



BEAM Plus

New Buildings

Version 1.2
(2012.07)

OVERVIEW

A STANDARD THAT DEFINES BUILDING QUALITY

BUILDING ENVIRONMENTAL ASSESSMENT METHOD (BEAM)

BEAM provides building users with a single performance label that demonstrates the overall quality of a building, either a new or refurbished building or one that is already in use. A certified BEAM building is safer, healthier, more comfortable, more functional and more efficient than a similar building that does not achieve the level of performance prescribed in BEAM. BEAM is:

- the leading initiative in Hong Kong to assess, improve, certify and label the performance of buildings;
- a set of comprehensive standard procedures covering all building types, including mixed use complexes;
- a means by which to benchmark and improve performance;
- a voluntary scheme developed in partnership with, and adopted by the industry, at a level that makes it one of the leading schemes in the world; and
- a driver for and means by which to sustain healthy, efficient, and environment friendly working or living environment.

COMPREHENSIVE ASSESSMENT

BEAM embraces a range of good practices in planning, design, construction, management, operation and maintenance of buildings, and is aligned with local regulations, standards and codes of practice.

BEAM

A standard for overall building performance

- Exemplary practices in planning and design.
- Exemplary practices in management, operation and maintenance.
- Exemplary practices in construction and commissioning,
- Exemplary best practices in meeting legal requirements.

A STANDARD FOR HEALTHY BUILDINGS

A healthy building does not adversely affect the health of its user or the environment. BEAM emphasises indoor environmental quality and amenities as key performance indicators, with proper consideration of the local, regional and global environmental impacts.

A UNIQUE STANDARD

The BEAM scheme is unique in the way that it:

- embraces a wide range of sustainability issues;
- covers the whole-life performance of buildings;
- assesses new buildings only upon completion, and certifying actual performance;
- selects BEAM Assessors randomly for the project certification; and
- embraces management, operation and maintenance practices to ensure a high level of building performance.

PURPOSE	<p>BEAM seeks to:</p> <ul style="list-style-type: none">• enhance the quality of buildings in Hong Kong;• stimulate demand for buildings that are more sustainable, giving recognition for improved performance and minimising false claims;• provide a comprehensive set of performance standards that can be pursued by developers and owners;• reduce the environmental impact of buildings throughout their life cycle; and• ensure that environmental considerations is integrated right at the design and planning stages.
VOLUNTARY ASSESSMENT	<p>An assessment under BEAM is voluntary, providing an independently certified performance rating for a building in clearly defined terms.</p> <p>BEAM covers all types of new and existing buildings: residential, commercial, institutional, and industrial. It embraces and endorses exemplary practices in the planning, design, construction, commissioning, management and operation of buildings in the context of Hong Kong's densely populated, predominantly high-rise cityscape.</p> <p>New buildings that are planned, designed, built and commissioned to the standards set under BEAM Plus for New Buildings are safe, healthy, comfortable and efficient buildings that sustain the quality of life and workplace productivity, whilst minimising the depletion of natural resources and reducing environmental loadings. Existing buildings managed and operated to the standards set under BEAM Plus for Existing Buildings can maintain high level performance over the life of the buildings.</p>
CLIENTS DECIDE	<p>BEAM provides a label for building quality. The label signifies a level of quality in respect of safety, health and comfort, which are important considerations for building users (buyers, tenants, occupants), and a level of performance in respect of environmental and social dimensions, which are of importance to society as a whole. It is for the Client (developer, owner) to decide whether to undertake a BEAM assessment and the performance standard that are appropriate for the building in the prevailing circumstances. The Client ultimately decides whether obtaining a BEAM label is a worthwhile endeavour, but completion of a BEAM assessment provides assurances on the quality of the building: based not just on a subjective promise, but on measurable evidence.</p>
DEVELOPMENT HISTORY	<p>The BEAM scheme was established in 1996 and published two assessment methods, one for 'new' [1] and one for 'existing' office buildings [2]. The contents of these two assessment methods were largely based on the UK Building Research Establishment's BREEAM. Environmental issues were categorised under 'global', 'local' and 'indoor' impacts, respectively. In 1999, the 'office' upgrades versions [3,4] were published with minor revisions, and an entirely new assessment method for high-rise residential buildings [5] was also published in the same year.</p>

1 CET. HK-BEAM 1/96. An Environmental Assessment Method for New Air-conditioned Office Premises. 1996.
2 CET. HK-BEAM 2/96. An Environmental Assessment Method for Existing Air-conditioned Office Premises. 1996.
3 CET. HK-BEAM 1/96R. An Environmental Assessment Method for New Air-conditioned Office Premises. 1999.
4 CET. HK-BEAM 2/96R. An Environmental Assessment Method for Existing Air-conditioned Office Premises. 1999.
5 CET. HK-BEAM 3/99. An Environmental Assessment Method for New Residential Buildings. 1999.

Both Version 4/04 'New Buildings'[6] and Version 5/04 'Existing Buildings' [7] had significant upgrades to the previous BEAM documents in 2004. These versions had been developed from the pilot versions 4/03 and 5/03 which were published in June 2003, following extensive review by the BEAM Society Technical Review Panel, supported by further research and development. Besides expanding the range of building developments that can be assessed, these versions of BEAM widened the coverage of issues that could further define the quality and sustainability of the buildings.

In 2009, climate change and global warming became international issues. Various countries both developed and developing cooperated to help improve the situation. In response to the critical global environmental issue, BEAM was further developed to meet higher expectations of the public and community. This gave birth to the BEAM Plus Version 1.1 in 2010 [8].

BEAM SOCIETY LIMITED BEAM is owned and operated by BEAM Society Limited [9], an independent not-for-profit organisation whose membership is drawn from many professional and interest groups in Hong Kong's building construction and real estate sectors. Following initial funding from The Real Estate Developers Association of Hong Kong (REDA), BEAM development is funded from assessment fees with voluntary support from the efforts of BEAM Society's members and associates, and the professional supporting team.

A SUCCESS STORY On a per capita basis, BEAM has assessed more buildings and more square meters of space than any other similar scheme in use worldwide. Most of the assessed buildings were air-conditioned commercial buildings and high-rise residential buildings, which are the leading users of energy and other natural resources in Hong Kong. In raising awareness about the environmental impact of buildings, BEAM has contributed to the development of green and sustainable buildings in the HKSAR. BEAM will continue contributing to this development process by widening its coverage and setting higher performance levels.

BEAM ACHIEVEMENTS As of May 2012, BEAM had provided recognition for improved building performance in more than 230 landmark properties in Hong Kong, Beijing, Shanghai and Shenzhen, comprising over 13 million m² of space. The comprehensive BEAM standard for New and Existing Buildings will definitely lead to a significant increase on this number.

FUTURE DEVELOPMENT To build on this success BEAM is being developed further by providing:

- on-line support to Clients; and
- web-based tools for the purposes of preliminary self assessments.

VERSION 1.2 OF BEAM PLUS In response to stakeholder engagement, BEAM Plus Version 1.2 was developed which brings together a holistic component of Passive Design for residential development as an alternative method of assessment.

BEAM Plus version 1.2 also contains minor amendments from the original guidelines in order to add clarity to the assessment.

6 BEAM Society. BEAM 4/04. Building Environmental Assessment Method for New Buildings. 2004.
7 BEAM Society. BEAM 5/04. Building Environmental Assessment Method for Existing Buildings. 2004.
8 BEAM Society, BEAM Plus Version 1.1 (2010.04)
9 BEAM Society Limited. <http://www.beamsociety.org.hk/>
(Ref. 3,4, 5, 6, 7 are available at http://www.beamsociety.org.hk/en_resources_1.php)

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INTRODUCTION

BEAM is intended to provide authoritative guidance to all stakeholders in the building construction and real estate sectors on practices which reduce the adverse environmental effects of buildings, whilst providing a quality built environment. It has been developed to set criteria for exemplary performance in buildings; verified independently, and acknowledged by the issuing of certification. An assessment under the scheme is voluntary.

BEAM defines performance criteria for a range of sustainability issues relating to the planning, design, construction, commissioning, management, operation and maintenance of buildings. ‘Credits’ are awarded where standard or defined performance criteria are satisfied. Where these are not satisfied guidance is provided on how performance can be improved. The credits are combined to determine an overall performance grade.

**ACKNOWLEDGING
COMMITMENT TO
SUSTAINABLE
DEVELOPMENT**

Increasingly organisations and companies are demonstrating their commitment and contribution to sustainable development, through:

- the maintenance of sustainable levels of economic growth;
- progress that recognises the needs of the community;
- efficient use of non-renewable natural resources; and
- enhanced protection of the environment.

AIMS

BEAM aims to contribute to the development of buildings that are more sustainable and reduce their long-term impact on the environment by:

- enhancing safety, improving hygiene and the quality of the indoor environment, and hence the health and well-being of occupants;
- minimising pollution to the external environment;
- promoting and encouraging energy efficient buildings, systems and equipment, including the use of renewable energy;
- reducing unsustainable consumption of increasingly scarce resources such as water and tropical timber; and
- improving waste management and encouraging recycling and reuse of materials.

**A SPECIFICATION FOR
SUSTAINABLE
BUILDINGS**

BEAM provides for a comprehensive and fair assessment of the overall performance of a building in a range of key areas, at either the completion stage or during its life. An assessment:

- embraces many areas of sustainability, particularly social and environmental;
- recognises best practices;
- provides for a comprehensive method of quantifying overall performance;
- demonstrates performance qualities to end users; and
- provides economic benefits to stakeholders.

MARKET RECOGNITION BEAM:

- sets targets and standards which are independently assessed and so help to minimise false claims or distortions;
- provides recognition for buildings where the quality has been enhanced and environmental impacts have been reduced;
- enables developers and building operators to respond to user demands for better quality buildings that have less impact on the environment; and
- helps stimulate the market for more sustainable buildings.

Whilst BEAM endeavours to provide for a comprehensive and fair assessment, it recognises that truly scientific assessment criteria and methods covering the sustainable building practices which form the substance of the BEAM assessment remain under development (continue to evolve) at the time of going to print.

DYNAMIC SYSTEM

Since the collective knowledge of what constitutes a sustainable building will continue to develop, BEAM will need to respond, requiring a dynamic system able to incorporate periodic changes and updates. With wider implementation it is also expected that the scheme will be subject to further scrutiny by, and feedback from, an increasing number of stakeholders.

The BEAM documentation is reviewed on an annual basis and revised when necessary. Where changes in regulations necessitate changes to the assessment criteria these will be issued to all parties involved in an assessment and will be announced on the BEAM Society Limited's website. An appropriate transitional period is allowed for buildings already under assessment.

The BEAM Society Limited's website [1] provides further advice to users in the form of guidance notes and assessment tools.

1 BEAM Society Limited. <http://www.beamsociety.org.hk/>

1.1 SUSTAINABLE BUILDINGS

Much is said and written about sustainable development and its social, economic and environmental aspects, but with many definitions available it is very much a matter of viewpoint as to what is sustainable. As a consequence there are few clear definitions of what constitutes a sustainable building, although ASTM[2] defines a 'green building' as – “a building that provides the specified building performance requirements while minimising disturbance to and improving the functioning of local, regional, and global ecosystems both during and after its construction and specified service life”. Furthermore, “a green building optimises efficiencies in resource management and operational performance; and, minimises risks to human health and the environment”. To this can be added social equity and economic viability.

A WORKING DEFINITION In the context of Hong Kong's sub-tropical climate and dense high-rise development, BEAM considers a sustainable building as one that is, in priority order, safe, healthy, comfortable, functional, and efficient.

Recently, climate change and global warming have become hot topics around the world. Because of their importance to the future of all people, Hong Kong must contribute to the international effort. Construction of new buildings and/or management of existing buildings should adjust to these global environmental issues.

Building safety is covered by a myriad of regulations, yet even in new buildings safety may be compromised through poor implementation or co-ordination of safety measures. For existing buildings, much depends on the quality of building management and user awareness.

After the epidemic of Severe Acute Respiratory Syndrome (SARS) in 2003, hygiene became a major issue in both design and management of buildings. Indoor air quality also relates to health, together with thermal aspects, lighting, noise, etc., it is also a comfort issue. Maintaining good Indoor Environmental Quality (IEQ) depends on design, operation and user understanding of the many factors involved. Poor IEQ impacts on the quality of life and productivity in the workplace. The qualities of services, such as vertical transportation, also influence user satisfaction and workplace efficiency. Consequently, the needs of users and the efficiency of buildings need to be balanced against the consumption of non-renewable natural resources and environmental loadings to air, land and water.

ENVIRONMENTAL ASPECTS³

An environmental aspect is defined in ISO 14004 [3] as an element of an organisation's activity, products or services that can interact with the environment. ISO defines 'environment' as the surroundings in which an organisation operates, including air, water, land, natural resources, flora, fauna, humans, and their interrelation. Surroundings in this context extend from within an organisation to the global system. An environmental impact is any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services. A significant environmental aspect is an environmental aspect that has or can have a significant environmental impact.

The BEAM scheme addresses items for which there is good evidence that they cause the environmental problems they cause, and for which reasonably objective performance criteria can be defined. Certain performance aspects attributable to buildings and their use have yet to

² ASTM International E 2114–01. Standard Terminology for Sustainability Relative to the Performance of Buildings. 2001.

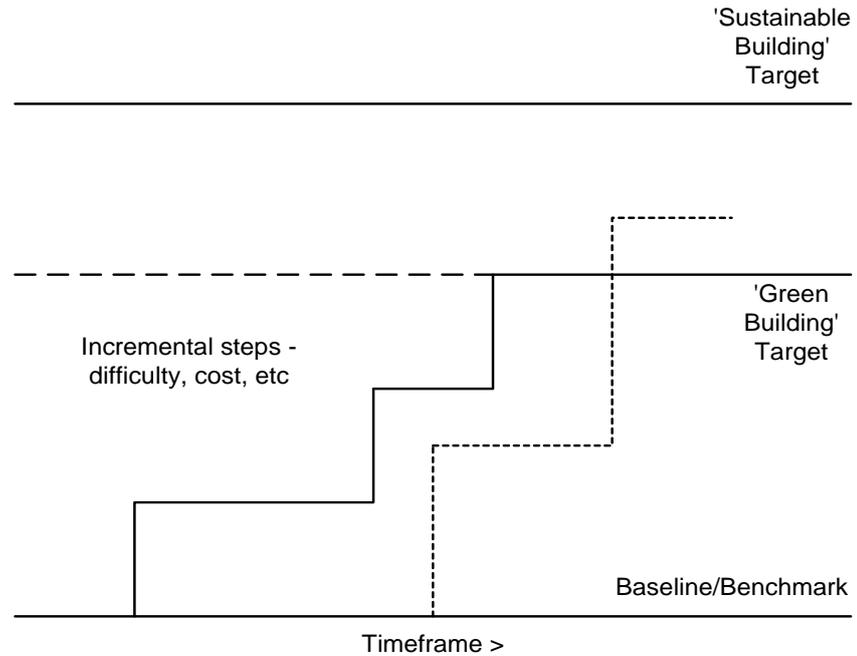
³ International Organisation for Standardization. ISO14004: Environmental management systems – General guidelines on principles, systems and supporting techniques.

be included, either because the environmental impacts are not well defined, or because performance criteria have not been established. They may be included in future updates, when enough information becomes available to permit reasonably objective assessment.

SOCIAL AND ECONOMIC ASPECTS

BEAM recognises the need to include social and economic dimensions when assessing building performance. Where there is consensus amongst stakeholders that an issue is important, and where a reasonably objective assessment can be made, the issue is included.

RAISING STANDARDS



Responding to environmental priorities and to social and economic issues, BEAM strives to improve the overall performance of buildings. BEAM encourages progressively higher standards of performance, and innovations that contribute to such performance. For a voluntary scheme, the extent to which performance can be enhanced is determined by market acceptance of the assessment criteria, the cost of undertaking assessments, the relative weighting of the credits counting towards the overall grade awarded, and the perceived benefits to the Client. The criteria included in BEAM are considered to be realistic and attainable in practice.

1.2 ASSESSMENT FRAMEWORK FOR NEW BUILDINGS

This document describes BEAM Plus for New Buildings. This version can also be used where buildings have undergone a major refurbishment. Assessment of existing buildings is carried out using BEAM Plus for Existing Buildings. Both New Buildings and Existing Buildings of BEAM are designed to dovetail together to allow coverage of the life cycle performance of buildings.

Assessment under BEAM Plus for New Buildings covers the demolition planning, design, construction and commissioning of a building and should be initiated in the early stages of project development. BEAM Plus for New Buildings aims to reduce the environmental impacts of new buildings whilst improving quality and user satisfaction, by adoption of the best techniques available within reasonable cost.

According to the emerging international consensus, building assessments should be performance based as far as possible. Assessment needs to take a holistic view of building performance with emphasis on life-cycle impacts. Assessment purely on the basis of prescriptive features would preclude buildings without the features from obtaining a good assessment result regardless of the actual performance. Furthermore, assessment based on features may encourage feature-based design, construction and operating practices.

A notable attribute of BEAM Plus for New Buildings, as compared with most schemes in use elsewhere, is that an assessment for new buildings is not finalised until a building is completed, ensuring that 'green' and 'sustainable' design features are actually implemented and construction practice meets the required performance standards. Besides being in the interests of the Client in certifying the actual performance of the finished product, this approach also serves to 'dovetail' assessment with that used for existing buildings. It would be expected that a building graded under BEAM Plus for New Buildings and suitably operated and maintained would achieve a similar grade under BEAM Plus for Existing Buildings five years later.

HOLISTIC ASSESSMENT BEAM integrates the assessment of many key aspects of building performance, embracing:

- hygiene, health, comfort, and amenity;
- land use, site impacts and transport;
- use of materials, recycling, and waste management;
- water quality, conservation and recycling; and
- energy efficiency, conservation and management.

TRANSPARENCY BEAM recognises that assessment criteria and methods to achieve compliance need to be transparent, providing details of the benchmarks (baselines), data, assumptions and issues taken into account in the assessments and the credit ratings.

ASSESSMENTS OF EXISTING BUILDINGS BEAM Plus for New Buildings attempts to cover all types of buildings, from small single buildings to large buildings on residential and commercial estates. The assessment needs to cover the various types of premises contained within the development, and may involve premises that are only a 'shell' or are fitted-out. Whatever the circumstances, assessment focuses on what the designer, builder and commissioning agent achieve. Assessment of some aspects of performance may be type dependent, or not feasible for various reasons, so the number of applicable credits and their aggregation will vary. This is taken into account in determining the performance grade.

ESTATES	<p>When a building forms part of an estate then certain features of the estate design will be included in the assessment. In an estate containing several buildings of essentially similar design, assessment of Site Aspects, Materials Aspects and Water Use for one building can apply to all the buildings, although Energy Use and IEQ assessments will require further evaluation if all the buildings are to be graded under BEAM.</p>
SPECIAL CASES	<p>It is possible that some new buildings may not be fully embraced by the criteria currently presented in BEAM Plus for New Buildings, due to their unusual nature or variety of forms and system designs, etc. This will be particularly true in respect of assessment of energy use. In such circumstances certain assessment criteria or the method of demonstrating compliance may need to be modified. This would require endorsement from BEAM Society Limited.</p>
ABSOLUTE VERSUS RELATIVE PERFORMANCE	<p>Through an opinion survey of BEAM Society members [4], it is clear that there should be a balance between assessment of 'absolute' performance, i.e. issues over which the Client may have little or no control (e.g. car parking provisions), and 'relative' performance, i.e. issues that can be influenced by the Client.</p> <p>In addition, BEAM takes the position that assessment of some aspects of building performance should not be penalised because of externalities that are not under the control of the Client, such as the efficiency of the utility supplying energy sources to a building. In this case, only consumption is quantified (e.g. kWh) and rated, and not the consequent environmental loadings (e.g. CO₂-kg) unless the mix of energy sources (gas, oil, electricity) is significant.</p>
ASSESSMENT BOUNDARIES	<p>BEAM is concerned about the interactions between the assessed building, neighbouring properties, and the neighbourhood in general. The assessment seeks to reduce negative impacts on neighbours and rewards efforts to improve the quality of the immediate surroundings to the benefit of the neighbourhood: the concept of 'good neighbour' buildings.</p>
ASSESSABLE AREA - DISCRETE AREAS EXCLUDED FROM ASSESSMENT	<p>The BEAM Plus rating tool is structured to cope with different types of buildings and allows certain discrete areas within the boundary of the project, or development, to be excluded from the assessment. Areas within the development or building, such as common areas, MVAC plant rooms, transformer rooms, lifts and lift motor rooms, plant rooms for environmentally friendly systems and features such as rainwater / grey water recycling systems, battery rooms for solar panels or similar, club house areas, swimming pools, car parks, garbage disposal and handling areas, workshops, balconies or similar CANNOT be excluded from the assessable area of the project.</p> <p>At the sole discretion of BEAM Society Limited, the Client may apply for an exemption for a limited area to be excluded from the project assessment, where the total CFA is less than 200 square metres, and it is demonstrated with LCA calculation that the environmental impact of the area omitted does not influence the overall value of the assessment.</p> <p>Examples of areas that might qualify for exclusion are: standalone buildings and structures like a guard house, gate house or shroff kiosk, and structures that house meters, switchgear, watering points, etc.</p>

REGIONALLY RESPONSIVE CRITERIA	<p>In Hong Kong's humid sub-tropical climate and dense urban living environment, people need to be provided with alternatives to enclosed, air-conditioned spaces, so that the provisions for natural ventilation and daylight figure prominently in the assessment of indoor environments.</p>
PERFORMANCE BENCHMARKS	<p>The benchmark (zero credit level) for particular performance criteria is established by reference to legal requirements which may be required as a prerequisite. BEAM uses local performance standards, codes and guides where these are available (e.g. indoor air quality). Where these are not available (e.g. impact noise) international or national standards, codes and guides are referenced. Where there are differences in the performance criteria set by the various authorities, BEAM will generally avoid specifying the performance criteria (e.g. thermal comfort), allowing Clients to specify what they consider to be appropriate for their building. A BEAM assessment seeks to establish that the specified levels of performance are acceptable and have been achieved. Where performance standards are not well defined (e.g. energy use), BEAM establishes its own performance benchmarks based on available data and stakeholder consensus. Credits are awarded for achieving higher levels of performance. It is intended that the assessment criteria be updated periodically as new information becomes available and as legal requirements evolve.</p>
FLEXIBLE AND OBJECTIVE	<p>BEAM embraces a wide range of buildings, variable in terms of scale, location and mix of uses (types of premises). The assessment criteria and methods of assessment need to be flexible and to allow for alternative means of compliance, yet be reasonably objective to enable the BEAM Assessor to arrive at decisions without undue controversy.</p> <p>Where issues are rather subjective, i.e. performance criteria cannot be quantified or determined through a compliance specification, BEAM uses 'checklists' to facilitate equitable and consistent assessments.</p>
PERFORMANCE CATEGORIES	<p>Different assessment methods in use world-wide arrange performance aspects under different headings to reflect the preferences of the tool developer. In BEAM, the various performance aspects covered are grouped within the following categories:</p>
SITE ASPECTS (SA)	<p>Generally speaking site issues, as listed in BEAM, will not vary significantly with the type of building. However, the scale and location of the building will determine the extent to which environmental aspects associated with the site are significant and can be addressed in the assessment. Site Aspects include:</p> <ul style="list-style-type: none">• location and design of the building;• emissions from the site; and• site management.
MATERIALS ASPECTS (MA)	<p>Similar to site issues, materials use issues included in BEAM will be similar for all types of buildings, although the size of the building will have significance. Materials Aspects include:</p> <ul style="list-style-type: none">• selection of materials;• efficient use of materials; and• waste disposal and recycling.

**ENERGY USE
(Eu)**

Assessment of energy use in a building containing a variety of uses, energy sources and building services systems and equipment is a complex process given the number of influencing variables. For the most part, BEAM Plus for New Buildings adopts a computational approach to determining the dominant energy uses, plus additional features known to have impact on overall performance. There is however, an alternative route to assess the passive design of residential buildings. This provides the practitioner with the option of assessing the development against a series of prescriptive or performance targets which target passive design. Energy Use includes:

- annual CO₂ emissions or energy use;
- energy efficient systems and equipment; and
- energy management;

**WATER USE
(Wu)**

Assessments under Water Use include quality and features that improve utilisation and reduce effluent, i.e.:

- water quality;
- water conservation and
- effluent discharges.

**INDOOR
ENVIRONMENTAL
QUALITY
(IEQ)**

Indoor issues included in BEAM are those aspects of building performance that impact on the health, comfort or well-being of the occupants, as well as aspects of performance that improve quality and functionality. Not included are the technical performance aspects of specialist premises, such as acoustic qualities of concert venues, stage lighting, or air quality in clean rooms. Indoor Environmental Quality (IEQ) includes:

- safety;
- hygiene;
- indoor air quality and ventilation;
- thermal comfort;
- lighting;
- acoustics and noise; and
- building amenities.

1.3 CREDIT WEIGHTINGS AND OVERALL GRADE The weighting system, i.e. the relative number of credits given for compliance with a particular aspect, is a critical part of a building performance assessment method. It is logical that BEAM should seek to assign credits or weightings to assessment criteria in accordance with the significance of the impact.

CATEGORY WEIGHTING Having reviewed local and international assessment schemes and other relevant information, a weighting for each environmental performance category has been assigned to reflect its importance and global trends as follows:

Category	Weighting (%)
Site Aspects (SA)	25
Materials Aspects (MA)	8
Energy Use (EU)	35
Water Use (WU)	12
Indoor Environmental Quality (IEQ)	20
	100

CREDITS ALLOCATED Credits have been broadly allocated to each assessment criterion by taking into account the international consensus as given by an analysis of weightings used in similar assessment methods operating elsewhere, as well as surveys and informed opinions of those who have contributed to the development of this BEAM version. The award of fractions of a credit is possible under BEAM.

EXCLUSIONS Exclusions are allowed where an issue or part of an assessment is not applicable to particular circumstances or building type. A spreadsheet is available on the BEAM Society Limited's website to show as 'NA' (not applicable) the credits affected.

PREREQUISITES For some of the environmental aspects, detailed compliance with legal requirements is a prerequisite for the award of credits. Consequently, when an assessed issue becomes subject to legislation it will no longer count for the award of credits, and will be amended or deleted in any future revisions of BEAM.

For each performance category, BEAM prescribes different prerequisites. Every applicable prerequisite, in every BEAM category, must be achieved; otherwise the project cannot be assessed.

ASSESSMENTS Many of the assessments verifying compliance with the prescribed criteria in BEAM will be undertaken by an independent BEAM Assessor on behalf of the BEAM Society Limited. The Client will provide documentation and photographic evidence.

ALTERNATIVE ASSESSMENT METHODS BEAM does not seek to be overly prescriptive in setting assessment criteria and in defining methods of compliance. It encourages Client's representatives to consider alternative approaches which meet the objectives of BEAM. Client representatives are invited to submit a 'method statement' if a credit is sought using an alternative approach. The statement shall address the stated objective of BEAM for which the credit or credits are sought, the proposed alternative criteria, and the proposed method for assessment. The proposal should be submitted at

the earliest opportunity in the assessment process. It will then be considered by the BEAM Assessor and, if necessary, submitted for technical review to BEAM Society Limited. A ruling will be made to accept, accept with defined modifications, or reject the 'method statement', which shall be binding on the assessment.

In the event that an alternative approach is endorsed by the Technical Review Committee, it will be incorporated in the guidance notes used by BEAM Assessors, and in future revisions to the BEAM documentation, as deemed appropriate.

INNOVATIONS AND ADDITIONS

BEAM Plus for New Buildings does not presume to be comprehensive in its coverage of all performance aspects. Under the heading of 'Innovation', the Client is encouraged to submit proposals for the award of credits for aspects not covered elsewhere in the BEAM Plus manual. In these circumstances, the Client shall submit a proposal in which the performance gains are demonstrated. BEAM Society Limited will examine the validity of the proposal and, weighing the performance gains against others covered by the scheme, award an appropriate number of credits.

Whilst innovative design solutions are encouraged, they do not necessarily justify credit. Innovation must demonstrate performance gains, such as through improved efficiency and/or improvements in the built environment. Indeed, it is expected that significant performance benefits will be realised from full and proper implementation of sound design, construction, installation, and operating practices.

BONUS CREDITS

These credits would not count towards the total number of credits available, but would count towards the total of credits qualifying for an award classification, i.e., innovative credits can be regarded as bonus credits. Subsequent revisions of BEAM may incorporate such credits as part of the core assessment, and they would then be counted within the total number of credits available.

1.3.1 DETERMINATION OF OVERALL GRADE

The Overall Assessment Grade is determined by the percentage (%) of the applicable credits gained under each performance category and its weighting factor. Given the importance of SA, EU and IEQ, it is necessary to obtain a minimum percentage (%) of credits for the three categories in order to qualify for the overall grade. In addition, a minimum number of credits may be earned under the category of Innovation and Additions (IA). The award classifications are:

	<u>Overall</u>	<u>SA</u>	<u>EU</u>	<u>IEQ</u>	<u>IA</u>	
Platinum	75%	70%	70%	70%	3 credits	(Excellent)
Gold	65%	60%	60%	60%	2 credits	(Very Good)
Silver	55%	50%	50%	50%	1 credit	(Good)
Bronze	40%	40%	40%	40%	-	(Above Average)

1.3.2 GRADING A BUILDING COMPLEX

After allowing for exclusions for particular circumstances, it is expected that applicable credits under Site Aspects, Materials Aspects and Water Use will not differ significantly for the different buildings that make up a building complex. However, it is clear that there may be significant differences in Energy Use and Indoor Environmental Quality aspects between buildings which differ in operating mode such as; for example, buildings that use central air-conditioning, as opposed to buildings where natural ventilation may be utilised.

Centrally air-conditioned buildings can be expected to consume greater amounts of energy, so the relative weighting for energy use as compared with other environmental aspects can be higher than for buildings which

are less energy intensive. In addition, aspects such as thermal comfort and IAQ are subject to tighter controls. To cater for a mix of building types in a complex and where an overall assessment for the complex is required, BEAM weighs the available credits for energy and IEQ according to the Construction Floor Area or normally occupied floor area of each building type.

BEAM assessment of energy use also allows for situations where several buildings within a complex are supplied from a common central air-conditioning plant, so that energy use in a particular building in the complex can be estimated for assessment purposes.

EU AND IEQ CREDITS

Where a building complex consists of several different types of building which each have different numbers of applicable credits in EU and IEQ sections, the overall number of credits for EU and IEQ shall be weighted according to the areas of the different building types.

**EU 1 ALTERNATIVE ROUTE
PASSIVE DESIGN**

EU1 Option 2 Alternative Route: Passive design has been included in the assessment procedure to provide the practitioner with an alternative method to quantify the benefits of passive building design. It considers the following aspects:

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

It encompasses EU1: Reduction of CO₂ 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.

The same total number of credits is available from both routes; no change to the credit weightings is required.

- 1.4 ASSESSMENT PROCESS** BEAM Assessments are currently undertaken by independent BEAM Assessors engaged by the BEAM Society Limited [5].
- ELIGIBILITY** All buildings are eligible for certification under BEAM Plus for New Buildings including, but not limited to, offices, retail, catering and service establishments, libraries, educational establishments, hotels and residential apartment buildings. Whilst it is not expected that buildings used primarily for industrial purposes or low-rise residential buildings will seek certification under this assessment method, the method is sufficiently flexible to embrace all types of buildings.
- INITIATION** Buildings can be assessed at any time, but the greatest benefit is derived if the assessment process begins at an earlier stage, allowing operators to make changes that will improve the building's overall performance.
- GUIDANCE** Provisional assessment will identify which credits have been achieved and the particular reason for the achievement.
Further guidance material is made available on the BEAM Society Limited's website.
- CERTIFICATION** Because a significant number of credits under BEAM are based on building performance, certification can only be issued after completion of the assessment.
When a building development is registered for assessment the credits and assessment criteria current at the time of registration will be used in the assessment, unless the Client wishes to comply with credits and criteria introduced after registration.
- APPEALS PROCESS** Any objection to any credit assessment can be submitted directly to BEAM Society Limited as the First Appeal and will be adjudicated by the Society. If the Client is dissatisfied with the result, they are at liberty to submit a Final Appeal which will be adjudicated by HKGBC [6].
- DISCLAIMER** The BEAM Building Environmental Assessment Method is intended for use by Client and project teams engaged in new buildings design, and owners and operators of existing facilities as a guide to more environmentally sustainable building design and operation. The Method has been prepared with the assistance and participation of many individuals and representatives from various organisations. The final outcome represents a general consensus, but unanimous support from each and every organisation and individual consulted is not implied.
This document represents the BEAM Society Limited's efforts to develop a standard that improves the performance of buildings using the latest techniques, practices and standards compatible with prevailing economic constraints. These are subject to changes, which will be included through periodic updating.
It should be noted that none of the parties involved in the funding of BEAM, including BEAM Society Limited and its members, provide any warranties or assume any liability or responsibility to users of BEAM, or any third parties for the accuracy, completeness or use of, or reliance on, any information contained in BEAM, or from any injuries, losses, or damages arising out of such use or reliance.

5 BEAM Plus Project Assessment Procedure Manual.
[http://www.beamsociety.org.hk/files/BEAM_Plus_Procedure_Manual_\(v1.4\)_12032012.pdf](http://www.beamsociety.org.hk/files/BEAM_Plus_Procedure_Manual_(v1.4)_12032012.pdf)
6 Appeal Procedure. http://www.beamsociety.org.hk/files/Appeal_Page_12August2011_v1.0.pdf

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FURTHER INFORMATION Further information on how to participate in the scheme is available from the BEAM Society Limited's Web site.

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1.5 SUMMARY OF CREDITS

Section:	Credit Requirement:	Exclusions	Credits	Target
2	SITE ASPECTS (SA)		22+3B	
SA P1	MINIMUM LANDSCAPE AREA	Demonstrate appropriate planting on site equivalent to at least 20% of the site area.		Required
		Buildings or sites not for residential use; or residential sites less than or equal to 1,000m ² .		
SA 1	CONTAMINATED LAND	1 BONUS credit for conducting a site contamination assessment and implementing measures for rehabilitation, and/or proper preparation of sites and structures adjacent to landfill sites.		1B
		Building developments on Greenfield sites and where the site contamination/ landfill gas hazard assessment and mitigation measures are statutory requirements of the project.		
SA 2	LOCAL TRANSPORT	1 credit where parking capacity does not exceed the minimum requirement from government and parking is provided for carpools or shuttle service vehicles. 2 credits where no car parking is provided other than provisions intended for use by disabled persons and/or shuttle service vehicles.		2
		None.		
		1 credit for availability of convenient pedestrian access to mainstream public transport.		1
SA 3	NEIGHBOURHOOD AMENITIES	1 credit where at least 10 different basic services are located within 500m walking distance from the Site and pedestrian access to the services is available for the Site.		1
		1 credit where at least 2 different recreational facilities are located within 500m walking distance from the Site and pedestrian access to the facilities is available for the Site.		1
		Emergency Service Premises (e.g. fire station, power substation, etc.)		
		1 credit where at least 2 different recreational facilities or at least 5 different basic services are located within the Site and will be made available for public use.		1

SA 4	SITE DESIGN APPRAISAL	1 credit for a site design appraisal report which demonstrates a proactive approach to achieve greater integration of site planning and design issues, and at least 50% of relevant sub-items of the Urban Design Guidelines in the Hong Kong Planning Standards and Guidelines are achieved.	None.	1
		1 BONUS credit for 100% of relevant sub-items of the Urban Design Guidelines are achieved.		1B
SA 5	ECOLOGICAL IMPACT	1 BONUS credit from SA 5 Ecological Impact can be achieved through the following: Having a site which scores less than 20% of the points in the Habitat Section of The Nature Conservation Policy – 2009 and having a site which scores less than 30% in the Biodiversity Section of The Nature Conservation Policy - 2009; or Demonstrating that appropriate design measures have been implemented to contribute positively to the ecological value of the site	None.	1B
SA 6	CULTURAL HERITAGE	1 credit where development does not have a negative impact on sites of cultural heritage.	Sites or buildings without cultural heritage.	1
SA 7	LANDSCAPING AND PLANTERS	1 credit for using pervious materials for a minimum of 50% of hard landscaped areas.		1
		1 credit for providing appropriate planting on site equivalent to at least 30% of the site area. 2 credits for providing appropriate planting on site equivalent to at least 40% of the site area.	None.	2
SA 8	MICROCLIMATE AROUND BUILDINGS	1 credit for demonstrating that no pedestrian areas will be subject to excessive wind velocities caused by amplification due to the site layout design and/or building design.		1
		1 credit for providing shade on at least 50% of non-roof impervious surfaces on the site (parking, walkways, plazas) using light coloured high-albedo materials (albedo of at least 0.4).	SA 8a – Sites which are located in urban zones with existing stagnant air	1
		1 credit for providing roof material that meets the Solar Reflectance Index (SRI) of 78 or vegetation roof covering at least 50% of the total roof area.		1

		1 credit for conducting an AVA by wind tunnel or Computational Fluid Dynamics (CFD) according to the prevailing AVA methodology introduced by the Government demonstrating the optimal option is selected in comparing with different options.		1
SA 9	NEIGHBOURHOOD DAYLIGHT ACCESS	1 credit for designs for which the access to daylight of neighbouring sensitive buildings is maintained to the prescribed level.	Buildings where daylight is of no value to neighbouring properties.	1
SA 10	ENVIRONMENTAL MANAGEMENT PLAN	1 credit for demonstrating that an Environmental Management Plan for demolition/construction including Environmental Monitoring and Auditing has been implemented.	None.	1
SA 11	AIR POLLUTION DURING CONSTRUCTION	1 credit for applying adequate mitigation measures for dust and air emissions during the construction as recommended by the Environmental Protection Department; and demonstrating compliance with the air quality management guidelines as detailed in the Environmental Monitoring and Audit Manual.	None.	1
SA 12	NOISE DURING CONSTRUCTION	1 credit for providing adequate mitigation measures for construction noise for all Noise Sensitive Receivers.	None.	1
SA 13	WATER POLLUTION DURING CONSTRUCTION	1 credit for undertaking adequate measures to reduce water pollution during construction.	None.	1
SA 14	NOISE FROM BUILDING EQUIPMENT	1 credit for demonstrating that the level of the intruding noise at the facade of the potential noise sensitive receivers is in compliance with the criteria recommended in the Hong Kong Planning Standards and Guidelines.	None.	1
SA 15	LIGHT POLLUTION	1 credit for demonstrating that obtrusive light from exterior lighting meets the specified performance for the environmental zone in which the building development is located.	None.	1
3	MATERIALS ASPECTS (MA)			22+1B
MA P1	TIMBER USED FOR TEMPORARY WORKS	Virgin forest products are not used for temporary works during construction.	None.	Required
MA P2	USE OF NON-CFC BASED REFRIGERANTS	Using non-chlorofluorocarbon (CFC)-based refrigerants in HVAC&R systems.	None.	Required

MA P3	CONSTRUCTION/ DEMOLITION WASTE MANAGEMENT PLAN	Implementation of a waste management system that provides for the sorting, recycling and proper disposal of construction/ demolition materials.	Project where demolition is not required or is not under the Client's control.	Required
MA P4	WASTE RECYCLE FACILITIES	Provision of facilities for the collection, sorting, storage and disposal of waste and recovered materials.	None.	Required
MA 1	BUILDING REUSE	1 credit for the reuse of 30% or more of existing sub-structure or shell. 2 credits for the reuse of 60% or more of existing sub-structure or shell.	Buildings on reclaimed land or Greenfield sites.	2
		1 additional BONUS credit for use of 90% or more of existing sub-structure or shell.		1B
MA 2	MODULAR AND STANDARDISED DESIGN	1 credit for demonstrating the application of modular and standardised design.	None.	1
MA 3	PREFABRICATION	1 credit when the manufacture of 20% of listed prefabricated building elements has been off-site.	None.	2
		2 credits where the manufacture of 40% of listed prefabricated building elements has been off-site.		
MA 4	ADAPTABILITY AND DECONSTRUCTION	1 credit for designs providing spatial flexibility that can adapt spaces for different uses, and allows for expansion to permit additional spatial requirements to be accommodated.	None.	1
		1 credit for flexible design of services that can adapt to changes of layout and use.		1
		1 credit for designs providing flexibility through the choice of building structural system that allows for change in future use, and which is coordinated with interior planning modules.		1
MA 5	RAPIDLY RENEWABLE MATERIALS	1 credit for demonstrating 2.5% of all building materials/products used in the project are rapidly renewable materials.	None.	2
		2 credits where 5% of all building materials/products used in the project are rapidly renewable materials.		
MA 6	SUSTAINABLE FOREST PRODUCTS	1 credit for demonstrating at least 50% of all timber and composite timber products used in the project are from sustainable sources/recycled timber.	None.	1

		1 credit for use of recycled materials contributing to at least 10% of all materials used in site exterior surfacing work, structures and features.		1
MA 7	RECYCLED MATERIALS	1 credit where at least 10% of all building materials used for facade and structural components are recycled materials.	None.	1
		1 credit where at least 10% of all building materials used for interior non-structural components are recycled materials		1
MA 8	OZONE DEPLETING SUBSTANCES	1 credit for the use of refrigerants with a value less than or equal to the threshold of the combined contribution to zone depletion and global warming potentials using the specified equation.	None.	1
		1 credit for the use of products in the building fabric and services that avoids the use of ozone depleting substances in their manufacture, composition or use.		1
MA 9	REGIONALLY MANUFACTURED MATERIALS	1 credit for the use of materials manufactured locally within 800km from the site, which contribute to at least 10% of all building materials used in the project. 2 credits for the use of materials manufactured locally within 800km from the site, which contribute to at least 20% of all building materials used in the project.	None.	2
MA 10	DEMOLITION WASTE REDUCTION	1 credit for demonstrating that at least 30% of demolition waste is recycled. 2 credits for demonstrating that at least 60% of demolition waste is recycled.	Projects where demolition is not required or is not under the Client's control.	2
MA 11	CONSTRUCTION WASTE REDUCTION	1 credit for demonstrating that at least 30% of construction waste is recycled. 2 credits for demonstration that at least 60% of construction waste is recycled.	None.	2
4	ENERGY USE (EU)			42+2B
EU P1	MINIMUM ENERGY PERFORMANCE	Demonstrate compliance with the latest edition of Building Energy Codes (BEC).	None.	Required

EU 1	REDUCTION OF CO₂ EMISSIONS	<p>For Commercial and Hotel Buildings, 1 to 15 credits for a reduction of CO₂ emissions or annual energy consumption by 3%, 5%, 7%, 9%, 11%, 14%, 17%, 20%, 23%, 26%, 29%, 33%, 37%, 41% and 45% respectively.</p> <p>For Educational Buildings, 1 to 15 credits for reduction of CO₂ emissions or annual energy consumption by 3%, 4%, 5%, 6%, 7%, 9%, 11%, 13%, 15%, 17%, 19%, 21%, 24%, 27% and 30% respectively.</p> <p>For Residential Buildings, 1 to 15 credits for reduction of CO₂ emissions or annual energy consumption by 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 11%, 12%, 13%, 14%, 16%, 18% and 20% respectively.</p> <p>For Other Building Types, 1 to 15 credits for reduction of CO₂ emissions or annual energy consumption by 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 12%, 14%, 16%, 18% and 20% respectively.</p>	None.	15
EU 1	OPTION 2 ALTERNATIVE ROUTE: PASSIVE DESIGN	<p>Note: if this route is followed the following credits, as they are covered in the alternative route, are excluded from the assessment:</p> <p>Eu 1 Reduction of CO₂ Emissions Eu 2 Peak Electricity Demand Reduction Eu 13 Energy Efficient Building Layout</p> <p>The following credits are available for optimised design in: Site planning and building orientation – Up to 3 credits. Envelope heat transfer – Up to 5 credits. Natural ventilation – Up to 5 credits. Daylight design– 1 credits. Common area servicing– Up to 6 credits.</p>	None.	20
EU 2	PEAK ELECTRICITY DEMAND REDUCTION	<p>For Commercial and Hotel Buildings, 1 to 3 credits for a reduction in the peak electricity demand by 15%, 23% and 30% respectively.</p> <p>For Educational and Residential Buildings, 1 to 3 credits for a reduction in the peak electricity demand by 8%, 12% and 15% respectively.</p> <p>For Other Building Types, 1 to 3 credits for a reduction in the peak electricity demand by 8%, 12% and 15% respectively.</p>	None.	3

EU 3	EMBODIED ENERGY IN BUILDING STRUCTURAL ELEMENTS	1 credit for demonstrating the embodied energy in the major elements of the building structure of the assessed building has been studied through a Life Cycle Assessment (LCA).	None.	1
		1 BONUS credit for demonstrating the major materials with low embodied energy are used in the project utilizing the LCA results.		1B
EU 4	VENTILATION SYSTEMS IN CAR PARKS	1 credit for ventilation systems that will consume less electricity than those meeting the zero credit requirements (baseline) by 20% or more. 2 credits where the consumption is reduced by 25% or more.	Buildings without carpark or carpark area less than 10% CFA.	2
EU 5	LIGHTING SYSTEM IN CAR PARKS	1 credit for using lamps and, where applicable, ballasts that will consume less electricity than those meeting the zero-credit requirements by 20% or more. 2 credits where the consumption is reduced by 25% or more.	Buildings without carpark or carpark area less than 10% CFA.	2
EU 6	RENEWABLE ENERGY SYSTEMS	1 to 5 credits where 0.5% to 2.5% or more of building energy consumption is obtained from renewable energy sources. Alternatively, 1 to 5 credits where the minimum percentage of 20% to 100% of the building footprint is being covered/used by PV panels respectively and/or other renewable power facility generation equivalent renewable power output.	None.	5
EU 7	AIR-CONDITIONING UNITS	1 credit for complying with the recommended installation positions for air-conditioning units with regard to internal spaces; complying with the minimum width of any external recess with regard to heat rejection; and complying with the items listed in the assessment checklist.	Buildings not using window and/or split-type air-conditioners.	1
EU 8	CLOTHES DRYING FACILITIES	1 credit for providing suitable clothes drying facilities which utilise the natural environment for all residential units.	Buildings other than residential buildings.	1
EU 9	ENERGY EFFICIENT APPLIANCES	1 credit when 60% of total rated power of appliances and equipment are certified energy efficient products. 2 credits when 80% of total rated power of appliances and equipment are certified energy efficient products.	Buildings where appliances are not provided by the developer.	2

EU 10 TESTING AND COMMISSIONING	1 credit for provision of appropriate specifications and cost provisions in contract documents detailing the commissioning requirements for all systems and equipment that impact on energy use and indoor environmental quality.		1
	1 credit for the appointment of a commissioning authority and provision of a detailed commissioning plan that embraces all specified commissioning work.		1
	1 credit for ensuring full and complete commissioning of all systems, equipment and components that impact on energy use and indoor environmental quality.	None.	1
	1 credit for providing fully detailed commissioning reports for all systems, equipment and components that impact on energy use and indoor environmental quality.		1
	1 BOUNS credit for engagement of an independent commissioning authority in the Testing and Commissioning process.		1B
EU 11 OPERATION AND MAINTENANCE	1 credit for providing a fully documented operations and maintenance manual to the minimum specified.		1
	1 credit for providing fully documented instructions that enable systems to operate at a high level of energy efficiency.	None.	1
	1 credit for providing training for operations and maintenance staff to the minimum specified; and demonstrating that adequate maintenance facilities are provided for operations and maintenance work.		1
EU 12 METERING AND MONITORING	1 credit for installation of: metering that allows monitoring of electricity use by the main chiller plant and auxiliaries; instruments for monitoring building cooling load and operating parameters of the central chiller plant; metering that allows separate monitoring of electricity use by the air side of the HVAC system; and metering for landlord's electricity consumption in common space/public areas.	None.	1
EU 13 ENERGY EFFICIENT BUILDING LAYOUT	1 credit for demonstrating the fulfillment of at least 3 items out of the following strategies.		
	2 credits for demonstrating the fulfillment of all of the following strategies.		
	For all building types excluding residential	None.	2
	a) Consideration of built form and building orientation to enhance energy conservation;		
	b) Consideration of optimum spatial planning to enhance energy conservation;		
	c) Consideration of building permeability provisions of building features to		

- enhance the use of natural ventilation;
- d) Provision of fixed or movable horizontal/vertical external shading devices; and
 - e) Provision of movable external shading devices for major atrium facade windows or skylights.

For residential developments

- a) To demonstrate compliance, energy simulation must be provided to show that the average solar irradiance of all facades is lower than 395 kW/m².
- b) Compliance is demonstrated by showing that a site permeability of 20% can be achieved between assessed building and nearby buildings/obstructions.
- c) Demonstrate that 20% of the habitable space can utilise natural ventilation either by the prescriptive approach or the performance approach.
- d) Demonstrate that the OTTV of habitable spaces is less than or equal to 30 W/m².
- e) Demonstrate that the VDF of habitable spaces are 50% more than the baseline requirements.

5 WATER USE (Wu)		9+1B	
WU P1 WATER QUALITY SURVEY	Demonstrate that the quality of potable water meets the referenced drinking water quality standards at all points of use.	None.	Required
WU P2 MINIMUM WATER SAVING PERFORMANCE	Demonstrate that the use of water efficient devices leads to an estimated aggregate annual saving of 10%.	None.	Required
WU 1 ANNUAL WATER USE	1 credit for demonstrating that the use of water efficient devices leads to an estimated aggregate annual saving of 20%. 2 credits for demonstrating an estimated annual saving of 25%. 3 credits for demonstrating an estimated annual saving of 30%.	None.	3
WU 2 MONITORING AND CONTROL	1 credit for installation of devices to monitor water leakage from the fresh water distribution systems without embedded plumbing pipework.	None.	1

WU 3	WATER EFFICIENT IRRIGATION	1 credit for the use of an irrigation system which does not require the use of municipal fresh water after a period of establishment is complete. Alternatively, 1 credit for demonstrating highly efficient irrigation technology and/or the use of harvested rainwater and/or recycled grey water to reduce fresh water consumption for irrigation by 50% or more in comparison with conventional irrigation of water intensive planting.	Where soft landscaping and planting coverage is less than 50% of the area of the building footprint.	1
WU 4	WATER RECYCLING	1 credit for harvesting of rainwater which will lead to a reduction of 5% or more in the consumption of fresh water. 1 credit where recycled grey water will lead to a reduction of 5% or more in the consumption of fresh water. 1 BONUS credit where harvesting and/or recycling leads to a reduction of 10% or more in the consumption of fresh water.	None.	1 1B
WU 5	WATER EFFICIENT APPLIANCES	1 credit for installing water efficient appliances that have Water Efficiency Labeling Scheme Grade 2 or above.	Buildings in which facilities and/or devices are not installed by the developer.	1
WU 6	EFFLUENT DISCHARGE TO FOUL SEWERS	1 credit for demonstrating an estimated reduction in annual sewage volumes by 20% or more.	None.	1
6	INDOOR ENVIRONMENTAL QUALITY (IEQ)			32+3B
IEQ P1	MINIMUM VENTILATION PERFORMANCE	Demonstrate that the project is in compliance with the minimum requirements of ASHRAE 62.1-2007 in respect of Outdoor Air Quality and Minimum Ventilation Rate.	Residential and similar buildings without central air conditioning.	Required
IEQ 1	SECURITY	1 credit for scoring at least 75% of the applicable security measures and facilities for the building.	None.	1
IEQ 2	PLUMBING AND DRAINAGE	1 credit for designs that reduce the potential for transmission of harmful bacteria viruses, and odours.	None.	1
IEQ 3	BIOLOGICAL CONTAMINATION	1 credit for complying with the recommendations given in the Code of Practice - Prevention of Legionnaires Disease, in respect of air-conditioning and ventilation and water systems.	Residential buildings.	1
IEQ 4	WASTE DISPOSAL FACILITIES	1 credit for the provision of a de-odourising system in all refuse collection rooms and chambers.	None.	1

IEQ 5	CONSTRUCTION IAQ MANAGEMENT	1 credit for implementing a Construction IAQ Management Plan.	Residential and similar buildings not provided with central air-conditioning and ventilation systems.	1
		1 credit for undertaking a building 'flush out' or 'bake out'; and replacement of all filters prior to occupancy.		1
IEQ 6	OUTDOOR SOURCES OF AIR POLLUTION	1 credit for demonstrating compliance with appropriate criteria for carbon monoxide, nitrogen dioxide and ozone.	Buildings that are designed for natural ventilation or using de-centralised A/C system.	1
		1 credit for demonstrating compliance with the appropriate criteria for RSP.		1
IEQ 7	INDOOR SOURCES OF AIR POLLUTION	1 credit for demonstrating compliance with the appropriate criteria for volatile organic compounds.	Items a) & b) are excluded for buildings that are designed for natural ventilation or using de-centralised A/C system and without interior decoration.	1
		1 credit for demonstrating compliance with the appropriate criteria for formaldehyde.		1
		1 credit for demonstrating compliance with the appropriate criteria for radon.		1
IEQ 8	IAQ IN CAR PARKS	1 credit for demonstrating compliance with the design requirements specified in ProPECC PN 2/96.	Buildings with no car park.	1
IEQ 9	INCREASED VENTILATION	1 credit for demonstrating an outdoor ventilation rate that exceeds ASHRAE 62.1:2007 requirements by at least 30%	Residential and similar buildings without central air conditioning.	1
IEQ 10	BACKGROUND VENTILATION	1 credit where it can be demonstrated that adequate ventilation can be achieved by natural means.	Buildings not designed to utilise natural ventilation.	1
IEQ 11	LOCALISED VENTILATION	1 credit for the provision of an adequate ventilation system for rooms/areas where significant indoor pollution sources are generated.	2 nd credit not applicable to residential and similar buildings.	1
		1 credit for the provision of a general exhaust system for future tenants.		1
IEQ 12	VENTILATION IN COMMON AREAS	1 credit for demonstrating that all enclosed common areas in a building are provided with adequate ventilation.	Spaces covered under the section on Localised Ventilation.	1
		1 BONUS credit where the provision for ventilation is by natural means.		1B

IEQ 13 THERMAL COMFORT IN AIR-CONDITIONED PREMISES	1 credit for sustaining the air temperature at the design value within $\pm 1.5^{\circ}\text{C}$ when the air side system is operating at steady state under normal occupied periods.	Premises where air-conditioning is provided by window units or split units.	1
	1 credit where room air diffusers satisfy the Air Diffusion Performance Index.		1
IEQ 14 THERMAL COMFORT IN NATURALLY VENTILATED PREMISES	1 credit for demonstrating indoor operative temperatures in occupied/habitable rooms meet the 80% acceptability limits.	Buildings that are not designed to utilise natural ventilation.	1
	Alternatively, 1 credit for demonstrating the predicted Mean Vote (PMV) in occupied/habitable rooms is between -1 and $+1$.		1
	Alternatively, 1 credit for demonstrating that, the thermal performance, and the internal wind speeds, of the occupied/habitable rooms fall within the 80% acceptability range for the tropical climate conditions of Hong Kong.		
	1 credit for sustaining the air temperature at the design value within $\pm 1.5^{\circ}\text{C}$ when the air-conditioning unit is operating at steady state under normal occupied periods.		
IEQ 15 NATURAL LIGHTING	1 credit where at least 80% of the floor area in all normally occupied spaces is adequately lit with an average daylight factor of 1%.	None.	1
	2 credits where at least 95% of the floor area in all normally occupied spaces is adequately lit with an average daylight factor of 1%.		1
IEQ 16 INTERIOR LIGHTING IN NORMALLY OCCUPIED AREAS	1 credit where the prescribed lighting performance in each type of premises in respect of illuminance and lighting quality is achieved.	Residential buildings, hotels and apartment buildings.	1
	It is required to fulfill (i) prescribed lighting performance in respect of maintained illuminance and illuminance variation; and (ii) the limiting unified glare rating is achieved and light sources have an appropriate colour rendering index. 1 BONUS credit for providing automatic control of artificial lighting such as daylight sensors at perimeter zone and/or occupancy sensor.		1B
IEQ 17 INTERIOR LIGHTING IN AREAS NOT NORMALLY OCCUPIED	1 credit where the prescribed lighting performance in each type of common or service space in respect of light output and lighting quality is achieved.	None.	1
IEQ 18 ROOM ACOUSTICS	1 credit for demonstrating that intruding noise levels are within the prescribed criteria and the mid-frequency reverberation time in applicable rooms meets the prescribed criteria for give types of premises.	Buildings/premises where speech intelligibility is not important, and rooms of	1

		Based on the nature of the building, relaxation should be allowed in considering a special acoustical the acceptance of this credit. The applicant should provide full submission of the nature. design and calculation to justify the relaxation.		
IEQ 19 NOISE ISOLATION		1 credit for demonstrating airborne noise isolation between rooms, spaces and premises meets the prescribed criteria.		1
		For residential developments only, 1 BONUS credit for demonstrating impact noise isolation between floors meets the prescribed criteria. Based on the nature of the building, relaxation should be allowed in considering the acceptance of this credit. The applicant should provide full submission of the design and calculation to justify the relaxation.	Buildings/premises which are inherently noisy and unaffected by noise.	1B
IEQ 20 BACKGROUND NOISE		1 credit for demonstrating background noise levels are within the prescribed criteria.	Buildings/premises in which speech intelligibility is not important.	1
		Based on the nature of the building, relaxation should be allowed in considering the acceptance of this credit. The applicant should provide full submission of the design and calculation to justify the relaxation.		
IEQ 21 INDOOR VIBRATION		1 credit for demonstrating vibration levels shall not exceed the prescribed criteria.	None.	1
		Based on the nature of the building, relaxation should be allowed in considering the acceptance of this credit. The applicant should provide full submission of the design and calculation to justify the relaxation.		
IEQ 22 ACCESS FOR PERSONS WITH DISABILITY		1 credit for providing at least 3 enhanced provisions	None.	1
IEQ 23 AMENITY FEATURES		1 credit for providing at least 3 amenity features that enhance the quality and functionality of a building to the benefit of building users	None.	1
		1 credit for providing at least 3 amenity features that allow for improved operation and maintenance of the building and its engineering services.		1
7	INNOVATIONS AND ADDITIONS (IA)			5B+1
IA 1	INNOVATIVE TECHNIQUES			NA.
IA 2	PERFORMANCE ENHANCEMENTS	Maximum 5 BONUS credits + 1 credit for BEAM Professional	NA.	5B+1
IA 3	BEAM PROFESSIONAL			

Note: B denotes Bonus Credit.

2 SITE ASPECTS

2.P PREREQUISITE

2.1 SITE LOCATION

2.2 SITE PLANNING AND DESIGN

2.3 EMISSIONS FROM THE SITE

INTRODUCTION

This section focuses on the site upon which the building is to be built; the land used and its location with respect to local transport and amenities, planning and design for the site to take account of both beneficial and negative impacts on neighbours and the development itself, mitigation of ecological impacts and emissions from the site over the building's lifetime, and aspects of site management. Obviously, there will be significant differences between large scale developments, such as estates, as compared with single buildings, which need to be reflected in the assessment criteria and weighting of credits.

2.P PREREQUISITE

SA P1 MINIMUM LANDSCAPING AREA

BACKGROUND

This part is to set out the minimum requirement for landscaping area for residential premise sites having an area of greater than 1,000 m².

2.1 SITE LOCATION

SA 1 CONTAMINATED LAND

SA 2 LOCAL TRANSPORT

SA 3 NEIGHBOURHOOD AMENITIES

BACKGROUND

Due to the shortage of land, the choices for building location are limited. From an environmental perspective, credit should be awarded when contaminated land and land adjacent to landfill sites are put to use, provided that appropriate steps are taken to reduce environmental and health hazards to users of the building and to its neighbouring properties. Site location is important in respect of adequacy of local amenities and public transport provisions in order to reduce travel needs and reliance on private vehicles.

2.2 SITE PLANNING AND DESIGN

SA 4 SITE DESIGN APPRAISAL

SA 5 ECOLOGICAL IMPACT

SA 6 CULTURAL HERITAGE

SA 7 LANDSCAPING AND PLANTERS

SA 8 MICROCLIMATE AROUND BUILDINGS

SA 9 NEIGHBOURHOOD DAYLIGHT ACCESS

SA 10 ENVIRONMENTAL MANAGEMENT PLAN

BACKGROUND

The planning and design issues which affect the environmental performance of a site and master layout planning should include:

- disposition of individual buildings within the site;
- spatial relationship of the building(s) to the immediate built and natural environment;
- relationship of the building(s) to the site topography and ground conditions;
- overall massing of the proposed development;
- built form of the buildings;
- orientation of buildings in relationship to view factors and ambient forces;

- balance of built-up and landscaped/open area;
- environmental enhancement to the surroundings of the site; and
- master landscaping strategy.

Greenfield site developments should seek to minimise disturbance, including the ecology of the site and impacts on cultural heritage. The aim is to ensure that appropriate landscape treatment is provided on site to ameliorate visual impact, and conserve natural features. For Brownfield sites, the emphasis should be on restoration of the local ecology and local environment.

Planning and design needs to take into account and allow for the adverse impacts that inevitably arise during construction, with high quality construction management the key to minimising the impacts.

2.3 EMISSIONS FROM THE SITE

SA 11 AIR POLLUTION DURING CONSTRUCTION

SA 12 NOISE DURING CONSTRUCTION

SA 13 WATER POLLUTION DURING CONSTRUCTION

SA 14 NOISE FROM BUILDING EQUIPMENT

SA 15 LIGHT POLLUTION

BACKGROUND

The various discharges and emissions from the site should be considered over a building's lifetime.

Construction site activities can be a source of significant environmental degradation, unless appropriate steps are taken to reduce the emissions to air, land and waters, and to reduce the often considerable annoyance from construction related noise. It is the responsibility of contractors to do all in their power to employ appropriate construction methods that reduce air pollution, noise and water pollution.

It is the responsibility of the project team to consider emissions from the site, primarily the buildings on the site, as they may affect neighbouring properties, especially noise sensitive receivers such as hospitals, schools, residential buildings, etc., which will be affected for the life of the building development. Any air pollution, noise pollution and light pollution arising from the building engineering systems and equipment is of concern, all of which can be alleviated by good design and proper installation and maintenance.

2	SITE ASPECTS	2.P PREREQUISITE SA P1 MINIMUM LANDSCAPING AREA
	EXCLUSIONS	Buildings or sites not for residential use; or residential sites less than or equal to 1,000 m ² .
	OBJECTIVE	Encourage building development to preserve or expand urban greenery to enhance the quality of living environment, reduce surface runoff to drainage system and minimise impacts on fresh water and ground water systems during building use.
	REQUIREMENT	It is required to demonstrate compliance with appropriate planting on site equivalent to at least 20% of the site area.
	ASSESSMENT	<p>The Client shall provide a report prepared by a suitably qualified person that outlines the Master Landscape Plan for the site and provides a dialogue that demonstrates how soft landscaping has addressed the guidelines and recommendations provided in the Hong Kong Planning Standards and Guidelines Chapter 4 Section 2 Greenery [1] & PNAP APP-152 Sustainable Building Design Guidelines [2], appropriate to the type and scale of the building development and the immediate surroundings. The report shall detail the landscape treatment of the development including the planting and hard finishes of all landscaped areas, slopes and retaining structures, including but not limited to details of:</p> <ul style="list-style-type: none">• compliance with existing legislation and administrative measures relevant to preservation of vegetation, including the felling of trees;• trees retained, replanted or removed, and work undertaken to protect existing trees both during construction and permanently;• site formation with specific details of slope treatment;• the choice of finishes in qualitative terms for all hardwork elements, indicating any perceived or quantifiable environmental benefits;• planting plans with the character and planting densities for all softworks elements, details of the species used, and assessment of environmental benefits;• the adequacy of soil depth and drainage for all planted areas;• the method of irrigation used and source of water supply; and• future maintenance provisions. <p>It is expected that due account shall be taken of the plant type and planter designs to minimise watering and maintenance requirements. The species, density, topsoil, fertiliser, pesticide, planting maintenance, etc. should comply with the General Specification for Building Section 25: Landscape, or at least equal equivalent.</p> <p>The Client shall demonstrate compliance through quantification of the areas of greenery on the site and any building, including sky gardens, podium areas, roofs and other parts of the building. Water features in landscape design shall be considered in the calculation of areas of greenery. Where the target percentage can be achieved the prerequisite requirement shall be met.</p>

1 Hong Kong Planning Standards and Guidelines, Chapter 4 – Recreation, Open Space and Greening.
http://www.info.gov.hk/planning/tech_doc/hkpsg/english/ch4/ch4_text.htm

2 Buildings Department - PNAP APP-152 Sustainable Building Design Guidelines

BACKGROUND

In addition to mitigating any damage to site ecology, landscaping strategies can:

- enhance a site's microclimate (trees for shade, windbreaks, ponds, fountains, acoustic barriers and podium with gardens, etc.);
- provide for efficient irrigation (efficient use of direct rainfall, plant selection, water retention, materials in walkways allowing percolation to sub-soil, using well water, drip irrigation systems, etc.); and
- control surface run-off (roof ponds, holding tanks, semi-permeable surfaces on open areas, etc.)

Large expanses of greenery are difficult to secure in densely built city centres. However, the provision of plants on the outside and on rooftops contributes to making the city greener. For example, a building rooftop covered with greenery can significantly reduce surface temperature in summer, compared with bare asphalt or concrete rooftops. Roof greenery also can reduce peak roof runoff and alleviate storm drainage pressure. To protect and improve the built and natural environment the Government in promoting the construction of green and innovative buildings has identified communal sky gardens and communal podium gardens [3,4].

Water pollution in Hong Kong remains a problem. Measures that mitigate against pollution will help reduce the environmental loading. Criteria for protection of the aquatic environment against water pollution include consideration of all the aquatic components: water quality, hydrology, bottom sediments, and ecology should be considered.

3 Buildings Department et al. Joint Practice Note No. 1. Green and Innovative Buildings. October 2004.
<http://www.bd.gov.hk/english/documents/joint/JPN01.pdf>

4 Buildings Department et al. Joint Practice Note No. 2. Second Package of Incentives to Promote Green and Innovative Buildings. February 2006.
<http://www.bd.gov.hk/english/documents/joint/JPN02.pdf>

2	SITE ASPECTS	2.1	SITE LOCATION
		SA 1	CONTAMINATED LAND
	EXCLUSIONS		Building developments on Greenfield sites and where the site contamination/ landfill gas hazard assessment and mitigation measures are statutory requirements of the project.
	OBJECTIVE		Ensure proper investigation and remediation of potential contamination of redevelopment sites, or proper precautions for sites adjacent to landfill sites.
	CREDITS ATTAINABLE		1 BONUS
	PREREQUISITES		None.
	CREDIT REQUIREMENT		1 BONUS credit for conducting a site contamination assessment and implementing measures for rehabilitation, and/or proper preparation of sites and structures adjacent to landfill sites.
	ASSESSMENT		<p>a) Contaminated sites</p> <p>The Client shall submit evidence in the form of a report prepared by a suitably qualified person that demonstrates through a site contamination assessment that the issues and requirements outlined in Guidance Note for Contaminated Land Assessment and Remediation [1] have been addressed and that the immediate environment are free from any hazardous contamination. The report shall confirm that the required remedial measures, other than excavation and transfer to landfill (which is not regarded as an environmentally sound solution), have been completed to restore the land to an acceptable condition for use for the building redevelopment.</p> <p>b) Sites adjacent to landfill</p> <p>The Client shall provide evidence in the form of a report prepared by a suitably qualified person confirming that the site has been properly assessed and all issues and requirements outlined in ProPECC PN 3/96 [2] have been adequately addressed. Due consideration to gas hazards that may arise during the construction, phase shall be included.</p>
	BACKGROUND		<p>Derelict land and sites previously used as factories, shipyards, for chemical manufacturing or processing, oil depots, car repair workshops, waste treatment, etc., might be contaminated by hazardous substances such as oil, heavy metals and organic substances. Most of these sites are targeted for renewal in the Urban Renewal Strategy Study. Such land can pose risks to users, the adjacent environment or even the building materials, possibly undermining the integrity of the building. Special attention and rehabilitation may be required. Reclaimed land constructed with soil dredged from seabed or construction and demolition material can also be contaminated.</p> <p>Guidance Note for Contaminated Land Assessment and Remediation sets out requirements for proper assessment and management of potentially contaminated sites, and suggests practical remedial measures that can be adopted for the clean-up of a contaminated site. Although the requirements set out in the Guidance Note are usually incorporated through the land use planning process, either as conditions</p>

1 Environmental Protection Department. Guidance Note for Contaminated Land Assessment and Remediation.
http://www.epd.gov.hk/epd/english/envir_standards/non_statutory/files/GN_for_land_contamination_e.pdf

2 Environmental Protection Department. Practice Notes for Professional Persons, ProPECC PN 3/96 Landfill Gas Hazard Assessment for Developments Adjacent to Landfills.
http://www.epd.gov.hk/epd/textonly/english/resources_pub/publications/files/pn96_3.pdf

to planning permission, or as special conditions in relevant land-title documents for cases associated with potential land contamination problems, it is a good practice to carry out an investigation of site contamination on developed or reclaimed land to eliminate any risk or hazard arising from potential land contamination. Technical particulars on how a detailed site assessment should be conducted, and should be made reference to the “Guidance Manual for Use of Risk-based Remediation Goals for Contaminated Land Management” [3] and the “Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol Filling Station, Boatyards and Car Repair/Dismantling Workshops” [4].

Hong Kong is running out of landfill space due to the continued growth of waste. Excavating the contaminated soil and disposing of it at landfills is not considered as an environmentally responsible measure. On-site or off-site remediation should be employed to restore the site to an acceptable condition for the proposed use, or to put the treated soil to good use elsewhere.

It is recognised that building developments on land adjacent to landfill sites may be affected by migrating landfill gas and/or leachate unless specific precautions are taken to control the potential hazards. The Practice Note [2] sets out the conditions when a landfill gas hazard assessment may be required and provides general guidelines on how such an assessment should be undertaken. A Guidance Note [5] describes in more detail of the process which should be followed in evaluating the risks and designing appropriate protection measures. The Guidance Note is not intended to provide comprehensive guidance on all aspects of risk assessment or design of precautionary/protection measures, but rather to give general guidance on important issues such as the factors to be considered when assessing the level of risk and the procedures which should be followed in undertaking the assessment.

- 3 Environmental Protection Department. Guidance Manual for Use of Risk-based Remediation Goals for Contaminated Land Management. http://www.epd.gov.hk/epd/tc_chi/environmentinhk/waste/guide_ref/files/0056485_GM_6Jul07.pdf
- 4 Environmental Protection Department. Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol Filling Station, Boatyards and Car Repair/Dismantling Workshops. http://www.epd.gov.hk/epd/textonly/english/environmentinhk/waste/guide_ref/guide_contamsite_2.html
- 5 Environmental Protection Department. Landfill Gas Hazard Assessment. http://www.epd.gov.hk/epd/textonly/english/environmentinhk/waste/guide_ref/guide_lgha.html

2	SITE ASPECTS	2.1	SITE LOCATION
		SA 2	LOCAL TRANSPORT
	EXCLUSIONS		None.
	OBJECTIVE		Discourage the use of private vehicles and taxis by building users, with the aim to reduce air pollution, energy use, and noise from traffic.
	CREDITS ATTAINABLE		3
	PREREQUISITES		None.
	CREDIT REQUIREMENT	a)	Car parking provisions 1 credit where parking capacity does not exceed the minimum requirement from government and parking is provided for carpools or shuttle service vehicles. 2 credits where no car parking is provided other than provisions intended for use by disabled persons and/or shuttle service vehicles.
		b)	Public transport 1 credit for availability of convenient pedestrian access to mainstream public transport.
	ASSESSMENT	a)	Car parking provisions The Client shall provide details of any car parking facilities and the means of vehicular access and egress, in terms of drawings and/or photographs, together with a report confirming access and restrictions on use, as they affect the occupants. To obtain credit, any car park shall comply with the following conditions: <ul style="list-style-type: none">• by providing access that ensures simultaneous free flow of vehicles in and out of the car park; and• provisions to avoid ground contamination from oil run-off.
		b)	Public transport To obtain the credit, the mass transit station or other public transport facilities must be within 500m walking distance of the occupied building, and the scheduled operating frequency between 07.00 to 19.00 hours shall be 10 minutes or less. The Client shall provide evidence in the form of a survey map of the occupied building and the public transport facilities in the near vicinity. The map shall identify the location of the building at or near the centre of a scale drawing produced on an A3 size sheet with each of the listed services identified. The unencumbered walking route from the building main entrance to the main entrance to each public transport stop/station shall be clearly marked by lines on the drawing and the walking distance shown alongside. An legend shall be included on the drawing identifying the mass transit system, the walking distance, and the frequency of services during 07.00 to 19.00 hours. For sites not directly served by mainstream public transport, the provision of a shuttle service vehicle which links to a main stream mass transport interchange operating at the stated frequency may be deemed to satisfy the criteria. The onus is on the Client to demonstrate that the service is of adequate capacity, the frequency will meet the needs of all building users, and the shuttle bus is company owned, or there is a minimum 1 year rolling contract in place with the service provider.

The principle is to demonstrate easy access for the public; applicants are required to measure from the main access points of the development.

Future services/facilities provisions not operable at the time of building completion will be considered if they will be in operation no later than one year after obtained the Occupation Permit (OP) for the proposed development.

BACKGROUND

The increasing number of private vehicles in Hong Kong not only increases pressure on the highway and urban traffic system, but also worsens local air pollution. The most urgent problem to be resolved comes from fossil fuel burning vehicles, often aggravated by the street canyon effect of high-rise buildings. Exhaust fumes from cars contain volatile organic compounds: some of these are known carcinogens while others contribute to photochemical smog by assisting in the rapid formation of ozone in the atmosphere. The exhaust fumes also contain CO, CO₂, NO_x and SO₂ which contribute a variety of environmental problems. Apart from the health effects of traffic fumes, motor vehicles also generate noise, another environmental nuisance.

Part of the solution to the air pollution problem is to reduce the use of private vehicles and taxis. Building users should be encouraged to use public transport to and from the building. Provision of pedestrian links which allow easy access to major public transport systems and local amenities can discourage use of private transport, thereby reducing air and noise pollution.

The adequacy of a shuttle bus service may be demonstrated by data showing capacity, frequency, service hours, and the percentage of building users that can be transported during peak periods of commuting.

2	SITE ASPECTS	2.1	SITE LOCATION
		SA 3	NEIGHBOURHOOD AMENITIES
	EXCLUSIONS		Emergency Service Premises (e.g. fire station, power substation, etc.)
	OBJECTIVE		Encourage building development that is integrated within, and an asset to, the immediate neighbourhood.
	CREDITS ATTAINABLE		3
	PREREQUISITES		None.
	CREDIT REQUIREMENT	a)	Provision of basic services 1 credit where at least 10 different basic services are located within 500m walking distance from the Site and pedestrian access to the services is available for the Site.
		b)	Neighbourhood recreational facilities 1 credit where at least 2 different recreational facilities are located within 500m walking distance from the Site and pedestrian access to the facilities is available for the Site.
		c)	Provision of basic services/recreational facilities 1 credit where at least 2 different recreational facilities or at least 5 different basic services are located within the Site and will be made available for public use.
	ASSESSMENT		Assessment is based on the overall provisions for local residents and building users within the immediate vicinity of the building development, whether these are provided within the immediate neighbourhood, or are an additional provision within the development for the benefit of the neighbourhood. a) Provision of basic services The Client shall provide a report based on a survey of the immediate neighbourhood and details of the development itself to demonstrate adequate provision of basic services for building users. Basic services shall include (1) Restaurants; (2) Banks (including Automated Teller Machine); (3) Medical Facility; (4) Dental Clinic; (5) Pharmacy; (6) Supermarket; (7) Convenience Stores; (8) School; (9) Kindergarten or Day Care Centre; (10) Library; (11) Post Box; (12) Laundry or Dry Cleaner; (13) Hairdresser; (14) Retail shops; (15) Place of Worship; and (16) Community Centre. The onus is on the Client to demonstrate that basic services, appropriate to the needs of the intended building users, exist within the site or within reasonable walking distances. b) Neighbourhood recreational facilities The Client shall provide a report based on a survey of the immediate neighbourhood and details of the development itself to demonstrate adequate provision of recreational facilities and open space for building users. Recreational facilities shall include (1) Shaded/covered sitting out areas/garden/park with seating facilities; (2) Waterfront Promenade; (3) Public Swimming pool; (4) Public Indoor Sports Hall; (5) Public Outdoor Sports Facility such as football field, basketball court, tennis court, etc; (6) Bicycle Tracks. The onus is on the Client to demonstrate that the facilities, appropriate to the needs of the intended building users, exist within the site or within reasonable walking distances. c) Provision of basic services/recreational facilities The Client shall provide evidence that on-site facilities will be made

available for public use, including details of any restrictions or conditions of access that will be in place. Credit shall be awarded where the provision of recreational facilities or open space adds to those available within the immediate neighbourhood, and provide for reasonable access by the public. Types of basic services and recreational facilities can be referred to SA 3a) and SA 3b) respectively. Private clubhouses shall not be counted in this credit requirement.

Judgment as to the nature of basic services and the provision of recreational facilities and open space with respect to a particular building development shall be made with reference to the Hong Kong Planning Standards and Guidelines [1].

A map shall identify the location of the building at or near the centre of a scale drawing produced on an A3 size sheet with each of the listed services/facilities identified. The unencumbered walking route from the building's main entrance to the main entrance of the services/facilities shall be clearly marked by lines on the drawing and the walking distance shown alongside.

Future services/facilities provisions not operable at the time of building completion will be considered if they will be in operation no later than one year after obtained the Occupation Permit (OP) for the proposed development.

BACKGROUND

The provision of basic services such as shops, restaurants, clinics, etc., in the immediate vicinity of a building improves efficiency and the quality of living. Building users can benefit from existing provisions as well as those provided by the development that adds to the neighbourhood.

Provision of recreational facilities and open space [2] are essential to the mental and physical well-being of the individual and the community as a whole. It contributes to the quality of life of building users, and is more sustainability. Recreational open space is outdoor open-air space used for active and/or passive recreation use. Active recreation facilities include core activities such as ball games, swimming pool and sports facilities, etc, while passive recreational facilities refer to parks, gardens, sitting-out areas, waterfront promenades, paved areas for informal games, children's playgrounds, etc. The design and layout of these facilities should be of a high quality which meets the needs of the users and are perform to high environmental standards.

To enhance the quality of a neighbourhood, a development can bring additional recreational facilities and open space that is accessible by the public with reasonable restrictions on time of use, etc.

- 1 Planning Department. Hong Kong Planning Standards and Guidelines.
http://www.pland.gov.hk/pland_en/tech_doc/hkpsg/index.html
- 2 Hong Kong Planning and Standards Guidelines. Chapter 4 : Recreation, Open Space and Greening
http://www.pland.gov.hk/pland_en/tech_doc/hkpsg/full/ch4/ch4_text.htm

2	SITE ASPECTS	2.2	SITE PLANNING AND DESIGN
		SA 4	SITE DESIGN APPRAISAL
	EXCLUSIONS		None.
	OBJECTIVE		Encourage a proactive approach in order to achieve greater integration of site planning issues.
	CREDITS ATTAINABLE		1 + 1 BONUS
	PREREQUISITES		None.
	CREDIT REQUIREMENT		<p>1 credit for site design appraisal report demonstrating a proactive approach to achieve greater integration of site planning and design issues, and at least 50% of relevant sub-items of the Urban Design Guidelines in the Hong Kong Planning Standards and Guidelines are achieved.</p> <p>1 BONUS credit for 100% of relevant sub-items of the Urban Design Guidelines are achieved.</p>
	ASSESSMENT		<p>The onus is on the Client to demonstrate that site planning and design have taken into full account the physical and environmental aspects of the immediate site surroundings and neighbourhood. A report shall be submitted that explains and details the design team's efforts in achieving integration of the development with the immediate surroundings, covering as a minimum the negative, neutral or positive impacts associated with:</p> <ul style="list-style-type: none">• <u>Special Major Urban Design Issues</u><ul style="list-style-type: none">• Massing and intensity in urban fringe areas and rural areas• Developing height profile• Waterfront sites• Public realm• Streetscape• Heritage• View Corridors• Stilted Structures• <u>Special Major Land Uses Issues</u><p>For Commercial Zone</p><ul style="list-style-type: none">• Project a positive recognisable image for district and city• Create safe, interesting and comfortable circulation route for pedestrians• Create an efficient vehicular circulation system to minimise negative impact of vehicles on pedestrians• Provide adequate and conveniently accessible parking facilities• Provide maximum air circulation to improve air quality in commercial core area and achieve acceptable air quality• Maintain the vibrant streetscape character

For Residential Zone and Village

- Create appropriate size of the development
- Minimise adverse visual impact of development height on surrounding areas
- Create interesting built form and mass
- Choose a suitable location for blocks/ houses to enhance privacy of residents and to minimise the negative visual, noise and air quality impacts
- Create an efficient, comfortable, safe, and convenient pedestrian circulation system throughout the neighbourhood
- Create an efficient vehicular circulation system with minimal negative impacts on pedestrian circulation
- Provide adequate and easily accessible parking facilities for residents' vehicles
- Provide open space and G/IC facilities which are usable, accessible and valuable to residents
- Minimise negative impacts on surrounding natural environment
- Create a recognisable identity
- Establish self-contained neighbourhoods and communities to encourage residents' civic pride and sense of belonging
- Respect topographical/ landscape setting and the harmony of the village layout
- Create a focus for village and enhance its individual identity
- Provide efficient pedestrian and vehicular circulation system suitable for the village setting
- Preserve historical and cultural characteristics of indigenous villages

For Industrial Zone

- Locate industry to ensure minimal negative impacts on surroundings
- Create an efficient layout for internal circulation and project a positive image of the industrial area
- Provide safe and efficient pedestrian networks to and through the industrial development
- Maximise available and usable open space for workforce

The appraisal shall make reference to the Urban Design Guideline presented in the Chapter 11 of the Hong Kong Planning Standards and Guidelines [1]. Where at least 50% of relevant sub-items of the Urban Design Guidelines shall be fulfilled, the credit shall be awarded. Where 100% of relevant sub-items achieved, one BONUS credit shall be awarded.

BACKGROUND

BEAM encourages the Client and the design team to adopt a more integrated and proactive approach to site planning matters. A site design appraisal report is to demonstrate how the various aspects of site and architectural planning issues can collectively contribute to the

1 Planning Department. Hong Kong Planning Standards and Guidelines. Chapter 11: Urban Design Guidelines. http://www.pland.gov.hk/pland_en/tech_doc/hkpsg/full/ch11/ch11_text.htm

enhancement of the site and its surrounding neighbourhood. Investigations should include:

- a detailed assessment of the climatic conditions and topographic conditions immediate to the site;
- examination of the orientation of the buildings with respect to environmental conditions, overshadowing and views;
- planning of building form in response to local environmental conditions, such as variation of heights and distances among buildings and breaks in and between buildings, to achieve better natural ventilation and daylighting;

The ratio between the area of a site covered by buildings, and the open ground area without buildings within the site, affects the resistance that the wind encounters in the particular site and the access of sun and daylight in the site and subsequently affects pollutant concentration. Site layout should seek to minimise any negative aspects relating to microclimate, solar heat gain, wind, and loss of natural daylight to the neighbouring buildings and public areas, as well as the development itself.

2	SITE ASPECTS	2.2 SITE PLANNING AND DESIGN
		SA 5 ECOLOGICAL IMPACT
	EXCLUSIONS	None.
	OBJECTIVE	To conserve and enhance the natural environment by protecting the ecological value of the site in terms of habitat and biodiversity, and using Brownfield sites.
	CREDITS ATTAINABLE	1 Bonus
	PREREQUISITES	For designated project (DP) as specified under the Environmental Impact Assessment Ordinance (EIAO), Environmental Permit shall be obtained by following the statutory Environmental Impact Assessment Process, unless exempted.
	CREDIT REQUIREMENT	One Bonus credit from SA 5 Ecological Impact can be achieved through the following: Having a site which scores less than 20% of the points in the Habitat Section of The Nature Conservation Policy - 2009[1] and having a site which scores less than 30% in the Biodiversity Section of The Nature Conservation Policy - 2009; or Demonstrating that appropriate design measures have been implemented to contribute positively to the ecological value of the site.
	ASSESSMENT	To obtain a proper balance between building development needs and unacceptable damage to the natural environment, the ETWB of the HKSAR Government introduced a revised scoring scheme for assessing the ecological value of a site, called Nature Conservation Policy - 2009. This is a relatively objective and systematic method of assessing the ecological importance and value of individual site by taking into accounts the value of the particular habitats and biodiversity. This indicator is particular applicable for Greenfield site building development. The assessment scheme facilitates the identification of the entire site or particular portion of the site that deserve better protection and their relative priorities for action. There are 2 portions in the Nature Conservation Policy, which are Habitat and Biodiversity. Lower percentage obtained in the Habitat section means the building is designed on a Brownfield site, which has low habitat value. The major Sub-criteria in this indicator are: <ul style="list-style-type: none">• Naturalness (weighting 15%)• Habitat diversity (weighting 15%)• Non-recreatability (weighting 10%) A lower percentage obtained in the Biodiversity section means the building is designed on a Brownfield site, which has a low biodiversity value. The major Sub-criteria in this indicator are: <ul style="list-style-type: none">• Species diversity & Richness (weighting 30%)• Species rarity / Endemism (weighting 30%) Survey of the site-wide ecological value is required in order to ensure the preventive measures and the following detailed design work will take full consideration of the existing sites' ecological conditions.

1 Paper for the Legislative Council Panel on Environmental Affairs - New Nature Conservation Policy 2009 revision - http://www.afcd.gov.hk/english/conservation/con_nnccp/con_nnccp_news/con_nnccp_news.html

Relevant site survey and assessment report for Habitat and Biodiversity sections as described in the Nature Conservation Policy shall be provided to demonstrate compliance with the bonus credit requirement.

BACKGROUND

Habitat conservation is the most effective means to minimise developmental impacts on the natural environment and endangered species (if any). The natural environment is a valuable asset belonging to the people of Hong Kong and our future generations. New developments may destroy the natural environment of the habitats. The complexity of the habitat types, the time and effort needed to recreate the ecosystem, and the degree of uncertainty in recreating the habitats within the site should be of concern. Hence, the ecological value of the site in terms of habitat is assessed in this indicator.

Hong Kong contains large areas of natural landscapes which support a diverse assemblage of plant and animal species. However, there are expanding areas of building development, connecting roads and parking areas, which endanger wildlife corridors and the survival of species. Therefore, at the site level, BEAM encourages the creation or retention of habitats for indigenous species to maintain / increase the local biodiversity. Biodiversity consideration shall be included in the design or redevelopment stages to improve / maintain the biodiversity conditions. If an area of high biodiversity is identified in the site, it is encouraged to formulate management strategies to protect the habitats and any rare or endangered species within the land under ownership. Hence, building development is encouraged at brownfield sites with a low ecological value.

2	SITE ASPECTS	2.2 SITE PLANNING AND DESIGN
		SA 6 CULTURAL HERITAGE
	EXCLUSIONS	Sites or buildings without cultural heritage.
	OBJECTIVE	Conserve and protect archaeological remains, historic buildings and monuments so as to maintain the local and regional cultural heritage.
	CREDITS ATTAINABLE	1
	PREREQUISITES	Compliance with the Antiquities and Monuments Ordinance, and where applicable to the development, the Environmental Impact Assessment Ordinance.
	CREDIT REQUIREMENT	1 credit where development does not have a negative impact on sites of cultural heritage.
	ASSESSMENT	<p>The Client shall conduct a site survey and desktop study to identify if there are any sites of cultural heritage on or near the development site. Information of the identified sites of cultural heritage may be assembled from the Antiquities and Monuments Office [1], public libraries and archives and tertiary institutions. The guidelines and criteria for the assessment of sites of cultural interest shall follow Annex 10 and Annex 19 of Technical Memorandum to the Environmental Impact Assessment Process [2]. The guidelines on conservation of historical buildings contained in the Chapter 10 of Hong Kong Planning and Standards Guidelines [3] shall be followed. Clients are encouraged to preserve sites or buildings of cultural heritage or enhance the setting of such neighbouring sites or buildings.</p> <p>Credit shall be awarded where evidence in the form of a report by a suitably qualified person is provided detailing the findings and confirming that site preparation (including the process of reclamation), construction and building commissioning has had no adverse impacts on these sites.</p>
	BACKGROUND	<p>Hong Kong has a long history which probably dates back to 6,000 years ago, and possesses rich cultural heritage resources. SUSDEV 21 Study has defined heritage resources as those sites which contain archaeological, historical and religious value. Cultural heritage provides a means of knowing and interpreting social, cultural and economic changes and enhancing our understanding of the past. It also provides a focus for community identity, from which a sense of belonging to Hong Kong can be fostered among the community [4].</p> <p>Preservation of cultural heritage resources is important. Besides the declared monuments that are protected under the Antiquities and Monuments Ordinance and the Environmental Impact Assessment Ordinance there are over 450 historic buildings have been accorded a grading, but which have no statutory protection. There remain thousands of historic buildings which are yet to be fully assessed and categorised, and are outside the protected areas. As such, special attention and measures must be given taken to ensure that any cultural heritage features on site and in the vicinity are properly retained and protected to</p>

- 1 Antiquities and Monuments Office. <http://www.lcsd.gov.hk/CE/Museum/Monument/en/index.php>
- 2 Environmental Protection Department. Technical Memorandum on Environmental Impact Assessment Process. <http://www.epd.gov.hk/eia/english/legis/index3.html>
- 3 Hong Kong Planning and Standards Guidelines. http://www.pland.gov.hk/pland_en/tech_doc/hkpsg/index.html
- 4 HK2030 Study. Working Paper No. 9. Built Heritage Preservation. http://www.pland.gov.hk/pland_en/p_study/comp_s/hk2030/eng/home/index.htm

maintain our cultural sustainability [5].

The definition of sites of cultural heritage is shown in Schedule 1 of the Environmental Impact Assessment Ordinance. They generally cover archaeological sites and structures, historical buildings, paleontological sites and other cultural heritage features in a wide variety of forms (e.g. old street furniture, lime kilns, graves, trackways, salt-pans, etc.).

Relics fashioned before 1800 (and discovered after 1976) belong to the Government under the Antiquities and Monuments Ordinance. The excavation and search for such relics require a license from the Authority.

5 Environmental Protection Department. Assessment of Impact on Sites of Cultural Heritage in Environmental Impact Assessment Studies. <http://www.epd.gov.hk/eia/english/guid/index5.html>

2	SITE ASPECTS	2.2 SITE PLANNING AND DESIGN
		SA 7 LANDSCAPING AND PLANTERS
	EXCLUSIONS	None.
	OBJECTIVE	Encourage building development to preserve or expand urban greenery to enhance the quality of living environment, reduce surface runoff to drainage systems and minimise impacts on fresh water and ground water systems during building use.
	CREDITS ATTAINABLE	3
	PREREQUISITES	For residential premises with site area larger than 1,000 m ² , it is required to demonstrate compliance with appropriate planting on site equivalent to at least 20% of the site area.
	CREDIT REQUIREMENT	a) Hard landscaping 1 credit for using pervious materials for a minimum of 50% of hard landscaped areas. b) Soft landscaping 1 credit for providing appropriate planting on site equivalent to at least 30% of the site area. 2 credits for providing appropriate planting on site equivalent to at least 40% of the site area.
	ASSESSMENT	<p>The Client shall provide a report prepared by a suitably qualified person that outlines the Master Landscape Plan for the site and provides a dialogue that demonstrates how soft landscaping has addressed the guidelines and recommendations provided in the Hong Kong Planning Standards and Guidelines Chapter 4 Section 2 Greenery [1] & PNAP APP-152 Sustainable Building Design Guidelines [2], appropriate to the type and scale of the building development and the immediate surroundings. The report shall detail the landscape treatment of the development including the planting and hard finishes of all landscaped areas, slopes and retaining structures, including but not limited to details of:</p> <ul style="list-style-type: none">• compliance with existing legislation and administrative measures relevant to preservation of vegetation, including the felling of trees;• trees retained, replanted or removed, and work undertaken to protect existing trees both during construction and permanently;• site formation with specific details of slope treatment;• the choice of finishes in qualitative terms for all hardworks elements, indicating any perceived or quantifiable environmental benefits;• planting plans with the character and planting densities for all softworks elements, details of the species used, and assessment of environmental benefits;• the adequacy of soil depth and drainage for all planted areas;• the method of irrigation used and source of water supply; and• future maintenance provisions.

1 Hong Kong Planning Standards and Guidelines, Chapter 4 – Recreation, Open Space and Greening.
http://www.pland.gov.hk/pland_en/tech_doc/hkpsg/full/ch4/ch4_text.htm

2 Buildings Department - PNAP APP-152 - Sustainable Building Design Guidelines

a) Hard landscaping

Where it can be demonstrated that a minimum 50% of hard landscaped area (e.g. roadways, surface parking, plazas, pathways, but excluding Emergency Vehicular Access), are pervious and measures are taken to restrict the contamination of ground waters by oil and similar contaminants, the credit shall be awarded.

b) Soft landscaping

It is expected that due account shall be taken of the plant type and planter designs to minimise watering and maintenance requirements. The species, density, topsoil, fertiliser, pesticide, planting maintenance, etc. should comply with the General Specification for Building Section 25: Landscape, or at least equal equivalent.

The Client shall demonstrate compliance through quantification of the areas of greenery on the site and any building, including sky gardens, podium areas, roofs and other parts of the building. The soft landscaped calculation method shall follow the criteria set out in PNAP APP-152 [2]. Where the target percentage can be achieved, the credit(s) shall be awarded.

BACKGROUND

In addition to mitigating any damage to site ecology, landscaping strategies can:

- enhance a site's microclimate (trees for shade and windbreaks, ponds and fountains, acoustic barriers, podium with gardens, etc.);
- provide for efficient irrigation (efficient use of direct rainfall, plant selection, water retention, materials in walkways allowing percolation to sub-soil, using well water, drip irrigation systems, etc.); and
- control surface run-off (roof ponds, holding tanks, semi-permeable surfaces on open areas, etc.)

Large expanses of greenery are difficult to secure in densely built city centres. However, the provision of plants on the outside and on rooftops contributes to making the city greener. For example, a building rooftop covered with greenery can significantly reduce surface temperature in summer, compared with bare asphalt or concrete rooftops. Roof greenery also can reduce peak roof runoff and alleviate storm drainage pressure. To protect and improve the built and natural environment, the Government in promoting the construction of green and innovative buildings has identified communal sky gardens and communal podium gardens [3,4].

Water pollution in Hong Kong remains a problem. Measures that mitigate against pollution will help reduce the environmental loading. Criteria for protection of the aquatic environment against water pollution include consideration of all the aquatic components: water quality, hydrology, bottom sediments, and ecology.

3 Buildings Department et al. Joint Practice Note No. 1 Green and Innovative Buildings. October 2004. <http://www.bd.gov.hk/english/documents/joint/JPN01.pdf>

4 Buildings Department et al. Joint Practice Note No. 2 Second Package of Incentives to Promote Green and Innovative Buildings. February 2006. <http://www.bd.gov.hk/english/documents/joint/JPN02.pdf>

2	SITE ASPECTS	2.2 SITE PLANNING AND DESIGN
		SA 8 MICROCLIMATE AROUND BUILDINGS
	EXCLUSIONS	SA 8a – Sites which are located in urban zones with existing stagnant air
	OBJECTIVE	Ensure the microclimate around and adjacent to buildings has been adequately considered, and where appropriate, suitable mitigation measures are provided.
	CREDITS ATTAINABLE	4
	PREREQUISITES	For Air Ventilation Assessment (AVA), those project belonging to the categories requiring AVA as specified in the Housing, Planning and Lands Bureau (HPLB) Technical Circular No. 1/06 – Air Ventilation Assessment.
	CREDIT REQUIREMENT	<p>a) Wind amplification</p> <p>1 credit for demonstrating that no pedestrian areas will be subject to excessive wind velocities caused by amplification due to the site layout design and/or building design.</p> <p>b) Elevated temperatures</p> <p>1 credit for providing shade on at least 50% of non-roof impervious surfaces on the site (parking, walkways, plazas) using light coloured high-albedo materials (albedo of at least 0.4).</p> <p>1 credit for providing roof material that meets the Solar Reflectance Index (SRI) of 78 or vegetation roof covering at least 50% of the total roof area.</p> <p>c) Air Ventilation Assessment</p> <p>1 credit for conducting an AVA by wind tunnel or Computer Fluid Dynamics (CFD) according to the prevailing AVA methodology introduced by the Government demonstrating the optimal option is selected in comparing with different options.</p>
	ASSESSMENT	<p>The microclimate around buildings includes commonly and frequently accessible areas, such as entrances and exits to buildings, pedestrian routes, opening spaces, streets, podium gardens, walkways, sitting-out areas, playground areas, etc.</p> <p>a) Wind amplification</p> <p>The Client shall submit a report prepared by a suitably qualified person, using either wind tunnel tests or CFD studies, demonstrating compliance.</p> <p>The assessment should be based on the following key approaches:</p> <ul style="list-style-type: none">• Assessment area where test points are positioned is within 1H (H being the height of the tallest building on the project site) from the site boundary;• Relative wind speeds around buildings shall be assessed by placing a suitable scale model of the building and surrounding large structures within radius of 2H (building height) of the tallest building from the development site in a boundary layer wind tunnel, if there are prominent features (e.g. tall buildings or large and bulky obstructions) immediately outside the 2H zone, the assessment boundary should be extended to include these prominent structures;

- Appropriately numbered and suitably located test points should be positioned in and outside the project site within the assessment area. Particular attention should be paid to building corners, gaps between buildings and building voids;
- The annual wind rose (wind probability table) of the site should be used;
- At least 8 of the prevailing wind directions (out of 16) should be tested;
- The average “hourly mean wind speed” of the test points to be reported;
- No test point reported should exceed an average “hourly mean wind speed” of 4 m/s.

b) Elevated temperatures

The Client shall submit a report detailing strategies and design solutions to mitigate elevated temperatures in exposed public areas. This should demonstrate the effectiveness of reducing temperatures by:

- i) providing shade on at least 50% of non-roof impervious surfaces on the site (parking, walkways, plazas) using light coloured high-albedo materials (albedo of at least 0.4); or
- ii) providing roof material with the Solar Reflectance Index (SRI) higher than 78 covering at least 50% of the total roof area; or provide vegetation covering at least 50% of the total roof area.

Area of exemption for the roof with material of high SRI or vegetation would include areas occupied by mechanical systems.

c) Air ventilation assessment

The HPLB and ETWB have formulated the methodology for Air Ventilation Assessment. The Client shall follow the prevailing technical circular as described and demonstrate the effects and impacts on the pedestrian wind environment.

The Client shall submit evidence in the form of a report prepared by a suitably qualified person which follows the reporting requirement listed in the prevailing technical circular.

BACKGROUND

The microclimate around buildings can suffer as a result of the restricted natural ventilation from winds and breezes, leading to stagnant areas of pollution and elevated temperatures. Conversely, the topology can lead to significant amplification of wind at pedestrian level, leading to discomfort and fatigue for pedestrians, damage to plant life, accumulation of debris, and in more extreme cases, danger from impeded walking and flying objects.

Wind flow around a site can be accelerated or decelerated due to the building form, typically 2 to 3 times greater than for open ground. Localised areas of accelerated wind around corners and between narrow channels are of particular concern.

The following table [1] indicates that mechanical discomfort sets in at wind speeds of about 5 ms^{-1} , with speeds above 8 ms^{-1} being very uncomfortable and speeds above 20 ms^{-1} being dangerous. Conversely, some areas may receive relatively low wind flow with free airflow being obstructed by buildings.

1 British Building Research Station, Wind Environment Around Tall Buildings. Digest 141, May 1972.

Beaufort Number	Wind speed ms ⁻¹	Effect
0,1	0-1.5	No noticeable wind
2	1.6-3.3	Wind felt on face
3	3.4-5.4	Hair disturbed, clothing flaps
4	5.5-7.9	Raises dust, dry soil and loose paper, hair blown
5	8.0-10.7	Force felt on body, limit of agreeable wind
6	10.8-13.8	Umbrellas use difficult, difficult to walk steadily
7	13.9-17.1	Inconvenience felt when walking
8	17.2-20.7	Generally impedes progress
9	20.8-24.4	People blown over by gusts

For wind amplification, the value of 4m/s is based on Frank H. Durgin's research [2]. This research shows that with 4m/s (actually 3.7 to 4.8m/s) and k, the exponent from the Weibull distribution = 2, the probability of the exceedance of a dangerous level will be within a reasonable range.

The use of non-reflective external surfaces contributes to localised elevated temperatures created when solar heat gains are absorbed and then radiated back to the surroundings. The effect may be local to pedestrian and recreational areas, and contribute to urban heat islands. As a result, local ambient and effective temperatures can rise by several degrees or more when compared with more open and better ventilated areas. Penalties include local discomfort, detrimental effects on site vegetation and wildlife, etc. Elevated temperatures can be mitigated through the choice of finishes on buildings and horizontal hard surfaces that reflect heat, the application of shading or planting vegetation.

Microclimatic conditions of the site should be designed with a thorough and balanced consideration of the wind, sunlight, temperature and air quality.

To promote the awareness of project proponents in order to ensure that air ventilation impacts are duly considered as one of the main criteria in the planning and design process, HPLB has encouraged Air Ventilation Assessment (AVA) to be included in the planning and design of the projects. A framework for applying AVA is developed on the basis of the 'Feasibility Study on Establishment of Air Ventilation Assessment' [3] completed and endorsed by the Committee on Planning and Land Development in 2005. HPLB promulgated the Technical Circular (TC) No. 1/06 on AVA in 2006.

AVA targets the projects that may have major impacts on the macro wind environment. The Government will take the lead to apply AVA for all major Government projects including public housing projects and comprehensive redevelopment areas, while quasi-government organisations and the private sector are encouraged to apply AVA to their projects on a voluntary and need basis. The framework of AVA would enable comparison of design options in external air ventilation terms and identification of potential problem areas for design improvements.

2 Pedestrian level wind criteria using the equivalent average - Frank H. Durgin 1997.
3 Advisory Council on the Environment- Feasibility Study for Establishment of Air Ventilation Assessment
http://www.epd.gov.hk/epd/english/boards/advisory_council/files/ace102005.pdf

2	SITE ASPECTS	2.2 SITE PLANNING AND DESIGN
		SA 9 NEIGHBOURHOOD DAYLIGHT ACCESS
	EXCLUSIONS	Buildings where daylight is of no value to neighbouring properties.
	OBJECTIVE	Encourage building development which is sensitive to the needs of neighbours in respect of preserving daylight and views.
	CREDITS ATTAINABLE	1
	PREREQUISITES	Compliance with Building (Planning) Regulation (CAP 123F) Regulation 37.
	CREDIT REQUIREMENT	1 credit for designs for which the access to daylight of neighbouring sensitive buildings is maintained to the prescribed level.
	ASSESSMENT	<p>Neighbouring buildings, both existing and planned, shall be assessed to determine the value of daylight (and to some extent sunlight) to sensitive buildings. Assessment shall be by appropriate computer and/or physical modelling.</p> <p>Sensitive building is defined as follow:</p> <ul style="list-style-type: none">(i) residential buildings;(ii) non-residential buildings:<ul style="list-style-type: none">- premises that requires daylight to enhance the lighting environment for the occupants to perform tasks, such as offices and schools;- premises that require daylight for energy saving and an improved environment for the transient stage of occupation, such as the circulation area of shopping centers and indoor games halls; and- premises that require daylight primarily for view, such as hotels and hospitals. <p>The Client shall submit a report prepared by a suitably qualified person containing a comprehensive analysis (calculations and drawings) that qualifies and quantifies the extent to which the building development will impact on the sensitive neighbouring buildings in respect of access to daylight.</p> <p>Change in the access to daylight may be objectively assessed in terms of the change in Vertical Daylight Factor (VDF) on the facades of sensitive receivers, or change in viewing angle, whichever is deemed most appropriate.</p> <p>Where the VDF on the facade of the lowest floor of the sensitive receiver most affected is either unchanged or is no less than 12%, or the viewing angle is reduced by less than 5%, the credit shall be awarded.</p>
	BACKGROUND	<p>Tall buildings can cause substantial overshadowing of neighbouring developments and amenities, affecting both direct and indirect sunlight and light from the sky. The profile of a building and its layout with respect to neighbouring buildings impacts on beneficial views, such as to the harbour or to mountains and open spaces, as well as affecting natural breezeways around the development.</p> <p>The impact of a new building on all existing or planned neighbouring buildings where daylight and sunlight is of value, such as residential buildings, hospitals, schools, etc should be assessed. Wherever possible the access to these beneficial natural elements should be safeguarded. This issue reinforces the concept of 'good neighbour buildings'.</p>

2	SITE ASPECTS	2.2 SITE PLANNING AND DESIGN
		SA 10 ENVIRONMENTAL MANAGEMENT PLAN
	EXCLUSIONS	None.
	OBJECTIVE	Encourage a higher standard of environmental management during construction.
	CREDITS ATTAINABLE	1
	PREREQUISITES	A prerequisite for credit is compliance with all relevant environmental protection and pollution control ordinances. Any evidence of non-compliance will nullify the award of any credits. The relevant enacted ordinances and their regulations are summarised in the Recommended Pollution Control Clauses for Construction Contracts by the Environmental Protection Department.
	CREDIT REQUIREMENT	1 credit if an Environmental Management Plan including Environmental Monitoring and Auditing has been implemented.
	ASSESSMENT	<p>The Client shall provide copies of relevant contract documents highlighting the clauses appropriate to the construction activities for the building development in accordance with recommendations set out by the Environmental Protection Department. The Demolition/Construction Contractor's Environmental Management Plan should be submitted which takes into account the Checklist and practical advice given in PNR 17 Appendix A [1]. The Client shall confirm through a report derived from appropriate site management and monitoring that environmental management practices on site are such as to comply with legislative requirements and to minimise nuisance. PNR 17 Appendix A [1] should be used as a point of reference in reporting on implementation of the environmental management on site.</p> <p>Where it can be demonstrated that contract documents, specifications and cost provisions provide for an Environmental Management Plan conforming to the guidelines, and the plan has been properly executed, the credit shall be awarded.</p>
	BACKGROUND	The environmental impacts arising during demolition and construction are often very significant, affecting site ecology, air, noise and water quality as well as nuisance from waste within and outside the site. The appointment of contractors who are environmentally aware and who are able to implement good environmental practices on site should make a significant contribution to reducing environmental pollution and waste. Appropriate pollution control clauses should be included in demolition and construction contracts in accordance with recommendations by the Environmental Protection Department [2]. Contractors should take appropriate steps to minimise the impact of demolition and construction activities on the surrounding environment.

1 Buildings Department. Practice Note for Registered Contractors PNR 17 Control of Environmental Nuisance from Construction Sites. August 1997. <http://www.bd.gov.hk/english/documents/pnr/Pnr17.pdf>
2 Environmental Protection Department. Recommended Pollution Control Clauses for Construction Contracts. http://www.epd.gov.hk/epd/english/environmentinhk/eia_planning/guide_ref/rpc.html

2	SITE ASPECTS	2.3 EMISSIONS FROM THE SITE
		SA 11 AIR POLLUTION DURING CONSTRUCTION
	EXCLUSIONS	None.
	OBJECTIVE	Minimise air pollution during the construction of buildings and the infrastructure serving buildings.
	CREDITS ATTAINABLE	1
	PREREQUISITES	Compliance with the Air Pollution Control Ordinance and its subsidiary regulations, particularly the Air Pollution Control (Open Burning) Regulation and Air Pollution Control (Construction Dust) Regulation and Air Pollution Control (Smoke) Regulation.
	CREDIT REQUIREMENT	1 credit for applying adequate mitigation measures for dust and air emissions during the construction as recommended by the Environmental Protection Department, and demonstrating compliance with the air quality management guidelines as detailed in the Environmental Monitoring and Audit Manual.
	ASSESSMENT	<p>Where demolition is included as part of the works it shall be included in the assessment.</p> <p>The Client shall submit confirmation in form of a report from a suitably qualified person that the works have been carried out without violation of the Air Pollution Control Ordinance and no conviction or complaint about air pollution from the site has been upheld by the Environmental Protection Department.</p> <p>The Client shall present evidence in the form of specifications and contract documents detailing the requirements to control dust and air emissions generated by construction activities. The Client's representative on site shall be responsible for monitoring and reporting on the execution of the instructions. The representative shall confirm in writing to the Assessor that the control of dust on site followed the requirements as laid down in the specifications and contract documents.</p> <p>The Client shall also present evidence in the form of a report prepared by a suitably qualified person that the monitoring and audit of Respirable Suspended Particulates (RSP) and Total Suspended Particulates (TSP) has been satisfactory for the scale of the works involved. The report shall make reference to the latest best practice guidelines or practices (e.g. Best Practice Guide for Environmental Protection on Construction Sites, etc.)</p> <p>For major projects compliance with EPD's Environmental Monitoring and Audit Manual [1] is required. For those projects for which this it is not a requirement the frequency of the monitoring can be reduced, and/or monitoring undertaken during key phases of construction. For instance, 1-hour TSP monitoring should be undertaken with a sampling frequency of at least three times in every six days, and when the highest dust impact occurs.</p>
	BACKGROUND	The Air Pollution Control Ordinance (APCO) is the main legislative framework governing the control of air pollution activities. Air pollution control regulations are enacted under the APCO for specific air pollution control purposes. Under the APCO, air pollution emissions from construction activities are subject to control under five regulations:

1 Environmental Protection Department, Generic Environmental Monitoring and Audit Manual, Chapter 2, Air Quality.

- Construction Dust Regulation
- Specified Processes Regulation
- Smoke Regulation
- Fuel Restriction Regulation
- Open Burning Regulation

Dust generated by various construction site activities can make a significant contribution to local air pollution. High levels of dust, combined with other outdoor air pollutants, can cause respiratory problems. Inhaled particles may aggravate asthma and bronchitis, and very small particles may cause cancer. Dust also reduces visibility, dirties clothing and buildings, and increases the rate of corrosion. All these effects decrease the quality of life and cost money. Good site practices are the major mitigation measures for prevention or minimisation of air pollution from construction activities. Practical guidance on the control of air pollution during construction is available from the Environmental Protection Department. Measures include:

- effective water sprays to be used to water exposed working areas that can generate dust;
- fine particle materials on site to be enclosed and covered;
- wheel washing facilities to be installed and used by all vehicles leaving the site; and
- at the end of the works, all bare surface to be hydroseeded as soon as possible.

A Guide, published by the Hong Kong Construction Association (HKCA) [2], aims to enhance the environmental awareness of the construction industry and to provide steps and practical solutions to identify and mitigate environmental problems which are often encountered on construction sites.

The Guide can assist project/environmental managers and engineers to implement environmental protection on construction sites, starting from the project planning stage (e.g. tender bidding) to implementation, with detailed descriptions of environmental impacts and mitigation measures. Particular attention has been focused on environmental issues and mitigation measures with regard to various construction activities including piling, civil and building works.

2 Hong Kong Construction Association (HKCA). Best Practice Guide for Environmental Protection on Construction Sites. January 2009.

2	SITE ASPECTS	2.3	EMISSIONS FROM THE SITE
		SA 12	NOISE DURING CONSTRUCTION
	EXCLUSIONS		None.
	OBJECTIVE		Minimise nuisance to the immediate neighbourhood caused by noise during the construction of buildings and the infrastructure serving buildings.
	CREDITS ATTAINABLE		1
	PREREQUISITES		Compliance with the Noise Control Ordinance.
	CREDIT REQUIREMENT		1 credit for providing adequate mitigation measures for construction noise for all Noise Sensitive Receivers.
	ASSESSMENT		<p>Where demolition is included as part of the works it shall be included in the assessment.</p> <p>The Client shall submit confirmation in the form of a report from suitably qualified person that the works have been carried out without violation of the Noise Control Ordinance, and that no complaint about noise from the site has been upheld by the Authority (Environmental Protection Department) or the Police leading to the issue of a fine or prosecution.</p> <p>The Client's representative on site, who shall be a suitably qualified person, shall be responsible for monitoring and shall submit monthly reports confirming that the control of noise on site has met the requirements with reference to the latest best practice guidelines or practices (e.g. Best Practice Guide for Environmental Protection on Construction Sites, etc.), in respect of all Noise Sensitive Receivers as defined in Annex 13 of the Technical Memorandum under the Environmental Impact Assessment Ordinance [1].</p>
	BACKGROUND		<p>Due to the high density of buildings, traffic and people, Hong Kong is perhaps one of the noisiest cities in the world. The Government's policy objective for controlling noise pollution is to ensure that a satisfactory noise environment is maintained to safeguard the quality of life of the population. Noise caused by construction activity is a major target for attention. Noise related to construction activities is controlled under the Noise Control Ordinance (NCO) Chapter 400. Despite the introduction of controls under the NCO [2] and general tightening of the controls, construction noise remains a problem.</p> <p>Guidance is given in practice notes issued by EPD and the Buildings Department [3,4]. A Guide, published by the Hong Kong Construction Association (HKCA) [5], aims to enhance the environmental awareness of the construction industry and to provide steps and practical solutions to identify and mitigate environmental problems which are often encountered on construction sites.</p>

1 Environmental Protection Department. EIA Technical Memorandum. Annex 13 Guidelines for Noise Assessment. <http://www.epd.gov.hk/eia/english/legis/memorandum/annex13.html>

2 A Concise Guide to the Noise Control Ordinance. Environmental Protection Department. 8th Ed. July 2000. http://www.epd.gov.hk/epd/english/environmentinhk/noise/guide_ref/files/CG_E-06n.pdf

3 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers. PNAP No. ADV-4 Control of Environmental Nuisance from Construction Sites. August 1997. <http://www.bd.gov.hk/english/documents/pnap/ADV/ADV004.pdf>

4 Environmental Protection Department. Environmental Noise. http://www.epd.gov.hk/epd/noise_education/web/ENG_EPd_HTML/index/index.html

5 Hong Kong Construction Association (HKCA). Best Practice Guide for Environmental Protection on Construction Sites. January 2009.

General requirements [6] and practical guidance [7] on meeting the requirements are available from EPD. The Police are also authorised to enforce the sections of industrial noise and construction noise under the NCO. Construction activities are grouped into two main categories:

- general works (e.g. excavation and concreting); and
- percussive piling (e.g. piling by means of a hydraulic hammer or a drop hammer).

A Technical Memorandum [8] details the procedures for determining any permitted hours of operation for percussive piling. Control of construction noise for general works can be further categorised into:

- control in the whole territory - the use of all Powered Mechanical Equipment (PME) requires a Construction Noise Permit (CNP) during restricted hours; and
- control in Designated Areas - stricter control is imposed on construction sites within Designated Areas (DA). Most of the built-up residential areas are within designated areas. The use of Specified Powered Mechanical Equipment and the carrying out of Prescribed Construction Work (PCW) during restricted hours requires a CNP.

For construction work other than percussive piling other technical memoranda [9,10] detail the procedures for determining (on the basis of equipment used, distance separation, and the calculated noise level) whether a CNP for general works should be granted. The noise impacts on nearby Noise Sensitive Receivers (NSRs, e.g. dwellings, school) are assessed in accordance with the Technical Memorandum. Under the Noise Control Ordinance, there is no statutory control on the noise from general works during the unrestricted hours (i.e. 7 am - 7 pm on weekdays).

Examples of 'good practices' in respect of further reducing noise nuisance from construction activities include erection of barriers and use of enclosures, and use of appropriate equipment such as:

- hydraulic piling hammers;
- hydraulic crushers instead of conventional excavator mounted breakers;
- wire saw for concrete cutting rather than excavator mounted breakers
- acoustic enclosures for hand-held breakers and generators;
- acoustic barriers for large equipment;
- disposal of rubble through plastic chutes; or
- providing temporary solutions to reduce noise at adjacent noise sensitive receivers, such as the provision of acoustic insulation.

6 Environmental Protection Department. EIA & Planning: guidelines & references, section 3 Noise Control.

7 http://www.epd.gov.hk/epd/english/news_events/current_issue/files/enoise2002.ppt

8 Environmental Protection Department. Technical Memorandum on Noise from Percussive Piling.

9 http://www.epd.gov.hk/epd/english/environmentinhk/noise/guide_ref/tm_pp.html

10 Environmental Protection Department. Technical Memorandum on Noise from Construction Work other than Percussive Piling. http://www.epd.gov.hk/epd/english/environmentinhk/noise/guide_ref/tm_nonpp.html

11 Environmental Protection Department. Technical Memorandum on Noise from Construction Work in Designated Areas. http://www.epd.gov.hk/epd/english/environmentinhk/noise/guide_ref/tm_des_area.html

2	SITE ASPECTS	2.3 EMISSIONS FROM THE SITE
		SA 13 WATER POLLUTION DURING CONSTRUCTION
	EXCLUSIONS	None.
	OBJECTIVE	Ensure the proper management of construction site discharges.
	CREDITS ATTAINABLE	1
	PREREQUISITES	Compliance with the Water Pollution Control Ordinance and its subsidiary regulation.
	CREDIT REQUIREMENT	1 credit for undertaking adequate measures to reduce water pollution during construction.
	ASSESSMENT	<p>Where demolition is included as part of the works it shall be included in the assessment.</p> <p>The Client shall submit confirmation in the form of a report from a suitably qualified person that the works have been carried out without violation of the Water Pollution Control Ordinance and no conviction or complaint about water pollution from the site has been upheld by the Environmental Protection Department.</p> <p>The Client shall present evidence in the form of specifications and contract documents detailing the requirements to undertake measures to reduce water pollution during construction, with reference to the latest best practice guidelines or practices (e.g. Best Practice Guide for Environmental Protection on Construction Sites, etc.)</p> <p>The Client's representative on site shall be responsible for monitoring and reporting the execution of the instructions. The Client shall confirm in writing that the works were conducted in accordance with the recommendations given in the above guidelines or practices appropriate to the particular circumstances of the site.</p>
	BACKGROUND	<p>Construction activity can pose a major pollution threat to the environment if discharges from construction sites are not properly handled. Such discharges are subject to control under the Water Pollution Control Ordinance [1]. The major types of discharges have been identified as follows:</p> <ul style="list-style-type: none">• muddy underground water and bentonite slurries from excavation work and/or bore piling activities;• run-off from site spraying watering and wheel washing effluent as a result of adopting dust control measures;• domestic sewage generated from canteen and toilet facilities on site; and• contaminated surface run-off during wet weather. <p>Construction site wastewater contains mainly silt, sand and gravel. Indiscriminate discharge of untreated or partially treated wastewater will have a major impact on the receiving water bodies. Common pollution threats include:</p> <ul style="list-style-type: none">• siltation in drainage pipes which may lead to blockage and eventually flooding risks;• visual nuisance and hazard to the aquatic life e.g. fish gills blocked

1 Environmental Protection Department. A Guide to the Water Pollution Control Ordinance. May 2001. http://www.epd.gov.hk/epd/english/environmentinhk/water/guide_ref/files/guide_wpc_wpcoc.pdf

up causing suffocation to death; and

- increase in turbidity of the receiving water which may adversely affect the ecosystem.

Prior to making a discharge, the responsible person for the discharge should submit an application to EPD for a discharge license. Under the Water Pollution Control Ordinance, it is an offence to discharge polluting matter in a water control zone without a valid license, or to discharge effluent in breach of the terms and conditions specified in the discharge license granted by the Authority. The contractor has the responsibility to ensure compliance with all legislative control requirements. Apart from obtaining a valid discharge license before the commencement of any discharge, the contractor must take all necessary steps to comply with the terms and conditions of the license. This requires due consideration to be given at the planning stage of a construction project. Attention should be paid to the wastewater characteristics, to minimise the quantity of pollution loads (both in terms of flow and concentration), plan and install proper site drainage to intercept stormwater run-off from outside the site and collect silt carrying site run-off to silt removal facilities; design and construct appropriate wastewater treatment facilities, provide the necessary training to the site personnel as well as constant on-site supervision and monitoring of the environmental performance. All wastewater treatment facilities should be well maintained to achieve the desired performance.

2	SITE ASPECTS	2.3 EMISSIONS FROM THE SITE
		SA 14 NOISE FROM BUILDING EQUIPMENT
	EXCLUSIONS	None.
	OBJECTIVE	Encourage proactive design techniques intended to reduce the nuisance caused to neighbours by noise from building services equipment.
	CREDITS ATTAINABLE	1
	PREREQUISITES	Compliance with the Noise Control Ordinance and Subsidiary Regulations.
	CREDIT REQUIREMENT	1 credit for demonstrating the level of the intruding noise at the facade of the potential noise sensitive receivers is in compliance with the criteria recommended in the Hong Kong Planning Standards and Guidelines.
	ASSESSMENT	<p>On the basis of promoting good environmental design assessment shall assume that a noise sensitive development already exists or has the potential to exist and be affected by the building. Ideally, therefore, assessment should be made at the facade of the potential noise sensitive receivers.</p> <p>The noise assessments shall be conducted in accordance with the Technical Memorandum [1]. This lays down statutory Acceptable Noise Levels (ANL). However, in order to plan for a better environment, all fixed noise sources should be located and designed so that when assessed in accordance with the Technical Memorandum, the level of the intruding noise at the facade of the nearest sensitive receiver should be at least 5 dB(A) below the appropriate ANL shown in Table 3 of the Technical Memorandum or, in the case of the background being 5 dB(A) lower than the ANL, should not be higher than the background, in accordance with paragraph 4.2.13, Chapter 9 of the Hong Kong Planning Standards and Guidelines [2].</p> <p>The Client shall provide evidence in form of detailed analysis, appropriate calculations and/or measurements that the building complies with the assessment criteria.</p>
	BACKGROUND	<p>Noise emission from equipment on and around buildings contributes to noise pollution with potential impacts on neighbouring properties. Under the Noise Control Ordinance noise emanating from certain types of premises is controlled by means of Noise Abatement Notices which may be served on owners or occupiers of offending premises if the noise emitted:</p> <ul style="list-style-type: none">• does not comply with the ANLs as set out in a technical memorandum;• is a source of annoyance to any person other than persons on the premises; and• does not comply with any standard or limit contained in any current Regulations.

1 Environmental Protection Department. Technical Memorandum for the Assessment of Noise from Places Other than Domestic Premises, Public Places or Construction Sites.
http://www.epd.gov.hk/epd/english/environmentinhk/noise/guide_ref/files/tm_nondomestic.pdf

2 Hong Kong Planning Standards and Guidelines, Chapter 9 Environment
http://www.pland.gov.hk/pland_en/tech_doc/hkpsg/full/ch9/ch9_text.htm

In practice the Authority will respond to complaints and compliance with the ANLs will be required only after a Noise Abatement Notice has been served. Non-compliance with such a notice will be an offence. The Technical Memorandum [1] contains the technical procedures that should be adopted by the Authority when investigating a complaint regarding noise emanating from such premises to determine whether or not a noise abatement notice should be issued.

BS 4142 [3] suggests methods for noise prediction and a generalised description of prediction is given in ISO 9613-2 [4]. Good practices on building services system noise control are published by the Environmental Protection Department [5,6].

- 3 British Standards Institution. Method for rating industrial noise affecting mixed residential and industrial areas. British Standard BS 4142:1997. London, BSI, 1997.
- 4 International Standards Organisation. ISO 9613-2. Attenuation of Sound During Propagation Outdoors Part 2. General Method of Calculation 1st Ed. 1996.
- 5 Environmental Protection Department. Good practices on pumping system noise control. 2005.
http://www.epd.gov.hk/epd/english/environmentinhk/noise/guide_ref/files/Pump_sys_E-06.pdf
- 6 Environmental Protection Department. Good practices on ventilation system noise control. 2006.
http://www.epd.gov.hk/epd/english/environmentinhk/noise/guide_ref/files/Vent_sys_E-06.pdf

2	SITE ASPECTS	2.3	EMISSIONS FROM THE SITE
		SA 15	LIGHT POLLUTION
	EXCLUSIONS	None.	
	OBJECTIVE	Ensure that exterior lighting does not create unwanted and unnecessary light pollution.	
	CREDITS ATTAINABLE	1	
	PREREQUISITES	None.	
	CREDIT REQUIREMENT	1 credit for demonstrating that obtrusive light from exterior lighting meets the specified performance for the environmental zone in which the building development is located.	
	ASSESSMENT	<p>The Client shall provide evidence that the site and building lighting installations comply with the criteria given in the reference publications through submission of detailed measurements, calculations and/or modelling studies carried out by a suitably qualified person.</p> <p>Compliance is achieved when the designs are within the maximum figure for each parameter (sky glow, light into windows, source intensity, and building luminance), taken from Tables 2.1 to 2.6 in CIE 150 [1], Table 1 in CIBSE Factfile7 [2], or Table 1 in ILE Guidance Notes [3].</p>	
	BACKGROUND	Outdoor and public area lighting is necessary for illuminating public connections between premises, buildings and facilities to ensure the security and safety of users. Light pollution [4,5] may be regarded as waste light from lighting schemes that produces glare, obscures the night sky, adversely effects nocturnal ecosystems, and may intrude on neighbouring properties.	

- 1 International Commission on Illumination. Guide on the limitation of the effects of obtrusive light from outdoor lighting installations. Technical Report CIE 150:2003.
- 2 Chartered Institution of Building Services Engineers. Environmental Considerations for Exterior Lighting. Factfile No.7, 2003. <http://www.cibse.org/pdfs/fact72003.pdf>
- 3 The Institution of Lighting Engineers. Guidance notes for the reduction of obtrusive light . <http://www.britastro.org/dark-skies/pdfs/ile.pdf>
- 4 International Dark-sky Association. Information Resource. <http://www.darksky.org/resources/>
- 5 International Commission on Illumination. Guidelines for Minimising Sky Glow. Technical Report CIE 126: 1997.

The brightness of advertising signs is also a concern [6]. The following table is taken from CIBSE Factfile 7 [2] :

Obtrusive light limitations for exterior lighting installations

Environmental Zone	Sky Glow ULR (Max %)	Light into Windows Ev (Lux) (1)		Source Intensity I (kcd) (2)		Building Luminance Before curfew (3)
		Before curfew	After curfew	Before curfew	After curfew	Average L (cd/m ²)
E1	0	2	1(4)	2.5	0.5 (4)	0
E2	2.5	5	1	7.5	0.5	5
E3	5	10	2	10	1	10
E4	15	25	5	25	2.5	25

The definitions of the four zones are:

E1: Intrinsically dark areas: National Parks, Areas of Outstanding Natural Beauty, etc.

E2: Low district brightness areas: rural or small village locations.

E3: Medium district brightness areas: small town centres or urban locations.

E4: High district brightness areas: town/city centres with high levels of night-time activity.

ULR = Upward Light Ratio of the Installation and is the maximum permitted percentage of luminaire flux for the total installation that goes directly into the sky.

Ev = Vertical Illuminance in Lux normal to window glazing

I = Light Intensity in Kilo-Candelas

L = Luminance in Candelas per Square Metre

Notes:

(1) These values are suggested maximums for any window. So any new lighting will have to produce less than this value if there is any existing light trespass at a specific window.

(2) This is the intensity going beyond the area being lit from any single source in the potentially obtrusive direction. The figures given are for general guidance only and for some large sports lighting applications with limited mounting heights may be difficult to achieve.

(3) This should be limited to avoid over lighting, and relates to the general district brightness. In this reference building luminance is applicable to buildings directly illuminated as a night-time feature as against the illumination of a building caused by spill light from adjacent floodlights or floodlights fixed to the building but used to light an adjacent area although this should be kept to a minimum.

(4) Acceptable from public road lighting and other safety lighting installations only, zero for all other lighting types.

3 MATERIALS ASPECTS

- 3.P PREREQUISITE**
- 3.1 EFFICIENT USE OF MATERIALS**
- 3.2 SELECTION OF MATERIALS**
- 3.3 WASTE MANAGEMENT**

INTRODUCTION

The amount and range of materials used in the construction, operation and maintenance and fitting-out of buildings represents a significant use of natural resources, in terms of extracted raw materials, emissions, and embodied energy. There are opportunities to reduce environmental impacts through improved design, choice of materials, and installation methods. Of concern are:

- pollutants arising from manufacturing and transportation; and
- waste generated and recycled.

There are opportunities to reduce material use through modular designs allowing off-site prefabrication, lean construction methods, etc. Improved materials management and on-site sorting can achieve significant reductions in waste generation and reduce construction costs.

3.P PREREQUISITE

- MA P1 TIMBER USED FOR TEMPORARY WORKS**
- MA P2 USE OF NON-CFC BASED REFRIGERANTS**
- MA P3 CONSTRUCTION/DEMOLITION WASTE MANAGEMENT PLAN**
- MA P4 WASTE RECYCLE FACILITIES**

BACKGROUND

This part is to set out the minimum requirement for materials aspects in terms of non-virgin timber used for temporary works, use of non-CFC based refrigerants, implementation of construction/demolition waste management and provision of waste recycling facilities.

3.1 EFFICIENT USE OF MATERIALS

- MA 1 BUILDING REUSE**
- MA 2 MODULAR AND STANDARDISED DESIGN**
- MA 3 PREFABRICATION**
- MA 4 ADAPTABILITY AND DECONSTRUCTION**

BACKGROUND

Efficiency in the use of materials can be significantly improved through reuse of building elements, such as foundations, main structures, facades, etc. Flexibility in design allows for change in use and layout of the premises within a building development. High standards of design detailing permits off-site fabrication of major building components, allows for deconstruction, and improves durability and longevity of buildings.

3.2 SELECTION OF MATERIALS

- MA 5 RAPIDLY RENEWABLE MATERIALS**
- MA 6 SUSTAINABLE FOREST PRODUCTS**
- MA 7 RECYCLED MATERIALS**
- MA 8 OZONE DEPLETING SUBSTANCES**
- MA 9 REGIONALLY MANUFACTURED MATERIALS**

BACKGROUND

The selection of materials that can be planted and harvested within a relatively short time, that are otherwise sustainable, have significant recycled content, or otherwise have relatively low environmental impacts should be considered at the earliest stages of planning and design of building developments, and carried over to fit-out and subsequent redecoration.

3.3 WASTE MANAGEMENT

MA 10 DEMOLITION WASTE REDUCTION

MA 11 CONSTRUCTION WASTE REDUCTION

BACKGROUND

Construction waste includes waste arising from such activities as construction, renovation, demolition, land excavation and road works. Ideally, the waste is separated and inert material is used as fill in reclamation sites, when available. However, a significant portion of the waste still goes to landfills. The continued growth in waste loads means Hong Kong is running out of landfill spaces far earlier than expected, and the existing landfills will be filled up, one by one, if waste levels continued to increase at current levels. Unless solutions are identified immediately, we could face a crisis in the next decade of having nowhere to put the thousands of tonnes of waste thrown away every day.

3	MATERIALS ASPECTS	3.P PREREQUISITE
		MA P1 TIMBER USED FOR TEMPORARY WORKS
	EXCLUSIONS	None.
	OBJECTIVE	Encourage the well-managed use of timber.
	REQUIREMENT	Virgin forest products are not used for temporary works during construction.
	ASSESSMENT	<p>The Client shall provide documentation and photographic evidence demonstrating that no virgin forest products were being used for temporary works, unless exceptional circumstances required such use, in form of a report prepared by a suitably qualified person. The report should highlight how contract documents and specifications precluded such use in formwork, hoardings, walkways, etc., together with evidence such as site photos and records to demonstrate that no new timber or timber products were used. Wood products from well-managed or sustainable sources are acceptable for this credit requirement. Sustainable timber shall be certified by Forest Stewardship Council (FSC)[1], the American Forest and Paper Association (AFPA)[2], or “Known Licensed Sources” [3].</p> <p>The Client’s representative on site shall be responsible for monitoring and reporting on construction activities, and shall confirm in writing that the works were conducted in accordance with the specifications and contract documents, and that all details regarding the use of timber contained in the report are accurate.</p> <p>Where it is demonstrated that all practical steps have been taken to avoid the use of virgin forest products, the credit shall be awarded.</p>
	BACKGROUND	<p>Timber is the most ecologically benign of construction materials. However, there are hardwoods which are being extracted from virgin forests in an unsustainable manner, destroying valuable forests and ecosystems. Similarly, some softwoods, such as redwood and cedar are being depleted. Where forests are being harvested in an unsustainable manner, the result is the extinction of indigenous species and the clearance of vegetation that would otherwise help regulating the amount of CO₂ in the atmosphere. Improved forestry practices can be encouraged by seeking timber from sources where the forests are well-managed.</p> <p>Hong Kong uses only imported timber and is one of the largest importers of tropical hardwoods. The construction sector in Hong Kong is a major consumer of hardwoods from tropical rainforests, with a large proportion used wastefully, and ending up at landfill sites. Timber should originate only from well-managed sources and should be reused whenever possible. Guidelines, templates and implementation measures are to assist organisations to develop purchasing policies and practices that help conserving forest resources are available [4]. PNAP No. ADV-5 [5] gives guidance for alternatives to the use of hardwoods in order to reduce the amount of tropical hardwood timber being used in constructions.</p>

- 1 Forest Stewardship Council. <http://www.fsc.org/>
- 2 American Forest and Paper Association. <http://www.afandpa.org/>
- 3 Architectural Services Department, General Specifications for Building 2007, Section 13, Carpentry and Joinery, 13.01.03.
- 4 World Wildlife Fund. http://www.wwf.org.uk/wwf_articles.cfm?unewsid=296
- 5 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineer. PNAP No. ADV-5 Tropical Hardwood Timber. <http://www.bd.gov.hk/english/documents/pnap/ADV/ADV005.pdf>

Works Bureau Technical Circular (WBTC) 19/2001 [6] establishes the revised policy requiring the use of metallic site hoardings and signboards, in order to reduce the amount of timber used on construction sites. This Circular supersedes WBTC 19/99 and shall be read in conjunction with WBTC 32/92 [7], the purpose of which is to reduce the amount of hardwood timber used on construction sites.

Certified Wood are wood-based materials originally sourced from forestlands participating in an acceptable system or program which certifies sustainable forest management. Acceptable systems or programs must include adherence to management practices which conserve biological diversity and maintain productive capacity of forest ecosystems, and be independently audited and monitored.

- 6 Works Bureau. Technical Circular No. 19/2001. Metallic Site Hoardings and Signboards.
<http://www.devb.gov.hk/filemanager/technicalcirculars/en/upload/153/1/wb1901.pdf>
- 7 Works Bureau. Technical Circular No. 32/92. The Use of Tropical Hardwood on Construction Sites.
http://www.devb.gov.hk/filemanager/en/content_673/WB3292.pdf

3 MATERIALS ASPECTS 3.P PREREQUISITE

MA P2 USE OF NON-CFC BASED REFRIGERANTS

EXCLUSIONS	None.
OBJECTIVE	Reduce the release of chlorofluorocarbon into the atmosphere.
REQUIREMENT	Using non-chlorofluorocarbon (CFC)-based refrigerants in HVAC&R systems.
ASSESSMENT	The Client shall submit a report by a suitably qualified person giving details of the HVAC&R system installed and demonstrating that no chlorofluorocarbon (CFC)-based refrigerants are being used in the HVAC&R systems.
BACKGROUND	<p>Chlorofluorocarbons (CFCs) are the major contributory substances of serious ozone depletion. The reaction between a CFC and an ozone molecule in the earth's stratosphere contributes to catalytic destruction of ozone. Due to ozone depletion, increased UV exposure leads to increases in skin cancer (e.g. Malignant Melanoma and Cortical Cataracts), damage to plants, and reduction of plankton population in the ocean's photic zone.</p> <p>In 1985, the Antarctic ozone hole was discovered, causing worldwide concern. In 1987, representatives from 43 nations signed the Montreal Protocol to limit CFC usage. At Montreal, the participants agreed to freeze production and phase-out use of CFCs. Since the adoption and strengthening of the Montreal Protocol, the usage and emissions of CFCs has reduced.</p> <p>The U.S. Environmental Protection Agency (U.S.EPA) has developed and implemented regulations for management of ozone depletion substances (ODSs) in the United States. The regulations include programs that ended the production of ODSs and require the manufacturers to label products either containing or made with chemicals that have significant ODSs.</p> <p>In Hong Kong, the Ozone Layer Protection Ordinance (Cap. 403) 1989 [1] gives effect to Hong Kong's international obligations to control the manufacture, import and export of ozone depleting substances. Ozone Layer Protection (Controlled Refrigerants) Regulation 1994 [2] requires the conservation of controlled refrigerants used in large scale installations and motor vehicles. Ozone Layer Protection (Products Containing Scheduled Substances) (Import Banning) Regulation 1993 prohibits the import of portable fire extinguishers containing halons and other controlled products from a country or place which is not a party to the Montreal Protocol, unless the Authority considers that it complies with the requirements of the Protocol.</p> <p>Banning the usage of CFCs in refrigerants slows the ozone depletion and global climate change. Non-CFC building equipment has standard specification. New non-CFC HVAC&R equipment is cost and energy effective. Selecting non-CFC HVAC&R equipment may increase energy saving and equipment efficiencies.</p>

1 Environmental Protection Department. A Concise Guide to the Ozone Layer Protection Ordinance. http://www.epd.gov.hk/epd/english/laws_regulations/comp_guides/files/cgto_olpo_eng.pdf

2 Environmental Protection Department. A Concise Guide to the Ozone Layer Protection (Controlled Refrigerants) Regulation. http://www.epd.gov.hk/epd/english/laws_regulations/comp_guides/files/cgt_olp_cr_eng.pdf

3	MATERIALS ASPECTS	3.P PREREQUISITE
		MA P3 CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT PLAN
	EXCLUSIONS	Where demolition is not necessary or is not under the Client's control, the submission of a Demolition Waste Management Plan is not required.
	OBJECTIVE	Encourage best practices in the management of construction and demolition wastes, including sorting, recycling and disposal of construction waste.
	REQUIREMENT	Implementation with proof of documentation of a waste management system that provides for the sorting, recycling and proper disposal of construction/demolition materials.
	ASSESSMENT	<p>The Client shall present evidence that the carrying out of the construction/demolition works complied with all the requirements specified in the form of a report by a suitably qualified person.</p> <p>a) Waste Management</p> <p>The Client shall submit tender documents, contract conditions and specifications to demonstrate that the contractor was required and able to prepare and implement a waste management system essentially in accordance with the guidelines provided in Environment, Transport and Works Bureau (ETWB) Technical Circular 19/2005 [1].</p> <p>It shall be demonstrated that the waste management system covers the items listed in the Buildings Department's PNAP 243 [2] and that all materials arising from or in connection with the works were separated into inert and non-inert materials, and disposed of in accordance with the WBTC No. 31/2004 [3], as they apply to the nature of the development work.</p> <p>b) Sorting and recycling of waste</p> <p>The following will guide the assessment:</p> <ul style="list-style-type: none">• how metals, including reinforcement bars, mechanical and electrical fittings, other building services fittings/materials are recovered for collection by recycling contractors; and• how waste from construction/demolition works is sorted to recover broken concrete and other inert non-metallic materials. <p>It shall be demonstrated through appropriate record keeping that sorting for the items of construction waste items specified in ETWB Technical Circular 19/2005 has been carried out.</p>
	BACKGROUND	<p>To ensure public safety, the control of demolition works has been strengthened with the enactment of the Buildings (Amendment) Ordinance 1996, Building (Administration) (Amendment) (No.4) Regulation 1997 and Building (Demolition Works) (Amendment) Regulation 1997, which impose new requirements for:</p> <ul style="list-style-type: none">• application for approval of plans for demolition works;• application for consent to commence the works;

1 Environment, Transport and Works Bureau Technical Circular (Works) No. 19/2005, Environmental Management on Construction Sites. <http://www.devb.gov.hk/filemanager/technicalcirculars/en/upload/19/1/C-2005-19-0-1.pdf>

2 Buildings Department. Practice Note for Authorized Persons and Registered Structural Engineers 243. Construction and Demolition Waste. June 2000. <http://www.bd.gov.hk/english/documents/pnap/ADV/ADV019.pdf>

3 Environment, Transport and Works Bureau Technical Circular 31/2004. Trip-ticket System for Disposal of Construction and Demolition Material. December 2004. <http://www.devb.gov.hk/filemanager/technicalcirculars/en/upload/44/1/c-2004-31-0-1.pdf>

- site safety supervision;
- appointment of Technically Competent Person to supervise demolition works and operator of powered mechanical plant or equipment; and
- certification of completion of works.

PNAP 71 [4] sets out the procedures to be followed by Authorised Persons (AP) and Registered Structural Engineers (RSE) in meeting these requirements. Some points for practical application are also clarified.

Chemical wastes are liquid, semi-solid and solid wastes which are hazardous in nature or constitute a risk of pollution to the environment. Chemical waste is defined by reference to a list of chemicals which forms Schedule 1 of the Waste Disposal (Chemical Waste) (General) Regulation. The Regulation provides for the definition of chemical waste, the registration of persons producing chemical waste and the control of the possession, storage, collection, transport and disposal of chemical waste.

In 2006, the Government introduced the construction waste disposal charging scheme and the quantity of construction waste disposed of at landfills decreased from 6,560 tonnes per day in 2005 to 2,910 tonnes per day in 2007. This figure fluctuates depending on the economics situation and the number of construction projects underway.

In May 2003, ETWB issued technical circular No.15/2003 requiring contractors to prepare and implement a Waste Management Plan (WMP) for all capital works projects tendered on or after 1 July 2003. Dedicated payment is allocated under the contract for preparation and implementation. This sets out the procedures for preparation and implementation of an enhanced WMP to encourage on-site sorting of Construction and Demolition (C&D) materials and to minimise their generation during the course of construction. The requirements apply to capital works contracts, including electrical and mechanical (E&M) contracts and Design and Build (D&B) contracts but excluding term contracts. C&D material means both inert and non-inert C&D materials.

Inert construction waste means waste that does not undergo any significant physical, chemical or biological transformations. It will not dissolve, burn or otherwise physically or chemically react, biodegrade or adversely affect other matter with which it comes into contact in a way likely to give rise to environmental pollution or harm human health. The total leachability and pollutant content of the waste and the ecotoxicity of the leachate must be insignificant, and in particular not endanger the quality of surface water and/or groundwater. Soil, sand/aggregate, bricks, concrete, cement and plaster are regarded as inert, whereas general debris, plastics, paper, Styrofoam, timber, etc., are not.

On-site sorting of surplus construction and demolition (C&D) material is desirable so that inert material can be disposed of at public filling areas, and the remainder at landfills. Dumping Licenses require that material to be disposed of at public filling areas must comprise only earth, building debris, broken rock and concrete. Such materials shall be free from marine mud, household refuse, plastic, metal, industrial and chemical waste, animal and vegetable matter etc. The materials which are considered unsuitable for disposal at public filling areas should go to a landfill.

4 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers. PNAP No. APP-21 Demolition Works Measures for Public Safety. <http://www.bd.gov.hk/english/documents/pnap/APP/APP021.pdf>

3	MATERIALS ASPECTS	3.P PREREQUISITE
		MA P4 WASTE RECYCLING FACILITIES
	EXCLUSIONS	One single family domestic building with not more than 3 floors or domestic part of a composite building for one single family with not more than 3 floors.
	OBJECTIVE	Reduce pressure on landfill sites and help to preserve non-renewable resources by promoting recycling of waster materials.
	REQUIREMENT	Provision of facilities for the collection, sorting, storage and disposal of waste and recovered materials.
	ASSESSMENT	<p>The assessment seeks to establish the extent to which facilities are provided to allow for the recycling of waste. The means to facilitate waste recycling is not prescribed as much depends on the design and type of building, and the activities carried out within it.</p> <p>The Client shall submit documentation and photographic evidence in the form of a report detailing the expected waste streams and estimated quantities for the building (organic, recyclable and non-recyclable), and demonstrate the adequacy of the waste storage, sorting and recycling facilities, appropriate to the type and size of the development, that will encourage and facilitate waste recycling. Separate storage of recycled materials such as metal, plastics, paper, cardboard and glass bottles should be provided.</p> <p>The assessment shall take into account how a system of waste collection, storage sorting, recycling and disposal can be managed for the buildings, with consideration given to the adequacy of space provisions on individual floors, within the building as a whole, and at local/estate level. Opportunity should exist to manage different waste types, such as organic, non-recyclable and recyclable waste. There should be easy access to facilities for cleaning staff/contractors and/or building users, and for waste recycling and collection companies. The storage area shall be adequately sized to allow for recycling of, as a minimum, paper, glass, plastics, metals and organic materials.</p>
	BACKGROUND	<p>Well-managed facilities for the recycling of solid waste encourage recycling and result in reductions in the disposal at landfill sites. Buildings should be designed with the provision of facilities for waste separation and sorting, and short term storage at appropriate locations.</p> <p>PNAP 98 [1] provides details of the basic refuse storage and recovery chambers expected in new buildings.</p> <p>Reference should be made to IEQ - Section 6.2 of this document with regard to the hygiene aspects of waste disposal.</p> <p>For a domestic building or composite building on a site of an area of not more than 250 m², the provision of a refuse storage and material recovery room on every floor of a domestic building shall be exempted in BEAM Plus Assessment.</p> <p>As an indication the space requirements for commercial building, industrial building and a building constructed or adapted for use principally as a church, a school, a carpark or similar buildings, are 2 m² per 1,000 m² of usable floor space.</p>

1 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineer. PNAP No. APP-35
<http://www.bd.gov.hk/english/documents/pnap/APP/APP035.pdf>

3	MATERIALS ASPECTS	3.1 EFFICIENT USE OF MATERIALS
		MA 1 BUILDING REUSE
	EXCLUSIONS	Buildings on reclaimed land or greenfield sites.
	OBJECTIVE	Encourage the reuse of major elements of existing buildings, to reduce demolition waste, conserve resources and reduce environmental impacts during construction.
	CREDITS ATTAINABLE	2 + 1 BONUS
	PREREQUISITES	The reuse of major elements from an existing building structure or shell shall comply with Building (Construction) Regulations Chapter 123B Regulation 90 Fire resisting construction and other relevant Building regulations.
	CREDIT REQUIREMENT	1 credit for the reuse of 30% or more of existing sub-structure or shell. 2 credits for the reuse of 60% or more of existing sub-structure or shell. 1 additional BONUS credit for use of 90% or more of existing sub-structure or shell.
	ASSESSMENT	<p>The Client shall provide a report prepared by a suitably qualified person outlining the extent to which major building elements from an existing building were used in the building. The report shall include pre-construction and post-construction details highlighting and quantifying the reused elements, be it foundations, structural elements or facades, but windows, doors and similar assemblies may be excluded.</p> <p>The percentage of building elements shall be calculated as the amount (volume or weight) of building elements reused as a percentage of the total amount (volume or weight) of that building elements in the new development.</p> <p>When it can be demonstrated that the target percentage of original building elements are reused, the credit(s) shall be awarded.</p>
	BACKGROUND	With greater flexibility in planning, approvals opportunities exist to rehabilitate existing buildings. The rehabilitation of old industrial buildings is as an example of successful commercial redevelopment in many cities around the world. There is a potential to lower building costs and provide a mix of desirable building characteristics. However, the reuse of existing structural elements depends on many factors, not least fire safety, energy efficiency, and regulatory requirements, all of which need to be critically reviewed to determine the advantages and feasibility of reuse as opposed to demolition.

3	MATERIALS ASPECTS	3.1 EFFICIENT USE OF MATERIALS								
		MA 2 MODULAR AND STANDARDISED DESIGN								
	EXCLUSIONS	None.								
	OBJECTIVE	Encourage increased use of modular and standardised components in building design in order to enhance buildability and to reduce waste.								
	PREREQUISITES	Compliance with the Building (Construction) Regulations.								
	CREDITS ATTAINABLE	1								
	CREDIT REQUIREMENT	1 credit for demonstrating the application of modular and standardised design.								
	ASSESSMENT	<p>The Client shall submit a report, including detailed drawings and specifications, that demonstrates and highlights the extent of application of modular design of building systems and components. Where it can be demonstrated that the building development incorporates modular and standardised layouts and components for over 50% of the major elements and modules, the credit shall be awarded.</p> <p>For the purposes of assessment, the extent of modular and standardised design shall make reference to the checklist provided herein. Additional or alternative examples may be submitted at the discretion of the Client.</p>								
	CHECKLIST	<table border="0" style="width: 100%;"> <tr> <td style="width: 50%; vertical-align: top;">Structural elements</td> <td style="width: 50%; vertical-align: top;">Structural beams system Concrete slab Concrete flooring</td> </tr> <tr> <td style="vertical-align: top;">Facade elements</td> <td style="vertical-align: top;">External wall Bay-window unit Cladding unit Utility platform</td> </tr> <tr> <td style="vertical-align: top;">Architectural/Internal building elements</td> <td style="vertical-align: top;">Internal partition/wall panels Door sets Staircases</td> </tr> <tr> <td style="vertical-align: top;">Building services elements</td> <td style="vertical-align: top;">Fire services Sanitary fittings Luminaires Air-Conditioning components</td> </tr> </table>	Structural elements	Structural beams system Concrete slab Concrete flooring	Facade elements	External wall Bay-window unit Cladding unit Utility platform	Architectural/Internal building elements	Internal partition/wall panels Door sets Staircases	Building services elements	Fire services Sanitary fittings Luminaires Air-Conditioning components
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Architectural/Internal building elements	Internal partition/wall panels Door sets Staircases									
Building services elements	Fire services Sanitary fittings Luminaires Air-Conditioning components									
	BACKGROUND	This refers to the use of standardised grid systems of design allowing standard size factory built and assembled components to be used. Standardisation of details goes hand in hand with optimisation of material quantity. It also generally has benefits for both quality and environmental cost. It simplifies the design and site operations. Building components produced in standard ranges of sizes can also be interchanged. Materials should be dimensioned carefully to use standard-sized								

modules to the greatest extent to minimise construction off-cutting waste.

International standards [1,2] recommend that modular components shall be designed to have size of a multiple or subdivision of the basic module of 100mm. BS 6750 [3] provides background on the requirements for modular coordination.

Environment, Transport, and Works Bureau offers a one-stop service [4] to help accessing and locating standardised components and modular components that have been successfully used in construction, and finding out the standardised practices, including standard designs, construction methods, and techniques adopted in the construction industry. This contains a standardisation database of hyperlinks which promotes the wider use of standardised and modular components in local construction, with the public sector taking the lead.

- 1 International Standard Organization. ISO 1006 Building construction – Modular coordination – Basic module. 1983.
- 2 International Standard Organization. ISO 2848 Building Construction – Modular coordination – Principles and rules. 1984.
- 3 British Standards Institution. British Standard BS 6750. Specification for Modular coordination in building. 1986.
- 4 Environment, Transport, and Works Bureau. Standardised Components and Practices.
http://www.devb.gov.hk/en/publications_and_press_releases/publications/standardised_components_and_practices/index.html

3	MATERIALS ASPECTS	3.1 EFFICIENT USE OF MATERIALS
		MA 3 PREFABRICATION
	EXCLUSIONS	None.
	OBJECTIVE	Encourage prefabrication building elements in order to reduce wastage of materials and quantities of on-site waste.
	CREDITS ATTAINABLE	2
	PREREQUISITE	None.
	CREDIT REQUIREMENT	1 credit when the manufacture of 20% of listed prefabricated building elements has been off-site. 2 credits where the manufacture of 40% of listed prefabricated building elements has been off-site.
	ASSESSMENT	<p>The listed building elements (pre-cast concrete) includes:</p> <ul style="list-style-type: none">• facades;• staircases;• slabs;• balcony/utility platform;• parapet;• partition walls;• bridge-decks; and• footbridges. <p>Additional or alternative elements may be included, which the Client believes to demonstrate a significant contribution to the assessment criteria. However, the curtain wall/windows shall be excluded from the assessment.</p> <p>In order to avoid long-distant transportation, the manufacturing factory shall be located within 800 km of the site. The Client shall demonstrate through the submission of contract specifications, drawings and other supporting documents that the quantities (by weight or volume) of those building elements fabricated off-site are in accordance with the Code of Practice for Pre-cast Construction 2003. The assessment shall take into account the number and quantities of building elements in the building development that was fabricated off-site and credits will be awarded where the assessment criteria have been met.</p>
	BACKGROUND	<p>Prefabrication is the manufacture of sections of a building at the factory so they can be easily and rapidly assembled at the building site, improving the buildability of the building. Since the factory fabrication of building elements is conducted under controlled conditions, it allows for more efficient disposal of debris and waste. Noise, dust, site traffic and other environmental nuisances can also be reduced. Interior millwork and custom metalwork should be detailed to be shop-finished and installed to the highest degree to limit the need for on-site painting and finishing work.</p> <p>The Hong Kong construction industry is continuously under pressure to raise productivity, reduce costs and improve the quality levels of constructed facilities. All these requirements are the key drivers for</p>

change in the industry [1]. A new research agenda has therefore been embarked by the Construction Industry Institute, Hong Kong (CII-HK) to explore the existing state of implementation of prefabrication and preassembly, and how they could be successfully applied to construction services. This paper provides a succinct review of the application of prefabrication and preassembly in the local public housing construction industry, followed by the significant ingredients of the captioned research agenda. A wider use of prefabrication would help overcome many of the hurdles inherent in traditional in-situ construction, and engender more technically feasible and cost-effective installations.

Prefabricated components are widely used in the construction of public housing blocks [2] for better workmanship and quality control and to maximise construction efficiency. Refer to the footnote [2] for the application of prefabrication in New Harmony 1 block, a standard block of today's public rental housing. The Code of Practice [3] provides guidance on the design, construction and quality control of precast structural and non-structural elements.

- 1 Yeung N S Y, Chan A P C, Chan D W M. Application of Prefabrication in Construction – A New Research Agenda for Reform by CII-HK.
- 2 Housing Department. Prefabrication in Housing Blocks.
<http://www.housingauthority.gov.hk/en/business-partnerships/resources/prefabrication-in-housing-blocks/>
- 3 Buildings Department. Code of Practice for Pre-cast Concrete Construction.
<http://www.info.gov.hk/bd/english/documents/code/cppcc2003.pdf>

3	MATERIALS ASPECTS	3.1 EFFICIENT USE OF MATERIALS
		MA 4 ADAPTABILITY AND DECONSTRUCTION
	EXCLUSIONS	None.
	OBJECTIVE	Encourage the design of building interior elements and building services components that allow modifications to space layout, and to reduce waste during churning, refurbishment and deconstruction.
	CREDITS ATTAINABLE	3
	PREREQUISITES	None.
	CREDIT REQUIREMENT	<p>a) Spatial adaptability</p> <p>1 credit for designs providing spatial flexibility that can adapt spaces for different uses, and allows for expansion to permit additional spatial requirements to be accommodated.</p> <p>b) Flexible engineering services</p> <p>1 credit for flexible design of services that can adapt to changes of layout and use.</p> <p>c) Structural adaptability</p> <p>1 credit for designs providing flexibility through the use of building structural systems that allow for change in future use, and which is coordinated with interior planning modules.</p>
	ASSESSMENT	<p>The Client shall provide a report prepared by a suitably qualified person presenting evidence as to how and the extent to which building adaptability and deconstruction is provided. The report shall include drawings and documents including building plans and detailed specifications together with elaboration and justification of specific design strategies that provide for the intended outcome.</p> <p>Assessment will be guided by the checklists included herein. Additions to the list may be proposed at the discretion of the Client.</p> <p>Where it can be demonstrated that applicable good practices in respect of structural and/or spatial flexibility, and/or flexibility in servicing have been adopted whenever feasible and at least 50% for residential development and 70% for other building types of the listed items in the relevant BEAM checklists could be achieved, the credit(s) shall be awarded.</p>
	SPATIAL ADAPTABILITY CHECKLIST	<p>ASTM provides guidance for various types of buildings and uses [e.g. 1, 2,3].</p> <ul style="list-style-type: none"> • use of adaptable floor plans, including large grids that can be subdivided, etc. • spaces designed for a loose fit rather than tight fit; • inclusion of multifunctional spaces; • design that allows interior fitting-out to use modular and pre-fabricated components; • spaces designed such that minimum disruption will be caused to

1 ASTM International. Designation E1692-95a Standard Classification for Serviceability of an Office for Change and Churn by Occupants.

2 ASTM International. Designation E1679-95 Standard Practice for Setting the Requirements for the Serviceability of a Building or Building-Related Facility.

3 ASTM International. Designation E1334-95 Standard Practice for Rating the Serviceability of a Building or Building-Related Facility.

occupants due to physical change;

- easy relocation of partition walls that causes minimum damage to flooring or ceiling systems;
- partition walls are fully salvageable;
- separating long-lived components from short-lived components to reduce the complexity of deconstruction and churning so as to facilitate the collection process for recycling; and
- use of interior partitions that are demountable, reusable and recyclable, etc.

FLEXIBLE ENGINEERING SERVICES CHECKLIST

- design that allows interior fitting-out to use modular and pre-fabricated components;
- using hybrid HVAC systems, with a balance between centralised components and distributed components;
- luminaires are easily relocated within ceiling grid or uplighters are used;
- air diffusers on flexible ducts can be relocated at minimum cost with minimum disruption to occupants;
- exhaust air ducts for special exhausts are easy to install, and space and capacity are available in ceiling and duct shafts;
- sprinkler heads are easily relocated within ceiling grid;
- pre-wired horizontal distribution systems in ceilings or floors, with spare capacity and easy access to accommodate change of workplace layouts; and
- reducing the use of embedded infrastructure for power, data and HVAC systems, etc.

STRUCTURAL ADAPTABILITY CHECKLIST

Reference may be made to various publications [e.g. 4]. Key points include:

- foundations allow for potential vertical expansion of the building;
- installation of isolation joints or other features avoid the potential for differential settlements and for progressive collapse due to accidental loading;
- reliance on a central core for lateral load resistance that allows for local modifications to the structure while maintaining complete structural integrity;
- wide structural grids;
- lower floors allow for heavier live load;
- sufficient height to lower floors to enable a range of uses;
- building envelope is independent of the structure (i.e., functionally discrete systems, with the interfaces designed for separation);
- versatile envelope capable of accommodating changes to the interior space plan;
- means of access to the exterior wall system from inside the building and from outside;
- structural floor system that accommodates a number of mechanical and electrical service distribution schemes based on

4 Assessing the Adaptability of Buildings. International Energy Agency. Annex 31. Energy-Related Environmental Impact of Buildings. November 2001.
<http://annex31.wiwi.uni-karlsruhe.de/Annex%2031%20Assessing%20the%20Adaptability%20of%20Buildings.doc>

different occupancies; and

- provision of more than the minimum spatial areas and floor heights, etc.

BACKGROUND

Change of ownership, changing use of premises, changing demography of family units, future growth and expansion etc., require modifications to the layout of most types of premises. Large amounts of solid waste can be generated during the remodelling of premises, such as demolition of walls and partitions. Designs that allow users flexibility in the layout of premises and designs that allow for dismantling during deconstruction can significantly reduce consumption of resources and generation of waste.

Adaptability refers to the capacity of buildings to accommodate substantial changes. The concept of adaptability can be broken down into a number of simple strategies that are familiar to most designers:

- flexibility, or enabling minor shifts in space planning;
- convertibility, or allowing for changes in use within the building; and
- facilitating additions to the quantity of space in a building.

Designs for adaptability can also increase the longevity of buildings, improve operating performance, and allow more efficient use of space, yielding economic benefits. The key design principles include independence of systems within a building, upgradeability of systems and components, and lifetime compatibility of building components. Examples include:

- foundations that allow for potential vertical expansion of the building;
- superstructures that rely on a central core for lateral load resistance to allow local modifications to the structure without affecting the building's structural integrity;
- reducing the use of embedded infrastructure for power, data and HVAC systems;
- the use of building systems that isolate structural and building enclosure systems used for housing building services components;
- the provision of lightweight partitions that can be moved to change layout;
- design that allows interior fitting-out to use modular and pre-fabricated components; and
- separating long-lived components from short-lived components to reduce the complexity of deconstruction and churning so as to facilitate the collection process for recycling; etc.

Deconstruction is the process of selectively and systematically disassembling buildings that would otherwise be demolished to generate a supply of materials suitable for reuse in the construction or rehabilitation of other structures. Designing for deconstruction facilitates the salvage of recyclable materials during disassembly. The benefits include the reduction of pollution impacts, saving landfill space, and increase in resource and economic efficiency.

3	MATERIALS ASPECTS	3.2 SELECTION OF MATERIALS
		MA 5 RAPIDLY RENEWABLE MATERIALS
	EXCLUSIONS	None.
	OBJECTIVE	Encourage the wider use of rapidly renewable materials in appropriate applications.
	CREDITS ATTAINABLE	2
	PREREQUISITES	Compliance with the Building (Construction) Regulations.
	CREDIT REQUIREMENT	1 credit for demonstrating 2.5% of all building materials/products used in the project are rapidly renewable materials. 2 credits where 5% of all building materials/products used in the project are rapidly renewable materials.
	ASSESSMENT	<p>The Client shall submit a report prepared by a suitably qualified person listing applications where rapidly renewable materials have been employed, and quantifying the amount of materials employed, as a percentage of all building materials. The unit may be mass/volume/dollar value but shall be consistent throughout the assessment of this credit. The report shall include supporting documentation from suppliers listing the rapidly renewable materials and quantities contained in the products used.</p> <p>With the provision of calculations demonstrating the target percentage of all building materials/products used is rapidly renewable, the credit(s) shall be awarded.</p> <p>For the purposes of assessment, reference will be made to the checklist given below.</p>
	CHECKLIST	<p>No material specified shall present a fire hazard when installed.</p> <p>FLOORING</p> <p>Bamboo Natural Linoleum Cork Other rapidly renewable materials</p> <p>PANELS/PARTITIONS</p> <p>Sunflower Seed Bamboo Wheatboard Other rapidly renewable materials</p> <p>CABINETRY/FITTINGS</p> <p>Wheatboard Strawboard Soy bean composite Bamboo Other rapidly renewable materials</p> <p>INSULATION</p> <p>Cotton Strawbale Soy-based foam Other rapidly renewable materials</p> <p>OTHER APPLICATIONS (MATERIAL)</p>

BACKGROUND

Most building materials necessitate the consumption of large amounts of natural resources. Rapidly renewable materials are materials that substantially replenish themselves faster than traditional extraction demands (i.e., planted and harvested in less than a 10 year cycle) and do not result in significant biodiversity loss, increased erosion, or air quality impacts. Rapidly renewable materials include, but are not limited to, bamboo, linoleum, cork, fast-growing poplar, pine and products such as wheat straw cabinetry. Materials such as bamboo, wool, natural linoleum, etc. require fewer inputs, have reduced environmental impacts, and can provide economic benefits.

Designers should establish objectives for the use of rapidly renewable materials and identify where such materials can be applied as substitutes for more commonly used resource intensive materials. The use of materials such as bamboo flooring, strawboard, cotton insulation, natural linoleum flooring, etc. should be considered as a minimum.

3	MATERIALS ASPECTS	3.2	SELECTION OF MATERIALS
		MA 6	SUSTAINABLE FOREST PRODUCTS
	EXCLUSIONS		None.
	OBJECTIVE		Encourage the use of timber from well-managed forests.
	CREDITS ATTAINABLE		1
	PREREQUISITES		None.
	CREDIT REQUIREMENT		1 credit for demonstrating at least 50% of all timber and composite timber products used in the project are from sustainable sources/recycled timber.
	ASSESSMENT		<p>The Client shall provide a report prepared by a suitably qualified person quantifying the amount of forest products used that are from sustainable source/recycled timber, as a percentage of all timber products used. The unit may be mass/volume/dollar value but shall be consistent throughout the assessment of this credit.</p> <p>The timber should conform to the requirement of sustainable forestry practice guidelines and accredited by recognised organisations, such as the non-profit Forest Stewardship Council (FSC) [1] or the American Forest and Paper Association (AFPA) [2] or “known licensed sources” [3]. The Client shall also demonstrate compliance with the specification for the recommended sustainable source (e.g. FSC or AFPA)</p>
	BACKGROUND		<p>Timber is the most ecologically benign construction material. However, there are hardwoods which are being extracted from virgin forests in an unsustainable manner, destroying valuable forests and ecosystems. Similarly, some softwoods, such as redwood and cedar, are being depleted. Where forests are being harvested in an unsustainable manner, the result is the extinction of indigenous species and the clearance of vegetation that would otherwise help regulate the amount of CO₂ in the atmosphere. Improved forestry practices can be encouraged by seeking timber from sources where the forests are well managed.</p> <p>Hong Kong uses only imported timber and is one of the largest importers of tropical hardwoods. The construction sector in Hong Kong is a major consumer of hardwoods from tropical rainforests, with a large proportion used wastefully and ending up at landfill sites. Timber should originate only from well-managed sources and should be reused whenever possible. Guidelines, templates and implementation measures to help organisations develop purchasing policies and practices that help conserve forest resources are available [4]. PNAP No. ADV-5 [5] gives guidance for alternatives to the use of hardwoods in order to reduce the amount of tropical hardwood timber used in building projects.</p> <p>A Works Bureau Technical Circular (WBTC) [6] establishes the revised policy requiring the use of metallic site hoardings and signboards in</p>

- 1 Forest Stewardship Council. <http://www.fsc.org/>
- 2 American Forest and Paper Association. <http://www.afandpa.org/>
- 3 Architectural Services Department, General Specifications for Building 2007, Section 13, Carpentry and Joinery, 13.01.03.
- 4 World Wildlife Fund. http://www.wwf.org.uk/wwf_articles.cfm?unewsid=2968
- 5 Buildings Department, Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers PNAP No. ADV-5 153, Tropical Hardwood Timber. <http://www.bd.gov.hk/english/documents/pnap/ADV/ADV005.pdf>
- 6 Works Bureau. Technical Circular No. 19/2001. Metallic Site Hoardings and Signboards.

order to reduce the amount of timber used on construction sites. This Circular supersedes WBTC 19/99 and shall be read in conjunction with WBTC 32/92 [7], the purpose of which is to reduce the amount of hardwood timber used on construction sites.

Certified Wood may be defined a wood-based materials originally sourced from forestlands participating in an acceptable system or program which certifies sustainable forest management. Acceptable systems or programs must include adherence to management practices which conserve biological diversity and maintain productive capacity of forest ecosystems, and be independently audited and monitored.

Forest Stewardship Council [1] is an independent, non-profit organisation established to promote the responsible management of the world's forest. FSC is a certification system that provides internationally recognised standard-setting, trademark assurance and accreditation services to companies, organisations, and communities interested in responsible forestry.

American Forest and Paper Association [2] believes that competition among forest certification systems drives continuous improvement in the systems and reduce costs for users. It supports forest certification as a means of assuring that wood used in products comes from sustainably managed forests and that economic, environmental, and social performance factors have been considered.

7 <http://www.devb.gov.hk/filemanager/technicalcirculars/en/upload/153/1/wb1901.pdf>
Works Bureau. Technical Circular No. 32/92. The Use of Tropical Hardwood on Construction Sites.
<http://www.devb.gov.hk/filemanager/technicalcirculars/en/upload/246/1/wb3292.pdf>

3	MATERIALS ASPECTS	3.2 SELECTION OF MATERIALS
		MA 7 RECYCLED MATERIALS
	EXCLUSIONS	None.
	OBJECTIVE	Promote the use of recycled materials in order to reduce the consumption of virgin resources.
	CREDITS ATTAINABLE	3
	PREREQUISITES	Compliance with the Building (Construction) Regulations, Chapter 123B Regulation 3.
	CREDIT REQUIREMENT	<p>a) Outside surface works and structures</p> <p>1 credit for the use of recycled materials contributing to at least 10% of all materials used in site exterior surfacing work, structures and features.</p> <p>b) Building structure</p> <p>1 credit where at least 10% of all building materials used for facade and structural components are recycled materials.</p> <p>c) Interior Components</p> <p>1 credit where at least 10% of all building materials used for interior non-structural components are recycled materials.</p>
	ASSESSMENT	<p>a) Surface work and structures</p> <p>The Client shall submit a report prepared by a suitably qualified person detailing the recycled materials used (minerals, plastics, etc), their quantities as compared to all materials used in exterior surfacing works and structures (structures and features, which include paths, surfaces for recreational areas, structures such as seating, playground features, etc), and technical and/or economic reasons for not using elements made from recycled materials. The unit may be mass/volume/dollar value but shall be consistent throughout the assessment of this credit. Credit will be awarded where at least 10% of all materials used in site exterior surfacing work, structures and features are recycled materials.</p> <p>b) Building structure</p> <p>The Client shall submit a report prepared by a suitably qualified person detailing the recycled materials used and their quantities as compared with all materials used for facade and structural components. The unit may be mass/volume/dollar value but shall be consistent throughout the assessment of this credit. Where the target percentage of all building materials used for the purposes in the requirements is recycled materials the credit(s) shall be awarded.</p> <p>c) Interior Components</p> <p>The Client shall submit a report prepared by a suitably qualified person detailing the recycled materials used and their quantities as compared with all materials used for interior non-structural components. The unit may be mass/volume/dollar value but shall be consistent throughout the assessment of this credit. Where the target percentage of all building materials used for the purposes in the requirements is recycled materials the credit(s) shall be awarded.</p>
	BACKGROUND	Waste materials and industrial by-products can be used in building construction in an unprocessed form, e.g. as fill material, or processed to a limited degree for use as aggregates in concrete, or used as raw material for manufacturing building products. This reduces the extraction of virgin materials. The basic properties required for technical

acceptance are that they can perform their intended functions throughout the design life without being deleterious on the environment or associated constructional features.

There are many opportunities for using recycled materials in structural and non-structural elements of a building and the surrounding site works. For large sections, high strengths, where shrinkage and cracking are critical, where resistance to sulphate attack is required, and where surface finish is particularly important, PFA concrete should be specified. Crushed concrete aggregate complying with the quality and grading requirements of British Standard BS 882 [1] or similar for use in concrete for foundations. The fills in foundations and for over-site use of recycled materials should comply with the requirements of BS 6543 [2] or similar specification.

A list of Recycled Construction Products is available from the Environmental Protection Department [3]. Works Branch Technical Circular 14/90 [4] and 14/90 Addendum 1 [5] discusses the quantities of PFA that can be used. PNAP No. APP-33 [6] sets out the conditions in which the use of PFA as a partial cement replacement in concrete is permitted. PNAP No. APP-129 [7] sets out the technical guidelines for using recycled aggregates in prescribed mix concrete of specified grade strength of 20P and designed mix concrete of specified grade strengths of 25D to 35D.

Materials which normally consist of recycled content will not be considered for this credit, for instance, steel and glass.

- 1 British Standards Institution. Specification for aggregates from natural sources for concrete. British Standard BS 882:1992.
- 2 British Standards Institution. Guide to use of industrial by-products and waste materials in building and civil engineering. British Standard BS 6543: 1985.
- 3 Environmental Protection Department. http://www.epd.gov.hk/epd/misc/cdm/text/t_products_list.htm
- 4 Works Branch Technical Circular No. 14/90. The Use of PFA in Structural Concrete. <http://www.devb.gov.hk/filemanager/technicalcirculars/en/upload/259/1/WB1490.pdf>
- 5 Works Branch Technical Circular No. 14/90 Addendum 1 to LWB PN4. <http://www.devb.gov.hk/filemanager/technicalcirculars/en/upload/259/2/WB14901.pdf>
- 6 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineer, PNAP No. APP-33 Pulverized Fuel Ash in Concrete. <http://www.bd.gov.hk/english/documents/pnap/signed/APP033se.pdf>
- 7 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineer, PNAP No. APP-129 Use of Recycled Aggregates in Concrete. <http://www.bd.gov.hk/english/documents/pnap/signed/APP129se.pdf>

3	MATERIALS ASPECTS	3.2 SELECTION OF MATERIALS
		MA 8 OZONE DEPLETING SUBSTANCES
	EXCLUSIONS	None.
	OBJECTIVE	Reduce the release of chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) into the atmosphere.
	CREDITS ATTAINABLE	2
	PREREQUISITES	Compliance with the Ozone Layer Protection Ordinance Chapter 403.
	CREDIT REQUIREMENT	<p>a) Refrigerants</p> <p>1 credit for the use of refrigerants with a value less than or equal to the threshold of the combined contribution to ozone depletion and global warming potentials using the specified equation.</p> <p>b) Ozone depleting materials</p> <p>1 credit for the use of products in the building fabric and services that avoid using ozone depleting substances in their manufacture, composition or use.</p>
	ASSESSMENT	<p>a) Refrigerants</p> <p>The air-conditioning and refrigeration equipments shall fulfill the following equation which determines a maximum threshold for the combined contributions to ozone depletion and global warming potentials:</p>

$$\text{LCGWP} + \text{LCODP} \times 10^5 \leq 775$$

$$\text{LCGWP} = [\text{GWPr} \times (\text{Lr} \times \text{Life} + \text{Mr}) \times \text{Rc}] / \text{Life}$$

$$\text{LCODP} = [\text{ODPr} \times (\text{Lr} \times \text{Life} + \text{Mr}) \times \text{Rc}] / \text{Life}$$

LCGWP = Lifecycle Global Warming Potential (kg CO₂ /kw -Yr)

LCODP = Lifecycle Ozone Depletion Potential (kg CFC 11/kw-Yr)

GWPr = Global Warming Potential of Refrigerant (0 to 12,000 kg CO₂ /kg r)

ODPr = Ozone Depletion Potential of Refrigerant (0 to 0.2 kg CFC 11 /kg r)

Lr = Refrigerant Leakage Rate (0.5% to 2.0%; default of 2% unless otherwise demonstrated)

Mr = End-of-life Refrigerant Loss (2% to 10%; default of 10% unless otherwise demonstrated)

Rc = Refrigerant Charge (0.2 to 2.3 kg of refrigerant per kW of gross ARI rated cooling capacity)

Life = Equipment Life (10 years; default based on equipment type, unless otherwise demonstrated)

For systems with different types of equipment, a weighted average of all air-conditioning and refrigeration equipments shall be calculated using the following equation:

$$[\sum (\text{LCGWP} + \text{LCODP} \times 10^5) \times \text{Qunit}] / \text{Qtotal} \leq 775$$

Qunit = Gross ARI rated cooling capacity of an individual air-conditioning or refrigeration unit (kW)

Qtotal = Total gross ARI rate cooling capacity of all air-conditioning or refrigeration (kW)

Small air-conditioning units, defined as those containing less than 0.23 kg of refrigerant, and other equipment, such as standard refrigerators, small water coolers and any other cooling equipment that contains less than 0.23 kg of refrigerant, can be excluded from this assessment.

The Client shall submit a report by a suitably qualified person giving details of the air-conditioning and refrigeration equipment installed; and demonstrating that the global warming potential and ozone depletion potential of the refrigerants used in equipment meets the specified requirement. Reference shall be made to refrigerant supplies and/or equipment manufacturer's data together with guidance provided by recognised authorities such as ASHRAE, CIBSE, etc.

b) Ozone depleting materials

The Client shall provide a full description and specifications of all major thermal insulation and fire retardant materials specified in roof constructions, walls, chilled water pipes, refrigerant pipes, ductwork, etc., advising the presence or otherwise of ozone depleting agents. Where there is any doubt as to the ozone depletion potential of a material or product, the Client shall ascertain details from the supplier. Credit will be awarded where demonstration of reasonable effort has been made to avoid the use of products that have significant ozone depletion potential.

BACKGROUND

The Montreal Protocol has scheduled the phasing out of controlled substances, including chemicals containing chlorine and bromine used as refrigerants, solvents, foam blowing agents, aerosol propellants, fire suppressants, and for other purposes. Ozone Layer Protection Ordinance (Cap. 403) 1989 [1] gives effect to Hong Kong's international obligations to control the manufacture, import and export of ozone depleting substances. Ozone Layer Protection (Controlled Refrigerants) Regulation 1994 [2] requires the conservation of controlled refrigerants used in large scale installations and motor vehicles. Ozone Layer Protection (Products Containing Scheduled Substances) (Import Banning) Regulation 1993 [3] prohibits the import of portable fire extinguishers containing halons and other controlled products from a country or place not a party to the Montreal Protocol unless the Authority considers that it complies with the requirements of the Protocol. Scheduled substances under the Ozone Layer Protection Ordinance are listed by the Environmental Protection Department.

In addition to having suitable thermodynamic properties, the ideal refrigerant would be nontoxic, non-inflammable, completely stable, environmentally benign, readily available, self-lubricating, compatible with materials used in equipment, easy to handle and detect. No current refrigerants are ideal. Compounds that contain no chlorine or bromine have ozone depletion potential (ODP) nearly zero. Increasing the amount of fluorine generally raises the global warming potential (GWP). Hydrogen content tends to shorten the atmospheric lifetime [4].

Climate change is much more complex than ozone depletion, yet there is wide agreement that warming is occurring. While refrigerants contribute to global environmental concerns, the impact is comparatively small [4]. The problem is not with refrigerants inside air-conditioning systems, but with their release. Given that ODP is largely addressed by legislation, BEAM basis assessment of refrigerants is based on GWP.

- 1 Environmental Protection Department. A Concise Guide to the Ozone Layer Protection Ozone Layer Protection Ordinance. http://www.epd.gov.hk/epd/english/laws_regulations/comp_guides/files/cgto_olpo_eng.pdf
- 2 Environmental Protection Department. A Concise Guide to the Ozone Layer Protection (Controlled Refrigerants) Regulation. http://www.epd.gov.hk/epd/english/laws_regulations/comp_guides/files/cgt_olp_cr_eng.pdf
- 3 Environmental Protection Department. Ozone Layer Protection Ordinance Scheduled Substance. http://www.epd.gov.hk/epd/english/application_for_licences/guidance/wn6_licen1_1.html
- 4 Calm S M. Option and Outlook for Chiller Refrigerants. International Journal of Refrigeration. Vol. 25, 2002, pp 705-715.

CFCs generally have high ODP and GWP. HCFCs generally have much lower ODP and GWP. HFCs offer near-zero ODP but some have comparatively high GWPs.

Refrigerant	ODP ^[1]	GWP ^[1]
Hydrofluorocarbons		
HFC-23	~0	12240
HFC-32	~0	650
HFC-134a	~0	1320
HFC-152a	~0	140
HFC-402A	~0	1680
HFC-404A	~0	3900
HFC-407C	~0	1700
HFC-410A	~0	1890
HFC-413A	~0	1774
HFC-507A	~0	3900
Hydrochlorofluorocarbons		
HCFC-22	0.04	1780
HCFC-123	0.02	76
Chlorofluorocarbons		
CFC-11	1.0	4680
CFC-12	1.0	10720
CFC-114	0.94	9800
CFC-500	0.605	7900
CFC-502	0.221	4600
<p>[1] – Sources:</p> <ul style="list-style-type: none"> i: IPCC Second Assessment Report; ii: "World Resources Institute (2005), World Business Council for Sustainable Development"; iii: U.S. Environmental Protection Agency. 		

The U.S. Environmental Protection Agency provides information on suitable substitutes for ozone depleting substances [5], including refrigerants for various types of air-conditioning and refrigeration equipment, fire suppression [6], blowing agents [7], solvents, etc. CIBSE GN01 [8] outlines the hazards of using these refrigerants and provides design guidance for refrigeration systems, thermal insulation and fire protection systems. An ASHRAE guideline [9] recommends practices and procedures that will reduce inadvertent release of halogenated refrigerants. The practices and procedures in this guideline cover emission reduction of halogenated hydrocarbon and halogenated ether refrigerants:

- from stationary refrigeration, air-conditioning, and heat pump equipment and systems; and
- during manufacture, installation, testing, operation, maintenance, and disposal of equipment and systems.

5 U.S. Environmental Protection Agency. <http://www.epa.gov/docs/ozone/snap/lists/index.html#refac>
6 U.S. Environmental Protection Agency. <http://www.epa.gov/ozone/snap/fire/index.html>
7 U.S. Environmental Protection Agency. <http://www.epa.gov/docs/ozone/snap/foams/lists/index.html>
8 Chartered Institution of Building Services Engineers. CFC's, HCFC's, HFC's and halons. 2000. ISBN 0900953993.
9 ASHRAE Guideline 3-1996. Reducing Emission of Halogenated Refrigerants in Refrigeration and AS

3	MATERIALS ASPECTS	3.2	SELECTION OF MATERIALS
		MA 9	REGIONALLY MANUFACTURED MATERIALS
	EXCLUSIONS		None.
	OBJECTIVE		Encourage the use of materials manufactured locally so as to reduce the environmental impacts arising from transportation.
	CREDITS ATTAINABLE		2
	PREREQUISITES		None.
	CREDIT REQUIREMENT		<p>1 credit for the use of materials manufactured locally within 800 km from the site, which contribute at least 10% of all building materials used in the project.</p> <p>2 credits for the use of materials manufactured locally within 800 km from the site, which contribute at least 20% of all building materials used in the project.</p>
	ASSESSMENT		<p>The Client shall submit a report prepared by a suitably qualified person listing the materials that satisfy the requirements, and quantifying the value of materials manufactured locally in percentage of the total value of the materials used. The unit may be mass/volume/dollar value but shall be consistent throughout the assessment of this credit. The report shall include supporting documentation from the suppliers listing the name of the manufacturer and the distance between the project site and the manufacturer.</p> <p>Mechanical and electrical systems components may not be included in the calculation. Plumbing products however may be included at the discretion of the project team. Reused and salvaged material such as furniture may also be included. The location from which they were salvaged may be used as the point of manufacture.</p> <p>When it is demonstrated that the target percentage of all building materials used in the project are manufactured locally within 800km from the site, the credit(s) shall be awarded.</p>
	BACKGROUND		<p>By using locally manufactured materials, environmental impacts and material costs are reduced, and the local economy is supported. Pollution associated with transportation, including air and noise, has become a serious obstruction to the quality of life and even the health of citizens. Furthermore, energy consumption by transportation, as well as the demand for petroleum, has dramatically increased. The use of locally manufactured materials reduces transportation activities and the accompanying pollution. It can assist in relieving air pollution generated by trucks, trains and other vehicles which deplete non-renewable fossil fuels. By purchasing local manufactured materials, transportation problems are further reduced.</p> <p>Local manufactured materials are more cost effective due to the reduced transportation costs. Also, the support of local manufacturers and labour forces contribute to a more stable tax base and a healthier local economy.</p>

3	MATERIALS ASPECTS	3.3 WASTE MANAGEMENT
		MA 10 DEMOLITION WASTE REDUCTION
	EXCLUSIONS	Projects where demolition is not required or is not under the Client's control.
	OBJECTIVE	Encourage best practices in the management of waste, including sorting, recycling and disposal of demolition waste.
	CREDITS ATTAINABLE	2
	PREREQUISITES	Compliance with the Waste Disposal (Chemical Waste) (General) Regulation.
	CREDIT REQUIREMENT	1 credit for demonstrating that at least 30% of demolition waste is recycled. 2 credits for demonstrating that at least 60% of demolition waste is recycled.
	ASSESSMENT	<p>The Client shall present documentation and photographic evidence in form of a report by a suitably qualified person quantifying the amount of demolition waste recycled as a percentage of total demolition waste. The disposal of inert waste to public fill will not be considered as an acceptable strategy for fulfilling this requirement.</p> <p>Where at least 30% (by weight or by volume) of all waste generated on site can be shown to have been recycled, the credit shall be awarded. Where the percentage is 60%, the second credit shall be awarded.</p> <p>The Client's representative on site shall be responsible for monitoring and reporting on the execution of the instructions and shall confirm through monthly reports the extent to which recycling and sorting has been achieved. ETWB TWC 19/2005 [1] should be used as a guide to the nature of reporting and recording keeping. The Client shall demonstrate that all waste and disposal are conducted in an environmentally friendly manner.</p>

1 Environment, Transport and Works Bureau. Technical Circular (Works) No. 19/2005. Environmental Management on Construction Sites. <http://www.devb.gov.hk/filemanager/technicalcirculars/en/upload/19/1/C-2005-19-0-1.pdf>

3	MATERIALS ASPECTS	3.3 WASTE MANAGEMENT
		MA 11 CONSTRUCTION WASTE REDUCTION
	EXCLUSIONS	None.
	OBJECTIVE	Encourage best practices in the management of waste, including sorting, recycling and disposal of construction waste.
	CREDITS ATTAINABLE	2
	PREREQUISITES	Compliance with the Waste Disposal (Chemical Waste) (General) Regulation.
	CREDIT REQUIREMENT	1 credit for demonstrating that at least 30% of construction waste is recycled. 2 credits for demonstration that at least 60% of construction waste is recycled.
	ASSESSMENT	<p>The Client shall present documentation and photographic evidence quantifying the amount of construction waste recycled as a percentage of total construction waste in the form of a report prepared by a suitably qualified person. Excavated waste will not be considered as part of the construction waste. The disposal of inert waste to public fill will not be considered as an acceptable strategy for fulfilling this requirement.</p> <p>Where at least 30% (by weight or by volume) of all waste generated on site can be shown to have been recycled, the credit shall be awarded. Where the percentage is 60%, the second credits shall be awarded.</p> <p>The Client's representative on site shall be responsible for monitoring and reporting on the execution of the instructions and shall confirm through monthly reports the extent to which recycling and sorting has been achieved. ETWB TWC 19/2005 [1] should be used as a guide to the nature of reporting and recording keeping. The Client shall demonstrate that all waste and disposal are conducted in an environmentally friendly manner.</p>

1 Environment, Transport and Works Bureau. Technical Circular (Works) No. 19/2005. Environmental Management on Construction Sites. <http://www.devb.gov.hk/filemanager/technicalcirculars/en/upload/19/1/C-2005-19-0-1.pdf>

4 ENERGY USE

4.P PREREQUISITE

4.1 ANNUAL ENERGY USE

4.2 ENERGY EFFICIENT SYSTEMS

4.3 ENERGY EFFICIENT EQUIPMENT

4.4 PROVISIONS FOR ENERGY MANAGEMENT

4.5 BUILDING DESIGN FOR ENERGY EFFICIENCY

INTRODUCTION

BEAM encourages detailed design of buildings and systems, with provisions that enhance energy efficiency and energy conservation. Credits are awarded on the basis of enhanced energy performance, the provision of energy efficient systems and equipment, and provisions for energy management.

CLASSIFICATION OF BUILDINGS

To deal with the wide range of buildings that may be encountered, buildings/premises are categorised according to the provisions for air-conditioning and ventilation. This is necessary as the operational needs of buildings together with the different air-conditioning and ventilation systems that serve their needs result in large variations in energy use between buildings.

AIR-CONDITIONED BUILDINGS

This refers to buildings and premises that are air-conditioned, either by a central plant serving the entire building or unitary equipment for individual spaces, and where the air-conditioning system operates almost throughout the year. When a significant portion of such buildings are mechanically or naturally ventilated additional assessments shall be included.

NATURALLY VENTILATED/AIR-CONDITIONED BUILDINGS

This refers to buildings that are designed to use natural ventilation, but may be air-conditioned when natural ventilation fails to provide adequate indoor comfort conditions. When a significant portion of such buildings are mechanically ventilated additional assessments shall be included.

MECHANICALLY VENTILATED BUILDINGS

This refers to buildings such as car parks, factories, godowns, etc., where the major areas rely solely on mechanical ventilation for indoor thermal environment and/or control of air quality. When a significant portion of such buildings are air-conditioned or naturally ventilated additional assessments shall be included.

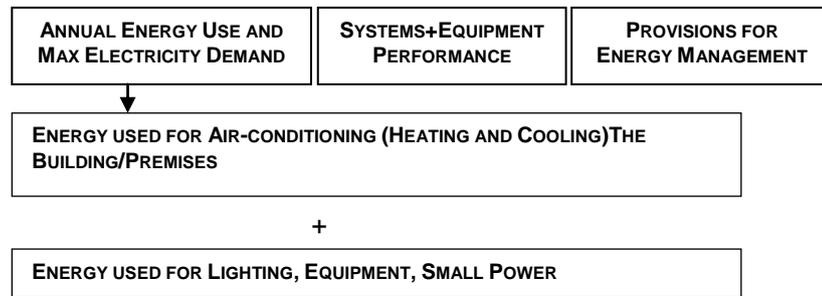
OTHER BUILDINGS

This embraces buildings/premises that cannot be categorised as one of the above and comprise an unusual mix of premises or premises with special uses. Such buildings would be assessed based on either the generic framework for assessment of energy performance, with the required parameters and benchmarks determined as the first stage of the assessment, and/or feature specific assessments.

ASSESSMENTS

The energy use assessments take account of the specific characteristics of the building development, such as the type and usage of premises it houses and the range and operational characteristics of the systems and equipment required to meet the needs of users, and comprise three parts:

- estimated Total Building Annual Energy Use (and where appropriate, Maximum Electricity Demand) for heating, cooling, lighting, equipment small power, etc.;
- features and performance of specific systems and equipment; and
- testing and commissioning of systems and provisions that facilitate energy efficient management, operation and maintenance.



**EU1 OPTION 2
ALTERNATIVE ROUTE:
PASSIVE DESIGN**

EU1 Option 2 Alternative Route: Passive design has been included in the assessment procedure to provide the practitioner with an alternative method to quantify the benefits of passive building design. It considers the following aspects:

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

It encompasses EU1: Reduction of CO₂ 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. The same total numbers of credits are available from both routes.

BACKGROUND

Electricity generation accounts for around 60% of the total CO₂ emissions from energy use in Hong Kong, and buildings, particularly air-conditioned buildings, account for more than half of the electricity consumed each year. Ensuring buildings are designed for good energy performance is the key to the conservation of resources and reductions in environmental loadings.

Power stations operate under licences issued by the Director of Environmental Protection, requiring operators to employ Best Practicable Means to control emissions to acceptable levels. However, a growth in demand is resulting in the construction of further generation, transmission and distribution capacity. Mainly because of air-conditioning, buildings are responsible for much of the peak load that occurs around midday during summer months. Demand side management can reduce the rate of expansion of supply-side capacity and emissions to the atmosphere.

4.P PREREQUISITE

EU P1 MINIMUM ENERGY PERFORMANCE

BACKGROUND

BEAM provides incentives to achieve energy performance better than the minimum compliance with the local energy codes. Consequently, compliance with the Building Energy Codes (BEC), a government initiative currently under review for mandatory implementation, is taken as the energy performance prerequisite for BEAM certification, unless otherwise agreed by the BEAM Society Limited.

BEC currently refers to four other Codes of Practice for Energy Efficiency, namely Air-conditioning Code [1], Lighting Code [2], Electrical

1 Electrical and Mechanical Services Department. Code of Practice for Energy Efficiency of Air Conditioning Installations (2007 Edition) and the subsequent amendment. http://www.emsd.gov.hk/emsd/e_download/pee/accop_2007.pdf
 2 Electrical and Mechanical Services Department. Code of Practice for Energy Efficiency of Lighting Installations (2007 Edition) and the subsequent amendment. http://www.emsd.gov.hk/emsd/e_download/pee/lightingcop_2007.pdf

Code [3], Lift & Escalator Code [4]. In the 2012 version these are all combined into one code of practice – Energy Efficiency for Building Services Installations [5].

Performance-based Building Energy Code (PBEC) [6] uses a computer simulation model to assess energy performance. In the 2012 version this is also combined in the same code of practice – Energy Efficiency for Building Services Installations. Compliance with the BEC automatically satisfies the energy performance prerequisite, irrespective of the simulation software and default values.

4.1 ANNUAL ENERGY USE

- EU 1 REDUCTION OF CO₂ EMISSIONS**
- EU 1 ALTERNATIVE ROUTE PASSIVE DESIGN**
- EU 2 PEAK ELECTRICITY DEMAND REDUCTION**

4.2 ENERGY EFFICIENT SYSTEMS

- EU 3 EMBODIED ENERGY IN BUILDING STRUCTURAL ELEMENTS**
- EU 4 VENTILATION SYSTEMS IN CAR PARKS**
- EU 5 LIGHTING SYSTEM IN CAR PARKS**
- EU 6 RENEWABLE ENERGY SYSTEMS**

BACKGROUND

The estimation of annual energy use and maximum electricity demand takes into account design improvements to the building envelope and the efficiency of air-conditioning and lighting systems and equipment and etc. It shall cover all aspects of energy use in buildings. BEAM credits additional measures address further energy efficient system.

Passive building design 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. There is an alternative route to assess these elements for residential buildings.

4.3 ENERGY EFFICIENT EQUIPMENT

- EU 7 AIR-CONDITIONING UNITS**
- EU 8 CLOTHES DRYING FACILITIES**
- EU 9 ENERGY EFFICIENT APPLIANCES**

BACKGROUND

As for the case of energy performance of systems, BEAM gives credit for the inclusion of particular equipment that provides for improved energy performance. The use of robust automatic controls has been shown to provide for energy conservation through ‘switching-off’ or ‘turn down’.

3 Electrical and Mechanical Services Department. Code of Practice for Energy Efficiency of Electrical Installations (2007 Edition) and the subsequent amendment. http://www.emsd.gov.hk/emsd/e_download/pee/eleccop_2007.pdf
 4 Electrical and Mechanical Services Department. Code of Practice for Energy Efficiency of Lift and Escalator Installations (2007 Edition) and the subsequent amendment. http://www.emsd.gov.hk/emsd/e_download/pee/lift_escop_2007.pdf
 5 Electrical and Mechanical Services Department. Code of Practice for Energy Efficiency for Building Services Installations www.emsd.gov.hk/emsd/e_download/pee/BEC_2012.pdf
 6 Electrical and Mechanical Services Department. Performance-based Building Energy Code. http://www.emsd.gov.hk/emsd/e_download/pee/pb-bec_2007.pdf

4.4 PROVISIONS FOR ENERGY MANAGEMENT

EU 10 TESTING AND COMMISSIONING **EU 11 OPERATION AND MAINTENANCE** **EU 12 METERING AND MONITORING**

BACKGROUND

One of the major reasons why buildings fail to meet performance expectations is the lack of adequate commissioning of systems and equipment, and the inadequacy of operations and maintenance manuals, commissioning data, and as-installed equipment data, as-fitted drawings, and operator training.

The installations considered in this section include the systems, equipment and components of the electrical and mechanical plant in the building development that have significant influence on energy consumption, electricity maximum demand and, to a lesser extent indoor environmental conditions. Indoor environmental conditions are verified in a series of tests which may be regarded as 'enhanced commissioning' and which are detailed in the section covering indoor environmental quality.

The Client should implement and execute a commissioning process that starts with performance requirements and ends with commissioning records for all energy related systems and equipment. The details of all systems, equipment and components, operating instructions, set points and results of all testing and commissioning should be provided to the building operator in a comprehensive and well organised operation and maintenance manual.

4.5 BUILDING DESIGN FOR ENERGY EFFICIENCY

EU 13 ENERGY EFFICIENT BUILDING LAYOUT

BACKGROUND

Through planning and architectural design, it is possible to improve the building energy efficiency. This section is to address various strategies in terms of building orientation, layout plan, external shading devices, such that the building energy consumption would be reduced.

REFERENCES

Energy Efficiency and Conservation for Buildings [7].
Guidelines on Energy Audit. April 2004 [8].
Guidelines on T5 Fluorescent Lamps [9].
Application Guide to Electronic Ballasts [10].
Application Guide to Variable Speed Drives (VSD) [11].
Application Guide to Central Control and Monitoring Systems (CCMS) [12].

7 http://www.emsd.gov.hk/emsd/e_download/pee/emsd100dpi.pdf
8 http://www.emsd.gov.hk/emsd/eng/pee/em_pub.shtml
9 http://www.emsd.gov.hk/emsd/e_download/pee/t5guide.pdf
10 http://www.emsd.gov.hk/emsd/eng/pee/em_pub_1.shtml
11 http://www.emsd.gov.hk/emsd/eng/pee/em_pub_2.shtml
12 http://www.emsd.gov.hk/emsd/e_download/pee/ccms17.pdf

4	ENERGY USE	4.P PREREQUISITE
		EU P1 MINIMUM ENERGY PERFORMANCE
	EXCLUSIONS	None.
	OBJECTIVE	Establish the minimum level of energy performance for the systems serving project spaces.
	REQUIREMENT	Demonstrate compliance with the latest edition of Building Energy Codes (BEC).
	ASSESSMENT	<p>As of 21 September 2012, The Buildings Energy Efficiency Ordinance is in full operation; all newly registered BEAM Plus projects shall comply with the minimum energy efficiency requirements governing building services installations defined in the Ordinance, that includes lighting installation, air-conditioning installation, electrical installation and lift and escalator installation, covered by the BEC.</p> <p>The Client shall submit documents to demonstrate compliance with the pertinent sections of the latest BEC that include, but are not limited to:</p> <ul style="list-style-type: none">a) plans and specifications showing details of scope of work, all pertinent data, features, equipment and systems of the project area including complete descriptions of materials, engineering data, test data, manufacturer's data, and all other data necessary to allow proper identification of components that affect the project area's energy use; andb) an energy analysis report prepared and certified by a qualified professional person. The energy analysis report shall include a formal certifying statement informing the scope of compliance and confirming the compliance with the BEC either by Prescriptive or Performance Option. The statement shall be accompanied by a set of documents, including as-fitted/installation drawings, design calculations and standard forms as required in the BEC. On the use of performance approach to demonstrate compliance, the statement shall include a report describing the simulation software, the simulation results, and the modeling assumptions. <p>Documents issued by the certifying body of the BEC, which confirm compliance, are recognised as an acceptable alternative to the submission of documents a) and b) above.</p>
	BACKGROUND	Compliance with the Building Energy Codes [1] can reduce energy consumption and operating costs. The power plants in Hong Kong mainly use coal and natural gas as fuel to generate electricity. The reduction of energy leads to the saving of fossil fuels, and reduces carbon dioxide emissions which contribute to global climate change.

1 Code of Practice for Energy Efficiency of Building Services Installation - Electrical and Mechanical Services Department HKSAR

4	ENERGY USE	4.1 ANNUAL ENERGY USE
		EU 1 REDUCTION OF CO₂ EMISSIONS
	EXCLUSIONS	None.
	OBJECTIVE	Reduce the consumption of non-renewable energy resources and the consequent harmful emissions of Carbon dioxide (CO ₂) to the atmosphere.
	CREDITS ATTAINABLE	15
	PREREQUISITES	Eu P1 Minimum Energy Performance.
	CREDIT REQUIREMENT	<p>(a) Commercial and Hotel Buildings, 1 to 15 credits for a reduction of CO₂ emissions or annual energy consumption by: 3%, 5%, 7%, 9%, 11%, 14%, 17%, 20%, 23%, 26%, 29%, 33%, 37%, 41% and 45% respectively.</p> <p>(b) Educational Buildings, 1 to 15 credits for reduction of CO₂ emissions or annual energy consumption by: 3%, 4%, 5%, 6%, 7%, 9%, 11%, 13%, 15%, 17%, 19%, 21%, 24%, 27% and 30% respectively.</p> <p>(c) Residential Buildings, 1 to 15 credits for reduction of CO₂ emissions or annual energy consumption by: 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 11%, 12%, 13%, 14%, 16%, 18% and 20% respectively.</p> <p>(d) Other Building Types, 1 to 15 credits for reduction of CO₂ emissions or annual energy consumption by: 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 12%, 14%, 16%, 18% and 20% respectively.</p>
	ASSESSMENT	<p>The number of credits to be awarded will be determined with reference to the percentage reduction of CO₂ emissions or annual energy consumption of the assessed building relative to the respective benchmark (zero-credit) criteria evaluated from the Baseline Building model.</p> <p>The calculation shall be done in terms of units of either CO₂ – kg or kWh per year. A simple conversion factor shall be adopted with reference to the Carbon Audit Guideline or default assumptions in Appendix 8.3. Full building energy simulation including energy used for heating, cooling, lighting, equipment, small power, etc shall be considered.</p> <p>The methodology of the energy simulation will make reference to the latest Building Energy Code (BEC) or Appendix G of ASHRAE 90.1-2007 or equivalent. (Note: As of interim measure before a Hong Kong equivalent of Appendix G of ASHRAE 90.1-2007 is available, lighting power density (LPD) in ASHRAE calculation shall use those parameters in Code of Practice for Energy Efficiency of Building Services Installation – 2012 Edition). Appendices 8.1 and 8.2 include the assumptions for design parameters for Performance-based approach for residential and other building types for reference.</p>

The energy analysis and supporting documentation shall be prepared and certified by a qualified professional person. The submission for compliance and the computer software to be used shall make reference to the latest Building Energy Code (BEC) or ASHRAE Standard 90.1-2007.

When the selected simulation program cannot adequately model a design (Note: For example: passive design with significant contribution to the reduction of CO₂ emissions), material, or device, the rating authority may approve an exceptional calculation method to demonstrate above-standard performance. The exceptional calculation shall make reference to Section A3.4 of Code of Practice for Energy Efficiency of Building Services Installation - 2012 Edition [1] and/or Appendix G2.5 of ASHRAE 90.1-2007[2] and/or Appendix D of the Advanced Energy Modelling for LEED – Technical Manual v1.0 (September 2011 Edition)[3].

- 1 EMSD - Code of Practice for Energy Efficiency of Building Services Installation - Section A3.4 2012
- 2 ASHRAE Standard 90.1-2007 – Energy Standard for Buildings Except Low Rise Residential Buildings
- 3 USGBC - Advanced Energy Modeling for LEED – Technical Manual v1.0 (August 2010 Edition).

4	ENERGY USE	4.1 ANNUAL ENERGY USE
		EU 1 - OPTION 2 ALTERNATIVE ROUTE: PASSIVE DESIGN
	EXCLUSIONS	None
	OBJECTIVE	<p>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.</p> <p>This alternative route considers:</p> <ul style="list-style-type: none"> • Site planning and building orientation; • Envelope heat transfer; • Natural ventilation; • Daylight design; and • Common area servicing. <p>It encompasses EU1: Reduction of CO₂ 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.</p> <p>This passive design route was developed for residential buildings and their unique operating criteria, so it is not applicable to non-residential buildings.</p>
	CREDITS ATTAINABLE	20
	PREREQUISITES	Eu P1 Minimum Energy Performance.
	CREDIT REQUIREMENT	<p>Passive Building Design</p> <p>(a) Site Planning/Building Orientation</p> <ul style="list-style-type: none"> • Site Planning <ul style="list-style-type: none"> 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. <p>Alternatively the second credit can be achieved by:</p> <p>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%.</p> • Building Orientation <ul style="list-style-type: none"> 1 credit attained if the average solar irradiation of all facades is ≤ 80% of baseline solar irradiation value of 395 kWh/m²/ apr-oct. <p>(b) Building Envelope</p> <ul style="list-style-type: none"> • Prescriptive Approach <ul style="list-style-type: none"> 1 credit if $28.0 \text{ W/m}^2 \leq \text{OTTV} < 30.0 \text{ W/m}^2$. 2 credits if $26.0 \text{ W/m}^2 \leq \text{OTTV} < 28.0 \text{ W/m}^2$. 3 credits if $24.0 \text{ W/m}^2 \leq \text{OTTV} < 26.0 \text{ W/m}^2$. 4 credits if $22.0 \text{ W/m}^2 \leq \text{OTTV} < 24.0 \text{ W/m}^2$. 5 credits if $20.0 \text{ W/m}^2 \leq \text{OTTV} < 22.0 \text{ W/m}^2$.

(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.

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 Except 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).

4	ENERGY USE	4.1 ANNUAL ENERGY USE
		EU 2 PEAK ELECTRICITY DEMAND REDUCTION
	EXCLUSIONS	None.
	OBJECTIVE	Encourage energy conservation and methods to reduce peak electricity demand.
	CREDITS ATTAINABLE	3
	PREREQUISITES	None.
	CREDIT REQUIREMENT	(a) Commercial and Hotel Buildings, 1 to 3 credits for a reduction in the peak electricity demand by 15%, 23% and 30% respectively. (b) Educational and Residential Buildings, 1 to 3 credits for a reduction in the peak electricity demand by 8%, 12% and 15% respectively. (c) Other Building Types, 1 to 3 credits for a reduction in the peak electricity demand by 8%, 12% and 15% respectively.
	ASSESSMENT	The number of credits to be awarded will be determined with reference to the percentage reduction of the monthly peak electricity demand for the month with the highest electricity demand throughout the year of the assessed building relative to the respective benchmark (zero-credit) criteria evaluated from the Baseline Building model. The assessment shall be included within the assessment of annual energy use for the project building.

4	ENERGY USE	4.2 ENERGY EFFICIENT SYSTEMS
		EU 3 EMBODIED ENERGY IN BUILDING STRUCTURAL ELEMENTS
	EXCLUSIONS	None.
	OBJECTIVE	Encourage the design of structural elements and choice of materials that results in lower embodied energy.
	CREDITS ATTAINABLE	1 + 1 BONUS
	PREREQUISITES	None.
	CREDIT REQUIREMENT	<p>1 credit for demonstrating the embodied energy in the major elements of the building structure of the assessed building has been studied through a Life Cycle Assessment (LCA).</p> <p>1 BONUS credit for demonstrating the major materials with low embodied energy are used in the project utilizing the LCA results.</p>
	ASSESSMENT	<p>The assessment covers only the elements and materials used in the building foundations, building core, walls, etc, i.e., major elements of building structure including building facade and primary and secondary structures, but does not include building services system.</p> <p>The Client shall provide a report detailing the methodology and result of the assessment. The method to estimate reduction in embodied energy should follow a well-established Life Cycle Assessment (LCA) approach. It is encouraged to use EMSD's tool or other equivalent tools to conduct a Life Cycle Assessment.</p> <p>The bonus credit will be given where changes in the design of the main structural elements, for example the use of less materials or alternative constructions, etc. enable a reduction in embodied energy compared with the same building where the enhancements were not included.</p>
	BACKGROUND	<p>The energy used in the extraction, processing and transportation of materials used in building construction can be a significant part of the total energy used over the life cycle of a building, particularly buildings that utilise natural ventilation where operating energy for cooling and ventilation are significantly less than for air-conditioned buildings. Estimations for Hong Kong residential buildings suggest that embodied energy amounts to 20-40% of total energy used over a 40-60 year lifetime [1,2,3].</p> <p>Heightened awareness of the importance of environmental protection, and the possible impacts associated with products manufactured and consumed, has increased the interest in the development of methods to better comprehend and reduce these impacts. One of the techniques being developed for this purpose is Life Cycle Assessment (LCA). ISO 14040 [4] describes the principles and framework for conducting and reporting LCA studies, and includes certain minimal requirements. LCA is a technique for assessing the environmental aspects and potential impacts associated with a product, by:</p> <ul style="list-style-type: none"> • compiling an inventory of relevant inputs and outputs of a product

1 Cole R J, Wong K S. Minimising environmental impact of high-rise residential buildings. Proc. Housing for millions: The challenge ahead. Hong Kong: Housing Authority, 1996, pp 262–5.

2 Humphrey S, Amato A, Frewer R. Whole Life Comparison of High Rise Residential Blocks in Hong Kong. International Housing Conference - Housing in the 21st Century: Challenges and Commitments. 2-4 February 2004.

3 Chen T Y, Burnett J, Chau C K. Analysis of embodied energy use in residential building of Hong Kong. Energy 26, 2001. pp 323-340.

4 International Organization for Standardization. EN ISO 14040:1997. Environmental management – Life cycle assessment – Principles and framework.

system;

- evaluating the potential environmental impacts associated with those inputs and outputs; and
- interpreting the results of the inventory analysis and impact assessment phases in relation to the objectives of the study.

ASTM E 1991 [5] is a general guide for the application of environmental Life Cycle Assessment (LCA) as a tool for evaluating the environmental aspects of materials/products, processes, and services produced and used in buildings and the built environment.

With the availability of more reliable and relevant data for use in Life Cycle Assessment (LCA) methods designers are better able to quantify embodied energy in buildings elements and structures.

5 American Society for Testing and Materials. ASTM E 1991-98. Standard Guide for Environmental Life Cycle Assessment of Building Materials/Products.

4 ENERGY USE	4.2 ENERGY EFFICIENT SYSTEMS
	EU 4 VENTILATION SYSTEM IN CAR PARKS
EXCLUSIONS	Buildings without carpark or carpark area less than 10% CFA.
OBJECTIVE	Encourage energy efficient design and control of ventilation systems in large mechanically ventilated car parks.
CREDITS ATTAINABLE	2
PREREQUISITES	Compliance with the Building (Ventilating Systems) Regulations, Chapter 123J Regulation 4.
CREDIT REQUIREMENT	1 credit for ventilation systems that will consume less electricity than those meeting the zero credit requirements (baseline) by 20% or more. 2 credits where the consumption is reduced by 25% or more.
ASSESSMENT	<p>The baseline (zero credit) performance criteria for mechanical ventilation systems shall be determined based on the following:</p> <ul style="list-style-type: none">• a mechanical ventilation system that consumes a fan power of 2 W per l/s of the total ventilation flow rate maintained in the ventilated spaces in the building; and• where a space is served by both a supply and an extraction system, the system fan power shall be the sum of the fan power of the supply and the extraction system whilst the ventilation flow rate shall either be the total supply or the total extraction flow rate, whichever is the larger. <p>Besides reduction, it is required to demonstrate that the control systems for regulating the operation of the ventilation systems(s) are provided to reduce energy use whenever conditions permit.</p> <p>Examples of control systems referred to in the credit requirements include variable fan speed control, duty cycling of multiple ventilation fans according to the CO concentration in car parks, etc.</p> <p>The Client shall submit the following information to demonstrate that the installations meet the basic requirements and the requirements for credits:</p> <ul style="list-style-type: none">• the criteria adopted in the design of the ventilation systems;• If natural ventilation is adopted, proof must be provided to ensure that CO and other relevant pollutant concentrations in the car park should meet the requirements set out in ProPECC PN 2/96[1];• the calculated ventilation rates;• the design performance and operating patterns of the ventilation equipment;• the energy use predictions for the zero-credit case and the as designed case for the ventilation system installation;• reports of air leakage tests on selected ducting systems (to be confirmed subsequently if the assessment is conducted prior to on-site testing and commissioning of the ventilation systems); and• the specified performance of any air-conditioning equipment for the building.

1 Environmental Protection Department. Practice Note for Professional Persons – Control of Air Pollution in Car Parks 1996). http://www.epd.gov.hk/epd/english/resources_pub/publications/files/pn96_2.pdf

The air leakage limit on ductwork shall conform to the criteria given in the Code of Practice for Energy Efficiency of Air Conditioning Installations [2], and the test method shall be based on DW143 [3], SMACNA [4] or equal equivalent method.

Where there is a need to take into account trade-off of performance between the mechanical ventilation and the lighting installations, the submitted calculations shall show that the extra energy used due to non-fulfillment of one criterion has been more than compensated by the extra energy saving due to a better performance over and above the other criterion.

- 2 Electrical and Mechanical Services Department. Code of Practice for Energy Efficiency of Air Conditioning Installations (2007 Edition) and the subsequent amendment. http://www.emsd.gov.hk/emsd/e_download/pee/accop_2007.pdf
- 3 Heating and Ventilation Contractors Association, UK. DW143 A Practical Guide to Ductwork Leakage Testing. 2000.
- 4 Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guideline for Occupied Buildings under Construction. <http://www.smacna.org/>

4	ENERGY USE	4.2 ENERGY EFFICIENT SYSTEMS
		EU 5 LIGHTING SYSTEM IN CAR PARKS
	EXCLUSIONS	Buildings without carpark or carpark area less than 10% CFA.
	OBJECTIVE	Encourage the adoption of lighting equipment and controls that will provide for energy conservation.
	CREDITS ATTAINABLE	2
	PREREQUISITES	None.
	CREDIT REQUIREMENT	1 credit for using lamps and, where applicable, ballasts that will consume less electricity than those meeting the zero-credit requirements by 20% or more. 2 credits where the consumption is reduced by 25% or more.
	ASSESSMENT	<p>The zero credit performance criteria for the interior lighting installations (not including that in public areas in and adjacent to the assessed building) shall be determined based on the following:</p> <ul style="list-style-type: none">• The use of 40W fluorescent tubes, each with a 10W control gear and producing 2,400 lm; and• The use of the minimum number of lighting fittings with lamps of performance as given above that will allow the required illumination levels in various premises in the building to be achieved. <p>The illumination levels required in various types of premises in the assessed building shall follow guidance given in relevant lighting design guides, such as the CIBSE Code for interior lighting [1]. Determination of the minimum number of lighting fittings required shall be based on the Lumen formula, based on a utilisation factor (UF) of 0.45 and a light loss factor (LLF) of 0.8.</p> <p>The Client shall submit the following information to demonstrate that the installations will meet the basic requirements and the individual requirements above for the related credits:</p> <ul style="list-style-type: none">• the criteria adopted in the design of the lighting systems;• If daylight harvesting is adopted, proof must be provided to show associated energy reductions. Recommended car park design lux levels must be maintained in the car park under a 10,000 lux overcast sky condition[2];• the quantity of lighting fittings designed for various premises, the wattage of each fitting and the operation patterns of the lighting systems; and• the energy use predictions for the zero-credit case and the as designed case for the lighting installations. <p>In addition to the above requirement, the Client is also required to demonstrate that control systems and devices have been provided to switch off or dim the output of lighting installations when and where illumination is not required.</p> <p>Where there is a need to take into account trade-off of performance between the mechanical ventilation and the lighting installations, the submitted calculations shall show that the extra energy used due to non-</p>

1 The Chartered Institution of Building Services Engineers. Code for interior lighting.

2 The Institute of Structural Engineers. Design recommendations for multi-storey and underground car parks (2002), Institute of Structural Engineers, London, U.K.

fulfillment of one criterion has been more than compensated by the extra energy saving due to a better performance over and above the other criterion.

4	ENERGY USE	4.2 ENERGY EFFICIENT SYSTEMS
		EU 6 RENEWABLE ENERGY SYSTEMS
	EXCLUSIONS	None.
	OBJECTIVES	Encourage the wider application of renewable energy sources in buildings.
	CREDITS ATTAINABLE	5
	PREREQUISITES	None.
	CREDIT REQUIREMENT	<p>1 to 5 credits where 0.5% to 2.5% or more of building energy consumption is obtained from renewable energy sources respectively.</p> <p>Alternatively,</p> <p>1 to 5 credits where the minimum percentage of 20% to 100% of the building footprint is being covered/used by PV panels respectively and/or other renewable power facility generation with equivalent renewable power output.</p>
	ASSESSMENT	<p>The Client shall submit a report providing details of the installations, and calculations showing the estimated energy use provided from renewable energy sources.</p> <p>In the case of systems that generate electricity from renewable sources (e.g. photovoltaic panels), the estimated amount of electricity that will be generated by the system for use by equipment in the building, either instantaneously or from an associated storage system.</p> <p>In the case of using systems that produce services direct from renewable sources, which will otherwise require the use of fuel or electricity to produce those services (e.g. hot water supply from solar panels or chilled water supply from absorption chillers powered by solar heat), the equivalent amount of electricity use that will be avoided.</p> <p>The calculation shall take due account of the diurnal and seasonal variations in the external environmental conditions (e.g. solar intensity and wind speed and direction) and in the demand for the electricity and/or services generated by the systems. Any energy use and losses by the systems shall be discounted from their output. The total energy consumption shall be referenced to the design value calculated in the Credit EU 1 Reduction of CO₂ Emission or other building energy estimation certified by a qualified professional person when EU 1 – Option 2 Alternative Route: Passive Design is adopted. The tenant's electrical loads, which are not controlled or influenced by the applicant, shall be excluded from the calculation.</p> <p>Alternatively, the credits may be awarded where the Client demonstrates that percentage of the building footprint is being covered/used by PV panels and/or other renewable power facility generation equivalent renewable power output. The number of credits awarded will be determined with reference to the percentage achieved.</p>
	BACKGROUND	<p>If energy consumption continues to increase at existing levels, projected carbon dioxide emissions generated for the year 2010 are expected to grow by 39% from the 2000 level. The effective use of renewable energy resources will help to reduce Hong Kong's reliance on fossil fuels and also to reduce greenhouse gas emissions arising from the use of fossil fuels. EMSD's information pamphlet [1] explains the meaning of</p>

1 Electrical and Mechanical Services Department. http://www.emsd.gov.hk/emsd/e_download/sgi/re_re_pamphlet.pdf

renewable energy, the benefits of using renewable energy, and the current status of application of renewable energy in Hong Kong.

Although large scale application of renewable energy in buildings does not yet exist in Hong Kong, its use should be promoted in the interest of sustainable development. To ensure credits will only be awarded to meaningful installations, the criteria of assessment have been set with reference to the percentage of the energy use in the assessed building that will be replaced by renewable sources. Furthermore, no distinction will be made of the means chosen for substituting electricity or fuel by renewable energy. Hence, different or a combination of systems and equipment may be incorporated into a building, such as solar hot water systems, building integrated photovoltaic panels or wind turbines, etc.

Recognizing the fact that the application of renewable energy in densely populated urban centres is more difficult than in less densely populated settings, the performance criteria are relaxed for building developments in urban centres.

4	ENERGY USE	<p>4.3 ENERGY EFFICIENT EQUIPMENT</p> <p>EU 7 AIR-CONDITIONING UNITS</p> <p>EXCLUSIONS Buildings not using window and/or split-type air-conditioners.</p> <p>OBJECTIVE Ensure the installation of air-conditioning units provides for near optimum performance.</p> <p>CREDITS ATTAINABLE 1</p> <p>PREREQUISITES Proper disposal system for the drainage of the condensation shall be provided in accordance with Buildings Department requirements [1].</p> <p>CREDIT REQUIREMENT 1 credit for complying with the recommended installation positions for air-conditioning units with regard to internal spaces; complying with the minimum width of any external recess with regard to heat rejection; and complying with the items listed in the assessment checklists.</p> <p>ASSESSMENT</p> <p>i) Window type air-conditioning units</p> <p>The Client shall provide relevant drawings and specifications demonstrating that the air-conditioning units installed comply with the installation requirements given in Tables 8.4 and 8.5 in Section 8.4.</p> <p>ii) Split-type air-conditioning units</p> <p>The Client shall provide relevant drawings and specifications demonstrating that the air-conditioning units installed comply with the relevant dimensions given in Table 8.4 in respect of internal unit, and with the relevant dimensions given in Table 8.5 in respect of the external unit.</p> <p>Compliance with the requirements shall be demonstrated for each type of domestic unit in a block, or each type of space or room in other types of premises, unless the Client can demonstrate either that circumstances mitigate against compliance in not more than 10% of installations, or that non-compliance will not affect the performance of air-conditioning units in respect of room cooling, or heat rejection.</p> <p>The Client shall confirm that the installation conforms with any four of the following items that are relevant to the type of air-conditioning units used:</p> <ul style="list-style-type: none"> • to reduce penetration of noise units shall be located on walls which do not face major noise sources (road traffic, major pedestrian walkways, playgrounds, etc); • to reduce intake of polluted air units shall be located in walls such that air is not drawn in from pollution sources such as roads, commercial activities, etc; • for improved acoustics properties and better circulation, the internal discharge shall be close to the centre of the wall in which it is located; • for the purpose of reducing noise from rain, and to reduce the potential for water dripping on to lower units, slabs shall be provided as support and as cover; • to encourage proper maintenance, the installation of units shall be such as to allow for safe and convenient removal; • where air-conditioning units are provided by the developer, the units
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1 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers. PNAP No. APP-112 Disposal of Condensation from Air-Conditioning Units. <http://www.bd.gov.hk/english/documents/pnap/APP/APP112.pdf>

selected shall be labelled as Grade 1 or 2 under the Government's energy efficiency labelling scheme for room coolers [2].

BACKGROUND

Due to the hot and humid weather, the majority of residential units in Hong Kong are equipped with window-type air-conditioners. However, the provisions made in the building envelope design for their installation are often inadequate, particularly in the clearances for intake and disposal of outdoor air for condenser cooling. Consequently, the air-conditioners would consume an unnecessarily high amount of electricity and at the same time output less cooling [3].

Proper location of air-conditioning units will improve internal operating efficiency and comfort, and the efficiency of external heat rejection. Good design of openings can improve the quality of air intake, reduce intrusion of external noise, reduce nuisance to neighbours and provide for better operation and maintenance.

For air-conditioning for residential buildings, wall boxes or platforms in reinforced concrete or other suitable material may be constructed as a permanent feature, even over streets, and as such may be excluded from site coverage considerations [4].

- 2 Electrical & Mechanical Services Department, the Government of the Hong Kong SAR. The Hong Kong Voluntary Energy Efficiency Labelling Scheme for Room Coolers.
[http://www.emsd.gov.hk/emsd/e_download/pee/eels_room_cooler_\(jan_2003\).pdf](http://www.emsd.gov.hk/emsd/e_download/pee/eels_room_cooler_(jan_2003).pdf)
- 3 Bojic M, Lee M, Yik F, Burnett J. Influence of clearances on the energy performance of window-type air-conditioners at the same level outside residential buildings. *Building and Environment* 37 (2002) 713 – 726
- 4 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers. PNAP No. APP-42 Amenity Features.
<http://www.bd.gov.hk/english/documents/pnap/APP/APP042.pdf>

4	ENERGY USE	4.3 ENERGY EFFICIENT EQUIPMENT
		EU 8 CLOTHES DRYING FACILITIES
	EXCLUSIONS	Buildings other than residential buildings.
	OBJECTIVE	Encourage greater use of natural resources in place of gas or electrical energy for clothes drying purposes.
	CREDITS ATTAINABLE	1
	PREREQUISITES	None.
	CREDIT REQUIREMENT	1 credit for providing suitable clothes drying facilities which utilise the natural environment for all residential units.
	ASSESSMENT	<p>The Client shall demonstrate the adequacy of the clothes drying facilities for efficient drying by sun and breeze, which is adequately protected from water droplets and debris falling from higher levels, and not adversely affected by smoke, fumes and pollutants emitted from water heaters, cooking exhausts, discharges from air-conditioning units, etc.</p> <p>In order to prove that the clothes drying facilities are satisfactory, the client shall demonstrate the performance with the following requirements:</p> <ul style="list-style-type: none">• Each clothes drying space should have access to sunlight or wind, this is determined as follows:<ul style="list-style-type: none">– 1 Hours of direct solar exposure in winter solstice (冬至日); or– Minimum wind velocity of 0.5m/s under the winter prevailing wind condition (direction and velocity).• If re-entrant locations or alike are used, justification has to be submitted to demonstrate suitability with respect to both the natural environmental conditions, as defined previously, and the mitigation of potential nuisances. The mitigation of potential nuisances requires the location of clothes drying facilities to be:<ul style="list-style-type: none">– 0.5m horizontal distance away from air-conditioning units; and– 1.5m horizontal distance away from kitchen exhausts (and operable windows).
	BACKGROUND	Provisions of clothes drying facilities in many existing residential buildings are inadequate, so that people tend not to use them and resort to gas or electric dryers, increasing energy consumption.

4	ENERGY USE	4.3 ENERGY EFFICIENT EQUIPMENT EU 9 ENERGY EFFICIENT APPLIANCES
	EXCLUSIONS	Buildings where appliances are not provided by the developer.
	OBJECTIVE	Encourage the wider use of energy efficient appliances.
	CREDITS ATTAINABLE	2
	PREREQUISITES	None.
	CREDIT REQUIREMENT	1 credit when 60% of total rated power of appliances and equipment are certified energy efficient products. 2 credits when 80% of total rated power of appliances and equipment are certified energy efficient products.
	ASSESSMENT	<p>The Client shall provide details of all the appliances installed in the building and evidence as to the efficiency ratings of each type and size of the appliances; and quantify the rated power of certified energy products as the percentage of total rated power of appliances and equipment. The eligible appliances and equipment include the products with efficiency Grade 1 or 2 under the Energy Efficiency Labelling [1,2] or USEPA Energy Star Rated [3] or certified under an equivalent labeling scheme.</p> <p>Where the target percent of total power of appliances and equipment are certified efficient product, the credit(s) shall be awarded.</p>
	BACKGROUND	<p>To make it easier for the public to choose energy efficient products, EMSD operates Mandatory and Voluntary Energy Efficiency Labelling Schemes for appliances and equipment used both in the home and office. The scheme aims to save energy by informing potential customers of the product's level of energy consumption and efficiency rating, so that buyers can take these factors into consideration when making their purchasing decision.</p> <p>The scheme now covers nineteen types of household appliances and office equipment. Eleven types of these are electrical appliances including refrigerators (Voluntary Scheme), washing machines, non-integrated type compact fluorescent lamps, dehumidifiers, electric clothes dryers, room coolers (Voluntary Scheme), electric storage water heaters, television sets, electric rice-cookers, electronic ballasts and LED Lamp. The seven types of office equipment comprise photocopiers, fax machines, multifunction devices, laser printers, LCD monitors, computers and hot / cold bottled water dispensers. There is also one type of gas appliance for domestic gas instantaneous water heaters.</p> <p>Products in more than 40 categories are eligible for the Energy Star. They use less energy, save money, and help protect the environment.</p>

1 Electrical and Mechanical Services Department. Voluntary Energy Efficiency Labelling Scheme.
http://www.emsd.gov.hk/emsd/eng/pee/eels_pub.shtml

2 Electrical and Mechanical Services Department. Mandatory Energy Efficiency Labelling Scheme.
http://www.emsd.gov.hk/emsd/eng/pee/eels_mpub.shtml

3 US Environmental Protection Agency. Energy Star Qualified Products.
http://www.energystar.gov/index.cfm?fuseaction=find_a_product.

4	ENERGY USE	4.4 PROVISIONS FOR ENERGY MANAGEMENT
		EU 10 TESTING AND COMMISSIONING
	EXCLUSIONS	None.
	OBJECTIVE	Commissioning the electrical and mechanical systems to ensure the impact on energy use of the systems is adequate, the systems performance is as specified and the systems operation is as intended.
	CREDITS ATTAINABLE	4 + 1 BONUS
	PREREQUISITES	None.
	CREDIT REQUIREMENT	<p>a) Commissioning specifications 1 credit for provision of appropriate specifications and/or cost provisions in contract documents detailing the commissioning requirements for all systems and equipment that impact on energy use and indoor environmental quality.</p> <p>b) Commissioning plan 1 credit for the appointment of a commissioning authority and provision of a detailed commissioning plan that embraces all specified commissioning work.</p> <p>c) Commissioning 1 credit for ensuring full and complete commissioning of all systems, equipment and components that impact on energy use and indoor environmental quality.</p> <p>d) Commissioning report 1 credit for providing fully detailed commissioning reports for all systems, equipment and components that impact on energy use and indoor environmental quality.</p> <p>e) Independent Commissioning Authority 1 BONUS credit for engagement of an independent commissioning authority in the Testing and Commissioning process.</p>
	ASSESSMENT	<p>a) Commissioning specifications The Client shall submit copies of detail specifications on the commissioning requirements for each system and equipment, and/or the details of the cost provisions for the commissioning work. The credit shall be awarded where it can be shown that the specifications meet the requirements given in Section 8.5.1 as a minimum or cost provisions are sufficient to carry out the intended work.</p> <p>b) Commissioning plan There shall be appropriate cost provisions for the appointment of a commissioning authority and for the commissioning processes. The commissioning authority shall be a Registered Professional Engineer with adequate expertise in the commissioning of electrical and mechanical systems, equipment and components. A suitably qualified member of the organization that performed the design may act as the commissioning authority. Reporting of all conditions and findings must be immediate and direct from the commissioning authority to the Client. The commissioning authority shall be responsible for:</p> <ul style="list-style-type: none">• review and approval of commissioning specifications;• the development of a commissioning plan; and

- determining and documenting whether systems, equipment and components are functioning in accordance with the design intent and in accordance with the construction documents.

Where the Client can provide evidence that the commissioning plan meets the requirements detailed in Section 8.5.2 as a minimum the credit shall be awarded.

c) Commissioning

Where the Client appoints a commissioning agent to be responsible for performing the functional testing of systems and equipment, as documented by the commissioning authority, using forms approved by the commissioning authority, and all of which meet the requirements of Section 8.5.3 as a minimum, the credit shall be awarded.

d) Commissioning report

Where the Client demonstrates that after all commissioning tasks except seasonally deferred testing have been completed, and a commissioning report is provided covering as a minimum the items given in Section 8.5.4, the credit shall be awarded.

e) Independent Commissioning Authority

Where the Client demonstrates that the commissioning authority shall fulfill the following requirements:

- the commissioning authority must have relevant experience in at least 2 building projects;
- the individual must not be responsible for any aspect of the project design or construction management or supervision for the subject building;
- the individual must not be an employee of the design firm;
- the individual must not be an employee of, or contracted through, a contractor or construction manager dealing with construction contracts; and
- the individual may be a qualified employee or consultant of the owner.

BACKGROUND

Commissioning is a quality assurance process for buildings from pre-design through design, construction, and operations. It involves achieving, verifying, and documenting the performance of each system to meet the building's operational needs within the capabilities of the documented design and equipment capacities, according to the owner's functional criteria. Commissioning includes preparing project operational and maintenance documentation and training operation and maintenance personnel. The result should be fully functional systems that can be properly operated and maintained throughout the life of the building.

CIBSE [1,2,3], BSRIA [4] and ASHRAE [5] publications provide guidance on commissioning requirements and procedures, such as management, design for commissioning, access, testing, measurements and tolerances, installed transducers, specification for portable measuring equipment, etc. The Architectural Services Department publishes

- 1 The Chartered Institution of Building Services Engineers. Air distribution systems. CIBSE. Commissioning Code A. <http://www.cibse.org/index.cfm>
- 2 The Chartered Institution of Building Services Engineers. Water distribution systems. CIBSE Commissioning Code W.
- 3 The Chartered Institution of Building Services Engineers. Automatic controls. CIBSE Commissioning Code C.
- 4 Building Services Research and Information Association. Commissioning air systems. Application procedures for buildings. <http://www.bsria.co.uk/>
- 5 ASHRAE. New Building Commissioning. <http://www.ashrae.org/>

commissioning procedures for Government buildings [6].

Effective commissioning and proper instructions on operations and maintenance procedures have been shown to improve the operating efficiency and environmental performance of a building over its life cycle.

The T&C requirements should cover all renewable systems, water conservation systems, building services systems (particularly the energy system) related to the BEAM Plus including the BMS/BAS system and all hydraulic systems. Examples of HVAC systems include, but are not limited to:

- chillers;
- cooling towers;
- controls for central plant and for HVAC, including, if present, the energy management system or building automation system (BAS);
- unitary and split-air conditioners;
- fans;
- pumps;
- heat exchangers;
- boilers;
- domestic hot water and hot water heaters;
- ducts and associated dampers;
- piping and associated valves; and
- waste heat recovery, thermal storage, etc.

The Commissioning Agent need to prepare a Commissioning Plan with details of how the review and testing will be carried out. His work should complement and not cross over the responsibility of the building services/BMS designers who also have commissioning responsibility.

6 Architectural Services Department, Building Services Branch. Testing and Commissioning Procedure No.1 for Air-conditioning, Refrigeration, Ventilation and Control System in Government Buildings.
http://www.archsd.gov.hk/english/publications/publication_pdf/e70.pdf

4	ENERGY USE	4.4 PROVISIONS FOR ENERGY MANAGEMENT
		EU 11 OPERATION AND MAINTENANCE
	EXCLUSIONS	None.
	OBJECTIVE	Enable building operators to implement the design intent, be able to monitor the performance of the building, and maintain the performance.
	CREDITS ATTAINABLE	3
	PREREQUISITES	None.
	CREDIT REQUIREMENT	<p>a) Operations and maintenance manual 1 credit for providing a fully documented operations and maintenance manual to the minimum specified.</p> <p>b) Energy management manual 1 credit for providing fully documented instructions that enable systems to operate at a high level of energy efficiency.</p> <p>c) Operator training and operation and maintenance facilities 1 credit for providing training for operations and maintenance staff to the minimum specified; and demonstrating that adequate maintenance facilities are provided for operations and maintenance work.</p>
	ASSESSMENT	<p>The Client shall submit details of the provisions for operation and maintenance as outlined below.</p> <p>a) Operations and maintenance manual The design intent and basis of design shall be included as a defining part of the operations and maintenance manual and the energy management manual. The manual shall include the details given in Section 8.5.6 as a minimum. Where an adequate contract sum was provided for the preparation of comprehensive operations and maintenance manual, and the manual covers adequately the major energy consuming building services systems and equipment the credit shall be awarded.</p> <p>b) Energy management Where the operations and maintenance manual, or a dedicated energy management manual is provided, and meets the requirements of Section 8.5.7 as a minimum, the credit shall be awarded.</p> <p>c) Operator training and operation and maintenance facilities The training program shall cover as a minimum the items listed in Section 8.5.8. Details of the facilities for operation and maintenance, such as the workshop(s), office accommodation, computing facilities etc., shall be provided, and the case made to demonstrate the adequacy of the facilities in relation to the size and complexity of the building served. Where the Client can verify that training of the building's operations and maintenance staff was undertaken for all commissioned systems and major equipment, using the operations and maintenance manual, and the energy management manual as the basis for the training, and demonstrate that the provided operation and maintenance facilities are adequate, the credit shall be awarded.</p>
	BACKGROUND	Facilities to carry out basic maintenance and equipment for monitoring consumption can help improve operating efficiency and environmental

performance of a building. ASHRAE [1] and BSRIA [2] provide advice on the preparations for operation and maintenance to ensure the safe and efficient operation of each system and major item of plant, including a description of the operating modes, a recommended strategy for operation and control, control data and set points, interlocks between plant items, etc.

- 1 American Society of Heating, Air-conditioning, and Refrigerating Engineers. Preparation of Operating and Maintenance Documentation for Building Systems. ASHRAE Guideline 4. Atlanta.
- 2 J H Armstrong. Building Services Research and Information Association. Operating and Maintenance Manuals for Building Services Installations. Application Guide 1/87. Dec. 1990.

4	ENERGY USE	4.4 PROVISIONS FOR ENERGY MANAGEMENT
		EU 12 METERING AND MONITORING
	EXCLUSIONS	None.
	OBJECTIVE	Enable building operators to measure, monitor and develop measures to improve the performance of the building's engineering systems, particularly concerning energy use.
	CREDITS ATTAINABLE	1
	PREREQUISITES	As a prerequisite metering provisions shall meet the requirements of the Government's energy codes.
	CREDIT REQUIREMENT	1 credit for installation of: metering that allows monitoring of electricity use by the main chiller plant and auxiliaries; instruments for monitoring building cooling load and operating parameters of the central chiller plant; metering that allows separate monitoring of electricity use by the air side of the HVAC system; and metering for landlord's electricity consumption in common space/public areas.
	ASSESSMENT	<p>The Owner/Operator shall provide details of the measuring and monitoring equipment installed and commissioning records of consumption and chiller plant performance, to demonstrate that electricity use and performance can be monitored as stipulated.</p> <p>Monitoring of central chiller plant will be assessed on the basis of BSRIA Technical Note TN 7/94 [1] or similar specification published by an appropriate authority. The monitoring system shall allow the overall performance of the plant and individual chillers to be determined for all operating modes and range of operating conditions.</p> <p>Electricity metering (for input power, energy and maximum demand), together with associated measuring transducers/transformers for indicating power and energy, shall comply with an appropriate standard such as BS EN [2] and to at least accuracy class 1. Sensors for temperature, flow rate and pressure measurements shall meet the minimum accuracy requirements in ASHRAE Standard 114 [3] or similar equivalent.</p> <p>Metering provision shall identify electricity use patterns for major air handling equipment, such as centralised air handling units for floors/zones, large designated areas, etc.</p> <p>Metering provision shall identify the electricity use pattern for each major system, fed from the Owner/Operator's main switchboard(s), i.e., landlord's lighting and small power, transportation, plumbing & drainage systems, major air handling equipment, such as centralised air handling units for floors/zones, large designated areas, etc.</p>

1 K Calder. The Building Services Research and Information Association. Practical Chiller System Monitoring. Technical Note TN 7/94. 1994.
2 British Standard BS EN 60521:1995. Class 0.5, 1 and 2 alternating-current watt-hour meters.
3 ASHRAE. Standard 114-1986: Energy Management Control Systems Instrumentation, American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc., USA. 1987.

BACKGROUND

Surveys of a large number of buildings in Hong Kong [4] revealed that buildings are in general insufficiently equipped with measuring and monitoring devices for measurement of energy performance. This makes it particularly difficult to improve the energy efficiency of buildings and major plant, such as the central chiller plant.

Opportunities for reducing energy consumption can be identified only if it is possible to monitor performance of the systems. Good monitoring systems can allow better control of part load performance, not only improving efficiency, but also improving the control of the building's thermal comfort conditions. Plant control can be altered and the results monitored to show how energy consumption changes. Unseen plant faults, which are not evident during routine maintenance, can be identified from analysis of performance trend data. Control problems can be detected and control strategies improved to match the building demand.

The cost of instrumentation is not significant when compared with installation costs and the accuracy should be such as to provide meaningful readings. The payback on improved performance can be very high taking into account the reduction in electricity consumption and demand charges resulting from more efficient plant operation.

4 Yik F W H, Chiu T W. Measuring instruments in chiller plants and uncertainties in performance evaluation. Transactions, The Hong Kong Institution of Engineers, 5(3) 95-99.

4	ENERGY USE	4.5 BUILDING DESIGN FOR ENERGY EFFICIENCY
		EU 13 ENERGY EFFICIENT BUILDING LAYOUT
	EXCLUSIONS	None.
	OBJECTIVE	To enhance the building energy efficiency through environmentally considered planning and architectural design.
	CREDITS ATTAINABLE	2
	PREREQUISITES	None.
	CREDIT REQUIREMENT	<p>1 credit for demonstrating the fulfillment of at least 3 items out of the following strategies;</p> <p>2 credits for demonstrating the fulfillment of all of the following strategies:</p> <p>For residential developments:</p> <ol style="list-style-type: none">To demonstrate compliance, energy simulation must be provided to show that the average solar irradiance of all facades is lower than 395 kWh/m²/ apr-oct;Compliance is demonstrated by showing that a site permeability of 20% can be achieved between assessed building and nearby buildings/obstructions;Demonstrate that 20% of the habitable space can utilise natural ventilation either by the prescriptive approach or the performance approach;Demonstrate that the OTTV of habitable spaces is less than or equal to 30 W/m²; andDemonstrate that the VDF of habitable spaces are 50% more than the baseline requirements. <p>For all building types excluding residential:</p> <ol style="list-style-type: none">Consideration of built form and building orientation to enhance energy conservation;Consideration of optimum spatial planning to enhance energy conservation;Consideration of building permeability provisions of building features to enhance the use of natural ventilation;Provision of fixed or movable horizontal/vertical external shading devices; andProvision of movable external shading devices for major atrium facade windows or skylights.
	ASSESSMENT	<p>The Client shall submit documentation to demonstrate compliance with the strategy indicators:</p> <ul style="list-style-type: none">Clear definition of the objectives of each energy efficient building design, features, evaluated options, applications and verification of the design strategies;Annual energy saving estimation;Other relevant supporting documentation for improved and innovative ideas;Relevant information to demonstrate sufficient effort has been made on the required provisions and considerations, as well as the final design solution that addressed the commitments; and

Where at least 3 items are achieved the credit shall be awarded. The second credit shall be awarded for all strategies achieved.

5 WATER USE

5.P PREREQUISITE

5.1 WATER CONSERVATION

5.2 EFFLUENT

INTRODUCTION

Water is known to be in scarce supply in many parts of the world, even though it is also in surplus elsewhere. Globally, water conservation is already a major issue [1]. Hong Kong has long enjoyed a reliable and economic supply of most of its fresh water needs from the Mainland. However, with increased industrialisation of Guangdong Province there is likely to be greater competition for water supply, meaning that water conservation may become a significant issue for Hong Kong in the future.

Hong Kong should look into ways to improve the utilisation and conservation of water resources.

5.P PREREQUISITE

WU P1 WATER QUALITY SURVEY

WU P2 MINIMUM WATER SAVING PERFORMANCE

BACKGROUND

In Hong Kong, the WSD controls water quality, such as taste, odour, hardness, sediment, pH, the quantity of dissolved iron, etc., in order to provide water that meets the Guidelines for Drinking-water Quality recommended by the World Health Organization (WHO). Samples are taken at treatment works, service reservoirs, consumer taps and analysed at site and at WSD's laboratories. Nevertheless, the unsatisfactory quality of potable water delivered at taps may be due to the corrosion of water pipes or the cleanliness of water tanks. As a consequence the use of bottled water is common, but is not considered to be an environmentally preferred solution due to the production and transport requirements. To ensure the health of building users, designers need to ensure optimal potable water quality at the tap - potable water that is both safe and acceptable in terms of taste, colour and odour.

It is also necessary to reduce the potable water consumption. This can be achieved through the application of water saving fixtures and the use of non-potable water (e.g. harvested rainwater and recycled grey water)

5.1 WATER CONSERVATION

WU 1 ANNUAL WATER USE

WU 2 MONITORING AND CONTROL

WU 3 WATER EFFICIENT IRRIGATION

WU 4 WATER RECYCLING

WU 5 WATER EFFICIENT APPLIANCES

WATER SUPPLY

Except for a small number of villages scattered in the remotest areas, over 99.9 per cent of Hong Kong's population receives piped fresh water supply. Sea water is supplied to about 80 per cent of the population for toilet flushing, though mains fresh water is supplied to areas that are not close to the seafront, or where the population is scattered and sparse. Effort will be made to bring sea water to more places, including the Peak, part of Southern District, Sai Kung, the outlying islands, Tin Shui Wai and Yuen Long [2]. Raw water from the Dongjiang River in Guangdong continues to be Hong Kong's main source of supply and makes up about 70-80 per cent of Hong Kong's needs.

In 2007 the average daily consumption of fresh water was 2.61 million

1 OECD. Environmental Performance Reviews - Water. Performance and Challenges in OECD Countries. 2003. <http://www.oecd.org/dataoecd/12/38/2498050.pdf>

2 Water Supplies Department. Annual Report. http://www.wsd.gov.hk/filemanager/en/share/annual_reports/rpt0203/pdf/09_water_supply.pdf

cubic metres while the average daily use of sea water for flushing stood at 0.74 million cubic metres [3]. Total freshwater consumption was 951 million cubic metres, with domestic consumption accounting for over 50%, and around 25% consumed by the service trade. Despite the continued decline in industrial consumption there is an annual trend of rising consumption due to increasing domestic consumption. Based on projected population growth for the period, the domestic and service uses, being the key components of our fresh water consumption, are expected to increase. Industrial use, for the same period, is expected to drop because of further decline in water intensive industries. Wider use of fresh water in water-cooled air-conditioning systems (WACS) will contribute to consumption by the non-domestic sector.

CONSERVATION

Although the demand growth has slowed in recent years, additional water resources are still required to secure a full supply. The lack of reservoir sites and high development costs limit the development of further areas as water-gathering grounds. Other than expanding the use of sea water for flushing and adopting water conservation measures, Hong Kong has few options to reduce dependency on the Mainland. There is opportunity to reduce potable water use through better design, management and user awareness. There are also opportunities to recycle used water and rain water in order to reduce the use of potable water. Additional benefits of potable water conservation are reduced energy use for transport and the cost of treatment of raw water.

BENCHMARKS

Given the paucity of available data for Hong Kong and variability of circumstances for different buildings and uses, BEAM provides default assumptions for the calculation of the reduction in water consumption of the project building when compared with an equivalent baseline case. The default assumption including the flow rate and operating time of the water device are given in Appendix 8.6. An information paper is also available that explain the basis and origins of the default assumption. Consequently, it is feasible to provide an exact target for reducing consumption with the baseline.

5.2 EFFLUENT

WU 6 EFFLUENT DISCHARGE TO FOUL SEWERS

BACKGROUND

Whilst some 80% of users in Hong Kong are supplied with seawater for flushing purposes there are environmental impacts associated with the treatment and delivery of seawater, and the load imposed on municipal sewage treatment plants. Measures taken to reduce volumes of effluent flows have significant environmental benefits.

3 Water Supplies Department. Annual Report.
http://www.wsd.gov.hk/filemanager/en/share/annual_reports/rpt0708/index.htm

5	WATER USE	5.P PREREQUISITE
		WU P1 WATER QUALITY SURVEY
	EXCLUSIONS	None.
	OBJECTIVE	Ensure that the quality of potable water delivered to building users is satisfactory.
	REQUIREMENT	Demonstrating that the quality of potable water meets the referenced drinking water quality standards at all points of use.
	ASSESSMENT	The Client shall provide details of the analysis of samples taken from a selection of potable water outlets used to supply human consumption. Sampling should be systematic, such as described in ISO 5667 [1], but as a minimum samples shall be taken at all the farthest point(s) of use in the distribution system from the storage tank, and shall include sampling for each water supply tank used in the building. If water quality at all sample points meets with Water Supplies Department (WSD) Guidelines the requirement shall be fulfilled.
	BACKGROUND	According to the agreement between Guangdong and Hong Kong, "all water supplies to Hong Kong will meet the water quality standard of Guangdong Province currently in force and will not be inferior to the Class II water quality standard stipulated in the Environmental Quality Standard for Surface Water GB 3838-83 published by the People's Republic of China in 1983" [2].
	QUALITY OF WATER SUPPLIED FROM THE MAINLAND	It is closely monitored by WSD on entering Hong Kong at reception points at Muk Wu Pumping Stations at the border and again at all treatment works receiving the raw water. Laboratory tests are performed daily on various parameters such as ammonia and manganese for monitoring because their levels in the raw water are useful reference for dosing of treatment chemicals. The sampling and testing frequencies of individual parameters vary from 4-monthly to three times per day, and if necessary as frequently as hourly. All raw water is delivered to water treatment works where it is treated to comply chemically and bacteriologically with the WHO Guidelines for Drinking-water Quality (2006) before being supplied to consumers.
	SUPPLY QUALITY	According to WSD [3] Hong Kong's water is of the safest quality and among the best in the world. However, it is affected in some instances by the inadequate maintenance of internal plumbing systems before it reaches customers' taps and this can cause discolouration of the water. To encourage building owners to maintain their plumbing systems properly and with the endorsement of the Advisory Committee on the Quality of Water Supplies (ACQWS), the Water Supplies Department launched the Fresh Water Plumbing Quality Maintenance Recognition Scheme [4] in 2002. Since 1 January 2008, the Scheme has been renamed the Quality Water Recognition Scheme for Buildings. Successful applicants will be awarded a Certificate to recognise proper maintenance of the plumbing systems inside a building for keeping the good quality of government-supplied water throughout the inside service up to the consumers' taps.

- 1 ISO 5667-5: 1991. Water quality — Part 6: Sampling — Section 6.5 Guidance on sampling of drinking water and water used for food and beverage processing.
- 2 Water Supplies Department. ACQWS Paper No. 5. Raw Water Quality Monitoring in Hong Kong.
- 3 Water Supplies Department. Annual Report.
http://www.wsd.gov.hk/filemanager/en/share/annual_reports/rpt0203/pdf/08_water_quality.pdf
- 4 Water Supplies Department. Fresh Water Plumbing Maintenance Guide.
<http://www.wsd.gov.hk/filemanager/en/share/pdf/FWPMGe.pdf>

**PLUMBING
INSTALLATIONS**

Section 14(3) of the Waterworks Ordinance (Chapter 102) empowers the Water Authority to prescribe the manner of construction or installation and the nature, size and quality of the pipes and fittings of an inside service or fire service for water supplies. All plumbing proposals for inside service and fire service are therefore subject to the approval of the Water Authority [5]. The Hong Kong Waterworks Standard Requirements is a set of normal requirements which are applicable to the installation of inside service and fire service in addition to the requirements that are set out in Schedule 2 of the Waterworks Regulations (Chapter 102) or modified under Regulation 25(1). Where necessary, additional requirements may also be imposed on an individual application for water supply, depending on the nature and type of the plumbing installations.

SAMPLING

Part 6 of ISO 5667 [2] establishes detailed principles to be applied to the design of sampling programmes, to sampling techniques and to the handling and preservation of samples of drinking water and water used for food and beverage processing (drinking water). It is important that the sampling purpose be defined as accurately as possible and that the measurements provide the required information in the most efficient and statistically representative manner.

5 Water Supplies Department. Hong Kong Waterworks Standards for Plumbing Installations in Buildings.
http://www.wsd.gov.hk/filemanager/en/content_149/hkwsre.pdf

5	WATER USE	5.P PREREQUISITE
		WU P2 MINIMUM WATER SAVING PERFORMANCE
	EXCLUSIONS	None.
	OBJECTIVE	Reduce the consumption of fresh (potable) water through the application of water saving devices that have proven performance and reliability.
	REQUIREMENT	Demonstrate that the use of water efficient devices leads to an estimated aggregate annual saving of 10%.
	ASSESSMENT	<p>Given the paucity of available data for Hong Kong and variability of circumstances for different buildings and uses, BEAM seeks to provide flexibility in the assessment by:</p> <ul style="list-style-type: none">• allowing Clients to submit justification for the award of credits, or• using the pro-forma calculation method described below. <p>Calculation shall be provided to determine the reduction of water consumption in the project space compared with a similarly occupied space whose water fittings and appliances conform to a baseline performance. Project teams may use the template as a point of reference when performing their calculations.</p> <p>The calculation takes into account the number of occupants, male to female ratio, and the number of operational days per annum. This information must be supplied by the Client and may be stated in the design brief or Owner's Project Requirements (OPR).</p> <p>Water use is based either on a 'per operation' basis or as the product of flow rate and operation time. The default assumptions for the calculation procedure are given in Appendix 8.6.</p> <p>Number of water devices installed and frequency of use must be the same for both the baseline and project case. Clients must provide the manufacturers' specifications for the performance of installed water devices.</p> <p>The Client shall submit a report that:</p> <ul style="list-style-type: none">• details all installed devices and their water consumption rate or discharge volume; and• details devices installed to reduce the potential wastage of water due to unnecessary operation of taps, etc; <p>The submitted report shall contain the following information:</p> <ul style="list-style-type: none">• number of operational days per annum;• number of occupants; and• male to female ratio. <p>There should be two sets of tables, one for the project space, and one for the base line space.</p> <p>In the table, each type of water using device shall be listed and all data used shall be referenced to the source. The calculation shall include water taps for bath, basin, pantry, kitchen, and also shower heads, and exclude water closets, urinals, water features, appliances and irrigation. There should be separate entries for water use in male and female facilities. Tabular data should be similar to the following format:</p>

Water consumption of flow devices (faucets, showers, etc):

Device/ equipment	Rated Flow rate	Duration of each operation	Daily Number of Uses	Daily Water Use
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Water consumption of utensil washing operation by hand:

Device/ equipment	Water Use per operation or cycle	Daily number of operations	Daily Water Use
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The calculations can be summarised as follows:

	Project case	Baseline case
Estimated total daily consumption (litres)		
Estimated total annual consumption (litres)		
Estimated annual savings (litres) and percentage:		

Where it can be demonstrated that the provision of equipment meets the intent, the requirement shall be fulfilled. Confirmation of the award of credits shall take into account the appropriateness of the data used and the estimated percentage of potable water saved.

BACKGROUND

Hong Kong differs from most other places in the world because most buildings have a saltwater flushing supply rather than using potable water. Therefore the scope for potable water reductions may be more limited here than elsewhere. Locally, neither the quantification of water use nor the potential for savings has been addressed in the research literature. Nevertheless, evidence from other countries suggests that reductions in water use may be achieved through the use of water efficient devices and automatic controls.

For the majority of projects, a limited amount of hand washing and perhaps some manual dish washing will take place in the pantry. It is not the intention to include water used for washing food or produce (required for hygiene), nor water used for coffee making machines, etc.

There is an increasing availability of devices and plumbing fixtures which have demonstrated an ability to save water over the lifetime of the system if installed and maintained properly. Flow rates can be controlled to reduce excessive discharge at taps, faucets and showers without detriment to the quality of water delivery. Substantial evidence shows that the use of water-efficient plumbing fixtures conserves water [1]. A number of studies in the U.S. have measured the impact of installing water-efficient plumbing fixtures through sophisticated sensors, before and after comparisons of water bills, or other means. Although the results varied, the studies generally concluded that low-flow fixtures are effective in saving water.

High efficiency devices include low flow rate faucets or faucets with aerated flows. However it must demonstrate that the actual quantity of water is reduced per standard operation (e.g. in the case of hand

1 United States General Accounting Office. Report to Congressional Requesters. Water Infrastructure. Water-Efficient Plumbing Fixtures Reduce Water Consumption and Wastewater Flows. GA RCED-00-23. August 2000.

washing show that a reduced flow rate does not result in an extended hand washing time resulting in no reduction in water volume used).

The provision of automatic shut-off devices, particularly in public use areas, can save significant amounts of water. Examples of automatic shut-off devices are spring-loaded (or push-once) taps, electronic proximity sensors, etc., but excluding timed shut-off devices.

SYNERGIES

There have been concerns that certain low flow devices such as aerated faucets may increase the risk of Legionella transmission [2]. Legionella concerns are addressed in credit Wu P1 Water Quality Survey.

Water recycling schemes are rare in Hong Kong. If such schemes are employed, project teams are encouraged to apply for credits under the Innovations and Additions section.

2 Prior, J. Sustainable retail premises: an environmental guide to design, refurbishment and management of retail premises, Building Research Establishment, Watford, 1999.

5	WATER USE	5.1	WATER CONSERVATION
		WU 1	ANNUAL WATER USE
	EXCLUSIONS	None.	
	OBJECTIVE	Reduce the consumption of fresh (potable) water through the application of water saving devices that have proven performance and reliability.	
	CREDITS ATTAINABLE	3	
	PREREQUISITES	WU P2 Minimum Water Saving Performance and compliance with Waterworks Regulation Chapter 102A [1].	
	CREDIT REQUIREMENT	1 credit for demonstrating that the use of water efficient devices leads to an estimated aggregate annual saving of 20%. 2 credits for demonstrating an estimated annual saving of 25%. 3 credits for demonstrating an estimated annual saving of 30%.	
	ASSESSMENT	Where the Client can demonstrate that the provision of equipment meets the intent and the target percentage of reduction can be achieved, the credit(s) shall be awarded according to the percentage of reduction achieved. The calculation methodology used for this credit shall be consistent with Prerequisite WU P2.	

1 Government of HKSAR Water, Bi-lingual Laws Information System (BLIS), Waterworks Regulations Chapter 102A.
http://www.legislation.gov.hk/blis_ind.nsf/WebView?OpenAgent&vwpg=CurAllChinDoc*102*100*102.2#102.2

5	WATER USE	5.1 WATER CONSERVATION
		WU 2 MONITORING AND CONTROL
	EXCLUSIONS	None.
	OBJECTIVE	Reduce wastage of fresh water and allow for auditing of water use.
	CREDITS ATTAINABLE	1
	PREREQUISITES	Compliance with Waterworks Regulation Chapter 102A Regulation 32.
	CREDIT REQUIREMENT	1 credit for installation of devices to monitor water leakage from the fresh water distribution systems without embedded plumbing pipework.
	ASSESSMENT	<p>The Client should demonstrate if means are in place that can effectively limit the wastage of water by early detection of water leakage from the plumbing system within the building.</p> <p>The applicant is required to state explicitly in the submitted plumbing drawings that no water pipe will be embedded in load bearing structural elements such as columns, beams and slabs in longitudinal directions [1]. And that plumbing installation does not have any embedded pipe work in non-structural elements of the construction. Pipe work protected by a sleeve and embedded in a non-structural element is accepted, and water leakage detectors such as infrared or moisture detector shall be provided.</p> <p>Various approaches are available and BEAM is not intended to be prescriptive as to which should be used.</p> <p>The Client shall submit a detail report on the system(s) for monitoring water leakage from internal plumbing installations. Where it can be demonstrated that the provisions of equipment meet the intent, the credit shall be awarded.</p>
	BACKGROUND	<p>Water seepage has been a cause for concern to a number of Government departments including the Buildings Department [2]. Detection of water leaks in service pipework also presents an opportunity to save water, and perhaps more importantly, reduce the potential for structural damage as well as the creation of unhygienic conditions.</p> <p>Causes of water seepage vary but one of the common sources of seepage is water-borne piping embedded in the structural members of a building. Water seepage arising from embedded piping causes not only nuisance but also deterioration to the structural member of a building if unattended for a prolonged period. Designers are strongly advised to design the routing of all water-borne piping off structural elements to meet the indispensable need for repair and replacement of such piping during the design life of the building, which would normally outlast the design life of the piping. The huge benefit to the consumers and the public that this will bring about in terms of easy maintenance of the building for its entire design life will certainly outweigh the efforts at the design stage of a building project.</p>

1 WSD circular letter No 1/2000 dated 7 June 2000.
2 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers. PNAP No. APP-105 Water Seepage.
<http://www.bd.gov.hk/english/documents/pnap/APP/APP105.pdf>

5	WATER USE	5.1 WATER CONSERVATION
		WU 3 WATER EFFICIENT IRRIGATION
	EXCLUSIONS	Where soft landscaping and planting coverage is less than 50% of the area of the building footprint.
	OBJECTIVE	Reduce the reliance on potable water for irrigation.
	CREDITS ATTAINABLE	1
	PREREQUISITES	None.
	CREDIT REQUIREMENT	<p>1 credit for the use of an irrigation system which does not require the use of municipal fresh water after a period of establishment is complete.</p> <p>Alternately,</p> <p>1 credit for demonstrating highly efficient irrigation technology and/or the use of harvested rainwater and/or recycled grey water to reduce fresh water consumption for irrigation by 50% or more in comparison with conventional irrigation of water intensive planting.</p>
	ASSESSMENT	<p>The Client shall provide a report prepared by a suitably qualified person describing the soft landscaping design, species of plants, etc., and confirm that, after a period of establishment of the plants and vegetation, irrigation will not require the use of municipal potable (fresh) water supply.</p> <p>Alternatively, the Client shall demonstrate highly efficient irrigation technology and/or the use of harvested rainwater and/or recycled grey water to reduce fresh (mains) water consumption for irrigation by 50% or more in comparison with conventional irrigation of water intensive planting.</p> <p>Water use reduction may be demonstrated by comparing the metered data to any suitable benchmark, or may be demonstrated by calculations provided by a suitably qualified person.</p>
	BACKGROUND	<p>Where a building development contains significant landscaping, as defined by the coverage of soft landscaping, greenery and planters, there is likely to be a significant consumption of potable water. Irrigation by lower quality (harvested or recycled) water can be equally effective. Native plants can survive without additional watering, and require less fertiliser and pesticides, thereby reducing impacts on local waters.</p> <p>There is the potential to use well water, but due consideration must be given to the requirements of the Water Authority. Normally, wells may not be sunk on government land [1]. Permission under Building (Construction) Regulation 85 [2] to sink a well in private land will be given only where the:</p> <ul style="list-style-type: none">• well yield is adequate; and• water abstraction will not adversely affect nearby services buildings, structures or land.

1 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineer. PNAP No. APP-4 Water Supply and Wells.
<http://www.bd.gov.hk/english/documents/pnap/APP/APP004.pdf>

2 Department of Justice, CAP 123B Building (Construction) Regulations
[http://www.legislation.gov.hk/blis_pdf.nsf/6799165D2FEE3FA94825755E0033E532/4DB8C4250F4FD17D482575EE003E38A/\\$FILE/CAP_123B_e_b5.pdf](http://www.legislation.gov.hk/blis_pdf.nsf/6799165D2FEE3FA94825755E0033E532/4DB8C4250F4FD17D482575EE003E38A/$FILE/CAP_123B_e_b5.pdf)

5	WATER USE	5.1 WATER CONSERVATION
		WU 4 WATER RECYCLING
EXCLUSIONS		None.
OBJECTIVE		Encourage harvesting of rainwater and recycling of grey water in order to reduce consumption of fresh water.
CREDITS ATTAINABLE		2 + 1 BONUS
PREREQUISITES		Compliance with the water quality standards appropriate to the use of the recycled water.
CREDIT REQUIREMENT		<p>a) Harvested rainwater</p> <p>1 credit for harvesting of rainwater which will lead to a reduction of 5% or more in the consumption of fresh water.</p> <p>b) Recycled water</p> <p>1 credit where recycled grey water will lead to a reduction of 5% or more in the consumption of fresh water.</p> <p>c) A combination</p> <p>1 BONUS credit where harvesting and/or recycling leads to a reduction of 10% or more in the consumption of fresh water.</p>
ASSESSMENT		<p>Harvested and/or recycled water shall satisfy the water quality requirements for the intended reuse, e.g., cleaning, irrigation, use in heat rejection systems, toilet flushing, etc.</p> <p>a) Harvested rainwater</p> <p>The Client shall provide a detailed report on the system or systems installed for the purpose of harvesting rainwater, the details of the expectations in respect of savings in the consumption of fresh water, and shall demonstrate that the rainwater is of a quality appropriate to the end use. Where it can be demonstrated that the expected savings in fresh water use will be 5% or more based on baseline building estimation (see Section WU P2), the credit shall be awarded.</p> <p>b) Recycled water</p> <p>The Client shall provide a detail report on the system or systems installed for the purpose of recycling grey water, the details of the expectations in respect of savings in the consumption of potable water and shall demonstrate that the treated grey water is of a quality appropriate to the end use. The condensed water shall be included in the calculation of recycled grey water. Where it can be demonstrated that the expected savings in fresh water use will be 5% or more based on baseline building estimation (see Section WU P2), the credit shall be awarded.</p> <p>c) A combination</p> <p>The Client shall provide a detailed report on the system or systems installed for the purpose of harvesting rainwater and/ or recycling grey water, the details of the expectations in respect of savings in the consumption of potable water and shall demonstrate that the rainwater and/ or treated grey water is of a quality appropriate to the end use. Where it can be demonstrated that the expected savings in fresh water use will be 10% or more based on baseline building estimation (see Section WU P2), the credit shall be awarded.</p>

BACKGROUND

Recycling of grey water not only helps to reduce the demand for potable water supply, but also provides a reliable source in case of supply interruptions. When properly done, it is possible to reuse all wastewater for various purposes. A grey water recycling system is one which collects grey water (reclaimed condensate, etc) for treatment and distributes the treated water to the points of use, such as for irrigation, cleaning, or for toilet flushing where seawater supply is not available. Another potential use of the recycled water is for evaporative heat rejection system in air conditioning, which will provide an energy benefit and improves the cost-effectiveness of water recycling.

Water quality should meet appropriate criteria, such as that outlined by ACQWS [1], the Building Research and Information Association [2], or similar authoritative guidance.

Due consideration has to be given to the amounts of water that can be generated and how this matches with the amounts that can be put to use; otherwise there is little incentive to recycle.

The problem for Hong Kong's high-rise dense built environments is that the potential for collecting rainwater is limited. Yang et al [3] provide the main parameters and their relationship to estimate the amount of rainwater that may be collected on different roof areas and different sizes of tanks, based on the amount of rainfall as recorded by the Hong Kong Observatory.

Well-populated buildings not supplied with seawater for flushing would be a good candidate for water recycling, otherwise reuse is likely to be limited, depending on the extent of cleaning, irrigation and the types of equipment used for cooling.

- 1 Water Supplies Department. ACQWS Paper No. 14 – Treated Effluent Reuse at Ngong Ping.
- 2 BSRIA, Greywater and Rainwater Systems: Recommended UK Requirements, The Building Services Research and Information Association, Final Report 13034/1, March 1997.
- 3 Yang H X, Chow W H, Burnett J. Water and Energy Conservation of Rainwater Collection Systems on Building Roofs. *Advances in Building Technology*, Vol. 2. Elsevier. 2002. pp 1281-1288.

5	WATER USE	5.1 WATER CONSERVATION
		WU 5 WATER EFFICIENT APPLIANCES
	EXCLUSIONS	Buildings in which facilities and/or appliances are not installed by the developer.
	OBJECTIVE	Encourage the wider use of water efficient facilities and appliances.
	CREDITS ATTAINABLE	1
	PREREQUISITES	None.
	CREDIT REQUIREMENT	1 credit for installing water efficient appliances that have Water Efficiency Labelling Scheme Grade 2 or above.
	ASSESSMENT	<p>The Client shall provide details of all the appliances installed in the building.</p> <p>Where all appliances with Water Efficiency Labelling Scheme (WELS) Grade 2 or above are provided this credit shall be achieved.</p> <p>The appliances which are not covered in WELS or equivalent system shall be excluded in the calculation.</p>
	BACKGROUND	Water use in washing machines, dishwashers in homes, in hotel laundries, etc., can be a substantial part of fresh water consumption. Likewise, there is an opportunity for reducing water loss from water features and recreational facilities. BEAM encourages attention to the selection of water efficient equipment and design of water using facilities that include means to save water.

5	WATER USE	5.2	EFFLUENT
		WU 6	EFFLUENT DISCHARGE TO FOUL SEWERS
	EXCLUSIONS	None.	
	OBJECTIVE	Reduce the volumes of sewage discharged from buildings thereby reducing burdens on municipal sewage supply and treatment facilities.	
	CREDITS ATTAINABLE	1	
	PREREQUISITES	Compliance with the Water Pollution Control Ordinance, and the Building (Standards of sanitary fitments, plumbing, drainage works and latrines) Regulations Chapter 123 Regulation 17.	
	CREDIT REQUIREMENT	1 credit for demonstrating a reduction in annual sewage volumes by 20% or more.	
	ASSESSMENT	Where the Client can demonstrate that the target percentage of reduction in annual sewage volume can be achieved, either based on the default assumptions for the calculation procedure given in Appendix 8.6 or any other appropriate estimation, the credit(s) shall be awarded.	
	BACKGROUND	<p>Demand for flushing and potable water should be assessed with regard to Building (Standards of Sanitary Fitments, Plumbing, Drainage Works and Latrines) Regulation 10A(4). "Potable water" refers to a supply of water for the purposes of Regulation 10A(2) [1]. The quantity of flushing water required is given in PNAP 17 [2].</p> <p>Regulation 19 of the Building (Standards of Sanitary Fitments, Plumbing, Drainage Works and Latrines) Regulations (Drainage Regulations) requires flushing cisterns of water closet fitments to have a discharge between 9 and 14 litres. Under the current Waterworks Regulations, flushing cisterns shall be of the valveless syphonic type and the flushing volume shall be within the range of 7.5 and 15 litres [3].</p> <p>With the application of modern technology in the design of water closet flushing systems, the effectiveness of flushing can be maintained with a reduced discharge. Therefore, to conserve our valuable water resources, both the Building Authority (BA) and Water Authority would have no objection to relaxing the use of syphonic flushing cisterns with discharge less than that required by the current regulations provided that the associated toilet bowls are compatible with the cisterns and the syphonic action is sufficient for the wastes in the toilet bowls to be cleared effectively by a single flush. WSD has relaxed the requirements in respect of the flushing mechanism and minimum flushing volume as follows:</p> <ul style="list-style-type: none"> • the use of valve type flushing devices (mechanical or sensor type with single flush or dual flush) in addition to valveless syphonic type flushing apparatuses; and • the use of flushing devices which are able to give a single flushing 	

1 Department of Justice, CAP 123I building (Standards of Sanitary Fitments, Plumbing, Drainage Works and Latrines) Regulations
[http://www.legislation.gov.hk/blis_pdf.nsf/6799165D2FEE3FA94825755E0033E532/182338FA79710018482575EE003F2DBE/\\$FILE/CAP_123I_e_b5.pdf](http://www.legislation.gov.hk/blis_pdf.nsf/6799165D2FEE3FA94825755E0033E532/182338FA79710018482575EE003F2DBE/$FILE/CAP_123I_e_b5.pdf)

2 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers. PNAP No. APP-4 Water Supply and Wells.
<http://www.bd.gov.hk/english/documents/pnap/APP/APP004.pdf>

3 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers. PNAP No. APP-99 Flushing Volume for Flushing Cisterns.
<http://www.bd.gov.hk/english/documents/pnap/APP/APP099.pdf>

volume of less than 7.5 litres.

The capacity of the flushing cistern in the case of trough water-closets and urinals shall be approved by the Water Authority subject to the discharge in the case of trough water-closets being not less than 9 litres of water for every metre of the channel and the discharge in the case of urinals being not less than 4.5 litres of water for every basin or stall, or in the case of a trough urinal, every metre thereof.

For the purposes of determining the number of persons for whom sanitary fittings should be provided in shops and department stores the determination shall be at the rate of 1 person for every 15 square metres of usable floor area [4].

4 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineer. PNAP No. APP-6 Shops and Department Stores Building Regulation 5. <http://www.bd.gov.hk/english/documents/pnap/APP/APP006.pdf>

6	INDOOR ENVIRONMENTAL QUALITY	6.P	PREREQUISITE
		6.1	SECURITY
		6.2	HYGIENE
		6.3	INDOOR AIR QUALITY
		6.4	VENTILATION
		6.5	THERMAL COMFORT
		6.6	LIGHTING QUALITY
		6.7	ACOUSTICS AND NOISE
		6.8	BUILDING AMENITIES

INTRODUCTION

This section of BEAM considers some of the broader issues of sustainable buildings as well as the most significant indoor performance issues. The broader issues include provisions of hygiene and amenities maintenance provided in the building, which have impact on the quality of working and living environments. Indoor environmental quality (IEQ) includes indoor air quality and ventilation provisions that safeguard health. Considerations of these issues, as well as thermal comfort, lighting, acoustics and noise, impact on well-being, comfort and productivity.

Given that on average people in Hong Kong spend around 85% of their time indoors [1], indoor environmental conditions have a significant impact on the quality of life. Buildings should provide safe, healthy, convenient and efficient indoor spaces. Poor indoor environments in commercial and institutional buildings can impact on productivity and may pose health risks to users. The design, management, operation and maintenance of buildings should seek to provide a good quality indoor environment, but with optimum use of energy and other resources.

ASSESSMENT OF INDOOR ENVIRONMENTS

In keeping with the BEAM assessment approach, the assessment of indoor environments is mainly performance based, with the majority of credits awarded for meeting performance specifications at the commissioning stage before handover and occupancy. In addition to performance, credits are also awarded for compliance with certain building features with known potential to enhance performance.

Assessment is not intended to embrace the negative impacts from the user of premises, and it is clear that a building that is not yet fully fitted-out, furnished and occupied cannot be fully tested for compliance with all possible performance specifications. BEAM Plus seeks to ensure that buildings and systems are tested as far as possible to ensure that intended performance is likely to be achieved, providing that tenants/occupants follow the fitting-out specifications and the guidance for use is appropriate to the type of the premises they occupy.

The assessment of indoor air quality (IAQ), ventilation and thermal comfort takes into account:

- the extent to which the building and installed engineering systems can provide for comfortable and healthy premises; and
- the potential ‘worst-case’ scenario in respect of exposure to harmful substances found in indoor air.

To allow for the differences in environmental conditions likely to be found in different buildings/premises, for the purposes of assessment BEAM

1 Chau C K, Tu E Y, Chan D W T, Burnett J. Estimating the total exposure to air pollutants for population age groups in Hong Kong. Environment International. Vol. 27. 2002. pp 617–630.

Plus considers buildings as follows:

- Air-conditioned Buildings;
- Air-conditioned / Naturally Ventilated Buildings; and
- Mechanically Ventilated Buildings.

AIR-CONDITIONED BUILDINGS

Thermal comfort conditions and ventilation in air-conditioned buildings/premises which are designed on the principle of ‘build tight, ventilate right’ are intended to be controlled within prescribed design limits. The thermal comfort criteria used for the design, such as ISO 7730 [2], ASHRAE 55 [3] etc, will be defined by the Client appropriate to the type and use of the premises included in the development, and is a basic performance specification.

BEAM Plus takes into account the Government’s Indoor Air Quality Certification Scheme [4], as implementation of the Scheme can have a significant impact on the performance of air-conditioned buildings through improved design, construction, and operating practices.

AIR-CONDITIONED/ NATURALLY VENTILATED BUILDINGS

In buildings/premises with operable windows or other ventilation openings, the extent to which natural ventilation is utilised for cooling will be dependent on user preference. Besides the prevailing climatic conditions, this is likely to be influenced by the level of outside air pollution and noise. Thermal comfort conditions in air-conditioned areas will depend on user preference, which can be satisfied by providing the proper size and installation of air-conditioning units to meet the required cooling load. Consideration of thermal comfort and IAQ in occupied/habitable rooms need to take into account the following conditions: when premises are air-conditioned or ‘closed’ because of cold or inclement weather; and when more ‘open’ to take advantage of natural ventilation. Consideration is given to worst case scenarios that might impact the health of building users.

6.P PREREQUISITE

IEQ P1 MINIMUM VENTILATION PERFORMANCE

BACKGROUND

This requirement ensures that ventilation systems of the air-conditioned premises have been designed according to recognised procedures to provide a minimum ventilation rate of sufficient quality and quantity.

6.1 SECURITY

IEQ 1 SECURITY

BACKGROUND

Provisions for security are considered to enhance the building performance and are considered here as credits.

6.2 HYGIENE

IEQ 2 PLUMBING AND DRAINAGE

IEQ 3 BIOLOGICAL CONTAMINATION

IEQ 4 WASTE DISPOSAL FACILITIES

BACKGROUND

Post-SARS has seen a lot more attention to building hygiene. Clearly, certain features of building and building services design, e.g. plumbing and drainage systems, are likely to contribute to health problems. Proper provisions for inspection, cleaning and maintenance allows for comprehensive management of hygiene in buildings.

2 International Organization for Standardization. International standard 7730, Moderate thermal environments – Determination of the PMV and PPD indices and specification of the conditions for thermal comfort. Geneva 1995.
3 American Society of Heating, Refrigeration and Air-conditioning Engineers. ASHRAE 55-2007: Thermal Environmental Conditions for Human Occupancy. Atlanta 2007.
4 Indoor Air Quality Management Group. A Guide on Indoor Air Quality Certification Scheme for Offices and Public Places. <http://www.iaq.gov.hk/cert/doc/CertGuide-eng.pdf>

6.3 INDOOR AIR QUALITY

- IEQ 5 CONSTRUCTION IAQ MANAGEMENT
- IEQ 6 OUTDOOR SOURCES OF AIR POLLUTION
- IEQ 7 INDOOR SOURCES OF AIR POLLUTION
- IEQ 8 IAQ IN CAR PARKS

BACKGROUND

Indoor air quality (IAQ) is defined by a list of the constituents, in both solid and gaseous states, in air. Subjectively, IAQ is the human perceived response to nasal irritants in the air. ASHRAE [5] defines 'Acceptable Indoor Air Quality' as "air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction."

A key factor in determining appropriate standards for IAQ is the duration of exposure. Exposure to indoor pollutants for a matter of minutes (e.g. car parks), hours (e.g. entertainment establishments), or over a working day (e.g. offices, classrooms, etc) will be different for most parameters depending on dose and response. For example, limits of the exposure considered acceptable for the general public, include the young and infirm, are different from exposures considered acceptable for the sedentary workplace, and certainly, the industrial workplace.

Sources of indoor pollutants include outdoor pollutants, building fabric materials, interior finishes, building systems and equipment, appliances, consumer products, and the occupants and their activities. The selection of building materials is important, as pollutants can be emitted for weeks, months or even years after installation. The design of the building envelope should consider moisture and vapour penetration, and infiltration. Air intakes should be sited away from pollutant sources and avoid short-circuiting with exhausts. Ventilation system design should not introduce pollutants, and filtering should be effective in removing outdoor pollutants.

6.4 VENTILATION

- IEQ 9 INCREASED VENTILATION
- IEQ 10 BACKGROUND VENTILATION
- IEQ 11 LOCALISED VENTILATION
- IEQ 12 VENTILATION IN COMMON AREAS

BACKGROUND

The outside air ventilation to a centrally air-conditioned building should be adequate for the intended levels of occupancy. The criteria often used to indicate satisfactory provision of ventilation in occupied premises is the level of carbon dioxide (CO₂) at design occupancy. In Hong Kong, it is usual that the minimum values for ventilation rate for various spaces will be specified in accordance with an appropriate version of ASHRAE 62 [5], or an equivalent design standard. However, the amount of ventilation supply reaching the breathing zone of occupants is critical to the adequacy of the ventilation. Inadequate distribution within zones or within rooms can result in dissatisfaction at a local level, even if the total ventilation supplied to a space meets specification. It is not possible to use CO₂ as a measure of satisfactory performance in unoccupied premises, but it is possible to determine if ventilation will be satisfactory through measurement of ventilation rate and ventilation effectiveness.

There are three basic requirements for ventilation of occupied rooms and rooms used for habitation [6,7]; background ventilation, local exhaust,

5 American Society of Heating, Refrigeration and Air-conditioning Engineers. ASHRAE 62.1-2007: Ventilation for Acceptable Indoor Air Quality. Atlanta 2007.
6 ASHRAE Standard 62.2. Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings. Atlanta 2007.
7 UK Department of the Environment and Welsh Office. The Building Regulations Part F Ventilation.

and source control. The concepts can be applied to workplaces, classrooms and similar workplaces where people spend long periods of time. Background ventilation is intended to dilute the unavoidable contaminant emissions from people and materials. Background ventilation should be provided for control of radon levels in occupied and habitable rooms, and reduces possibility of mould growth under conditions of high humidity. Local exhaust is intended to remove contaminants from those specific rooms, such as kitchens, in which concentrated sources are expected.

6.5 THERMAL COMFORT IEQ 13 THERMAL COMFORT IN AIR-CONDITIONED PREMISES

IEQ 14 THERMAL COMFORT IN NATURALLY VENTILATED PREMISES

BACKGROUND

BEAM Plus does not specify the standards of performance for air-conditioned buildings, as the performance criteria will vary amongst building/premises types, and is also a matter of choice for the Client. For example, there may be a preference for operating an air-conditioned space at higher temperatures for the purposes of energy conservation. BEAM Plus seeks to ensure that buildings and systems are tested as far as practicable and the specified thermal comfort conditions can be achieved under conditions of normal occupancy and expected heat gains.

6.6 LIGHTING QUALITY IEQ 15 NATURAL LIGHTING

IEQ 16 INTERIOR LIGHTING IN NORMALLY OCCUPIED AREAS

IEQ 17 INTERIOR LIGHTING IN AREAS NOT NORMALLY OCCUPIED

BACKGROUND

Although it is difficult to achieve in many building developments located in Hong Kong with a dense urban environment, daylight penetration into work places and habitable rooms should be encouraged. Lack of daylight and views to the external environment contribute to discomfort and dissatisfaction of users. Where daylight is accessible, some form of control at windows may be required to avoid glare from direct sunlight.

A consequence of poor lighting in work places is discomfort and loss of working efficiency. Although interior lighting in workplaces is one of the most challenging design tasks, unfortunately often relatively little attention is given to design for work spaces where productive and creative activities take place.

To focus only on luminance level on the horizontal plane is insufficient. The quality of an interior lighting scheme cannot be specified or demonstrated through measurement of light sources and outputs alone, but needs to consider the relationship of the light sources to the nature of the space being illuminated, and visual tasks of users in the space.

6.7 ACOUSTICS AND NOISE IEQ 18 ROOM ACOUSTICS

IEQ 19 NOISE ISOLATION

IEQ 20 BACKGROUND NOISE

IEQ 21 INDOOR VIBRATION

BACKGROUND

When indoor noise is above a certain level, it can cause discomfort, irritation and interference with workplace activities. In addition, poor acoustics in certain premises will interfere with speech intelligibility. Background noise inside buildings comes from a number of sources, including noise break-in from the surrounding environment and noise produced inside the building, such as from building services equipment and adjoining premises. Background noise should be limited to levels which are suitable for the use of the premises in a building development,

expressed as appropriate criteria.

Many Hong Kong buildings are built close to roads and railway lines so ground transportation noise impacts on occupants. Noise from fixed sources and aircraft may also pose a problem for some developments. Good planning and design is especially important to mitigate external noise. Noise mitigation measures such as appropriate road surface design, screening by non-noise sensitive building structures, podium structures or purpose built barriers, orientation, or disposition and internal layout of buildings should be explored in an effort to minimise rail and road traffic noise.

The design of a building facade, including windows, balconies, openings for air-conditioning and ventilation, etc., is important in further reducing the propagation of noise into noise sensitive premises, particularly where external noise levels exceed the limits given in the Hong Kong Planning Standards and Guidelines. Even where external sources of noise and/or noise mitigation measures are shown to satisfy the guidelines, further attention to noise attenuation is warranted on the grounds of comfort and privacy.

The selection and erection of building services systems and equipment also influences the background noise levels in certain locations, and may also induce unwanted vibration. The sound insulation properties of floors and internal walls are crucial in controlling noise propagation inside a building. It is also necessary to consider how the design of premises affects speech intelligibility.

6.8 BUILDING AMENITIES IEQ 22 ACCESS FOR PERSONS WITH DISABILITY

IEQ 23 AMENITY FEATURES

BACKGROUND

In recent years the HKSAR Government has sought to encourage better building designs through various 'green and innovative' features [8,9] that can enhance the quality of buildings, and has put in place a number of incentives to encourage the adoption of such features. Provisions that improve access for users, make for more enjoyable living and working spaces, and ensure efficient services to meet the needs of users, etc., all enhance the quality and efficiency of built environments and thereby ensure buildings are more sustainable.

8 Buildings Department, Lands Department, Planning Department. Joint Practice Note No. 1. Green and Innovative Buildings. <http://www.info.gov.hk/bd/english/documents/joint/JPN01.pdf>

9 Buildings Department, Lands Department, Planning Department. Joint Practice Note No. 2. Second Package of Incentives to Promote Green and Innovative Buildings. <http://www.info.gov.hk/bd/english/documents/joint/JPN02.pdf>

6	IEQ	6.P PREREQUISITE
		IEQ P1 MINIMUM VENTILATION PERFORMANCE
	EXCLUSIONS	Residential and similar buildings without central air conditioning.
	OBJECTIVE	Ensure that a minimum quality and quantity of outdoor air is supplied to spaces in the project in order to support the well-being and comfort of occupants.
	REQUIREMENT	Demonstrate that the project is in compliance with the minimum requirements of ASHRAE 62.1-2007 [1] in respect of Outdoor Air Quality; and Minimum Ventilation Rate.
	ASSESSMENT	<p>The Client shall provide evidence in the form of a report prepared by a suitably qualified person detailing the outdoor ventilation performance. The report shall include:</p> <ol style="list-style-type: none">1. Confirmation that the outdoor air pollutants Carbon monoxide (CO), Nitrogen dioxide (NO₂), Ozone (O₃) and Respirable Suspended Particulates (RSP) conform to the IAQ Certification Scheme Good Air Quality level.2. Completion of Table H-2 of ASHRAE Standard 62.1-2007 demonstrating compliance with the minimum ventilation rate(s) provided.
	BACKGROUND	<p>The purpose of this prerequisite is to provide the minimum outdoor air ventilation for the control of odours, that is, the supply, distribution and control of ventilation to maintain carbon dioxide (CO₂) levels within the design targets in normally occupied spaces, and the control of indoor pollutants such as TVOC's, formaldehyde, etc.</p> <p>The assessment for building follows requirements of ASHRAE 62.1:2007. The standard includes significant requirements other than outdoor air rates, such as requirements for equipment to reduce the potential for microbial growth, air cleaning requirements, and start-up and commissioning requirements. All of these requirements must be met to comply with this prerequisite.</p>

1 American Society of Heating Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE Standard 62.1-2007. Ventilation for Acceptable Indoor Air Quality.

6 IEQ 6.1 SECURITY

IEQ 1 SECURITY

EXCLUSIONS None.

OBJECTIVE Engender a feeling of well-being amongst building users.

CREDITS ATTAINABLE 1

PREREQUISITES Burglar alarm systems shall comply with the Noise Control Ordinance.

CREDIT REQUIREMENT 1 credit for scoring at least 75% of the applicable security measures and facilities for the building.

ASSESSMENT The Client shall submit a report prepared by a suitably qualified person which includes a completed checklist of the security measures and facilities provided, justification for each checked item, details of the physical security systems provided, and a detailed security manual explaining how the physical provisions (hardware) integrate with the management system (software) for the building.

Where 75% compliance of applicable items is demonstrated, the credit shall be awarded.

Alternatively, the Client may provide detailed rationale and arguments to demonstrate that security systems are integrated and an enhanced standard of security can be provided.

ASSESSMENT GRID

Site perimeter controls:	Pt	Surveillance:	Pt	Building Security:	Pt	Site/Building Layout	Pt
Site is fenced, gate(s) attended during active hours, intercom and camera surveillance during silent hours.	2	Lighting of site: Overall illumination of the site is between 50 and 200 lux.	2	Entry from adjacent building(s): Access is prevented by a separating distance of 6m.	2	Pathways are short, wide and straight	1
Restricted areas of the site are fenced with a locked gate.	1	Site is illuminated by street and building exterior lighting.	1	Access from adjacent building is inhibited by barriers.	1	Footpaths are well lit, convex steel mirrors to forestall concealment.	1
Vehicle Access Control: Parking is indoor and with attended control station.	2	Monitoring of site: Colour monitoring of building entrances and perimeter.	2	Security guards can verify by CCTV monitor and card reader.	2	Amenity/play areas overlooked from the building.	1
Parking for visitors and building users are separated with guard patrol.	1	B&W monitoring of building entrances and perimeter.	1	All people and traffic from parking must pass security control or parking control station.	1	Elevators are monitored by CCTV.	1
Security of stored vehicles: Company vehicles in indoor parking or fenced compound with CCTV monitoring in silent hours.	2	Guard patrol: Frequent patrol of building and fence perimeter.	2	Doors and windows at grade: Secured with heavy duty hardware, security glazing and deadlocks.	2	Staircases are wide, open and well lit.	1
Company vehicles in separate well lit area.	1	Single guard patrol during silent hours.	1	Secured with high grade hardware.	1	Meters are located in common areas	1
Optional (by Client)	2	Planting: clear of building pathways and parking.	2	Alarmed for opening and breakage to central control and perimeter is monitored with CCTV.	2	Optional (by Client)	2
Optional (by Client)	1	Planting 6m clear of building.	1	Alarmed locally for opening and breakage.	1	Optional (by Client)	1
Total Applicable Points:		Points Achieved:		Percentage Achieved:			

BACKGROUND

Local surveys undertaken in recent years show that security is a serious concern for estates' residents. This may be in the context of personal safety and in the context of loss of belongings. For commercial and institutional buildings security is also an issue, in public buildings where strangers congregate, in common areas such as staircases and toilets, etc.

The design of building, landscape and the implementation of security facilities can effectively reduce most burglaries and other crimes. The security facilities and measures required depend on the type of premises and level of security needed. In general, effective security incorporates three elements: natural and architectural barriers that discourage access, human security and electronic security.

Security can be enhanced through the integrated use of reliable hardware (surveillance cameras, security barriers, etc.) coupled with a sound management system (watchman tour, etc.). Security systems need to be integrated with fire safety management and communications systems.

Assessment should take into account the guidelines provided in ASTM [1,2], BS [3], and similar authoritative guidance, and the extent to which the security provisions 'score' against the assessment grid provided herein.

- 1 ASTM International. Designation E 1665-95a. Standard Classification for Serviceability of an Office Facility for Facility Protection.
- 2 ASTM International. Designation E 1693 -95a. Standard Classification for Serviceability of an Office Facility for Occupant Assets.
- 3 British Standards Institution. BS8220. Standard Guide for Security of Buildings Against Crime.

6	IEQ	6.2	HYGIENE
		IEQ 2	PLUMBING AND DRAINAGE
	EXCLUSIONS	None.	
	OBJECTIVE	Reduce the potential for contamination of plumbing and drainage systems, the ability of systems to carry infections, and the likelihood of odours.	
	CREDITS ATTAINABLE	1	
	PREREQUISITES	Compliance with the provisions of the Building (Standards of Sanitary Fitments, Plumbing, Drainage Works and Latrines) Regulations.	
	CREDIT REQUIREMENT	1 credit for designs that reduce the potential for transmission of harmful bacteria viruses and odours.	
	ASSESSMENT	<p>The Client shall submit details of the plumbing and drainage systems in the form of drawings and specifications, and confirmation that installation of the systems was carried out according to the specifications. A summary report shall be submitted highlighting where appropriate means have been included to allow for safe and hygienic operation over the expected lifespan of the systems and components.</p> <p>The 'appropriate means' shall include, but are not limited to the following:</p> <ul style="list-style-type: none">• adequacy of flushing water supply to meet the pattern of demand;• design of drainage stacks of adequate capacity for peak loading;• venting of stacks;• access to pipework and ducts for maintenance purposes;• installation of buried pipework that pays attention to leaks at joints, seals, etc. for the expected life of the installation;• design of floor drains; and• maintenance of water seals. <p>Where it can demonstrate that the design and installation of the plumbing and drainage systems, and any other provisions that can impact on performance (e.g. ventilation of bathrooms) have been given due attention, e.g. comply with the recommended practices promoted by various authorities, then the credit shall be awarded.</p>	
	BACKGROUND	<p>Since the outbreak of the SARS virus, there has been a great deal of attention to the design of buildings to improve building hygiene. There appears to be sufficient evidence to conclude that a building drainage system was a path for the transmission of the SARS virus. Subsequent investigations have identified that certain features of drainage and sewage system design should be improved. BEAM seeks to ensure greater attention is paid to the design and installation of plumbing and drainage systems in buildings in order to reduce the risk of transmission of bacteria, viruses and odours into occupied areas.</p> <p>Water seal traps are required to be provided for all sanitary fitments, including floor drains (if provided), before they are connected to a common drainage stack [1]. Trap seal retention can be a problem in multi-level drainage systems. The main ways that air passes a trap are:</p>	

1 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. ADV-24 Floor Drains in Kitchens and Bathrooms. <http://www.bd.gov.hk/english/documents/pnap/ADV/ADV024.pdf>

- system pressure variations cause air-entrained bubbles to pass through the water seal; and/or
- complete or partial trap seal loss.

Unless water is replenished, from time to time, by the building users or through discharge of waste water, cross-contamination is likely. Viruses can enter in indoor spaces through water traps if water seals are dried out or contaminated, or there is leakage in pipework.

Under working and test conditions traps should retain a minimum seal of 25mm of water or equivalent. Self priming type drainage traps or drainage pipe connections which ensure trap priming may be considered, e.g. connection of washbasin discharge to the pipe between the floor drain grating and its U-trap. Care should also be taken to prevent back-flowing at the floor drain.

Any provision requiring modification of the relevant Building (Standards of Sanitary Fittings, Plumbing, Drainage Works and Latrines) Regulations may be considered by the Building Authority on the merits of the individual case upon application.

TWO-PIPE SYSTEM

According to regulations [2], waste pipes must be connected to a soil pipe. Use of two pipes for drainage, one for foul water and one for greywater, may also be a consideration (note that such an arrangement can allow for greywater recycling). Separation of soil and waste pipes can reduce the chance of cross contamination between systems. The connection of wash basin; bath and floor drain to the same waste stack can still permit cross contamination within the waste system. A more effective measure is to provide an independent stack for floor drains.

However, the use of a one-pipe system of combined soil and waste stack has been commonly used in Hong Kong for decades. Many local designers do not regard the adoption of separate stacks for soil and waste as a practical and cost-effective solution because it does not resolve the problem of drying out U-traps. The amount of drainage pipework will be doubled and, besides extra cost, can impose spatial constraints [3].

INSTALLATIONS

Leaky joints and broken drainage pipes are the result of the lack of regular inspection and maintenance. Pipework needs to be as accessible as possible in order to carry out such work, and building management should be provided with means for regular inspection, maintenance and repair of building drainage systems.

MAINTENANCE

A common problem is the difficulty of gaining access to systems from public or common areas. Locating pipework on the exterior of a building has the advantage that maintenance can be carried out with minimal disturbance to users; however, locating pipework internally is acceptable if adequate duct space is provided with proper access from a public area, such as a common corridor.

As drainage and other service pipes are often placed in lightwells and re-entrants, when designing these designers should pay special attention to access for repair and maintenance [4]. The lowest level of re-entrants and lightwells housing soil and waste pipes or stacks should be designated as common areas with access, including access through cat-ladder where appropriate, to facilitate maintenance and clearance of any

2 Regulation 12. Hong Kong Building (Standards of sanitary Fittings, Plumbing, Drainage Works and Latrines) Regulations.
3 Ma Y Y, Lee HV. Institute of Plumbing Hong Kong. Preventing Infection of Virus from Drainage System. August 2003.
4 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. ADV-14 Facilities for External Inspection and Maintenance of Buildings. <http://www.bd.gov.hk/english/documents/pnap/ADV/ADV014.pdf>

refuse.

VENTILATION

Where mechanical ventilation in the form of extractor fan is provided, such as in bathrooms and lavatories, care should be taken to ensure that water seals are intact and operate according to the design intent [5]. Consideration should be given to the quality and quantity of air intake, air-flow path and fan capacity.

The Environmental Health Team of the World Health Organisation (WHO) has advised that the optimum volume for bathroom ventilation is 2 cfm/sq ft (10.2 l/s per sq. metre). WHO is of the view that a larger volume does not add much on the comfort side and has the hidden risk of building up negative pressure. Designers are advised to provide an opening to bathrooms and lavatories for make-up air, such as an undercut to the door or an opening with a louvre at the door or wall, in order to minimise the build-up of negative pressure where an extractor fan is used for ventilation. The airflow path created should avoid circuiting of the ingress and exhaust air.

5 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. ADV-25 Extractor Fans in Bathrooms and Lavatories in Domestic Buildings. <http://www.bd.gov.hk/english/documents/pnap/ADV/ADV025.pdf>

6	IEQ	6.2	HYGIENE
		IEQ 3	BIOLOGICAL CONTAMINATION
	EXCLUSIONS	Residential buildings.	
	OBJECTIVE	Ensure that the design, installation and facilities for operation and maintenance of air conditioning systems, and water systems and features, are such as to reduce the risk of biological contamination.	
	CREDITS ATTAINABLE	1	
	PREREQUISITES	None.	
	CREDIT REQUIREMENT	1 credit for complying with the recommendations given in the Code of Practice - Prevention of Legionnaires Disease, in respect of air-conditioning and ventilation systems, and water systems.	
	ASSESSMENT	The Client shall submit a report prepared by a suitably qualified person detailing how the design and installation of the air-conditioning and ventilation systems and equipment meet with the requirements and recommendation contained in the Code of Practice - Prevention of Legionnaires Disease [1], or at least equal equivalent code. The report shall also detail how water supply, particularly hot water supply, and water use in features such as spas, fountains, etc., are designed and installed in compliance with the Code or Practice.	
	BACKGROUND	<p>Most cases of legionnaires' disease (LD) are caused by the bacterium <i>Legionella pneumophila</i>, There are many other species of the organism which have been implicated in human disease, but other milder illnesses may be caused by these organisms. All illnesses due to legionella species are known collectively as 'legionelloses'; Pontiac Fever is one of the milder conditions. <i>Legionella pneumophila</i> is found in natural water supplies and in soil. It is also found in many recirculating and water supply systems.</p> <p>Measurements in a newly completed building are unlikely to reveal problems with biological contamination caused by either air-conditioning and ventilation systems, or water systems. Consequently, BEAM requires the confirmation on the design and installation of systems and equipment to reduce the possibility of problems arising during use of the building.</p>	

1 Prevention of Legionnaires' Disease Committee, Electrical and Mechanical Services Department, Hong Kong Government. Code of Practice for the Prevention of Legionnaires' Disease in Hong Kong. 2007. http://www.emsd.gov.hk/emsd/e_download/pps/code.doc

6	IEQ	6.2	HYGIENE
		IEQ 4	WASTE DISPOSAL FACILITIES
	EXCLUSIONS	None.	
	OBJECTIVE	Ensure that the design, installation and facilities waste disposal and recycling are such as to reduce the risk of odours entering occupied areas or public areas.	
	CREDITS ATTAINABLE	1	
	PREREQUISITES	Compliance with the Building (Refuse Storage Chambers and Material Recovery Chambers and Refuse Chutes) Regulations.	
	CREDIT REQUIREMENT	1 credit for the provision of a de-odourising system in all refuse collection rooms and chambers.	
	ASSESSMENT	<p>The Client shall submit details of the de-odourising systems, noise control abatement system and fire protection provisions. The system shall comply with those recommendations contained in PNAP No. APP-35 [1] in respect of refuse storage and recovery chambers appropriate to the given circumstances.</p> <p>The provision of a purpose-designed automated/mechanical system for waste disposal is deemed to meet the requirements.</p>	
	BACKGROUND	Where refuse contains large amounts of food and other organic waste there are potential odours and health problems if refuse is not well contained from the points of disposal by users to the place of final collection. Automatic systems are available to isolate refuse from users.	
	REFUSE CHAMBERS	<p>Where a centralised ventilation system is adopted, a single air purifier may be installed before final discharge into the atmosphere. Alternatively where there is no particular odour problem a mechanical fan coupled with a particulate filter at each RS&MRR/MRC may be considered. The main exhaust outlet for a centralised ventilation system should be located at upper roof level away from other buildings; however in the case where the building is surrounded by taller buildings the discharge may be located at the main RS&MRC.</p> <p>The noise level of the system should conform with the Technical Memorandum [2] published under the Noise Control Ordinance (Cap 400). Fire dampers should be provided if the system has exhaust grilles and ducting at each floor.</p> <p>Air purifying devices such as 'Chemical Air Scrubber', 'Bio-oxygen Generator', 'Photo-oxidation Generator' or other appropriate devices should be provided within a RS&MRC.</p>	

1 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. APP-35 Refuse Storage and Collection Building (Refuse Storage and Material Recovery Chambers and Refuse Chutes) Regulations. <http://www.bd.gov.hk/english/documents/pnap/APP/APP035.pdf>

2 Environmental Protection Department. Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites. http://www.epd.gov.hk/epd/english/environmentinhk/noise/guide_ref/tm_nonpp.html

6	IEQ	6.3 INDOOR AIR QUALITY
		IEQ 5 CONSTRUCTION IAQ MANAGEMENT
	EXCLUSIONS	Residential and similar buildings not provided with central air-conditioning and ventilation systems.
	OBJECTIVE	Ensure that building ventilation systems are not contaminated as a result of residuals left over from construction activities.
	CREDITS ATTAINABLE	2
	PREREQUISITES	None.
	CREDIT REQUIREMENT	a) Construction IAQ management 1 credit for implementing a Construction IAQ Management Plan. b) Filter replacement and flush-out 1 credit for undertaking a building 'flush out' or 'bake out'; and replacement of all filters prior to occupancy.
	ASSESSMENT	a) Construction IAQ management To demonstrate compliance, the Client shall submit a report prepared by a suitably qualified person documenting effective implementation of a Construction IAQ Management Plan appropriate to the scale and extent of the development including, but not limited to, the following: <ul style="list-style-type: none">• a copy of the Plan;• evidence of measures showing protection of ducts, on-site storage or protection of installed absorptive materials, etc;• checklists, worksheets, notifications, deficiencies, resolutions, etc., related to construction IAQ issues;• documentation that demonstrates implementation of construction IAQ management measures during construction;• details of filtration media used during construction and installed immediately prior to occupancy; and• documentation for duct cleaning and testing. Where due attention has been paid to construction IAQ management as detailed in the checklist below, the credit shall be awarded. b) Filter replacement and flush-out The Client shall submit a report prepared by a suitably qualified person detailing the technical information for the filtration media used during construction and installed immediately prior to occupancy. The report shall also provide the detail of building flush-out procedures including actual dates of the flush-out. Where it can be demonstrated that filtration media used had a Minimum Efficiency Reporting Value (MERV) of 13 as determined by ANSI/ASHRAE 52.2-2007[1] or equivalent performance specification, and a flush-out with new filtration media is being carried out after the completion of construction and prior to occupancy, the credit shall be awarded. The flushing duration shall be subject to calculation of the fresh air required to attain the IAQ certification 'good' class requirement. During

1 American Society of Heating, Refrigerating and Air-conditioning Engineers. ANSI/ASHRAE Standard 52.2-2007. Method of Testing General Ventilation Air-cleaning Devices for Removal Efficiency by Particle Size. Atlanta, 1999. www.ashrae.org

the flushing period, there should be no construction work done in the vicinity of the space being flushed, such that the flushing result may be reduced. After flushing, the space should be protected against any re-contamination.

CHECK LIST

Contract conditions for the project specifications should require a written Construction IAQ Management Plan which includes procedures meeting or exceeding the minimum requirements, as follows:

- measures to protect the ventilation system components and air pathways against contamination during construction;
- cleaning procedures to be employed prior to the building being occupied, in the event that ventilation system components and air pathways are not adequately protected;
- control measures for HVAC system and component protection;
- contaminant source control; and
- interruption of moisture/pollutant pathways;

Events shall be scheduled to protect indoor air quality by:

- permitting adequate airing-out of new materials;
- sequencing the installation of finish materials; and
- proper curing of concrete before covering.

The Plan should specify the location, type, amount, sequence and timing of the various control measures, including emergency procedures, and the labour, materials and time required to implement them. The project construction documents should address the following:

- an overview of tasks to be executed;
- a list of reference documents, including specifications, drawing list, and submittal drawings;
- a list of participants in the process and their responsibilities;
- a plan for management, communication and documentation;
- an outline of the scope of the IAQ Management Plan, including submittal review, inspection, and enforcement;
- the expected written work products, including checklists and worksheets; and
- a schedule of activities.

The project construction documents should require the contractor to:

- designate a representative with daily responsibility for IAQ issues;
- include procedures related to the IAQ Management Plan on the agenda during regularly scheduled meetings;
- store building materials in a weather tight, clean area protected from dust, debris and moisture damage;
- keep the premises free from accumulations of waste materials, rubbish and other debris resulting from the work. Identify the storage, disposal and housekeeping practices to be applied to building supplies and waste materials to protect HVAC systems from contamination;
- submit a construction schedule to prevent materials from acting as sinks for storage and subsequent release of contaminants emitted from finishes which have the potential for short-term off-gassing. In the schedule, the contractor should include appropriate allowances

for drying or curing times before installation of materials that have a fibrous or porous nature that tend to adsorb contaminants;

- provide adequate outside air continuously during installation of materials and finishes;
- replace all construction-related filtration media used on permanent HVAC equipment at substantial completion of the work;
- confirm that all air filters, casing, coils, fans and ducts are clean, before air quality testing; and
- ensure air ducts are clean by coordinating duct testing and cleaning procedures with the commissioning requirements.

BACKGROUND

Buildings, especially those with extensive ventilation systems, can suffer from indoor air pollution problems arising from residuals left in HVAC and mechanical ventilation systems. Proper management during construction, followed by cleaning and replacement strategies, can significantly reduce air pollution caused by construction. Designers should specify containment control strategies including protecting the HVAC systems, controlling pollutant sources, interrupting pathways for contamination, enforcing proper housekeeping and coordinating schedules to minimise disruption. The construction sequencing to install absorptive materials after the prescribed dry or cure time of wet finishes should be specified to minimise adverse impacts on indoor air quality. Materials directly exposed to moisture through precipitation, plumbing leaks, or condensation are susceptible to microbial contamination. Absorptive materials to be protected and sequenced during installation include: insulation, fabrics, ceiling tiles, and gypsum products. During construction the IAQ management should be monitored and reported.

The flush-out may begin only after all construction work and finishing is completed; all cleaning finalised and all fixed furniture installed. Final test and balancing should be completed and HVAC control should be functional, particularly if the occupants will be moving in during the second phase of flush-out.

The flush-out procedure may use the building's HVAC system, but alternatives are acceptable providing that they can comply with the air quantity, temperature and humidity requirements.

One approach uses temporary supply and exhaust systems placed into windows or window openings. EPA's indoor air quality for schools web site [2] provides information on exhaust and spot ventilation during construction activities that can be helpful for design teams who are considering using this approach.

Care must be taken to ensure the airflow is not short circuited, potentially leaving remote corners within the project spaces with less than adequate circulation, or other parts of the building with unanticipated increases, such as a stack effect up elevator shafts.

If the building's HVAC system is used, any temporary filters and duct coverings installed shall be removed. The filtration media shall be replaced with new media unless the system is configured such that filters filter only the outside air. The new filters installed prior to the start of flush-out must be MERV 13 or better [1].

Depending upon the season, outside air can be cold or humid. Appropriate internal temperature and relative humidity shall be maintained during flush-out procedure.

2 EPA, Controlling Pollutants and Sources; 5. Ventilation Techniques,
<http://www.epa.gov/iaq/schooldesign/controlling.html#Air Out and Flush Out>

If the HVAC system is part of the project scope, it shall be designed to meet the minimum ventilation rate. If the project is served by an existing HVAC system, the outside air delivery capabilities should be part of the building selection criteria.

6	IEQ	6.3 INDOOR AIR QUALITY
		IEQ 6 OUTDOOR SOURCES OF AIR POLLUTION
	EXCLUSIONS	Buildings that are designed for natural ventilation or using de-centralised air conditioning system.
	OBJECTIVE	Demonstrate that airborne contaminants from external sources will not give rise to unacceptable levels of indoor air pollution in normally occupied spaces.
	CREDITS ATTAINABLE	2
	PREREQUISITES	None.
	CREDIT REQUIREMENT	a) Carbon monoxide (CO), Nitrogen dioxide (NO ₂) and Ozone (O ₃) 1 credit for demonstrating compliance with the appropriate criteria for CO, NO ₂ and O ₃ . b) Respirable suspended particulate (RSP, PM ₁₀) 1 credit for demonstrating compliance with the appropriate criteria for RSP.
	ASSESSMENT	<p>The Client shall provide a report prepared by a suitably qualified person detailing the criteria adopted for indoor air quality for each type of normally occupied areas within the building development.</p> <p>Where the Client does not offer criteria, BEAM aligns with the HKSAR IAQ Certification Scheme [1]. The criteria for air-conditioned buildings shall be those defined under Good Class in Table 1 of the scheme. For other occupied areas and habitable rooms, the criteria can be that defined in the Scheme, in ASHRAE 62.1-2007 [2] or equivalent standard.</p> <p>Compliance shall be demonstrated by measurement. The report shall identify the measurement protocol. i.e., the measuring equipment used, duration of measurements, number and details of the sampling points, the measurement results, and overall conclusions from the measurements survey. Measurements shall be made at all fresh air intake locations.</p> <p>For RSP, the instrument type used shall be of gravimetric type, such as cyclone elutriator or impactor. An instrument based on the optical scattering method is acceptable with a referenced calibration curve with respect to a gravimetric instrument. In a zone where it can be demonstrated that CO, NO₂, O₃ and RSP are solely from outside, measurements can be taken at the outdoor air intake locations where CO, NO₂, O₃ and RSP are likely to infiltrate.</p> <p>The objective of sampling is to ensure that the building will not suffer unduly from outside sources of pollution. The sampling protocol (number and locations of samples) shall follow as a minimum that given in Appendix 8.7. Any other protocol demonstrated to be of equal rigour appropriate to the nature of the premises surveyed would be acceptable.</p> <p>In the case of occupied/habitable rooms in air-conditioned/naturally ventilated buildings the measurement of indoor air pollutants shall take place whilst operating in the naturally ventilated mode. Given that air and pollutant exchange with the outside depends on prevailing climatic conditions, particularly wind speed and direction, it is expected that due</p>

1 Indoor Air Quality Management Group. A Guide on Indoor Air Quality Certification Scheme for Offices and Public Places. <http://www.iaq.gov.hk/cert/doc/CertGuide-eng.pdf>

2 American Society of Heating Refrigeration and Air Conditioning Engineers. ASHRAE Standard 62.1. Ventilation for Acceptable Indoor Air Quality, Atlanta 2007.

account is taken and that measurements will be taken under typical or average climatic conditions.

Where it can be demonstrated that the identified pollutants are unlikely to exceed the limits prescribed, and as determined from an appropriate sample of measurements, relevant credit(s) shall be awarded.

BACKGROUND

This section deals with pollutants found in indoor air which are mainly attributable to outdoor sources. In the case of occupied/habitable rooms in air-conditioned/naturally ventilated buildings the concern is indoor air pollutant from outdoor sources whilst operating in the naturally ventilated mode. Undertaking appropriate measurements in air-conditioned buildings will demonstrate that the design and construction of the building and services serve to reduce indoor air pollution from outdoor sources.

CO is a toxic gas which interferes with the oxygen transport capacity of the blood, and at levels to which people can be exposed in buildings, leads to symptoms such as headaches, nausea, chest constriction, etc, as well as affecting concentration. Exposure to oxides of nitrogen (NO_x, NO₂) can result in irritations to the eyes and respiratory system. Sources in occupied areas include infiltration from vehicle exhausts and enclosed car parks, and incomplete combustion within premises. O₃ irritates the eyes and respiratory system. Sources of ozone in occupied areas include infiltration from outside occupied areas, and from equipment which utilises ultra-violet light or causes ionisation of air.

Respirable Suspended Particles (PM₁₀) are suspended airborne particles with a nominal aerodynamic diameter of 10 µm or less. The health impacts from inhalation of particles depend on size, shape and chemical reactivity. Outdoor sources are numerous, but vehicular exhaust and construction activity contribute significantly. Particulates from outside sources are carried into air-conditioned buildings through outside air intakes and through uncontrolled infiltration. Indoor sources include air ducts, equipment and user activities. Levels of RSP may be used as an indicator of the effectiveness of the air filtration system, sampling should be carried out at one representative zone in each type of premises.

Survey data for Hong Kong buildings show that if design and construction is adequate it should be possible to meet the Excellent Class of the Guidance Note for CO, NO₂, O₃ and RSP in new air-conditioned buildings.

6	IEQ	6.3 INDOOR AIR QUALITY
		IEQ 7 INDOOR SOURCES OF AIR POLLUTION
	EXCLUSIONS	Items a) & b) are excluded for buildings that are designed for natural ventilation or using de-centralised air-conditioning system and without interior decoration.
	OBJECTIVE	Demonstrate that airborne contaminants, predominantly from inside sources, do not give rise to unacceptable levels of indoor air pollution in normally occupied spaces.
	CREDITS ATTAINABLE	3
	PREREQUISITES	None.
	CREDIT REQUIREMENT	a) Volatile organic compounds (VOCs) 1 credit for demonstrating compliance with the appropriate criteria for VOCs. b) Formaldehyde (HCHO) 1 credit for demonstrating compliance with the appropriate criteria for HCHO. c) Radon (Rn) 1 credit for demonstrating compliance with the appropriate criteria for Rn.
	ASSESSMENT	<p>The Client shall provide a report prepared by a suitably qualified person detailing the criteria adopted for indoor air quality for each type of normally occupied area within the building development.</p> <p>Where the Client does not offer criteria, BEAM aligns with the HKSAR IAQ Certification Scheme [1]. The criteria for air-conditioned buildings shall be those defined under Good Class in Table 1 of the scheme. For other occupied areas and habitable rooms, the criteria can be that defined in the Scheme, in ASHRAE 62.1-2007 [2] or equivalent standard.</p> <p>Compliance shall be demonstrated by measurement. The report shall identify the measurement protocol. i.e., the measuring equipment used, duration of measurements, number and details of the sampling points, the measurement results, and overall conclusions from the measurements survey. The number of measurement points shall make reference to IAQ Certification Scheme.</p> <p>A sample at the lowest outdoor air intake location can help to identify the relative contribution of VOCs from indoor and outdoor. However, the common alpha track detector and gamma ray detector for Rn detection are not regarded as suitable for measurement. Scintillation cells and electronic monitors are more suitable for both grab sampling and continuous measurements.</p> <p>The objective of sampling is to ensure that the building will not suffer unduly from outside sources of pollution. The sampling protocol (number and locations of samples) shall follow as a minimum that given in Appendix 8.7. Any other protocol demonstrated to be of equal rigour appropriate to the nature of the premises surveyed would be acceptable.</p> <p>In the case of occupied/habitable rooms in air-conditioned/naturally ventilated buildings the measurement of indoor air pollutants shall take</p>

1 Indoor Air Quality Management Group. A Guide on Indoor Air Quality Certification Scheme for Offices and Public Places. <http://www.iaq.gov.hk/cert/doc/CertGuide-eng.pdf>

2 American Society of Heating Refrigeration and Air Conditioning Engineers. ASHRAE Standard 62.1. Ventilation for Acceptable Indoor Air Quality, Atlanta 2007.

place whilst operating in the background ventilation mode, or where there is no specific provision for background ventilation, with all windows and doors closed.

Where it can be demonstrated that the identified pollutants are unlikely to exceed the limits prescribed, and as determined from an appropriate sample of measurements, relevant credit(s) shall be awarded.

BACKGROUND

This section deals with pollutants found in indoor air, which are mainly attributable to indoor sources. In the case of occupied/habitable rooms in air-conditioned/naturally ventilated buildings the concern is indoor air pollutant from indoor sources whilst operating in the background ventilation mode, i.e. all openings other than those provided for background ventilation are 'closed'.

VOCs includes hundreds of chemical compounds found in indoor environments from trace levels to levels that can cause various symptoms such as eye and throat irritations, respiratory problems, headaches, etc. Reactions can occur as a result of exposure to a single sensitizing dose or sequence of doses, even at low levels. VOCs may enter from outdoors, but are more likely to be emitted from building materials, finishes and furnishings, pesticides and cleaning products.

HCHO is a type of volatile organic compound which is separately identified due to its abundance in many building materials, adhesives, fabrics and carpets, etc. HCHO is a suspected human carcinogen, and in sufficiently high concentrations is known to cause eye, nose and respiratory irritation and sensitisations. Since formaldehyde is most likely to come from indoor sources, sampling should be carried out in at least one representative zone of each type of occupied area.

Rn is a colourless radioactive gas that exhibits no taste or smell. There is concern that exposure to elevated levels of Rn indoors increases the risk of lung cancer. Rn is mainly emitted from granite and marble which are major building materials in Hong Kong. The concentration of Rn may accumulate to an unaccepted level in an enclosed space without adequate ventilation. Choice of building materials and surface coverings can have significant impact on emission rates. Since outdoor Rn infiltration is minimal. Rn and its progenies are mainly generated indoors.

6	IEQ	6.3	INDOOR AIR QUALITY
		IEQ 8	IAQ IN CAR PARKS
	EXCLUSIONS		Buildings not provided with enclosed or semi-enclosed car parks.
	OBJECTIVE		Meet the minimum requirements of performance in respect of air quality.
	CREDITS ATTAINABLE		1
	PREREQUISITES		None.
	CREDIT REQUIREMENT		1 credit for demonstrating compliance with the design requirements specified in ProPECC PN 2/96.
	ASSESSMENT		The Client shall submit a report prepared by a suitably qualified person demonstrating that the design of the ventilation system meets or exceeds the guidelines given in ProPECC PN 2/96 [1], including provisions for the monitoring and automatic control of air pollution. The report shall include an estimation of peak pollutant loading and the ventilation system performance to meet the maximum concentration of pollutants as listed in ProPECC PN 2/96.
	BACKGROUND		This applies to enclosed and semi-enclosed car parks that rely on mechanical ventilation or mechanically assisted natural ventilation.

1 Environmental Protection Department. Practice Notes for Professional Persons. ProPECC PN 2/96. Control of Air Pollution in Car Parks. 1996.

6	IEQ	6.4 VENTILATION
		IEQ 9 INCREASED VENTILATION
EXCLUSIONS	Residential and similar buildings without central air conditioning.	
OBJECTIVE	Ensure that ventilation systems provide for effective delivery to support the well being and comfort of occupants in normally occupied spaces.	
CREDITS ATTAINABLE	1	
PREREQUISITES	Compliance with CAP 123J Building (Ventilating Systems) Regulations.	
CREDIT REQUIREMENT	1 credit for demonstrating an outdoor ventilation rate that exceeds ASHRAE 62.1:2007 [1] requirements by at least 30%.	
ASSESSMENT	<p>The Client shall provide evidence in the form of a report prepared by a suitably qualified person detailing that the Client’s specified criteria has been adopted for each category of space included in the project, through the submission of calculations and/or measurements in the specified sample of premises to demonstrate compliance.</p>	

Calculations should be based on the following table.

Spaces Identification ⁽¹⁾	Space Type ⁽²⁾	Occupant Density People/sq. m	Ventilation Rate/Person L/s	Rate/m ² L/s	Zone Air Distribution Effectiveness ⁽³⁾	System Ventilation Efficiency ⁽⁴⁾	Class of Air ⁽⁵⁾
<p>1: List number or name of each ventilation zone, such as office number or name, retail space name, classroom number, etc 2: List occupancy category of the space from ASHRAE 62.1: 2007 Table 6-1 (Minimum ventilation rates in breathing zone) such as office space, retail sales, classroom, etc. 3: ASHRAE 62.1: 2007 Table 6-2 (Zone Air Distribution Effectiveness) 4: ASHRAE 62.1: 2007 Table 6-3 (System Ventilation Efficiency) or Appendix A 5: ASHRAE 62.1: 2007 Tables 5-2 (Airstreams) or 6-1; include justification for classification if not in these tables</p>							

The outcome of measurements shall demonstrate that the required amount of outdoor air corresponding to the corrected design ventilation rate is actually provided. Air flow measurements may be made using conventional procedures, such as described in ASHRAE 111 [2], or by tracer gas techniques in accordance with ASTM E 741 [3] or equivalent.

BACKGROUND The purpose of this credit is to demonstrate the potential for improving indoor air quality through increased outdoor ventilation.

The current version of ASHRAE 62.1 [1] is considered a “code – minimum” standard [4]. There is concern that the ventilation rates calculated under the standard will have a negative impact on productivity and occupant well being. As an example, consider a typical Hong Kong

1 American Society of Heating Refrigeration and Air Conditioning Engineers. ASHRAE Standard 62.1-2007 Ventilation for Acceptable Indoor Air Quality, Atlanta 2007.
 2 American Society of Heating Refrigeration and Air Conditioning Engineers. ASHRAE Standard 111. Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air Conditioning and Refrigeration Systems, Atlanta 1998
 3 American Society for Testing and Materials. ASTM Standard E 741-00, Standard Test Methods for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution. Philadelphia, 2000.
 4 Taylor, S.T., LEED and Standard 62.1, ASHRAE Journal, Vol. 47, No. 9, September 2005.

Office of 1,000 m² and an occupant density of 9 m² per occupant. Using the ASHRAE 62.1-2007 criteria results in a ventilation rate of 5.2 l/s/person, much less than previously accepted values of 8 or even 10 l/s per person.

For simple systems where the outdoor air serves only a single space, or a small number of similar spaces, the outdoor air flow rate can be measured either:

- using a pitot tube [5] and manometer to perform a pitot tube traverse in accordance with ASHRAE 111-98 [2] or
- using an installed Wilson Flow Grid with a manometer.

The majority of systems will be too complex for such measurements and the supply of outdoor air should be verified using a tracer gas measurement. ASTM 741-00 [3] describes the required properties of tracer gases and discusses procedures for tracer decay, tracer step up and constant concentration measurements.

SYNERGIES

Air movement within spaces is dealt with under Thermal Comfort criteria.

Increased ventilation rates will have a negative impact on energy use, particularly in a hot humid climate such as Hong Kong. Consideration should be given to using heat recovery techniques to lessen the impact or utilising CO₂ sensors in conjunction with the BMS to affect Demand Control Ventilation (DCV).

5 International Organization for Standardization. ISO 3966-1977. Measurement of fluid flow in closed circuits - Velocity area method using Pitot static tubes.

6	IEQ	6.4 VENTILATION
		IEQ 10 BACKGROUND VENTILATION
	EXCLUSIONS	Buildings not designed to utilise natural ventilation.
	OBJECTIVE	Ensure that normally occupied premises designed to utilise natural ventilation are provided with a minimum of background ventilation to control indoor air pollutants.
	CREDITS ATTAINABLE	1
	PREREQUISITES	Compliance with the Building (Planning) Regulations (B(P)Reg.) 30, 31 and 32.
	PREREQUISITES	1 credit where it can be demonstrated that adequate ventilation can be achieved by natural means.
	ASSESSMENT	<p>The Client shall provide evidence in form of a report by a suitably qualified person stating that appropriate analysis or measurements have been undertaken to verify the adequacy of background ventilation (minimum air change rate).</p> <p>The minimum ventilation rate required to maintain known contaminants below recognised limits can be calculated using recognised procedures, for example, Appendix D of BS 5925 [1] or similar.</p> <p>Ventilation performance may be simulated using wind tunnel tests, computational fluid dynamics (CFD) or other appropriate modelling techniques [2,3].</p> <p>The modelling technique shall show a boundary layer as appropriate for the site, and the model will include any significant buildings and site obstructions within a distance of approximately 2 building heights. The pressure data will be used with recognised calculation procedures (e.g. BS 5925) to estimate flows through the habitable areas. Buoyancy or turbulence driven flows need not be considered. Ventilation rates can be predicted using either CFD or approaches that range in complexity from simple single zone models to elaborate multi-zone models [2]. Principles of model operation are discussed in the ASHRAE Handbook [4].</p> <p>Alternatively, a suitable commissioning test may be performed, for example a tracer gas decay test [5]. The test should be carried out in representative units as defined above and performed under average wind conditions with windows closed and purposely designed ventilators open.</p> <p>Where it can be demonstrated that background ventilation meets ACH of 2.0 that is of a higher level (ACH of 1.5) as prescribed by the Building Authority (BA), the credit can be awarded.</p>

- 1 BS 5925:1991 (Inc. Amendment No 1), Code of Practice for Ventilation principles and designing for natural ventilation. British Standards Institute, London. December 1995.
- 2 American Society for Testing Materials. ASTM E 2267-03. Specifying and Evaluating Performances of Single Family Attached and detached Dwellings – Indoor Air Quality. 2003.
- 3 American Society of Heating, Refrigerating and Air Conditioning Engineers. ASHRAE Fundamentals Handbook Chapter 26. Atlanta 2001.
- 4 American Society of Heating, Refrigerating and Air Conditioning Engineers. ASHRAE Fundamentals Handbook Chapter 26. Atlanta 2001.
- 5 ASTM E 741-00. Standard Test Method for Determining Air Change in a Single Zone by means of a Tracer Gas Dilution. American Society for Testing Materials. Pasadena USA. 2000.

BACKGROUND

Background ventilation is a combination of uncontrolled air infiltration and ventilation through purposely designed vents. Purpose designed ventilation is preferable to relying on uncontrolled infiltration. BEAM encourages designs that provide for adequate background ventilation by natural means.

Background ventilation is intended to dilute the unavoidable contaminant emissions from people and materials (e.g. radon) and for control of internal moisture levels due to occupant activities in order to minimise risk of mould growth. During periods when windows and other openings are closed it is possible for indoor radon levels to rise above the criteria recommended by the Environmental Protection Department [6]. Local research on residential buildings suggests that 0.5 to 1 ACH would be sufficient to maintain radon below the target level.

For domestic buildings the Building Authority (BA) is prepared to accept the following alternative performance standards on the provision of natural ventilation in habitable rooms [7]:

Room of domestic building	Air Change per Hour (ACH)
Habitable Room	1.5 (natural means)
Kitchen	1.5 (natural means) plus 5 (mechanical means)

- 6 Indoor Air Quality Management Group. A Guide on Indoor Air Quality Certification Scheme for Offices and Public Places. <http://www.iaq.gov.hk/cert/doc/CertGuide-eng.pdf>
- 7 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. APP-130 Lighting and Ventilation Requirements – Performance-based Approach. <http://www.bd.gov.hk/english/documents/pnap/APP/APP130.pdf>

6	IEQ	6.4 VENTILATION
		IEQ 11 LOCALISED VENTILATION
	EXCLUSIONS	Item b) is excluded for residential buildings.
	OBJECTIVE	Prevent exposure of building occupants to concentrated indoor sources of pollutants.
	CREDITS ATTAINABLE	2
	PREREQUISITES	Compliance with CAP 123J Building (Ventilating Systems) Regulations.
	CREDIT REQUIREMENT	a) Source control 1 credit for the provision of an adequate ventilation system for rooms/areas where significant indoor pollution sources are generated. b) Local exhaust 1 credit for the provision of a general exhaust system for future tenants.
	ASSESSMENT	a) Source control The Client shall provide evidence in form of a report prepared by a suitably qualified person detailing the design criteria that have been adopted and details of the ventilation system designs providing local exhaust where concentrated pollutant sources are likely to be present. The report shall provide details of tests and the results demonstrating that the design performance is achieved. Where the design ventilation rate specified is lower than that specified in a recognised international or national standard the client shall demonstrate through appropriate testing that there is 99% isolation between areas with concentrated pollutant sources and occupied areas. b) General exhaust system The report shall provide technical details to demonstrate how the ventilation system design(s) may be temporarily adapted so that air from any areas undergoing fit out or renovation can be exhausted to the outside without re-circulation or entrainment to occupied areas. The ventilation provisions shall be adequate to exhaust to outside air any material off-gassing, combustion products, excess moisture, etc., and the exhaust is discharged such that it does not re-enter the premises or enter adjacent premises under typical wind conditions. Compliance may be demonstrated by conducting appropriate tests in a sample of units. Where it can be demonstrated that source control measures can meet the performance requirements the credit(s) shall be awarded.
	BACKGROUND	Concentrated pollution sources are best managed at source. The provision of localised ventilation, segregated from the general ventilation, is an appropriate strategy. In commercial and similar premises sources such as photocopying equipment, smoking lounges, etc. should be provided with dedicated exhaust systems. It is also appropriate to provide a system that allows for localised exhaust of premises during fit-out and redecoration, to avoid entrainment to occupied areas. It could be part of the fixed ventilation system, or a simple approach that allows temporary exhaust provisions. In other buildings local exhaust is intended to remove contaminants from specific rooms such as kitchens, in which concentrated sources are expected.

DOMESTIC KITCHENS PNAP No. APP-130 [1] specifies performance based criteria for kitchen ventilation as an alternative means of satisfying Building (Planning) Regulations (B(P)Reg.) 30, 31 and 32. These criteria are 1.5 ACH under natural ventilation, plus 5 ACH from mechanical means i.e. these values are by definition the minimum legal requirement. Whilst these are performance based alternatives to the prescriptive criteria they are considered worthy of credit. It should be noted that specifying higher values may result in negatively pressurizing the building and causing other IAQ problems with in flow of air from other spaces.

Elsewhere, ASHRAE 62.2 [2] states that kitchen fans are mandatory as this standard considers that windows do not provide sufficient ventilation, although this standard specifically applies to low rise residential units (3 storeys or less above grade) and wind conditions may not be as favourable for ventilation as in the case of high rise buildings. The basic requirement is that a vented cooker hood can exhaust 100 cfm (approx 50 l/s). An alternative approach is that ventilation (either continuous or intermittent) of 5 ACH be achieved.

COMMERCIAL KITCHENS In commercial kitchens a mechanical ventilation rate of 20 ACH may be appropriate [3] for the cooking styles found in Hong Kong.

BATHROOMS AND TOILETS The Building Authority will give favourable consideration to an application for modification of Building (Planning) Regulation 36 in respect of bathrooms and lavatories in domestic buildings [4] where the following criteria are met :

- the room is part of a unit of accommodation for domestic use;
- the room is of a reasonable size; and
- the modification to be granted is unlikely to result in standards of public health and safety being compromised.

Upon the grant of a modification of the Regulation, the Building Authority will impose the following conditions:

- mechanical ventilation producing 5 air changes per hour (ACH) is in operation at any time when the room is in use. The change of air shall be with the outside of the building and to achieve this, the use of ventilation ducting is acceptable;
- there is permanent ventilation to the 'open air', the 'external air' or with another room which is provided with a window meeting the area requirement for the combined windows. The permanent ventilation may be in form of an air duct, an aperture in a wall or a door suitably located and permanently open or protected with louvers having a minimum size of 1/20 of the floor area of the room; and
- the requirements of Building (Planning) Regulation 35A and PNAP No. APP-27 [5] regarding water heaters are complied with, where applicable.

1 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. APP-130. Lighting and Ventilation Requirements - Performance Based Approach. <http://www.bd.gov.hk/english/documents/pnap/APP/APP130.pdf>

2 ASHRAE 62.2-2003. Ventilation and Acceptable Indoor Air Quality in Low Rise Residential Buildings. American Society of Heating, Refrigerating and Air Conditioning Engineers. Atlanta. 2003.

3 Singapore Standard SS CP13. Code of Practice for Mechanical Ventilation and Air Conditioning in Buildings. 1999.

4 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineer PNAP No. APP-98. Lighting and Ventilation for Bathrooms and Lavatories in Domestic Buildings. <http://www.bd.gov.hk/english/documents/pnap/APP/APP098.pdf>

5 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. APP-27. Gas Water Heaters - Building (Planning) Regulation 35A. <http://www.bd.gov.hk/english/documents/pnap/APP/APP027.pdf>

Where mechanical ventilation in form of an extractor fan is provided in bathrooms and lavatories, care should be taken to ensure that plumbing seals are intact and operate according to the design intent [6]. In addition, consideration should be given to the quality and quantity of air intake, air-flow path and fan capacity. The Environmental Health Team of the World Health Organization (WHO) has advised that the optimum flow rate for bathroom ventilation is 2 cfm/sq ft ($10.2 \text{ l s}^{-1} \text{ m}^{-2}$). WHO is of the view that a larger flow rate does not add much on the comfort side and has the hidden risk of building up negative pressure in the room. It is recommended to provide an opening to bathrooms and lavatories for air relief, such as an undercut to the door or an opening with louvre at the door or wall, in order to minimise the build-up of negative pressure if an extractor fan is provided for ventilation.

UTILITY AND LAUNDRY ROOMS ASHRAE 62.2 [2] makes no requirement for mechanical ventilation although it stipulates an opening not less than 4% of the room floor area nor less than 0.15 m^2 . However it does stipulate that clothes dryers must be directly exhausted to outside.

REFUSE AREAS Exhaust from refuse storage areas and material recovery centres (RS & MRC) should follow the principles of PNAP No. APP-35 [7]. In the cases where a centralised ventilation system is adopted, a single air purifier may be installed prior to the air being exhausted to the atmosphere. If there is no odour problem then a mechanical fan and filter can be used. The main exhaust outlet for a centralised system should be located at roof level away from other buildings. If the building is surrounded by taller buildings then the air may be exhausted at the main RS & RMC location. The noise level of the system should conform to the Technical Memorandum published under the Noise Control Ordinance (Cap 400). Fire dampers should be provided if the system has exhaust grilles and ducting at each floor.

DOMESTIC GARAGES ASHRAE 62.2 states that for low rise residential buildings where air handlers or return ducts are in an attached garage the ductwork should be tested for air tightness. A ductwork air leakage test conforming to test procedure DW 143 [8] or similar authority should be performed.

CHIMNEYS AND FLUES The siting and height of chimneys and flues should follow PNAP No. APP-8 [9]. In particular, chimneys and flues should be situated so that products of combustion cannot enter windows, ventilation openings, supply air intakes.

- 6 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. ADV-25 Extractor Fans in Bathrooms and Lavatories in Domestic Buildings. <http://www.bd.gov.hk/english/documents/pnap/ADV/ADV025.pdf>
- 7 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. APP-35. Refuse Storage and Collection Building (Refuse Storage and Material Recovery Chambers and Refuse Chutes) Regulations. <http://www.bd.gov.hk/english/documents/pnap/APP/APP035.pdf>
- 8 DW 143. A practical guide to Ductwork Leakage Testing. Heating and Ventilating Contractors Association. 1994.
- 9 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. APP-8. Chimneys and Flues. <http://www.bd.gov.hk/english/documents/pnap/APP/APP008.pdf>

6	IEQ	6.4 VENTILATION
		IEQ 12 VENTILATION IN COMMON AREAS
	EXCLUSIONS	Spaces covered under the section on IEQ 11 Localised Ventilation.
	OBJECTIVE	Ensure adequate ventilation in common areas and circulation routes within premises and to avoid cross-contamination between areas.
	CREDITS ATTAINABLE	1 + 1 BONUS
	PREREQUISITES	Compliance with applicable regulations covering ventilation provisions in buildings.
	CREDIT REQUIREMENT	a) Ventilation by any means 1 credit for demonstrating that all enclosed common areas in a building are provided with adequate ventilation. b) Use of natural ventilation 1 BONUS credit where the provision for ventilation is by natural means.
	Assessment	<p>The Client shall provide evidence in form of a report prepared by a suitably qualified person detailing the design criteria that have been adopted for each type of common area included in the development, and the results of calculations, simulations and/or measurements in the specified sample of spaces to demonstrate compliance with the assessment criteria. Common areas include corridors, lift lobbies, entrance lobbies, etc. Staircases shall be excluded from the assessment.</p> <p>a) Ventilation by any means Design ventilation rates shall be defined by the Client, but should comply with recommendations from recognised authorities, e.g. BS 5925 [1], ASHRAE 62 [2] or equivalent. Compliance shall be demonstrated by measurements on a representative sample of each type of space, including worst cases, under average wind conditions.</p> <p>b) Use of natural ventilation Where natural ventilation is employed it shall demonstrate that the ventilation rate (a ACH of higher than 0.5) is achieved under average wind conditions in at least 80% of the common areas, aggregated by floor area. Compliance may be demonstrated by suitable commissioning measurements such as a tracer gas test [3] on a representative sample of spaces, including worst cases, or by appropriate modelling techniques, such as wind tunnel test, CFD or other computer models [4, 5]. Outside air brought into common areas should be free from known or potential localised sources of pollution (e.g. motor vehicle exhaust, workshops, etc), and exhausted air should not contaminate public areas or occupied areas.</p>
	BACKGROUND	The Buildings Department seeks to improve building design in the

- 1 BS 5929: 1991 (Amendment No. 1) Code of practice for Ventilation Principles and designing for Natural Ventilation. British Standards Institute, London, 1995.
- 2 American Society of Heating, Refrigerating and Air Conditioning Engineers. ASHRAE 62-2007. Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating and Air Conditioning Engineers. Atlanta, 2007.
- 3 ASTM International. E 741-00. Standard Test Method for Determining Air Change in a Single Zone by means of a tracer Gas Dilution. 2000
- 4 ASTM International. ASTM E 2267-03. Specifying and Evaluating Performances of Single Family Attached and detached Dwellings – Indoor Air Quality. 2003.
- 5 American Society of Heating, Refrigerating and Air Conditioning Engineers. ASHRAE Fundamentals Handbook Chapter 26. Atlanta 2001.

context of environmental hygiene. Designers are recommended to consider the provision of ventilation to common areas, such as corridors, lift lobbies, entrance lobbies, etc. [6]. Where design constraints render the provision of natural ventilation not feasible, mechanical ventilation should be provided to improve the indoor environment. Good practices when designing mechanical ventilation in public areas require:

- the ventilation system to be capable of providing sufficient fresh air taking into account the anticipated population;
- intake and exhaust points be properly designed to prevent contamination of fresh air supply and avoid short-circuiting; and
- the ventilation system and its associated ductwork, where provided, should be conveniently accessible for maintenance.

Ventilation for bathrooms, kitchens, refuse rooms, etc., as covered elsewhere in BEAM, may be sources of pollution affecting common areas.

Cross ventilation of common and circulation areas not provided with mechanical cooling or ventilation is important to control temperatures and to dilute pollutants and odours. Recommended practice is to place ventilation openings so that cross ventilation can occur. However, wind driven cross ventilation can only happen when there is a reliable higher pressure on one side of openings than on the other. For an isolated building this may be easily achieved by simple consideration of prevailing winds and the building form. For buildings within dense groupings, however, local wind direction may be less apparent, turbulence high, and cross-ventilation decreased. A more sophisticated analysis of the behaviour of the wind is necessary to ensure beneficial cross flows.

MEASUREMENT APPROACH

A suitable commissioning test may be performed. The test should be carried out in representative sample, including worst case spaces as defined above and performed under average wind conditions. In the case of naturally ventilated spaces, measurements should be made under conditions when windows are closed and purpose designed ventilators are open.

MODELLING APPROACH

Boundary layer wind tunnel modelling may be used for wind pressure analysis. Wind pressure coefficients at inlet/outlet areas for common areas shall be measured for at least one representative floor, including worst case, for each type of occupied premise in the assessed building. These may be site specific depending on the building's height in relation to nearby buildings and local terrain. The measurements will be taken for at least the prevailing wind conditions which are likely to be site specific and therefore should be determined case by case.

The modelling technique shall show a boundary layer as appropriate for the site, and the model will include any significant buildings and site obstructions within a distance of approximately 2 building heights. The pressure data will be used with standard calculation procedures to estimate flows through the common areas, arising from an average wind condition. Buoyancy or turbulence driven flows need not be considered.

ASTM 2267 [4] states that building ventilation rates can be predicted using approaches that range in complexity from simple single zone models to elaborate multi-zone models. The underlying principles of model operation are discussed in the ASHRAE Handbook [5]. The modelling should take into account average wind speed conditions. In

6 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. ADV-26 Ventilation of Common Corridors and Lift Lobbies in Buildings. <http://www.bd.gov.hk/english/documents/pnap/ADV/ADV026.pdf>

the case of naturally ventilated premises, the simulation should be performed when windows are closed and purpose designed ventilators are open.

6	IEQ	6.5 THERMAL COMFORT
		IEQ 13 THERMAL COMFORT IN AIR-CONDITIONED PREMISES
	EXCLUSIONS	Buildings where air-conditioning is provided by window units or split units.
	OBJECTIVE	Ensure that the air-conditioning system can provide the stated design conditions in occupied spaces under changing load conditions.
	CREDITS ATTAINABLE	2
	PREREQUISITES	None.
	CREDIT REQUIREMENT	a) Temperature 1 credit for sustaining the air temperature at the design value within $\pm 1.5^{\circ}\text{C}$ when the air side system is operating at steady state under normal occupied periods. b) Room air distribution 1 credit where room air diffusers satisfy the Air Diffusion Performance Index.
	ASSESSMENT	The Client shall provide evidence in the form of a report prepared by a suitably qualified person detailing the design criteria with respect to thermal comfort conditions for all types of premises included in the building, and the results of the measurements in the specified sample of premises. a) Temperature The measurement locations shall include at least one representative sample of each type of premises (occupied spaces) as defined by the type of HVAC system used, design occupancy density, nature of usage, zoning, etc. The main physical parameters of the indoor climate (air temperature and relative humidity) are undertaken under normal occupied periods. The results shall demonstrate compliance with the prescribed design criteria within the prescribed limits, for a minimum of 90% of the prescribed locations. The measurement shall be made with reference to the current EPD's IAQ certification scheme. The sensors used in the measurement survey shall have an accuracy that complies with ASHRAE 55-2004 [1], ISO 7726 [2] or equivalent. b) Room air distribution The measurement locations shall be as for a). It is acceptable to demonstrate the credit compliance by either calculation or by in-situ measurements.
	BACKGROUND	The HVAC system should be able to maintain room conditions (within acceptable tolerances) under normal occupied periods. Measurements under such circumstances can demonstrate compliance with the operating requirements.

- 1 American Society of Heating, Refrigeration and Air-conditioning Engineers. ASHRAE 55-2004: Thermal Environmental Conditions for Human Occupancy. Atlanta 2004.
- 2 International Standard Organization. International standard 7726, Ergonomics of the thermal environment — Instruments for measuring physical quantities. 1998.

6	IEQ	6.5 THERMAL COMFORT
		IEQ 14 THERMAL COMFORT IN NATURALLY VENTILATED PREMISES
	EXCLUSIONS	Buildings that are not designed to utilise natural ventilation.
	OBJECTIVE	Promote the application of measures that reduce elevated temperatures caused by external heat gains, and ensure installed air-conditioning units can provide adequate control of indoor temperature.
	CREDITS ATTAINABLE	2
	PREREQUISITES	None.
	CREDIT REQUIREMENT	<p>a) Performance with natural ventilation</p> <p>1 credit for demonstrating indoor operative temperatures in occupied/habitable rooms meet the 80% acceptability limits.</p> <p>Alternatively,</p> <p>1 credit for demonstrating the predicted Mean Vote (PMV) in occupied/habitable rooms is between -1 and +1.</p> <p>Alternatively,</p> <p>1 credit for demonstrating that, the thermal performance, and the internal wind speeds, of the occupied/habitable rooms fall within the 80% acceptability range for the tropical climate conditions of Hong Kong.</p> <p>b) Performance with air-conditioning</p> <p>1 credit for sustaining the air temperature at the design value within $\pm 1.5^{\circ}\text{C}$ when the air-conditioning unit is operating at steady state under normal occupied periods.</p>
	ASSESSMENT	<p>a) Performance with natural ventilation</p> <p>The assessment establishes the extent to which the design of the building envelope can mitigate the effects of external heat gains. Based on the output from a suitable thermal simulation model of the building the predicted indoor operative temperature shall be compared with the criteria given in ASHRAE 55 [1] under the 'Optional Method for Determining Acceptable Thermal Conditions in Naturally Conditioned Spaces'.</p> <p>Assessment may be confined to the scenarios with the highest mean monthly temperature of the hottest month or higher radiation heat gain of whichever is higher, i.e., for those normally occupied areas of the building most susceptible to external heat gains and/or which do not benefit from the prevailing climatic conditions.</p> <p>The spaces in question must be equipped with operable windows that can be readily opened and adjusted by the occupants. Mechanical cooling for the space shall not be provided, although mechanical ventilation with unconditioned air may be utilised.</p> <p>The thermal analysis shall be undertaken using dynamic thermal modelling software. The thermal performance within the occupied or habitable space of each type of premises most affected by solar gains shall be determined. The modelling shall include full annual simulation using standard Hong Kong weather data. The modelling will include the effect of installed solar control features, e.g. glazing, internal or external shading components, fabric and infiltration specifications, and site obstructions. The modelling needs not include any internal gains, i.e.,</p>

1 American Society of Heating, Refrigeration and Air-conditioning Engineers. ASHRAE 55-2004: Thermal Environmental Conditions for Human Occupancy. Atlanta 2004.

simulations for unoccupied premises are required.

Alternatively, compliance may be demonstrated under appropriate summer and winter conditions through the measurement of temperature in suitable locations in a sample of premises most exposed to external heat gains.

The Client shall provide evidence in the form of a report prepared by a suitably qualified person detailing any means used to control the external (solar) heat gains, the specification and details of the thermal simulation software used in the analysis, and the results of the simulations.

Where compliance is demonstrated by measurements the details of measuring equipment, sampling locations, sampling time, time of measurements, external temperature and prevailing weather conditions shall be provided.

Where it can be demonstrated that the predicted indoor temperature lies within the 80% acceptability limits given in ASHRAE 55-2004 a credit shall be awarded.

Alternately, where it can be demonstrated that the Predicted Mean Vote (PMV) in occupied/ habitable rooms is between -1 and $+1$, a credit shall be awarded.

b) Performance with air-conditioning

The measurement locations shall include at least one representative sample of each type of premises (occupied spaces) as defined by the type of HVAC system used, design occupancy density, nature of usage, zoning, etc. The measurements shall be undertaken in a normal occupied period. The sensors used in the measurement survey shall have an accuracy that complies with ISO 7726 [2] or equivalent. To earn credit the results shall demonstrate compliance with the prescribed design criteria within the prescribed limits, for a minimum of 90% of the prescribed locations.

BACKGROUND

Thermal comfort standards such as ISO 7730 [3] and ASHRAE 55 establish relatively tight limits on recommended indoor thermal environments, and do not distinguish between what would be considered thermally acceptable in buildings conditioned with natural ventilation. Derived from laboratory experiments using a thermal-balance model of the human body these standards have attempted to provide an objective criterion for thermal comfort, specifying combinations of personal and environmental factors that will produce interior thermal environments acceptable to at least 80% of a building's occupants. The heat-balance models, on which the standards are based, were developed in tightly controlled conditions. The people involved were considered passive subjects of climate change in artificial settings, and little consideration was given to the broad ways they might naturally adapt to a more wide ranging thermal environments in realistic settings.

Field studies and research has demonstrated that occupants of buildings with centralised HVAC systems become finely tuned to the very narrow range of indoor temperatures provided, developing high expectations for homogeneity and cool temperatures, and soon became critical if thermal conditions do not match these expectations [4,5]. In contrast, occupants of naturally ventilated buildings are more tolerant of a wider range of

- 2 International Standard Organization. ISO 7726, Ergonomics of the thermal environment — Instruments for measuring physical quantities. 1998.
- 3 International Standard Organization. ISO 7730. Moderate thermal environments – Determination of the PMV and PPD indices and specification of the conditions for thermal comfort.
- 4 de Dear R, Brager G S, Reardon J, Nicol F et al. Developing an adaptive model of thermal comfort and preference/ Discussion. ASHRAE Transactions. Vol. 104. 1998. pp 145-167.
- 5 Brager G S, de Dear R. A Standard for Natural Ventilation. ASHRAE Journal. October 2000. pp 21-28.

temperatures. This range extends beyond the comfort zones established for air-conditioned buildings, and may more closely reflect the local patterns of outdoor climate.

Analysis of the available data has established that behavioural adaptations, such as changes in clothing insulation or indoor air speeds, could account for only half the observed variance in thermal preferences of people when in naturally ventilated buildings. Given that physiological adaptation is unlikely to play much of a role; it is suggested that the rest of the variance is attributable to psychological factors [4]. Relaxation of thermal expectations may be due to a combination of higher levels of perceived control and a greater diversity of thermal experiences in a naturally ventilated building.

For the purposes of ASHRAE 55-2004, occupant-controlled naturally conditioned spaces are those spaces where the thermal conditions of the space are regulated primarily by the occupants through opening and closing of windows. The 'Optional Method for Determining Acceptable Thermal Conditions in Naturally Conditioned Spaces' is intended for such spaces. In order for this optional method to apply, the space in question must be equipped with operable windows that open to the outdoors and that can be readily opened and adjusted by the occupants of the space. Mechanical cooling for the space should not be available, although mechanical ventilation with unconditioned air may be utilised. The method applies only to spaces where the occupants are engaged in near sedentary physical activities, with metabolic rates ranging from 1.0 met to 1.3 met, and may freely adapt their clothing to the indoor and/or outdoor thermal conditions.

Allowable indoor operative temperatures for spaces that meet these criteria may be determined from Figure 5.3 in ASHRAE 55-2004. The 80% acceptability limits are for typical applications and shall be used when other information is not available.

The allowable operative temperature limits in Figure 5.3 may not be extrapolated to outdoor temperatures above and below the end points of the curves in this figure. If the mean monthly outdoor temperature is less than 10°C or greater than 33.5°C, this option may not be used, and no specific guidance for naturally conditioned spaces is included in this standard. Consequently, for the BEAM assessment, months for which the mean monthly outdoor temperatures are outside these limits can be discounted.

It is most likely that some of the premises within a building development will be subject to higher than average external heat gains, with consequent higher internal temperatures during summer months. Those premises at more exposed facades will suffer from adverse winter conditions. It is appropriate to examine the detailed thermal performance of the most susceptible premises, and based on detailed analysis employ mitigation measures, such as changes in fabric design and other solar control strategies.

When air-conditioning is likely to be installed the type, rating and installation of units should be such as to provide for control over thermal comfort conditions over the range of thermal loads that are likely to arise.

The Predicted Mean Vote (PMV) refers to a thermal scale that runs from Cold (-3) to Hot (+3), originally developed by Fanger and later adopted as an ISO standard. The original data was collected by subjecting a large number of people (reputedly many thousands of Israeli soldiers) to different conditions within a climate chamber and having them select a position on the scale the best described their comfort sensation. A mathematical model of the relationship between all the environmental and

physiological factors considered was then derived from the data.

From the PMV, the Predicted Percentage of Dissatisfied people (PPD) can be determined. As PMV moves away from neutral (PMV=0) in either direction, PPD increases. The maximum number of people dissatisfied with their comfort conditions is 100% and, as you can never please all of the people all of the time, the minimum number even in what would be considered perfectly comfortable conditions is 5%.

SIMULATION SOFTWARE For the purposes of simulating thermal conditions (and in estimating energy use) previous BEAM assessments have employed the simulation software HTB2 [6]. Any software meeting the requirements of ASHRAE standard 140 [7] would be acceptable.

6 Alexander D K. HTB2 User Manual Version 2.0. Welsh School of Architecture, Cardiff University.
7 American National Standards Institute/American Society of Heating, Refrigeration and Air-conditioning Engineers. ANSI/ASHRAE Standard 140-2001. Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs

6	IEQ	6.6 LIGHTING QUALITY
		IEQ 15 NATURAL LIGHTING
	EXCLUSIONS	None.
	OBJECTIVE	Encourage a holistic examination of site layout, building design, and fenestration design, such as to maximise access to daylight for the purposes of improved health and comfort.
	CREDITS ATTAINABLE	2
	PREREQUISITES	None.
	CREDIT REQUIREMENT	1 credit where at least 80% of the floor area in all normally occupied spaces is adequately lit with an average daylight factor of 1%. 2 credits where at least 95% of the floor area in all normally occupied spaces is adequately lit with an average daylight factor of 1%.
	ASSESSMENT	<p>The Client shall submit evidence in form of a report prepared by a suitably qualified person demonstrating compliance with the assessment criteria. Daylight availability, based on 'worst case' scenarios, i.e., the most obstructed windows, shall be demonstrated by either one of the following methods:</p> <p>a) Measurement of DF</p> <p>Measurement of average daylight factor (DF) shall be by the methods recommended by CIBSE [1], or equivalent.</p> <p>Given that the specified sky condition can be difficult to obtain in practice the following modelling methods are acceptable alternatives.</p> <p>b) Estimation of DF</p> <p>The average daylight factor (DF) shall be estimated according to the preferred method [2], that given in the CIBSE design guide [3], or equivalent method. Alternatively, daylighting design software such as Radiance [4] can be used to calculate the average DF provided it can be demonstrated that the method of computation employed by the software used is not inconsistent with the preferred calculation method.</p> <p>The report submitted shall identify the key parameters used in the computations/modelling, especially with regard to glazing transmittance, and the reflectances of external and internal surfaces; and the suitable daylight glare control. The values of the parameters shall reflect the nature and type of surfaces on the external vertical obstructions and horizontal surfaces, and likely internal finishes.</p> <p>The room dimensions shall be taken to be a typical perimeter room for the building, such as a habitable room, office, classroom, etc.</p> <p>Where at least 80% of floor area in all normally occupied spaces is adequately lit with an average daylight factor of 1% or more the credit shall be awarded. The second credit shall be awarded where at least 95% of floor area in all normally occupied spaces is adequately lit with an average daylight factor of 1% or more.</p> <p>In addition, to ensure a realistic result that reflects the urban density of</p>

- 1 The Chartered Institution of Building Services Engineers. Applications Manual – Window design.
- 2 Cheung H D, Chung T M. Calculation of Mean Daylight Factor in a Building Interior Within a Dense Urban Environment. Department of Building Services Engineering, Hong Kong Polytechnic University.
- 3 The Chartered Institution of Building Services Engineers. Lighting Guide LG10. daylighting and window design. CIBSE.
- 4 Ward Larson, G. and Shakespeare, R. Rendering with RADIANCE. Morgan Kaufmann. San Francisco.

Hong Kong, surrounding buildings shall be included in the model.

BACKGROUND

Access to daylight is an important aspect of building design from the perspectives of comfort and health. Critical to providing sufficient daylight is the provision of a view of the sky. The amount of daylight available for specific rooms is related to:

- window and room geometry and room surface finishes;
- sky obstruction due to the form of the building and its overshadowing from neighbouring buildings; and
- glazing transmittance.

In Hong Kong's congested built form rooms on lower floors of buildings may be considerably overshadowed by the built form. This can result in significantly reductions in natural light, and will incur increased electricity consumption for artificial lighting, and degradation of internal comfort and health conditions. It is possible to take into account the overshadowing by adjacent buildings using appropriate design tools.

6	IEQ	6.6 LIGHTING QUALITY
		IEQ 16 INTERIOR LIGHTING IN NORMALLY OCCUPIED AREAS
	EXCLUSIONS	Residential buildings, hotels and apartment buildings.
	OBJECTIVE	Ensure the adequacy and maintenance of visual comfort conditions achieved by the electric lighting provisions in occupied spaces.
	CREDITS ATTAINABLE	1 + 1 BONUS
	PREREQUISITES	None.
	CREDIT REQUIREMENT	<p>1 credit where the prescribed lighting performance in each type of premises in respect of illuminance and lighting quality is achieved.</p> <p>It is required to fulfill the following:</p> <ul style="list-style-type: none">(i) prescribed lighting performance in respect of maintained illuminance and illuminance variation; and(ii) the limiting unified glare rating is achieved and light sources have an appropriate colour rendering index. <p>1 BONUS credit for providing automatic control of artificial lighting such as daylight sensors at perimeter zones and/or occupancy sensors.</p>
	ASSESSMENT	<p>The design criteria for interior lighting shall be at the discretion of the Client but shall embrace both 'quantity' and 'quality' of the lighting system performance including: maintained horizontal, and where appropriate vertical, illuminance, illuminance variation, limiting glare index, colour rendering, and modulation of light output appropriate to the type and use of the premises/indoor spaces.</p> <p>The criteria adopted shall be based on authoritative guidance, such as that provided in CIE [1,2], CIBSE [3] and/or IESNA [4] publications, or equivalent. As the focus is on lighting for comfort and productivity, lighting for performing arts, display decoration, ambience. etc., will normally be excluded from consideration.</p> <p>Compliance with the assessment criteria shall be demonstrated either by measurements using a standardised measurement protocol appropriate to the parameter being assessed, and/or by modelling (calculation), providing the calculation method or software used is based on a standardised method, and uses data/assumptions appropriate to the circumstances. Notwithstanding, demonstration of compliance with a) requires that the maintained illuminance take into account the influence on light output by adjacent air-conditioning or ventilation fixtures, and the lighting maintenance plan (the period for luminaire cleaning and group re-lamping) appropriate to the circumstances [5].</p> <p>The Client shall submit a report prepared by a suitably qualified person detailing the 'as installed' lighting systems or, for premises/spaces yet to be fitted-out, the technical details of the proposed lighting systems for each type of normally occupied space within the development. The report shall detail the design criteria and the results of measurements or other means of demonstrating compliance. For premises to be fitted out by tenants compliance shall be confirmed if the technical details and contractual arrangements with tenants in respect of lighting installations</p>

- 1 Commission Internationale de l'Eclairage (CIE). Lighting of Indoor Work Places. CIE Standard S 008/E.
- 2 Commission Internationale de l'Eclairage (CIE). Discomfort Glare in Interior Lighting. CIE 117-1995.
- 3 The Chartered Institution of Building Services Engineers. Code for interior lighting. London. CIBSE.
- 4 Illuminating Engineering Society of North America. Lighting Handbook, Reference & Applications. 9th edition., New York.
- 5 Commission Internationale de l'Eclairage (CIE). Maintenance of indoor electric lighting systems. CIE Technical Report - Publication No. 97. Vienna.

are deemed to meet the assessment criteria.

The Client shall submit a report prepared by a suitably qualified person detailing the automatic control of artificial lighting such as daylight sensors in perimeter zones and/or occupancy sensors.

**MEASURED
PERFORMANCE**

For lighting installations that are already installed, horizontal and vertical illuminance and luminance can be measured using a lux meter and a luminance meter. The colour quality of lamps can be assessed from the lamp specifications. Colour appearance (correlated colour temperature) can be checked from the lamp labels or by measurement using a colour meter. Flicker can be assessed by whether the specified ballasts are magnetic or electronic, and can be tested using a simple 'flicker meter'.

Air diffusers located near to fluorescent luminaires with open lamp compartments may result in cool air blowing over the lamps directly causing decrease light output and lamp efficacy. The design details should demonstrate that the cool air from diffusers will not adversely impact lamp performance.

COMPUTATION

The 'lumen method' can be used to calculate the maintained illuminance over the working plane according to the calculation procedure described in Section 4.5.3 of the CIBSE Code or in Appendix 3 of the CIBSE Lighting Guide [6]. The calculated maintained illuminance will then be checked for compliance with the recommendations given in Section 2.6.4 of the Code, or the recommendations given in Chapter 5 of the Guide.

The illuminance variation consists of 'uniformity' which is concerned with illuminance conditions on the task and immediate surroundings, and 'diversity' which expresses changes in illuminance across a larger space. The uniformity and diversity can be calculated according to that described in Section 4.5.4 of the Code. The calculated uniformity (minimum to average illuminance) over any task area and immediate surround should not be less than 0.8. The diversity of illuminance expressed as the ratio of the maximum illuminance to the minimum illuminance at any point in the 'core area' of the interior should not exceed 5:1. The core area is that area of the working plane having a boundary 0.5 m from the walls.

The glare index can be calculated according to either of the two methods described by CIE [2], or the CIBSE Technical Memoranda [7]. These methods are also summarised in Section 4.5.6 of the CIBSE Code [3]. The calculated glare index shall be checked for compliance with the recommendations given in Section 2.6.4 of the Code or Chapter 5 of the Lighting Guide.

For assessment using the IESNA Lighting Criteria, the calculation methods described in Chapter 9 of the IESNA Lighting Handbook can be used for the calculation of the following parameters:

- horizontal and vertical illuminance;
- glare: VCP or UGR; and
- luminance.

Alternatively, a validated computer program such as RADIANCE, LIGHTSCAPE etc can be used for the calculation. The calculated results will then be checked for compliance with the recommended criteria in the IESNA Lighting Design Guide.

6 The Chartered Institution of Building Services Engineers. Lighting Guide LG7: Lighting for offices. London, CIBSE, 1993.
7 The Chartered Institution of Building Services Engineers. Technical Memoranda TM10. Calculation of glare indices. London, CIBSE, 1985.

BACKGROUND

Energy efficiency aspects of electric lighting are dealt with in the assessment of energy use. This section deals with the lighting quality and maintenance aspects of lighting. Lighting quality is a complicated subject and is an integration of task performance, visual comfort, social communication, mood, health, safety and well-being and aesthetic judgment. It is also related to economics and the environment in respect of the installation, maintenance and operation of the lighting system.

Proper lighting maintenance (clean lamps and luminaires, lamps replaced periodically to avoid depreciation) is important to maintain good lighting quality throughout the whole life of the lighting installation. Besides the energy conservation, power quality and control benefits offered by dimmable high-frequency electronic ballasts, the high frequency modulation avoids the problem of 'flicker' that can occur when using mains frequency ballasts.

6	IEQ	6.6 LIGHTING QUALITY
		IEQ 17 INTERIOR LIGHTING IN AREAS NOT NORMALLY OCCUPIED
	EXCLUSIONS	None.
	OBJECTIVE	Ensure the adequacy of artificial lighting provisions in common areas and service areas such as plant rooms.
	CREDITS ATTAINABLE	1
	PREREQUISITES	Compliance with the Building Regulations for those common areas covered by regulations, e.g. Building (Planning) Regulation (B(P)R) 40 in respect of lighting of staircases.
	CREDIT REQUIREMENT	1 credit where the prescribed lighting performance in each type of common or service space in respect of light output and lighting quality is achieved.
	ASSESSMENT	<p>The Assessment focus is on lighting for safety, security and work activities required for operation and maintenance. The design criteria is at the discretion of the Client but shall embrace both 'quantity' and 'quality' of the lighting system performance including: maintained horizontal, and where appropriate vertical, illuminance, illuminance variation, limiting glare index, colour rendering, and modulation of light output appropriate to the type and use of the premises/indoor spaces. The criteria adopted shall be based on authoritative guidance, such as that provided in CIE [1,2], CIBSE [3] and/or IESNA [4] publications, or equivalent.</p> <p>The Client shall submit a report prepared by a suitably qualified person detailing the 'as installed' lighting systems or, for spaces yet to be fitted-out, the technical details of the proposed lighting systems for each type of common or service space within the development. The report shall detail the design criteria and the results of measurements or other means demonstrating compliance.</p> <p>Compliance with the assessment criteria shall be demonstrated either by measurements using a standardised measurement protocol appropriate to the parameter being assessed, and/or by modelling (calculation), providing the calculation method or software used is based on a standardised method, and uses data/assumptions appropriate to the circumstances. Notwithstanding, demonstration of compliance with a) requires that the maintained illuminance take into account the influence on light output appropriate to the circumstances, such as the recommendations given by CIE [5].</p>
	BACKGROUND	<p>Energy efficiency aspects of electric lighting are dealt with in the assessment of energy use. This section deals with the lighting quality and maintenance aspects of lighting systems provided in both common areas and service areas of a building.</p> <p>Reference should be made to Section IEQ 16 for further information on measurements and modelling on interior lighting systems.</p>

- 1 Commission Internationale de l'Eclairage (CIE). Lighting of Indoor Work Places. CIE Standard S 008/E.
- 2 Commission Internationale de l'Eclairage (CIE). Discomfort Glare in Interior Lighting. CIE 117-1995.
- 3 The Chartered Institution of Building Services Engineers. Code for interior lighting. London. CIBSE.
- 4 Illuminating Engineering Society of North America. Lighting Handbook, Reference & Applications. New York.
- 5 Commission Internationale de l'Eclairage (CIE). Maintenance of indoor electric lighting systems. CIE Technical Report - Publication No. 97. Vienna.

6	IEQ	6.7 ACOUSTICS AND NOISE
		IEQ 18 ROOM ACOUSTICS
	EXCLUSIONS	Buildings/premises where speech intelligibility is not important, and rooms of a special acoustical nature.
	OBJECTIVE	Improve the acoustical properties of rooms in which speech intelligibility is important.
	CREDITS ATTAINABLE	1
	PREREQUISITES	None.
	CREDIT REQUIREMENT	<p>1 credit for demonstrating that internal noise levels are within the prescribed criteria and the mid-frequency reverberation time in applicable rooms meets the prescribed criteria for give types of premises.</p> <p>Based on the nature of the building, relaxation should be allowed in considering the acceptance of this credit. The applicant should provide full submission of the design and calculation to justify the relaxation.</p>
	ASSESSMENT	<p>There is no single all-encompassing set of criteria that will define good acoustical properties for all types of rooms and uses. The Client shall define the criteria appropriate to the type and use of the premises/rooms in the building. The criteria for intruding noise level will be expressed in terms of NC level. However, for the purposes of assessment account should be taken of the criteria given below. Where alternative criteria are used the Client shall provide evidence as to the suitability of the alternative, e.g. by making reference to authoritative guidance. Likewise, where criteria appropriate to the type and use of premises/spaces are not stated herein, the Client shall provide evidence as to the suitability of the criteria adopted. Mid-frequencies refer to 500Hz, 1kHz and 2kHz. The internal noise sources include air conditioning units, breakout noise from air ducts, air grills, etc.</p> <p>Compliance shall be demonstrated by detailed calculations, or measurement, or both, depending on the Client's preference. The reverberation time shall be assessed using Sabine's formula [1] or similar alternative taking into account the room details and appropriate assumptions about the materials in the space. Measurements during commissioning shall use the method given in ISO 3382 [2] or equal equivalent.</p> <p>The Client shall submit details in the form of a report prepared by a suitably qualified person providing a schedule of the premises and spaces in the building, relevant design details as their impact on acoustical properties, the rooms/premises subject to field tests or for which detailed calculations have been made, the acoustical criteria used, underlying assumptions, and the results of tests or calculations demonstrating compliance with the criteria.</p> <p>Where it can be demonstrated that the acoustical quality in a sample of each type of room in which speech intelligibility is important, as measured or calculated, meets appropriate performance criteria the credit shall be awarded.</p>
	PERFORMANCE	a) Office type premises
	CRITERIA	The reverberation time of A-weighted sound pressure level, in modular (private) offices and conference rooms, shall be 0.6 s or below. The

1 I.Sharland. Woods practical guide to noise control. Colchester, England.

2 International Standard Organization. ISO 3382. Acoustics - Measurement of the reverberation time of rooms with reference to other acoustical parameters.

noise assessment criterion shall be NC40.

b) Classrooms and similar premises

The reverberation time of A-weighted sound pressure level in teaching rooms, other than specialist teaching rooms such as laboratories and workshops, shall be 0.6 s or below. The noise assessment criterion shall be NC 35.

c) Residential premises, hotel and apartments

The reverberation time of A-weighted sound pressure level, in bedrooms and living rooms, shall be between 0.4 and 0.6 s. The noise assessment criterion shall be NC 30.

d) Indoor games halls & indoor swimming pools etc

The reverberation time of A-weighted sound pressure level, in indoor game halls, indoor swimming pools or other recreational premises, shall be 2.0 s or below. The noise assessment criterion shall be NC 45.

Criteria from standards and guides from authoritative sources should be referenced. For example, Table 8 of BS 8233 [3] provides a guide to reverberation time in unoccupied rooms for speech and music.

BACKGROUND

A first step in architectural acoustic design is to identify appropriate values of reverberation time for the intended use of a room and then to specify materials to be used in the construction which will achieve the desired value of the reverberation time for a given space and use.

The focus for BEAM is on the acoustical qualities in workplaces such as offices and classrooms, libraries, and places of residence, etc. Whilst the matter of room acoustics is complex, and defining performance by a single indicator is problematic, an important acoustical measurement is the reverberation time. It is used to determine the decay rate of sound in a room, and offers a relatively simple assessment of acoustical design.

BEAM is not intended to replace design standards. It sets criteria for good acoustical quality while the design guidelines and standards established in other countries can also be considered.

Whilst reverberation time continues to be regarded as a significant parameter, other types of measurements are needed for a complete evaluation of acoustical quality of rooms. With respect to the standards and guides recommendations, ANSI [4] suggests the maximum reverberation time of A-weighted sound pressure level in classrooms and similar learning spaces. However, for office type premises, residential premises, hotels and apartments there seems to be little available in the way of standards or guides. ASTM [5] gives an alternative parameter, speech privacy in open offices, for an average speech spectrum using the Articulation Index Method.

3 British Standards Institution BS8233:1999 – Sound insulation and noise reduction for buildings – Code of Practice.

4 American National Standard ANSI S12.60-2002.

5 ASTM International. Designation E1130-02. Standard Test Method for Objective Measurement of Speech Privacy in Open Offices Using Articulation Index.

6	IEQ	6.7 ACOUSTICS AND NOISE
		IEQ 19 NOISE ISOLATION
	EXCLUSIONS	Buildings/premises which are inherently noisy and unaffected by noise from adjacent premises/spaces.
	OBJECTIVE	Improve the noise isolation of normally occupied premises/rooms to reduce impact of unwanted noise.
	CREDITS ATTAINABLE	1 + 1 BONUS
	PREREQUISITES	None.
	CREDIT REQUIREMENT	<p>1 credit for demonstrating airborne and impact noise isolation between rooms, spaces and premises meets the prescribed criteria.</p> <p>For residential developments only,</p> <p>1 BONUS credit for demonstrating impact noise isolation between floors meets the prescribed criteria.</p> <p>Based on the nature of the building, relaxation should be allowed in considering the acceptance of this credit. The applicant should provide full submission of the design and calculation to justify the relaxation.</p>
	ASSESSMENT	<p>As there are number of ways to quantify or classify noise isolation (insulation) in buildings, the exact performance criteria used to define both airborne noise isolation and impact noise isolation shall be stated by the Client. However, for the purposes of assessment account should be taken of the criteria given below. Where alternative criteria is used the Client shall provide evidence as to the suitability of the alternative, e.g. by making reference to authoritative guidance. Likewise, where criteria appropriate to the type and use of premises/spaces is not stated herein, the Client shall provide evidence as to the suitability of the criteria adopted.</p> <p>Compliance shall be demonstrated by measurement or by detailed calculations, or both, depending on the Client's preference. Measurements shall follow the protocols given in the referenced standards. Calculations should be done with reference to appropriate standards.</p> <p>The Client shall submit details in the form of a report prepared by a suitably qualified person providing a schedule of the premises and spaces in the building, the noise isolation criteria adopted, relevant structural details as they impact on noise isolation, the rooms/premises subject to field tests or for which detailed calculations have been made, underlying assumptions, and the results of tests or calculations demonstrating compliance with the criteria (expressed in parameters that are consistent with the test and/or calculation methods).</p> <p>Where it can be demonstrated that airborne noise isolation, as measured or calculated for the most susceptible spaces/rooms/premises, meets appropriate performance criteria the credit shall be awarded.</p> <p>For residential development, where it can demonstrate that impact noise isolation (insulation) meet appropriate performance criteria in the most susceptible spaces/ rooms/premises, the BONUS credit shall be awarded.</p>

MEASUREMENTS

Procedures for measuring the sound isolation between rooms shall follow that given in either ISO [1], ASTM [2] or equivalent. The measurements shall be undertaken in at least one sample of each type of normally occupied space, but shall include the worst case circumstances likely to occur (e.g., conference rooms adjacent to corridors, hotel rooms adjacent to lift lobbies, etc). No special preparation of the tested spaces or rooms is permitted, i.e., tests are carried out in as-built premises/rooms. The measurements shall be interpreted to a single number indicator using either ISO [3], ASTM [4], or equivalent.

Similar considerations shall apply to the measurement of impact noise isolation, following the methods given in either ISO [5], ASTM [6] or equivalent. No floor coverings, such as carpets, shall be used during the measurements. The measurements shall also be interpreted as a single number using either ISO [7], ASTM [8] or equivalent.

PERFORMANCE CRITERIA

a) Office premises

- Between two offices $D_w = 38$ dB minimum.
- Where privacy is important: $D_w = 48$ dB.
- Noise Isolation Class (NIC) of at least 40 for cellular offices.

b) Classrooms

Sound Transmission Class of walls between classrooms to be equal to or greater than STC37 for classrooms on the same floor and equal or greater than STC50, Impact Insulation Class IIC46 between floors.

c) Residential premises and hotel rooms

- Partitions separating a WC from a noise sensitive room: $D_{nT,w}$ of at least 38 dB.
- In hotels, partitions and floors between rooms and between rooms and corridors: $D_{nT,w}$ of at least 50 dB.

d) Residential premises

- Bedroom to living room: STC46 (same residential unit)
- Bedroom to bedroom: STC52, IIC52 (between residential units); STC44 (same unit)
- Living room to living room: STC52, IIC52 (between residential units).

BACKGROUND

Noise from outside sources, and consequently the noise isolation provided by the building envelope, is covered under the assessment of background noise. Noise from building equipment is also covered under the assessment of background noise, and to some extent under the assessment of vibration. There remains the problem of noise transmitted between spaces, through walls and floors, which are not addressed under the local Building Regulations, but have been a matter for

- 1 International Standard Organization. ISO 140-4: 1998. Acoustics - Measurement of sound Insulation in buildings and of building elements. Part 4: Field measurements of airborne sound insulation between rooms.
- 2 ASTM International. Designation E 336 – 97. Standard Test Method for Measurement of Airborne Sound Insulation in Buildings.
- 3 International Standard Organization. ISO 717-1. 1996. Acoustics – Rating of sound Insulation in buildings and of building elements. Part 1 – Airborne sound insulation.
- 4 ASTM International. Designation: E413 – 04. Classification for Rating Sound Insulation.
- 5 International Standard Organization. ISO 140-7. Acoustics - Measurement of sound Insulation in buildings and of building elements. Part 7: Field measurements of impact sound insulation of floors.
- 6 ASTM International. Designation: E 1007 – 97. Standard test method for field measurement of tapping machine impact sound transmission through floor-ceiling assemblies and associated support structures.
- 7 International Standard Organization. ISO 717-2. Acoustics – Rating of sound Insulation in buildings and of building elements. Part 2 – Impact sound insulation.
- 8 ASTM International. Designation: E 989 -89. Standard Classification for determination of impact Insulation Class (IIC).

legislation elsewhere.

The extent to which walls and floor can attenuate unwanted noise from neighbours and neighbouring spaces is an important aspect of controlling noise levels in interiors. Ventilation openings, doors, etc., are likely to be the weakest part of the envelope enclosing a space as far as airborne noise transmission is concerned. Guidance on the design of walls and floors, and guidelines for assessing performance are available in the literature [9].

6	IEQ	6.7 ACOUSTICS AND NOISE
		IEQ 20 BACKGROUND NOISE
	EXCLUSIONS	Buildings/premises in which speech intelligibility is not important.
	OBJECTIVE	Control as far as practicable the background noise in premises at levels appropriate to the intended use of the premises.
	CREDITS ATTAINABLE	1
	PREREQUISITES	None.
	CREDIT REQUIREMENT	<p>1 credit for demonstrating background noise levels are within the prescribed criteria.</p> <p>Based on the nature of the building, relaxation should be allowed in considering the acceptance of this credit. The applicant should provide full submission of the design and calculation to justify the relaxation.</p>
	ASSESSMENT	<p>BEAM regards background noise in premises/rooms as a matter having an important bearing on quality and productivity. Given that different criteria may be used the Client shall define the criteria appropriate to the type and use of the premises/rooms in the building. However, for the purposes of assessment account should be taken of the criteria given below. Where alternative criteria are used, the Client shall provide evidence as to the suitability of the alternative, e.g. by making reference to authoritative guidance. Likewise, where criteria appropriate to the type and use of premises/spaces are not stated herein, the Client shall provide evidence as to the suitability of the criteria adopted.</p> <p>Compliance shall be demonstrated by detailed calculations or measurements, or both, depending on the Client's preference. Sufficient numbers of calculations and/or measurements shall be made to ensure that the requirements are met in all specified premises, but in particular for premises near street level and major outdoor sources. Some relaxation of the noise criterion for residential units may be considered. The intruding noise sources shall include external noise sources such as traffic noise, railway noise, etc.</p> <p>Site measurements on the completed building should be on at least one sample of each type of premises/room, taking account the worst case conditions of exposure to noise sources external to the space, and undertaken during periods appropriate to the usage pattern for the space. Measuring equipment shall conform to the accuracy requirements given in IEC 60804 [1] to type 2 or better, or equal equivalent standard.</p> <p>For centrally air-conditioned buildings, the assessment shall take into account noise from building services equipment while for de-centralised air-conditioned buildings, the assessment shall only consider the external noise sources.</p> <p>The Client shall submit details in form of a report prepared by a suitably qualified person providing a schedule of the premises and spaces in the building, relevant design details as they impact on noise isolation, the rooms/premises subject to field tests or for which detailed calculations have been made, the background noise criteria used, underlying assumptions, and the results of tests or calculations demonstrating compliance with the criteria (expressed in parameters that are consistent with the test and/or calculation methods).</p> <p>Where it can be demonstrated that background noise isolation, as</p>

1 International Electrotechnical Commission. IEC 60804: 2000. Integrating-averaging sound level meters.

measured or calculated for the most susceptible spaces/rooms/premises, meets appropriate performance criteria the credit shall be awarded.

ASSESSMENT CRITERIA

a) Offices

- Modular (private) offices and small conference rooms: 40 dB $L_{Aeq,T=8}$ hr or 45 dB $L_{Aeq,T=5}$ mins.
- Large landscaped offices: 45 dB $L_{Aeq,T=8hr}$ or 50 dB $L_{Aeq,T=5min}$.

b) Classrooms

Background noise shall be below 45 dB L_{Amax} in schools in urban areas, otherwise at or below 40 dB L_{Amax} , effective between the hours of 08:00 to 16:00.

c) Residential premises and hotel rooms

- In bedrooms under window closed conditions at or below 30 dB $L_{Aeq,T=8}$ hr, or 35 dB $L_{Aeq,T=5}$ mins, and < 45 dB between 23:00 to 07:00.
- In habitable rooms (other than kitchens) under closed window conditions < 55 dB $L_{Aeq,T=16}$ hrs between 07:00 to 23:00.

d) Indoor games halls & indoor swimming pools etc

Background noise level shall be less than 50 dB $L_{Aeq,T=5}$ mins.

Tables 5 and 6 of BS 8233 [2] give criterion for various activities in buildings.

BACKGROUND

Background noise includes that from external sources as well as from the building services equipment. Table 4.1 in Chapter 9 of the Hong Kong Standards and Planning Guidelines provides a summary of maximum permissible noise levels at the external facade applicable to building uses which rely on operable windows for ventilation. Guidance on separation distances between road traffic and rail traffic and residential buildings is given in the Guidelines.

Calculations can be made in terms of $L_{Aeq,T}$ according to BS 8233, where $T = 16$ h (daytime) and 8 h (night time), appropriate to the criteria chosen. Calculations using the statistical energy analysis [3] are also acceptable. In centrally air-conditioned premises while NC, NR, PNC, NCB and RC are acceptable criteria for noise from air-conditioning equipment, the presence of outside noise sources renders $L_{Aeq,T}$ a better performance indicator for the aural environment [4]

Noise levels at the facade of a building can be established by measurement or prediction by simulation methods approved by the Environmental Protection Department. Predictions should take into consideration future as well as existing land uses. Estimation of road traffic noise can be made using the UK Department of Transport's prediction method [5]. For railway noise, calculations shall be made in terms of $L_{Aeq,T}$ using the UK Department of Transport's prediction method [6]. For noise from industry which is more or less of steady level, $L_{Aeq,T}$ is estimated according to British Standard BS 4142 [7]. T in the case can be 1 hr or 30 minutes.

2 British Standard Institution. BS 8233 Code of Practice for sound insulation and noise reduction for buildings.
3 European Committee for Standardization. CEN EN 12354 Building Acoustics – Estimation of acoustic performance of buildings from the performance of elements. Bruxelles.
4 Chan D W T, Tang S K, Burnett J. Noise Criteria for Hong Kong Building Environmental Assessment Method for New Offices and Existing Offices (HK-BEAM). HKIE Transactions. HKIE Transactions, Vol. 5, No. 2, 1998, pp. 1-5.
5 UK Department of Transport. The Calculation of Road Traffic Noise. HM Stationary Office.
6 UK Department of Transport. The Calculation of Railway Noise. HM Stationary Office.
7 British Standards Institution. Method for rating industrial noise affecting mixed residential and industrial areas. British Standard BS 4142:1990. London, BSI, 1990.

The Environmental Protection Department also describes practical measures that can be taken at the design stages to achieve an acceptable noise environment in new noise sensitive developments [8], and for planning residential developments against road traffic noise [9]. The Environmental Protection Department also provides guidelines on practical noise control measures for ventilation systems [10], and for pumping systems [11].

- 8 Environmental Protection Department. Practice Note for Professional Persons. ProPECC PN 4/93. Planning and Designing Noise Sensitive Developments.
- 9 Environmental Protection Department. Practice Note for Professional Persons. ProPECC PN 1/97. Streamlined Approach for the Planning of Residential Developments Against Road Traffic Noise.
- 10 Environmental Protection Department. Good Practices on Ventilation System Noise Control.
- 11 Environmental Protection Department. Good Practices on Pumping System Noise Control.

6	IEQ	6.7 ACOUSTICS AND NOISE
		IEQ 21 INDOOR VIBRATION
	EXCLUSIONS	None.
	OBJECTIVE	Avoidance of excessive vibration from building services equipment and external sources.
	CREDITS ATTAINABLE	1
	PREREQUISITES	None.
	CREDIT REQUIREMENT	1 credit for demonstrating vibration levels do not exceed the prescribed criteria. Based on the nature of the building, relaxation should be allowed in considering the acceptance of this credit. The applicant should provide full submission of the design and calculation to justify the relaxation.
	ASSESSMENT	The Client shall provide evidence of the investigation in the form of a report prepared by a suitably qualified person demonstrating compliance with the criteria given in ISO 2631-2 [1].
	BACKGROUND	Excessive vibration in buildings can also be a source of annoyance to users. It is possible to mitigate against vibration caused by external sources, such as traffic, and internal sources, such as building services equipment, through good design.

1 International Standard Organization. ISO2631-2. Evaluation of human exposure to whole-body vibration – Part 2 : Continuous and shock-induced vibration in buildings (1 to 80Hz)

6	IEQ	6.8 BUILDING AMENITIES
		IEQ 22 ACCESS FOR PERSONS WITH DISABILITY
	EXCLUSIONS	None.
	OBJECTIVE	Ensure full access to pertinent building facilities for persons with disability.
	CREDITS ATTAINABLE	1
	PREREQUISITES	Full compliance with Building (Planning) Regulation (CAP 123F) Regulation 72 'Buildings to be planned for use by persons with a disability' and Schedule 3 'Persons With A Disability', and the obligatory design requirements set out in the Code of Practice for Barrier Free Access (BFA).
	CREDIT REQUIREMENT	1 credit for providing at least 3 enhanced provisions
	ASSESSMENT	The Client shall provide evidence of the investigation in form of a report prepared by a suitably qualified person demonstrating provision of at least 3 enhanced provisions as stipulated in the "Recommended Design Requirements" of BFA 2008.
	BACKGROUND	<p>In order to enhance social integration disabled persons should have the same rights as any other individuals. Under the Disability Discrimination Ordinance, discrimination against persons with a disability by failing to provide means of access to any premises that the public is entitled to enter or use, or by refusing to provide appropriate facilities is prohibited, unless the premises are designed to be inaccessible to persons with a disability. The legal requirements for the provision of facilities for the disabled are prescribed in the Building (Planning) Regulations (CAP 123F) Regulation 72 'Buildings to be planned for use by persons with a disability' and Schedule 3 'Persons With A Disability'.</p> <p>Full access for disabled persons means more than just being able to enter and leave a building, or use the toilets. It enables persons with a disability to make full use of the basic facilities in a building without assistance and undue difficulties. The Code of Practice for Barrier Free Access [1] sets out design requirements to cater for the special needs of persons with locomotory disabilities, visual impairment and hearing impairment.</p> <p>Facilities that cater for the special needs of the physically impaired should be provided, which include but are not limited to shaded areas for walking and sitting; access to public toilets; adequate lighting; emergency phones; visual-free walking areas; ramps with handrails; and car or bus dropping-off points near to venues.</p> <p>As the advice provided cannot be exhaustive, developers and designers should exercise forethought and creativity to cater for the well-being of disabled persons when designing buildings, and allowing greater independence of disabled persons, the elderly, and other less physically able persons using the facilities.</p>

1 Code of Practice for Barrier Free Access. http://www.info.gov.hk/bd/english/documents/code/e_bfa.htm

6	IEQ	6.8 BUILDING AMENITIES
		IEQ 23 AMENITY FEATURES
	EXCLUSIONS	None.
	OBJECTIVE	Improve the standard and quality of buildings.
	CREDITS ATTAINABLE	2
	PREREQUISITES	Compliance with the Building Regulations.
	CREDIT REQUIREMENT	<p>a) Amenities for the benefit of building users.</p> <p>1 credit for providing at least 3 amenity features that enhance the quality and functionality of a building to the benefit of building users.</p> <p>b) Amenities for improved operation and maintenance.</p> <p>1 credit for providing at least 3 amenity features that allow for improved operation and maintenance of the building and its engineering services.</p>
	ASSESSMENT	<p>a) Amenities for the benefit of building users.</p> <p>The Client shall submit a report prepared by a suitably qualified person detailing the amenity features provided within the building for the purposes of improving the living and/or working experience of building users.</p> <p>Where it can be demonstrated that passive and active recreational facilities, balconies, mail rooms, lift lobbies, common areas, etc., are provided, the credit shall be awarded.</p> <p>b) Amenities for improved operation and maintenance.</p> <p>The Client shall submit a report prepared by a suitably qualified person detailing the amenity features provided within the building for the purposes of improving the flexibility in use and operation and maintenance of the building.</p> <p>Where it can be demonstrated that provisions that serve to enhance operation and maintenance exist, the credit shall be awarded.</p> <p>Given that the nature and extent of amenities will vary with the type and scale of the development the Client should provide the rationale if any of the listed amenities is not included.</p>
	BACKGROUND	<p>Amenity features are loosely defined as those elements of design that, whilst not statutory requirements are desirable to improve the standard and quality of a building [1].</p> <p>To encourage these features, the Building Authority is prepared to consider modification and exemption, under the Buildings Ordinance and Regulations, for the provision of new amenities in both new developments and existing buildings. To justify favourable consideration for modification or exemption, such proposals should meet one or a combination of the following objectives:</p> <ul style="list-style-type: none">• encouraging efficient and effective building management;• enhancing the quality of life for residents and users;• obviating the desire or temptation for unauthorised building works; and

1 Buildings Department. Practice Note for Authorized Persons and Registered Structural Engineers, PNAP No. APP-42. Amenity Features. <http://www.bd.gov.hk/english/documents/pnap/APP/APP042.pdf>

- improving environmental compatibility with the neighbourhood.

The amenity features identified includes:

- provisions for air-conditioning installations;
- security gates;
- counters, kiosks, offices, stores, guard rooms, lavatories for building management staff;
- logistics service room;
- mail room;
- horizontal screens;
- recreational facilities; and
- satellite dishes.

GREEN AND INNOVATIVE BUILDINGS

To protect and improve the built and natural environment, the Buildings Department (BD), the Lands Department (LandsD) and the Planning Department (PlanD) promote the construction of green and innovative buildings. The objective is to encourage the design and construction of buildings that encompass the following features:

- (a) Adopting a holistic life cycle approach to planning, design, construction and maintenance;
- (b) Maximizing the use of natural renewable resources and recycled/green building material;
- (c) Minimizing the consumption of energy, particularly in those non-renewable types; and
- (d) Reducing construction and demolition waste.

Joint Practice Note No. 1 [2] sets out the incentives provided to encourage the incorporation of certain features in building development, including:

- balconies;
- wider common corridors and lift lobbies;
- communal sky gardens; and
- communal podium gardens.

Criteria and conditions for exempting the above green features are listed in the JPN.

Joint Practice Note No. 2 [3] includes:

- mail delivery rooms with mailboxes; and
- communal sky gardens for non-residential buildings.

OPEN SPACE AND RECREATIONAL AREAS

PNAP No. APP-132 [4] describes the factors that the Building Authority may take into account in considering applications for flexibility in determining site coverage and open space to facilitate innovative design. PNAP No. APP-108 [5] sets out the general guidelines on proposals to

- 2 Buildings Department, Land Department, Planning Department. Joint Practice Note No. 1. Green and Innovative Buildings. <http://www.info.gov.hk/bd/english/documents/joint/JPN01.pdf>
- 3 Buildings Department, Land Department, Planning Department. Joint Practice Note No. 2. Second Package of Incentives to Promote Green and Innovative Buildings. <http://www.info.gov.hk/bd/english/documents/joint/JPN02.pdf>
- 4 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. APP-132 Site Coverage and Open Space Provision. <http://www.bd.gov.hk/english/documents/pnap/APP/APP132.pdf>
- 5 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. APP-108 Dedication of Land/Area for Use as Public Passage. <http://www.bd.gov.hk/english/documents/pnap/APP/APP108.pdf>

dedicate land or area within a building for use as public passage and the concessions which the Building Authority (BA) may grant upon acceptance of such dedication.

The provision of podium roof gardens and play areas is encouraged. Where these are under and within the perimeter of a domestic building, a modification would be granted provided the area is of open design and not encumbered with structural elements. Lands Department provides details of the recreational facilities commonly allowed in residential developments [6].

BUILDING SERVICES FACILITIES

Particular designs of building services facilities such as chimney shafts, fire refuge areas, swimming pool filtration plant rooms, pipe-ducts, etc., can also be exempt [7]. The area of refuse container chambers, hopper rooms, chutes, and storage chambers planned to suit factors listed in PNAP No. APP-35 [8] may also be discounted.

For residential buildings, projections such as wall boxes or platforms, window cills, flower boxes, etc., of prescribed dimensions may be excluded from site coverage considerations [9]. Notwithstanding, canopies, balconies, air-conditioner platforms, etc., need to be properly designed and constructed [10].

For commercial and industrial buildings, a centralised air-conditioning system should be provided or suitable internal areas set aside for this purpose at the design stage, with allowance made for adequate ducting and trunking, recesses, etc.

The lift service in a building has been the subject of complaints from time to time. The Building Authority (BA) accepts that occupants of the building may have legitimate cause for concern in some cases. PNAP No. APP-89 [11] introduces guidelines on the provision of lifts in buildings for domestic and office use with a view to enhancing standards of lift services, thereby improving the quality of life for the occupants of domestic and office buildings.

PNAP No. APP-84 [12] specifies the BA's requirements other provisions for communications systems. It would also be appropriate to make provisions for accommodating satellite dishes.

- 6 Lands Administration Office, Lands Department. Practice Note 4/2000. Recreational Facilities in Domestic Development.
- 7 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. APP-2 Calculation of Gross Floor Area and Non-accountable Gross Floor Area Building (Planning) Regulation 23(3) (a) and (b). <http://www.bd.gov.hk/english/documents/pnap/APP/APP002.pdf>
- 8 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. APP-35 Refuse Storage and Collection - Building (Refuse Storage and Material Recovery Chambers and Refuse Chutes) Regulations. <http://www.bd.gov.hk/english/documents/pnap/APP/APP035.pdf>
- 9 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. APP-19 Projections in relation to site coverage and plot ratio Building (Planning) Regulations 20 & 21. <http://www.bd.gov.hk/english/documents/pnap/APP/APP019.pdf>
- 10 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. APP-68 Safe Design and Construction of Cantilevered Projecting Structures. <http://www.bd.gov.hk/english/documents/pnap/APP/APP068.pdf>
- 11 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. APP-89. Provision of better lift service. <http://www.bd.gov.hk/english/documents/pnap/APP/APP089.pdf>
- 12 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. APP-84. Access Facilities for Telecommunications and Broadcasting Services. <http://www.bd.gov.hk/english/documents/pnap/APP/APP084.pdf>

7	INNOVATIONS AND ADDITIONS	<p>IA 1 INNOVATIVE TECHNIQUES</p> <p>IA 2 PERFORMANCE ENHANCEMENTS</p> <p>IA 3 BEAM PROFESSIONAL</p>
	INTRODUCTION	This section allows the Client to submit for consideration for the award of bonus credits on any innovative techniques or performance enhancements which the Client deems to provide environmental benefits additional to those already covered in BEAM Plus for New Buildings.
	CREDITS	Maximum 5 BONUS credits + 1 credit for BEAM Professional
IA 1	INNOVATIVE TECHNIQUES	<p>This section applies to advanced practices and new technologies that have not hitherto found application in Hong Kong or even elsewhere. Any credits gained under this heading shall be regarded as ‘Bonus’ credits, counting towards the total credits obtained, but not towards the total credits obtainable.</p> <p>Credits may be awarded to an assessed building for innovative and/or unconventional designs, construction techniques or provisions for operation that will improve the environmental performance of a building development during any part of its life cycle.</p>
	OBJECTIVE	Encourage adoption of practices, new technologies and techniques that have yet to find application in Hong Kong.
	ASSESSMENT	<p>The onus will be on the Client to present evidence of the application of new practices, technologies and techniques and the associated benefits. The benefits may be considered in relation to sustainable living, energy use, materials use, improved comfort, reduced pollution, etc. The Assessor will refer the proposal to the BEAM Technical Review Committee who will consider each aspect on its merits and award credits accordingly.</p> <p>The Client shall make a submission for granting additional credits that identifies the intent of the proposed innovative technique, the proposed criteria for assessing compliance, and the assessment criteria. The weighting (number of credits) proposed will be considered in the light of existing weightings under the various environmental impacts categorised in BEAM, i.e. a technique which can demonstrate a resource saving or reduced environmental loading would be compared with existing criteria deemed to achieve similar levels of benefit.</p>
IA 2	PERFORMANCE ENHANCEMENTS	An alternative approach to achieving bonus credits under BEAM is to demonstrate significant performance enhancements, i.e. strategies and techniques that greatly exceed the requirements of existing BEAM credits. For example, features that result in significantly higher levels of service, energy, water or materials savings. Any credits gained under this heading shall be regarded as ‘Bonus’ credits, counting towards the total credits obtained, but not towards the total credits obtainable.
	OBJECTIVE	Encourage adoption of practices, technologies and techniques that provide for performance enhancements over and above stated performance criteria in BEAM Plus for New Buildings.
	ASSESSMENT	<p>The onus will be on the Client to present evidence of the performance gains as compared to existing criteria. The Assessor will refer the proposal to the BEAM Technical Review Committee who will consider each aspect on its merits and award credits accordingly.</p> <p>The Client shall make a submission for granting additional credits which identifies the level of enhancement in performance in any environmental aspect. The weighting (number of credits) proposed will be considered in</p>

the light of existing weightings provided under the various environmental impacts categorised in BEAM, i.e. a demonstrated resource saving would be compared with existing criteria on a pro-rata basis to determine the bonus credits to be awarded.

A maximum of one credit from the Innovation and Performance Enhancement category can be achieved for Social Aspects through planning, managing and conducting a significant and wide ranging social engagement, engaging at least 75% of the local and pertinent organizations in the community.

**IA 3 BEAM
PROFESSIONAL**

At least 1 key member of the Project Team shall be a certified BEAM Professional.

OBJECTIVE

To facilitate the application for the BEAM certification process and to ensure the design of the project follows the requirements of the BEAM standards.

ASSESSMENT

The Client shall provide evidence of engagement of the BEAM Professional as the key project team member.

8	APPENDICES	8.1	ANNUAL ENERGY USE
		8.2	BASELINE BUILDING MODEL
		8.3	EQUIVALENT CARBON DIOXIDE EMISSIONS
		8.4	INSTALLATION OF AIR-CONDITIONERS
		8.5	PROVISIONS FOR ENERGY MANAGEMENT
		8.6	ASSUMPTIONS AND BASELINES FOR WATER CONSUMPTION
		8.7	SAMPLING PROTOCOL FOR INDOOR AIR QUALITY ASSESSMENTS
		8.8	PASSIVE DESIGN ASSESSMENT METHODOLOGY

8.1	ANNUAL ENERGY USE	8.1.1	ASSESSMENT FRAMEWORK
		8.1.2	PERFORMANCE-BASED APPROACH
		8.1.3	KEY FEATURES
		8.1.4	PREREQUISITES
		8.1.5	SIMULATION REQUIREMENTS
		8.1.6	ASHRAE APPROACH
		8.1.7	EXCEPTIONAL CALCULATION METHODS

8.1.1 ASSESSMENT FRAMEWORK

The assessment framework described herein applies to all types of new building developments:

- those that are air-conditioned throughout the year, including standalone buildings accommodating a single type or a mix of premises;
- buildings/premises in the same development served by a central air-conditioning plant; and
- buildings/premises that also utilise natural ventilation.

8.1.2 PERFORMANCE-BASED APPROACH

Buildings accommodating predominantly air-conditioned premises, such as malls, offices, hotels and high-rise apartments, are the dominant electricity consumers in Hong Kong. In order to allow designers flexibility in achieving the energy performance target for a building development, the assessment of Annual Energy use is based primarily on the 'Energy Budget' approach, supplemented by a range of basic requirements.

The Code of Practice for Energy Efficiency of Building Services Installations (BEC) [1] provides a framework for demonstrating compliance in which the proposed design has annual energy consumption no greater than that of a reference case that satisfies the prescriptive requirements.

The Performance Based Approach described in Section 9 of the Code of Practice for Energy Efficiency of Building Services Installations is primarily geared towards demonstrating compliance to performance requirements in section 5 to 8 of the BEC. A number of important modifications are listed here for extending the BEC's Performance Based Approach for the purpose of quantifying energy reduction as a result of efficient design.

Energy Reduction Measures Considered for this credit

The major modifications concerns clause 9.5.4.1 in BEC, which states:

In fulfilling clause 9.5.3 (the requirement that the design energy shall not exceed the energy budget), the increase in design energy as a result of not satisfying the trade-off allowable requirements in clause 9.4.2 (performance requirements for lighting, air-conditioning, lift and escalators, electrical installations) of BEC, can be off-set with reduction in design energy as a result of –

- (a) An improvement over the corresponding minimum allowable levels of performance in any one or more of the items listed with energy efficiency requirements in Sections 5 to 8 of the Code (lighting, A/C, vertical transport and electrical), *[This clause effectively limits the baseline A/C system to be the same as the proposed system with the same components (albeit with minimum performance requirements). For example: both baseline and designed building will have VAV, though the designed building can have better fan*

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

efficiencies] And/or,

- (b) A better OTTV, on condition that the energy reduction (as a result of better OTTV) counted towards the reduction shall be limited to not more than 5% of the energy budget, and/or
- (c) Having recovered energy or renewable energy captured or generated on site.

For the purpose of quantifying energy reduction as a result of efficient design towards demonstration of compliance to this credit, the reduction due to OTTV need not be limited to 5% of the energy budget, and the acceptable reduction measures are extended to:

- (a) An improvement over the corresponding minimum allowable levels of performance in any one or more of the items listed with energy efficiency requirements in Section 5 to 8 of BEC (such as lighting A/C, vertical transport and electrical);
- (b) Reduce facade heat gain through improved OTTV;
- (c) Having recovered energy or renewable energy captured or generated on site;
- (d) Adoption of load reduction strategies, such as (but not limited to) natural ventilation, free-cooling, natural daylight etc. When the selected simulation program cannot adequately model a design or a control strategy, exceptional calculation method can be used with reference to 8.1.6 - ASHRAE Approach (see below);
- (e) Addition of energy reduction components, such as (but not limited to) variable speed drives, heat recovery, energy efficient lamps and ballasts, smart control over lift banks etc), light pipes and light tubes, sensors (daylight, CO₂ occupancy), dimming devices (see below);
- (f) Reduction in equipment/process loads, where sufficient evidence is given to support the savings over common practices;
- (g) Reduction in energy use through the selection of a more efficient baseline cooling system (see below).

Baseline Building Design (Reference Building)

A3.3.1 in the BEC states that “the simulation model of the reference building shall be developed by modifying the model of the designed building as described in clause A3.2 (simulation of the designed building). Except as specifically instructed in the Appendix of the BEC, all building systems and equipment shall be modelled identically for both the reference building and designed building.”

For the purpose of assessment of this credit, the baseline building shall also be developed based on designed building but with the following important distinctions:

- (a) Modifications as described by clauses A3.3.2, A3.3.4, A3.3.6, and A3.3.7;
- (b) Energy saving devices and load reduction strategies need not be included in the baseline building. These are defined as components or operation strategies that reduce energy use while delivering the same level of environmental comfort to the building. Classification of energy saving devices and load reduction strategies is subject to the acceptance of the BEAM assessor.

Baseline Air-Conditioning System

In A3.3.5 of BEC, concerning air-conditioning system:

“The air-conditioning systems, zoning and equipment types of the reference building shall be identical to the designed building; and the system and equipment of the reference building shall exactly meet the

relevant requirements in Section 6 of the BEC.”

For the purpose of assessment of this credit, the baseline air-conditioning shall have identical zoning to the designed building, but shall be modeled with a system and equipment as described in the following table:

	Public Housing	Private Housing	Industrial, commercial, and other building types < CFA 14,000sqm	Industrial, commercial, and other building types > CFA 14,000sqm
Cooling Generation	Unitary air-conditioner, non-split-type	Unitary air-conditioner, split-type	Unitary air-conditioner, split-type	Chiller*
Terminal type	N/A	N/A	N/A	VAV
Heat Rejection	Air-cooled	Air-cooled	Air-cooled	Water-cooled

Reference shall be made to the latest BEC on the performance of individual components of the systems.

*For buildings with area less than 20,000 sqm – 2 water-cooled screw chillers sized equally, for buildings with area more than 20,000 sqm – 2 water cooled centrifugal chillers minimum with chillers added so that no chiller is larger than 2800 kW, all sized equally.

Baseline Envelope Design

Also, in A3.3.2 (d) of BEC, concerning building envelope:

“For buildings not governed by the OTTV requirements, the dimensions of the windows, doors and skylights shall be the same as the designed building”

Again, for the purpose of the assessment of this credit, in the case of buildings not governed by the OTTV requirements, the baseline building envelope need not be the same as the designed building, instead suggested baseline envelope specifications are given in Appendix 8.2.

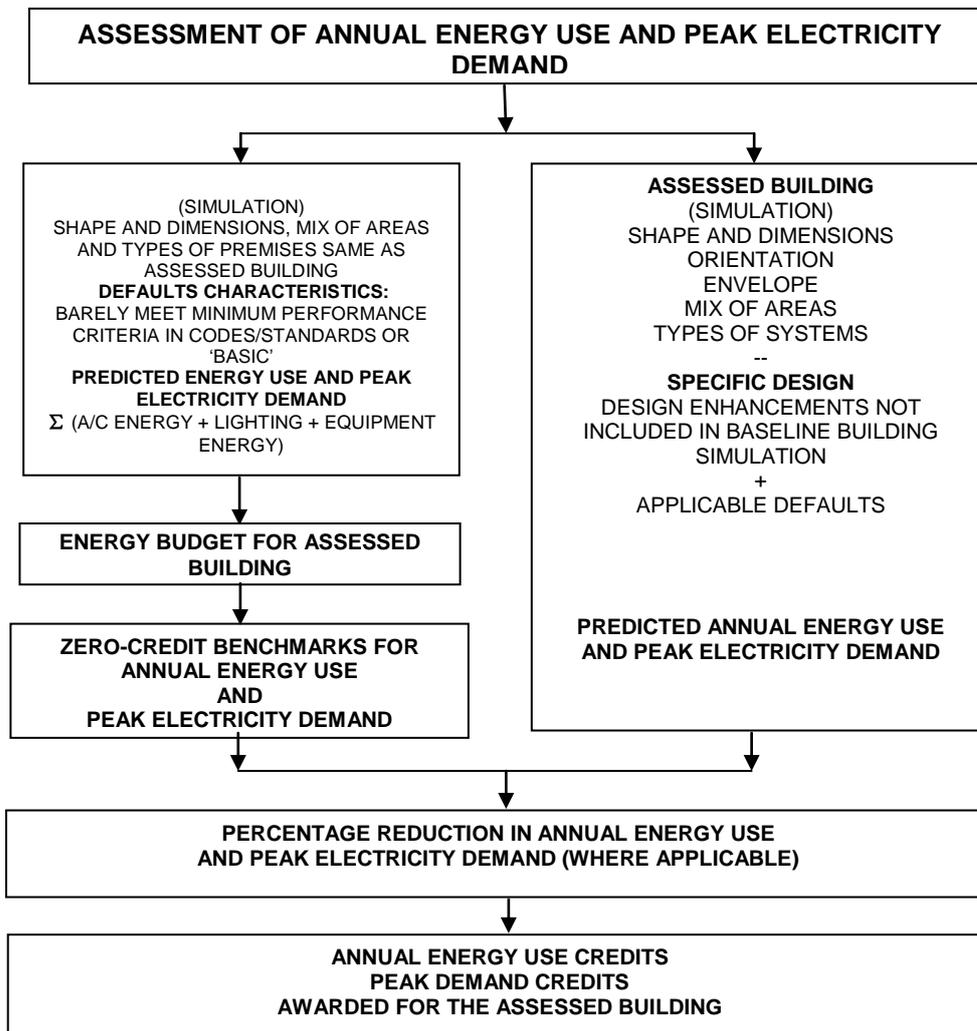


Figure 8.1 Building energy performance assessment

8.1.3 KEY FEATURES

The key features of the Performance-based Approach are as follows.

- the 'Energy Budget' for an ASSESSED BUILDING is the predicted Annual Energy Use for a BASELINE BUILDING (zero-credit benchmark);
- the BASELINE BUILDING model has the same shape and dimensions, comprises the same mix of areas and types of premises as the ASSESSED BUILDING (except for window-to-wall ratio adjustment to meet the relevant regulatory requirement);
- the BASELINE BUILDING model will incorporate a range of standard (default) characteristics such that the model represents a building whose energy performance barely meets the relevant regulatory requirements or meets only 'basic' design quality ;
- as far as possible the predicted Annual Energy Use of the ASSESSED BUILDING will be based on its specific design characteristics (except for some parameters for which default values are specified - see Section 8.2); and
- the number of credits awarded is determined by the percentage reduction in the predicted Annual Energy Use or Annual CO₂ Emissions of the ASSESSED BUILDING relative to the BASELINE BUILDING.

The assessment of Peak Electricity Demand Reduction is conducted in a similar manner, as follows:

- the zero-credit benchmark for Peak Electricity Demand will be that of the BASELINE BUILDING model; and
- the number of credits awarded is determined by the percentage reduction in the predicted monthly peak electricity demand for the month with the highest electricity demand throughout the year of the ASSESSED BUILDING relative to the BASELINE BUILDING.

8.1.4 PREREQUISITES

A prerequisite for obtaining credits for Annual Energy Use under the Performance-based Approach is compliance with the basic requirements given in Building Energy Code of EMSD, as follows:

- items listed in Table 8.1 in Section 8 (from Code of Practice for Energy Efficiency of Building Services Installation – 2012 Edition [2]);

Where applicable, those requirements listed in Table 9.4 of Code of Practice for Energy Efficiency of Building Services Installation – 2012 Edition shall be strictly complied with as a pre-requisite for credits under the Performance-based Approach. Substitutes or trade-offs in performance for such requirements are not accepted.

Items covered in the referenced codes not defined here as basic requirements are regarded as the minimum (benchmark) performance for the relevant systems or components, but trade-off in performance of such systems or components with other systems or components is allowed within the overall energy performance assessment.

Other building specific requirements are given in relevant sections that define the assessment method for the particular building type.

TABLE 8.1 BASIC REQUIREMENTS GIVEN IN BUILDING ENERGY CODE

Basic Requirements for Performance-based Approach in the Code of Practice for Energy Efficiency of Building Services Installation – 2012 Edition

Lighting installations, given in Section 5 of BEC

- Lighting control ⁽¹⁾ (clause no. 5.5) ⁽²⁾

Air-conditioning installations, given in Section 6 of BEC

- System load calculation (clause no. 6.4) ⁽²⁾
- Separate air distribution system for process zone (clause no. 6.5) ⁽²⁾
- Air distribution ductwork leakage limit (clause no. 6.6) ⁽²⁾
- Pumping system variable flow (clause no. 6.8) ⁽²⁾
- Frictional loss of water piping system (clause no. 6.9) ⁽²⁾
- System control (clause no. 6.10) ⁽²⁾
- Thermal insulation (clause no. 6.11) ⁽²⁾
- Energy metering (clause no. 6.13) ⁽²⁾

Electrical installations, given in Section 7 of BEC

- Power distribution (clause no. 7.4) ⁽²⁾
- Motor installation (clause no. 7.5) ⁽²⁾
- Power quality (clause no. 7.6) ⁽²⁾
- Metering and monitoring facilities (clause no. 7.7) ⁽²⁾

Lift and escalator installations, given in Section 8 of BEC

- Electrical power (clause no. 8.4) ⁽²⁾
- Utilization of power (clause no. 8.5) ⁽²⁾
- Total harmonic distortion (clause no. 8.6) ⁽²⁾
- Metering and monitoring facilities (clause no. 8.7) ⁽²⁾

Energy efficiency requirements on building envelope

- Overall thermal transfer value, requirements same as given in Building (Energy Efficiency) Regulation (Cap. 123M)

(1) For multi-tenanted buildings, this shall be confirmed by submitting a "Tenant's fitting out specification" that governs lighting installations and controls inside tenants' areas.

(2) Clause number in BEC

8.1.5 SIMULATION REQUIREMENTS

The computer simulation requirements shall be referred to Section A2 - Numerical Method for Building Energy Analysis in BEC.

Clause A2.1 in BEC states: The numerical method for the building energy analysis shall be targeted for the estimation of energy consumption in buildings in a comprehensive manner and shall include calculation methodologies for the building components or systems being considered.

The required numerical method shall include but not limit to the following features:-

- The use of a computer-based hour-by-hour, full-year, multiple-zone numerical analysis for modelling and simulating the design energy and energy budget is required.
- The simulation program shall be capable of modeling and simulating the thermal behaviour of a building and the interaction of its building fabric, air-conditioning, lighting and other relevant energy consuming equipment and systems.
- The simulation program shall be capable of performing design load calculations to determine the required air-conditioning equipment capacities and air and water flow rates for both the designed building and reference building.
- The simulation program shall be able to deliver the following printouts:-
 - (a) breakdown of energy consumption for lighting installation, space cooling and heat rejection equipment, space heating (if provided), fans of AHUs and ventilation fans, pumps for

air-conditioning, service water heating equipment, miscellaneous, equipment/appliance loads (e.g. office equipment); and

(b) monthly building energy consumption profile.

The functions and capabilities of the selected simulation program shall be stated clearly in the energy assessment submission.

Alternatively, the computer simulation requirements shall be referred to section G2 – Simulation General Requirements in ASHRAE Standard 90.1-2007 Energy Standard for Buildings Except Low-Rise Residential Buildings when ASHRAE approach adopted.

8.1.6 ASHRAE APPROACH

ASHRAE Standard 90.1-2007 Energy Standard for Buildings Except Low-Rise Residential Buildings is to provide minimum requirements for the energy-efficient design of buildings except low-rise residential buildings. Appendix G of ASHRAE 90.1-2007 provides the alternative approach, which is intended for use in rating the energy efficiency of building designs that exceed the requirement of Section 11 of the ASHRAE standard 90.1-2007. It may be useful for evaluating the performance of all proposed designs, including alterations and additions to existing buildings, except designs with no mechanical systems. The detailed requirement, assumption and modeling methodology for calculating the proposed and baseline building performance shall be made reference to the ASHRAE Standard.

8.1.7 EXCEPTIONAL CALCULATION METHODS

When the selected simulation program cannot adequately model a design (Note: For example: passive design with significant contribution on the reduction of CO₂ emissions), material, or device, the rating authority may approve an exceptional calculation method to demonstrate above-standard performance. The exceptional calculation shall make reference to Section A3.4 of Code of Practice for Energy Efficiency of Building Services Installation - 2012 Edition³] and/or Appendix G2.5 of ASHRAE 90.1-2007⁴] and/or Appendix D of the Advanced Energy Modelling for LEED – Technical Manual v1.0 (September 2011 Edition)⁵].

3 EMSD - Code of Practice for Energy Efficiency of Building Services Installation - Section A3.4 2012
4 ASHRAE Standard 90.1-2007 – Energy Standard for Buildings Except Low Rise Residential Buildings
5 USGBC - Advanced Energy Modeling for LEED – Technical Manual v1.0 (August 2010 Edition).

8.2	BASELINE BUILDING MODEL	<p>8.2.1 ENVELOPE DESIGN FEATURES</p> <p>8.2.2 COMMERCIAL BUILDINGS/HOTEL BUILDINGS</p> <p>8.2.3 RESIDENTIAL BUILDINGS</p> <p>8.2.4 OTHER BUILDING TYPES</p> <p>8.2.5 INDOOR DESIGN CONDITIONS, OCCUPANCY DENSITIES AND VENTILATION AND INFILTRATION RATES</p> <p>8.2.6 INTERNAL LOADS</p>
8.2.1	ENVELOPE DESIGN FEATURES	<p>The characteristics to be incorporated into the Baseline Building model include:</p> <ul style="list-style-type: none"> • envelope design features; • indoor design conditions, ventilation rates, occupation densities and usage patterns; • internal load intensities and usage patterns, and • performance of air-conditioning systems and equipment. <p>The Baseline Building model shall satisfy the minimum requirement of relevant regulations, code of practice, or those that are regarded in local practice as the basic requirements.</p> <p>The Baseline Building model should not have skylights, even if there are skylights in the Assessed Building.</p>
8.2.2	COMMERCIAL BUILDINGS/HOTEL BUILDINGS	<p>The regulatory control over the overall thermal transfer value (OTTV) of new commercial and hotel buildings is taken as the benchmark envelope design for these two types of building. The envelope of the Baseline Building model will be assigned with characteristics that comply with the OTTV requirement as stipulated in Buildings Department's Practice Note APP-67 [1]. Calculation of OTTV shall be based on the method and data given in the Code of Practice for Overall Thermal Transfer Value in Buildings [2]. Since, according to this OTTV calculation method, the heat gain from fenestration dominates the OTTV of a building, adjustment of the envelope characteristics from the 'as designed' condition to the baseline condition shall be made by varying the fenestration area at the external walls or roofs.</p> <p>The modification of the envelope design of the Assessed Building into that of the Baseline Building model shall preferably be made through adjusting the window-to-wall area ratio (WWR, the ratio of the total window area in the building facade to the total facade area). The WWR shall be adjusted such that the OTTV of the envelope of the Baseline Building model will just meet the relevant regulatory requirement (24 W/m² for a building tower and 56 W/m² for a podium).</p>
8.2.3	RESIDENTIAL BUILDINGS	<p>The default WWR area ratio of the Baseline Building model shall be 0.4, while the materials for facade construction are described in table 8.2. The annual energy use and maximum electricity demand for the Baseline Building model should be found by taking the average of the results generated by 4 separate simulations: 1 with the building in its actual orientation and 3 others with the entire building rotated 90, 180 and 270 degrees from the actual orientation.</p> <p>In predicting the annual energy use and maximum electricity demand for the Assessed Building, all components of the building envelope,</p>

1 Buildings Department. PNAP APP-67. Energy Efficiency of Buildings Building (Energy Efficiency) Regulation. August 2011. <http://www.bd.gov.hk/english/documents/pnap/APP/APP067.pdf>

2 Buildings Department. Code of Practice for Overall Thermal Transfer Value in Buildings 1995. http://www.bd.gov.hk/english/documents/code/e_ottv.htm

including the respective orientations, shall be modelled as designed.

8.2.4 OTHER BUILDING TYPES The default WWR area ratio of the Baseline Building model shall be 0.65.

For other types of new buildings, the Baseline Building model will be assumed to have envelope components (windows, walls, roofs, etc.) of construction characteristics as summarised in Table 8.2.

TABLE 8.2 DEFAULT CHARACTERISTICS FOR THE BUILDING ENVELOPE ⁽¹⁾

	Thickness (m)	Material	k (W/mK)	ρ (kg/m ³)	Cp (J/kgK)	α (-)
External walls						
Layer 1	0.005	Mosaic Tiles	1.5	2500	840	0.58
Layer 2	0.01	Cement/Sand Plastering	0.72	1860	840	
Layer 3	0.1	Heavy Concrete	2.16	2400	840	
Layer 4	0.01	Gypsum Plastering	0.38	1120	840	0.65
Roofs						
Layer 1	0.025	Concrete Tiles	1.1	2100	920	0.65
Layer 2	0.02	Asphalt	1.15	2350	1200	
Layer 3	0.05	Cement/Sand Screed	0.72	1860	840	
Layer 4	0.05	Expanded Polystyrene	0.034	25	1380	
Layer 5	0.15	Heavy Concrete	2.16	2400	840	
Layer 6	0.01	Gypsum Plaster	0.38	1120	840	0.65
Windows						
Layer 1	0.006	Tinted Glass (SC of 0.65)	1.05	2500	840	0.65
Window to wall area ratio		0.40 for Residential 0.65 for Other Building Types				

Symbols:

- k Thermal conductivity
- ρ Density
- Cp Specific heat
- α Solar absorptivity of exposed surface
- SC Shading coefficient of glazing

(1) This applies to all types of buildings except commercial, office, retail and hotel buildings. The envelope of the Baseline Building model for commercial, office, retail and hotel buildings will be set to achieve an OTTV that barely meets the threshold value stipulated in the OTTV Code.

8.2.5 INDOOR DESIGN CONDITIONS, OCCUPANCY DENSITIES AND VENTILATION AND INFILTRATION RATES For building operation parameters, including Occupant Density, Minimum Outdoor Air, Operating Schedule, Service Water Heating Power and Equipment Power Density, the designer should prepare a table summarizing the design value of these operation parameters for all the different spaces in the building. For simplification purpose, spaces with similar functions and operational characteristics, as represented by the operation parameters, may be grouped together as a space type. For details including table format, Section A3.5.2 (a) of BEC 2012 [3] may be considered as a reference.

An operating schedule for each type of space should be prepared summarizing for different times of a day the operation densities of occupants, equipment, lighting, AHU/fan, cooling, heating hot water etc. The operating schedule should reflect the time profiles which establish the extent of operation, such as the percentage of the equipment load during operation. For details regarding time profile and occupant density, Section A3.5.2 (b) & (c) of BEC 2012 can be referred to. For residential building type, it needs to note that the air-conditioner operation pattern applies to all days in April to October inclusive. The assumption is made

3 Electrical and Mechanical Services Department - Code of Practice for Energy Efficiency of Building Services Installation 2012 - Section A3.4 2012 (Page 14 of 65)

that Air-conditioners will not be used in other months in the year.

8.2.6 INTERNAL LOADS

The lighting power intensities to be used for various types of premises in the Baseline Building model shall be the threshold compliance values as stipulated in the Building Energy Code (BEC 2012) applicable to the types of premises. For those types of premises that the Building Energy Code (BEC 2012) does not cover, the values in Table 8.3 should be used.

The equipment power density shall be modelled as designed. The equipment power reduction in Assessed Building model must be documented by an exceptional calculation method: the applicants must provide justification for assumptions used in both the Baseline Building model and the Assessed Building model, supported by following:

- Side-by-side comparison of local industry standard equipment and new proposed equipment, with energy efficiency metric for each piece of equipment (e.g., kWh/ pound of material processed);
- List of modifications that make new equipment more efficient;
- Operation schedules for facility and equipment.

TABLE 8.3 BASELINE BUILDING LIGHTING POWER DENSITY FOR VARIOUS PREMISES

Type of Premises	Lighting power intensity (W/m ²)
Residential flat	
Bedroom	13
Living/dinning room	15
Entrance Lobby	15
Lift Lobby	12
Lift Car	13
Corridor	10
Staircase	8
Plant / Machine / Switch Room	12
Kitchen	15
Bathroom	13
School	
Classroom/ Laboratory	15
Library	15

8.3 EQUIVALENT CARBON DIOXIDE EMISSIONS

There are at present two power companies generating and selling electricity to consumers in Hong Kong. One of the power companies uses primarily coal for generating electricity but the other uses natural gas as well. The carbon dioxide emission per unit electricity consumed, therefore, depends on from which power company the electricity was generated. For the purpose of converting electricity consumption into the equivalent carbon dioxide emission for BEAM assessment, an average value, weighted by the market shares of the two power companies, is used irrespective of from which power company an Assessed Building will be fed with electricity supply. Besides electricity, buildings in Hong Kong may also use gas for water heating, cooking and other purposes. Majority of the buildings use town gas but buildings in certain areas may use natural gas instead.

Where a mix of fuel is used in an existing building, such as a hotel, the energy performance assessment will be based on the incurred carbon dioxide emission rather than the amount of energy used. The followings show the conversion factors to be used for this purpose:

ELECTRICITY	0.7 kg CO ₂ per kWh electricity consumed [1]
TOWN GAS	0.592 kg CO ₂ per unit of town gas consumed [1] (1 unit of town gas = 48 mega-joules consumed)
NATURAL GAS	2.31 kg CO ₂ per kg of natural gas consumed

1 Environmental Protection Department. Guidelines to Account for and Report on Greenhouse Gas Emissions and Removals for Buildings (Commercial, Residential or Institutional Purposes) in Hong Kong, 2008
http://www.epd.gov.hk/epd/english/climate_change/files/CAGuidelines_Eng.pdf

8.4 INSTALLATION OF AIR-CONDITIONERS

The temperature and flow rate of ambient air available to air-conditioners for rejection of condenser heat affects the energy performance of the air-conditioners. The ambient air flow rate and temperature is dependent on the positions of the air-conditioners relative to the building envelope elements and other air-conditioners. For instance, if the condenser side of an air-conditioner is too close to an opposing wall, condenser air discharge will be affected, which may lead to insufficient condenser airflow, or the discharged hot air being re-circulated back into the condenser. Also, an air-conditioner shall not be too close to a solid wall or to another air-conditioner at either side, as such conditions would limit the amount of air that can be drawn through the condenser coil. In the situation of a high rise residential building, the ambient air temperature around the air-conditioners at the top floors could be higher than the outdoor air temperature due to heat rejection from other air-conditioners below. This problem will be particularly acute if the air-conditioners are situated inside a recessed space with limited open area at the side.

At the indoor side, the location of air-conditioners will affect the thermal environmental conditions in the indoor space, and may give rise to condensation on wall or floor surfaces in adjacent spaces. For maintaining uniform space air conditions inside an air-conditioned space, air-conditioners shall be installed at high level. This would also avoid discomfort caused by the cold air stream discharged by the air-conditioner blowing against the occupants. Furthermore, the air-conditioner shall not be too close to the ceiling slab or to a partition wall to avoid contact of the slab or wall with the cold air. Otherwise, the temperature at the other side of the slab or wall may become lower than the dew point of the air in the adjacent spaces and may thus give rise to condensation.

For the purpose of avoiding deterioration of air-conditioner performance and maintenance of satisfactory indoor thermal environmental conditions, the installation locations of air-conditioners are assessed in BEAM. Credits will be awarded for buildings designed to provide air-conditioner installation locations that comply with the minimum dimensions specified in Tables 8.4 and 8.5. Minimum dimensions specified in this table are as shown in Figures 8.2 and 8.3.

TABLE 8.4 MINIMUM DISTANCES FROM AIR-CONDITIONERS*

Dimension	A	B	C	E	F	G	J	K	M
Minimum value (m)	1.5	0.75	1.5	0.75	2.0	See Table 8.5	0.3	1.7	0.6

*(ALL APPLICABLE TO THE OUTDOOR UNITS OF SPLIT-TYPE AIR-CONDITIONING UNITS EXCEPT DIMENSION J AND K)

TABLE 8.5 MINIMUM WIDTH (G) OF RECESSED SPACE FOR HEAT REJECTION

Depth of recessed space (D) (m)	No. of Storey (S)	Minimum width (G) (m)	
		2 A/C units per storey	4 A/C units per storey
D < 6 m	S ≤ 5	2.0	3.5
	5 < S ≤ 10	2.5	Undesirable
	10 < S ≤ 25	3.0	Undesirable
	S > 25	3.5	Undesirable
10m > D ≥ 6m	S ≤ 5	2.0	2.5
	5 < S ≤ 10	2.0	3.0
	10 < S ≤ 20	2.0	3.5
	20 < S ≤ 60	2.5	Undesirable
	S ≤ 20	2.0	2.5
D ≥ 10m	20 < S ≤ 35	2.0	3.0
	35 < S ≤ 60	2.0	3.5

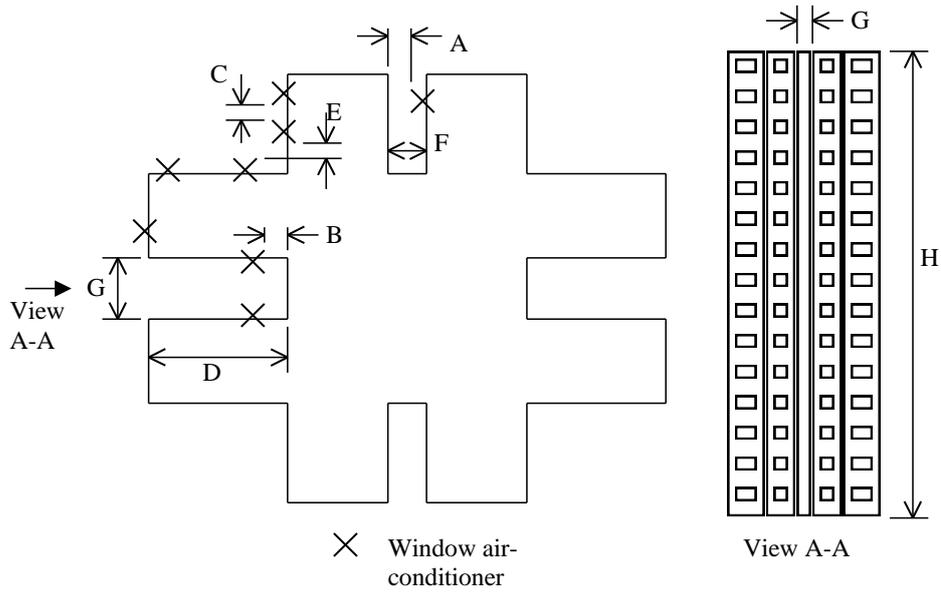


Figure 8.2 Layout plan and elevation of building

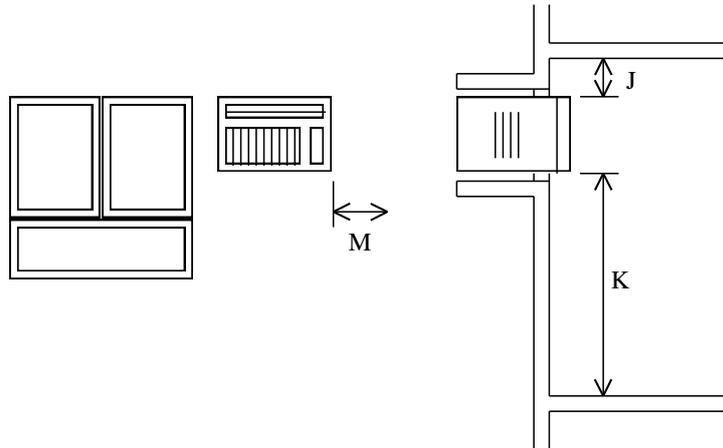


Figure 8.3 Elevation and section of a room in a residential building

**LEGEND FOR FIGURES
8.2 AND 8.3:**

- A Distance between window air-conditioner and nearest obstructing wall at the condenser side
- B Distance between window air-conditioner and nearest obstructing wall at either side
- C Distance between two adjacent window air-conditioners side-by-side
- D Depth of a recessed space into which air-conditioners reject heat
- E Distance between two window air-conditioners perpendicular to each other
- F Distance between two opposite walls with one window air-conditioner installed per storey at one wall
- G Distance between two opposite walls with two to 4 window air-conditioners installed at either or both walls
- H Height of building
- J Distance of top side of air-conditioner from ceiling slab
- K Distance of bottom side of air-conditioner from finished floor level
- M Distance of side of air-conditioner from nearest wall surface

8.5 PROVISIONS FOR ENERGY MANAGEMENT

8.5.1 COMMISSIONING SPECIFICATIONS

8.5.2 COMMISSIONING PLAN

8.5.3 COMMISSIONING

8.5.4 COMMISSIONING REPORT

8.5.5 INDEPENDENT COMMISSIONING AUTHORITY

8.5.6 OPERATIONS AND MAINTENANCE MANUAL

8.5.7 ENERGY MANAGEMENT MANUAL

8.5.8 OPERATOR TRAINING AND FACILITIES

8.5.1 COMMISSIONING SPECIFICATIONS

Functional performance testing procedures shall be defined and must be used to functionally test systems, equipment, components, and modes of operation. Test procedures must be documented to describe the individual test procedure, the expected system response, and acceptance criteria for each procedure. Testing documentation must identify the actual system response and must provide any pertinent observations.

Commissioning specifications shall be included in the construction documents and embrace:

- scope and details of the commissioning process;
- qualifications and skills required by the commissioning agent;
- detailed description of the responsibilities of all parties included in the commissioning process;
- systems, equipment and components to be commissioned;
- requirements for functional checklists and start-up;
- the functional performance testing process;
- specific functional performance test requirements, including testing conditions and acceptance criteria for each piece of equipment being commissioned;
- provisions for resolving deficiencies;
- requirements for reporting and documentation for commissioning;
- requirements for training; and
- requirements for an operations and maintenance manual, and for systems and an energy management manual.

8.5.2 COMMISSIONING PLAN

To execute commissioning in a comprehensive and orderly manner a commissioning plan, covering a given system, equipment or component shall be prepared. The plan shall include:

- start-up and inspection checklists and procedures;
- functional performance testing procedures and checklists;
- testing, adjusting, and balancing;
- development of a comprehensive operations and maintenance manual and energy management manual; and
- completion of the commissioning report.

For each system commissioned the plan shall provide:

- an overview of the tasks to be executed during commissioning;
- a list of all features to be commissioned;

- a list of reference documents related to commissioning, including specification references, drawing list, and submittal drawings;
- a list of primary participants in the commissioning process and their responsibilities;
- a plan for management, communication and documentation;
- description of checklists and tests to be performed, with reference to specification;
- pre-start and start-up checklists;
- list of the functional performance tests to be performed; and
- description of the training to be provided to the operations and maintenance personnel.

8.5.3 COMMISSIONING

Start-up and inspection checklist shall comprise the checks and tests to determine that all components, equipment, subsystems, systems, and interfaces between systems operate in accordance with specifications and construction documents, including all modes and sequences of control operation, interlocks and conditional control responses, and specified responses to abnormal or emergency conditions.

The results of the start-up and check-out shall be documented and must be performed according to the manufacturer's written instructions for the systems and equipment being commissioned, and the as-fitted construction documents.

Certificates of readiness shall be prepared by the commissioning agent verifying that start-up and inspections have been successfully completed and that all equipment, systems, and controls are complete and ready for functional performance testing.

After initial inspection and checking has been verified each sequence in the sequence of operations shall be tested, including the following:

- start-up;
- shutdown;
- unoccupied and manual modes;
- modulation up and down the unit's range of capacity, if applicable;
- staging, if applicable;
- power failure/power down;
- alarms;
- backup upon failure; and
- interlocks with other equipment.

The commissioning authority shall verify that:

- initial inspections, start-up and checking were successfully completed;
- every point of the control system has been checked and that a minimum sample of each type of control point is commanding, reporting and controlling as specified in the as-fitted construction documents;
- if any control point in the sample is not functioning as specified, then an additional sample shall be checked, until all control points in the sample are found to be performing as specified;
- a minimum sample of each type of sensor has been calibrated so that the value reported in the control system represents the actual

local value;

- if any sensor in the sample is out of calibration, then an additional sample shall be re-calibrated, until all sensors in a the sample are found to be in calibration;
- a minimum sample of each type actuators have been adjusted and observed to fully close and open dampers and valves, and that the reported values in the control system are correct;
- if any actuator, valve, or damper in the sample does not operate as required, then an additional sample of each type of actuator, valve, or damper shall be checked until all actuators, valves, or dampers in the sample are found to be to be operating as required;
- testing, adjusting and balancing by re-measuring a minimum sample of values reported for each type of component, equipment, subsystem, or system in the testing, adjusting and balancing reports;
- if any re-measured value in the sample deviates from requirements by more than 10 percent, then an additional samples shall be re-measured for each type part for which there is a deviation;
- any chimneys, chimney connectors and stacks are free of cracks, blockages and leaks;
- ensure that proper combustion air is provided to equipment; and
- ensure that all appliances are installed in accordance with applicable fire safety and local building codes.

The functional performance of each type of system, equipment, and component shall be tested based on a minimum sample for each type. If any part is found not to operate as required then additional samples shall be tested to ensure satisfactory performance has been achieved.

As far as practicable equipment shall be tested to demonstrate performance at near-design conditions (details of seasonally deferred testing can be submitted as an alternative).

The efficiency of central plant shall be recorded for reference by operations staff.

Functional performance testing can carried out using manual methods, control system trend logs, stand-alone data loggers, etc, as considered appropriate.

8.5.4 COMMISSIONING REPORT

The report shall contain:

- an executive summary;
- list of participants and their respective roles;
- a brief building description;
- an overview of the scope of commissioning and testing;
- a general description of testing and verification methods;
- a list of each feature or system commissioned; and
- for each piece of commissioned equipment, the determination of the commissioning authority regarding the adequacy of the equipment, documentation and training.

The commissioning report shall address the following areas:

- adequacy of equipment with respect to construction documents

and design intent;

- equipment installation;
- functional performance and efficiency;
- equipment documentation;
- operations and maintenance review and recommendations; and
- operator training.

The functional performance and efficiency section for each piece of equipment shall identify the verification method used observations and conclusions from the testing.

The report must also include a list of outstanding commissioning issues and any testing that is scheduled for a later date.

All outstanding deficiencies identified during or as a result of commissioning activities shall have been corrected or must be separately listed and highlighted in the commissioning report.

Each non-compliance issue must be referenced to where the deficiency is documented.

Verification and documentation of installation of systems, equipment and components shall ensure:

- that they are installed according to construction documents and manufacturer's instructions;
- or any differences between the final installation and the original construction documents are documented;
- that other building systems or components are not compromising the efficiency of the systems or features being commissioned;
- the start-up and inspection checklists were completed and performed as required;
- that functional performance tests are completed as required.
- that HVAC piping testing and duct testing is completed and documentation is included in operations and maintenance manuals;
- sufficient functional testing of any control systems;
- that testing record include any deficiencies and corrections;
- final testing outcomes are included in the commissioning report and in operations and maintenance manuals;
- documentation of any seasonally deferred testing and corrections of any deficiencies;
- the operations and maintenance manual and energy management manual are complete for all components, equipment, subsystems, and systems that have been commissioned; and
- adequacy of training provided for the Owner's management, operations and maintenance personnel.

If components, equipment, subsystems, or controls, or sequences of operations as-built are differing from the original construction documents, the report shall detail these differences.

If seasonally deferred testing is completed to be under the original contract, the commissioning authority shall issue an addendum to the report, arranged in the same manner as in the initial report.

8.5.5 INDEPENDENT COMMISSIONING AUTHORITY The Commissioning Authority shall be an entity that is independent of the design term appointed by the Client to carry out the role of commissioning authority.

8.5.6 OPERATIONS AND MAINTENANCE MANUAL The parties responsible for the design each system to be commissioned shall provide in writing:

- the design intent;
- the basis of design; and
- full sequences of operation for all equipment and systems, all of which must meet the legal requirements and industry wide standards.

The description of the design intent shall include as a minimum:

- space temperature and humidity criteria (refer also to the section on IEQ);
- levels operator and/or occupant control over HVAC systems;
- ventilation requirements and related indoor air quality criteria (refer also to the section on IAQ);
- performance criteria related to energy efficiency;
- environmental responsiveness of the facility; and
- commissioning criteria.

The basis of design shall include at a minimum:

- details of occupancy;
- space activity and any process requirements;
- applicable regulations, codes, and standards;
- design assumptions;
- performance standards and benchmarks; and
- control system appropriate for the skill of the operations and maintenance staff.

The operations and maintenance manual must include for each piece of equipment and each system:

- the name and contact information of the manufacturer or vendor and installing contractor;
- submittal data; and
- operations and maintenance instructions with the models and features for the subject site clearly marked.

The manual shall include only data for equipment that is actually installed, and include the following:

- instructions for installation, maintenance, replacement, start-up;
- special maintenance requirements and sources for replacement parts/equipment;
- parts list and details of and special tooling requirements;
- performance data; and
- warranty information.

The manual shall include an as-built documentation package for controls covering the following:

- control drawings and schematics;
- normal operation;
- shutdown;
- unoccupied operation;
- seasonal changeover;
- manual operation;
- controls set-up and programming;
- troubleshooting;
- alarms; and
- final sequences of operation.

8.5.7 ENERGY MANAGEMENT MANUAL The details shall include:

- descriptions of the final design intent and basis of design, including brief descriptions of each system;
- final sequences of operations for all equipment;
- procedures for seasonal start-up and shutdown, manual and restart operation;
- as-built control drawings;
- for all energy-saving features and strategies, rationale description, operating instructions, and caveats about their function and maintenance relative to energy use;
- recommendations and brief method for appropriate accounting of energy use of the whole building;
- specifications for re-calibration frequency of sensors and actuators by type and use;
- recommendations for continuous commissioning or recommended frequency for re-commissioning by equipment type, with reference to tests conducted during initial commissioning;
- recommendations regarding seasonal operational issues affecting energy use;
- list of all user-adjustable set points and reset schedules, with a discussion of the purpose of each and the range of reasonable adjustments with energy implications;
- schedules of frequency for reviewing the various set points and reset schedules to ensure they still are near optimum;
- list of time-of-day schedules and a frequency to review them for relevance and efficiency;
- guidelines for establishing and tracking benchmarks for building energy use and primary plant equipment efficiencies;
- guidelines for ensuring that future renovations and equipment upgrades will not result in decreased energy efficiency and will maintain the design intent;
- list of diagnostic tools, with a description of their use, that will assist facility staff for the building in operating equipment more efficiently;
- a copy of the commissioning report; and
- index of all commissioning documents with notation as to their location.

**8.5.8 OPERATOR TRAINING
AND FACILITIES**

The training program shall cover the following:

- general purpose of each building system including basic theory of operation, capabilities and limitations, and modes of control and sequences of operation;
- review of control drawings and schematics;
- procedures for start-up, shutdown, seasonal changeover, normal operation, unoccupied operation, and manual operation;
- controls set-up and programming;
- troubleshooting;
- alarms;
- interactions with other systems;
- operational monitoring and record keeping requirements, and the use of data for analyzing system performance;
- adjustments and optimizing methods for energy conservation;
- any relevant health and safety issues;
- inspection, service, and maintenance requirements for each system, including any need for specialised services;
- sources for replacement parts/equipment; and
- any tenant interaction issues.

The demonstration portion of the training program shall include at least the following:

- operation typical examples of each system;
- start-up and shutdown procedures;
- operation under all specified modes of control and sequences of operation;
- procedures under emergency or abnormal conditions; and
- procedures for effective operational monitoring.

The Client shall submit details in the form of drawings and a report demonstrating:

- that proper maintenance facilities are provided for operations and maintenance work in the form of workshop(s), office accommodation and control room;
- adequate provision of chemical storage and mixing areas for housekeeping products (central storage facilities and janitors closets, where appropriate) to allow for adequate and secure product storage with water in the space for mixing concentrated chemicals; and
- adequate provision of drains plumbed for the appropriate disposal of liquid waste products, equipped with separate outside venting, and operated under negative pressure.

8.6 ASSUMPTIONS AND BASELINES FOR WATER CONSUMPTION The following details the default assumptions for the calculation of the reduction in water use of the project building when compared with an equivalent base line space.

NUMBER OF WORKING OR OPERATIONAL DAYS The number of operational days per annum (Nop) shall be obtained from the design brief or Owner's Project Requirement (OPR) document.
The number of non-operational days is equal to 365-Nop.
The same values of operational and non-operational days will be used for both the project space and the base line space.

OCCUPANCY CONSIDERATIONS The number of occupants shall be taken from the design brief, or owner's project requirements (OPR). If this data is not obtainable then, in the absence of any other data, the occupant space allowance shall be taken as 9 m²/person. [1]
The male:female ratio shall be determined from the design brief or OPR. If the data is not available then the default assumptions are as follows:

- In offices, the male to female occupancy ratio is 1:1 [2]
- In public places, the male to female occupancy ratio is 1:1.25 [2]

The same occupancy load shall apply to the project space and the baseline space.

WC WATER USE The base line building will have a single flush WC (i.e. no low flush option) with a flushing volume of 7.5 litres per flush. [3] The water closet, cistern and flushing fitting shall be of compatible types.
For non-residential,
Males use the WC once per day. If a dual flush system is installed in the project space, it is assumed that the WC will be flushed using the high flush volume.
Females use the WC five (5) times per day. If a dual flush system is installed in the project space, it is assumed that the average flush volume is equal to the average of one full flush and four low volume flushes for both males and females.
For residential,
Residents use the WC five (5) times per day. If a dual flush system is installed in the project space, it is assumed that the average flush volume is equal to the average of one full flush and four low volume flushes for both males and females.
The flow rate of the water appliance shall be read as an absolute figure irrespective of the working pressure in predicting the water consumption.

WATER USE IN URINALS For the purposes of calculation, the baseline building would have urinals fitted with 4.5 litres flush and manual controls. The urinal would be

1 Hong Kong Buildings Department (1996), Code of Practice for the Provision of Means of Escape in Case of Fire, Building Authority, Hong Kong.
2 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers. PNAP No. ADV-28 Provision of Sanitary Fittings in Offices, Shopping Arcades and Department Store, Places of Public Entertainment and Cinemas, May 2005.
3 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers. PNAP No. APP-99 Flushing Volume for Flushing Cisterns.

flushed after every use. Each male employees use the urinal on average four (4) times per day.

The water use in the project building would be based on the same number of male employees each using the urinals four (4) times per day. The calculation shall consider the actual flushing strategy employed.

An estimate of the potential water savings is not able to be determined as it would be influenced by the number of male employees and the time interval of flushing.

HAND WASHING IN REST ROOMS

- Number of hand wash operations per occupant per day = 5
- Hand washing time = 10 seconds

For the baseline building, the tap flow rate is 8.3 litres/min [4]

Note that to obtain significant savings the project space would need to install automatic controls such as proximity sensors to reduce the tap operation time to less than the default assumption of 10 seconds per hand washing operation.

WATER USE IN PANTRIES/ KITCHEN

For non-residential,

- Number of pantry tap operations per occupant per day = 1
- Baseline faucet flow rate = 8.3 litres/min [4]
- Duration of use = 15 seconds
- Utensil washing operation carried out by hand = 6 litres of water per operation

For residential,

- Number of use per resident per day = 4
- Baseline faucet flow rate = 8.3 litres/min [4]
- Duration of use = 60 seconds

SHOWERS

- Number of use of shower per occupant per day = 0.1 (for non-residential)
- Number of use of shower per resident per day = 1 (for residential)
- The baseline shower flow rate = 9.5 litres/min [4]
- Shower duration = 5 minutes (300 seconds)

OTHER APPLIANCES/ EQUIPMENT

Justification for capacities of appliance/equipment used in the benchmark building shall be provided by making reference to regulations, standards, guides and other publication published by various authorities.

8.7 SAMPLING PROTOCOL FOR IAQ ASSESSMENTS

As an alternative to the sampling protocol described in the Guidance Notes, the sampling method can be simplified based on the following rationale. This protocol seeks to reduce the number of sampling points and sampling parameters without significantly reducing the representation of IAQ.

PRINCIPLE 1: DETERMINING THE POPULATION OF MEASUREMENT POINTS

Before sampling is undertaken, the population of IAQ zone has to be defined. A sampling zone is defined as a region of indoor space, whether it is confined by partitions providing a physical barrier to another zones, or a part of an open indoor space within which every physical location (preferably the workstations) has the same quality of ventilating air, the same distribution of the ventilating air and the same emission characteristics of all significant pollutants. Within a zone, the pollutant concentrations of a set of pollutants are expected to be unchanged within any location in the zone, within the accuracy of the measuring instruments used.

Air sampling zones can be defined by a suitably experienced person during an initial walkthrough survey of all spaces. The total number of zones forms the population of the representative air quality zones.

PRINCIPLE 2: DETERMINING THE NUMBER OF SAMPLING POINTS

If the zones within a building are viewed as the total population, once this is defined, the number of sampling points can be computed using classic statistical sampling theory. Determination of the number of sampling points is done using two procedures. The first procedure involves in grouping of similar zones into 'categories'. When zones have the same three factors as defined in Principle 1, they will be grouped together to form 'category'. In a given category, zones are expected to have similar pollutant profiles. For example, zones within a building where the activities are the same, such as typical offices with sedentary workers and non-smoking, served with typical air conditioning systems, and with the same pollutant inventories within the zones, can be grouped together to form a category.

The second procedure follows the definition of all the categories. The classic statistical sampling comes into effect the number of sampling points can be reduced to provide a more economical and viable monitoring schedule. Typically, the number of sampling points (N) in a category can be computed by equation (1).

$$N = \frac{t^2 S^2}{d^2} \quad (1)$$

where t = number of standard deviations that account for the confidence level

S = standard deviation for the variable to be estimated

d = the margin of error (e.g. 10% of the mean value).

PRINCIPLE 3: REDUCING THE NUMBER OF SAMPLING PARAMETERS IN EACH SAMPLING POINT

Either if the pollutant comes from outdoor sources and its concentration at the intake point is below the prescribed criteria at all times, or if the pollutant is known to have a constant emission rate and its profile relative to the ventilation rate is known and is under control at all times, this pollutant can be discounted in IAQ sampling program.

PRINCIPLE 4: REDUCING THE SAMPLING TIME FOR EACH PARAMETER IN EACH SAMPLING POINT

The reduction of sampling time is based on the assumption that when a building enters into its routine operation that including the activities of the occupancy and the operation of ventilation system, the function of the zone or the pollutant inventory are ever changing, it is reasonable to assume that the pollution profiles of the target pollutants would remain similar with small changes of magnitude. When the pollutant profile is

known, a snapshot of measurement at any time can be used to determine the equivalent 8-hour exposure, and to check if any abnormal built up of the pollutant has occurred. This is particularly useful when availability of instrumentation is a problem.

PRINCIPLE 5:
CHOICE OF ALTERNATIVE INSTRUMENTATION

If the simpler measuring instrument using in the sampling is different from the requirement mentioned in the Guidance Notes for any reason, the calibration of this measuring instrument against the standard shall be undertaken in order to prove that the measuring instrument is suitable for the sampling. Therefore, the cost of sampling can be reduced if the Client's representative already has an instrument that is not specified in the Guidance Note.

8.8 PASSIVE DESIGN ASSESSMENT METHODOLOGY	8.8.1 BUILDING PASSIVE DESIGN
	8.8.1.1 Site Planning
	8.8.1.2 Building Orientation
	8.8.1.3 Building Envelope
	8.8.1.4 Natural Ventilation
	8.8.1.5 Daylight
	8.8.2 Active Building System
	8.8.2.1 HVAC System in Common Areas
	8.8.2.2 Artificial Lighting System in Common Areas
	8.8.2.3 Vertical Transportation System in Common Areas

8.8.1.1 Site Planning Site Planning

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.

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.

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=China

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.

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

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 is 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° 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° ; (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)

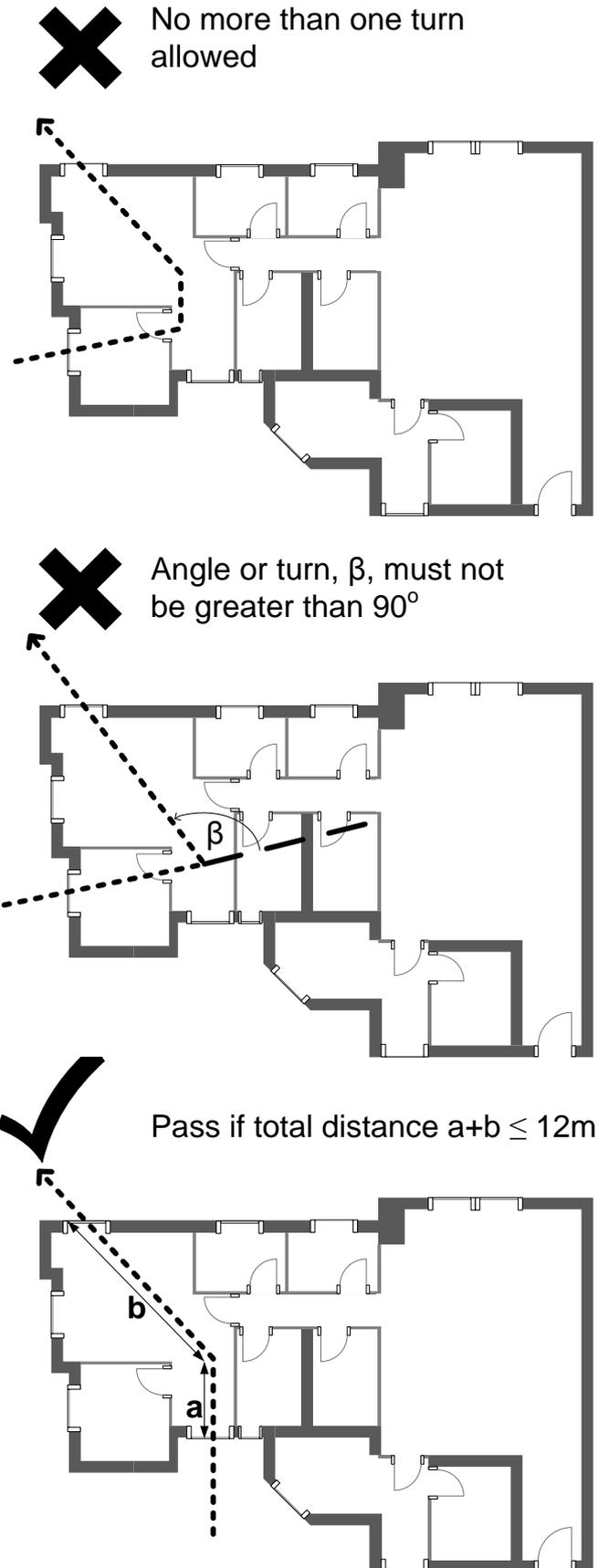
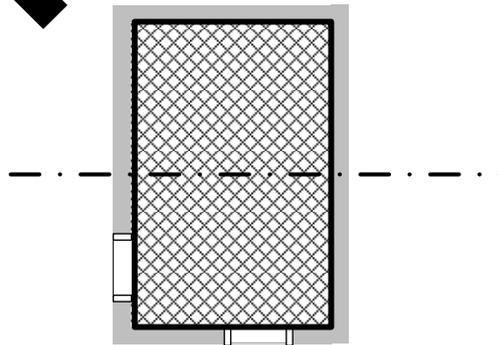


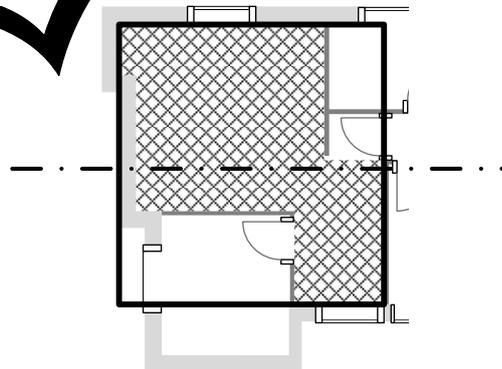
Figure 8.8.1.4-1: area to be considered in the performance assessment of site wind availability

- 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)

 Fail – windows lie in same half



 Pass – windows lie in different halves



 Habitable area

 Assessment box

 Half way line

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.

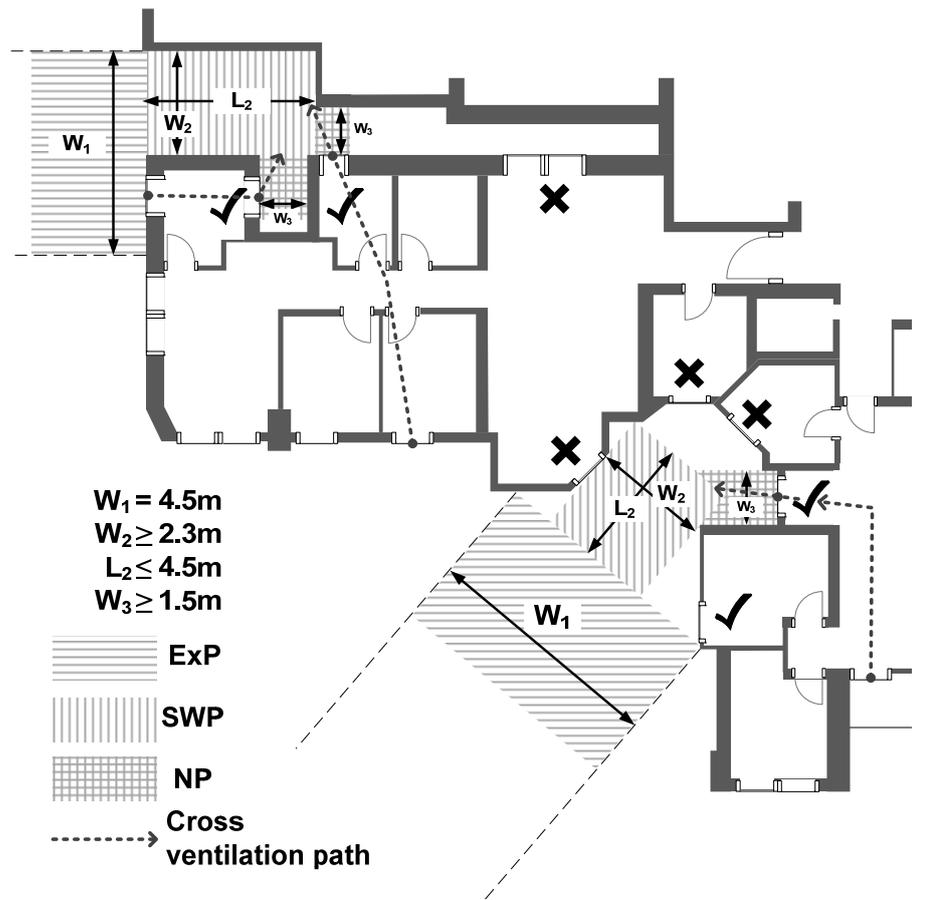


Figure 8.8.1.4-3: Allowable locations of windows in re-entrants

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)

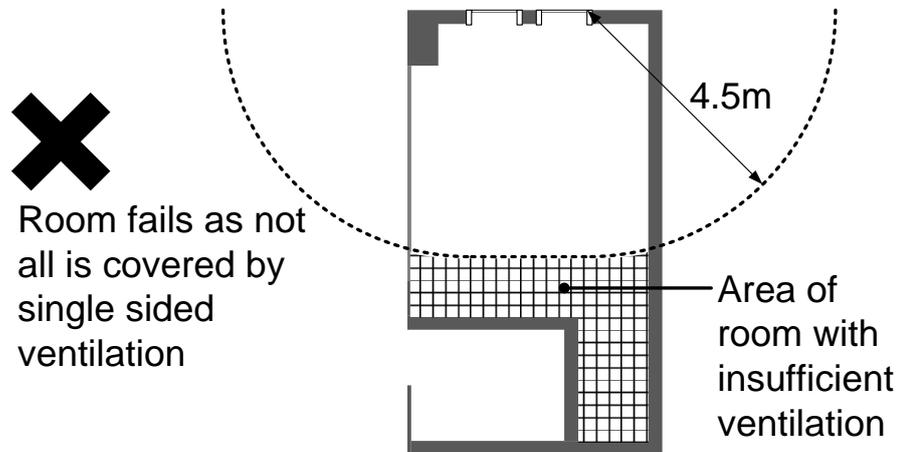


Figure 8.8.1.4-4: Room ventilation zone

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

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.

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:

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 respective 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 CO₂ emission & Appendix 8.1/8.2.

If a hybrid ventilation system is adopted, an exceptional calculation methodology shall be conducted (see EU 1 – Reduction of CO₂ 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 CO₂ emission & Appendix 8.1/8.2.

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.