



# BEAM Plus

## Existing Buildings

Version 1.2  
(2012.07)

## OVERVIEW

## BUILDING ENVIRONMENTAL ASSESSMENT METHOD (BEAM)

### A STANDARD THAT DEFINES BUILDING QUALITY

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 healthier, more 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**

BEAM seek to:

- 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 are integrated at the design and planning stage.

**VOLUNTARY  
ASSESSMENT**

An assessment under BEAM is voluntary, providing an independently certified performance rating for a building in clearly defined terms.

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.

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.

**CLIENTS DECIDE**

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.

**DEVELOPMENT HISTORY** 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.

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 the 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 standards.

**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 m<sup>2</sup> of space. The comprehensive BEAM standards 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 purpose of preliminary self assessments.

**VERSION 1.2 OF BEAM PLUS**

Version 1.2 of BEAM Plus contains minor amendments to the guidelines to add clarity to the assessment process. This will not affect the technical content of the document.

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](http://www.beamsociety.org.hk/en_resources_1.php))



## ACKNOWLEDGEMENTS

<b>BEAM SOCIETY</b>	Ms. Agnes Ng, Chairperson
<b>BOARD OF DIRECTORS</b>	Prof. John Ng, 1 <sup>st</sup> Vice Chairperson Mr. K. M. So, 2 <sup>nd</sup> Vice Chairperson Mr. Dan Rusu, Honorary Treasurer Ir. Cary Chan, Mr. C. K. Lau, Dr. Conn Yuen, Ir. Daniel Chan, Ir. David Yau, Ms. Ivy Lee, Mr. James Chiu, Prof. James Pong, Dr. John Burnett, Mr. John Herbert, Ir. Jonathan Lee, Mr. Kendrew Leung, Mr. Martin King, Mr. Michael Arnold, Mr. Peter Lee, Ir. Reuben Chu, Mr. Russell Jones, Mr. Victor Cheung
<b>BEAM PLUS VERSION 1.1 WORKING GROUPS</b>	<p>Ir. Reuben Chu - Chair, Prof. John Ng (Chair for Site Aspects Sub-group), Prof. C. S. Poon (Chair for Material Aspects Sub-group), Dr. Raymond Yau (Chair for Energy Use Sub-group), Mr. William Cheung (Chair for Water Use Sub-group), Prof. Daniel W. T. Chan (Chair for IEQ Sub-group), Mr. Peter Young (Chair for O&amp;M Aspects Sub-group).</p> <p>Working group members include: Mr. Alfred Sit, Mr. Andrew Wong, Dr. Anne Kerr, Mr. Anthony Fok, Mr. Benny Au, Mr. Billy Li, Mr. Bobby Ng, Mr. C. C. Ngan, Mr. C. W. Tse, Mr. C. F. Leung, Mr. C. K. Chan, Mr. C. K. Wong, Mr. C. S. Chin, Mr. C. S. Ho, Dr. Calvin Chiu, Ir. Cary Chan, Mr. Clarence Fung, Ms. Claudine Lee, Dr. Conn Yuen, Ms. Connie Yeung, Mr. Edmond Wu, Mr. Edward Chan, Prof. Edward Ng, Ms. Emily Wong, Ms. Eva Ho, Mr. Fredrick Leong, Ms. Grace Kwok, Mr. H. S. Lam, Mr. H. Y. Chiu, Mr. Hyvan Wong, Ms. Ivy Lee, Mr. Jacky Lau, Mr. Jacky Leung, Ms. Janet Ng, Mr. Jeffrey Siu, Ms. Jennifer Chung, Mr. John Cheng, Mr. John Herbert, Mr. Jon Seller, Mr. Jonathan Yau, Mr. Julian Bott, Ms. Julie Wong, Mr. K. C. Mak, Mr. K. L. Tam, Mr. K. M. Li, Mr. K. M. So, Mr. K. S. Tso, Mr. Keith Kan, Mr. Ken Cheung, Mr. Kenneth Chan, Mr. Kenneth Lam, Mr. Kenneth Li, Mr. Martin Tam, Mr. Michael Li, Mr. Peter Chan, Ms. Phyllis Li, Ms. Priscilla Lee, Mr. Richard Cuncliffe, Mr. Robert Allender, Ms. Rosa Ho, Mr. Ryan Lee, Dr. Ryan Song, Prof. S. C. Kot, Mr. S. K. Ho, Ms. Shani Yip, Mr. Shawn Dolley, Mr. Stanley Chow, Prof. Stephen Lau, Dr. Tony Lam, Dr. Trevor Ng, Mr. Vincent Cheng, Mr. W. S. Tsui, Mr. Wallace Leung, Ms. Wei Jiang, Dr. William Yu, Mr. Wilson Law, Mr. Wolfgang Peck, Mr. Y. T. Tang, Mr. Y. K. Cheung</p>
<b>BEAM PLUS VERSION 1.2 WORKING GROUPS</b>	Prof. John Ng - Chair, Ms. Alice Yeung, Mr. Benny Au, Ir. Cary Chan, Prof. C. S. Poon, Mr. Christopher Law, Ms. Connie Yeung, Prof. Daniel W. T. Chan, Ms. Ivy Lee, Mr. John Herbert, Mr. Kenneth Chan, Ms. Luciana Wong, Dr. Raymond Yau, Ms. Susana Wong

<b>1</b>	<b>FRAMEWORK OF BEAM PLUS FOR EXISTING BUILDINGS</b>			<b>1</b>
	1.1		SUSTAINABLE BUILDINGS	3
	1.2		ASSESSMENT FRAMEWORK FOR EXISTING BUILDINGS	5
	1.3		CREDIT WEIGHTINGS AND OVERALL GRADE	9
	1.4		ASSESSMENT PROCESS	12
	1.5		SUMMARY OF CREDITS	14
<b>2</b>	<b>SITE ASPECTS (SA)</b>			<b>24</b>
2.P	PREREQUISITE	SA P1	ENVIRONMENTALLY PURCHASING PLAN	26
2.1	SITE SELECTION	SA 1	BEAM CERTIFIED BUILDING	28
2.2	EMISSIONS FROM THE SITE	SA 2	NOISE FROM BUILDING EQUIPMENT	29
		SA 3	LIGHT POLLUTION	31
2.3	SITE MANAGEMENT	SA 4	HEALTH, SAFETY AND ENVIRONMENTAL MANAGEMENT	33
		SA 5	ENVIRONMENTAL PURCHASING PRACTICES	35
		SA 6	BUILDING AND SITE OPERATION AND MAINTENANCE	36
		SA 7	BUILDING SERVICES OPERATION AND MAINTENANCE	39
		SA 8	STAFFING AND RESOURCES	42
		SA 9	USER GUIDANCE	43
		SA 10	GREEN CLEANING	44
<b>3</b>	<b>MATERIALS ASPECTS (MA)</b>			<b>45</b>
3.P	PREREQUISITE	MA P1	USE OF NON-CFC BASED REFRIGERANTS	46
		MA P2	WASTE RECYCLING FACILITIES	47
3.1	EFFICIENT USE OF MATERIALS	MA 1	BUILDING REUSE	48
		MA 2	MODULAR AND STANDARDISED DESIGN	49
		MA 3	ADAPTABILITY AND DECONSTRUCTION	51
3.2	SELECTION OF MATERIALS	MA 4	RAPIDLY RENEWABLE MATERIALS	54
		MA 5	SUSTAINABLE FOREST PRODUCTS	56
		MA 6	OZONE DEPLETING SUBSTANCES	58
3.3	WASTE MANAGEMENT	MA 7	WASTE MANAGEMENT	62
<b>4</b>	<b>ENERGY USE (EU)</b>			<b>64</b>
4.P	PREREQUISITE	EU P1	MINIMUM ENERGY PERFORMANCE	68
4.1	ANNUAL ENERGY USE	EU 1	REDUCTION OF CO <sub>2</sub> EMISSIONS	69
		EU 2	PEAK ELECTRICITY DEMAND REDUCTION	72
4.2	ENERGY EFFICIENT SYSTEMS	EU 3	VENTILATED SYSTEMS IN CAR PARKS	73
		EU 4	LIGHTING SYSTEM IN CAR PARKS	75
		EU 5	RENEWABLE ENERGY SYSTEMS	77
4.3	ENERGY EFFICIENT EQUIPMENT	EU 6	AIR-CONDITIONING UNITS	79
		EU 7	ENERGY EFFICIENT APPLIANCES	81
4.4	PROVISIONS FOR ENERGY MANAGEMENT	EU 8	TESTING AND COMMISSIONING	82
		EU 9	METERING AND MONITORING	84
		EU 10	ENERGY MANAGEMENT	86
<b>5</b>	<b>WATER USE (WU)</b>			<b>88</b>
5.P	PREREQUISITE	WU P1	WATER QUALITY SURVEY	90
		WU P2	MINIMUM WATER SAVING PERFORMANCE	92
		WU P3	WATER CONSERVATION PLAN	95
5.1	WATER CONSERVATION	WU 1	ANNUAL WATER USE	96
		WU 2	MONITORING AND CONTROL	97
		WU 3	WATER USE FOR IRRIGATION	98
		WU 4	WATER RECYCLING	99
		WU 5	WATER AUDIT	101
5.2	EFFLUENT	WU 6	EFFLUENT DISCHARGE TO FOUL SEWERS	102
<b>6</b>	<b>INDOOR ENVIRONMENTAL QUALITY (IEQ)</b>			<b>103</b>
6.P	PREREQUISITE	IEQ P1	MINIMUM VENTILATION PERFORMANCE	108
6.1	SECURITY	IEQ 1	SECURITY	109
6.2	HYGIENE	IEQ 2	PLUMBING AND DRAINAGE	111
		IEQ 3	BIOLOGICAL CONTAMINATION	113
		IEQ 4	WASTE DISPOSAL FACILITIES	114
		IEQ 5	INTEGRATED PEST CONTROL	115
6.3	INDOOR AIR QUALITY	IEQ 6	CONSTRUCTION IAQ MANAGEMENT	117
		IEQ 7	OUTDOOR SOURCES OF AIR POLLUTION	119

		IEQ 8	INDOOR SOURCES OF AIR POLLUTION	121
		IEQ 9	IAQ IN CAR PARKS	123
6.4	VENTILATION	IEQ 10	INCREASED VENTILATION	124
		IEQ 11	BACKGROUND VENTILATION	126
		IEQ 12	LOCALISED VENTILATION	128
		IEQ 13	VENTILATION IN COMMON AREAS	130
6.5	THERMAL COMFORT	IEQ 14	THERMAL COMFORT IN AIR-CONDITIONED PREMISES	132
		IEQ 15	THERMAL COMFORT IN NATURALLY VENTILATED PREMISES	133
6.6	LIGHTING QUALITY	IEQ 16	NATURAL LIGHTING	136
		IEQ 17	INTERIOR LIGHTING IN NORMALLY OCCUPIED AREAS	137
		IEQ 18	INTERIOR LIGHTING IN AREAS NOT NORMALLY OCCUPIED	140
6.7	ACOUSTICS AND NOISE	IEQ 19	ROOM ACOUSTICS	141
		IEQ 20	NOISE ISOLATION	143
		IEQ 21	BACKGROUND NOISE	146
6.8	BUILDING AMENITIES	IEQ 22	ACCESS FOR PERSONS WITH DISABILITY	148
		IEQ 23	AMENITY FEATURES	149
7	INNOVATIONS AND ADDITIONS (IA)			151
		IA 1	INNOVATIVE TECHNIQUES	151
		IA 2	PERFORMANCE ENHANCEMENTS	151
		IA 3	BEAM PROFESSIONAL	152
8	APPENDICES			A-1
		8.1	ANNUAL ENERGY USE	A-2
		8.2	BASELINE BUILDING MODEL	A-9
		8.3	EQUIVALENT CARBON DIOXIDE EMISSIONS	A-11
		8.4	INSTALLATION OF AIR-CONDITIONERS	A-12
		8.5	ASSUMPTIONS AND BASELINES FOR WATER CONSUMPTION	A-14
		8.6	SAMPLING PROTOCOL FOR INDOOR AIR QUALITY ASSESSMENTS	A-16

<b>1</b>	<b>FRAMEWORK OF BEAM PLUS FOR EXISTING BUILDINGS</b>	<b>1.1 SUSTAINABLE BUILDINGS</b>
		<b>1.2 ASSESSMENT FRAMEWORK</b>
		<b>1.3 CREDIT WEIGHTINGS AND OVERALL GRADE</b>
		<b>1.4 ASSESSMENT PROCESS</b>
		<b>1.5 SUMMARY OF CREDITS</b>

## 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; with 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 standards 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 recognizes 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 impacts that buildings have on the environment by:

- enhancing safety, improving hygiene and the quality of indoor environments, 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 will be 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.

## 1.1 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, but 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 ASPECTS

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 environmental problems, and for which reasonably objective performance criteria can be defined. Certain performance aspects attributable to buildings and their use have yet to be included, either because the environmental impacts are not well defined, or

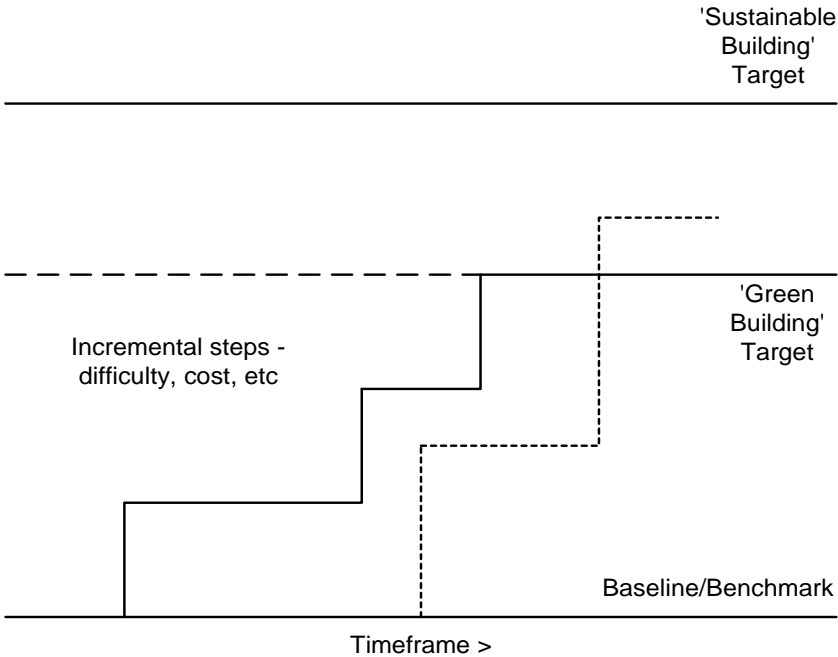
2 ASTM International E 2114–01. Standard Terminology for Sustainability Relative to the Performance of Buildings. 2001.

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

because performance criteria have not been established. They may be included in future updates, when 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 EXISTING BUILDINGS**

This document describes BEAM Plus for Existing Buildings. Assessment of new buildings and buildings that have undergone major refurbishment is carried out using BEAM Plus for New 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 Existing Buildings covers the management, operation and maintenance of a building and may be initiated at any time. BEAM Plus for Existing Buildings aims to reduce the environmental impacts of existing 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 Existing Buildings, as compared with most schemes in use elsewhere, is that an assessment for an existing building is closely related to a BEAM Plus for New Buildings assessment, should one have been carried out at construction. BEAM Plus 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. 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 Existing 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 building, and may involve premises that are fitted-out by tenants.

The purpose is not only to assess the actual performance of a building, but also to give guidance on potential performance, that is, the best performance that can be obtained from the building given the prevailing levels of occupancy and nature of use. Actual performance determines operating costs, consumption of resources and the by-products from building use, and is the starting point for determining various improvement measures.

For existing buildings, there are two facets to performance. Building and system performance are a consequence of technical features of the building and depend on the standards to which the building was built and/or subsequently modified. The building end use and the effectiveness of management practices in operating the building also have significant influence on performance. In order to encourage improvements, BEAM Plus for Existing Buildings, distinguishes between the potential impacts of these two aspects of the performance of a building.

**ESTATES**

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.

**SPECIAL CASES**

It is possible that some buildings may not be fully embraced by the criteria currently presented in BEAM Plus for Existing 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.

**ABSOLUTE VERSUS  
RELATIVE  
PERFORMANCE**

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.

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. CO<sub>2</sub>-kg) unless the mix of energy sources (gas, oil, electricity) is significant.

**ASSESSMENT  
BOUNDARIES**

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.

**ASSESSABLE AREA -  
DISCRETE AREAS  
EXCLUDED FROM  
ASSESSMENT**

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.

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.

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.

**REGIONALLY  
RESPONSIVE CRITERIA**

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 the provisions for natural ventilation and daylight figure prominently in the assessment of indoor environments.

**PERFORMANCE  
BENCHMARKS**

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.

**FLEXIBLE AND  
OBJECTIVE**

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.

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.

**PERFORMANCE  
CATEGORIES**

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:

**SITE ASPECTS  
(SA)**

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:

- location and design of the building;
- emissions from the site; and
- site management.

<b>MATERIALS ASPECTS (MA)</b>	<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"><li>• selection of materials;</li><li>• efficient use of materials; and</li><li>• waste disposal and recycling.</li></ul>
<b>ENERGY USE (Eu)</b>	<p>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. Where available BEAM Plus for Existing Buildings uses benchmarks derived from audits of similar types of buildings, and/or a computational approach to determine the dominant energy uses, plus additional features known to have impact on overall performance. Energy Use includes:</p> <ul style="list-style-type: none"><li>• annual CO<sub>2</sub> emissions or energy use;</li><li>• energy efficient systems and equipment; and</li><li>• energy management.</li></ul>
<b>WATER USE (Wu)</b>	<p>Assessments under Water Use include quality and features that improve utilisation and reduce effluent, i.e.:</p> <ul style="list-style-type: none"><li>• water quality;</li><li>• water conservation; and</li><li>• effluent discharges.</li></ul>
<b>INDOOR ENVIRONMENTAL QUALITY (IEQ)</b>	<p>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:</p> <ul style="list-style-type: none"><li>• safety;</li><li>• hygiene;</li><li>• indoor air quality and ventilation;</li><li>• thermal comfort;</li><li>• lighting;</li><li>• acoustics and noise; and</li><li>• building amenities.</li></ul>

**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)	18
Materials Aspects (MA)	12
Energy Use (Eu)	30
Water Use (Wu)	15
Indoor Environmental Quality (IEQ)	25
	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 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 Existing 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.



<b>1.4 ASSESSMENT PROCESS</b>	BEAM Assessments are currently undertaken by independent BEAM Assessor engaged by the BEAM Society Limited [5].
<b>ELIGIBILITY</b>	All existing buildings are eligible for certification under BEAM Plus for Existing 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.
<b>INITIATION</b>	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.
<b>GUIDANCE</b>	<p>Provisional Assessment will identify which credits have been achieved, and the particular reason for achievement.</p> <p>Further guidance material is made available on the BEAM Society Limited's website.</p>
<b>CERTIFICATION</b>	<p>Because a significant number of credits under BEAM are based on building performance, certification can only be issued after completion of the assessment.</p> <p>When a building 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. Certification is valid for a period of up to 5 years.</p>
<b>APPEALS PROCESS</b>	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].
<b>DISCLAIMER</b>	<p>The BEAM Building Environmental Assessment Method is intended for use by Client and project teams engaged in new building 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 organizations. The final outcome represents a general consensus, but unanimous support from each and every organization and individual consulted is not implied.</p> <p>This document represents 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.</p>

- 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](http://www.beamsociety.org.hk/files/Appeal_Page_12August2011_v1.0.pdf)

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.

As a condition of use, users covenant not to sue, and agree to waive and release BEAM Society Limited and its members from any and all claims, demands and causes of actions for any injuries, losses or damages that users may now or hereafter have a right to assert against such parties as a result of the use of, or reliance on BEAM.

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

Copyright © 2012 BEAM Society Limited. All rights reserved.

The copyright of all publications including BEAM Plus for New Buildings (Version 1.1), BEAM Plus for Existing Buildings (Version 1.1), BEAM 4/04 for New Buildings, BEAM 5/04 for Existing Buildings, BEAM 4/04 for New Buildings (Chinese), BEAM 5/04 for Existing Buildings (Chinese), 2004.12 HK-BEAM 4/04 'New Buildings', 2004.12 HK-BEAM 5/04 'Existing Buildings', HK-BEAM version 3/99 - An environmental assessment for new residential buildings, HK-BEAM version 1/96R - An environmental assessment for new office designs, HK-BEAM version 2/96R - An environmental assessment for existing office buildings, as well as content including text, graphics, logo, data compilation are owned by BEAM Society Limited.

## 1.5 SUMMARY OF CREDITS

	Section:	Credit Requirement:	Exclusions	Credits	Target
<b>2</b>	<b>SITE ASPECTS (SA)</b>			<b>18+1B</b>	
<b>SA P1</b>	<b>ENVIRONMENTALLY PURCHASING PLAN</b>	Demonstrate that environmentally purchasing plan and procedure either following their internal company guideline or other international standards shall be in place.	None.	<b>Required</b>	
<b>SA 1</b>	<b>BEAM CERTIFIED BUILDING</b>	5 credits where the building has been certified with Platinum grade; 4 credits where the building has been certified with Gold grade; or 3 credits where the building has been certified with any other grade.  Alternatively, Up to 4 credits for an uncertified building that meets the listed performance characteristics.	None.	<b>5</b>	
<b>SA 2</b>	<b>NOISE FROM BUILDING EQUIPMENT</b>	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.	<b>1</b>	
<b>SA 3</b>	<b>LIGHT POLLUTION</b>	1 credit for demonstrating that obstrusive light from exterior lighting meets the specified performance for the environmental zone in which the building development is located.	None.	<b>1</b>	
<b>SA 4</b>	<b>HEALTH, SAFETY AND ENVIRONMENTAL MANAGEMENT</b>	1 credit where the building management operates an Operational Health and Safety Management System certified to OHSAS 18001 or an Environmental Management System to ISO14001. 1 BONUS credit where both a certified OHSAS and a certified EMS are in place.	None.	<b>1</b> <b>1B</b>	
<b>SA 5</b>	<b>ENVIRONMENTAL PURCHASING PRACTICES</b>	1 credit for demonstrating 70% of purchased items are environmentally friendly materials, products or equipment for the past 12 months, or equivalent programme for implementation.	None.	<b>1</b>	
<b>SA 6</b>	<b>BUILDING AND SITE OPERATION AND MAINTENANCE</b>	1 credit for implementing an effective system of regular inspection, cleaning and maintenance of the building's fabric and structure.  1 credit for implementing an effective system of regular inspection, cleaning and maintenance of areas and facilities external to the building.  1 credit for providing a fully documented operations and maintenance manual for the building and site to the minimum specified.	Refer to assessment criteria.	<b>1</b> <b>1</b> <b>1</b>	

<b>SA 7</b>	<b>BUILDING SERVICES OPERATION AND MAINTENANCE</b>	1 credit for demonstrating the operation of a planned programme of regular inspection, cleaning and maintenance of central HVAC plant.	None.	<b>1</b>
		1 credit for demonstrating the operation of a planned programme of regular inspection, cleaning and maintenance of the building's engineering systems.		<b>1</b>
		1 credit for having undertaken an audit of the effectiveness of the operation and maintenance practices for all building services engineering systems.		<b>1</b>
<b>SA 8</b>	<b>STAFFING AND RESOURCES</b>	1 credit for the adequacy of staffing and resources to meet the operation and maintenance requirements of the building.	None.	<b>1</b>
<b>SA 9</b>	<b>USER GUIDANCE</b>	1 credit for providing comprehensive guidance on building safety, hygiene and environmental issues in a building user's guide.	None.	<b>1</b>
<b>SA 10</b>	<b>GREEN CLEANING</b>	1 credit for demonstrating appropriate green cleaning procedures/practices are implemented for the project and at least 50% of green cleaning products are used.	None.	<b>1</b>
<b>3</b>	<b>MATERIALS ASPECTS (MA)</b>			<b>11+2B</b>
<b>MA P1</b>	<b>USE OF NON-CFC BASED REFRIGERANTS</b>	Using no chlorofluorocarbon (CFC)-based refrigerants in HVAC&R systems.	Building using split-units and/ or window units.	<b>Required</b>
<b>MA P2</b>	<b>WASTE RECYCLING FACILITIES</b>	Providing facilities for the collection, sorting, storage and disposal of waste and recovered materials.	None.	<b>Required</b>
<b>MA 1</b>	<b>BUILDING REUSE</b>	1 BONUS credit for the reuse of 30% or more of existing sub-structure or shell.	None.	<b>1B</b>
<b>MA 2</b>	<b>MODULAR AND STANDARDISED DESIGN</b>	1 credit for demonstrating the use of modular and standardised design.	None.	<b>1</b>
<b>MA 3</b>	<b>ADAPTABILITY AND DECONSTRUCTION</b>	1 credit for designs providing spatial flexibility that can adapt spaces for different uses.		<b>1</b>
		1 credit for flexible design of services that can adapt to changes of layout and use.	Residential buildings.	<b>1</b>
		1 BONUS credit for designs providing flexibility through the use of building structural systems that allows for change in future use.		<b>1B</b>

<b>MA 4</b>	<b>RAPIDLY RENEWABLE MATERIALS</b>	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.	None.	<b>2</b>
<b>MA 5</b>	<b>SUSTAINABLE FOREST PRODUCTS</b>	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.	<b>1</b>
<b>MA 6</b>	<b>OZONE DEPLETING SUBSTANCES</b>	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. Alternatively, 1 credit for demonstrating a phased programme of refrigerant replacement together with limitations on leakage.	Buildings using split-units and/or window units.	<b>1</b>
		1 credit for the use of products that avoids the use of ozone depleting substances in their manufacture, composition or use.		<b>1</b>
		1 credit for undertaking a waste stream audit and developing a waste management system.		<b>1</b>
<b>MA 7</b>	<b>WASTE MANAGEMENT</b>	1 credit for developing and implementing an environmentally responsive waste management system. 1 credit where the waste management system demonstrates reductions in waste disposal to landfills and increased recycling.	None.	<b>2</b>
<b>4</b>	<b>ENERGY USE (EU)</b>			<b>39+2B</b>
<b>EU P1</b>	<b>MINIMUM ENERGY PERFORMANCE</b>	Demonstrate compliance with the Building Energy Codes (BEC).	None.	<b>Required</b>

<b>EU 1</b>	<b>REDUCTION OF CO<sub>2</sub> EMISSIONS</b>	1 to 15 credits for a reduction of CO <sub>2</sub> emissions or annual energy consumption by 3%, 5%, 7%, 9%, 11%, 14%, 17%, 20%, 23%, 26%, 29%, 33%, 37%, 41% and 45% respectively for Commercial and Hotel Buildings.	None.	<b>15</b>
		1 to 15 credits for reduction of CO <sub>2</sub> emissions or annual energy consumption by 3%, 4%, 5%, 6%, 7%, 9%, 11%, 13%, 15%, 17%, 19%, 21%, 24% and 27% and 30% respectively for Educational Buildings.		
		1 to 15 credits for reduction of CO <sub>2</sub> emissions or annual energy consumption by 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 11%, 12%, 13%, 14%, 16% and 18% and 20% respectively for Residential Buildings.		
		1 to 15 credits for reduction of CO <sub>2</sub> emissions or annual energy consumption by 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 11%, 12%, 13%, 14%, 16% and 18% and 20% respectively for other building types,		
		Alternatively, 1 or 2 credits for compliance with the Energy Efficiency codes Up to 4 credits based on energy consumption benchmarks.		<b>6</b>
<b>EU 2</b>	<b>PEAK ELECTRICITY DEMAND REDUCTION</b>	Alternatively, 1 or 2 credits for compliance with the Energy Efficiency codes. Up to 3 credits for reduced energy use based on billing/metering data.	None.	<b>5</b>
		1 to 3 credits for a reduction in the peak electricity demand by 15%, 23% and 30% respectively for Commercial Buildings.		<b>3</b>
		1 to 2 credits for a reduction in the peak electricity demand by 10% and 20% respectively for Hotel Buildings.		
		1 to 2 credits for a reduction in the peak electricity demand by 8% and 15% respectively for Educational and Residential Buildings.		
		1 to 3 credits for a reduction in the peak electricity demand by 8%, 12% and 15% respectively.		

		Alternatively, 1 credit for a reduction in electricity maximum demand of 10%, as demonstrated by billing/metering data. 2 credits for a reduction of electricity maximum demand of 20%, as demonstrated by billing/metering data.		2
<b>EU 3</b>	<b>VENTILATION SYSTEMS IN CAR PARKS</b>	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
<b>EU 4</b>	<b>LIGHTING SYSTEM IN CAR PARKS</b>	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
<b>EU 5</b>	<b>RENEWABLE ENERGY SYSTEMS</b>	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
<b>EU 6</b>	<b>AIR-CONDITIONING UNITS</b>	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
<b>EU 7</b>	<b>ENERGY EFFICIENT APPLIANCES</b>	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
<b>EU 8</b>	<b>TESTING AND COMMISSIONING</b>	1 credit for ongoing programme of commissioning of water side equipment of central air-conditioning system. 1 credit for ongoing programme of commissioning of air side equipment of central air-conditioning system.  Alternatively, 1 credit for ongoing programme of commissioning of all HVAC equipment.	All 3 credits applicable to buildings with central HVAC services.  For residential and similar buildings only the last 2 credits apply.	2  1



		1 credit for ongoing programme of commissioning of all non-HVAC equipment.		<b>1</b>
<b>EU 9</b>	<b>METERING AND MONITORING</b>	1 credit for ability to measure and monitor all major electrical loads in the building. 1 additional credit where central chiller plant is provided with adequate instrumentation to determine operating performance.	Residential buildings.	<b>2</b>
		1 credit for conducting Category 3 energy audit (EMSD's guidelines on Energy Audit) with evidence. 1 BONUS credit for conducting carbon audit or GHG emission audit and demonstrating that an action plan of GHG reduction is in progress.		<b>1+1B</b>
<b>EU 10</b>	<b>ENERGY MANAGEMENT</b>	1 credit for an effective energy monitoring and targeting system.	None.	<b>1</b>
		1 credit for demonstrating an approved budget to improve the energy performance of the building with management plan.		<b>1</b>
		1 credit for maintaining a comprehensive energy management manual.		<b>1</b>
		1 BONUS credit where separate charges are made for energy use.		<b>1B</b>
<b>5</b>	<b>WATER USE (Wu)</b>			<b>7+2B</b>
<b>WU P1</b>	<b>WATER QUALITY SURVEY</b>	Demonstrate that the quality of potable water meets the referenced drinking water quality standards at all points of use.	None.	<b>Required</b>
<b>WU P2</b>	<b>MINIMUM WATER SAVING PERFORMANCE</b>	Demonstrate that the use of water efficient devices leads to an estimated aggregate annual saving of 10%.	Water consumption in tenancy areas can be excluded.	<b>Required</b>
<b>WU P3</b>	<b>WATER CONSERVATION PLAN</b>	Develop a water conservation plan endorsed by directorate level management.	None.	<b>Required</b>
<b>WU 1</b>	<b>ANNUAL WATER USE</b>	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%.	Water consumption in tenancy areas can be excluded.	<b>3</b>
<b>WU 2</b>	<b>MONITORING AND CONTROL</b>	1 credit for installation of devices to monitor water leakage within the fresh water distribution system.	None.	<b>1</b>
<b>Wu 3</b>	<b>WATER USE FOR IRRIGATION</b>	1 credit for limited use of fresh water for the purposes of irrigation. Alternately,	Where soft landscaping coverage is less than 50% of the area of the	<b>1</b>

		1 credit for demonstrating highly efficient irrigation technology and/or the use of building footprint. 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.		
<b>WU 4</b>	<b>WATER RECYCLING</b>	1 credit for harvesting rainwater and/or recycling greywater that leads 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.	<b>1</b>  <b>1B</b>
<b>WU 5</b>	<b>WATER AUDIT</b>	1 BONUS credit for undertaking a water audit and maintaining a water use inventory.	None.	<b>1B</b>
<b>WU 6</b>	<b>EFFLUENT DISCHARGE TO FOUL SEWERS</b>	1 credit for demonstrating a reduction in annual sewage volumes by 20% or more, or reduction in sewage concentration by a 30% or more.	None.	<b>1</b>
<b>6</b>	<b>INDOOR ENVIRONMENTAL QUALITY (IEQ)</b>			<b>30+3B</b>
<b>IEQ P1</b>	<b>MINIMUM VENTILATION PERFORMANCE</b>	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.	<b>Required</b>
<b>IEQ 1</b>	<b>SECURITY</b>	1 credit for scoring at least 75% of the applicable security measures and facilities for the building.	None.	<b>1</b>
<b>IEQ 2</b>	<b>PLUMBING AND DRAINAGE</b>	1 credit where system design, operation and maintenance is such as to reduce the potential for transmission of harmful bacteria viruses, and odours.	None.	<b>1</b>
<b>IEQ 3</b>	<b>BIOLOGICAL CONTAMINATION</b>	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.	Residential buildings.	<b>1</b>
<b>IEQ 4</b>	<b>WASTE DISPOSAL FACILITIES</b>	1 credit for the provision of a de-odourising system in all refuse collection rooms.	None.	<b>1</b>
<b>IEQ 5</b>	<b>INTEGRATED PEST MANAGMENT</b>	1 credit for implementing an integrated programme for pest management.	None.	<b>1</b>
<b>IEQ 6</b>	<b>CONSTRUCTION IAQ MANAGEMENT</b>	1 credit for availability and effective implementation of a Construction IAQ Management.	Residential and similar buildings.	<b>1</b>
<b>IEQ 7</b>	<b>OUTDOOR SOURCES OF AIR POLLUTION</b>	1 credit for demonstrating compliance with appropriate criteria for monoxide, Nitrogen dioxide and Ozone.	Buildings that are designed for natural ventilation or using de-centralised a/c system.	<b>1</b>

		1 credit for demonstrating compliance with the appropriate criteria for RSP.		1
<b>IEQ 8</b>	<b>INDOOR SOURCES OF AIR POLLUTION</b>	1 credit for demonstrating compliance with the appropriate criteria for VOCs.	The first two items are excluded for 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 formaldehyde.		1
		1 credit for demonstrating compliance with the appropriate criteria for radon.		1
<b>IEQ 9</b>	<b>IAQ IN CAR PARKS</b>	1 credit for demonstrating compliance with the design requirements specified in ProPECC PN 2/96.	Buildings with no car park.	1
<b>IEQ 10</b>	<b>INCREASED VENTILATION</b>	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
<b>IEQ 11</b>	<b>BACKGROUND VENTILATION</b>	1 credit where it can be demonstrated that adequate ventilation is achieved by natural means.	Buildings not designed to utilize natural ventilation.	1
<b>IEQ 12</b>	<b>LOCALISED VENTILATION</b>	1 credit for the provision of an adequate ventilation system for rooms/areas where significant indoor pollution sources are generated.	None.	1
<b>IEQ 13</b>	<b>VENTILATION IN COMMON AREAS</b>	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
<b>IEQ 14</b>	<b>THERMAL COMFORT IN AIR-CONDITIONED PREMISES</b>	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

<b>IEQ 15 THERMAL COMFORT IN NATURALLY VENTILATED PREMISES</b>	1 credit for demonstrating indoor operative temperatures in occupied/habitable rooms meet the 80% acceptability limits. Alternately, 1 credit for demonstrating the Predicted Mean Vote (PMV) in occupied/habitable rooms is between -1 and +1.	Buildings that are not designed to utilize natural ventilation.	<b>1</b>
	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.		<b>1</b>
<b>IEQ 16 NATURAL LIGHTING</b>	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.	<b>2</b>
	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%.		
<b>IEQ 17 INTERIOR LIGHTING IN NORMALLY OCCUPIED AREAS</b>	1 credit where the prescribed lighting performance in each type of premises in respect of illuminance and lighting quality is achieved. It is required to fulfill prescribed lighting performance in respect of maintained illuminance and illuminance variation; and the limiting unified glare rating is achieved and light sources have an appropriate colour rendering index.	Residential buildings, hotels and apartment buildings.	<b>1</b>
	1 BONUS credit for providing automatic control of artificial lighting such as daylight sensors at perimeter zone and/or occupancy sensor.		<b>1B</b>
<b>IEQ 18 INTERIOR LIGHTING IN AREAS NOT NORMALLY OCCUPIED</b>	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.	<b>1</b>
<b>IEQ 19 ROOM ACOUSTICS</b>	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.  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 where speech intelligibility is not important, and rooms of a special acoustical nature.	<b>1</b>

<b>IEQ 20 NOISE ISOLATION</b>	1 credit for demonstrating airborne noise isolation between rooms, spaces and premises meets the prescribed criteria.		<b>1</b>
	For residential developments only, 1 BONUS credit for demonstrating impact noise isolation between floors meets the prescribed criteria.	Buildings/premises which are inherently noisy and unaffected by noise.	<b>1B</b>
	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.		
<b>IEQ 21 BACKGROUND NOISE</b>	1 credit for demonstrating background noise levels are within the prescribed criteria.	Buildings/premises in which speech intelligibility is not important.	<b>1</b>
	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.		
<b>IEQ 22 ACCESS FOR PERSONS WITH DISABILITY</b>	1 credit for providing at least 3 enhanced provisions	None.	<b>1</b>
<b>IEQ 23 AMENITY FEATURES</b>	1 credit for providing 50% of listed amenity features that enhance the quality and functionality of a building.	None.	<b>2</b>
	2 credits for providing 75% of listed amenity features.		
<b>7</b>	<b>INNOVATIONS AND ADDITIONS (IA)</b>		<b>5B+1</b>
<b>IA 1</b>	<b>INNOVATIVE TECHNIQUES</b>	Not applicable.	
<b>IA 2</b>	<b>PERFORMANCE ENHANCEMENTS</b>	Maximum 5 BONUS credits + 1 credit for BEAM Professional	<b>5B+1</b>
<b>IA 3</b>	<b>BEAM PROFESSIONAL</b>	Not applicable.	

## 2 SITE ASPECTS

### 2.P PREREQUISITE

#### 2.1 SITE LOCATION

#### 2.2 SITE EMISSIONS

#### 2.3 SITE MANAGEMENT

#### BACKGROUND

The performance aspects included in this part focuses on the location of the building, ecological aspects, emissions from the site, and site management. Commitment to improving environmental performance is a key factor in reducing the environmental impacts of building operation and use. Site location is important with regard to adequacy of local amenities and public transport provisions, reduction of travel needs and reliance on private vehicles. There is often an opportunity to enhance the qualities of buildings through more thoughtful 'greening' and other features. The impacts on neighbouring developments and various discharges and emissions from the site can be significant when taken over a building's lifetime. Building managers play a key role in enhancing building performance but there will be significant differences between buildings of different size and complexity.

### 2.P PREREQUISITE

#### SA P1 ENVIRONMENTALLY PURCHASING PLAN

#### BACKGROUND

It is encouraged to investigate the products that are purchased for the building and to replace with environmentally friendly alternatives. A purchasing plan or practice is formulated to use green products whenever possible.

### 2.1 SITE LOCATION

#### SA 1 BEAM CERTIFIED BUILDING

#### BACKGROUND

The location of an existing building is already determined. Building 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. It would be an advantage of an existing building certified under BEAM for New Building in the past.

### 2.2 SITE EMISSIONS

#### SA 2 NOISE FROM BUILDING EQUIPMENT

#### SA 3 LIGHT POLLUTION

#### BACKGROUND

Various emissions from the building development can have a negative impact on neighbouring properties. Certain emissions are within control of the building management and efforts should be made to minimise any potential negative impacts on neighbours and anyone passing by the development.

Discharges and emissions from the site should be considered over a building's lifetime. Any air pollution, noise pollution and light pollution arising from the building engineering systems and equipment is of concern, all of these can be alleviated by good design and proper installation and maintenance.

### 2.3 SITE MANAGEMENT

#### SA 4 HEALTH, SAFETY AND ENVIRONMENTAL MANAGEMENT

#### SA 5 ENVIRONMENTAL PURCHASING PRACTICES

#### SA 6 BUILDING AND SITE OPERATION AND MAINTENANCE

#### SA 7 BUILDING SERVICES OPERATION AND MAINTENANCE

#### SA 8 STAFFING AND RESOURCES

#### SA 9 USER GUIDANCE

#### SA 10 GREEN CLEANING

**BACKGROUND**

No matter what the age and condition of a building, there are initiatives that management can undertake to improve the quality and performance of a building. It is expected that the Client will have programmes in place to enhance health and safety, reduce environmental impacts and improve building services and amenities, which have appropriate levels of senior management support, staffing and resources, and can provide tangible evidence of the actions taken and results achieved.



<b>2</b>	<b>SITE ASPECTS</b>	<b>2.P PREREQUISITE</b>
		<b>SA P1 ENVIRONMENTALLY PURCHASING PLAN</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Encourage purchasing practices which reduce the environmental impact of products used in the operation and maintenance of buildings through formulation of procedure or plan for achieving the purpose.
	<b>REQUIREMENT</b>	Demonstrate that environmentally purchasing plan and procedure either following their internal company guideline or other international standards shall be in place.
	<b>ASSESSMENT</b>	<p>The Client shall provide documentary evidence that purchasing plan and procedure are in place to source, and where available at an economic cost, to purchase materials, products and equipment which have no significant negative impacts on the safety and health of employees and building users, and have no significant negative impacts on the environment. The documentary evidence shall include correspondence with suppliers/potential suppliers, etc.</p> <p>Purchasing plan shall include the use of:</p> <ul style="list-style-type: none"> <li>• durable materials, products and equipment; materials with low embodied energy;</li> <li>• locally produced materials where available;</li> <li>• wood products from well-managed sources;</li> <li>• products which do not use CFCs, HCFCs, halons;</li> <li>• salvaged materials and components;</li> <li>• rapidly renewable materials;</li> <li>• durable materials;</li> <li>• furnishes; paints, adhesives, etc with low levels of emissions;</li> <li>• minimal packaging and/or recyclable packaging;</li> <li>• products having significant recyclable content;</li> <li>• products that are recyclable;</li> <li>• energy efficient appliances and equipment; and</li> <li>• water efficient appliances, etc.</li> </ul>
	<b>BACKGROUND</b>	<p>An organisation's purchasing practices should form part of environmental management. Where major consumers include safety, health and environmental considerations in purchasing decisions, the market place does respond. BEAM encourages purchasing practices that promote the supply and use of environmentally friendly products, materials and equipment used in building operations and maintenance, redecoration, fit-out, etc.</p> <p>There are no well-defined criteria to label materials as green or environmentally friendly although life-cycle analysis can be used to assess materials and products. This involves the identification and quantification of all of the raw materials and energy consumed in the production, use, and disposal of the product, as well as pollutants and by-products generated. Two of the most significant sources of</p>

environmental impact from materials used in buildings are waste streams and the possible impacts on the health and comfort of occupants. Many products used in buildings have environmentally friendly alternatives that can be substituted.

<b>2</b>	<b>SITE ASPECTS</b>	<b>2.1 SITE SELECTION</b>
		<b>SA 1 BEAM CERTIFIED BUILDING</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Encourage selection of buildings that employ best practices in design and/or construction in order to enhance green performance.
	<b>CREDITS ATTAINABLE</b>	Up to 5 credits
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENT</b>	<p>5 credits where the building has been certified with Platinum grade; 4 credits where the building has been certified with Gold grade; or 3 credits where the building has been certified with any other grade.</p> <p>Alternatively:</p> <p>Up to 4 credits for an uncertified building that meets the listed performance characteristics.</p>
	<b>ASSESSMENT</b>	<p>For BEAM certified buildings, the credits shall be awarded automatically based on the records held by the Secretariat of BEAM Society Limited.</p> <p>For certification under any other assessment method, the Client shall provide details of the assessment method, and evidence confirming the building has been certified, and the certification remains current, in form of a letter or a certificate. Where the assessment method is recognised by BEAM Society Limited (and the grade corresponds to BEAM grades), the prescribed number of credits shall be awarded in accordance with the equivalence to BEAM grades.</p> <p>Grades such as 'Excellent' shall be deemed equivalent to 'Platinum', and so on, for lower grades.</p>
	<b>ALTERNATIVE COMPLIANCE</b>	For an uncertified building, a half credit is awarded for each of the listed characteristics of the building, up to a maximum of 4 credits. The listed characteristics or features are referenced to the Site Aspects Category of the latest version of BEAM for New Buildings.
	<b>BACKGROUND</b>	BEAM encourages the Client to select certified green buildings, be BEAM certified or otherwise, or buildings whose land use and site design can be shown to include green features. The Client's real estate representatives are responsible for sourcing and selecting premises and have the opportunity to demonstrate corporate commitment to sustainability by selecting a building that has been certified as 'green' or demonstrates green features in respect of site aspects.

<b>2</b>	<b>SITE ASPECTS</b>	<b>2.2 EMISSIONS FROM THE SITE</b>
		<b>SA 2 NOISE FROM BUILDING EQUIPMENT</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Reduce the nuisance caused to neighbours by noise from building services equipment.
	<b>CREDITS ATTAINABLE</b>	1
	<b>PREREQUISITES</b>	Compliance with the Noise Control Ordinance and Subsidiary Regulations.
	<b>CREDIT REQUIREMENT</b>	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.
	<b>ASSESSMENT</b>	<p>Assessment should be made at the facade of the potential noise sensitive receivers.</p> <p>Noise assessments shall be conducted in accordance with the Technical Memorandum [1]. This lays down statutory Acceptable Noise Levels (ANL).</p> <p>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 5dB(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 and Standards 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. In cases where a Noise Abatement Notice has been served, evidence of full compliance with the required remedial action shall also be presented.</p>
	<b>BACKGROUND</b>	<p>Unwanted sound 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"> <li>• does not comply with the ANLs as set out in a technical memorandum;</li> <li>• is a source of annoyance to any person other than persons on the premises; and</li> <li>• does not comply with any standard or limit contained in any current Regulations.</li> </ul> <p>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</p>

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](http://www.epd.gov.hk/epd/english/environmentinhk/noise/guide_ref/files/tm_nondomestic.pdf)

2 Hong Kong Planning and Standards Guidelines, Chapter 9 Environment  
[http://www.pland.gov.hk/pland\\_en/tech\\_doc/hkpsg/full/ch9/ch9\\_text.htm](http://www.pland.gov.hk/pland_en/tech_doc/hkpsg/full/ch9/ch9_text.htm)

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. 1999.  
[http://www.epd.gov.hk/epd/english/environmentinhk/noise/guide\\_ref/files/pump\\_sys.pdf](http://www.epd.gov.hk/epd/english/environmentinhk/noise/guide_ref/files/pump_sys.pdf)
- 6 Environmental Protection Department. Good practices on ventilation system noise control. 1999.  
[http://www.epd.gov.hk/epd/english/environmentinhk/noise/guide\\_ref/files/vent\\_sys.pdf](http://www.epd.gov.hk/epd/english/environmentinhk/noise/guide_ref/files/vent_sys.pdf)

## 2 SITE ASPECTS 2.2 EMISSIONS FROM THE SITE

### SA 3 LIGHT POLLUTION

<b>EXCLUSIONS</b>	None.
<b>OBJECTIVE</b>	Ensure exterior lighting does not create unwanted and unnecessary light pollution.
<b>CREDITS ATTAINABLE</b>	1
<b>PREREQUISITES</b>	None.
<b>CREDIT REQUIREMENT</b>	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.
<b>ASSESSMENT</b>	<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>
<b>BACKGROUND</b>	<p>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. The brightness of advertising signs is also a concern [6]. The following table is taken from CIBSE Factfile 7 [2] :</p>

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 <sup>2</sup> )
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.

- 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 Library. <http://www.darksky.org/resources>
- 5 International Commission on Illumination. Guidelines for Minimising Sky Glow. Technical Report CIE 126: 1997.
- 6 The Institution of Lighting Engineers. Brightness of Illuminated Advertisements. Technical Report No.5, 2001.

- 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.

<b>2</b>	<b>SITE ASPECTS</b>	<b>2.3</b>	<b>SITE MANAGEMENT</b>
		<b>SA 4</b>	<b>HEALTH, SAFETY AND ENVIRONMENTAL MANAGEMENT</b>
	<b>EXCLUSIONS</b>		None.
	<b>OBJECTIVE</b>		Encourage development of systematic building management systems that embrace safety, health and environmental performance.
	<b>CREDITS ATTAINABLE</b>		1 + 1 BONUS
	<b>PREREQUISITES</b>		None.
	<b>CREDIT REQUIREMENTS</b>		<p>1 credit where the building management operates an Operational Health and Safety Management System certified to OHSAS 18001 or an Environmental Management System to ISO14001.</p> <p>1 BONUS credit where both a certified OHSAS and a certified EMS are in place.</p>
	<b>ASSESSMENT</b>		<p>The Client shall provide documentation supporting any claim to having a certified OHSAS [1] and/or certified EMS [2] in place, plus a commitment confirmed at directorate level of management that the intention is to renew certification(s) when next due.</p> <p>As an alternative, where no certified OHSAS or EMS is in place the onus shall be on the Client to demonstrate that the key elements of a certified OHSAS and certified EMS are incorporated within the systems of building management that already exist.</p> <p>Appropriate policies, objectives and targets, communications, responsibilities, actions taken, results/outcomes, etc. shall be outlined in summary form. The Applicant shall provide documentation and photographic evidence.</p>
	<b>BACKGROUND</b>		<p>The importance of managing Occupational Health and Safety is recognised by all interested parties: employers, employees, customers, suppliers, insurers, shareholders, the community, contractors, and regulatory agencies. OHSAS 18001:1999 [1] was released in April 1999. OHSAS 18002 [3] is the Occupational Health and Safety Management Systems Guidelines for the implementation of OHSAS 18001. OHSAS 18001 was developed in response to urgent customer demand for a recognisable occupational health and safety management system standard against which their management system may be assessed and certified. OHSAS 18001:1999 is compatible with ISO 9001:1994 and ISO 14001:1996.</p> <p>The specification takes a structured approach to OH&amp;S management. The emphasis is placed on practices being pro-active and preventive, by the identification of hazards and the evaluation and control of work related risks. OHSAS 18001 can be used by organisation of all sizes regardless of the nature of their activities or location. Organisations can now achieve third party certification for their Occupational Health and Safety management system.</p> <p>OHSAS 18001 features include the following elements:</p> <ul style="list-style-type: none"> <li>• OH&amp;S policy;</li> </ul>

1 British Standards Institution. OHSAS 18001:1999. Occupational health and safety management systems — Specification.  
2 International Organization for Standardization. ISO 14001: Environmental management systems – Specification with guidance for use.  
3 British Standards Institution. OHSAS 18002:2000, Occupational health and safety management systems –Guidelines for the implementation of OHSAS 18001.



- planning;
- implementation and operation;
- checking and corrective action;
- management review; and
- continual improvement.

OHSAS 18001 is the sound solution to the ever increasing challenge facing most organisations from high injury and illness rates, lost work days, increasing occupational health and safety regulations, large citations/penalties, rising worker's compensation costs, costly medical claims, worker retention and employee satisfaction.

For an organisation to be successful in addressing environmental issues, it must set clear objectives at the highest level with an appropriate programme for their management, checking and review. An environmental policy, endorsed by directorate level management, is a key element of such a programme. ISO 14004 [4] sets out guidelines for establishing an environmental management system (EMS) and specifies the key features of an effective environmental policy as:

- being appropriate to the nature, scale and environmental impacts of the organisation's activities, products and services;
- a commitment to comply with relevant environmental legislation;
- a commitment to continual improvement and pollution prevention;
- providing a framework for setting and reviewing environmental objectives and targets; and
- being documented and communicated to all employees, suppliers, and customers.

Corporate environmental policies naturally vary between organisations [5]. BEAM seeks a commitment to environmental protection and improvements where these can be demonstrated to be appropriate, practical and achievable within the context of the particular building development.

## NOTES

Specific criteria in respect of management practices and performance are included elsewhere in BEAM Plus for Existing Buildings.

OHSAS 18001 will be withdrawn on publication of its contents in, or as, a British Standard.

4 International Organization for Standardization. ISO 14004 Environmental management systems – General guidelines on principles, systems and supporting techniques.

5 Environmental Protection Department. [http://www.epd.gov.hk/epd/english/how\\_help/tools\\_ems/overview.html](http://www.epd.gov.hk/epd/english/how_help/tools_ems/overview.html)

<b>2</b>	<b>SITE ASPECTS</b>	<b>2.3 SITE MANAGEMENT</b>
		<b>SA 5 ENVIRONMENTAL PURCHASING PRACTICES</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Encourage purchasing practices which reduce the environmental impact of products used in the operation and maintenance of buildings.
	<b>CREDITS ATTAINABLE</b>	1
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENTS</b>	1 credit for demonstrating 70% of purchased items are environmentally friendly materials, products or equipment for the past 12 months, or equivalent programme for implementation.
	<b>ASSESSMENT</b>	<p>The Client shall provide documentary evidence that includes correspondence with suppliers/potential suppliers, samples of invoices, records of purchases of environmentally friendly materials, etc.</p> <p>Purchasing practices shall be demonstrated by the use of:</p> <ul style="list-style-type: none"> <li>• durable materials, products and equipment;</li> <li>• materials with low embodied energy;</li> <li>• locally produced materials where available;</li> <li>• wood products from well-managed sources;</li> <li>• products which do not use CFCs, HCFCs, halons;</li> <li>• salvaged materials and components;</li> <li>• rapidly renewable materials;</li> <li>• durable materials;</li> <li>• furnishes, paints, adhesives, etc. with low levels of emissions;</li> <li>• minimal packaging and/or recyclable packaging;</li> <li>• products having significant recyclable content;</li> <li>• products that are recyclable;</li> <li>• energy efficient appliances and equipment; and</li> <li>• water efficient appliances, etc.</li> </ul> <p>Credit shall be awarded where it is demonstrated either that 70% of purchased items are environmentally friendly materials, products or equipment for the past 12 months or there is equivalent programme for implementation.</p>

<b>2</b>	<b>SITE ASPECTS</b>	<b>2.3 SITE MANAGEMENT</b>
		<b>SA 6 BUILDING AND SITE OPERATION AND MAINTENANCE</b>
	<b>EXCLUSIONS</b>	Refer to assessment criteria.
	<b>OBJECTIVE</b>	Encourage planned inspection, maintenance and repair of the building fabric and structure, external areas to enhance safety and reduce environmental impacts.
	<b>CREDITS ATTAINABLE</b>	3
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENTS</b>	<p>a) Building maintenance</p> <p>1 credit for implementing an effective system of regular inspection, cleaning and maintenance of the building's fabric and structure.</p> <p>b) External areas and facilities</p> <p>1 credit for implementing an effective system of regular inspection, cleaning and maintenance of areas and facilities external to the building.</p> <p>c) Operations and maintenance manual</p> <p>1 credit for providing a fully documented operations and maintenance manual for the building and site to the minimum specified.</p>
	<b>ASSESSMENT</b>	<p>a) Building maintenance</p> <p>The onus is on the Client to demonstrate that the system of inspections, cleaning, maintenance and general repairs to the building fabric and structural elements are effective in maintaining reliability and prolonging service life.</p> <p>The general maintenance programme shall include as a minimum:</p> <ul style="list-style-type: none"> <li>• list of all elements of the building fabric and structure subject to regular inspection, cleaning, servicing and maintenance, e.g. window frames, cladding, roof structures, etc.;</li> <li>• details of planned and pre-venture maintenance for each item;</li> <li>• methods and frequency of cleaning;</li> <li>• frequency of inspections;</li> <li>• details of maintenance undertaken by outside agents;</li> <li>• competence of personnel undertaking inspection, cleaning maintenance and repair, including outside contractors; and</li> <li>• records of inspections, maintenance and repairs for a period of up to 3 years.</li> </ul> <p>Where it can be shown that the frequency of inspections, adequacy of preventive maintenance, and timely and adequate repairs are undertaken, the credit shall be awarded.</p> <p>b) External areas and facilities</p> <p>This credit shall not be applied where the building footprint exceeds 80% of the site area, unless the building roof, podium and/or sky gardens, etc., include provision of facilities accessible to building users.</p> <p>The assessment covers all external areas and facilities under the responsibility of the management team, for example slopes, retaining walls, roads, pavements, hard and soft landscaping, exterior lighting, stairs, ramps, barriers, recreational facilities and areas, etc.</p>

In a similar manner to building maintenance, the onus is on the Client to provide evidence in terms of inspection schedules, preventive maintenance, repairs, etc., to demonstrate their adequacy in relation to the size of the external area and extent of the facilities provided.

Where there exists an appropriate frequency of inspections, adequate preventive maintenance, and timely and adequate repairs appropriate to type and extent of external areas and facilities, the credit shall be awarded.

c) Operations and maintenance manual

The documentation covering building and site maintenance should include sufficient information to allow personnel to carry out work on the fabric and structure at any time, including as a minimum:

- design specifications;
- as-built drawings and plans;
- details of construction methods and materials;
- maintenance requirements and any specific procedures;
- inspection schedules, including post-typhoon and emergencies;
- operation and maintenance of plant and equipment installed on the building; and
- details showing type and location of utility services on and adjacent to the site, etc.

Environmental issues shall be included in the maintenance manual such as how to reduce noise, dust, waste and water during maintenance periods. The Client shall submit a declaration stating the operation and maintenance manual in use for the building is sufficiently detailed for the size and complexity of the building and external site elements.

## BACKGROUND

Where buildings are not properly maintained, they deteriorate more quickly, in extreme cases requiring major refurbishment or demolition. In such cases, the process of refurbishment or reconstruction will require significant consumption of both energy and materials, placing an unnecessary burden on natural resources. Appropriate planned inspection, cleaning and maintenance is necessary to retain a building's value as an asset, sustain utility, and to ensure compliance with legal requirements, such as health and safety regulations, and will assist owners and occupiers to manage the building in a more efficient and hence environmentally conscious manner. Regular inspections of the building fabric and structural elements should be carried out, with a management system to monitor the long-term planned maintenance programme, to ensure that all maintenance will continue in order to retain asset value of the building and meet the performance requirements.

A comprehensive Guidebook [1] is available that consolidates guidelines from the Buildings Department (BD) and other relevant sources for building owners, Owners' Corporations, Owners' Committees and personnel involved in building maintenance and management. Besides identifying the legal responsibilities of owners and usual problems encountered, it also enhances readers' awareness of the existing conditions of buildings and facilitates the formulation of plans for rectification and improvement. Further guidance on the management and setting up of a building maintenance programme is given in ISO [2] and British Standards [3].

- 1 Buildings Department. Building Maintenance Guidebook.  
[http://www.info.gov.hk/bd/english/documents/code/bmg/BDG\\_ENG.pdf](http://www.info.gov.hk/bd/english/documents/code/bmg/BDG_ENG.pdf)
- 2 International Organization for Standardization. ISO 15686 Buildings and constructed assets (3 parts).
- 3 British Standards Institution. BS 8210: 1986. Guide to building maintenance management.

<b>2</b>	<b>SITE ASPECTS</b>	<b>2.3 SITE MANAGEMENT</b>
		<b>SA 7 BUILDING SERVICES OPERATION AND MAINTENANCE</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Encourage proper and efficient operation of the engineering systems in and around buildings.
	<b>CREDITS ATTAINABLE</b>	3 for buildings with central HVAC systems, otherwise 2.
	<b>PREREQUISITES</b>	Compliance with applicable regulations [1].
	<b>CREDIT REQUIREMENTS</b>	<p>a) Central HVAC systems</p> <p>1 credit for demonstrating the operation of a planned programme of regular inspection, cleaning and maintenance of central HVAC plant.</p> <p>b) Other engineering systems</p> <p>1 credit for demonstrating the operation of a planned programme of regular inspection, cleaning and maintenance of the building's engineering systems.</p> <p>c) Assessment of operation &amp; maintenance practices</p> <p>1 credit for having undertaken an audit of the effectiveness of the operation and maintenance practices for all building services engineering systems.</p>
	<b>ASSESSMENT</b>	<p>a) Central HVAC systems</p> <p>The Client shall provide evidence in the form of maintenance manuals, inspection records, records of repairs, inventory of spares, etc. demonstrating the adequacy of inspection, maintenance and repair to all HVAC equipment. Maintenance undertaken by outside agents shall also be identified.</p> <p>The maintenance manual covering HVAC systems and equipment shall provide sufficient information to allow personnel carrying out work at any time, including as a minimum:</p> <ul style="list-style-type: none"> <li>• overview of the HVAC system and sub-systems and main equipment;</li> <li>• modes of operation;</li> <li>• schematic diagram of the systems and sub-systems;</li> <li>• automatic controls diagrams and descriptions;</li> <li>• record drawings of the installations as built;</li> <li>• safety procedures and instructions;</li> <li>• manufacturers information on all major equipment (not just catalogue copies);</li> <li>• relevant statutory regulations and codes of practice;</li> <li>• commissioning and re-commissioning results;</li> <li>• the operating and maintenance strategy for the installation;</li> <li>• equipment operating parameters and control settings to be monitored;</li> </ul>

1 Lai J H K, Yik F W H. Law and Building Services Maintenance in Hong Kong. HKIE Trans. Vol. 11, No. 1, 2004, pp 7-14.

- full maintenance instructions with access points, monitoring points, etc., identified;
- maintenance schedules; and
- inventories of parts held and/or details of supply of spares.

The maintenance programme shall include as a minimum:

- list of all equipment subject to regular inspection and maintenance;
- details of planned and pre-ventive maintenance for each item;
- frequency of inspections;
- competence of personnel undertaking inspection, maintenance and repair, including outside contractors; and
- records of inspections, maintenance and repairs.

Where it can be shown that the frequency of inspections is appropriate, preventive maintenance is adequate, and that timely and adequate repairs are undertaken, the credit shall be awarded.

b) Other engineering systems

The Client shall provide evidence in form of maintenance manuals, inspection records, records of repairs, etc. demonstrating the adequacy of inspection, maintenance and repair to all equipment (other than central HVAC equipment covered in a). For buildings without central HVAC plant, the coverage shall include unitary and other air-conditioning and ventilation equipment.

The maintenance manual shall have similar coverage as for a) above. Likewise, the maintenance programme shall include as a minimum the items listed in a) above.

c) Assessment of operation & maintenance practices

The Client shall provide a report detailing the steps taken, outcomes and actions taken or planned (with appropriate budget information) for improvements in the building services operation and maintenance practices. The audit approach should follow the details in BSRIA's guide [2] or similar equivalent approach. The effectiveness audit shall be conducted every 5 years. Continuous monitoring shall be accepted. Priority based on energy consumption shall be considered when establishing monitoring programme.

## BACKGROUND

Although some may still regard building services operation and maintenance (O&M) as simple and routine, the increase in sophistication of services provisions in buildings necessitated by the increasingly demanding user and statutory requirements has made management, operation and maintenance work much more complicated than hitherto [1]. Besides satisfying the occupants' demand for quality services, the management team shoulders the responsibility to safeguard the safety and health of occupants, visitors and any other passers-by.

Regulatory requirements include prescribing certain work be undertaken only by a qualified person or firm, which may be referred to as a competent person, a competent worker, a competent examiner, a registered specialist engineer, a registered specialist contractor etc. Apart from the rules or requirements documented in the statutes, statutory orders, directions or abatement or improvement notices may be issued by government departments as when and where installation defects or nuisance develop to such a stage that public health or safety

is likely to be jeopardised, or the environment is threatened.

However, proper maintenance involves requirements far exceeding the regulatory requirements. Building owners and maintenance personnel may be held liable from breaching of the duties of care that they are required to exercise under Common Law. There exists the concept of duty of care, whereby a reasonable man must take reasonable care to avoid acts or omissions that would be likely to injure his neighbour, which he can reasonably foresee!

Effective operation and maintenance of the building services systems and equipment can have a significant impact on building performance. It will also help to prevent unexpected breakdowns and prolong the life of equipment, avoiding unnecessary use of resources for premature replacements.

All documentation, including operating manuals and maintenance instructions should be clearly written, detailing the design approach and describing the actual systems and equipment and controls installed [3,4]. Unfortunately, there is much evidence to show that this is not always adequate and that the lack of care for detail can have significant negative impact on the indoor environment and/or efficiency of energy use.

The Building Maintenance Guidebook [5] provides guidelines on building maintenance work which embraces also building services maintenance, but the coverage is confined to the basic provisions such as electrical, fire services, lift and escalator and water supply. Good maintenance management planning includes proper cost analysis and a process to ensure that occupant comfort and health, energy use, and safety and security systems are at optimal levels of performance for the installed systems and equipment [6]. The effectiveness of operation and maintenance may be assessed through a systematic audit [7].

**NOTE**

Additional management, operation and maintenance actions are covered elsewhere in BEAM Plus for Existing Buildings.

- 3 American Society of Heating, Air-conditioning, and Refrigerating Engineers. ASHRAE Guideline 4. Preparation of Operating and Maintenance Documentation for Building Systems.
- 4 Building Services Research and Information Association. Application Guide AG 1/87.1. Operating and maintenance manuals for building services installations.
- 5 Buildings Department. Building Maintenance Guidebook.  
[http://www.info.gov.hk/bd/english/documents/code/bmg/BDG\\_ENG.pdf](http://www.info.gov.hk/bd/english/documents/code/bmg/BDG_ENG.pdf)
- 6 Building Services Research and Information Association. Application Guide AG 1/98. Maintenance programme set-up.
- 7 Building Services Research and Information Association. Application Guide AG 24/97. Operation and maintenance audits.



<b>2</b>	<b>SITE ASPECTS</b>	<b>2.3 SITE MANAGEMENT</b>
		<b>SA 8 STAFFING AND RESOURCES</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Ensure staffing resources are adequate for carrying out and maintaining improvements to building and system performance.
	<b>CREDITS ATTAINABLE</b>	1
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENTS</b>	1 credit for the adequacy of staffing and resources to meet the operation and maintenance requirements of the building.
	<b>ASSESSMENT</b>	<p>The Client shall provide evidence that the staffing arrangements and technical resources are sufficient to meet the demands of enhancing the quality of operation and maintenance for the building. Where outsourcing is used, the contractual arrangements and the experience, skills and technical resources of any appointed contractors shall be included. In-house technical resources shall include adequate space and equipment for undertaking inspection, basic testing, maintenance and general repairs. Resources for testing the performance of equipment such as boilers, resetting AHU controls, etc. may also be provided. Alternatively, it is expected that contractors will be assessed by the Client to ensure the adequacy of their technical resources.</p> <p>The Client shall also provide details of training undertaken by staff responsible for operations and maintenance for up to three years previous, and details of plans and budgets for further training. The training should provide staff with updated knowledge on regulations, improved management, operation and maintenance practices, etc., relevant to such aspects of building performance as energy auditing, indoor air quality, use of materials, etc.</p> <p>Where managers and engineers have appropriate qualifications and/or experience, and technical staff have appropriate technical and/or trade qualifications befitting their assigned duties, where technical resources are sufficient, and where appropriate continuing education and training to meet the demands of enhancing building performance are in place, the credit shall be awarded.</p>
	<b>BACKGROUND</b>	<p>Staff skills and experience are important factors in achieving improvements in building performance [ 1 ]. The qualifications and experience of management, operation and maintenance staff should be commensurate with the size and complexity of the buildings and engineering systems under their control. Where maintenance is outsourced, the contractors should also be suitably qualified and resourced.</p> <p>With new initiatives such as the Indoor Air Quality Certification Scheme, demand side management programme etc., and new techniques for condition monitoring, automatic controls, power conditioning etc., building management, operation and maintenance staff need to maintain currency of their knowledge and skills to meet new demands from a building and its users. As a guideline, it is expected that on average staff undergo a minimum of 3 full days of appropriate training each year.</p>

1 Yik F. W. H, Lee, W.L. A preliminary enquiry as to why buildings remain energy inefficient and potential remedy, HKIE Transactions. Vol. 9, No. 1, 2002, pp 32-36.

<b>2</b>	<b>SITE ASPECTS</b>	<b>2.3 SITE MANAGEMENT</b>
		<b>SA 9 USER GUIDANCE</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Inform tenants/owners on the environmental, comfort and health impacts of their activities, and to encourage actions that reduce adverse impacts.
	<b>CREDITS ATTAINABLE</b>	1
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENTS</b>	1 credit for providing comprehensive guidance on building safety, hygiene and environmental issues in a building user's guide.
	<b>ASSESSMENT</b>	<p>The Client shall provide details of the instructions and guidance materials issued to tenants/users of the building. Credit shall be awarded where it is demonstrated that the guidance given encourages and promotes environmentally friendly building use and activities by users, including but not limited to the followings:</p> <ul style="list-style-type: none"> <li>• fire safety management;</li> <li>• emergency procedures;</li> <li>• health and hygiene;</li> <li>• the selection, installation and use of energy efficient equipment (for example, equipments and appliances certified under the Energy Efficiency Labelling Scheme [1]);</li> <li>• energy efficient operation of equipment and facilities, for example, air conditioning units, ventilation fans, kitchen exhaust fans and hoods, etc.;</li> <li>• water conservation;</li> <li>• the selection of sustainable materials for fit-out and redecoration, etc.;</li> <li>• cleaning, use of pesticides, etc.;</li> <li>• sorting, recycling, and hygienic disposal of waste materials, particularly hazardous waste;</li> <li>• control of indoor pollutant sources; and</li> <li>• emphasis on environmental protection.</li> </ul>
	<b>BACKGROUND</b>	<p>Overall performance can be improved and environmental impacts reduced with the co-operation of the tenants or sub-owners of premises within a building. Very often users are not aware of safety, hygiene, comfort and environmental issues. It is good practice to provide guidance on the design and use of premises as they interface with the overall building performance. It should contain guidance and information on applicable regulations, recommendations or requirements regarding internal decoration and fit-out work in occupied areas, advice on partitioning to maintain adequate ventilation, etc.</p>

<b>2</b>	<b>SITE ASPECTS</b>	<b>2.3 SITE MANAGEMENT</b>
		<b>SA 10 GREEN CLEANING</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Encourage the use of cleaning methods with environmental friendly ingredients and chemicals to protect human health and environmental quality.
	<b>CREDITS ATTAINABLE</b>	1
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENTS</b>	1 credit for demonstrating appropriate green cleaning procedures/practices are implemented for the project and at least 50% of green cleaning products are used.
	<b>ASSESSMENT</b>	<p>The Client shall demonstrate that a green cleaning plan for the building and site is in place.</p> <p>The plan shall address the followings:</p> <ul style="list-style-type: none"><li>• purchase of green cleaning products;</li><li>• safe and green cleaning procedures;</li><li>• staff and training requirement; and</li><li>• feedback from occupants.</li></ul> <p>The green cleaning products shall have certification to the Green Seal standard for Industrial and Institutional Cleaners (GS-37) [ 1 ] or equivalent.</p> <p>Green Seal is an independent, non-profit organisation that strives to achieve a healthier and a cleaner environment by identifying and promoting products and services that cause less toxic pollution and waste, conserve resources and habitats, and minimise global warming and ozone depletion.</p>

1 Green Seal. Environmental Standard for Industrial and Institutional Cleaners - GS-37  
[http://www.greenseal.org/Portals/0/Documents/Standards/GS-37%20std%20dev/GS-37\\_Draft\\_Standard\\_041808.pdf](http://www.greenseal.org/Portals/0/Documents/Standards/GS-37%20std%20dev/GS-37_Draft_Standard_041808.pdf)

### **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 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 interior design methods, choice of materials, and installation methods. Of concern are:

- toxic pollutants arising from manufacturing and combustion; and
- waste generated and recycled.

#### **3.P PREREQUISITE**

##### **MA P1 USE OF NON-CFC BASED REFRIGERANTS**

##### **MA P2 WASTE RECYCLING FACILITIES**

#### **BACKGROUND**

This part is to set out the minimum requirement for materials aspects in terms of use of non-CFC based refrigerants and provision of waste recycling facilities.

#### **3.1 EFFICIENT USE OF MATERIALS**

##### **MA 1 BUILDING REUSE**

##### **MA 2 MODULAR AND STANDARDISED DESIGN**

##### **MA 3 ADAPTABILITY AND DECONSTRUCTION**

#### **BACKGROUND**

Efficiency in the use of materials can be significantly improved through reuse of building elements. Flexibility in design allows for change in use and layout of the premises within a building. High standards of design detailing permits off-site fabrication of major building components, and allow for deconstruction.

#### **3.2 SELECTION OF MATERIALS**

##### **MA 4 RAPIDLY RENEWABLE MATERIALS**

##### **MA 5 SUSTAINABLE FOREST PRODUCTS**

##### **MA 6 OZONE DEPLETING SUBSTANCES**

#### **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 for maintenance, redecoration, fit-out and renovations.

#### **3.3 WASTE MANAGEMENT**

##### **MA 7 WASTE MANAGEMENT**

#### **BACKGROUND**

Hong Kong is running out of land for waste disposal, and without concerted effort the existing landfill sites could be exhausted by 2015. The latest situation indicates that the available public fill capacity (mainly reclamations) will be exhausted by mid-2005. Without new outlets for public fill materials, the landfills will be filled up in the next 5-7 years. To tackle the problem, much effort has been put on reducing waste generation and identifying outlets for reusing recycled materials.

With adequate provisions for waste collection and sorting, and a pro-active approach in seeking opportunities to recycle, the management of waste from buildings can be significantly improved.

<b>3</b>	<b>MATERIALS ASPECTS</b>	<b>3.P PREREQUISITE</b>
		<b>MA P1 USE OF NON-CFC BASED REFRIGERANTS</b>
	<b>EXCLUSIONS</b>	Building using split-units and / or window units.
	<b>OBJECTIVE</b>	Reduce the release of chlorofluorocarbon into the atmosphere.
	<b>REQUIREMENT</b>	Using no chlorofluorocarbon (CFC)-based refrigerants in HVAC&R systems.
	<b>ASSESSMENT</b>	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 used in HVAC&R systems.
	<b>BACKGROUND</b>	<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 has led to reductions in the usage and emissions of CFCs.</p> <p>The U.S. Environmental Protection Agency (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 gives effect to Hong Kong's international obligations to control the manufacture, import and export of ozone depleting substances [1]. Ozone Layer Protection (Controlled Refrigerants) Regulation 1994 requires the conservation of controlled refrigerants used in large scale installations and motor vehicles [2]. 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 slow the ozone depletion and global climate change. Non-CFC building equipment has standard specification. New non-CFC HVAC&amp;R equipments is cost and energy effective. Selecting non-CFC HVAC&amp;R equipments 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](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](http://www.epd.gov.hk/epd/english/laws_regulations/comp_guides/files/cgt_olp_cr_eng.pdf)

<b>3</b>	<b>MATERIALS ASPECTS</b>	<b>3.P PREREQUISITE</b>
		<b>MA P2 WASTE RECYCLING FACILITIES</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Reduce pressure on landfill sites and help to preserve non-renewable resources by promoting recycling of waste materials.
	<b>REQUIREMENT</b>	Providing facilities for the collection, sorting, storage and disposal of waste and recovered materials.
	<b>ASSESSMENT</b>	<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 details of expected and prevailing streams and 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.</p> <p>The assessment shall take into account how 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> <p>The Applicant shall provide documentation and photographic evidence.</p>
	<b>BACKGROUND</b>	<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 provided with facilities for waste separation and sorting, and short term storage at appropriate locations.</p> <p>PNAP No. APP-35 [1] provides details of the basic refuse storage and recovery chambers expected in new buildings, and can be used as a benchmark for assessment. As an indication the space requirements for offices and similar buildings are 2 m<sup>2</sup> per 1000 m<sup>2</sup> of floor area.</p> <p>Reference should be made to Section 6 IEQ 4 of this document with regard to the hygiene aspects of waste disposal.</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>

3	<b>MATERIALS ASPECTS</b>	<b>3.1 EFFICIENT USE OF MATERIALS</b>
		<b>MA 1 BUILDING REUSE</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Encourage the reuse of major elements of existing buildings.
	<b>CREDITS ATTAINABLE</b>	1 BONUS
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENT</b>	1 BONUS credit for the reuse of 30% or more of existing sub-structure or shell.
	<b>ASSESSMENT</b>	<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>
	<b>BACKGROUND</b>	<p>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 should have been taken into account for reuse in the existing building.</p> <p>BEAM Plus for New Buildings provides credit for reuse of existing structural elements in new buildings. Where an existing building can demonstrate reuse of such elements a bonus credit is awarded in BEAM Plus for Existing Buildings.</p>

<b>3</b>	<b>MATERIALS ASPECTS</b>	<b>3.1</b>	<b>EFFICIENT USE OF MATERIALS</b>
		<b>MA 2</b>	<b>MODULAR AND STANDARDISED DESIGN</b>
	<b>EXCLUSIONS</b>	None.	
	<b>OBJECTIVE</b>	Encourage use of modular and standardised components in buildings in order to improve serviceability and reduce waste.	
	<b>PREREQUISITES</b>	Full compliance with the Building (Construction) Regulations.	
	<b>CREDITS ATTAINABLE</b>	1	
	<b>CREDIT REQUIREMENT</b>	1 credit for demonstrating the use of modular and standardised design.	
	<b>ASSESSMENT</b>	<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>	
	<b>CHECKLIST</b>	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 Fitted furniture
		Building services elements	Fire services Sanitary fittings Luminaires Air-Conditioning components
	<b>BACKGROUND</b>	<p>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.</p>	



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](http://www.devb.gov.hk/en/publications_and_press_releases/publications/standardised_components_and_practices/index.html)

<b>3</b>	<b>MATERIALS ASPECTS</b>	<b>3.1</b>	<b>EFFICIENT USE OF MATERIALS</b>
		<b>MA 3</b>	<b>ADAPTABILITY AND DECONSTRUCTION</b>
	<b>EXCLUSIONS</b>	Residential buildings.	
	<b>OBJECTIVE</b>	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.	
	<b>CREDITS ATTAINABLE</b>	2 + 1 BONUS	
	<b>PREREQUISITES</b>	None.	
	<b>CREDIT REQUIREMENT</b>	<p>a) Spatial adaptability</p> <p>1 credit for designs providing spatial flexibility that can adapt spaces for different uses.</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 BONUS credit for designs providing flexibility through the use of building structural systems that allow for change in future use.</p>	
	<b>ASSESSMENT</b>	<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 how the designs and installations can accommodate changes in use through deconstruction rather than demolition and replacement.</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 building design and services installations allow for adaptability in respect of interior layout and changes in use mainly through deconstruction and reassembly; and at least 70% of the listed items in the relevant BEAM checklists could be achieved, the credit(s) shall be awarded. Where structural adaptability is provided the bonus credit shall be awarded.</p>	
	<b>SPATIAL ADAPTABILITY CHECKLIST</b>	<p>ASTM provides guidance for various types of buildings and uses [e.g.1, 2,3].</p> <ul style="list-style-type: none"> <li>• use of adaptable floor plans, including large grids that can be subdivided, etc.</li> <li>• spaces designed for a loose fit rather than tight fit;</li> <li>• inclusion of multifunctional spaces;</li> <li>• design that allows interior fitting-out to use modular and pre-fabricated components;</li> </ul>	

- 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

- spaces designed such that minimum disruption will be caused to 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;

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>

- 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 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.

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.

<b>3</b>	<b>MATERIALS ASPECTS</b>	<b>3.2 SELECTION OF MATERIALS</b>
		<b>MA 4 RAPIDLY RENEWABLE MATERIALS</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Encourage the wider use of rapidly renewable materials in appropriate applications.
	<b>CREDITS ATTAINABLE</b>	2
	<b>PREREQUISITES</b>	Compliance with the Building (Construction) Regulations.
	<b>CREDIT REQUIREMENT</b>	<p>1 credit for demonstrating 2.5% of all building materials/products used in the project are rapidly renewable materials.</p> <p>2 credits where 5% of all building materials/products used in the project are rapidly renewable materials.</p>
	<b>ASSESSMENT</b>	<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>
	<b>CHECKLIST</b>	<p>No material specified shall present a fire hazard when installed.</p> <p><b>FLOORING</b></p> <p>Bamboo Natural Linoleum Cork Other rapidly renewable materials</p> <p><b>PANELS/PARTITIONS</b></p> <p>Sunflower Seed Bamboo Wheatboard Other rapidly renewable materials</p> <p><b>CABINETRY/FITTINGS</b></p> <p>Wheatboard Strawboard Soy bean composite Bamboo Other rapidly renewable materials</p> <p><b>INSULATION</b></p> <p>Cotton Strawbale Soy-based foam Other rapidly renewable materials</p> <p><b>OTHER APPLICATIONS (MATERIAL)</b></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.

3	<b>MATERIALS ASPECTS</b>	<b>3.2 SELECTION OF MATERIALS</b>
		<b>MA 5 SUSTAINABLE FOREST PRODUCTS</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Encourage the use of timber from well-managed forests.
	<b>CREDITS ATTAINABLE</b>	1
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENT</b>	1 credit for demonstrating at least 50% of all timber and composite timber products used in the project are from sustainable sources/recycled timber.
	<b>ASSESSMENT</b>	<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], 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>
	<b>BACKGROUND</b>	<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 CO<sub>2</sub> 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>Certified Wood may be defined as 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</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](http://www.wwf.org.uk/wwf_articles.cfm?unewsid=296)

5 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. ADV-5 Tropical Hardwood Timber. <http://www.bd.gov.hk/english/documents/pnap/ADV/ADV005.pdf>

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] believe 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 haven been considered.



<b>3</b>	<b>MATERIALS ASPECTS</b>	<b>3.2 SELECTION OF MATERIALS</b>
		<b>MA 6 OZONE DEPLETING SUBSTANCES</b>
	<b>EXCLUSIONS</b>	Buildings using split-units and/or window units.
	<b>OBJECTIVE</b>	Reduce the release of chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) into the atmosphere.
	<b>CREDITS ATTAINABLE</b>	2
	<b>PREREQUISITES</b>	Compliance with the Ozone Layer Protection Ordinance Chapter 403.
	<b>CREDIT REQUIREMENT</b>	<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>Alternatively,</p> <p>1 credit for demonstrating a phased programme of refrigerant replacement together with limitations on leakage.</p> <p>b) Fire suppression and other materials</p> <p>1 credit for the use of products that avoid the use of ozone depleting substances in their manufacture, composition or use.</p>
	<b>ASSESSMENT</b>	<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> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <math display="block">LCGWP + LCODP \times 10^5 \leq 775</math> </div> <p> <math>LCGWP = [GWPr \times (Lr \times Life + Mr) \times Rc] / Life</math>  <math>LCODP = [ODPr \times (Lr \times Life + Mr) \times Rc] / Life</math>  <math>LCGWP = \text{Lifecycle Global Warming Potential (kg CO}_2\text{/kw -Yr)}</math>  <math>LCODP = \text{Lifecycle Ozone Depletion Potential (kg CFC 11/kw-Yr)}</math>  <math>GWPr = \text{Global Warming Potential of Refrigerant (0 to 12,000 kg CO}_2\text{/kg r)}</math>  <math>ODPr = \text{Ozone Depletion Potential of Refrigerant (0 to 0.2 kg CFC 11/kg r)}</math>  <math>Lr = \text{Refrigerant Leakage Rate (0.5\% to 2.0\%; default of 2\% unless otherwise demonstrated)}</math>  <math>Mr = \text{End-of-life Refrigerant Loss (2\% to 10\%; default of 10\% unless otherwise demonstrated)}</math>  <math>Rc = \text{Refrigerant Charge (0.2 to 2.3 kg of refrigerant per kW of gross ARI rated cooling capacity)}</math>  <math>Life = \text{Equipment Life (10 years; default based on equipment type, unless otherwise demonstrated)}</math> </p> <p>For systems with different types of equipment, a weighted average of all air-conditioning and refrigeration equipments shall be calculated using the following equation:</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <math display="block">[ \sum (LCGWP + LCODP \times 10^5) \times Q_{unit} ] / Q_{total} \leq 775</math> </div> <p> <math>Q_{unit} = \text{Gross ARI rated cooling capacity of an individual air-conditioning or refrigeration unit (kW)}</math>  <math>Q_{total} = \text{Total gross ARI rate cooling capacity of all air-conditioning or refrigeration (kW)}</math> </p>

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.

Where the refrigerant replacement programme has not been completed the Client shall provide details of the programme. This shall include details of all existing plant, existing quantities of each refrigerant by trade name, chemical composition and ODP, and similar details upon planned completion of the programme. Documentation shall be presented that demonstrates that emissions of refrigerants for equipment are limited to an average of 3% or less of the total charge per year, and that leakage over the remaining life of the equipment should be maintained to within 20%.

b) Fire suppression and other materials

A Client shall provide details of any fire suppression systems that use ozone depleting substances. These may include hand-held extinguishers or fixed fire protection systems serving, for example, computer rooms or electricity switch rooms. Where such systems are present in the building, the Client shall provide details of the practices adopted to ensure that emissions are reduced to a minimum.

Replacement of fire suppressants, thermal insulations, and other applications shall avoid the use of materials that emit CFCs in their manufacture or use.

## 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 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 [3].

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

- 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](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](http://www.epd.gov.hk/epd/english/laws_regulations/comp_guides/files/cgt_olp_cr_eng.pdf)
- 3 EPD. [http://www.epd.gov.hk/epd/english/application\\_for\\_licences/guidance/wn6\\_licen1\\_1.html](http://www.epd.gov.hk/epd/english/application_for_licences/guidance/wn6_licen1_1.html)

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.

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 <sup>[1]</sup>	GWP <sup>[1]</sup>
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
[1] – Sources: i: IPCC Second Assessment Report; ii: "World Resources Institute (2005), World Business Council for Sustainable Development"; iii: US 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 the use of these refrigerants and provides design guidance for refrigeration systems, thermal insulation

4 Calm S M. Option and outlook for chiller refrigerants. International Journal of Refrigeration. Vol. 25, 2002, pp 705-715.  
 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.

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.

<b>3</b>	<b>MATERIALS ASPECTS</b>	<b>3.3 WASTE MANAGEMENT</b>
		<b>MA 7 WASTE MANAGEMENT</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Reduce pressure on landfill sites and help to preserve non-renewable resources by promoting recycling of waste and obsolete materials.
	<b>PREREQUISITES</b>	Compliance with regulations in respect of proper identification, collection and sorting of hazardous waste.
	<b>CREDITS ATTAINABLE</b>	3
	<b>CREDIT REQUIREMENT</b>	<p>a) Waste management audit</p> <p>1 credit for undertaking a waste stream audit and developing a waste management system.</p> <p>b) Waste management practices</p> <p>1 credit for developing and implementing an environmentally responsive waste management system.</p> <p>1 credit where the waste management system demonstrates reductions in waste disposal to landfills and increased recycling.</p>
	<b>ASSESSMENT</b>	<p>a) Waste management audit</p> <p>The Client shall demonstrate that a detailed waste management audit has been undertaken of the prevailing waste streams (see a) above) that identifies the types of waste, and the amounts of each type that are expected regularly (from day to day use) and from activities such as renovations, fit-out, etc. The audit should determine the amounts of materials that have potential for recycling (paper, plastics, metals, obsolete equipment, etc), and the potential market for recycling.</p> <p>The Client shall also demonstrate that a waste management system is in place and/or is being developed to deal with waste and recycling.</p> <p>Where waste management has been a relatively new initiative for the building the credit may be awarded where it can be demonstrated that the on-going audit and developing waste management system will lead to improved waste management to the extent outlined above.</p> <p>b) Waste management practices</p> <p>The assessment seeks to establish the extent to which building management is pro-active in the management of waste streams from the building. All waste streams are covered, such as those from building renovations, redecoration, operation and maintenance, cleaning, etc. as well as from tenants/occupants and visitors. Waste in this context shall also include items such as obsolete or discarded building services components, office equipment, furniture, fittings, etc.</p> <p>The Client shall provide details of the waste management system for the building and records that quantify waste streams (hazardous, organic, non-organic, components, equipment, etc), disposal to landfill or elsewhere, recycled, sold or donated, etc. for up to the previous 3 years. Data may be provided in terms of percentage, volume and/or weight.</p> <p>The waste management system shall be judged to be environmentally responsive if it:</p> <ul style="list-style-type: none"> <li>demonstrates compliance with all current regulations in respect of the management and disposal of hazardous waste (chemicals, asbestos, etc);</li> </ul>

- is pro-active in the management of potentially hazardous waste (such as batteries, light fittings, etc);
- is pro-active in reducing use of toxic materials;
- is pro-active in reducing incoming waste streams (packaging etc);
- is pro-active in sourcing opportunities for recycling waste;
- is pro-active in educating, advising and facilitating building users to adopt environmentally sound waste management practices; and
- is an ongoing commitment; and
- continues to be adequately resourced in time and effort.

The second credit can be awarded if the building management can demonstrate success in reducing waste disposal to landfills and increasing the amounts of waste recycled over at least 3 years previous. Where waste management has been in place for less than 3 years the onus shall be on the Client to demonstrate the extent of the gains achieved in the short term were significant, and can be prolonged or increased.

The Applicant shall provide documentation and photographic evidence.

## BACKGROUND

The managers of buildings can achieve a great deal in improving waste management and recycling, especially through positive engagement with building users [1]. Where waste management is in an emergent stage the starting point is a waste stream audit to establish current waste benchmarks, then to evaluate how each type of waste can be reduced through source reduction, reuse and recycling. Development of a waste management system, suitably resourced with facilities, staff and time, should follow. Targets should include the reduction of incoming waste streams, compliance with regulations in respect of hazardous waste, reducing waste disposal at land fill, identifying recycling opportunities, etc. Pro-active management should consider reducing use of toxic materials, or at least ensure environmentally sound disposal. Examples include mercury in lamps, batteries, equipment containing polychlorinated biphenyl, etc.

Hong Kong generates several different types of waste, and each has its own requirements for handling. The Environmental Protection Department [2] keeps regular statistics on each waste type, such as composition, quantity sent for disposal and quantity recycled, such as for example, municipal solid waste [3], waste paper [4], plastic waste [5] and glass bottles [6]

## NOTE

Purchasing practices, as covered elsewhere in this BEAM version, can also contribute to reducing waste streams.

Reference should be made to Section 6 IQE 4 with regard to the hygiene aspects of waste disposal.

- 1 Good Practice Guide to Waste Management for Hotels in Hong Kong  
[http://www.bse.polyu.edu.hk/research/BEP/hotels14000/acrobat/waste\\_guide.pdf](http://www.bse.polyu.edu.hk/research/BEP/hotels14000/acrobat/waste_guide.pdf)
- 2 Environmental Protection Department. Waste Reduction Guidelines and Factsheets.  
[https://www.wastereduction.gov.hk/en/assistancewizard/recyc\\_fact\\_sheet.htm](https://www.wastereduction.gov.hk/en/assistancewizard/recyc_fact_sheet.htm)
- 3 Environmental Protection Department. Waste Reduction and Recycling Factsheet No.1  
[https://www.wastereduction.gov.hk/en/materials/info/wr\\_msw.pdf](https://www.wastereduction.gov.hk/en/materials/info/wr_msw.pdf)
- 4 Environmental Protection Department. Waste Reduction and Recycling Factsheet No.2.  
[http://www.epd.gov.hk/epd/english/environmentinhk/waste/guide\\_ref/files/wr\\_paper.pdf](http://www.epd.gov.hk/epd/english/environmentinhk/waste/guide_ref/files/wr_paper.pdf)
- 5 Environmental Protection Department. Waste Reduction and Recycling Factsheet No.3.  
[http://www.epd.gov.hk/epd/english/environmentinhk/waste/guide\\_ref/files/wr\\_plastics.pdf](http://www.epd.gov.hk/epd/english/environmentinhk/waste/guide_ref/files/wr_plastics.pdf)
- 6 Environmental Protection Department. Waste Reduction and Recycling Factsheet No.6.  
[http://www.epd.gov.hk/epd/english/environmentinhk/waste/guide\\_ref/files/wr\\_glass.pdf](http://www.epd.gov.hk/epd/english/environmentinhk/waste/guide_ref/files/wr_glass.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

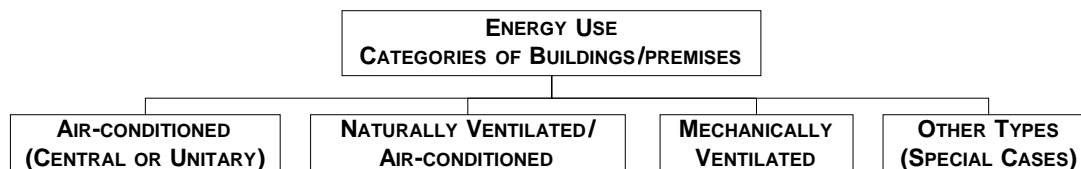
### INTRODUCTION

An objective of BEAM is to encourage thorough evaluation of the performance of building and services system designs, and greater investments into measures that will help improve the energy performance of existing buildings, so as to reduce energy consumption and the associated environmental impacts, and to reduce summer peak electricity demand.

The assessment of the building and engineering systems is performance based as far as possible, but credits are also given for features which have proven to contribute to energy efficiency and conservation. Credits are given where management, operation and maintenance practices are such as to seek continued improvements in energy performance.

### 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.

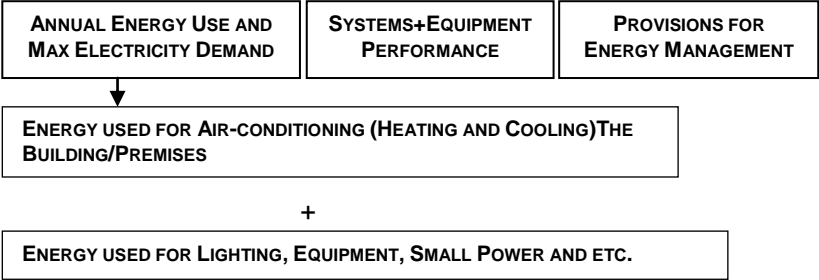
### OTHER BUILDINGS

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 Full 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.



**BACKGROUND**

Electricity generation accounts for around 60% of the total CO<sub>2</sub> 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 Code (BEC), a government initiative currently under review for mandatory implementation, is taken as the energy performance Prerequisite for BEAM certification, unless otherwise agreed by BEAM Society Limited.

BEC refers also to other 4 other Codes of Practice for energy efficiency, namely Air-conditioning Code [1], Lighting Code [2], Electrical 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 CO<sub>2</sub> EMISSIONS  
EU 2 PEAK ELECTRICITY DEMAND REDUCTION

### 4.2 ENERGY EFFICIENT SYSTEMS

- EU 3 VENTILATION SYSTEMS IN CAR PARKS  
EU 4 LIGHTING SYSTEM IN CAR PARKS  
EU 5 RENEWABLE ENERGY SYSTEMS

### BACKGROUND

Whilst the estimation of annual energy use and maximum electricity demand takes into account improvements to the efficiency of air-conditioning and lighting systems and equipment it does not embrace all aspects of energy use in buildings. Therefore, BEAM credits additional measures that can improve the energy performance of buildings.

### 4.3 ENERGY EFFICIENT EQUIPMENT

- EU 6 AIR-CONDITIONING UNITS  
EU 7 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 but account for which is not included in the estimation of annual energy use.

- 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](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](http://www.emsd.gov.hk/emsd/e_download/pee/lightingcop_2007.pdf)
- 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](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](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](http://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](http://www.emsd.gov.hk/emsd/e_download/pee/pb-bec_2007.pdf)

#### 4.4 PROVISIONS FOR ENERGY MANAGEMENT

##### EU 8 TESTING AND COMMISSIONING

##### EU 9 METERING AND MONITORING

##### EU 10 ENERGY MANAGEMENT

##### 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 management and operation of a building and the way the tenants use the building can have a major impact on its energy consumption. Energy management should:

- be fully integrated into the organisation's management systems;
- have monitoring and targeting systems in place based on sub-metering of the fuels used;
- include regular reports and reviews of the monitored data;
- set targets for energy efficiency improvements, and
- be supported by an action plan.

<b>4</b>	<b>ENERGY USE</b>	<b>4.P PREREQUISITE</b>
		<b>EU P1 MINIMUM ENERGY PERFORMANCE</b>
	<b>EXCLUSIONS</b>	None
	<b>OBJECTIVE</b>	Establish the minimum level of energy performance for the systems serving project spaces.
	<b>REQUIREMENT</b>	Demonstrate compliance with the Building Energy Codes (BEC).
	<b>ASSESSMENT</b>	<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 required to demonstrate compliance with the pertinent sections of the latest BEC that include, but are not limited to:</p> <ol style="list-style-type: none"> <li>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; and</li> <li>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 modelling assumptions.</li> </ol> <p>Documents issued by the certifying body of the BEC confirming compliance are recognised as an acceptable alternative to the submission of documents a) and b) above.</p>
	<b>BACKGROUND</b>	Compliance with the Building Energy Codes 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.

<b>4</b>	<b>ENERGY USE</b>	<b>4.1 ANNUAL ENERGY USE</b>
		<b>EU 1 REDUCTION OF CO<sub>2</sub> EMISSIONS</b>
	<b>EXCLUSIONS</b>	None
	<b>OBJECTIVE</b>	Reduce the consumption of non-renewable energy resources and the consequent harmful emissions of Carbon dioxide (CO <sub>2</sub> ) to the atmosphere.
	<b>CREDITS ATTAINABLE</b>	15
	<b>PREREQUISITES</b>	Eu P1 Minimum Energy Performance
	<b>CREDIT REQUIREMENT</b>	<p>a) Commercial and Hotel Buildings, 1 to 15 credits for a reduction of CO<sub>2</sub> 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 CO<sub>2</sub> 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 CO<sub>2</sub> 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) For other Building Types, 1 to 15 credits for reduction of CO<sub>2</sub> emissions or annual energy consumption by: 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 12%, 14%, 16%, 18% and 20% respectively.</p>
	<b>ALTERNATIVE CREDIT REQUIREMENT</b>	<p>1 credit for compliance with the Code of Practice for Energy Efficiency of Air Conditioning Installations.</p> <p>1 credit for compliance with the Code of Practice for Energy Efficiency of Lighting Installations.</p> <p>and energy use in comparison with similar premises:</p> <p>1 credit where annual energy use is <math>\leq</math> 40% cumulative percentage. 2 credits where annual energy use is <math>\leq</math> 30% cumulative percentage. 3 credits where annual energy use is <math>\leq</math> 20% cumulative percentage. 4 credits where annual energy use is <math>\leq</math> 10% cumulative percentage.</p> <p>or, energy use reductions as demonstrated by billing/metering data:</p> <p>1 credit where the reduction in annual energy use has been 10%. 2 credits where the reduction in annual energy use has been 15%. 3 credits where the reduction in annual energy use has been 20%.</p>
	<b>ASSESSMENT</b>	<p>The number of credits awarded will be determined with reference to the percentage reduction of CO<sub>2</sub> emissions or annual energy consumption of the Assessed Building relative to the benchmark (zero-credit) criteria evaluated from an equivalent Baseline Building model (see Section 8.1).</p> <p>The calculation shall be done in terms of units of either CO<sub>2</sub> – kg or kWh per year. A simple conversion factor shall be adopted with reference to</p>

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.

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.

The determination of annual energy use of the Baseline Building model will be based on the default indoor conditions and occupancy, lighting and equipment load densities and patterns for the relevant types of premises in the assessed building, as summarised in Tables 8.3 and 8.4 in Section 8.2. Performance of air-conditioning equipment shall be taken as being at a level that barely complies with the minimum requirements stipulated in the Code of Practice for Energy Efficiency of Air Conditioning Installations [1].

The zero-credit criteria for the annual energy use of the assessed building shall then be determined by scaling up the annual energy use of the baseline building model by 150%. Where applicable, the default values or assumptions for design parameters shall make reference to Appendix 8.2.

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 CO<sub>2</sub> 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<sup>2</sup> and/or Appendix G2.5 of ASHRAE 90.1-2007<sup>3</sup> and/or Appendix D of the Advanced Energy Modelling for LEED – Technical Manual v1.0 (September 2011 Edition)<sup>4</sup>.

#### **USE OF REGRESSION MODELS**

For some types of buildings regression models may be used as an alternative to the generic simulation method, for the determination of the zero-credit energy use and maximum electricity demand criteria (based on the baseline building model) for the assessed building.

#### **USE OF ENERGY CONSUMPTION INDICATORS AND BENCHMARKS**

The assessment covers all areas, premises and energy uses under the control of the building management, i.e. the building management is responsible for energy and fuel bills.

As an alternative to the prescriptive codes for air-conditioning [1] and lighting [5] compliance with the Performance-based Building Energy

- 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](http://www.emsd.gov.hk/emsd/e_download/pee/accop_2007.pdf)
- 2 EMSD - Code of Practice for Energy Efficiency of Building Services Installation - Section A3.4 2012
- 3 ASHRAE Standard 90.1-2007 – Energy Standard for Buildings Except Low Rise Residential Buildings
- 4 USGBC - Advanced Energy Modeling for LEED – Technical Manual v1.0 (August 2010 Edition).
- 5 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](http://www.emsd.gov.hk/emsd/e_download/pee/lightingcop_2007.pdf)

Code [6] also satisfies the first two credits. Certification under either scheme shall be submitted to demonstrate compliance.

The first alternative assessment is limited to premises for which energy consumption indicators and benchmarks are available in EMSD's Energy Consumption Indicators and Benchmarks [7]. Up to 4 additional credits are available using this alternative assessment criterion.

The Client shall submit details of the premises/areas/facilities in the building, their areas (m<sup>2</sup>) and uses, billing data for up to 3 years previous, and details as per submissions to the on-line documentation provided by EMSD.

Where a building includes a variety of premises/uses as identified in the Indicators and Benchmarking the credits awarded shall be weighting by percentage of floor area of the areas/premises covered in the submission. For example, assuming A, B and C are various 'Principle Group/Major Group' areas as identified in the database, and have percentages of 30%, 30% and 40%, respectively of the total building area. A is within the 30% cumulative percentage, B is within 10%, and C is within 40%. The weighted credit score is then  $(0.3 \times 2) + (0.3 \times 4) + (0.4 \times 1) = 2.2 > 2$  credits.

#### USE OF BILLING/ METERING DATA

Alternatively, in addition to compliance with the air-conditioning and/or lighting codes up to 3 credits are available for demonstrating a reduction in annual energy use, and up to 2 credits for demonstrating a reduction in electricity maximum demand, based on billing/metering data.

The starting point for the audit shall be any period after which the building became fully occupied, or for at least the past 3 years. Changes of occupancy, use, etc. over the audit period shall be stated, and an estimation of energy saving resulting from under utilisation of the building or change of use shall be included.

Whichever of the alternative assessments are submitted the onus shall be on the Client to demonstrate what management initiatives (rather than changes in occupancy or use) have served to reduce annual energy use and/or maximum demand, that there has been consistent improvement, and that the gains are likely to be maintained.

#### BACKGROUND

BEAM encourage energy saving and reduction in maximum electricity demand. The alternative credit and assessment criterion takes into account that existing buildings may or may not have been assessed under previous versions of BEAM, but also the accuracy and reliability of data used.

6 Electrical and Mechanical Services Department. Performance-based Building Energy Code.  
[http://www.emsd.gov.hk/emsd/e\\_download/pee/pb-bec\\_2007.pdf](http://www.emsd.gov.hk/emsd/e_download/pee/pb-bec_2007.pdf)

7 Electrical & Mechanical Services Department. Energy Consumption Indicators and Benchmarks.  
<http://www.emsd.gov.hk/emsd/eng/pee/ecib.shtml>

<b>4</b>	<b>ENERGY USE</b>	<b>4.1 ANNUAL ENERGY USE</b>
		<b>EU 2 PEAK ELECTRICITY DEMAND REDUCTION</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Encourage energy conservation and methods to reduce peak electricity demand.
	<b>CREDITS ATTAINABLE</b>	3 credits for commercial buildings; 2 credits for hotel, educational and residential buildings.
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENT</b>	<p>(a) Commercial Buildings, 1 to 3 credits for a reduction in the peak electricity demand by 15%, 23% and 30% respectively.</p> <p>(b) Hotel Buildings, 1 to 2 credits for a reduction in the peak electricity demand by 10% and 20% respectively.</p> <p>(c) Educational and Residential Buildings, 1 to 2 credits for a reduction in the peak electricity demand by 8% and 15% respectively.</p> <p>(d) Other Building Types, 1 to 3 credits for a reduction in the peak electricity demand by 8%, 12% and 15% respectively.</p>
	<b>ALTERNATIVE CREDIT REQUIREMENT</b>	<p>1 credit for a reduction in electricity maximum demand of 10%, as demonstrated by billing/metering data.</p> <p>2 credits for a reduction of electricity maximum demand of 20%, as demonstrated by billing/metering data.</p>
	<b>ASSESSMENT</b>	<p>The number of credits to be awarded will be determined with reference to the percentage reduction of maximum electricity demand of the assessed building relative to the respective benchmark (zero-credit) criteria evaluated from the Baseline Building model.</p> <p>The assessment shall be included within the assessment of annual energy use for the project building.</p>

<b>4</b>	<b>ENERGY USE</b>	<b>4.2 ENERGY EFFICIENT SYSTEMS</b>
		<b>EU 3 VENTILATION SYSTEM IN CAR PARKS</b>
	<b>EXCLUSIONS</b>	Buildings without carpark or carpark area less than 10% CFA.
	<b>OBJECTIVE</b>	Encourage energy efficient design and control of ventilation systems in large mechanically ventilated building/premises.
	<b>CREDITS ATTAINABLE</b>	2
	<b>PREREQUISITES</b>	Compliance with the Building (Ventilating Systems) Regulations, Chapter 123J Regulation 4.
	<b>CREDIT REQUIREMENT</b>	<p>1 credit for ventilation systems that will consume less electricity than those meeting the zero credit requirements (baseline) by 20% or more.</p> <p>2 credits where the consumption is reduced by 25% or more.</p>
	<b>ASSESSMENT</b>	<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"> <li>• 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</li> <li>• 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.</li> </ul> <p>Beside 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"> <li>• the criteria adopted in the design of the ventilation systems;</li> <li>• 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].</li> <li>• the calculated ventilation rates;</li> <li>• the design performance and operating patterns of the ventilation equipment;</li> <li>• the energy use predictions for the zero-credit case and the as designed case for the ventilation system installation;</li> <li>• 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</li> <li>• the specified performance of any air-conditioning equipment for the building.</li> </ul>

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](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](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/>

<b>4</b>	<b>ENERGY USE</b>	<b>4.2 ENERGY EFFICIENT SYSTEMS</b>
		<b>EU 4 LIGHTING SYSTEM IN CAR PARKS</b>
	<b>EXCLUSIONS</b>	Buildings without carpark or carpark area less than 10% CFA.
	<b>OBJECTIVE</b>	Encourage the adoption of lighting equipment and controls that will provide for energy conservation.
	<b>CREDITS ATTAINABLE</b>	2
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENT</b>	<p>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.</p> <p>2 credits where the consumption is reduced by 25% or more.</p>
	<b>ASSESSMENT</b>	<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"> <li>• The use of 40W fluorescent tubes, each with a 10W control gear and producing 2,400 lm; and</li> <li>• 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</li> </ul> <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"> <li>• the criteria adopted in the design of the lighting systems;</li> <li>• 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].</li> <li>• the quantity of lighting fittings designed for various premises, the wattage of each fitting and the operation patterns of the lighting systems; and</li> <li>• the energy use predictions for the zero-credit case and the as designed case for the lighting installations.</li> </ul> <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	<b>ENERGY USE</b>	<b>4.2 ENERGY EFFICIENT SYSTEMS</b>
		<b>EU 5 RENEWABLE ENERGY SYSTEMS</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Encourage the wider application of renewable energy sources in buildings.
	<b>CREDITS ATTAINABLE</b>	5
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENT</b>	<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>
	<b>ASSESSMENT</b>	<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 CO<sub>2</sub> Emission.</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>
	<b>BACKGROUND</b>	<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 renewable energy, the benefits of using renewable energy, and the current status of application of renewable energy in Hong Kong.</p> <p>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</p>

1 Electrical and Mechanical Services Department. [http://www.emsd.gov.hk/emsd/e\\_download/sgi/re\\_pamphlet.pdf](http://www.emsd.gov.hk/emsd/e_download/sgi/re_pamphlet.pdf)

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	<b>ENERGY USE</b>	<b>4.3 ENERGY EFFICIENT EQUIPMENT</b>
		<b>EU 6 AIR-CONDITIONING UNITS</b>
	<b>EXCLUSIONS</b>	Buildings not using window and/or split-type air-conditioners.
	<b>OBJECTIVE</b>	Ensure the installation of air-conditioning units provides for near optimum performance.
	<b>CREDITS ATTAINABLE</b>	1
	<b>PREREQUISITES</b>	Proper disposal system for the drainage of the condensation shall be provided in accordance with Buildings Department requirements [1].
	<b>CREDIT REQUIREMENT</b>	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.
	<b>ASSESSMENT</b>	<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 8.6 and 8.7 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 8.6 in respect of internal unit, and with the relevant dimensions given in Table 8.7 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"> <li>• 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);</li> <li>• 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;</li> <li>• for improved acoustics properties and better circulation, the internal discharge shall be close to the centre of the wall in which it is located;</li> <li>• 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;</li> <li>• to encourage proper maintenance, the installation of units shall be such as to allow for safe and convenient removal;</li> <li>• where air-conditioning units are provided by the developer, the units</li> </ul>

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>

<b>4</b>	<b>ENERGY USE</b>	<b>4.3 ENERGY EFFICIENT EQUIPMENT</b>
		<b>EU 7 ENERGY EFFICIENT APPLIANCES</b>
	<b>EXCLUSIONS</b>	Buildings where appliances are not provided by the developer.
	<b>OBJECTIVE</b>	Encourage the wider use of energy efficient appliances.
	<b>CREDITS ATTAINABLE</b>	2
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENT</b>	<p>1 credit when 60% of total rated power of appliances and equipment are certified energy efficient products.</p> <p>2 credits when 80% of total rated power of appliances and equipment are certified energy efficient products.</p>
	<b>ASSESSMENT</b>	<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>
	<b>BACKGROUND</b>	<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](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](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](http://www.energystar.gov/index.cfm?fuseaction=find_a_product).



<b>4</b>	<b>ENERGY USE</b>	<b>4.4 PROVISIONS FOR ENERGY MANAGEMENT</b>
		<b>EU 8 TESTING AND COMMISSIONING</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Ensure that commissioning of electrical and mechanical systems that impact on energy use is adequate, that systems perform as specified, and can be operated as intended.
	<b>CREDITS ATTAINABLE</b>	3 for centrally air-conditioned buildings, otherwise 2.
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENT</b>	<p>a) HVAC systems and equipment</p> <p>1 credit for ongoing programme of commissioning of water side equipment of central air-conditioning system.</p> <p>1 credit for ongoing programme of commissioning of air side equipment of central air-conditioning system.</p> <p>Alternatively:</p> <p>1 credit for ongoing programme of commissioning of all HVAC equipment.</p> <p>b) Non-HVAC systems and equipment</p> <p>1 credit for ongoing programme of commissioning of all non-HVAC equipment.</p>
	<b>ASSESSMENT</b>	<p>The Client shall submit copies of original commissioning records and/or testing and commissioning following changes to building use, systems and equipment (as these form part of the building's operation and maintenance manual), details of how testing and commissioning was undertaken, and shall be undertaken in future, and the personnel involved.</p> <p>The onus is on the Client to demonstrate that ongoing plan is in place, appropriate budgets and personnel are available, and that repairs, replacements and testing has been systematic and continuous in the building since first occupancy, or for a period of not less than 3 years.</p> <p>Credits shall be awarded where it can demonstrate that the buildings engineering systems are regularly tested and where necessary re-commissioned to meet the building operational requirements.</p>
	<b>BACKGROUND</b>	<p>Commissioning is a quality assurance process for buildings. 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.</p> <p>CIBSE [e.g. 1,2,3], BSRIA [e.g. 4] and ASHRAE publications provide guidance on commissioning requirements and procedures, such as</p>

- 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/>

management, design for commissioning, access, testing, measurements and tolerances, installed transducers, specification for portable measuring equipment, etc.

Ongoing 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 systems to be commissioned are all installed building heating, ventilating, and air-conditioning (HVAC) systems, equipment and components that affect energy use.

4	<b>ENERGY USE</b>	<b>4.4 PROVISIONS FOR ENERGY MANAGEMENT</b>
		<b>EU 9 METERING AND MONITORING</b>
	<b>EXCLUSIONS</b>	Residential buildings.
	<b>OBJECTIVE</b>	Enable building operators to measure, monitor and develop measures to improve the performance of the building's engineering systems, particularly concerning energy use.
	<b>CREDITS ATTAINABLE</b>	2 for centrally air-conditioned buildings, otherwise 1.
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENT</b>	<p>a) Electrical loads</p> <p>1 credit for ability to measure and monitor all major electrical loads in the building.</p> <p>b) Central HVAC plant</p> <p>1 additional credit where central chiller plant is provided with adequate instrumentation to determine operating performance.</p>
	<b>ASSESSMENT</b>	<p>The Owner/Operator shall provide details of the measuring and monitoring equipment installed and records of consumption, in order to demonstrate that electricity use in the building can be adequately monitored for audit purposes.</p> <p>a) Electrical loads</p> <p>Metering provision shall identify the electricity use pattern for each major system, fed from the Landlord's main switchboard(s), i.e., landlords lighting and small power, transportation, plumbing &amp; drainage systems, major air handling equipment, such as centralised air handling units for floors/zones, large designated areas, etc.</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 [1] 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 [2] or similar equivalent.</p> <p>b) Central HVAC plant</p> <p>Monitoring of central chiller plant will be assessed on the basis of BSRIA Technical Note TN 7/94 [3] 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>
	<b>BACKGROUND</b>	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.

1 British Standard BS EN 60521:1995. Class 0.5, 1 and 2 alternating-current watt-hour meters.

2 ASHRAE. Standard 114-1986: Energy Management Control Systems Instrumentation, American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc., USA. 1987.

3 K Calder. The Building Services Research and Information Association. Practical Chiller System Monitoring. Technical Note TN 7/94. 1994.

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.

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.

<b>4</b>	<b>ENERGY USE</b>	<b>4.4 PROVISIONS FOR ENERGY MANAGEMENT</b>
		<b>EU 10 ENERGY MANAGEMENT</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Encourage actions that can improve energy efficiency and conservation.
	<b>CREDITS ATTAINABLE</b>	4 + 2 BONUS
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENT</b>	<p>a) Energy auditing</p> <p>1 credit for conducting Category 3 energy audit (EMSD's guidelines on Energy Audit) with evidence</p> <p>1 BONUS credit for conducting carbon audit or GHG emission audit and demonstrating that an action plan of GHG reduction is in progress.</p> <p>b) Monitoring and targets</p> <p>1 credit for an effective energy monitoring and targeting system.</p> <p>c) Energy Management Plan</p> <p>1 credit for demonstrating an approved budget to improve the energy performance of the building with management plan.</p> <p>d) Energy management manual</p> <p>1 credit for maintaining a comprehensive energy management manual.</p> <p>e) Energy charge</p> <p>1 BONUS credit where separate charges are made for energy use.</p>
	<b>ASSESSMENT</b>	<p>a) Energy auditing</p> <p>The Client shall provide a report prepared by a suitably qualified person, confirming that a category 3 energy audit has been completed essentially in accordance with EMSD's guidelines on Energy Audit. The audit result should include breakdown of energy use by departments/units, individual major services systems and equipment. The audit should embrace, where possible, energy consumption by tenants. The evidence shall include energy consumption records, operation, maintenance records and show that an action plan based on findings is in place and in good progress to achieve target, etc.</p> <p>Where the report shows evidence of auditing practices appropriate to the size and complexity of the development, the credit shall be awarded.</p> <p>Where a carbon audit or GHG emission audit and as action plan of GHG reduction that is in progress is demonstrated, the BONUS credit shall be awarded.</p> <p>b) Monitoring and targets</p> <p>The submitted audit report should verify where actions to improve energy efficiency or reduce energy consumption have been identified, those that have been completed, and those that are in progress. The report should include recommendations on measures to reduce consumption with costs, savings and payback periods, and comparison with any available benchmarks (targets) for efficient operation. The subsequent energy monitoring and analysis should provide detailed energy use data for facilitating the energy performance assessment as specified in others sections of this document.</p> <p>Where the Client can demonstrate that appropriate monitoring, record</p>

keeping and target setting is in place the credit shall be awarded.

c) Energy Management Plan

Documents shall be submitted to provide information about how financial and other resources are deployed for building energy management. The submission shall include data collection, analysis, indicator, programme, auditing, target and person in charge.

Credit shall be awarded where energy efficient measures are financed at an appropriate level, either from operating budgets and/or from savings in energy costs.

d) Energy management manual

The onus is on the Client to demonstrate that an appropriate energy management manual exists.

e) Energy charge

The bonus credit shall be awarded where, in buildings with tenants, energy costs to tenants are charged separately and not included in base rents. In buildings under single ownership/occupancy the credit may be awarded if it can be demonstrated that individual departments within the organisation are charged for energy use from within their operating budgets. In all cases the accounting details shall be provided.

## BACKGROUND

Proactive management will seek to improve the performance of systems and equipment, i.e., improved energy efficiency, and promote energy conservation, i.e., minimise wastage of energy. Staff awareness of the importance of energy costs and efficiency is important if efficiency is to be improved through management procedures. Financial support for an action plan for implementing energy-saving measures is essential, either by a budget allocation or by allocation of all or part of savings in fuel bills. It is also vital that an appropriate senior person in the organisation be responsible for energy management. End-users of premises in a building should also be made aware that reducing energy use within their premises not only will reduce their own energy bills, it will also lead to reduced energy cost for providing air-conditioning for their premises. Tenants will be motivated to reduce their own energy use and to minimise use of air-conditioning if they can share the benefits of reduced energy cost on the landlord side.

Similar to the function of financial audit to a company, energy audit needs to be conducted at regular intervals to provide the building management with a clear picture about the types and quantities of energy being used in a building and for what purposes, whether energy has been used efficiently and effectively, and the room for improvements.

Effective energy management in building services requires an easy-to-follow up-to-date manual. All documentation, including operating manuals and maintenance instructions should be clearly written, detailing the design approach and describing the actual systems and equipment and controls installed.

## 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 PREREQUISITES

#### WU P1 WATER QUALITY SURVEY

#### WU P2 MINIMUM WATER SAVING PERFORMANCE

#### WU P3 WATER CONSERVATION PLAN

#### 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) and implementation of a water conservation plan.

### 5.1 WATER CONSERVATION

#### WU 1 ANNUAL WATER USE

#### WU 2 MONITORING AND CONTROLS

#### WU 3 WATER USE FOR IRRIGATION

#### WU 4 WATER RECYCLING

#### WU 5 WATER AUDIT

#### 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 of purity that, according to WSD, is among the best to be found anywhere. 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. 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>

cubic metres while the average daily use of sea water for flushing stood at 0.74 million cubic metres [2]. 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, where water resources are becoming increasingly limited. 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 8.5. 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.

2 Water Supplies Department. Annual Report.  
[http://www.wsd.gov.hk/filemanager/en/share/annual\\_reports/rpt0708/index.htm](http://www.wsd.gov.hk/filemanager/en/share/annual_reports/rpt0708/index.htm)



<b>5</b>	<b>WATER USE</b>	<b>5.P PREREQUISITE</b>
		<b>WU P1 WATER QUALITY SURVEY</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Ensure that the quality of potable water delivered to building users is satisfactory.
	<b>REQUIREMENT</b>	Demonstrate that the quality of potable water meets the referenced drinking water quality standards at all points of use.
	<b>ASSESSMENT</b>	<p>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. The frequency of sampling at any outlet shall be determined by the Client, as dictated by expectations from building users, or any management concerns about water quality following maintenance, outages, leaks, etc.</p> <p>The requirement shall be fulfilled if water quality at all sample points meets the Water Supplies Department (WSD) Guidelines, and additional measures are taken which reassure building users of the quality of the water supplied to all parts of the building. Such measures include a suitable frequency of sampling, publicising the details and results of sampling to building users, and surveying opinions of users as to satisfaction with the fresh water supply.</p>
	<b>BACKGROUND</b>	<p>The treated fresh water provided by the Water Supplies Department complies fully with the drinking water standard according to the guidelines of the World Health Organization. However, in order to ensure that consumers can enjoy good quality of water at the taps, building owners have to maintain their plumbing systems properly. 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 [2] in 2002. Since 1 January 2008, the Scheme has been renamed the Quality Water Recognition Scheme for Buildings. Participation in this Scheme is voluntary. The target groups to join this Scheme are the owners, operators and management agents of buildings in general.</p> <p>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. There are three grades of Certificates: Blue, Silver and Gold. The Certificate is valid for one or two years subject to the satisfactory maintenance of the plumbing system and the number of years of participation in the scheme. The Certificate may be displayed in the building, and on stationeries and promotional materials, subject to the guidelines issued by the Water Supplies Department. The Scheme aims to:</p> <ul style="list-style-type: none"><li>• enable local residents and overseas visitors to have greater confidence in the water quality at the tap;</li><li>• strengthen the capability of building management agents to achieve</li></ul>

- 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. Fresh Water Plumbing Maintenance Guide. <http://www.wsd.gov.hk/filemanager/en/share/pdf/FWPMGe.pdf>

value-added performance in meeting the needs of consumers with respect to quality of tap water;

- give recognition to those building management agents who can demonstrate consistent compliance with the prescribed criteria under the Scheme; and
- assist the owners, operators and building management agents to conduct self assessments on plumbing conditions and to identify areas for necessary maintenance.

The application will be assessed based on the following criteria:

- the plumbing system is inspected at least once every three months by licensed plumbers or qualified building services surveyors or engineers and is found to be in good physical condition;
- all defects identified in the inspections are promptly rectified by licensed plumbers or qualified persons;
- the water tanks are cleaned at least once every three months; and
- water samples are taken in accordance with the recommended procedure and tested for items specified at least once a year, and the test results comply with the acceptable limits of these water quality indicators.

## **SAMPLING**

Part 6 of ISO 5667 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.

<b>5</b>	<b>WATER USE</b>	<p><b>5.P PREREQUISITE</b></p> <p><b>WU P2 MINIMUM WATER SAVING PERFORMANCE</b></p> <p><b>EXCLUSIONS</b> Water consumption in tenancy areas can be excluded.</p> <p><b>OBJECTIVE</b> Reduce the consumption of fresh (potable) water through the application of water saving devices that have proven performance and reliability.</p> <p><b>REQUIREMENT</b> Demonstrate that the use of water efficient devices leads to an estimated aggregate annual saving of 10%.</p> <p><b>ASSESSMENT</b> 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"> <li>• allowing Clients to submit justification for the award of credits, or</li> <li>• using the pro-forma calculation method described below.</li> </ul> <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 above calculation shall take 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 8.5.</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"> <li>• details all installed devices and their water consumption rate or discharge volume;</li> <li>• details devices installed to reduce the potential wastage of water due to unnecessary operation of taps, etc;</li> </ul> <p>The submitted report shall contain the following information:</p> <ul style="list-style-type: none"> <li>• Number of operational days per annum;</li> <li>• Number of occupants; and</li> <li>• Male to Female ratio.</li> </ul> <p>There should be two sets of tables, one for the project case, and one for the baseline case.</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
----------------------	--------------------	----------------------------------	----------------------------	-----------------

Water consumption of utensil washing operation by hand:

Device/ equipment	Water Use per operation or cycle	Daily number of operations	Daily Water Use
----------------------	---	----------------------------------	-----------------

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 is different from most other places in the world because most buildings use saltwater flushing rather than potable water flushing. 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.

<b>5</b>	<b>WATER USE</b>	<b>5.P PREREQUISITE</b>
		<b>WU P3 WATER CONSERVATION PLAN</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Reduce the consumption of fresh (potable) water.
	<b>REQUIREMENT</b>	Develop a water conservation plan endorsed by directorate level management.
	<b>ASSESSMENT</b>	<p>The Client shall submit a copy of the water conservation plan that is endorsed at directorate level management.</p> <p>The conservation plan shall provide details of the water conservation measures and the credentials of the staff who are undertaking implementation. The plan and regular review shall be integrated into management and operations structure and have clear delegation of responsibility for auditing and/or monitoring water consumption. The plan shall include:</p> <ul style="list-style-type: none"> <li>● details of the channels of communication for staff at all levels, and building users;</li> <li>● monitoring of consumption;</li> <li>● details of actions taken to reduce water consumption, including those already completed, those in progress, and those for future implementation; and</li> <li>● a quantification of the savings.</li> </ul> <p>The assessment will seek to establish if mechanisms are in place to effectively limit wastage of water, and to set targets for water saving with an appropriate budget for upgrading the installations.</p>
	<b>BACKGROUND</b>	<p>There is an increasing availability of devices and plumbing fixtures that 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.</p>

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. <http://www.gao.gov/new.items/rc00232.pdf>

<b>5</b>	<b>WATER USE</b>	<b>5.1 WATER CONSERVATION</b>
		<b>WU 1 ANNUAL WATER USE</b>
	<b>EXCLUSIONS</b>	Water consumption in tenancy areas can be excluded.
	<b>OBJECTIVE</b>	Reduce the consumption of fresh (potable) water through the application of water saving devices that have proven performance and reliability.
	<b>CREDITS ATTAINABLE</b>	3
	<b>PREREQUISITES</b>	Wu P2 Minimum Water Saving Performance.
	<b>CREDIT REQUIREMENT</b>	<p>1 credit for demonstrating that the use of water efficient devices leads to an estimated aggregate annual saving of 20%.</p> <p>2 credits for demonstrating an estimated annual saving of 25%.</p> <p>3 credits for demonstrating an estimated annual saving of 30%.</p>
	<b>ASSESSMENT</b>	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. Confirmation of the award of credits shall take into account the appropriateness of the data used and the estimated percentage of potable water saved.

<b>5</b>	<b>WATER USE</b>	<b>5.1 WATER CONSERVATION</b>
		<b>WU 2 MONITORING AND CONTROL</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Reduce wastage of fresh water and allow for auditing of water use.
	<b>CREDITS ATTAINABLE</b>	1
	<b>PREREQUISITES</b>	Compliance with Waterworks Regulation Chapter 102A Regulation 32.
	<b>CREDIT REQUIREMENT</b>	1 credit for installation of devices to monitor water leakage within the fresh water distribution system.
	<b>ASSESSMENT</b>	<p>The Client shall submit a report detailing any system for monitoring water leaks within internal plumbing installations.</p> <p>The assessment will seek to establish if mechanisms are in place that effectively limit wastage of water by the application of water saving devices. The provision of devices for monitoring consumption for each of the major water using sectors shall be identified.</p> <p>Various approaches are available and BEAM is not intended to be prescriptive as to which should be used.</p>
	<b>BACKGROUND</b>	<p>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 taps, electronic proximity sensors, etc., but excluding timed shut-off devices.</p> <p>Generally in Hong Kong buildings there is very limited provision for monitoring water use other than the meters required for utility billing purposes. The provision of measurement devices for major water uses can assist facility managers to audit water use and can encourage the introduction of water saving measures.</p>



<b>5</b>	<b>WATER USE</b>	<b>5.1 WATER CONSERVATION</b>
		<b>WU 3 WATER USE FOR IRRIGATION</b>
<b>EXCLUSIONS</b>	Where soft landscaping and planting coverage is less than 50% of the area of the building footprint.	
<b>OBJECTIVE</b>	Reduce the reliance on potable water for irrigation.	
<b>CREDITS ATTAINABLE</b>	1	
<b>PREREQUISITES</b>	None.	
<b>CREDIT REQUIREMENT</b>	<p>1 credit for limited use of fresh water for the purposes of irrigation.</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>	
<b>ASSESSMENT</b>	<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>	
<b>BACKGROUND</b>	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 fertilizer and pesticides, thereby reducing impacts on local waters.	

5	<b>WATER USE</b>	<b>5.1 WATER CONSERVATION</b>
		<b>WU 4 WATER RECYCLING</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Encourage harvesting of rainwater and recycling of grey water in order to reduce consumption of fresh water.
	<b>CREDITS ATTAINABLE</b>	1 + 1 BONUS
	<b>PREREQUISITES</b>	Compliance with the water quality standards appropriate to the use of the recycled water.
	<b>CREDIT REQUIREMENT</b>	1 credit for harvesting rainwater and/or recycling greywater that leads 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.
	<b>ASSESSMENT</b>	<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>The Client shall provide a detailed report on the system or systems installed for the purpose of harvesting rainwater and/or recycled water, the details of the expectations in respect of savings in the consumption of fresh water. The Client 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.</p> <p>Where it can be demonstrated that the savings in fresh water use is 5% or more based on baseline building estimation the credit shall be awarded. Where it can be demonstrated that the savings in fresh water use is 10% or more the bonus credit shall be awarded.</p>
	<b>BACKGROUND</b>	<p>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.</p> <p>The problem for Hong Kong's high-rise dense built environments is that the potential for collecting rainwater is limited. Yang et al [1] 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.</p> <p>Well-populated buildings not supplied with seawater for flushing would be a good candidate from water recycling, otherwise reuse is likely to be limited, depending on the extent of cleaning, irrigation and the types of equipment used for cooling.</p>

1 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.

Water quality should meet appropriate criteria, such as that outlined by ACQWS [2], the Building Research and Information Association [3], or similar authoritative guidance.

- 2 Water Supplies Department. ACQWS Paper No. 14 – Treated Effluent Reuse at Ngong Ping.
- 3 BSRIA, Greywater and Rainwater Systems: Recommended UK Requirements, The Building Services Research and Information Association, Final Report 13034/1.

<b>5</b>	<b>WATER USE</b>	<b>5.1 WATER CONSERVATION</b>
		<b>WU 5 WATER AUDIT</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Reduce the consumption of fresh (potable) water.
	<b>CREDITS ATTAINABLE</b>	1 BONUS
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENT</b>	1 BONUS credit for undertaking a water audit and maintaining a water use inventory.
	<b>ASSESSMENT</b>	<p>The Client shall submit documentation prepared by a suitably qualified person confirming that an audit has been completed. The report shall include water consumption records, operation and maintenance records, etc. for all areas of water use, but may exclude water consumption by tenants. The report shall include a spreadsheet listing each water-using fixture and end use data, such as:</p> <ul style="list-style-type: none"> <li>● frequency of floor cleaning and water volume per use;</li> <li>● frequency of garden irrigation and water volume per use;</li> <li>● frequency, duration and water volume per use of each fixture in kitchens and laundry;</li> <li>● frequency of male and female daily uses of the water-using fixture, duration per use, and the water volume per use.</li> </ul>
	<b>BACKGROUND</b>	<p>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.</p>

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. <http://www.gao.gov/new.items/rc00232.pdf>

<b>5</b>	<b>WATER USE</b>	<b>5.2</b>	<b>EFFLUENT</b>
		<b>WU 6</b>	<b>EFFLUENT DISCHARGE TO FOUL SEWERS</b>
	<b>EXCLUSIONS</b>	None.	
	<b>OBJECTIVE</b>	Reduce the volumes of sewage discharged from buildings thereby reducing burdens on municipal sewage supply and treatment facilities.	
	<b>CREDITS ATTAINABLE</b>	1	
	<b>PREREQUISITES</b>	Compliance with the Water Pollution Control Ordinance.	
	<b>CREDIT REQUIREMENT</b>	1 credit for demonstrating a reduction in annual sewage volumes by 20% or more, or reduction in sewage concentration by a 30% or more.	
	<b>ASSESSMENT</b>	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 the Appendix 8.6 or any other appropriate estimation, the credit(s) shall be awarded.	
	<b>BACKGROUND</b>	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. Similarly, the concentration of sewage in discharges can be reduced at the building level to reduce the burden on sewage treatment plants.	

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

## 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

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.

in different buildings/premises, for the purposes of assessment BEAM 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 adopted, 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 building.

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**

**IEQ 5 INTEGRATED PEST MANAGEMENT**

- 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>

## BACKGROUND

Post-SARS, a lot more attention has been paid 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.

## 6.3 INDOOR AIR QUALITY

### IEQ 6 CONSTRUCTION IAQ MANAGEMENT

### IEQ 7 OUTDOOR SOURCES OF AIR POLLUTION

### IEQ 8 INDOOR SOURCES OF AIR POLLUTION

### IEQ 9 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, including 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. 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 10 INCREASED VENTILATION

### IEQ 11 BACKGROUND VENTILATION

### IEQ 12 LOCALISED VENTILATION

### IEQ 13 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 (CO<sub>2</sub>) at design occupancy. In Hong Kong it is usual that the minimum values for ventilation rates 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 CO<sub>2</sub> as a measure of satisfactory performance in unoccupied premises but it is possible to determine if ventilation will be satisfactory

5 American Society of Heating, Refrigeration and Air-conditioning Engineers. ASHRAE 62.1-2007: Ventilation for Acceptable Indoor Air Quality. Atlanta 2007.



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, 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 14 THERMAL COMFORT IN AIR-CONDITIONED PREMISES**

### **IEQ 15 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 16 NATURAL LIGHTING**

### **IEQ 17 INTERIOR LIGHTING IN NORMALLY OCCUPIED AREAS**

### **IEQ 18 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 19 ROOM ACOUSTICS**

### **IEQ 20 NOISE ISOLATION**

### **IEQ 21 BACKGROUND NOISE**

#### **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,

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.

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 a level 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 such that ground transportation noise impacts on occupants. Noise from fixed sources and aircraft may also pose a problem for some developments.

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>

<b>6</b>	<b>IEQ</b>	<b>6.P PREREQUISITE</b>
		<b>IEQ P1 MINIMUM VENTILATION PERFORMANCE</b>
	<b>EXCLUSIONS</b>	Residential and similar buildings without central air conditioning.
	<b>OBJECTIVE</b>	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.
	<b>REQUIREMENT</b>	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.
	<b>ASSESSMENT</b>	<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"> <li>1. Confirmation that the outdoor air pollutants Carbon monoxide (CO), Nitrogen dioxide (NO<sub>2</sub>), Ozone (O<sub>3</sub>) and Respirable Suspended Particulates (RSP) conform to the IAQ Certification Scheme Good Air Quality level.</li> <li>2. Completion of Table H-2 of ASHRAE Standard 62.1-2007 demonstrating compliance with the minimum ventilation rate(s) provided.</li> </ol>
	<b>BACKGROUND</b>	<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 (CO<sub>2</sub>) levels within 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**

<b>EXCLUSIONS</b>	None.
<b>OBJECTIVE</b>	Engender a feeling of well-being amongst building users.
<b>CREDITS ATTAINABLE</b>	1
<b>PREREQUISITES</b>	Burglar alarm systems shall comply with the Noise Control Ordinance.
<b>CREDIT REQUIREMENT</b>	1 credit for scoring at least 75% of the applicable security measures and facilities for the building.
<b>ASSESSMENT</b>	<p>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.</p> <p>Where 75% compliance of applicable items is demonstrated, the credit shall be awarded.</p> <p>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.</p>

**ASSESSMENT GRID**

<b>Site perimeter controls:</b>	<b>Pt</b>	<b>Surveillance:</b>	<b>Pt</b>	<b>Building Security:</b>	<b>Pt</b>	<b>Site/Building Layout</b>	<b>Pt</b>
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.

<b>6</b>	<b>IEQ</b>	<b>6.2 HYGIENE</b>
		<b>IEQ 2 PLUMBING AND DRAINAGE</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Reduce the potential for contamination of plumbing and drainage systems, reduce the ability of systems to carry infections, and reduce the likelihood of odours.
	<b>CREDITS ATTAINABLE</b>	1
	<b>PREREQUISITES</b>	Compliance with the provisions of the Building (Standards of Sanitary Fitments, Plumbing, Drainage Works and Latrines) Regulations.
	<b>CREDIT REQUIREMENT</b>	1 credit where system design, operation and maintenance is such as to reduce the potential for transmission of harmful bacteria, viruses and odours.
	<b>ASSESSMENT</b>	<p>The Client shall submit details of the plumbing and drainage systems in the building, and confirmation that installation of the systems and equipment satisfies applicable regulations. A summary report shall be submitted highlighting appropriate means in place to ensure the safe and hygienic operation of the systems and components.</p> <p>The 'appropriate means' shall include, but are not limited to, reference to the following:</p> <ul style="list-style-type: none"> <li>• adequacy of flushing water supply to meet peak demand;</li> <li>• adequacy of drainage stacks under peak loading;</li> <li>• venting of stacks;</li> <li>• access to pipework and ducts for maintenance purposes;</li> <li>• attention to leaks at joints, seals, etc;</li> <li>• design of floor drains; and</li> <li>• maintenance of water seals.</li> </ul> <p>Where it can demonstrate that the management, operation and maintenance of the plumbing and drainage systems and equipment, 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>
	<b>BACKGROUND</b>	<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 maintenance 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</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>

multi-level drainage systems. The main ways that air passes a trap are:

- 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 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.

#### **INSTALLATIONS**

Leaky joints and broken drainage pipes are the result of 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.

#### **VENTILATION**

Where mechanical ventilation in the form of an 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 [2]. 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.

2 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>

<b>6</b>	<b>IEQ</b>	<b>6.2 HYGIENE</b>
		<b>IEQ 3 BIOLOGICAL CONTAMINATION</b>
	<b>EXCLUSIONS</b>	Residential buildings.
	<b>OBJECTIVE</b>	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.
	<b>CREDITS ATTAINABLE</b>	1
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENT</b>	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.
	<b>ASSESSMENT</b>	The Client shall submit a report prepared by a suitably qualified person detailing how the operation and maintenance 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 operated and maintained in compliance with the Code or Practice, or equivalent.
	<b>BACKGROUND</b>	<p>Most cases of legionnaires' disease (LD), are caused by the bacterium <i>Legionella pneumophila</i>, but 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 'legionellosis'; 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 building may reveal problems with biological contamination caused by either air-conditioning and ventilation systems, or water systems. BEAM requires the confirmation that the operation and maintenance of systems and equipment is such as to reduce the possibility of problems arising.</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. [http://www.emsd.gov.hk/emsd/e\\_download/pps/code.doc](http://www.emsd.gov.hk/emsd/e_download/pps/code.doc)



<b>6</b>	<b>IEQ</b>	<b>6.2</b>	<b>HYGIENE</b>
		<b>IEQ 4</b>	<b>WASTE DISPOSAL FACILITIES</b>
	<b>EXCLUSIONS</b>	None.	
	<b>OBJECTIVE</b>	Ensure that the design, installation and facilities for waste disposal and recycling are such as to reduce the risk of odours entering occupied areas or public areas.	
	<b>CREDITS ATTAINABLE</b>	1	
	<b>PREREQUISITES</b>	Compliance with the Building (Refuse Storage Chambers and Material Recovery Chambers and Refuse Chutes) Regulations where applicable.	
	<b>CREDIT REQUIREMENT</b>	1 credit for the provision of a de-odourising system in all refuse collection rooms.	
	<b>ASSESSMENT</b>	<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>	
	<b>BACKGROUND</b>	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.	
	<b>REFUSE CHAMBERS</b>	<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&amp;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&amp;MRC.</p> <p>The noise level of the system should conform with 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.</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&amp;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>

<b>6</b>	<b>IEQ</b>	<b>6.2 HYGIENE</b>
		<b>IEQ 5 INTEGRATED PEST MANAGEMENT</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Ensure that the management of pests is safe, hygienic and with limited environmental impacts.
	<b>CREDITS ATTAINABLE</b>	1
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENT</b>	1 credit for implementing an integrated programme for pest management.
	<b>ASSESSMENT</b>	<p>The onus is on the Client to demonstrate the suitability of the pest management programme or system adopted for the particular circumstances. The Client shall submit details of the measures taken to control pests in the least harmful manner to humans and the environment.</p> <p>Assessment shall take into account:</p> <ul style="list-style-type: none"> <li>• the methods used to monitor pests and to keep records on problems;</li> <li>• actions to identify the root causes of pest problems</li> <li>• the extent to which pest treatment actions avoid chemicals and pesticides that may be harmful to staff, building users and passers-by, and to the environment;</li> <li>• details of reference/educational material maintained in-house, and extent of staff training that deals with pest management; and</li> <li>• availability of documentation detailing pest management in the buildings and its surrounding site.</li> </ul>
	<b>BACKGROUND</b>	<p>Pesticides pose risks to human health and the environment when people do not follow directions on product labels or use products irresponsibly. For example, pesticides might be used when they are not really needed, too much is applied, or disposal is in a manner that could contaminate the environment. Even alternative or organic pesticides can have these unintended consequences if not used correctly. Building management should adopt pest control in ways that offer a means to reduce the risk from, and in some cases, the amount of pesticides needed.</p> <p>Integrated pest management is an approach to pest control that utilizes regular monitoring and record keeping determining if and when treatments are needed, and employs a combination of strategies and tactics to keep pest numbers low enough to prevent unacceptable damage or annoyance. Biological, cultural, physical, mechanical, educational, and chemical methods are used in site-specific combinations to solve the pest problem. Chemical controls are used only when needed, and in the least-toxic formulation that is effective against the pest. Educational strategies are used to enhance pest prevention and to build support for the IPM program.</p> <p>The US EPA promotes integrated pest management through documents such as for schools [1], because IPM represents a prudent approach to understanding and dealing with environmental concerns. Because IPM is a decision-making process and not a rote method, an IPM program will always be able to take into account the wide spectrum of pest problems</p>

1 US Environmental Protection Agency. Integrated Pest Management In Schools. <http://www.epa.gov/opp00001/ipm/>

and the diversity of people involved. IPM methods equip pest control operators and other members of the IPM team to design flexible, site-specific pest management plans scaled to the severity of the problems and the level of resources available.

An IPM program is built around the following components:

- monitoring the pest population and other relevant factors;
- accurate identification of the pest;
- determining injury and action levels that trigger treatments; and
- timing treatments to the best advantage.

An IPM manual would contain, for example:

- management policies;
- purchasing practices;
- pest management objectives;
- biological and ecological information on pests;
- monitoring of each type of pest;
- field data and interpretation;
- proper storage, cleaning and use of equipment and supplies;
- tactics allowed for treatment; and
- evaluation of effectiveness of treatments, etc.

<b>6</b>	<b>IEQ</b>	<b>6.3 INDOOR AIR QUALITY</b>
		<b>IEQ 6 CONSTRUCTION IAQ MANAGEMENT</b>
	<b>EXCLUSIONS</b>	Residential and similar buildings not provided with central air-conditioning and ventilation systems.
	<b>OBJECTIVE</b>	Ensure that building users are not affected and ventilation systems are not contaminated during renovation work.
	<b>CREDITS ATTAINABLE</b>	1
	<b>PREREQUISITES</b>	If applicable, compliance with the Air Pollution Control Ordinance with regard to asbestos control.
	<b>CREDIT REQUIREMENT</b>	1 credit for availability and effective implementation of a Construction IAQ Management.
	<b>ASSESSMENT</b>	<p>To demonstrate compliance the Client shall submit a report prepared by a suitably qualified person documenting effective implementation of Construction IAQ Management appropriate to the scale and extent of the work.</p> <p>Where renovations require the removal or treatment of asbestos containing materials the work shall be carried out in accordance with the instructions given by the Environmental Protection Department [1].</p> <p>Where due attention has been paid to construction IAQ management as detailed in the checklist below, the credit shall be awarded.</p>
	<b>CHECK LIST</b>	<p>Written Construction IAQ Management procedures should exist which shall meet or exceed the minimum requirements, as follows:</p> <ul style="list-style-type: none"> <li>• details of the procedures adopted during renovation, fit-out and redecoration;</li> <li>• contract documentation that demonstrates implementation of the construction IAQ management measures;</li> <li>• operation and maintenance measures in place during construction work;</li> <li>• measures to avoid contamination of adjacent normally occupied areas;</li> <li>• measures to avoid contamination of common areas or public areas, including outside areas;</li> <li>• contaminant source control;</li> <li>• provision of adequate outside air continuously during installation of materials and finishes;</li> <li>• evidence of measures providing protection of ducts, on-site storage or protection of installed absorptive materials, etc;</li> <li>• 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;</li> <li>• details of any procedures for building flush-out; and</li> <li>• replacement of all construction-related filtration media used on permanent HVAC equipment at substantial completion of the work.</li> </ul>

1 Environmental Protection Department — Environmental Asbestos Control  
[http://www.epd.gov.hk/epd/english/environmentinhk/air/guide\\_ref/asbestos\\_control\\_02.html#removeasbestos](http://www.epd.gov.hk/epd/english/environmentinhk/air/guide_ref/asbestos_control_02.html#removeasbestos)

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 procedures should include emergency procedures and cover the following:

- a list of participants in the process and their responsibilities;
- communication and documentation;
- designate a representative with daily responsibility for IAQ issues; and
- keeping 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;

## **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 renovation, fit out and redecoration, followed by cleaning and replacement strategies, can significantly reduce the potential for air pollution. 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.

<b>6</b>	<b>IEQ</b>	<b>6.3 INDOOR AIR QUALITY</b>
		<b>IEQ 7 OUTDOOR SOURCES OF AIR POLLUTION</b>
	<b>EXCLUSIONS</b>	Buildings that are designed for natural ventilation or using de-centralised a/c system.
	<b>OBJECTIVE</b>	Demonstrate that airborne contaminants from external sources will not give rise to unacceptable levels of indoor air pollution in normally occupied spaces.
	<b>CREDITS ATTAINABLE</b>	2
	<b>PREREQUISITES</b>	Compliance with relevant chapters of the Occupational Safety and Health Ordinance.
	<b>CREDIT REQUIREMENT</b>	<p>a) Carbon monoxide (CO), Nitrogen dioxide (NO<sub>2</sub>) and Ozone (O<sub>3</sub>)</p> <p>1 credit for demonstrating compliance with appropriate criteria for CO, NO<sub>2</sub> and O<sub>3</sub>.</p> <p>b) Respirable suspended particulate (RSP, PM<sub>10</sub>)</p> <p>1 credit for demonstrating compliance with the appropriate criteria for RSP.</p>
	<b>ASSESSMENT</b>	<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, NO<sub>2</sub>, O<sub>3</sub> and RSP are solely from outside, measurements can be taken at the outdoor air intake locations where CO, NO<sub>2</sub>, O<sub>3</sub> 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 8.4. 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</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.

conditions, particularly wind speed and direction, it is expected that due account is taken and that measurements will be taken under typical or average climatic conditions.

Where access to premises is limited, e.g. due to the presence of tenants, the onus shall be on the Client to demonstrate measurements in those areas that are accessible is representative of the building as a whole.

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 the relevant credit(s) shall be awarded.

Where certification under the IAQ Certification scheme is current and covers all parts of the building for which this BEAM version certification is being sought then the credits shall be awarded.

## BACKGROUND

This section deals with pollutants found in indoor air which are mainly attributable to sources external to occupied spaces when the sources attributable to occupants and their activities is excluded. 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 all 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 ( $\text{NO}_x$ ,  $\text{NO}_2$ ) 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.  $\text{O}_3$  irritates the eyes and respiratory system. Sources of  $\text{O}_3$  in occupied areas include infiltration from outside occupied areas, and from equipment which utilizes ultra-violet light or causes ionization of air.

Respirable Suspended Particles ( $\text{PM}_{10}$ ) are suspended airborne particles with a nominal aerodynamic diameter of 10  $\mu\text{m}$  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, so sampling should be carried out at one representative zone in each type of premises.

<b>6</b>	<b>IEQ</b>	<b>6.3 INDOOR AIR QUALITY</b>
		<b>IEQ 8 INDOOR SOURCES OF AIR POLLUTION</b>
	<b>EXCLUSIONS</b>	Items a) & b) are excluded for buildings that are designed for natural ventilation or using de-centralised a/c system.
	<b>OBJECTIVE</b>	Demonstrate that airborne contaminants, predominantly from inside sources, do not give rise to unacceptable levels of indoor air pollution in normally occupied spaces.
	<b>CREDITS ATTAINABLE</b>	3
	<b>PREREQUISITES</b>	Compliance with relevant chapters of the Occupational Safety and Health Ordinance.
	<b>CREDIT REQUIREMENT</b>	<p>a) Volatile organic compounds (VOCs)</p> <p>1 credit for demonstrating compliance with the appropriate criteria for VOCs.</p> <p>b) Formaldehyde (HCHO)</p> <p>1 credit for demonstrating compliance with the appropriate criteria for formaldehyde.</p> <p>c) Radon (Rn)</p> <p>1 credit for demonstrating compliance with the appropriate criteria for radon.</p>
	<b>ASSESSMENT</b>	<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 premises 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 Guide. For other occupied areas and habitable rooms the criteria can be that defined in the Guide, 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 radon 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 8.6. Any other protocol demonstrated to be of equal rigour appropriate to the nature of the premises surveyed would be acceptable.</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.



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 background ventilation mode, or where there is no specific provision for background ventilation, with all windows and doors closed.

Where access to premises is limited, e.g. due to the presence of tenants, the onus shall be on the Client to demonstrate that measurements in those areas that are accessible are representative of the building as a whole.

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, the relevant credit(s) shall be awarded.

Where certification under the IAQ Certification scheme is current and covers all parts of the building for which BEAM certification is being sought then the credits shall be awarded.

## **BACKGROUND**

This section deals with pollutants found in indoor air which are mainly attributable to indoor sources, but excluding those from occupants or their activities. 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'.

Volatile Organic Compounds (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 sensitising 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.

Formaldehyde is a type of volatile organic compound which is separately identified due to its abundance in many building materials, adhesives, fabrics and carpets, etc. Formaldehyde is a suspected human carcinogen, and in sufficiently high concentrations is known to cause eye, nose and respiratory irritation and sensitisation. 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.

Radon is a colourless radioactive gas that exhibits no taste or smell. There is concern that exposure to elevated levels of radon indoors increases the risk of lung cancer. Radon is mainly emitted from granite and marble which are major building materials in Hong Kong. The concentration of radon 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 radon infiltration is minimal. Radon and its progenies are mainly generated indoors.

<b>6</b>	<b>IEQ</b>	<b>6.3 INDOOR AIR QUALITY</b>
		<b>IEQ 9 IAQ IN CAR PARKS</b>
	<b>EXCLUSIONS</b>	Buildings not provided with enclosed or semi-enclosed car parks.
	<b>OBJECTIVE</b>	Meet the minimum requirements of performance in respect of air quality.
	<b>CREDITS ATTAINABLE</b>	1
	<b>PREREQUISITES</b>	Compliance with relevant chapters of the Occupational Safety and Health Ordinance.
	<b>CREDIT REQUIREMENT</b>	1 credit for demonstrating compliance with the air quality criteria specified in ProPECC PN 2/96.
	<b>ASSESSMENT</b>	<p>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.</p> <p>Alternatively, compliance may be demonstrated by a series of measurements taken at appropriate locations during peak periods of use. Locations shall include main vehicular routes and main pedestrian areas. Where it can be demonstrated that monitoring systems and ventilation systems are able to respond to maintain the target pollutants within the prescribed limits of PN 2/96 the credit shall be awarded.</p>
	<b>BACKGROUND</b>	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. [http://www.epd.gov.hk/epd/english/resources\\_pub/publications/files/pn96\\_2.pdf](http://www.epd.gov.hk/epd/english/resources_pub/publications/files/pn96_2.pdf)

**6 IEQ**

**6.4 VENTILATION**

**IEQ 10 INCREASED VENTILATION**

<b>EXCLUSIONS</b>	Residential and similar buildings without central air conditioning.
<b>OBJECTIVE</b>	Ensure that ventilation systems provide for effective delivery to support the well being and comfort of occupants in normally occupied spaces.
<b>CREDITS ATTAINABLE</b>	1
<b>PREREQUISITES</b>	Compliance with CAP 123J Building (Ventilating Systems) Regulations.
<b>CREDIT REQUIREMENT</b>	1 credit for demonstrating an outdoor ventilation rate that exceeds ASHRAE 62.1:2007 [1] requirements by at least 30%.
<b>ASSESSMENT</b>	<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> <p>Calculations should be based on the following table.</p>

Spaces Identification <sup>(1)</sup>	Space Type <sup>(2)</sup>	Occupant Density People/sq. m	Ventilation Rate/Person L/s	Rate/m <sup>2</sup> L/s	Zone Air Distribution Effectiveness <sup>(3)</sup>	System Ventilation Efficiency <sup>(4)</sup>	Class of Air <sup>(5)</sup>
<p>1: List number or name of each ventilation zone, such as office number or name, retail space name, classroom number, etc</p> <p>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.</p> <p>3: ASHRAE 62.1: 2007 Table 6-2 (Zone Air Distribution Effectiveness)</p> <p>4: ASHRAE 62.1: 2007 Table 6-3 (System Ventilation Efficiency) or Appendix A</p> <p>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.

<b>BACKGROUND</b>	<p>The purpose of this credit is to demonstrate the potential for improving indoor air quality through increased outdoor ventilation.</p> <p>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</p>
-------------------	--

- 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.

and occupant well being. As an example, consider a typical Hong Kong Office of 1000 m<sup>2</sup> and an occupant density of 9 m<sup>2</sup> 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 CO<sub>2</sub> sensors in conjunction with the BMS to affect Demand Control Ventilation (DCV).

<b>6</b>	<b>IEQ</b>	<b>6.4 VENTILATION</b>
		<b>IEQ 11 BACKGROUND VENTILATION</b>
	<b>EXCLUSIONS</b>	Buildings not designed to utilize natural ventilation.
	<b>OBJECTIVE</b>	Ensure that normally occupied premises designed to utilize natural ventilation are provided with a minimum of background ventilation to control indoor air pollutants.
	<b>CREDITS ATTAINABLE</b>	1
	<b>PREREQUISITES</b>	Compliance with the Building (Planning) Regulations (B(P)Reg.) 30, 31 and 32.
	<b>CREDIT REQUIREMENT</b>	1 credit where it can be demonstrated that adequate ventilation is achieved by natural means.
	<b>ASSESSMENT</b>	<p>The Client shall provide evidence in the 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). Compliance should be demonstrated using any suitably verified or scientifically validated method, for example a tracer gas decay test [1].</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>
	<b>BACKGROUND</b>	<p>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 seeks to encourage designs that provide for adequate background ventilation by natural means.</p> <p>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 minimize 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 [2]. Local research on residential buildings suggests that 0.5 to 1 ACH would be sufficient to maintain radon below the target level 3.</p>

- 1 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.
- 2 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>
- 3 Chao C Y H, Tung T C W, Burnett J. Influence of ventilation on indoor radon level. Building and Environment. Vol. 32, No. 6. pp 527-534. 1997.

For domestic buildings the Building Authority (BA) advises the following performance criteria for the provision of natural ventilation in habitable rooms [4]:

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

4 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>

<b>6</b>	<b>IEQ</b>	<b>6.4 VENTILATION</b>
		<b>IEQ 12 LOCALISED VENTILATION</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Prevent exposure of building occupants to concentrated indoor sources of pollutants.
	<b>CREDITS ATTAINABLE</b>	1
	<b>PREREQUISITES</b>	Compliance with CAP 123J Building (Ventilating Systems) Regulations.
	<b>CREDIT REQUIREMENT</b>	1 credit for the provision of an adequate ventilation system for rooms/areas where significant indoor pollution sources are generated.
	<b>ASSESSMENT</b>	The Client shall provide evidence in the form of a report prepared by a suitably qualified person detailing the design criteria that have been adopted and details of the ventilation system providing for 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>BACKGROUND</b>	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. In other buildings local exhaust is intended to remove contaminants from specific rooms such as kitchens, in which concentrated sources are expected.
	<b>DOMESTIC KITCHENS</b>	<p>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.</p> <p>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.</p>

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.

**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**

Where mechanical ventilation in the 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 [4]. 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 minimize the build-up of negative pressure if an extractor fan is provided for ventilation.

**REFUSE AREAS**

Exhaust from refuse storage areas and material recovery centres (RS & MRC) should follow the principles of PNAP No. APP-35 [5]. 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 are no odour problems 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 with 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.

**CHIMNEYS AND FLUES**

The siting and height of chimneys and flues should follow PNAP No. APP-8 [6]. In particular, chimneys and flues should be situated so that products of combustion cannot enter windows, ventilation openings, supply air intakes.

- 3 Singapore Standard SS CP13. Code of Practice for Mechanical Ventilation and Air Conditioning in Buildings.
- 4 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>
- 5 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>
- 6 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>



<b>6</b>	<b>IEQ</b>	<b>6.4 VENTILATION</b>
		<b>IEQ 13 VENTILATION IN COMMON AREAS</b>
	<b>EXCLUSIONS</b>	Spaces covered under the section on IEQ 12 Localised Ventilation.
	<b>OBJECTIVE</b>	Ensure adequate ventilation in common areas and circulation routes within premises and to avoid cross-contamination between areas.
	<b>CREDITS ATTAINABLE</b>	1 + 1 BONUS
	<b>PREREQUISITES</b>	Compliance with applicable regulations covering ventilation provisions in buildings.
	<b>CREDIT REQUIREMENT</b>	<p>a) Ventilation by any means</p> <p>1 credit for demonstrating that all enclosed common areas in a building are provided with adequate ventilation.</p> <p>b) Use of natural ventilation</p> <p>1 BONUS credit where the provision for ventilation is by natural means.</p>
	<b>ASSESSMENT</b>	<p>The Client shall provide evidence in the form of a report prepared by a suitably qualified person detailing the performance criteria that have been adopted for each type of common area included in the building, and the results of 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</p> <p>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</p> <p>Where natural ventilation is employed it shall demonstrated that the ventilation rate (ACH of higher than 0.5) specified 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. In the case of naturally ventilated spaces, measurements should be made under conditions when windows are closed and purpose designed ventilators are open.</p> <p>Compliance is conditional that outside air brought in to 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>

- 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 62-2001. Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating and Air Conditioning Engineers. Atlanta, 2001.
- 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

## BACKGROUND

Building owners should consider the provision of ventilation to common areas, such as corridors, lift lobbies, entrance lobbies, etc. [4]. 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.

4 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>

<b>6</b>	<b>IEQ</b>	<b>6.5 THERMAL COMFORT</b>
		<b>IEQ 14 THERMAL COMFORT IN AIR-CONDITIONED PREMISES</b>
	<b>EXCLUSIONS</b>	Premises where air-conditioning is provided by window units or split units.
	<b>OBJECTIVE</b>	Ensure that the air-conditioning system can provide the stated design conditions in occupied spaces under changing load conditions.
	<b>CREDITS ATTAINABLE</b>	2
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENT</b>	<p>a) Temperature</p> <p>1 credit for sustaining the air temperature at the design value within <math>\pm 1.5^{\circ}\text{C}</math> when the air side system is operating at steady state under normal occupied periods.</p> <p>b) Room air distribution</p> <p>1 credit where room air diffusers satisfy the Air Diffusion Performance Index.</p>
	<b>ASSESSMENT</b>	<p>The Client shall provide evidence in the form of a report prepared by a suitably qualified person detailing the performance 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.</p> <p>a) Temperature</p> <p>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 in 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 55-1992 [1], ISO 7726 [2] or equivalent.</p> <p>Where certification under the IAQ Certification scheme [3] is current and covers all parts of the building for which BEAM certification is being sought then the credit shall be awarded.</p> <p>b) Room air distribution</p> <p>The measurement locations shall be as for a). It is acceptable to demonstrate the credit compliance by either calculation or by in-situ measurement.</p>
	<b>BACKGROUND</b>	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 55-1992: Thermal Environmental Conditions for Human Occupancy. Atlanta 1992.
- 2 International Standard Organization. International standard 7726, Ergonomics of the thermal environment — Instruments for measuring physical quantities. 1998.
- 3 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>

<b>6</b>	<b>IEQ</b>	<b>6.5 THERMAL COMFORT</b>
		<b>IEQ 15 THERMAL COMFORT IN NATURALLY VENTILATED PREMISES</b>
	<b>EXCLUSIONS</b>	Buildings that are not designed to utilize natural ventilation.
	<b>OBJECTIVE</b>	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.
	<b>CREDITS ATTAINABLE</b>	2
	<b>PREREQUISITES</b>	None
	<b>CREDIT REQUIREMENT</b>	<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>b) Performance with air-conditioning</p> <p>1 credit for sustaining the air temperature at the design value within <math>\pm 1.5^{\circ}\text{C}</math> when the air-conditioning unit is operating at steady state under normal occupied periods.</p>
	<b>ASSESSMENT</b>	<p>a) Performance with natural ventilation</p> <p>The assessment will seek to establish the extent to which the building envelope mitigates the effects of external heat gains. The 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, monthly, mean temperature or highest solar gain, whichever is highest 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. 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>Compliance may be demonstrated under appropriate summer conditions through the measurement of temperature in suitable locations in a sample of premises most exposed to external heat gains.</p> <p>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 details of measuring equipment, sampling locations, sampling time, time of measurements, external temperature and prevailing weather conditions.</p> <p>Where it can be demonstrated that the indoor temperature lies within the 80% acceptability limits given in ASHRAE 55-2004 a credit shall be awarded.</p> <p>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.</p>

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

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 normally 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. 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 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. Allowable indoor operative temperatures for spaces that meet these criteria may be determined from Figure 5.3 in ASHRAE 55-2004. This figure includes two sets of operative temperature limits—one for 80% acceptability and one for 90% acceptability. 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

- 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.

standard. Consequently, for the BEAM assessment, months for which the mean monthly outdoor temperatures are outside these limits can be discounted.

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%.

<b>6</b>	<b>IEQ</b>	<b>6.6 LIGHTING QUALITY</b>
		<b>IEQ 16 NATURAL LIGHTING</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Maximize access to daylight for the purposes of improved health and comfort.
	<b>CREDITS ATTAINABLE</b>	2
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENT</b>	<p>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%.</p> <p>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%.</p>
	<b>ASSESSMENT</b>	<p>The Client shall submit evidence in the 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 the following methods.</p> <p>Measurement of average daylight factor (DF) shall be by the methods recommended by CIBSE [1], or equal 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>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 Hong Kong, surrounding buildings shall be included in the model.</p>
	<b>BACKGROUND</b>	<p>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:</p> <ul style="list-style-type: none"> <li>• window and room geometry and room surface finishes;</li> <li>• sky obstruction due to the form of the building and its overshadowing from neighbouring buildings;</li> <li>• glazing transmittance.</li> </ul> <p>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.</p> <p>A typical overcast sky condition in Hong Kong provides 5000 to 10000 lux, so a 1% average DF is an average of 50 to 100 lux in the space.</p>

1 The Chartered Institution of Building Services Engineers. Applications Manual – Window design.

<b>6</b>	<b>IEQ</b>	<b>6.6 LIGHTING QUALITY</b>
		<b>IEQ 17 INTERIOR LIGHTING IN NORMALLY OCCUPIED AREAS</b>
	<b>EXCLUSIONS</b>	Residential buildings, hotels and apartment buildings.
	<b>OBJECTIVE</b>	Ensure the adequacy and maintenance of visual comfort conditions achieved by the electric lighting provisions in occupied spaces.
	<b>CREDITS ATTAINABLE</b>	1 + 1 BONUS
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENT</b>	<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"> <li>(i) prescribed lighting performance in respect of maintained illuminance and illuminance variation; and</li> <li>(ii) the limiting unified glare rating is achieved and light sources have an appropriate colour rendering index.</li> </ul> <p>1 BONUS credit for providing automatic control of artificial lighting such as daylight sensors at perimeter zones and/or occupancy sensors.</p>
	<b>ASSESSMENT</b>	<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 by measurements using a standardised measurement protocol appropriate to the parameter being assessed. Demonstration of compliance requires that the maintained illuminance take into account 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 not fitted-out, the technical details of the proposed lighting systems for each type of normally occupied space within the building. 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 are deemed to meet the assessment criteria.</p> <p>The Client shall submit a report prepared by a suitably qualified person detailing the automatic control of artificial lighting such as daylight</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. 9<sup>th</sup> edition., New York.
- 5 Commission Internationale de l'Eclairage (CIE). Maintenance of indoor electric lighting systems. CIE Technical Report - Publication No. 97. Vienna.



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'.

**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.

**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

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.

lighting quality throughout the whole life of the lighting installation.

<b>6</b>	<b>IEQ</b>	<b>6.6 LIGHTING QUALITY</b>
		<b>IEQ 18 INTERIOR LIGHTING IN AREAS NOT NORMALLY OCCUPIED</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Ensure the adequacy of artificial lighting provisions in common areas and service areas such as plant rooms.
	<b>CREDITS ATTAINABLE</b>	1
	<b>PREREQUISITES</b>	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.
	<b>CREDIT REQUIREMENT</b>	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.
	<b>ASSESSMENT</b>	<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 equal.</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>
	<b>BACKGROUND</b>	<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 IEQ17 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 19 ROOM ACOUSTICS

<b>EXCLUSIONS</b>	Buildings/premises where speech intelligibility is not important, and rooms of a special acoustical nature.
<b>OBJECTIVE</b>	Improve the acoustical properties of rooms in which speech intelligibility is important.
<b>CREDITS ATTAINABLE</b>	1
<b>PREREQUISITES</b>	None.
<b>CREDIT REQUIREMENT</b>	<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 five 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>
<b>ASSESSMENT</b>	<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 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. Mid-frequencies refer to 500Hz, 1kHz and 2kHz. The internal noise sources shall 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 they 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 demonstrate 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>

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.

**PERFORMANCE CRITERIA a) Office type premises**

The reverberation time of A-weighted sound pressure level, in modular (private) offices and conference rooms, shall be 0.6 s or below. The 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 NC35.

**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 NC30.

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.

**d) Indoor games halls & indoor swimming pools etc**

The reverberation time of A-weighted sound pressure level, in door game halls, indoor swimming pools or other recreations premises, shall be 2.0s or below. The noise assessment criterion shall be NC45.

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 how quickly sound decays 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, there is reasonable agreement that other types of measurements are needed for a more 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.

<b>6</b>	<b>IEQ</b>	<b>6.7 ACOUSTICS AND NOISE</b>
		<b>IEQ 20 NOISE ISOLATION</b>
	<b>EXCLUSIONS</b>	Buildings/premises which are inherently noisy and unaffected by noise from adjacent premises/spaces.
	<b>OBJECTIVE</b>	Improve the noise isolation of normally occupied premises/rooms to reduce impact of unwanted noise.
	<b>CREDITS ATTAINABLE</b>	1 + 1 BONUS
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENT</b>	<p>1 credit for demonstrating airborne 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>
	<b>ASSESSMENT</b>	<p>As there are a 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 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) meets 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 equal 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 equal equivalent.

Similar considerations shall apply to the measurement of impact noise isolation, following the methods given in either ISO [5], ASTM [6] or equal 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 through floors, which are not addressed under the local Building Regulations, but have been a matter

- 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).

for 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.



<b>6</b>	<b>IEQ</b>	<b>6.7 ACOUSTICS AND NOISE</b>
		<b>IEQ 21 BACKGROUND NOISE</b>
	<b>EXCLUSIONS</b>	Buildings/premises in which speech intelligibility is not important.
	<b>OBJECTIVE</b>	Control as far as practicable the background noise in premises at levels appropriate to the intended use of the premises.
	<b>CREDITS ATTAINABLE</b>	1
	<b>PREREQUISITES</b>	None.
	<b>CREDIT REQUIREMENT</b>	<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>
	<b>ASSESSMENT</b>	<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 is 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 non-residential buildings, the assessment shall take into account noise from building services equipment while for residential premises, the assessment shall only consider the external noise sources (e.g. road traffic, etc).</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 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 measured or calculated for the most susceptible spaces/rooms/premises,</p>

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

meets appropriate performance criteria the credit shall be awarded.

#### ASSESSMENT CRITERIA

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

#### b) Classrooms

Background noise shall be below 45dB  $L_{Amax}$  in schools in urban areas, otherwise at or below 40dB  $L_{Amax}$ , 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 30dB  $L_{Aeq,T}=8 hr$ , or 35dB  $L_{Aeq,T}=5min$ , and < 45 dB between 23:00 to 07:00.
- In habitable rooms (other than kitchens) under closed window conditions < 55dB  $L_{Aeq,T}=16 hr$  between 07:00 to 23:00.

#### d) Indoor games halls & indoor swimming pool etc

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

Tables 5 and 6 of BS 8233 [2] gives 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. 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 [5], and for planning residential developments against road traffic noise [6]. The Environmental Protection Department also provides guidelines on practical noise control measures for ventilation systems [7], and for pumping systems [8].

- 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 Environmental Protection Department. Practice Note for Professional Persons. ProPECC PN 4/93. Planning and Designing Noise Sensitive Developments. [http://www.epd.gov.hk/epd/english/resources\\_pub/publications/files/pn93\\_4.pdf](http://www.epd.gov.hk/epd/english/resources_pub/publications/files/pn93_4.pdf)
- 6 Environmental Protection Department. Practice Note for Professional Persons. ProPECC PN 1/97. Streamlined Approach for the Planning of Residential Developments Against Road Traffic Noise. [http://www.epd.gov.hk/epd/english/resources\\_pub/publications/files/pn97\\_1.pdf](http://www.epd.gov.hk/epd/english/resources_pub/publications/files/pn97_1.pdf)
- 7 Environmental Protection Department. Good Practices on Ventilation System Noise Control. [http://www.epd.gov.hk/epd/english/environmentinhk/noise/guide\\_ref/files/pump\\_sys.pdf](http://www.epd.gov.hk/epd/english/environmentinhk/noise/guide_ref/files/pump_sys.pdf)
- 8 Environmental Protection Department. Good Practices on Pumping System Noise Control. [http://www.epd.gov.hk/epd/english/environmentinhk/noise/guide\\_ref/files/vent\\_sys.pdf](http://www.epd.gov.hk/epd/english/environmentinhk/noise/guide_ref/files/vent_sys.pdf)

<b>6</b>	<b>IEQ</b>	<b>6.8 BUILDING AMENITIES</b>
		<b>IEQ 22 ACCESS FOR PERSONS WITH DISABILITY</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Ensure full access to pertinent building facilities for persons with disability.
	<b>CREDITS ATTAINABLE</b>	1
	<b>PREREQUISITES</b>	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 [1].
	<b>CREDIT REQUIREMENT</b>	1 credit for providing at least 3 enhanced provisions
	<b>ASSESSMENT</b>	The Client shall provide evidence of the investigation in the 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 [2]
	<b>BACKGROUND</b>	<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 intended 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>

1 Code of Practice for Barrier Free Access. [http://www.info.gov.hk/bd/english/documents/code/e\\_bfa.htm](http://www.info.gov.hk/bd/english/documents/code/e_bfa.htm)

2 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)

<b>6</b>	<b>IEQ</b>	<b>6.8 BUILDING AMENITIES</b>
		<b>IEQ 23 AMENITY FEATURES</b>
	<b>EXCLUSIONS</b>	None.
	<b>OBJECTIVE</b>	Improve the standard and quality of buildings.
	<b>CREDITS ATTAINABLE</b>	2
	<b>PREREQUISITES</b>	Compliance with the Building Regulations.
	<b>CREDIT REQUIREMENT</b>	<p>1 credit for providing 50% of listed amenity features that enhance the quality and functionality of a building.</p> <p>2 credits for providing 75% of listed amenity features.</p>
	<b>ASSESSMENT</b>	<p>With reference to the checklist below and the cited documents the Client shall submit details of the amenities provided in the building. The onus is on the Client to demonstrate that the provisions meet one or a combination of the following objectives :</p> <ul style="list-style-type: none"> <li>• provide efficient and effective building management, operation and maintenance;</li> <li>• enhance the living and/or working experience of building users; and</li> <li>• improve the environmental and social compatibility with the neighbourhood.</li> </ul> <p>Where it can be demonstrated that the building, appropriate to its size, type and use, provides 50% or more of the amenities to the appropriate standard, a credit shall be awarded. Where 75% are provided to the appropriate standard, the second credit is awarded.</p> <p>In this context, the standard refers to the criteria given in the cited documents, including dimensional information where this is provided. Alternatively, the Client is free to argue for the use of alternative criteria, provided they meet the objectives.</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>
	<b>CHECKLIST</b>	<p>The amenity features identified [1] includes:</p> <ul style="list-style-type: none"> <li>• provisions for air-conditioning installations;</li> <li>• security gates;</li> <li>• counters, kiosks, offices, stores, guard rooms, lavatories for building management staff;</li> <li>• logistics service room;</li> <li>• mail room;</li> <li>• horizontal screens;</li> <li>• recreational facilities; and</li> <li>• satellite dishes.</li> </ul> <p>Listed under the incentives for 'green and innovative building [2]:</p>

1 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>

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>

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

In addition [3]:

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

Other features include:

- land or area within a building for use as public passage [4];
- space within the site for recreational use by neighbours and/or visitors [5, 6];
- prestige entrances such as large voids in front of cinema and theatre balconies, in banking halls and shopping arcades, entrance lobbies, etc [7];
- air-conditioning plant rooms with 1% or more of the total floor area of a building, air handling units with 4% or more of the GFA of each floor;
- enhanced standards of lift services [8]; and
- communications systems [9].

Projects such as wall boxes or platforms, window cills, flower boxes, etc., of prescribed dimensions [10].

Canopies, balconies, air-conditioner platforms, etc., need to be properly designed and constructed [11].

## BACKGROUND

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. 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 [2].

- 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-108 Dedication of Land/Area for Use as Public Passage. <http://www.bd.gov.hk/english/documents/pnap/APP/APP108.pdf>
- 5 Lands Administration Office, Lands Department. Practice Note 4/2000. Recreational Facilities in Domestic Development.
- 6 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. APP-104 Exclusion of Floor Areas for Recreational Use. <http://www.bd.gov.hk/english/documents/pnap/APP/APP104.pdf>
- 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) Regulations 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-89 Provision of better lift service. <http://www.bd.gov.hk/english/documents/pnap/APP/APP089.pdf>
- 9 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>
- 10 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>
- 11 Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers, PNAP No. APP-68 Design and Construction of Cantilevered Projecting Structures. <http://www.bd.gov.hk/english/documents/pnap/APP/APP068.pdf>

<b>7</b>	<b>INNOVATIONS AND ADDITIONS</b>	<b>IA 1 INNOVATIVE TECHNIQUES</b> <b>IA 2 PERFORMANCE ENHANCEMENTS</b> <b>IA 3 BEAM PROFESSIONAL</b>
	<b>INTRODUCTION</b>	<p>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.</p>
	<b>CREDITS</b>	<p>Maximum 5 BONUS credits + 1 credit for BEAM Professional</p>
<b>IA 1</b>	<b>INNOVATIVE TECHNIQUES</b>	<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>
	<b>OBJECTIVE</b>	<p>Encourage adoption of practices, new technologies and techniques that have yet to find application in Hong Kong.</p>
	<b>ASSESSMENT</b>	<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>
<b>IA 2</b>	<b>PERFORMANCE ENHANCEMENTS</b>	<p>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.</p>
	<b>OBJECTIVE</b>	<p>Encourage adoption of practices, technologies and techniques that provide for performance enhancements over and above stated performance criteria in BEAM Plus for New Buildings.</p>
	<b>ASSESSMENT</b>	<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>

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 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.

<b>8</b>	<b>APPENDICES</b>	<b>8.1</b>	<b>ANNUAL ENERGY USE</b>
		<b>8.2</b>	<b>BASELINE BUILDING MODEL</b>
		<b>8.3</b>	<b>EQUIVALENT CARBON DIOXIDE EMISSIONS</b>
		<b>8.4</b>	<b>INSTALLATION OF AIR-CONDITIONERS</b>
		<b>8.5</b>	<b>ASSUMPTIONS AND BASELINES FOR WATER CONSUMPTION</b>
		<b>8.6</b>	<b>SAMPLING PROTOCOL FOR INDOOR AIR QUALITY ASSESSMENTS</b>



## **8.1 ANNUAL ENERGY USE**

### **8.1.1 ASSESSMENT FRAMEWORK**

#### **8.1.2 PERFORMANCE-BASED APPROACH**

#### **8.1.3 PREREQUISITES**

#### **8.1.4 SIMULATION REQUIREMENTS**

#### **8.1.5 ASHRAE APPROACH**

#### **8.1.6 EXCEPTIONAL CALCULATION METHOD**

### **8.1.1 ASSESSMENT FRAMEWORK**

The assessment framework described in this Appendix embraces all types of existing buildings and complexes, including commercial, hotel, school and other types of buildings with or without air-conditioning. Buildings comprising predominantly air-conditioned premises and those comprising predominantly non-air-conditioned premises will be assessed following different procedures, with the former assessed somewhat more rigorously than the latter. This is because air-conditioning is the dominant energy end-use in modern buildings in Hong Kong and hence it is crucial to ensure the air-conditioning installations are energy efficient.

The assessment of the energy performance of a building development comprises three parts. The first part of the assessment is on the in-use energy performance, which includes a comparison of the energy use of the building against a predicted/calculated annual energy use benchmark that is dependent on the 'as-built' characteristics of the building, the types of premises it houses and the range and operational characteristics of services systems required to meet the functional needs of the premises. Where a mix of fuel is used in the same building, e.g. a hotel, the assessment is based on the incurred CO<sub>2</sub> emission due to energy use.

The assessment will be based, as far as practicable, on metered energy use in buildings. Variations in the assessment method also exist between multi-tenanted and single-user buildings, due to the different energy use metering arrangements involved. Since the energy use data required for the assessment can be made available from a thorough energy audit, having an energy audit completed right before the assessment is highly preferred.

Included in the second part are assessments of relevant features specific to individual types of buildings, which are based either on component-performance or feature specific criteria. Also included in this part is renewable energy use in buildings, such as the use of solar panels for water heating and photovoltaic panels, fuel cells and wind turbines for electricity generation. Considering that renewable energy application in buildings in Hong Kong is still in its infancy and most methods remain economically non-viable and require a quantum jump in product efficiency and/or a large drop in price to change the situation, the relevant credits will be awarded as bonus credits so as to encourage wider application of renewable energy, without diminishing the scores for buildings that have not incorporated such measures. The third part covers provisions that facilitate energy efficient operation and maintenance.

### **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 Clients the greatest flexibility in achieving the energy performance targets for their buildings, the assessment will be based primarily on the 'energy budget approach', supplemented by a range of basic requirements. The key features of the assessment framework developed for assessing air-conditioned buildings are as described below.

The 'energy budget' for an assessed building development is the zero-

credit annual energy use benchmark, which will be determined on an individual building basis taking into account the specific characteristics of the building, particularly those that will be difficult or impossible to change even if the landlord is willing to invest in energy efficiency improvement measures (which is a constraint to existing buildings). This is intended to make allowance in the assessment outcome for buildings possessing unfavourable features (e.g. a west facing facade), which are impractical to rectify, and to encourage landlords to concentrate on areas where improvements are possible.

The zero-credit benchmark will be determined from the predicted annual energy use of a Baseline Building model, which would have the same shape, dimensions, and envelope characteristics, would comprise the same mix of areas for the same range of types of premises, and would have the same types of major services systems, including the cooling medium and the type of system used for condenser heat rejection, as the Assessed Building.

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 should 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 efficiencies]* And/or,
- (b) A better OTTV, on condition that the energy reduction (as a result of better OTTV) counted towards the reduction should 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.

Since the building facade design is considered as difficult to change for an existing building, the envelope characteristics of the baseline building model for assessing an existing building will be basically same as the “as-built” characteristics of the assessed building. Therefore the OTTV is

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

assumed same for existing building and assessed building. For the purpose of quantifying energy reduction as a result of efficient design towards demonstration of compliance to this credit, the acceptable reduction measures can be:

- (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) Having recovered energy or renewable energy captured or generated on site
- (c) 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 8.1.4 - ASHRAE Approach (see below)
- (d) 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, CO<sub>2</sub> occupancy), dimming devices. (see below)
- (e) Reduction in equipment/process loads, where sufficient evidence is given to support the savings over common practices
- (f) 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 should 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 should be modeled identically for both the reference building and designed building.”

For the purpose of assessment of this credit, the baseline building should 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 should be identical to the designed building; and the system and equipment of the reference building should exactly meet the relevant requirements in Section 6 of the BEC.”

For the purpose of assessment of this credit, the baseline air-conditioning should have identical zoning to the designed building, but should 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 should 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

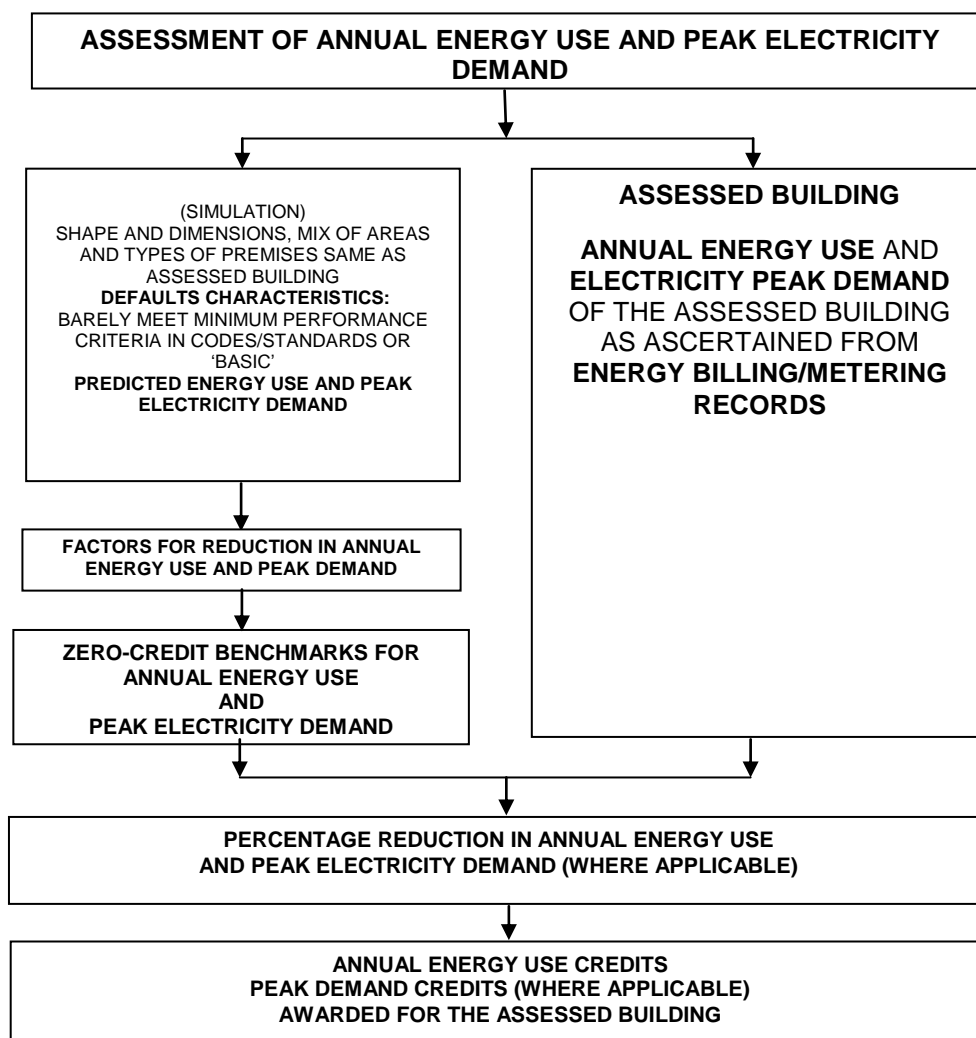


Figure 8.1 Building energy performance assessment

The zero-credit benchmark for the Assessed Building (the existing building) will equal 150% of the predicted annual energy use of the Baseline Building. The 50% margin is meant for making allowances for operating conditions that will inevitably arise which will cause more energy to be used, e.g. over-time air-conditioning provision for offices in an office/commercial building and deterioration in performance of the air-conditioning equipment, etc.

The annual energy use of the assessed building will be determined based on the records of energy use in the building, as given in available energy billing and audit data. For a single-user building (e.g. a government complex), the records will reflect the total energy use in the entire building. However, for a multi-tenanted building (e.g. a typical office/commercial building), individual tenants have their consumption separately metered and it is impossible to ask all tenants to provide their consumption records for the assessment. The assessment for multi-tenanted buildings, therefore, will be limited to the consumption of the landlord. However, where there is air-handling equipment inside tenants' premises, which are supplied with electricity from the tenants' meters, the annual energy use of such air-handling equipment will be estimated and added to the landlord's consumption. The zero-credit energy use benchmark will also take this into account.

Besides the annual energy use, the assessment of the energy performance of a building includes, where applicable, an assessment of its peak electricity demand. This will be undertaken in a way similar to the energy use assessment. The zero-credit benchmark for peak electricity demand will be 125% of that of the Baseline Building model. Credits for this assessment will be determined with reference to the factor of reduction in the peak electricity demand of the Assessed Building relative to that of the Baseline Building model. Note that this part of the assessment will apply only to those buildings where electricity charges are based either on the Bulk Tariff, Large Power Tariff or Maximum Demand Tariff. Buildings not using one of these tariff will not be assessed for peak electricity demand under this approach, due to lack of reliable data.

The characteristics to be incorporated into the Baseline Building model, including the indoor design conditions, ventilation rates, occupation density and patterns, internal load intensities and patterns, and performance of air-conditioning equipment are to be as described in Section 8.2.

The energy use and peak electricity demand of installations and equipment other than the air-conditioning installations will be predicted based on the installed power, the operating hours and the pattern of use for each type of installations. The assessment will be based on the sum of the energy use, and the peak electricity demand, of the air-conditioning and other installations. Here, the assumption is made that the air-conditioning energy use is the dominant time-varying load whilst the energy use of other installations is relatively stable and may be regarded as a steady load.

### 8.1.3 PREREQUISITES

A prerequisite for obtaining credits for Annual Energy Use under the Energy Budget approach is compliance with specific items in the HKSAR Government's energy efficiency codes, 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 <sup>(1)</sup> (clause no. 5.5 ) <sup>(2)</sup>

Air-conditioning installations, given in Section 6 of BEC

- System load calculation (clause no. 6.4 ) <sup>(2)</sup>
- Separate air distribution system for process zone (clause no. 6.5 ) <sup>(2)</sup>
- Air distribution ductwork leakage limit (clause no. 6.6 ) <sup>(2)</sup>
- Pumping system variable flow (clause no. 6.8 ) <sup>(2)</sup>
- Frictional loss of water piping system (clause no. 6.9 ) <sup>(2)</sup>
- System control (clause no. 6.10 ) <sup>(2)</sup>
- Thermal insulation (clause no. 6.11 ) <sup>(2)</sup>
- Energy metering (clause no. 6.13 ) <sup>(2)</sup>

Electrical installations, given in Section 7 of BEC

- Power distribution (clause no. 7.4 ) <sup>(2)</sup>
- Motor installation (clause no. 7.5 ) <sup>(2)</sup>
- Power quality (clause no. 7.6 ) <sup>(2)</sup>
- Metering and monitoring facilities (clause no. 7.7 ) <sup>(2)</sup>

Lift and escalator installations, given in Section 8 of BEC

- Electrical power (clause no. 8.4 ) <sup>(2)</sup>
- Utilization of power (clause no. 8.5 ) <sup>(2)</sup>
- Total harmonic distortion (clause no. 8.6 ) <sup>(2)</sup>
- Metering and monitoring facilities (clause no. 8.7 ) <sup>(2)</sup>

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

#### 8.1.4 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 should be targeted for the estimation of energy consumption in buildings in a comprehensive manner and should include calculation methodologies for the building components or systems being considered.

The required numerical method should include but not limit to the

2 Electrical and Mechanical Services Department. Code of Practice for Energy Efficiency of Building Services Installation [http://www.emsd.gov.hk/emsd/e\\_download/pee/BEC\\_2012.pdf](http://www.emsd.gov.hk/emsd/e_download/pee/BEC_2012.pdf)

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 should 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 should 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 should 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 should 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,

#### 8.1.5 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.

#### 8.1.6 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 CO<sub>2</sub> 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[3] and/or Section G2.5 of ASHRAE 90.1-2007[4] 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).

<b>8.2</b>	<b>BASELINE BUILDING MODEL</b>	<b>8.2.1</b>	<b>ENVELOPE CHARACTERISTICS</b>
		<b>8.2.2</b>	<b>INDOOR DESIGN CONDITIONS, OCCUPANCY DENSITIES, AND VENTILATION AND INFILTRATION RATES</b>
		<b>8.2.3</b>	<b>INTERNAL LOADS</b>
		<b>8.2.4</b>	<b>AIR-CONDITIONING SYSTEM DESIGN AND EQUIPMENT PERFORMANCE</b>

<b>8.2.1</b>	<b>ENVELOPE CHARACTERISTICS</b>	<p>Since the building facade design is considered as difficult to change for an existing building, the envelope characteristics of the baseline building model for assessing an existing building will be basically same as the “as-built” characteristics of the assessed building, except that features like overhangs and side-fins will be ignored for two reasons: i) for simplicity in establishing the zero-credit benchmark; and ii) to be consistent with the basis upon which the simplified models were established.</p>
<b>8.2.2</b>	<b>INDOOR DESIGN CONDITIONS, OCCUPANCY DENSITIES, AND VENTILATION AND INFILTRATION RATES</b>	<p>For building operation parameters, including Occupancy 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 [1] may be considered as a reference.</p> <p>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 that ON by hour of day. For details regarding time profile and occupant density, Section A3.5.2 (b) &amp; (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 that Air-conditioners will not be used in other months in the year.</p>
<b>8.2.3</b>	<b>INTERNAL LOADS</b>	<p>The lighting power intensities to be used for various types of premises in the Baseline Building model for an existing building 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 are used.</p> <p>The equipment power density shall be modelled as existing condition. The equipment power reduction in Assessed Building model must be documented by an exceptional calculation methods: the applicants must provide justification for assumptions used in both the Baseline Building model and the Assessed Building model, supported by following:</p> <ul style="list-style-type: none"> <li>• 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);</li> <li>• List of modifications that make new equipment more efficient;</li> <li>• Operation schedules for facility and equipment.</li> </ul>

1 Electrical and Mechanical Services Department - Code of Practice for Energy Efficiency of Building Services Installation 2012  
[http://www.emsd.gov.hk/emsd/e\\_download/pee/BEC\\_2012.pdf](http://www.emsd.gov.hk/emsd/e_download/pee/BEC_2012.pdf)



**TABLE 8.3 BASELINE BUILDING LIGHTING POWER DENSITY FOR VARIOUS PREMISES**

Type of Premises	Lighting power intensity
	(W/m <sup>2</sup> )
<b>Residential flat</b>	
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
<b>School</b>	
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 following lists the conversion factors to be used for this purpose:

<b>ELECTRICITY</b>	0.7 kg CO <sub>2</sub> per kWh electricity consumed [1]
<b>TOWN GAS</b>	0.592 kg CO <sub>2</sub> per unit of town gas consumed [1] (1 unit of town gas = 48 mega-joules consumed)
<b>NATURAL GAS</b>	2.31 kg CO <sub>2</sub> 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](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 should 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 should 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 should 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 8.6 and 8.7. Minimum dimensions specified in this table are as shown in Figures 8.2 and 8.3.

**TABLE 8.6      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 8.7	0.3	1.7	0.6

\*(ALL APPLICABLE TO THE OUTDOOR UNITS OF SPLIT-TYPE AIR-CONDITIONING UNITS EXCEPT DIMENSION J AND K)

**TABLE 8.7      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
D ≥ 10m	S ≤ 20	2.0	2.5
	20 < S ≤ 35	2.0	3.0
	35 < S ≤ 60	2.0	3.5

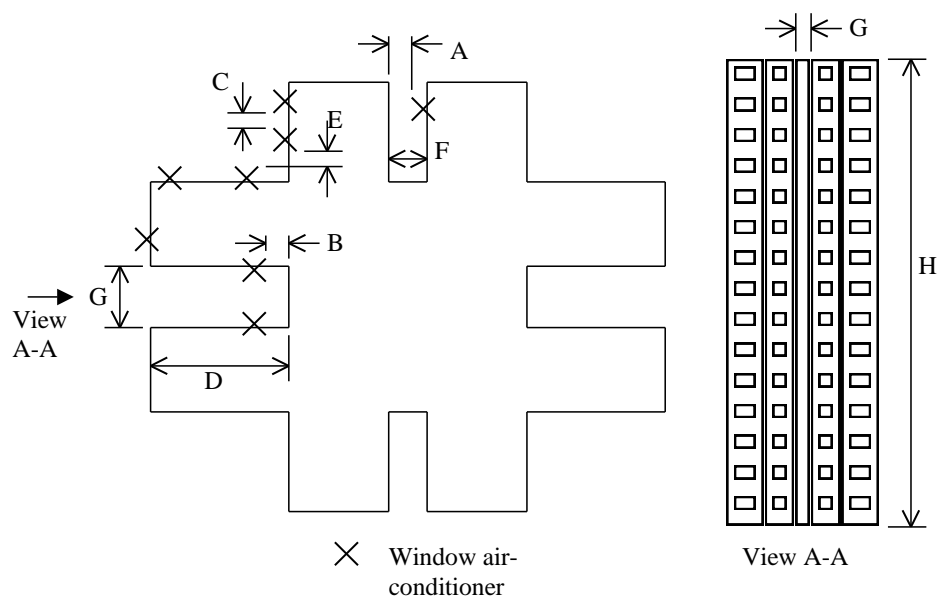


Figure 8.2 Layout plan and elevation of building

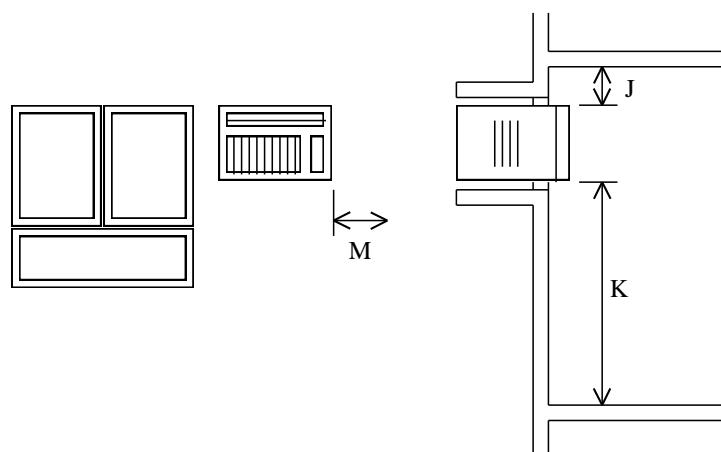


Figure 8.3 Elevation and section of a room in a residential building

**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 ASSUMPTIONS AND BASELINES FOR WATER CONSUMPTION

**NUMBER OF WORKING OR OPERATIONAL DAYS** The number of operational days per annum (Nop) should 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 should be taken as 9 m<sup>2</sup>/person. [1]

The male:female ratio should 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 should be read as an absolute figure irrespective of the working pressure in predicting the water consumption.

- 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. <http://www.bd.gov.hk/english/documents/pnap/ADV/ADV028.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>

**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 flushed after every use. Male employees each 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 should 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 base line 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.

## 8.6 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 should 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.