2
2. Laboratory Energy Performance		35 (+5)
2.1	Energy Efficiency	20 (+4)
2.1a	Air Conditioning System Efficiency <i>~2 additional credits for Physical Laboratories</i>	8 (+ 2)
2.1b	Ventilation optimisation	6
2.1c	Lighting Efficiency <i>~2 additional credits for Physical Laboratories</i>	6 (+ 2)
2.2	Energy Effectiveness	15 (+ 1)
2.2a	Operation Energy Efficiency	1
2.2b	Fume Hood/Biosafety Cabinet Performance	4
2.2c	Plug load management <i>~1 additional credit for Physical Laboratories</i>	4 (+ 1)
2.2d	Equipment Maintenance	2
2.2e	Energy Efficient Practices, Design and Features	4
3. Resource Stewardship		25
3.1	Water	8
3.1a	Water Efficient Measures	5
3.1b	Water Usage Monitoring	1
3.1c	Water Efficiency Improvement Plans	1
3.1d	Alternative Water Sources	1
3.2	Materials	11
3.2a	Sustainable Construction	2
3.2b	Sustainable Products	7
3.2c	Material Management	2
3.3	Waste	6
3.3a	Operational Waste Management	6
4. Smart and Healthy Laboratory		35
4.1	Indoor Air Quality	15
4.1a	IAQ Performance	8
4.1b	Contaminants Management	7
4.2	Spatial Quality	12
4.2a	Lighting	6
4.2b	Acoustics	1
4.2c	Wellbeing and Safety	5
4.3	Smart Building Operations	8
4.3a	Energy Monitoring	2
4.3b	Demand Control	4
4.3c	Integration and Analytics	2
5. Advanced Green Efforts		20
5.1	Implementation of good practices	10
5.2	Innovative Green Features	10

All design must not compromise safety

BCA Green Mark Award Rating

Green Mark Rating	Green Mark Points		
	Biological Laboratories	Chemical Laboratories	Physical Laboratories (with cooling load $\geq 50\text{W/m}^2$)
Green Mark Platinum	70 and above		
Green Mark Gold ^{PLUS}	60 to < 70		
Green Mark Gold	50 to < 60		

Prerequisites

Section	Category	Award Rating	Requirements			
			Biological Laboratories (incl chemical & physical activities)	Chemical Laboratories* (including physical activities)	Physical Laboratories (physical activities only)	
Sustainable Design	Minimum scoring for section	Platinum	≥ 20 points			
		Gold ^{PLUS}	≥ 15 points			
	ACH Design (Prescriptive minimum safety design) (Adoption of Annex B: Risk Assessment Ventilation Optimisation Flowchart)	Platinum & Gold ^{PLUS}	Required	Required	N.A.	
Laboratory Energy Performance	ACH Design (Performance energy reduction design) Active Reduction of Total Air Exhaust Rate	Platinum	Able to trend-log and monitor ACH value over time. Design/operation to demonstrate active reduction of total air exhaust rate which may include the following measures: <ul style="list-style-type: none"> • Auto-sash for fume hoods (NA if there is no fume hood) • Use of LEV where possible 			
		Platinum & Gold ^{PLUS}	<ul style="list-style-type: none"> • Calculation of ACH required based on cooling and dilution needs, working towards lower ACH for BSL ≤ 3 or CSDL ≤ 3. • Monitoring of ACH versus time. 			
	EEI _{normalised} (kWh/yr/m ²) (normalised to 80hrs/week)	Platinum & Gold ^{PLUS}	BSL > 2: <680 BSL = 2: <400 BSL = 1: <330	CSDL* ≥ 3 : <750 CSDL* = 2: <500 CSDL* ≤ 1 : <330	Category (W/m ²)	Plug Load W/m ²
					≤ 100	<300
				Category (W/m ²)	EEI over plug load W/m ²	
				100 to 300	< 3.5	
				>300	< 5	

Section	Category	Award Rating	Requirements		
			Biological Laboratories (incl chemical & physical activities)	Chemical Laboratories* (including physical activities)	Physical Laboratories (physical activities only)
	Coupled variable supply and exhaust system	Platinum & Gold ^{PLUS}	Required	Required	Required
	Fume Hood/ Biosafety Cabinet Face Velocity (weighted average)	Platinum	≤0.5 m/s		N.A.
		Gold ^{PLUS}	≤0.55 m/s (for BSL ≥ 3 or CSDL ≥ 3)		
	Lighting (for areas requiring 500 to 800 lux, excluding lighting-related experiments)	Platinum	≤11W/m ²		≤9W/m ²
		Gold ^{PLUS}	≤13W/m ²		≤11W/m ²
Resource Stewardship	Water Fitting (for fittings within laboratories, support areas and tenant's areas only ^)	Platinum & Gold ^{PLUS}	≥ 2 WELS ticks Or Achieve Water Efficient Building Certification (Basic)		
	Sustainable Products	Platinum	Use of at least 2 environmental friendly products, certified by approved local certification body		
		Gold ^{PLUS}	Use of at least 1 environmental friendly product, certified by approved local certification body		
Smart and Healthy Laboratory	Setback Control for Non-Occupancy Operation	Platinum	ACH for non-occupancy hours to be <60% of maximum operating ACH (Where safety is not compromised, lab with shutdown of ventilation or even lower ACH during non-operating hours is encouraged)	Reduced ventilation/lighting operation during non-occupancy hours	
	Safety	Platinum & Gold ^{PLUS}	Comprehensive regular internal reviews of Safety and Health Management System, in compliance with SS506 or equivalent; or Lab owner/operator to be OHSAS 18001 certified		

All design must not compromise safety

* Referenced to ASHRAE Guideline for the Classification of Chemical Laboratories

^ exclude lab specialised fittings and/or emergency fittings

Part 1 – Sustainable Design	Green Mark Points
<p>or Laboratory demonstrates energy saving over the last 8 quarters (against own historical baseline)</p> <p>or Laboratory demonstrates energy saving for particular equipment over the last 8 quarters (against own historical baseline)</p>	<p>or 1 point for every 2% energy saving over laboratory's total energy consumption</p> <p>1 point for every 2% energy saving over laboratory's total energy consumption</p> <p>(Up to 6 points)</p>
<p><u>Lab 1.2c Environmental Credentials of Project Team</u> This pertains to the appointment of environmental specialists at building design, construction and operation stages.</p> <p>(i) Green Individuals:</p> <p>Key project members has any of the following qualifications:</p> <ul style="list-style-type: none"> • Certified Green Mark Manager (GMM) • Certified Green Mark Facilities Manager (GMFM) • Certified Green Mark Professional (GMP) • Certified Green Mark Facilities Professional (GMFP) • Singapore Certified Energy Manager (SCEM) as key project members <p>(ii) Safety Individuals</p> <ul style="list-style-type: none"> • Registered Workplace Safety and Health Officer (WSHO) • Various internationally recognised certification such as: <ul style="list-style-type: none"> ➢ <u>Registered Biosafety Professional</u> ➢ Certified Industrial Hygienist ➢ Certified Safety Professional <p>(iii) Green Team:</p> <ul style="list-style-type: none"> • Project team's companies are ISO 14001 / OHSAS 18001 certified: Laboratory owner, M&E Engineer, C&S Engineer, Laboratory consultant or Main/specialist Contractor. • SGBC Green Services Certified firm. 	<p>1 point for GMM, GMFM, WSHO, SCEM (Associate) 2 point for GMP, GMFP, SCEM (Professional)</p> <p>1 point each</p> <p>(may have up to 2 different classification of certification per individual) (Up to 5 points for green individuals)</p> <p>1 point each</p> <p>1 point each</p> <p>(Up to 3 points for green team) (Up to 6 points for Environmental Credentials)</p>

Part 1 – Sustainable Design	Green Mark Points						
<p>Lab 1.2d User Engagement This refers to the provision of relevant information and guidance to building occupants as to how they can contribute positively to the reduction of the building's environmental impact.</p> <ul style="list-style-type: none"> (i) Green guide for laboratory occupants should be disseminated. Best practices pertaining to reduction of energy use, water use and maintenance of a good indoor environment should be documented in this green guide. Evidence of laboratory occupants' involvement in environmental sustainability should also be demonstrated. (ii) Periodic energy awareness program to inform lab users of the energy usage (with the use of electrical submeters) from the laboratories activities which can be used to drive continuous improvement. 	<p>1 point each (Up to 2 points)</p>						
Part 1 – Sustainable Leadership	Green Mark Points						
Lab 1-3 Urban Harmony							
<p>Lab 1-3a Sustainable Commuting Promote the use of sustainable commuting to reduce pollution from individual car use.</p> <ul style="list-style-type: none"> (i) Provision of bus services to pool staff to work and/or after work (ii) Provision of regular shuttle buses to ferry staff between premises during office hours (iii) Encourage staff to use public transport, bicycle or other human-powered/electric personal transportation through awareness and incentive programs (iv) Allocation of spaces to encourage sustainable commuting such as sheltered bicycle lots, showers and lockers facilities (v) Foster effective carpooling program (involving at least 15% of staff) 	<p>1 point each (Up to 3 points)</p>						
<p>Lab 1-3b Greenery provision Encourage greater use of greenery to create a more conducive laboratory environment, particular for the support and common areas.</p> <ul style="list-style-type: none"> (i) Provision of access to greenery at common spaces (ii) Provision of planters or plotted plants, within laboratory and its support areas as well as corridors connecting them. 	<ul style="list-style-type: none"> i) 0.5 point for provision of access to greenery at common spaces ii) Point based on extent of coverage <table border="1"> <thead> <tr> <th>Extent of coverage</th> <th>Points</th> </tr> </thead> <tbody> <tr> <td>0.1% of lab areas or 2 pots per 100m² of lab areas</td> <td>1</td> </tr> <tr> <td>0.2% of lab areas or 4 pots per 100m² of lab areas.</td> <td>2</td> </tr> </tbody> </table> <p>(up to 2 points)</p>	Extent of coverage	Points	0.1% of lab areas or 2 pots per 100m ² of lab areas	1	0.2% of lab areas or 4 pots per 100m ² of lab areas.	2
Extent of coverage	Points						
0.1% of lab areas or 2 pots per 100m ² of lab areas	1						
0.2% of lab areas or 4 pots per 100m ² of lab areas.	2						

Part 2 – Lab Energy Performance	Green Mark Points									
Lab 2-1 Energy Efficiency										
<p><u>Lab 2-1a Air Conditioning System Efficiency</u></p> <p>Encourage the use of more efficient air-conditioning to minimise energy consumption.</p> <p>(i) Cooling system</p> <ul style="list-style-type: none"> ➤ Water cooled chilled water system ➤ Air cooled chilled water system/Unitary Air-Conditioning System <p>(ii) Air distribution system</p>	<p>1 point for meeting 0.8 kW/ton and 1 point for each 0.1 kW/ton improvement (up to 3 points)*</p> <p>Scoring based on either:</p> <ul style="list-style-type: none"> • Air distribution performance • AHU's weighted average face velocity <table border="1"> <thead> <tr> <th>Parameter</th> <th>Baseline</th> <th>Improvement</th> </tr> </thead> <tbody> <tr> <td>Air distribution performance</td> <td>1 point for meeting 0.35kW/ton</td> <td>1 point for each 15% improvement</td> </tr> <tr> <td>AHU's weighted average face velocity</td> <td>1 point for meeting 2.2m/s</td> <td>1 point for each 5% improvement</td> </tr> </tbody> </table> <p>Full credit based on measured readings and half credit based on nameplates. (up to 5 points)*</p> <p>(up to 8 points for DCS or A/C under landlord that is not related to tenant)*</p> <p>Additional 1 point for every 10% improvement for air distribution system (up to 2 points)*</p> <p>*full point for design for natural ventilation</p>	Parameter	Baseline	Improvement	Air distribution performance	1 point for meeting 0.35kW/ton	1 point for each 15% improvement	AHU's weighted average face velocity	1 point for meeting 2.2m/s	1 point for each 5% improvement
Parameter	Baseline	Improvement								
Air distribution performance	1 point for meeting 0.35kW/ton	1 point for each 15% improvement								
AHU's weighted average face velocity	1 point for meeting 2.2m/s	1 point for each 5% improvement								
Additional credit for Physical Laboratories										
<p><u>Lab 2-1b Ventilation optimisation</u></p> <p>Design</p> <p>(i) Adopt risk based assessment to minimise lab ventilation rate</p> <p>(ii) Segregation of areas with different ACH design for more than 70% of applicable areas</p> <p>(iii) Localised exhaust or provision of effective isolation zoning of heat-generating equipment for 70% of critical heat sources and instrument</p>	<p>1 point each (up to 6 points)</p>									

Part 2 – Lab Energy Performance	Green Mark Points
<p>Recovery</p> <ul style="list-style-type: none"> (iv) Reuse of return or recirculated cooled air from office/support areas for air make-up to laboratories areas or design for air recirculation within laboratory while meeting safety requirement. (v) Apply run-around coil, wraparound heat pipe or sensible heat recovery between the exhaust and fresh airstreams. Heat recovery from exhaust systems to pre-cool outdoor air (vi) Use of onsite recovered energy to reheat air <p>Exhaust</p> <ul style="list-style-type: none"> (vii) Adopt VAV lab air flow and variable flow exhaust controls (Variable design) (viii) Multi-stack exhaust plenum with staged-exhaust fans (Shut-off design) 	
<p><u>Lab 2-1c Lighting Efficiency</u></p> <p>Encourage the use of energy efficient lighting in common areas to minimise energy consumption from lighting usage while maintaining proper lighting level. Baseline = Maximum lighting power budget stated in SS530</p> <p>Design should include tasklighting required to achieve intended lux level for workspace.</p> <p>Additional credit for Physical Laboratories</p>	<p>0.15 point for every percentage improvement in the lighting power budget</p> <p>Points scored = 0.15 x (% improvement)</p> <p>(Up to 6 points)</p> <p>1 point for every 10% improvement in lighting power budget (Up to 2 points)</p>
<p><u>Lab 2-2 Energy Effectiveness</u></p>	
<p><u>Lab 2-2a Operation Energy Efficiency</u></p> <p>Encourage laboratories with energy efficiency improvement plan and effective monitoring of energy usage.</p> <p>Setting target to improve laboratories energy performance. To show intent, measures and implementation strategies of energy efficiency improvement plans over the next three years. Committed energy saving accrued from proposed measures should be quantified.</p>	<p>1 point</p>
<p><u>Lab 2-2b Fume Hood/Biosafety Cabinet Performance</u></p> <ul style="list-style-type: none"> (i) Use energy efficient equipment for at least 90% of fume hoods/biosafety cabinet: 	

Part 2 – Lab Energy Performance	Green Mark Points														
<p>a. VAV fume hoods/BSC b. VAV fume hoods/BSC with occupancy sensor or sash position monitoring to reduce exhaust air ventilation</p> <p>(ii) Use of VAV fume hood/BSC with lower face velocity, while meeting safety requirements.</p> <p>(iii) Sash position monitoring and/or monitoring of exhaust rate/face velocity linked to Building Management System (BMS), Energy Management System (EMS) or equivalent for purpose of trend logging and readouts</p>	<p>0.5 point 1 point (Up to 1 point)</p> <p>1 point for every 0.1m/s reduction from 0.6m/s (weighted average flow) (Up to 2 points)</p> <p>1 point</p>														
<p><u>Lab 2-2c Plug load management and operation</u></p>															
<p>Encourage design that optimises equipment used in the laboratory areas to reduce energy use.</p>															
<p>(i) Proper heat load calculation with diversity and occupancy consideration or benchmarking of receptacle load based on comparable existing facilities or relevant data from benchmarking study to enhance cooling load estimate.</p>	<p>1 point</p>														
<p>Additional credit for Physical Laboratories for fulfilling Lab 2-2ci</p>															
<p>(ii) Provision of energy efficient labelled equipment by 3rd party such as Energy Star, Energy Labelling Scheme or equivalent for more than 80% of applicable equipment type</p>	<p>0.5 point each</p>														
<p>(iii) Use of energy efficient freezers for more than 80% of freezers</p>	<p>1 point for tier 1 2 points for tier 2</p>														
<table border="1"> <thead> <tr> <th rowspan="2">Freezers</th> <th colspan="2">kWh/litre/yr</th> </tr> <tr> <th>Tier 1</th> <th>Tier 2</th> </tr> </thead> <tbody> <tr> <td>Ultra low temperature freezers ($\leq - 80^{\circ}\text{C}$)</td> <td><12</td> <td><8</td> </tr> <tr> <td>Low temperature freezers ($\leq - 35^{\circ}\text{C}$)</td> <td><8</td> <td><5</td> </tr> <tr> <td>Biomedical freezers/refrigerators</td> <td><5</td> <td><3</td> </tr> </tbody> </table>	Freezers	kWh/litre/yr		Tier 1	Tier 2	Ultra low temperature freezers ($\leq - 80^{\circ}\text{C}$)	<12	<8	Low temperature freezers ($\leq - 35^{\circ}\text{C}$)	<8	<5	Biomedical freezers/refrigerators	<5	<3	<p>1 point for tier 1 2 points for tier 2</p>
Freezers		kWh/litre/yr													
	Tier 1	Tier 2													
Ultra low temperature freezers ($\leq - 80^{\circ}\text{C}$)	<12	<8													
Low temperature freezers ($\leq - 35^{\circ}\text{C}$)	<8	<5													
Biomedical freezers/refrigerators	<5	<3													

Part 2 – Lab Energy Performance	Green Mark Points
<p>(iv) Active plug load management based on operation schedule (auto cut-off switches with user overrides)</p> <p>(v) Overnight equipment management system (trend-log to monitor the consumption of the equipment)</p>	<p>1 point</p> <p>1 point (up to 4 points for 2-2c)</p>
<p><u>Lab 2-2d Equipment Maintenance</u></p> <p>Systematic management plan to emphasis on the following:</p> <p>(i) Effective regular maintenance of equipment such as annual cleaning, defrosting of freezers, furnace & oven inspection, oil change program, servicing of specific devices)</p> <p>(ii) Inventory optimisation such as</p> <ul style="list-style-type: none"> • Storage of samples and materials in the most energy efficient way and effective preservation through appropriate measures and risk assessment (e.g. increase freezer temperature from -80°C to -70°C) • Inventory sharing between lab users 	<p>1 point each (up to 2 points)</p>
<p><u>Lab 2-2e Energy Efficient Practices, Design and Features</u></p> <p>Encourage the use of energy efficient features which are innovative and have positive environmental impact. Use of the following energy efficient features such as:</p> <p>(i) Calculation of Energy Efficiency Index (EEI) (1 point)</p> <p>(ii) Demand control ventilation based on active air quality sampling</p> <p>(iii) Ductless fume hoods for at least 80% of applicable equipment (1 point)</p> <p>(iv) Ductless biosafety cabinets with HEPA filter for at least 80% of applicable equipment (0.5 point)</p> <p>(v) Adoption of task lightings to reduce general lighting W/m² design (achieving overall W/m² with at least 40% improvement over code requirement) (1 point)</p>	<p>2 points for high impact item 1 point for medium impact item 0.5 point for low impact item Up to 4 points</p> <p>High impact item: Refers to items that are highly significant to overall design of laboratories</p> <p>Medium impact item: Refers to items that will have measureable saving to the laboratories</p> <p>Low impact item: Refers to items that are known to be beneficial to the performance of laboratories</p>

Part 3 – Resource Stewardship	Green Mark Points									
Lab 3-1 Water										
<p><u>Lab 3-1a Water Efficient Measures</u> Reduce potable water consumption through the use of water efficient products and systems within laboratories, support areas and tenant’s areas only.</p> <p>(i) Provision of products that are certified under WELS</p> <ul style="list-style-type: none"> • Basin taps and mixers • Sink taps and mixers <p>* exclude lab specialised fittings and/or emergency fittings</p> <p>Or</p> <p>Achieve PUB Water Efficient Building Certification</p> <p>(ii) Provision of laboratory equipment that is able to do water recycling or has water saving function such as recycling final rinse, reducing cold water consumption through mixers with condensate for autoclaves, etc.</p> <p>(iii) Recycle water generated from regular flushing of laboratory safety fitting to maintain hygiene.</p>	<table border="1"> <thead> <tr> <th>Product Type</th> <th>Rating based on Water Efficiency Labelling Scheme (WELS)</th> <th>Weightage</th> </tr> </thead> <tbody> <tr> <td>Water Fittings <ul style="list-style-type: none"> • Basin Taps & Mixers • Sink Taps & Mixers </td> <td style="text-align: center;">✓✓</td> <td style="text-align: center;">2</td> </tr> <tr> <td></td> <td style="text-align: center;">✓✓✓</td> <td style="text-align: center;">3</td> </tr> </tbody> </table> <p>Points scored based on the number, water efficiency rating of the products used</p> <p style="text-align: center;">2 point for basic certification 3 points for Silver/Gold certification</p> <p style="text-align: center;">0.5 point for each equipment type 1 point for each equipment type, saving more than 0.5% of facility’s water consumption</p> <p style="text-align: center;">1 point (up to 5 points)</p>	Product Type	Rating based on Water Efficiency Labelling Scheme (WELS)	Weightage	Water Fittings <ul style="list-style-type: none"> • Basin Taps & Mixers • Sink Taps & Mixers 	✓✓	2		✓✓✓	3
Product Type	Rating based on Water Efficiency Labelling Scheme (WELS)	Weightage								
Water Fittings <ul style="list-style-type: none"> • Basin Taps & Mixers • Sink Taps & Mixers 	✓✓	2								
	✓✓✓	3								
<p><u>Lab 3-1b Water Usage Monitoring</u></p> <p>Facilitate continual monitoring of water use within the development through the provision of water meters for major water uses.</p> <p>For equipment only:</p> <p>(i) Local private meters</p> <p>(ii) Leak Detector</p> <p>(iii) Smart meters with remote monitoring</p>	<p style="text-align: center;">0.5 point 0.5 point 1 point (Up to 1 point)</p>									
<p><u>Lab 3-1c Water Efficiency Improvement Plans</u></p> <p>Targets to improve laboratories’ water performance should be set. To show intent, measures and implementation strategies of water efficiency improvement plans over the next three years. Committed water savings accrued from proposed measures should be quantified.</p>	<p style="text-align: center;">1 point</p>									

Part 3 – Resource Stewardship	Green Mark Points						
<p><u>Lab 3-1d Alternative Water Sources</u></p> <p>Encourage the use of alternative water sources to reduce potable water consumption for laboratories applications such as washing, cleansing and cooling.</p> <ul style="list-style-type: none"> • Use of NEWater • Use of rainwater harvested • Use of on-site recycled water including AHU condensate 	<p style="text-align: center;">1 point</p>						
Lab 3-2 Materials							
<p><u>Lab 3-2a Sustainable Construction</u></p> <p>Encourage the selection of more sustainable base building and the adoption of laboratories designs and materials that are environmentally friendly and sustainable.</p> <p>Laboratory renovation conserves at least 50% (by area) of the existing finishing for walls, flooring and ceilings</p>	<p style="text-align: center;">2 points</p>						
<p><u>Lab 3-2b Sustainable Products</u></p> <p>Encourage the adoption of laboratories materials that are environmentally friendly and sustainable.</p> <ul style="list-style-type: none"> (i) Maintain at least 50% (by volume) of the existing furniture (ii) Procurement policy for environmental-friendly products (iii) Use of environmental friendly products that are certified by approved local certification body. 	<p style="text-align: center;">2 points</p> <p style="text-align: center;">1 point</p> <p>Points scored based on the weightage and the extent of coverage & impact</p> <ul style="list-style-type: none"> • 1 point for high impact item • 0.5 point for low impact item <p>Weightage based on the extent of environmental friendliness of products</p> <table border="1"> <thead> <tr> <th>Good</th> <th>Very Good</th> <th>Excellent</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">0.5</td> <td style="text-align: center;">1.5</td> <td style="text-align: center;">2</td> </tr> </tbody> </table> <p style="text-align: center;">(Up to 7 points for 3-2b)</p>	Good	Very Good	Excellent	0.5	1.5	2
Good	Very Good	Excellent					
0.5	1.5	2					

Part 3 – Resource Stewardship	Green Mark Points
<p><u>Lab 3-2c Material management</u></p> <p>Centralised materials and chemical resources management</p> <p>Encourage minimising of consumption of chemical and materials, using and disposal of them which has environment and financial benefit and promote sharing of scientific equipment within organisation.</p> <p>(i) Labelling with details of contents, ownership and (where relevant) hazard and emergency details</p> <p>(ii) Records of equipment for tracking and ensure surplus stock can be re-distributed and to reduce unnecessary procurement.</p>	<p>1 point</p> <p>1 point</p>
Lab 3-3 Waste	
<p><u>Lab 3-3a Operational Waste Management</u></p> <p>(i) Provision of recycling facilities (for recycling glass, paper, metal as well as one for non-recyclable waste)</p> <p>(ii) Recycling of equipment packaging waste</p> <p>(iii) Provide laundry service for lab coat to reduce wastage and encourage hygiene and safety.</p> <p>(iv) Waste collecting and monitoring including hazard waste management</p> <p>(v) Waste management improvement plan</p>	<p>At a central location (1 point) At every laboratory or strategic locations to encourage recycling (2 points) (Up to 2 points)</p> <p>1 point</p> <p>1 point</p> <p>1 point</p> <p>1 point</p> <p>(Up to 6 points for 3-3a)</p>

Part 4 – Smart and Healthy Laboratories	Green Mark Points									
Lab 4-1 Indoor Air Quality										
<p><u>Lab 4-1a IAQ Performance</u></p> <p>Encourage and recognise good indoor air quality (IAQ) to ensure the comfort and well-being of laboratory occupants</p> <ul style="list-style-type: none"> (i) Conduct IAQ audit once every three years to understand performance gap in terms of parameters, as stated in SS554: 2015 Singapore Standard Code of Practice for “Indoor Air Quality for Air-conditioned Buildings” at workstations and support areas. The audit should be conducted by an accredited laboratory under Singapore Accreditation Council. (ii) Conduct yearly post occupancy evaluation to assess occupant’s satisfaction with the indoor environment, health and safety requirements are being met. (iii) List of corrective actions taken following the post occupancy evaluation. (iv) Optimising airflow based on CFD or physical modeling to ensure health and safety of laboratory occupants (v) Develop an active IAQ management programme 	<p>1 point for indicative method 2 points for reference method (up to 2 points)</p> <p>2 points</p> <p>1 point</p> <p>2 points</p> <p>1 point</p>									
<p><u>Lab 4-1b Contaminants Management</u></p> <ul style="list-style-type: none"> (i) Enhanced Filtration Media <p>Permanent provision of filter with good Minimum Efficiency Rating Value (MERV) (ASHRAE 52.2) or EN filter class (EN779) or equivalent in air distribution.</p> <ul style="list-style-type: none"> (ii) Contaminants monitoring <p>TVOC, specific chemical or bacteria count monitoring to ensure safety standards are met</p>	<p>1 point for MERV 13, F7 or equivalent 2 points for MERV 14, F8 or equivalent 1 additional point for provision of HEPA filter for exhaust or supply.</p> <table border="1"> <thead> <tr> <th>Type of measurement</th> <th>Particulates</th> <th>Point</th> </tr> </thead> <tbody> <tr> <td>Spot measurements</td> <td>≥ 3</td> <td>1</td> </tr> <tr> <td>Continuous measurements</td> <td>≥ 2</td> <td>2</td> </tr> </tbody> </table> <p>(up to 2 point)</p>	Type of measurement	Particulates	Point	Spot measurements	≥ 3	1	Continuous measurements	≥ 2	2
Type of measurement	Particulates	Point								
Spot measurements	≥ 3	1								
Continuous measurements	≥ 2	2								

Part 4 – Smart and Healthy Laboratories	Green Mark Points
<p>(iii) Fume Hood Commissioning (for certification and maintenance)</p> <p>Engage third party to conduct fume hood commissioning report, reference to ASHRAE 110 or equivalent</p> <p>Tier 1</p> <ul style="list-style-type: none"> • Airflow visualization • Cross draft velocity • Exhaust flow measurement; at different sash configurations for VAV hoods • Face velocity; at different sash configurations for VAV hoods <p>Tier 2</p> <ul style="list-style-type: none"> • VAV response and stability • Hood static pressure measurement • Tracer gas containment tests. The hood performance rating for the Tracer Gas Test procedure shall be at least 4.0 l/min AI (As Installed) 0.1 ppm as specified in ANSI Z9.5 	<p>1 point for tier 1 2 points for tier 2</p>
Lab 4-2 Spatial Quality	
<p>Lab 4-2a Lighting</p> <p>To encourage good workplace lighting quality to promote productivity and comfort of occupants</p> <p>(i) Provision of daylighting</p> <p>(ii) Lighting Zoning</p> <p>(iii) Lighting level</p> <p>(iv) Controllability of lighting system</p> <p>(v) High frequency ballasts and/or LED with $\leq 30\%$ flicker</p> <p>Improve workplace lighting quality by avoiding low frequency flicker associated with fluorescent lighting with the use of high frequency ballast in the fluorescent luminaries</p>	<p>1 point for provision 2 point for provision and glare control strategies such as operable window blinds where applicable.</p> <p>1 point Adequate switches for each zone. (Not less than 2 switches for each space < 25m² and not less than 3 switches for each space < 100 m²)</p> <p>1 point Meeting lux level stated in SS531:2006</p> <p>1 point Extent of Coverage : At least 80% of occupants able to adjust lighting control to suit their task needs and preference</p> <p>1 points Extent of Coverage : At least 80% of applicable fittings</p>

Part 4 – Smart and Healthy Laboratories	Green Mark Points
<p><u>Lab 4-2b Acoustics</u></p> <p>Occupied spaces are designed with good ambient sound level ≤ 55 dBA (excluding lab equipment) or ≤ 65 dBA (with lab equipment).</p> <p>In the event where specific noisy equipment are deployed in the lab, it should be isolated and not applicable in the noise measurement.</p>	<p>1 point</p>
<p><u>Lab 4-2c Wellbeing and Safety</u></p> <p>Wellbeing</p> <ul style="list-style-type: none"> (i) Controllability of temperature (ii) Provision of ergonomic (adjustable) chairs/workstations for users (iii) Wellbeing awareness <ul style="list-style-type: none"> ➤ Display panel showing the level of CO₂, TVOC and/or chemicals for each laboratory (iv) Designated breakout areas for occupants to relax/eat outside laboratory environment <p>Safety</p> <ul style="list-style-type: none"> (v) Space pressure control on monitoring system to prevent exfiltration of contaminants (vi) Availability to relevant safety devices in each room/zone (eyewashes, safety showers, first aid kits) (vii) Safety measures for performing lab tasks <ul style="list-style-type: none"> ➤ Guidelines and visible notices to encourage safe usage (viii) Periodic briefing on lab safety and emergency procedures 	<p>1 point each (up to 5 points)</p>
<p><u>Lab 4-3 Smart Building Operations</u></p>	
<p><u>Lab 4-3a Energy Monitoring</u></p> <p>Controls and monitoring are used to ensure that the equipment is functioning as designed and that energy is being saved.</p> <p>For each laboratory:</p> <ul style="list-style-type: none"> (i) Provision of monitoring of individual electrical circuits/equipment, such as freezer, incubators etc, by means of power meter readings (ii) Provision of monitoring of electrical loads with link to Building Management System (BMS), Energy Management System (EMS) or equivalent for purpose of trend logging and readouts 	<p>1 point</p> <p>1 point</p>

Part 4 – Smart and Healthy Laboratories	Green Mark Points
<p><u>Lab 4-3b Demand Control</u></p> <p>Encourage the use of BMS controls to schedule equipment to turn off or run at lower settings for energy savings.</p> <ul style="list-style-type: none"> (i) Provision of automated night-setback for lower ACH for laboratory during non-operation hours. ACH to be ramped up to operating mode by means of motion/occupancy sensors or user override (ii) Automatic switch off/dim lighting during non-occupied hours. Lightings to be switched on means of motion/occupancy sensors or user override (iii) Provision of variable airflow control for different zones (by means of VAV or otherwise) (iv) Admin areas such as meeting rooms, pantry etc controlled by separate demand control ventilation 	<p>1 point each (up to 4 points)</p>
<p><u>Lab 4-3c Integration and Analytics</u></p> <p>To encourage innovative and integrative use of sensor and motion data for optimizing or attaining persistence of high performance and energy efficiency of the laboratories.</p> <p>For each laboratory:</p> <ul style="list-style-type: none"> • Provision of website and/or accessible monthly readout per laboratory • Provision of energy portal and/or dashboard for laboratory management team, displaying lab energy consumption (with breakdown) and/or lab air borne status 	<p>1 point</p> <p>1 point</p>

Part 5 – Advanced Green Efforts	Green Mark Points
Lab 5-1 Advanced Green Efforts	
<p><u>Lab 5-1a Implementation of good practices</u></p> <p>High impact items (2 points each)</p> <ul style="list-style-type: none"> • Provision of accurate Permanent Measurement & Verification • 20% reduction of operating ACH for existing laboratory • Energy modelling to calculate energy saving • Embodied Energy Calculation • Provision of renewable energy meeting 0.5% of the laboratory's total energy consumption <p>Medium impact items (1 point each)</p> <ul style="list-style-type: none"> • Energy modelling to calculate EUI/EEI • 10% reduction of operating ACH for existing laboratory • Continual review of processes with established green practices • Participate in internal/external lab benchmarking to share performance data • Provision of renewable energy meeting 0.25% of the laboratory's total energy consumption <p>Low impact items (0.5 point each)</p> <ul style="list-style-type: none"> • 5% reduction of operating ACH for existing laboratory • Member for local/international laboratory association. • Achieve other recognition as sustainable laboratory • Participate international competition related to laboratory performance 	<p>2 points for high impact item 1 point for medium impact item 0.5 point for low impact item Up to 10 points</p>
<p><u>Lab 5-1b Innovative Green Features</u></p> <p>Open for recommendation (Items subjected to assessors' review)</p> <p>Low impact item (0.5 point each)</p> <ul style="list-style-type: none"> • Use of UVC emitter filter • Recycling of lab related items such as <ul style="list-style-type: none"> ➢ Personal protective equipment (gloves, shoes and head covers etc). ➢ Laboratory experiment tools (plastic pipettes, syringe etc). ➢ Recycling or Treatment of chemicals used in the laboratory. 	<p>2 points for high impact item 1 point for medium impact item 0.5 point for low impact item Up to 10 points</p>

Annex A: Laboratory Types

1) Biological laboratories (Labs handling biological agents)

- Biosafety Laboratories Level 1 to 4 including biological containment laboratories using infectious agents

2) Chemical laboratories (Labs handling chemicals)

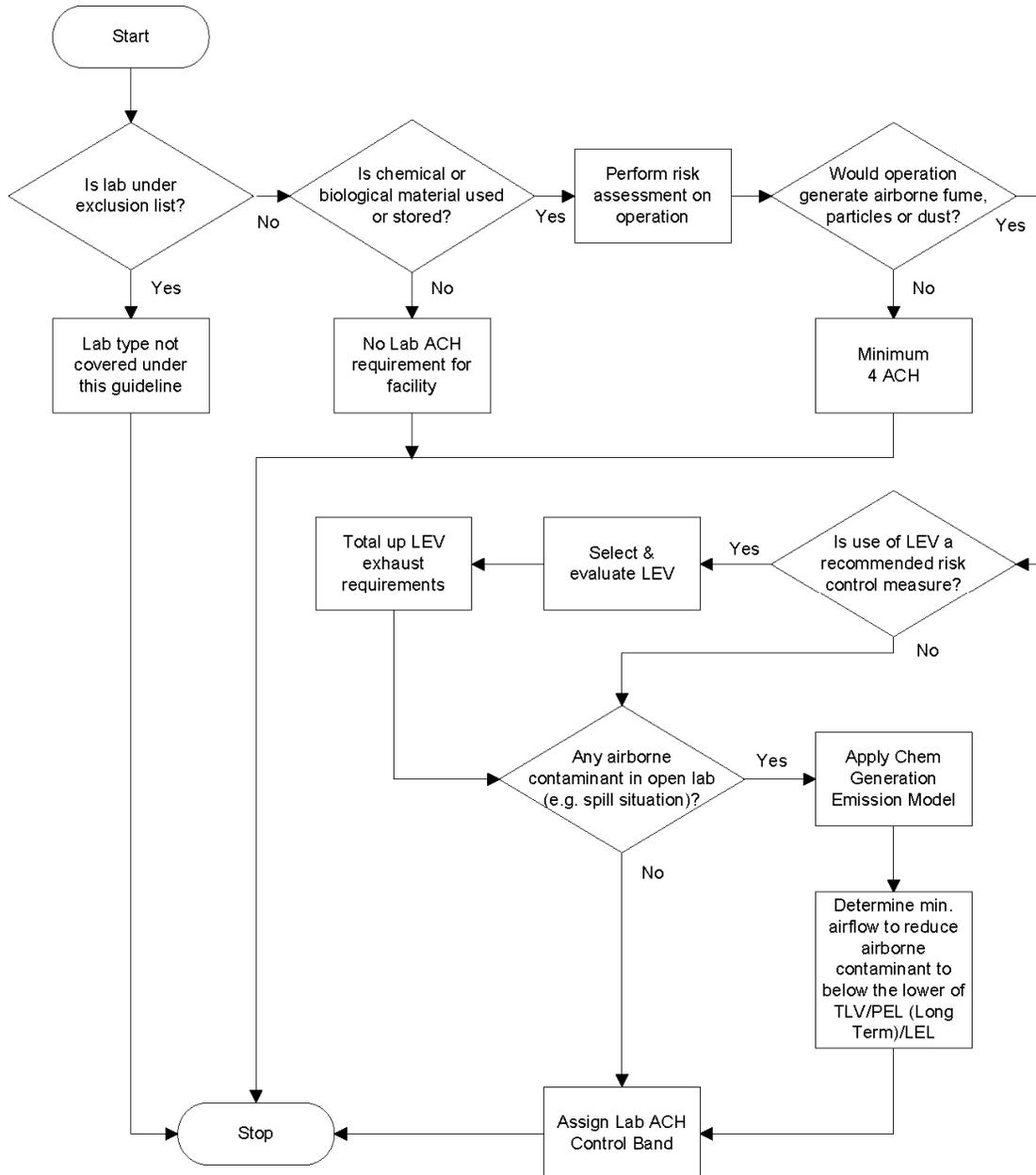
- Chemical Safety Design Laboratories Level 0 to 4
(Referenced to ASHRAE Guideline for the Classification of Chemical Laboratories)
- Analytical chemistry
- Physical chemistry
- Synthetic chemistry (inorganic & organic)
- Special (high hazard) labs

3) Physical laboratories (No use of chemicals)

- Materials testing laboratories (Physical properties)
- Electronics/instrumentation laboratories

4) Support spaces

Annex B: Risk Assessment Ventilation Optimisation Checklist



Exclusion List refers to lab under the following classification:

- BSL 3 or BSL 4
- ABSL 3 or ABSL 4
- CSDL 4

Lab ACH Control Band may refer to Singapore Standard or internationally accepted standard such as Cornell's Lab Ventilation Management Programme.

Chemical Generation Emission Model may refer to Annex B of SS567:2011 (Code of Practice for Factory Layout – Safety, Health and Welfare considerations) or equivalent standard.