4 ENERGY USE

4.1 ANNUAL ENERGY USE

EU 1 - OPTION 2 ALTERNATIVE ROUTE: PASSIVE DESIGN

EXCLUSIONS

None

OBJECTIVE

Passive building design allows buildings to respond to the local climate; reducing the reliance on active servicing for human comfort. This in turn reduces energy consumption and associated carbon dioxide emissions.

This alternative route considers:

- Site planning and building orientation;
- Envelope heat transfer;
- Natural ventilation;
- Daylight design; and
- Common area servicing.

It encompasses EU1: Reduction of CO_2 Emissions, EU2: Peak Electricity Demand Reduction and EU13: Energy Efficient Building Layout from the conventional assessment; these credits should not be assessed when following this route to prevent double counting.

This passive design route was developed for residential buildings and their unique operating criteria, so it is not applicable to non-residential buildings.

CREDITS ATTAINABLE

20

PREREQUISITES

Eu P1 Minimum Energy Performance.

CREDIT REQUIREMENT

Passive Building Design

(a) Site Planning/Building Orientation

- Site Planning

  1 credit attained if the permeability of the site is in accordance with APP 152.

  2 credits attained if the permeability of the site is 33% or more in both projection planes in accordance with APP 152.

  Alternatively the second credit can be achieved by:

  Carrying out a performance assessment to show an improvement in ventilation performance for the proposed case compared with a site with a permeability of 33%.

- Building Orientation

  1 credit attained if the average solar irradiation of all facades is ≤ 80% of baseline solar irradiation value of 395 kWhr/m^2/ apr-oct.

(b) Building Envelope

- Prescriptive Approach

  1 credit if 28.0 W/m^2 ≤ OTTV < 30.0 W/m^2.

  2 credits if 26.0 W/m^2 ≤ OTTV < 28.0 W/m^2.

  3 credits if 24.0 W/m^2 ≤ OTTV < 26.0 W/m^2.

  4 credits if 22.0 W/m^2 ≤ OTTV < 24.0 W/m^2.

  5 credits if 20.0 W/m^2 ≤ OTTV < 22.0 W/m^2.

(c) Natural Ventilation

- Prescriptive Approach

  1 credit if 20% of habitable areas meet the ventilation requirements.

  2 credits if 40% of habitable areas meet the ventilation requirements.

  3 credits if 60% of habitable areas meet the ventilation requirements.

  4 credits if 80% of habitable areas meet the ventilation requirements.

  5 credits if 100% of habitable areas meet the ventilation requirements.

- Performance Approach

  1 credit if 20% of habitable areas satisfy the Area-Weighted Average Wind Velocity (AAWV) requirement.

  2 credits if 40% of habitable areas satisfy the AAWV requirement.

  3 credits if 60% of habitable areas satisfy the AAWV requirement.

  4 credits if 80% of habitable areas satisfy the AAWV requirement.

  5 credits if 100% of habitable areas satisfy the AAWV requirement.

(d) Daylight

1 credit if 80% of the habitable areas have glazing with a vertical daylight factor (VDF) 50% higher than the minimum requirement in APP 130.

(e) Active Building Systems

Two pre-requisites must be achieved to gain the credits:

- Compliance with the latest Building Energy Codes (BEC) by Prescriptive Option; and
- In the case where air-conditioning units are provided by the developer, units selected shall either be Grade 1 or 2 under the Government's energy efficiency labelling scheme for room coolers.

Three different categories fall under the section Active Building Systems,

- HVAC systems in common areas:

  1 credit for a 20% energy reduction compared to current BEC.

  2 credits for a 25% energy reduction compared to current BEC.

- Artificial lighting system in common areas:

  1 credit for a 20% energy reduction compared to current BEC.

  2 credits for a 25% energy reduction compared to current BEC.

  3 credits for a 30% energy reduction compared to current BEC.

- Vertical transportation in common areas:

  1 credit for a 10% reduction from the maximum allowable electrical power rating.

ASSESSMENT

The number of credits to be awarded will be determined with reference to Appendix 8.8 which provides detailed assessment methodologies for all the above elements. A report shall be prepared and certified by a suitably qualified professional person which summaries all the calculation procedures, results and assumptions. 1

BACKGROUND

Passive building design is a common design strategy, as this approach allows buildings to respond to the local climate; reducing the reliance on active servicing for human comfort, which in turn reduces energy consumption and associated carbon dioxide emissions.

The ultimate goal of passive building design is to maintain occupant comfort whilst completely eliminating the use of mechanical servicing throughout the operational period. In Hong Kong's climate it is unlikely that this ultimate goal can be achieved due to the high ambient temperatures and humidity from April to October and the use of artificial lighting during the night. There is however, a large window of opportunity where significant energy savings can be achieved.

This alternative route allows the practitioner to put greater emphasis on passive building design. This is of particular relevance to buildings, such as residential developments, which traditionally incorporate a range of passive design features.

This alternative route provides the practitioner with a simpler method to quantify the benefits of passive building design. It is, however, noted that the aspects under consideration often involve relatively complex situations. When carrying out the assessment it is encouraged that the practitioner considers the use of more complex building energy modelling tools, several of which are available in the market[1].

1 - Electrical and Mechanical Services Department - Code of Practice for Energy Efficiency of Building Services Installation - Section A3.4 2012
ASHRAE Standard 90.1-2007 – Energy Standard for Buildings Expect Low Rise Residential Buildings
ASHRAE Standard 90.2-2007 – Energy-Efficient Design of Low-Rise Residential Buildings
ASHRAE Standard 55-2004 – Thermal Environmental Conditions for Human Occupancy.
USGBC - Advanced Energy Modeling for LEED – Technical Manual v1.0 (August 2010 Edition).

8.8 PASSIVE DESIGN ASSESSMENT METHODOLOGY

8.8.1 BUILDING PASSIVE DESIGN

8.8.1.1 Site Planning

Site Planning 2

Site planning with respect to building massing has a significant effect on wind flow across the site and downwind of the site – it is a neighbourhood feature, not necessarily a site feature, however, it is included here to ensure the development in question is a benefit to the community.

Building separation is a fundamental contributor to wind flow across a built up site, larger building separation generally enables better wind flow across a site. The Sustainable Building Design Guidelines (SBD) [1], which are set out in APP 152, have prescriptive requirements for building separation.

The prescriptive assessment of building separation is to be carried out in accordance with the methodology set out in APP 152. This quantifies the gaps between or the "permeability" of the buildings as a percentage of the total building frontage.

To gain the second credit only, If the practitioner feels this method does not adequately represent their situation, they can carry out a performance assessment, in line the AVA methodology [2]. This compares a notional base case having a building permeability of 33% and the proposed design case.

The assessment shall be carried out in the following way:

1. The model and domain shall be set up as per AVA methodology.
2. Different to the AVA assessment, the measurement plane shall be taken at the half the average building height.

8.8.1.2 Building Orientation

The solar environment of Hong Kong determines that different facade orientations will be exposed to different levels of solar irradiation. This in turn will affect the energy required to condition internal spaces. 3

Residential developments, conditioned from April to October inclusive, have an average solar irradiation of 395 kWh/m2/(Apr-Oct). The peak solar irradiation occurs towards the west.

The solar irradiation (incident solar power) for the design shall be calculated as follows:

- Solar irradiance calculated over the period from 1st April to 31st October

1 Buildings Department PNAPP152 - The Sustainable Building Design Guidelines.
2 HPLB Technical Circular No. 1/06. http://www.devb.gov.hk/filemanager/en/content_679/hplb-etwb-tc-01-06.pdf

- Hong Kong weather data from the U.S. Department of Energy – Energy Efficiency & Renewable Energy - Hong Kong SAR 450070 (CityUHK) [3].
- Computational model has the same orientation and massing as the design.
- Glazing shall not be included in the model and replaced by an opaque surface.
- Surrounding buildings and a reasonable approximation to topography can be included.
- The average solar irradiation across the all external facades shall be calculated.
- The effect of roofs shall not be included in the results.

8.8.1.3 Building Envelope

Building envelopes in Hong Kong shall be designed to minimise solar heat gain. This reduces summer cooling loads and associated energy consumption. 4

There is no current measure for residential envelope heat transfer in Hong Kong, as such reference is made to the Overall Thermal Transfer Value (OTTV)[4]. As this does not directly apply to residential developments, it shall be used only as a method to quantify envelope parameters, not to calculate actual heat transfer.

The OTTV calculation methodology was published in 1995 by Hong Kong's Buildings Department for commercial buildings, and is an indicator of the thermal performance of building envelopes. It considers the following factors:

1. Orientation;
2. Window to wall ratio;
3. Glazing specification (shading coefficient);
4. Solar shading;
5. Wall configuration (overall u-value, thermal mass and outer absorptivity); and
6. Roof configuration (overall u-value, thermal mass and outer absorptivity).

For this assessment the OTTV is calculated only for external walls which connect to habited spaces and not the roofs. Roofs are excluded to eliminate the risk that a high specification roof could enable a lower specification facade. In the case of residential developments this would be detrimental to the majority of occupants.

In order to undertake an assessment based on OTTV, a maximum permissible OTTV (baseline) is required. As there is no current baseline for residential buildings reference is made to the National Standard of the People's Republic of China – JGJ 75-2003 - "Design Standard for Energy Efficiency of Residential Buildings in Hot Summer and Warm Winter Zone"[5] .

3 http://apps1.eere.energy.gov/buildings/energyplus/cfm/weather_data3.cfm/region=2_asia_wmo_region_2/country=CHN/cname=Ch ina
4 Buildings Department -Code of Practice for Overall Thermal Transfer Value in Buildings, 1995.
5 National Standard of the People's Republic of China – JGJ 75-2003 "Design Standard for Energy Efficiency of Residential Buildings in Hot Summer and Warm Winter Zone"

Based on JGJ 75-2003 , the maximum permissible OTTV for residential buildings with good envelope design will have an equivalent OTTV of less than or equal to 30 W/m^2; as such this is taken as the baseline value against which improvements are calculated.

8.8.1.4 Natural Ventilation

When outdoor conditions are suitable, natural ventilation, as oppose to mechanical cooling, can be used to remove heat gains and pollutants from buildings. This reduces energy consumption. 5

The wind availability at a window is determined by site massing and neighbourhood massing which are addressed elsewhere in this guidance. It is not the intention of this credit to assess the natural ventilation potential in a specific wind environment, simply to give designers a tool to optimise window design and spatial to achieve good natural ventilation.

This methodology allows for two methods of compliance, both can receive the same number of credits - 5.

Prescriptive Approach 6

The prescriptive approach assesses the quality of natural ventilation within habitable areas based on a set of requirements. The assessment for the prescriptive approach shall demonstrate compliance for either the cross ventilation requirements or the single sided ventilation, but not both.

Note 1: This simplified, prescriptive, approach can only be applied to single floor units or a single floor of a multi-floor unit.

Note 2: If the building is designed without internal partitions, the designer must include a reasonable number of partitions to represent typical occupancy.

Cross Ventilation Requirements

Units can be considered to have good cross ventilation when the air flow path between facade openings if relatively unobstructed. As such, in this assessment, all windows and internal doors (excluding the main entrance) that can be opened are assumed to be opened.

- Openable windows can be located in different habitable areas, e.g. living room and bedroom or on differently orientated facades of the same habitable area. Facades shall be orientated, so that they face, a minimum of 90^o difference;
- The cross ventilation path between the two shall consist of no more than two straight lines (one turn only), from the middle of one window to another; (Figure 8.8.1.4-1)
- The angle of turn for the cross ventilation path at the joint of the two lines shall not be greater than 90^o; (Figure 8.8.1.4-1)
- Cross ventilation path shall not be more than 12m in length for each habitable area; (Figure 8.8.1.4-1)

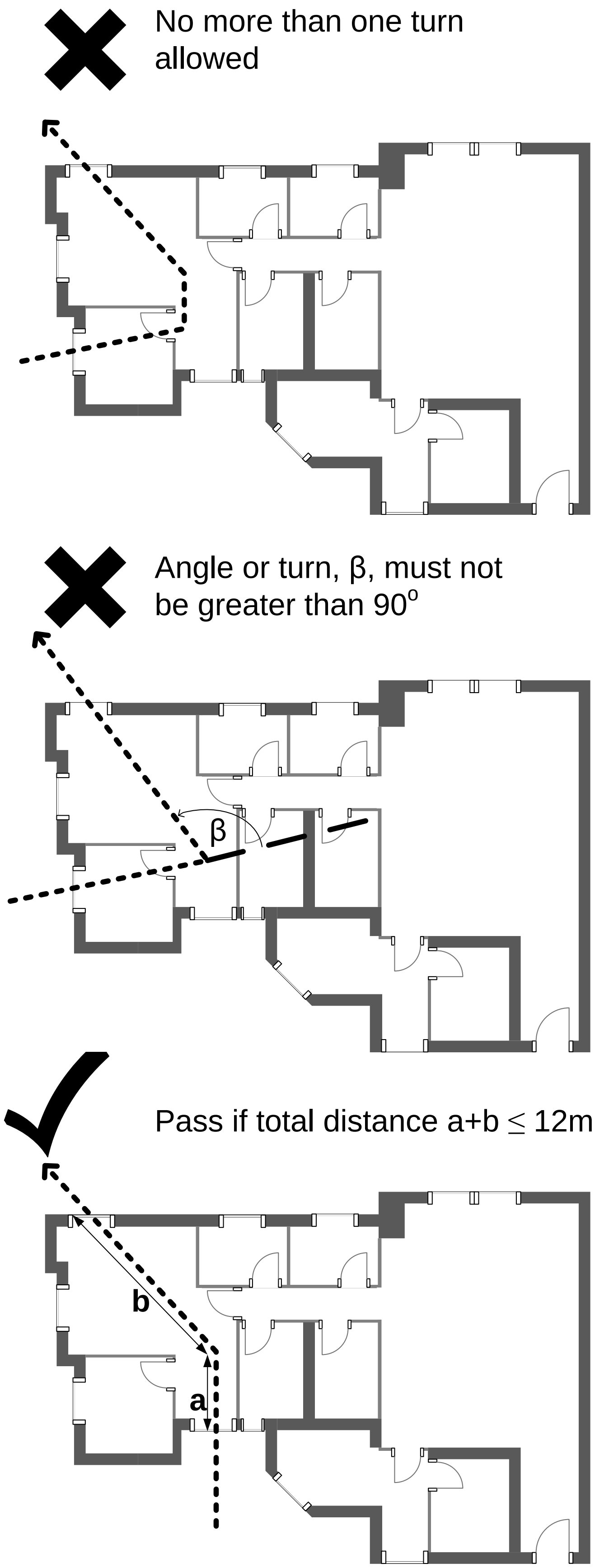

Figure 8.8.1.4-1: area to be considered in the performance assessment of site wind availability

- The total openable window size (i.e. physical opening not aerodynamic free area) in each habitable area shall be double of that of the statutory requirement (i.e.1/8 of openable window area to usable floor area);
- When considering a single room the openable window size located at each wall shall be at least 1/16 of the usable floor area;
- To ensure cross ventilation can affect the majority of the habitable space, it is required to have the windows a reasonable distance apart. To assess this, draw the smallest box possible that covers the habitable area and divide into equal halves through the longest side. The windows shall lie in different halves of the habitable area. (Figure 8.8.1.4-2)

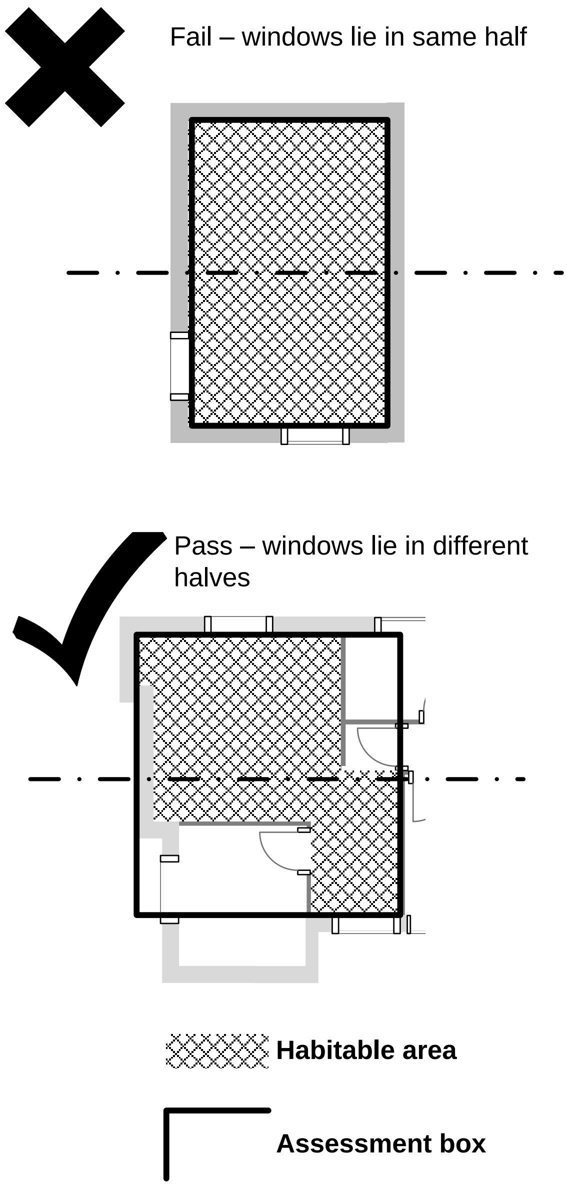

Figure 8.8.1.4-2: Allowable locations of windows in a zone

- For windows located within Re-entrants

  Concave areas of buildings with width greater than 4.5m will typically have similar flow characteristics to the free-stream. Hence, for the purpose of ventilation, a re-entrant begins when a concaved area has width less than 4.5m.This can be defined graphically by a plane of 4.5m wide (referred to as the External Plane, (ExP), extending from infinity towards a concave area: the re-entrant begins where such a plane can no longer pass through.

  A secondary opening located in the re-entrant may still achieve satisfactory cross-ventilation performance provided that the re-entrant is sufficiently wide and the window is located relatively close to the beginning of the re-entrant. Such an acceptable window can be defined by connecting a plane of 2.3m width and 4.5m length (referred to as Secondary Window Plane, (SWP) to ExP. Windows that can be reached by SWP are considered acceptable secondary windows.

  For the purpose of this assessment, the effective area of an apartment can be extended by the concept of a “notional” area. Such a notional area can be defined by connecting a Notional Plane (NP) of 1.5m width from SWP to a secondary window. The conditions for demonstrating cross ventilation explained above now cover NOT only the actual residential unit, but also the notional area together, i.e. the ventilation path is measured from the primary window to the SWP, See Figure 8.8.1.4-3.

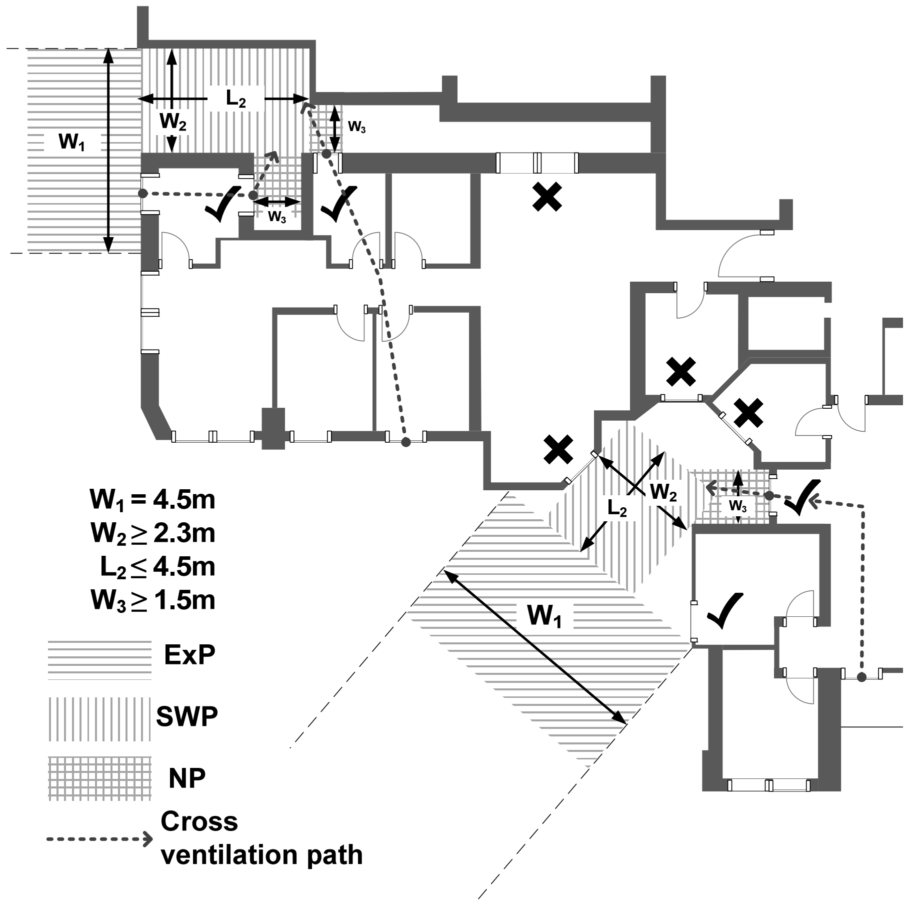

Figure 8.8.1.4-3: Allowable locations of windows in re-entrants

Single Side Ventilation Requirements

Units can be considered to have good single sided ventilation when the ventilated space is sufficiently small to allow for air exchanges resulting from turbulent fluctuations in the wind which induce pressure differentials across openings or stack effects. The following criteria set out guidelines to achieve single side ventilation requirements.

1. The window will ventilate up to 4.5m from opening area, the area under question shall be contained within this zone. (Figure 8.8.1.5-1)

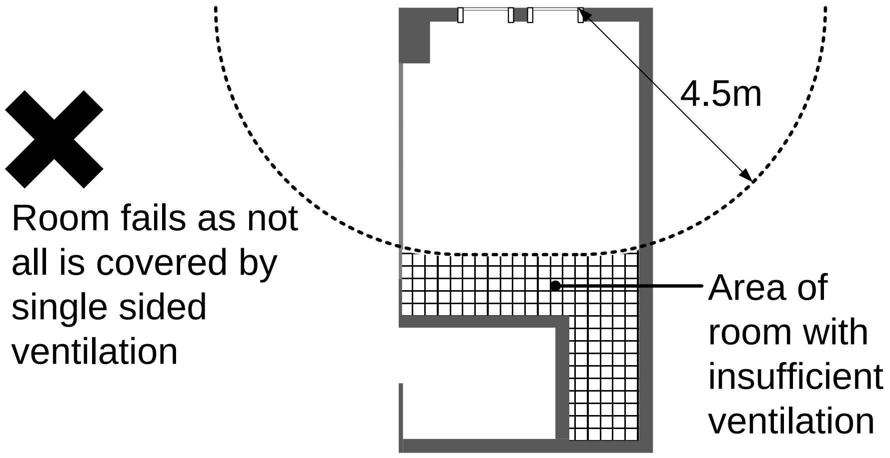

Figure 8.8.1.4-4: Room ventilation zone

2. At least two separated openable window panes shall be located at same wall or different walls; and

3. The total openable window size (i.e. physical opening not aerodynamic free area) in each habitable area shall be at least 1/5 openable window of the usable floor area.

Performance Approach

7

An alternative option is to assess natural ventilation using computational simulation – the performance approach. This can be carried out with a field model or zone model, and shall be undertaken to identify the Area-Weighted Average Wind Velocity (AAWV) in occupied zone of habitable areas.

The below methodology shall be used to perform computational simulation.

- Wind speed of 3.0 m/s (the mean average wind speed at 50mPD).
- A maximum of 4 wind directions can be chosen, there is no set requirement for these directions and they shall be chosen as the designers sees fit.
- The simulated domain shall include all habitable areas, structural elements, fixed internal partitions, false ceilings/floors and wing walls.
- The model can be simplified to include envelope ‘holes’ which are equivalent to the opening areas shall the practitioner feel it inappropriate to model the opened window pane in situ. The calculation for the opening

areas is as per CIBSE Applications Manual AM10: 2005[6].

- The simulation shall identify the AAWV from each habitable area under each wind direction.
- Internal doors within a unit are assumed to be fully opened.
- Entrance doors that connect to the common area within the building (e.g. lift lobbies) are assumed to be fully closed.
- A habitable room is deemed to have satisfied the requirements if the AAWV is not less than 0.4m/s for any one of the four wind direction.
- All habitable rooms are calculated separately.
- Find out the percentage area of spaces which satisfy the AAWV requirements based on total habitable area in the building.

Note 1: If the building is designed without internal partitions, the designer must include a reasonable number of partitions to represent typical occupancy.

8.8.1.5 Daylight

Natural daylight can provide adequate light for buildings for a large proportion of the year. This saves the energy use associated with artificial lighting. 8

BD APP-130[7] sets out a methodology for calculating vertical daylight factors (VDFs) and requires a minimum factor of 8% for habitable areas and 4% for kitchens.

This credit can be achieved if this criteria is exceeded by 50% (i.e. VDF >12%) for 80% of the habitable rooms & >6% for 80% of kitchens.

Note: The 80% is calculated by area.

8.8.2 Active Building System

The developer will still be responsible for some active systems within the development. This section ensures that the selection of these ensures efficient operation.

The following requirements must be achieved:

Two pre-requisites must be achieved to gain the credits: 9

1. Compliance with the latest Building Energy Codes (BEC) by the prescriptive option; and
2. In the case where air-conditioning units are provided by the developer, units selected shall either be Grade 1 or 2 under the Government's Energy Efficiency Labelling Scheme for room coolers.[8]

Three different categories fall under the section for Active Building Systems,

1. HVAC in common areas.
2. Artificial lighting systems in common areas.

6 CIBSE Applications Manual AM10: 2005
7 Buildings Department - PNAPP-130 - Lighting and Ventilation Requirements – Performance-based Approach
8 HKSAR Government - CAP 598 ENERGY EFFICIENCY (LABELLING OF PRODUCTS) ORDINANCE http://www.gov.hk/en/residents/environment/energy/mandatorylabel.htm

3. Efficient vertical transportation system in common areas.

The requirements for these are addressed subsequently.

8.8.2.1 HVAC System in Common Area

Energy simulation will be required to show that the carbon emissions or energy consumption of the building is less than a respectively benchmark criteria evaluated from a baseline building model for mechanical ventilation systems. Methodology of the energy simulation of the baseline model and the proposed model shall make reference to EU 1 – Reduction of CO_2 emission & Appendix 8.1/8.2. 10

If a hybrid ventilation system is adopted, an exceptional calculation methodology shall be conducted (see EU 1 – Reduction of CO_2 emission & Appendix 8.1/8.2).

If natural ventilation is adopted in common areas, the reduction in the energy consumption of the HVAC System can be assessed based on the area of the location where natural ventilation is applicable. The calculation or simulation will be required to demonstrate that natural ventilation can provide adequate indoor comfort conditions.

8.8.2.2 Artificial Lighting System in Common Area

Energy simulation will be required to show that the carbon emissions or energy consumption of the designed building compared to a baseline model. The methodology for the energy simulation of the baseline model and the proposed model shall make reference EU 1 – Reduction of CO_2 emission & Appendix 8.1/8.2. 11

Note that car park is excluded from this assessment as energy consumption of ventilation system of car park is assessed by EU 4.

8.8.2.3 Vertical Transportation in Common Area

The EMSD's Building Energy Codes 2012[9] sets out requirements for the efficiency of vertical transport. To achieve the credits, buildings have to exceed the requirements of the building energy codes 2012. 12

9 Electrical and Mechanical Services Department - Code of Practice for Energy Efficiency of Building Services Installation - Section A3.4 2012