



Green Mark 2021

HHW

TECHNICAL GUIDE

Revision Log

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HW1 Physiological

A maximum of 5 points can be scored across RE 1 Protect section.

HW1.1 Active Movement Design

To recognise and promote an active building and to reduce sedentary behaviour which is associated with a number of health issues. This takes a whole of building approach from, facilitating a safe access to and around the site for pedestrians and cyclists, allowing for an active commute or journey to the building. To the provision of an active interior design and fit out for occupants.

HW1.1a Active Mobility

The design, implementation and provision of safe and segregated access for pedestrians and cyclists with the provision of bicycle parking and associated facilities.

Assessment Criteria

HW1.1a Active Mobility	New Buildings	Existing Buildings
(i) Safe and Convenient Access in and around the project site	0.5 Points	1 Point
(ii) Bicycle Lots	0.5 Points	1 Point

(i) To promote safe access within the project, pedestrians, cyclists and vehicle users shall be safely and clearly separated and users shall not have to compete for entry and exit to the site. Pedestrians shall not need to cross over vehicular traffic to enter the site or access the building. There shall be direct connections to existing or planned cycle lanes and footpaths. Key pedestrian routes e.g. to adjacent developments and major transport nodes shall be sheltered. All cycle lanes and pedestrian lanes are to be provided in accordance with Walking Cycling Design Guide by LTA and URA.

(ii) Provision of bicycle parking lots with 50% more than the stipulated minimum within URA circular URA/PB/2018/03-DCG (or prevailing circular) and LTA's Code of Practice - Street Work Proposal Relating to Development Works (or prevailing COP). For projects with GFA \leq 1,000 m², the number of bicycle lots would be evaluated based on reasonableness for the project, taking into account factors such as space, occupancy, visitorship and location.

The bicycle parking lots shall be sheltered, and secure with adequate surveillance (e.g. CCTV). Reference shall be made to the distribution and location of short-term and long-term bicycle parking.

The bicycle parking lots with End-of-Trip facilities shall be located at accessible locations which are less than 50m away from main entrances and/or lift lobbies, complete with proper wayfinding and signage. Proper consideration shall be given to the connection to adjacent cycling paths/shared paths, public transportation nodes and amenities. The provision of End-of-Trip facilities is not applicable to residential buildings.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

Submission of:

- Site plans and dimensioned drawings showing pedestrian, vehicle and bicycle pathways and points of connection with public pathways
- An Access Statement with particular details of on people's movement and access to the site, outlining the segregation of vehicular traffic from pedestrians and cyclists. The statement shall provide details on how everyone can get to and move through the place on equal terms

- Location and numbers of bicycle lots, end of trip facilities and distance to main entrance/ accessible lift lobby

At Verification stage (New Buildings & Existing Buildings):

- As-built site plans with photographs of showing pedestrian and bicycle pathways and points of connection, bicycle lots and end of trip facilities

Guidance Notes

As a guide, the Access Statement should include and not be limited to the following details:

- a) Outline of approach and ambition: identify the aims for accessibility, how you intend to put them into practice and targets that will help you monitor success. Highlight any policies that demonstrate commitment to ensuring an inclusive society, where the young, the elderly, and persons with limited mobility will be able to get to and around site, enjoy its facilities and fully participate in the experiences on offer.
- b) Address key design elements: Consider how people will get to and around your development, in particular:
 - Approaches and entrances that provide for shared use for people of different mobility abilities
 - Safe and unencumbered access for pedestrians, with physical separation from motor vehicles, maintained throughout the journey around and within the development
 - Cycle friendly design that removes tension between pedestrians and cyclists, and cyclists and motor vehicles
 - Accessible parking and drop-off near entrances and key destination points
 - Levels and how gradients will be accommodated
 - Route widths, surfaces, colours, markings, distance
 - Emergency egress accessible to all users
 - Lighting (consider people with partial sight)
 - Seating and shelter
 - Accessible signage, information and communication
 - Wayfinding
- c) Consultation with existing and potential users: how this has informed the plan
- d) Site constraints: Where environmental factors constrain best practice, identify the nature of the constraints, demonstrate why the relevant design standards can't be achieved and identify proposed alternative solutions
- e) Management plans: Explain how the policies and approaches to making the development access inclusive and safe will be maintained in the longer term, for example in maintenance programmes and management plans

References:

URA-LTA Walking and Cycling Design guide and the URA circular URA/PB/2018/03-DCG

[CABE Design and Access Statements: How to write, read and use them](#)

HW1.1b Active Interior

Active interior promotes active behaviour by influencing occupants through active interior designs and features.

Assessment Criteria

HW1.1b Active Interior	New Buildings	Existing Buildings
(i) Internal staircases	<p><u>For Non-Residential Buildings</u></p> <p>1 Point</p> <p>[All floors = 1 point. ≥50% of floors = 0.5 points]</p> <p><u>For Residential Buildings</u></p> <p>1 Point</p> <p>[All floors = 1 point. ≥10 floors* = 0.5 points]</p> <p><i>*Includes basement & ground floors</i></p>	<p><u>For Non-Residential Buildings</u></p> <p>1 Point</p> <p>[All floors = 1 point. ≥50% of floors = 0.5 points]</p> <p><u>For Residential Buildings</u></p> <p>1 Point</p> <p>[All floors = 1 point. ≥10 floors* = 0.5 points]</p> <p><i>*Includes basement & ground floors</i></p>
(ii) Active Furnishing	<p><u>For Non-Residential Buildings</u></p> <p>1 Point</p> <p>[≥90% of workstations = 1 point. ≥50% of workstations = 0.5 points]</p> <p><u>For Residential Buildings</u></p> <p>N/A</p>	<p><u>For Non-Residential Buildings</u></p> <p>1 Point</p> <p>[≥90% of workstations = 1 point. ≥50% of workstations = 0.5 points]</p> <p><u>For Residential Buildings</u></p> <p>N/A</p>

Points shall be awarded based upon the following:

Internal Staircases Providing internal staircases serving all floors that are highly visible, visually appealing, well ventilated and prominent, which encourages active movement and usage and allows convenient connections between multi-storey spaces or tenancies.

Active Furnishing include standing tables, tables with easy height adjustment features (sit stand) and chairs with active siting features.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

Submission of:

- Design drawings with location of the staircases indicated.
- Concept drawing with a simple write-up on design elements incorporated to make the staircase more appealing and prominent.
- Product catalogues of the active furnishing features.
Design drawings with numbers and locations of these features.

At Verification stage (New Buildings & Existing Buildings):

- As-built drawings with location of the staircases indicated
- Photos of the completed staircase with design elements incorporated to make the staircase more appealing and prominent
- As-built drawings with numbers and locations of the active furnishing features
- Photos of the active furnishing features

HW1.2 Low VOC Materials

Interior building materials and products with high Volatile Organic Compound (VOC) emission are harmful to human. Use of low VOC materials and products are encouraged for health and well-being of building occupants.

Assessment Criteria

HW1.2 Low VOC Materials	New Buildings	Existing Buildings
Material Finishes to be SGBP 4 tick. OR VOC emission levels stated in Table HW1.2.1	<p><u>For Non-Residential Buildings</u></p> <p>1 Point</p> <p>[≥60% of all areas* = 1 point. ≥80% common areas = 0.5 points]</p> <p><u>For Residential Buildings</u></p> <p>2 Points</p> <p>[≥60% of all areas* = 2 points ≥80% common areas = 1 point]</p> <p><i>*includes lettable areas for non-residential developments and dwelling units for residential developments</i></p>	<p><u>Both Residential and Non-Residential Buildings</u></p> <p>1 Point</p> <p>[≥80% of common areas OR at least 3 Material Finishes to be SGBP 4 tick]</p>

Points shall be awarded where the applicable interior finishes, furniture and carpentry works use

- materials and products that are certified to be Leader (4 tick rating) under the Singapore Green Building Product (SGBP) certification scheme OR
- materials and products that can meet the emission levels stated in Table HW1.2.1.

The area of compliance shall be calculated based on the surface area (floor + wall + ceiling) of the interior.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Extracts of the tender design specification showing the requirement stating the use of
 - SGBP 4 ticks certified products on material finishes and furnishings or
 - Materials finishes, furnishings and products that meet the emission levels stated in Table HW1.2.1 (data sheets)
- Design drawings marking the extent of use for each compliant low VOC emission products/ materials and the calculation of the extent of use

- Product catalogues and SGBP certificates or product/material testing reports (if the product selection is confirmed)

At Verification stage (New Buildings & Existing Buildings):

- As-built drawings and calculation of extent of application for each product / material
- SGBP 4 tick certificates or product/ material testing reports that meet the low VOC emission levels stated in Table HW1.2.1 within the criteria (extracted below within the guidance notes)
- Purchase Orders (POs) and Delivery Orders (DOs) of the low VOC emission products and materials used

Guidance Notes

Applicable materials

(a) Flooring, wall and ceiling finishes

- i. Adhesives and sealants used for the flooring, wall or ceilings (including tile grouts and sealants, carpet adhesives, wall covering adhesives.)
- ii. Floor coverings such as carpets, laminates and vinyl's
- iii. Wall coverings such as laminates, fabrics and wall papers
- iv. Ceiling coverings such as ceiling boards
- v. Varnish, stains, lacquers, paints or other finishes

(b) Furniture and carpentry (where provided)

- i. Desks
- ii. Chairs
- iii. Cabinetry including wardrobes, kitchen, pantry and bathroom cabinets
- iv. Cubicle partitions

(c) Doors

- i. Paints
- ii. Varnishes
- iii. Lacquers
- iv. Other finishes

Material Emissions Requirements for non SGBP 4 tick labelled products	
For products, finishes and furnishings	<ul style="list-style-type: none"> • TVOC emission rate shall be $\leq 0.25 \text{ mg m}^{-3} \text{ h}^{-1}$ after 24 hours • Formaldehyde emission rate shall be $\leq 0.02 \text{ mg m}^{-3} \text{ h}^{-1}$ after 48 hours
Paints, Varnishes, lacquers,	<ul style="list-style-type: none"> • VOC content for trim, stains and varnishes shall be $\leq 75 \text{ gL}^{-1}$ • VOC content for paints (water-based) shall be $\leq 25 \text{ gL}^{-1}$ for matt, $\leq 30 \text{ gL}^{-1}$ for low sheen, $\leq 75 \text{ gL}^{-1}$ for semi-gloss
<p><i>Limits for products are based upon ASTM D5116-90, "Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products".</i></p> <p><i>Test methods for paints and coatings shall comply with ISO 17895 or ISO 11890</i></p> <p><i>Testing must be by an accredited laboratory.</i></p>	

HW1.3 Air Quality and Comfort

To promote sustainable designs, systems and features that can provide satisfactory thermal comfort, while enhancing outdoor air provision for greater well-being of occupants.

HW1.3a Thermal Comfort

Thermal comfort preferences are highly individual, and can be affected by metabolism, body type and clothing. These factors make it hard to find a temperature that will satisfy all occupants in the same space at the same time. Providing a range of thermally comfortable spaces means that the building systems allow for a variability of temperatures, and greater ability to adjust to individual preferences in different zones, allowing occupants to adjust the temperature in their immediate surroundings in order to achieve better thermal comfort.

(i) Air-Conditioned Non-Residential Buildings

The building can adjust temperature and thermal conditions so that parts of the building can have an occupant centric thermal variation and comfort within it.

Assessment Criteria

HW1.3a Thermal Comfort	New Buildings	Existing Buildings
(i) Air-Conditioned <u>Non-residential</u> Buildings: zonal temperature and air speed controls	<u>For Non-Residential Buildings</u> 1 Point (at least 90% of regularly occupied functional spaces) OR 0.5 Points (at least 50% of regularly occupied functional spaces) <u>For Residential Buildings</u> N/A	<u>For Non-Residential Buildings</u> 1 Point (at least 90% of regularly occupied functional spaces) OR 0.5 Points (at least 50% of regularly occupied functional spaces) <u>For Residential Buildings</u> N/A

Points shall be awarded based upon the design and operational strategies that detail how thermal comfort can be tailored to suit occupants in different spaces, at different times, and be adaptable to user preferences.

Strategies include:

- The use of hybrid cooling systems with elevated temperatures with provision of ceiling fans and/or individual desk fans. Where comfort can be controlled by the temperature of conditioned air and the air speed variation
- Spatial and zonal temperature monitoring with occupant feedback, controls to allow for adjustable air speeds and temperatures in discrete zones in open areas or by room.

Requirements:

- Control zones shall not exceed 100m²
- Controls shall provide the logic to modify the operation of the VAV box, FCU, Passive Displacement System coil temperature, Ceiling fan speed or other system employed, which will adjust thermal comfort in that zone
- The strategies shall cover at least 50% (0.5 points) or 90% (1 point) of regularly occupied functional spaces.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Thermal comfort analysis including relevant simulations of alternative cooling technology employed
- Write up and schematics of control strategy and control logic and its impact on comfort
- Mark up of control zones and thermal variation limits

At Verification stage (New Buildings & Existing Buildings):

- As built drawings, photos and schematics of thermal control systems installed
- Testing reports of alternative cooling system
- Photos of ceiling fans/ individual fans provided for each occupant

(ii) Non-Air-Conditioned Functional Spaces

Naturally ventilated regularly occupied functional areas should be effectively designed to be thermally comfortable and healthy for the building occupants.

Assessment Criteria

HW1.3a Thermal Comfort	New Buildings	Existing Buildings
(ii) Non-Air-Conditioned functional spaces.	<u>For Non-Residential Buildings</u>	<u>For Non-Residential Buildings</u>
	1 Point	1 Point
	<u>For Residential Buildings</u>	<u>For Residential Buildings</u>
	3 Points	N/A

Points shall be scored through meeting either one of the performance routes (a), (b) or (c).

For draft sensitive sports spaces, or industrial buildings with occupancy densities less than 50m² per person, projects can meet the following requirements in lieu of a) and b):

- Air Change rate ≥ 10
- Air Change Effectiveness ≥ 1.2

a) Thermal comfort simulation

The thermal comfort assessment shall be carried out using Predicted Mean Vote (PMV) equation to identify the most effective building design and layout for the development.

Thermal Comfort
$-0.5 \leq PMV \leq 0.5$

b) Effective cross ventilation:

70% of habitable areas to meet the Area weighted average wind velocity of 0.6m/s using Computational Fluid Dynamics (CFD) modelling. Refer to the GM Guideline on Computational Fluid Dynamics (CFD) Simulation.

c) Prescriptive performance

Parameter	Description	Points
Openings towards prevailing wind directions	0.1 point for every 10% of room openings facing the prevailing winds.	<u>For Non-Residential Buildings</u> 0.5 Points <u>For Residential Buildings</u> 1 Point
Non-Residential Buildings Depth of Room vs Openings	<u>A. Single sided ventilation:</u> the limiting depth(W) for effective ventilation is twice the floor-to-ceiling height (H) [$W \leq 2H$] <u>B. Cross Ventilation:</u> the limiting depth(W) for effective ventilation is five times the floor-to-ceiling height (H) [$W \leq 5H$] <u>C. Atria/ event space:</u> Atria to have an effective opening >10% floor area: Atria can be 1.5x the depth of room (A and B), or up to 2x depth where the use of fixed air movement technologies are employed (e.g. HVLS fans).	0.5 points where $\geq 50\%$ of applicable spaces meet 1 point where $\geq 70\%$ of applicable spaces meet
Residential Dwelling Unit Cross ventilation	Plan level analysis based on the number of living rooms, bedrooms, home office spaces that are designed with true cross ventilation.	0.5 point for $\geq 50\%$ 1 point for $\geq 60\%$ 2 points for $\geq 70\%$ 3 points for $\geq 75\%$

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Dimensioned plan, sections, window schedule and details
- For a) and b) the simulation report as outlined in the GM 2021 Guideline on Computational Fluid Dynamics (CFD) Simulation
- For c) calculations with detailed drawings showing compliance with the parameters outlined.
- Summary score sheet

At Verification stage (New Buildings & Existing Buildings):

- As built drawings and photographs
- Any design changes to be highlighted on the plan drawing and the areas recalculated/ re-simulated
- Site Measurements for existing buildings, demonstrating PMV or effective cross ventilation based on minimally 3 months aggregated data collected during typical operational hours of the building

Guidance Notes

General:

- Effective opening areas, and distances shall be compliant with BCA approved documents, or shall demonstrate an acceptable performance-based approach which has been approved by the commissioner of building control.
- Prevailing winds can be taken as N, NNE, NE, SE, SSE, S, SSW with prominent winds from the northeast and the south reflecting the dominance of the monsoons, with winds from the Northerly to north-easterly during December to March, and Southerly to south-easterly during June to September. The inter monsoon months (April, May, October and November) are transition periods and show lighter and more variable winds.
- For a) Thermal comfort simulation and b) Effective cross ventilation, the details on how to conduct the simulation, the validated software and PMV equations are found in the GM: 2021 Guideline on Computational Fluid Dynamics (CFD) Simulation.

a) Thermal Comfort Modelling:

- Area weighted average velocity of 0.2m/s shall be achieved in order to use the fixed Dry Bulb Temperature (DBT) within the PMV formula within the BCA, else the DBT would be derived from simulations.

b) Effective Cross Ventilation:

- The area weighted average of 0.6m/s for 70% of the units must be met in order for points to be scored, note that this performance, for residential buildings differs from the performance requirements in the EE section.

c) Prescriptive Performance:

A. Single Sided Ventilation

- This applies to naturally ventilated regularly occupied functional spaces with window openings on one side.
- Limiting depth for effective single sided ventilation is no more than 8m. This can be extended to 12m with use of air movement technologies such as ceiling fans.

B. Cross Ventilation

- This applies to naturally ventilated regularly occupied functional spaces with window openings on opposing sides of the space.
- Limiting depth for effective cross ventilation is 15m. This can be extended to 24m with use of air movement technologies such as ceiling fans.
- One of the sides for cross ventilation can consider openings to a naturally ventilated atrium.

C. Atria/ Event Space

- For atria or event spaces which are single-sided, they may apply a factor of 1.5 to the W-H ratio for regularly occupied functional spaces. This means they can meet $W \leq 3H$ instead to score. Where air movement technologies are employed, such as HVLS fans, this can be increased to $W \leq 4H$
- For atria or event spaces which have cross ventilation, they may apply a factor of 1.5 to the W-H ratio for regularly occupied functional spaces. This means they can meet $W \leq 7.5H$ instead to score. Where air movement technologies are employed, such as HVLS fans, this can be increased to $W \leq 10H$

Residential Buildings.

- Plan level analysis based on the number of living rooms, bedrooms, home office spaces that are designed with true cross ventilation.
- The main entrance door (where the developer provides a lockable gate /grille), all windows and internal doors are assumed to be open.
- Provision of dedicated power point(s) to enable the installation of ceiling fans in the living room

- Refer to GM 2021 Energy Efficiency technical guide – Ventilation performance for further guidance notes and worked examples.

References

GM 2021 Guideline on Computational Fluid Dynamics (CFD) Simulation

CIBSE AM10, Natural Ventilation in non-domestic buildings

See <http://www.weather.gov.sg/climate-climate-of-singapore/> for the overview of Singapore’s climate data including wind speed and directional data.

HW1.3b Outdoor Air Provision

(i) Enhanced Outdoor Air Provision

Outdoor air provision (ventilation) in buildings is critical in diluting various indoor air pollutants such as those generated by human (odour etc.), human activities (CO, CO₂, PM2.5 etc.) and building materials/ furnishings (VOCs etc.).

Assessment Criteria

HW1.3b Outdoor Air Provision	New Buildings	Existing Buildings
(i) Outdoor air provision greater than ventilation rates in SS553, with demand control and monitoring systems.		
a) Outdoor air supply at 1.5 times minimum ventilation rate required in SS553	1 Point	1 Point
b) Outdoor air supply at 2 times minimum ventilation rate required in SS553	2 Points	2 Points

(Applicable to non-residential buildings only) Points shall be awarded for the adoption of an outdoor air supply strategy which is greater than the minimum ventilation rate required within SS553 Table 1 (air-conditioned spaces) or Table 5 (mechanically ventilated spaces. (Buildings outside of the SS553 scope such as healthcare facilities shall refer to relevant authorities’ minimum ventilation rate requirements.)

- Points can be scored based on % of functional spaces and the enhanced ventilation rate
- Outdoor air supply rate shall be measured by direct outdoor airflow measurement devices located at each AHU or each floor
- Occupancy based ventilation rates can be used to demonstrate performance, control logic shall be based on real-time occupancy density and link to the outdoor air supply. Reference should be made to international documents such as ASHRAE 62.1 ventilation rates based on occupancy density.
- CO₂ monitoring shall be within the occupancy area (breathing zone), not at the return air side of AHUs
- CO₂ levels should not exceed;
 - For (a) 800ppm or
 - For (b) 600ppm
- Connected sensors for outdoor airflow, occupant density and indoor CO₂ levels shall be linked to the BMS or an independent system that provides direct control and data management functions

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

Measurement, monitoring and control of outdoor airflow rate

- Increased outdoor air supply rate calculation by zones based on SS 553 Table 1 or Table 5
- Extracts of specifications showing the detailed performance requirements of the ventilation system, control system and real time monitoring system
- Design and construction details reflecting the outdoor supply rates to individual zones
- Method statement for operations of the system including the strategy to monitor, control and maintain outdoor air intake volume to be 1.5 times or 2 times greater than SS553 rates
- Drawings of the positioning of sensors at outdoor air duct in accordance with the manufacturer's guidelines and link to a building management system (or equivalent) for monitoring and controlling the outdoor air volume
- Plan layout indicating the provision of the sensors at least one location per AHU or per floor
- Plan layout indicating the provision of access panel for regular maintenance of airflow sensors
- In cases where outdoor airflow monitoring and control system is linked to occupant density monitoring and control system, a detailed method statement with supporting documents and specifications shall be provided to demonstrate how enhanced ventilation rates to each person in a space can be achieved

CO₂ Sensors

- Method statement on the monitoring and regulation of indoor CO₂ levels, including alerts programmed into a BMS or a central monitoring and control system to notify the CO₂ levels exceeding the targeted set point
- Plan layouts and schematics showing the locations of CO₂ sensors, providing representative readings to control the outdoor airflow
- At least two CO₂ sensors per AHU or at least one CO₂ sensor per 250m² whichever provides greatest granularity. Sensors should be installed at the height of breathing zone (0.75m to 1.2m from the floor).
- CO₂ sensor specifications to meet the following requirements;
 - Sensor technology: Non-dispersive Infrared
 - Measurement range: 300 to 3000 ppm or wider
 - Accuracy: not more than ±50 ppm or ±5% within measurement range
 - Resolution: 5 ppm or less
 - Yearly calibration
- Data monitoring at a central location (e.g. BMS) with daily, weekly, monthly data viewing and logging capability at logging interval of least 30 minutes

At Verification stage (New Buildings & Existing Buildings):

Measurement, monitoring and control of outdoor airflow rate

- Delivery orders, technical specifications, as-built drawings, outdoor airflow computations by zones and onsite photographs of the airflow measurement devices
- Details of BMS or equivalent monitoring and control system with screenshots and control logics to showing real-time nature of the system
- Past daily, weekly, monthly logged data of the outdoor airflow at each AHU or each floor demonstrating the compliance to the respective requirement. Data logging interval to be at least 30 minutes.
- In cases where outdoor airflow monitoring and control system is linked to occupant density monitoring and control system, a detailed method statement with supporting documents and specifications shall be submitted

CO₂ Sensors

- Delivery orders, technical specifications, calibration certificate, plan drawings showing the locations and onsite photographs of the CO₂ sensors
- Monitoring and control system screenshots and control logic details

- extract of at least 1 month of logged data demonstrating the compliance to the respective requirement. Data logging interval to be at least 30 minutes

Guidance Notes

An operational method statement shall be provided to bridge the gap between design intent and operational reality. This shall include details on programming alerts for when the outdoor air volume drops below the minimum set points and varies by more than 15% above the airflow set point.

Accuracy of outdoor airflow measurement shall have the capability to measure and control the outdoor air intake volume with an accuracy of at least +/-10%.

Worked Example

Outdoor airflow rate computation:

AHU schedule	Area type	Area served (m ²)	SS553 table 1 (l/s/m ²)	Min. OA amount (l/s)	Targeted OA amount (l/s) 2 times	Remarks
AHU 1-1	Lobby	300	0.3	90	90	Common area
AHU 1-2	Office	500	0.6	300	600	Functional area
AHU 2-1	Office	400	0.6	240	480	Functional area
AHU 2-2	Office	400	0.6	240	480	Functional area
AHU 3-1	Office	400	0.6	240	480	Functional area
AHU 3-2	Office	400	0.6	240	480	Functional area
AHU 4-1	Office	400	0.6	240	480	Functional area
AHU 4-2	Office	400	0.6	240	480	Functional area

The project above would score 2.5 points as all functional areas are designed with 2x the outdoor air ventilation rate.

Example of proration of points:

- 25% of the functional area, with outdoor air supplied at 2 times the ventilation rate required in SS553. The remaining spaces are a typical demand control strategy pegged to SS553. The projects would score 0.5 points.
- A mixture of strategies employed in a project where 50% of regularly occupied functional spaces are based on 1.5 times enhanced ventilation, while the other 50% is based on 2 times the ventilation rate. The total score would be 1.5 points.

(ii) Periodic (Post) Occupancy Evaluation

Periodic Occupancy Evaluation, or a Post Occupancy Evaluation (POE) provides insights on the occupants' experience within the building and a platform in which to identify performance shortfalls and introduce corrective actions to address issues.

Assessment Criteria

HW1.3b Outdoor Air Provision	New Buildings	Existing Buildings
(ii) Periodic (Post) Occupancy Evaluation	0.5 Points	0.5 Points

Points will be awarded if a Periodic (Post) Occupancy Evaluation (POE) survey is conducted at least once every 3 years and corrective actions are taken to address occupant concerns that arise from the analysis of the evaluation (applicable to non-residential buildings only).

The POE sample size shall be at least 10% of the occupant population with the following exceptions:

- Projects with occupancies < 100 pax, minimum of 10 occupants surveyed
- Projects with occupancies >1,000, minimally 100 occupants surveyed.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Extracts of the tender specifications showing the requirements to conduct a POE within one year after occupancy and to undertake corrective actions

At Verification stage (New Buildings & Existing Buildings):

- A written confirmation on the building occupancy (total number), demonstrating that the response rate of the POE meets the sample size requirement
- Samples of completed survey forms and emails submitted by the respondents
- POE survey results showing the summary of the survey analysis and the list of corrective actions taken
- Evaluation of the POE results and the list of the corrective actions based on the respondents' comments

Guidance Notes

The spreadsheet for the standardised BCA POE survey questionnaire and results template is available for use and meets the requirements of the criteria.

- Survey Template: https://www1.bca.gov.sg/docs/default-source/docs-corp-buildsg/sustainability/poe_survey_template.xlsx
- Survey Analysis: https://www1.bca.gov.sg/docs/default-source/docs-corp-buildsg/sustainability/poe_results_template.xlsx

For Projects wishing to develop or adapt their own POE system these can follow the guidance below, however the questions and language should be tailored to suit the building occupants to yield meaningful data on which to act. Within the survey, there should be room for occupant's comments and observations.

- (i) General Information:
 - Basic data of the individual
 - Location within the building
 - Nature of work

- Time spent within the building (average week)
- (ii) Lighting Quality:
- Lighting system with adequate intensity (brightness) and even distribution
 - Appropriate lighting for each different activity area
 - Appropriate lighting controls and zoning
 - Access and quality of natural light
 - Discomfort glare / daylight control
- (iii) Acoustic Quality:
- Appropriate sound levels for each different activity area
 - Acoustic/ speech privacy
 - Background noise
 - Noise transmission between rooms / spaces
- (iv) Indoor Air Quality:
- Temperature (thermal comfort)
 - Humidity
 - Smell
 - Air movement
 - Freshness of the air (perceived air quality)
 - Ability to control indoor conditions
- (v) Environment:
- Cleanliness of the workspaces
 - Cleanliness of the common areas (toilets, pantry's, lobbies, terraces etc.)
 - General building maintenance
 - Waste sorting and recycling strategies or programmes
 - Corporate environmental policies and programmes
- (vi) Health:
- Respiratory irritations (blocked, runny, itchy nose)
 - Sore throat
 - Chronic cough
 - Irritated eyes
 - Chronic fatigue
 - Linking these symptoms to the building

(iii) IAQ Surveillance Audit

Assessment Criteria

HW1.3b Outdoor Air Provision	New Buildings	Existing Buildings
(iii) Indoor Air Quality Surveillance Audit		
a) Once every 3 years	0.5 Points	0.5 Points
b) Annually	1 Point	1 Point

IAQ audits shall be performed by an IAQ laboratory accredited by Singapore Accreditation Council (SAC) with respect to the recommended IAQ parameters and acceptable limits stated in Table 1 of SS554 (applicable to non-residential buildings only).

- For Projects that conduct the IAQ audit annually – 1 Point
- Projects which conduct the audit every 3 years – 0.5 Points

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Commitment as part of the scope of works from the project team to conduct IAQ surveillance audit within one year after occupancy by an accredited laboratory

At Verification stage (New Buildings & Existing Buildings):

- IAQ surveillance audit report by an accredited laboratory. For regularly occupied functional spaces outside of the above-mentioned standards/ guidelines' remit, the performance standards for the respective IAQ parameters shall be determined based on prevailing industry best practice standards

Guidance Notes

A spreadsheet of the standardised IAQ report template is available at https://www1.bca.gov.sg/docs/default-source/docs-corp-buildsg/sustainability/iaq-report-template.xlsx?sfvrsn=d683e678_6

HW1.3c Clean Air

Building occupants and users' exposure to air pollutants can be reduced by arresting air pollutants through high-efficiency media filters, by disinfecting air or by setting designated smoking points.

Assessment Criteria

HW1.3c Clean Air	New Buildings	Existing Buildings
(i) UVGI System for Air Disinfection	0.5 Points	0.5 Points
(ii) Air Filtration	1 Point	1 Point

(i) UVGI System for Air Disinfection

Assessment Criteria

Points shall be awarded for projects using Ultraviolet Germicidal Irradiation (UVGI) System for air disinfection at AHUs, FCUs, in-duct or upper rooms. The UVGI system shall cover at least 90% of regularly occupied functional spaces. (applicable to non-residential buildings only)

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Extracts of the tender specifications and schematics showing the provision of UVGI system for air disinfection.
- UVC germicidal wavelength (260nm)
- Plan drawings showing locations of the UVGI system
- Technical specifications and safety features of the UVGI system
- Manufacturer's guideline on the intensity, location, reflector design and number of lights

At Verification stage (New Buildings & Existing Buildings):

As-built drawings showing locations and pictures of the UVGI system

- Actual specifications and safety features of the UVGI system
- Plan drawings showing the coverage of at least 90% of regularly occupied functional spaces
- Manufacturer's guideline on the intensity, location, reflector design and number of lights

(ii) Air Filtration

Assessment Criteria

The filtration provision shall cover at least 90% of regularly occupied functional spaces (applicable to non-residential buildings only).

a) For Air conditioned and Mechanically Ventilated Functional Spaces:

1 point will be awarded for projects using ePM1 \geq 75% (ISO 16890) or alternatively at least MERV-A14 (ASHRAE 52.2 Appendix J) media filters permanently for airside systems, including AHUs, PAHUs and FCUs.

For Existing Buildings where high-efficiency filters cannot be fitted due to existing building constraints, portable air cleaners can be used, this would be eligible for 0.5points.

A mixture of strategies is allowed for existing buildings with constraints (e.g. ePM1 \geq 75% media filter to cover 50% of regularly occupied functional spaces and the other 50% of regularly occupied functional spaces are provided with portable air cleaners). Points shall be pro-rated, in this instance, $((50 \times 1\text{point}) + (50 \times 0.5\text{point}) / 100) = 0.75$ Points

b) For Naturally Ventilated Functional Spaces:

Use of portable air cleaners during periods of poor air quality (e.g. Haze events) or public health events (such as a communicable disease outbreak).

The clean air delivery rate (CADR) for smoke or equivalent of portable air cleaners with HEPA filters shall be used to determine the size and number of portable air cleaners needed in a space.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Extracts of tender specification for the permanent provision of ePM1 \geq 75% (ISO 16890) or at least MERV-14 (ASHRAE 52.2 Appendix J) media filter for air distribution systems
- Technical specifications and air filtration classification testing report for the filters to be used for each air distribution system
- Plan drawings showing the coverage of at least 90% of regularly occupied functional spaces

At Verification stage (New Buildings & Existing Buildings):

- Pictures showing filter locations and installations
- Technical specifications and filtration classification testing report for the actual filters and/or portable air cleaners used on site
- Adequate provision of portable air cleaners supported by computations
- Plan drawings showing the coverage of at least 90% of regularly occupied functional spaces

Guidance Notes

For Portable Air Cleaners:

If the unit of CADR is in m³/h, the total CADR of the air cleaner(s) shall be at least five times the room volume in m³. If the unit of CADR is in ft³/min, the total CADR of the air cleaner(s) shall be at least three times the room volume in m³.

Worked Example

To determine the size and number of portable air cleaners needed in a space;

Space conditions

- Space area = 100m²
- Space height = 2.8m
- Space volume = 100m² X 2.8m = 280m³

Computation example

- CADR (CMH, m³/hr) > 5 x Volume (m³) = 5 x 280 = 1,400, therefore CADR > 1,400
- Assume the CADR of the air purifier with HEPA filter is 500 CMH/unit
- 1,400 / 500 = 2.8, therefore the number of units required = 3 units

HW2 Psychological

A maximum of 5 points can be scored across HW 2 Psychological section.

HW2.1 Access to Nature

Well-being refers to the state of being comfortable, healthy or happy. Providing nurturing, healing and inclusive spaces can enhance the building occupant and user’s environment, and overall wellbeing. This includes integrating within buildings places of respite, nature access, architecture that invoke a connection to nature as well as accessible and inclusive spaces.

Assessment Criteria

HW2.1 Access to Nature		New Buildings	Existing Buildings
(i)	Provision of accessible planted sky terraces, courtyards, and roof top gardens.	1 Point	1 Point
(ii)	Fixed indoor planting distributed at key common areas. >10% of common area (by floor Area) to have fixed indoor planting, and/or ponds, supporting systems such as grow lights, irrigation systems need to be shown.	0.5 Points	1 Point
(iii)	Placement of natural elements and use of mixed textures in key common areas such as atria, entrance lobbies, shared seating areas, and key circulation routes.	0.5 Points	0.5 Points
(iv)	In the absence of indoor or accessible planting, to orientate and design common areas for direct visual access to greenery.	0.5 Points	0.5 Points

Points shall be scored based on the above criteria. Note that supporting infrastructure shall be included, including landscape maintenance plan (both for internal and external planting), interior fitout guides and evidence of use of natural materials, with a range of textures to provide a haptic and visual journey through the building.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Design statement on the approach, strategies implementation of the incorporation of, and access to nature within the development
- Landscape plans of the relevant accessible sky gardens, sky terraces, internal courtyards and rooftop gardens that indicate the outdoor furniture, the outdoor refreshment area
- Plan layouts and perspectives of the interior planting design at the applicable areas with calculations that demonstrate the plant coverage as a percentage of the relevant floor areas
- Layout identifying common area, the design and haptic qualities of the space, the natural elements being introduced and their locations
- Site plan and images of orientation, window placement and the associated framed views out to nature that the occupants would be orientated to

At Verification stage (New Buildings & Existing Buildings):

- As-built drawings and photographs highlighting the provision of the committed features

References

[World Health Organisation, Urban Green Spaces and Health: A review of evidence.](#)

<https://www.nparks.gov.sg/skyrisegreenery>

HW2.2 Circadian Rhythm

Humans and animals have internal clocks that synchronise physiological functions (the circadian rhythm). In buildings this natural rhythm can be disturbed if we are exposed to light at certain hours of the day (e.g., at night time). The Circadian Rhythm has a major role in sleep, cognitive performance, and the immune system.

Assessment Criteria

HW2.2 Circadian Rhythm	New Buildings	Existing Buildings
	<u>For Non-Residential Buildings</u>	<u>For Non-Residential Buildings</u>
(i) Views to Outside	1 Point	1 Point
(ii) Quality of Artificial Lighting	0.5 Points	0.5 Points
(iii) Circadian Lighting System	2 Points	2 Points
	<u>For Residential Buildings</u>	<u>For Residential Buildings</u>
	(iii) 2 Points	(iii) 2 Points

(i) Views to Outside

We spend around 90% of our time inside buildings. Window views provide a connection to the outside, giving us information about ongoing changes that occur outside (passage of time and weather). Distant views refocus our visual gaze from nearby content (computer displays) onto far away content. This helps minimise eyestrain.

Assessment Criteria

Points shall be awarded for the following:

- 75% of the floor area of all regularly occupied spaces is within 8m of windows, with unobstructed views – 0.5 points, OR
- 95% of the floor area of all regularly occupied spaces is within 12m of windows, with unobstructed views – 1 point

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Floor plans with areas of compliance marked up
- Window schedules and elevations

At Verification stage (New Buildings & Existing Buildings):

- As-built drawings and photographs

Guidance Notes

Unobstructed views have 2 meanings for this criterion:

1. View content - Window(s) looking onto another unit, service yard, or directly onto the façade of another building shall have a sufficient distance gap of at least 10m to allow sufficient view to the sky and surroundings. Distant views also provide a greater sense of privacy.
2. View access - Window(s) shall be sufficiently sized at an appropriate height with windows to wall ratio (WWR) of at least 25% of each facade. This access shall be unobstructed within the interior, which means that there is a direct view to the window(s), and an allowance for daylight penetration. For example cubicles in open-plan offices, or discrete rooms that are subdivided into individual spaces shall not have opaque partition walls that are higher than 1.4m. However, layouts with a range of partition heights can be accepted where the design shows that the view to the outside is not negatively impacted.

Where the floor area is unable to demonstrate compliance, detailed analysis can be undertaken to show that 75% or 95% of desks or regularly occupied seats meet the distance requirements.

(ii) Quality of Artificial Lighting

Where daylight alone is not possible to provide adequate lighting conditions, a minimum quality for artificial lighting should be employed to provide comfort, uniformity, and colour rendition, which support visual tasks.

Assessment Criteria

a) Colour Rendering

All electric lights (except decorative fixtures, emergency lights and other special-purpose lighting) meet the minimum colour rendering index in accordance with SS 531-1:2006 (2019) Code of practice for lighting of work places - Indoor.

b) Responsive Light Control

All lighting (except decorative fixtures) are programmed using occupancy sensors to automatically dim to 20% or less (or switch off) when the zone is unoccupied, and all lighting in areas where there is access to daylight have the capacity to and are programmed to dim continuously in response to daylight.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Specifications and data sheets of light selections including relevant simulations and calculations
- Sensor details, control strategy and electrical drawings indicating the zoning of lights and control groups

At Verification stage (New Buildings & Existing Buildings):

- As-built drawings, delivery orders, data sheets and photographs

Guidance Notes

For projects to be able to score, basic lighting quality standards are to be met, these include:

lifespan rating is in accordance with - IES TM-21 method, based on LM80 test report

Lighting designed with minimal flicker and stroboscopic effects: Submission of specifications showing use of LED lights or high frequency ballasts with frequency > 20 kHz and LED drivers with ≤30% flicker

Worked Example

The proposed development provides the following lighting quality for its occupants at various spaces:

Type of interior, task or activity	Design R _a	Reference R _a (as specified in SS531: 2006)
Office Space Type 1	80	80
Atrium	60	60
Corridor type 1	40	40
Toilet	80	80
Mechanical & Electrical Rooms	60	60
Carpark	40	40

The proposed lighting design meets the reference values as stated in SS 531-1:2006 (2019) and the LED lightings installed are based on lifespan rating of L70 for $\geq 50,000$ life hours and lighting designed with minimal flicker and stroboscopic effects (LED drivers with $\leq 30\%$ flicker). Daylight responsive systems shall adhere to the manufacturer's recommendations when continuous dimming is used to prevent flicker at low light levels. Light sensors shall be positioned in strongly daylighted areas, but shall avoid direct light from either electric light or daylight as recommend in the LP-6-20. This allows smooth dimming signals to be sent to the light controller.

When ceiling fans are installed with recessed lighting, flicker shall be avoided. For example, dropdown lighting shall ideally be suspended at the same level or lower than the ceiling fan blades. These lights shall be securely fastened to avoid suspended lights from swaying. Ceiling fans shall not be installed underneath skylights, which will cause flicker and strobing from daylight. Recommendations to prevent flicker from ceiling fans can be followed in Fans for cooling people guidebook (2023) – Ceiling fan interaction with lighting.

Responsive Light Control

The following requirements are met in all major workspace areas:

- All lighting except decorative fixtures is programmed using occupancy sensors to automatically dim to 20% or less (or switch off) when the zone is unoccupied
- All lighting except decorative fixtures has the capacity and is programmed to dim continuously in response to daylight

(iii) Circadian Lighting System

Dynamic 'circadian' lighting uses dimmable, colour-tuning LEDs to give brighter and blue-enriched light in the morning middle of the day, while providing dimmer and blue depleted light later in the day.

Assessment Criteria

HW2.2 Circadian Rhythm	New Buildings	Existing Buildings
(iii) Circadian Lighting System a) Task Lighting b) All Lighting	<u>For Non-Residential Buildings</u> a) 1 Point OR b) 2 Points <u>For Residential Buildings</u> b) 2 Points – all relevant common area lighting	<u>For Non-Residential Buildings</u> a) 1 Point OR b) 2 Points <u>For Residential Buildings</u> b) 2 Points – all relevant common area lighting

Projects can either:

1. Engage a lighting specialist to look at the various opportunities for a bespoke circadian lighting system that balances brightness and dimming with graduated colour shift during the day. Typically the system would reference either Equivalent Melanopic Lux (EML) and/or Melanopic Equivalent Daylight Illuminance (MEDI).
2. A project can install a dynamic lighting system with colour shift settings that graduate between colour temperatures during the day. At least 3 colour shifts could be considered during the day. A recommended programme is below for a building with normal daytime occupancy. Note that the colour changes shall be gradual and recommended to be over a 1-hour period.

Time	Recommended Colour Temperature Range
7am to 10am	3500-4000K
10am to 2pm	5000K-6500K
2pm to 5pm	3500K-4000K
5pm onwards	2700 -3000K

Points would be based on the extent of coverage, whether this is for

- a) Task Lighting – 1 point OR
- b) All lighting – 2 Points

For residential projects, colour shift lighting would be applicable for the management office, outsourced workers rest areas, common lobbies and corridors, function rooms. Landscape and outdoor lighting should aim for low colour temperatures (2700K) where used at night to prevent disturbance to residents sleep. Gyms, fitness and sports areas, as well as carparks would not be included due to separate functional requirements. For car parks it is recommended to use a neutral colour temperature suited for visibility, security, and human comfort.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Lighting specialist design report and recommendations highlighting the circadian rhythm design strategies and standards used
- Extent of coverage (task lighting or general lighting)
- Lighting system specification, colour temperatures and control logic for time and length of transition

At Verification stage (New Buildings & Existing Buildings):

- Lighting data sheets, control systems and lighting management plan

References

https://www.designingbuildings.co.uk/wiki/Circadian_rhythms

BRE Trust (2019) [Lighting for Circadian Rhythms](#)

CIBSE Journal May 2019 – [Evaluating Dynamic Lighting](#)

CIE standard S 026/E:2018

DIN SPEC 67600.

DIN SPEC 5031-100.

Fans for cooling people guidebook (2023) – [Ceiling fan interaction with lighting](#)

LP-6-20 – Lighting Practice: Lighting Control Systems – Properties, Selection, and Specification

The SLL Code for Lighting (2022)SSL-erate (2014) [Lighting for Health and Wellbeing in Education, Work Places, Nursing Homes, Domestic Applications and Smart Cities](#)

HW2.3a Sound Zoning Design Approach

Implement passive and/or active acoustic control measures to minimise exterior sourced noises by creating positive soundscapes, to improve the aural comfort of occupants.

Assessment Criteria

HW2.3a Sound Zoning Approach	New Buildings	Existing Buildings
<ul style="list-style-type: none"> • Orienting and locating noise-sensitive buildings and spaces away from exterior sourced noises. Using less noise-sensitive spaces (e.g. MSCP, pedestrian/cycling pathways) and/or natural or engineered barrier (e.g. balconies, toilets/kitchen, dense landscaping) as buffers from exterior sourced noises • 	0.5 Points	0.5 Points

0.5 Points will be awarded where the project team can demonstrate a sensitive contextual design to the project in relation to the prevailing soundscape. Consideration to the location and massing of blocks, landscape interventions, spatial arrangement and positioning of rooms and spaces, and physical acoustical barriers shall be shown and articulated in the plans.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Sound Zoning or Soundscape plan that details the design approach and optimisation to minimise exterior sourced noises to sensitive spaces

At Verification stage (New Buildings & Existing Buildings):

- Implementation and analysis of the design features and techniques employed

References

[Sound in Landscape Architecture. A Soundscape Approach to Noise](#)

<https://soundscapedesign.info/design-tool/>

<https://www.arup.com/perspectives/what-should-a-city-sound-like>

HW2.3b Interior Acoustic Comfort

An improved acoustical performance for normally occupied spaces can enhance the aural comfort of its occupants, facilitating communication, reducing unwanted sound and aiding in speech privacy.

Assessment Criteria

HW2.3b Interior Acoustic Comfort	New Buildings	Existing Buildings
(i) Impact Sound Insulation (residential buildings)	<u>For Non-Residential Buildings</u> (ii) 0.5 Points	<u>For Non-Residential Buildings</u> (ii) 0.5 Points
(ii) Internal Noise Level	(iii) 0.5 Points	(iii) 0.5 Points
(iii) Airborne Sound Transmission Reduction (non-residential buildings)	(iv) 1 Point	(iv) 1 Point
(iv) Reverberation Time (non-residential buildings)	<u>For Residential Buildings</u> (i) 1.5 Points (ii) 0.5 Points	<u>For Residential Buildings</u> N/A

(i) Impact Sound Insulation

Compliance with the following Isolation class (IIC) or BB90, or HTM08-01 standards.

Impact Sound Transmission Reduction Requirements	
Area	Performance (IIC)
Floors between residential spaces such as bedrooms, living rooms and lounges.	≥ 50
<i>Floors separating enclosed and fully vertically adjacent wet areas (e.g., bathrooms) are not subject to the impact sound insulation requirements</i>	

(ii) Internal Noise Level

The internal noise level requirement is aimed at ensuring that building occupants are not exposed to excessive noise levels that can negatively impact their health and well-being. Internal noise level is the noise level in a space when unoccupied but ready for occupancy with closed façade condition (i.e. all normally operable windows and doors to outside are closed) and with building services running as per normal operating conditions during normal operating hours. The internal noise level criteria shall be met across the whole floor area, complying with SS553 where applicable, otherwise per AS2107:2016, BB93 or HTM08-01. Some areas extracted from AS2107:2016 below:

Recommended design sound level L_{Aeq} dB(A)		
Area	Description	Recommended maximum sound level
Office	Open Plan Office	45
	Board and Conference	40

	Corridors and lobbies	50
	Reception Area	45
Institutional, Community and civic spaces	Teaching Spaces	45
	Lecture Theatre	35 – 45
	Libraries	45 – 50
	Music Practice Rooms	45
	Assembly Halls (up to 250 seats)	40
	Staff Common Room	45
	Airport Terminals	55
	Art Galleries	45
	Cinemas	35
	Court Rooms	35
	Museums	45
	Post Office and General Banking Areas	50
	Cafeteria and Food Courts	55
	Restaurants	50
Hotel	Meeting Room	35 – 40
	Banquet Room / Hall	35 – 40
Residential buildings	Living Areas	45
	Sleeping Areas	40
	Kitchen / Laundry Areas	50
<i>AS/ NZS 2107 (2016) 'Acoustics – Recommended design sound levels and reverberation times for building interiors'</i> <i>Standards Australia</i>		

(iii) Airborne Sound Transmission Reduction

Sound transmission class (STC): A rating of how well a partition attenuates airborne sound. The higher the STC is, the higher the sound reduction. Points shall be awarded where compliance with the airborne sound insulation criteria outlined below otherwise per BB93 or HTM08-01 are demonstrated.

Sound Transmission Reduction Requirements	
Area	Performance (STC)
General Office Spaces	≥ 45
Any spaces where confidential or critical speech is required examples include, Meeting Rooms, Conference Rooms, Classrooms	≥ 50-60
Between Mechanical/ Equipment spaces and occupied spaces	≥ 55
<p><i>The above reduction requirements apply to partitions between rooms.</i></p> <p><i>For partitions with doors or significant glazing between rooms and corridors/general office areas the above criteria do not apply, however doors and glazing systems shall be specified as minimum STC 35 and the designer is to consider overall room-to-room sound level difference and flanking paths.</i></p>	

(iv) Reverberation Time

Reverberation time (RT): The length of time required for sound to diminish 60 decibels from its initial level in an enclosed space. Points shall be awarded with compliance with Reverberation Time criteria provided in AS2107:2016, some areas extracted for ease below:

Reverberation Requirements		
Area	Description	Reverberation Time
Office	Open Plan Office	0.4 – minimised for noise control
	Conference	0.6-0.8
	Meeting Room (small)	<0.6
	Video/Audio Conference rooms	0.2-0.4
Institutional, Community and civic spaces	Classrooms	0.3-0.7
	Conference Rooms	0.6-0.7
	Libraries	<0.6
	Music Practice Rooms	0.7-0.9
	Assembly Halls (up to 250 seats)	0.6-0.8
	Sports Halls	0.7-2
Hotel	Meeting Room	0.6-0.8
	Banquet Room/Hall	<1.2 should be minimised for noise control
Atria, commercial lobbies	Retail, office, institutional, or hotel atria or main lobby spaces	(reduce as far as practicable for noise control)

AS/ NZS 2107 (2016) 'Acoustics – Recommended design sound levels and reverberation times for building interiors' Standards Australia

BS 8233 (2014) 'Guidance on sound insulation and noise reduction for buildings'; British Standards Institution

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

Either an Acoustic Design report conducted by an accredited acoustician or

- (i) IIC performance be captured within the tender documentation with acoustic report and testing commitment
- (ii) Detailed design and specification of internal noise conditions based on external noise conditions measured
- (iii) Detailed specifications and testing details of STC performance of partitions between spaces
- (iv) Calculations or acoustic simulations of reverberation times of key functional areas and the design strategies to maintain the reverberation times.

At Verification stage (New Buildings & Existing Buildings):

Either an acoustic verification report complete with testing data and evaluation that demonstrate full performance with the standards outlined above or

- (i) A representative selection of rooms, of at least 5% of the total. With on-site measurements undertaken in accordance with the relevant standards confirming compliance. A site correction to the IIC may be allowed with suitable justification (typically 5dB i.e. NISR no less than IIC – 5dB) or as otherwise indicated within BB93 or HTM08-01 as applicable.
- (ii) Measured internal noise levels for a representative selection of rooms, of at least 5% of the total
- (iii) On-site noise measurements undertaken in accordance with the relevant standards confirming compliance with the airborne sound insulation criteria. A representative sample of partitions shall be tested i.e. at least 10%.
A site correction to the STC performance outlined in Table HW2.3.2 may be allowed with suitable justification (typically 5dB i.e. FSTC no less than STC – 5dB) or as otherwise indicated within BB93 for education buildings or HTM08-01 for healthcare buildings.
- (iv) Measured reverberation time in accordance with ISO 3382-2 or equivalent, for a representative selection of rooms, at least 5% of the total.

Guidance Notes

Acoustic Design report: can be used for demonstration of compliance of HW2.3b. It should follow the following format:

Acoustic Design and Verification report

Design Report:

Executive Summary – Summary of the key design recommendations for the project

Acoustic Considerations:

- (1) Impact of the project on the immediate noise environment, especially noise sensitive accommodation, including both the construction and operational stages of the building.
- (2) External noise sources and propagation affecting the development
- (3) Internal noise sources, acoustical design and criteria used within the building
- (4) Internal layout planning, finishes selection and acoustical performance of the building
- (5) Site massing, landscaping and facades design to mitigate the adverse impacts of external noise

Facade Noise Ingress Control Criteria:

- (1) Noise survey methodology and standards
- (2) Results
- (3) Recommendations for façade treatment & spatial arrangement of interior spaces

Internal Acoustic Design Criteria:

- (1) Sound transmission reduction targets, calculated using recognised design guidelines, field or laboratory test results by certified/ accredited agency
- (2) Reverberation time targets demonstrated by detailed design calculations or acoustic modelling
- (3) Sound reinforcement systems and/or public address system (where applicable)

Internal Acoustic Design Proposals

- (1) Proposals for sound absorptive finishes and supporting calculations for typical areas
- (2) Proposals for sound insulation with supporting calculations or field or laboratory test results by certified/accredited agency for typical areas.

Acoustic Verification:

Environmental Noise & Survey (As-Built):

- (1) Methodology and testing standards
- (2) External impact of development on the surroundings

Façade Noise Ingress Control (As-Built)

Façade ingress noise measurement for internal areas

Internal Acoustics (As-Built):

- (1) Sound Insulation measurements
- (2) Reverberation times measurements
- (3) Commissioning and handover of noise masking or sound reinforcement systems (*where applicable*)

Useful references:

AS/ NZS 2107 (2016) 'Acoustics – Recommended design sound levels and reverberation times for building interiors' Standards Australia

BS 8233 (2014) 'Guidance on sound insulation and noise reduction for buildings'; British Standards Institution

ISO 16283-1 (2014) 'Acoustics - Field measurement of sound insulation in buildings and of building elements -- Part 1: Airborne sound insulation'; International Standards Organisation

ISO 3382 Acoustics - Measurement of room acoustic parameters

Impact Isolation Class (IIC): A laboratory rating defined by ASTM E989 of how well a floor construction attenuates noise from impact. The higher the IIC, the higher the impact sound reduction.

Calculation of reverberation time

The reverberation time can be calculated by hand where:

$$A = (\alpha_1 S_1 + \alpha_2 S_2 + \alpha_3 S_3 + \dots + \alpha_n S_n)$$

$$RT = 0.163 \times V/A$$

A - Total equivalent sound absorption area of a room (in Sabin or m²)

$\alpha_{1,i}$ - the sound absorption coefficient for different materials 1→i as specified/used in a space/room.

$S_{1,i}$ - the total surface area of different materials, 1→i corresponding to the respective absorption coefficient (m²).

RT – Reverberation Time in seconds.

V – Room Volume (m³)

HW3 Sociological

A maximum of 5 points can be scored across HW 3 Sociological section.

HW3.1 Inclusive

To raise greater public awareness towards user-friendly buildings, where developments and stakeholders adopt a user-centric philosophy in their design, operations and maintenance

Assessment Criteria

HW3.1 Inclusive	New Buildings	Existing Buildings
BCA Universal Design: UD Mark or Universal Design index (UDi) <ul style="list-style-type: none"> UD Mark Gold or UDi C rating UD Mark GoldPLUS or UDi A or B rating 	1 Point	<u>For Non-Residential Buildings</u> 1 Point (UD Mark Gold or UDi C rating)
	2 Points	2 Points (UD Mark GoldPLUS or UDi A or B rating) <u>For Residential Buildings</u> N/A

Points shall be awarded where the UDi ratings or UD mark certification levels are met.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

Tender documentation and written commitment from the developer / building owner that the project shall achieve the relevant UDi rating at the building plan submission stage

At Verification stage (New Buildings & Existing Buildings):

The UDi rating at TOP/CSC or UD Mark award

HW3.2a Restorative and Community Spaces

To provide a range of spaces catering for a broad spectrum of human activities that are suitably adaptable for collaborating, resting and relaxing, or community bonding. The provision of such spaces especially in a working environment help reduce stress, provide places of focus, connection and refuge for occupants

Assessment Criteria

HW3.2a Restorative and Community Spaces	New Buildings	Existing Buildings
(i) Designated indoor and/or outdoor space for restorative practices (minimum 16m ² per space, and large enough for meditation/yoga or just quiet respite) which are accessible for all building occupants	<u>For Non-Residential Buildings</u>	<u>For Non-Residential Buildings</u>
	(i) 0.5 Points	(i) 0.5 Points
	(ii) 1 Point	(ii) 1 Point
	<u>For Residential Buildings</u>	<u>For Residential Buildings</u>
(ii) Provision of community spaces and facilities, within the development, including physical exercise facilities, playgrounds, communal gardens / allotments/ sensory spaces	(ii) 1 Point	(ii) 1 Point

0.5 points can be awarded for the provision of designated indoor and/ or outdoor spaces for restorative purpose in non-residential building. These spaces shall be accessible to all building occupants. Projects would need to determine reasonable provision based on building type, occupancy and accessibility to the spaces. Spaces shall be decentralised across a number of floors and areas within the building. Considerations should be made to interior finishes and noise separation. For designated indoor spaces, external facing windows for outdoor view and daylight shall be provided..

1 point can be awarded for non-residential and residential developments with the provision of a range of active exterior spaces and shared facilities where community groups can come together. These can include physical exercise facilities, playgrounds for a range of ages, communal gardens or allotments, sensory spaces and sheltered seating.

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Spaces shall be identified on the plan, with the design intent clearly articulated
- For indoor restorative spaces details shall include the separation from the working environment, the interior design considerations and the soft furnishings
- The range of outdoor spaces shall be articulated, identifying the primary user as well ensuring space for care givers where applicable (playgrounds, water play areas and fitness areas). Planting strategy, soundscape design considerations shall be considered as a part of the sensory experience where sensory spaces are included

At Verification stage (New Buildings & Existing Buildings):

- Submission of as built drawings and photographs of the spaces

HW3.2b Outsourced Workers

To allow outsourced workers having access to proper and reasonable rest areas for their well-being.

Assessment Criteria

HW3.2b Outsourced Workers	New Buildings	Existing Buildings
Locations that afford privacy and provide a pleasant environment as well as provision of amenities such as tables, chairs, water coolers, lockers.	1 Point	1 Point

1 point can be awarded for the provision of proper and reasonable rest areas for outsourced workers (e.g. security officers, cleaners) to rest, recuperate and eat. These areas shall afford privacy and provide a pleasant, well designed and constructed environment with adequate amenities such as tables, comfortable chairs, free to use water coolers and secure lockers for personal use. Full reference shall be made to the ‘Tripartite Advisory on Provision of Rest Areas for Outsourced Workers’ (Dec 2019).

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Rest area location marked on plan, the size of the space must be sufficient to cater for the expected numbers of outsourced workers and come with the relevant furniture and amenities provided

At Verification stage (New Buildings & Existing Buildings):

- Submission of as built drawings and photographs of the spaces

HW3.3a Physical Activity and Mental Wellness Programmes

Physical health and mental wellbeing are inextricably related. Physical activities can bring health benefits including elevated mood and reduced stress, anxiety, opportunities for bonding, socialisation and help prevent mental health problems.

Assessment Criteria

HW3.3a Physical and Mental Wellness Programmes	New Buildings	Existing Buildings
Structured, regular fitness and mental wellness programmes for all staff, or occupants through engagement of external facilities and resources e.g. subsidised gym memberships, health assessments, personal training, fitness classes, mass workouts, talks and workshops, counselling.	<u>For Non-Residential Buildings</u> N/A	<u>For Non-Residential Buildings</u> 0.5 Points
	<u>For Residential Buildings</u> N/A	<u>For Residential Buildings</u> N/A

0.5 points can be awarded for a range of programmes to be implemented for the building, which would involve its tenants, occupants and/or visitors depending on the project type and use. A Minimum of 6 events would need to be organised each year. Subsidised memberships to external facilities, such as gym memberships can be included.

Documentation Requirements

At Verification stage (Existing Buildings):

- Submission of materials showing the range of activities organised, the policies and subsidies offered as well as uptake rate

HW3.3b Healthy Eating and Drinking

Create a healthy food environment through provision of facilities, programmes and policies.

Assessment Criteria

HW3.3b Healthy Eating and Drinking	New Buildings	Existing Buildings
(i) Accessible drinking water points at convenient locations	<u>For Non-Residential Buildings</u> (i) 0.5 Points	<u>For Non-Residential Buildings</u> (i) 0.5 Points
(ii) On site eateries with HPB's healthier dining programme	(ii) 0.5 Points	(ii) 0.5 Points
(iii) Corporate policies on healthy eating including catering procurement policies	(iii) 0.5 Points <u>For Residential Buildings</u> (i) 0.5 Points	(iii) 0.5 Points <u>For Residential Buildings</u> (i) 0.5 Points

Convenient locations include (but not limited to)

- Residential – near playgrounds, recreational areas, sports courts and fitness areas
- Non-residential – internally within common areas near WC's, changing rooms, and circulation nodes on each floor. Externally in accessible landscape areas, playgrounds and recreational spaces

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

- Plans identifying the accessible water point locations on the plan and the areas in which these serve
- Leasing requirements for eateries to be part of HPB's healthier eating programme and to provide healthier choices
- Draft corporate policies on catering for events and functions based on healthier choices for food and beverages

At Verification stage (New Buildings & Existing Buildings):

- Submission of as built drawings and photographs of the water points
- List of on-site eateries and details showing that these eateries are participating in HPB's Healthier Dining Programme
- Submission of endorsed corporate policy on healthy eating including procurement policies

Health and Wellbeing - Innovation

Assessment Criteria

Health and Wellbeing - Innovation	New Buildings	Existing Buildings
Projects can demonstrate substantial performance to a specific Health and Wellbeing indicator or outcome, where innovation points can be awarded on a case-by-case basis. Points shall be awarded based on the strength of evidence of benefits and potential impact.	2 Points	2 Points

Documentation Requirements

At Design stage (New Buildings) / Pre-retrofit stage (Existing Buildings):

The project team is to submit a concise summary that articulates:

- The nature of the environmental benefit of their intervention/innovation
- Justify the impact of the intervention through detailed calculations and comparisons with industry norms
- Substantiate the calculations and comparisons with evidence and data

At Verification stage (New Buildings & Existing Buildings):

The operations team is to submit:

- Details of the implemented intervention/innovation
- Measurements and recordings of key metrics/indicators to show improvements of environmental performance arising from implemented intervention/innovation
- Lessons learnt if the intervention does not perform as expected

Guidance Notes

Projects can innovate to go above and beyond to attain exceptional Health and Wellbeing outcomes as intended in one or more criterion or demonstrate unique solutions to enhance other aspects of health and wellbeing not specified in the criteria. Innovations will be considered on a case by case basis.

Some examples include:

- Wind driven rain simulations
- Daylight and glare simulations for internal spaces

WELL Certification

WELL certified buildings are recognised leaders in holistic health and wellbeing practices.

The WELL version 2 standard consists of 10 concepts:

1. Air
2. Water
3. Nourishment
4. Light
5. Movement
6. Thermal Comfort
7. Sound
8. Materials
9. Mind
10. Community

Each concept consists of features with distinct health intents. Features are either preconditions or optimisations. For more information visit <https://www.wellcertified.com>

Assessment Criteria

WELL Certification		WELL Core Certification	
WELL Rating	GM HW Points	WELL Rating	GM HW Points
WELL Bronze	6	WELL Core Bronze	4
WELL Silver	8	WELL Core Silver	6
WELL Gold	12	WELL Core Gold	8
WELL Platinum	15	WELL Core Platinum	10

- Projects that have attained WELL certifications would be accredited the respective Green Mark points in the Health and Wellbeing section
- Projects that have attained WELL Gold or WELL Platinum (core assessment) will also be awarded the Health and Wellbeing badge recognizing their exemplary performance
- For projects that have attained lower WELL ratings, additional points can be attempted within the Health and Wellbeing section to achieve the Health and Wellbeing badge, that are not duplicated in the WELL Certification criteria

Documentation Requirements

A copy of the certificate of the WELL Certificate and the scorecard

Acknowledgements:

Criteria Development

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