HK - BEAM

Version 5/03
Pilot
May 2003

HONG KONG BUILDING ENVIRONMENTAL ASSESSMENT METHOD

香港建築環境評估法

An Environmental Assessment for Existing Building Developments

HK-BEAM Society

HK-BEAM Society

HK-BEAM 5/03 (Existing Buildings)

An environmental assessment for existing building developments Version 5/03

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http://www. hkbeam.org.hk
http://www.bse.polyu.edu.hk/Research_Centre/BEP/hkbeam/main.html

Also available from BEC

HK-BEAM, Version 4/03
An Environmental Assessment for NewBuilding Developments

Further information on how to participate in the HK-BEAM schemes is available from:

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It is intended that this pilot version of HK-BEAM 5/03 be updated for full implementation in 2004.

1 HK BUILDING ENVIRONMENTAL ASSESSMENT METHOD

1.1 INTRODUCTION

The Hong Kong Building Environmental Assessment Method (HK-BEAM) is intended to provide authoritative guidance to all stakeholders in the building construction and real estate sectors on practices which reduce the adverse effects of buildings on the environment, whilst providing good quality built environments. It has been developed to set criteria for good environmental performance in building developments; performance that would be verified through independent assessment and acknowledged through an independently issued certificate. An assessment under the scheme is voluntary.

HK-BEAM defines good practice criteria for a range of environmental issues relating to the planning, design, construction, commissioning, management and 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.

This document describes HK-BEAM version 5/03 for existing building developments. Assessment under HK-BEAM 5/03 focuses on the management, operation and maintenance as well as the performance of a building, and may be carried out at any time during the life of a building. HK-BEAM 5/03 aims to reduce the environmental impacts of existing buildings using the best available techniques and within reasonable cost. It is not expected that a building development will meet all of the target requirements. However, by meeting some of the criteria the building will have less impact than one in which the requirements have not been met.

1.1.1 INTERNATIONAL CONTEXT

The HK-BEAM scheme was established in 1996 with the issue of two assessment methods, one for 'new'[(1)] and one for 'existing' office buildings[(2)], largely based on the UK Building Research Establishment's BREEAM[(3)]. Environmental issues were categorised under 'global', 'local' and 'indoor' impacts, respectively. In 1999 the 'office' versions[(4,5)] were re-issued with minor revisions and updated references, together with an entirely new assessment method for new high-rise residential buildings[(6)].

Both Version 4/03 covering 'new building developments' and Version 5/03 for 'existing building developments' represent significant upgrades to the previous HK-BEAM documents. Besides broadening the types of building developments that can be assessed these versions of HK-BEAM take into account recent developments, both locally and internationally, in respect of so-called 'green buildings' techniques and practices. In HK-BEAM 5/03 environmental aspects are grouped within a general framework similar to other schemes in use worldwide (Sections 2 to 7).

1.1.2 AIMS

HK-BEAM specifies criteria for a range of environmental aspects. Its main aims are:

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1 CET. HK-BEAM 1/96. An Environmental Assessment Method for New Air-conditioned Office Premises. ISBN 962-85076-2-1. 1996.

2 CET. HK-BEAM 2/96. An Environmental Assessment Method for New Air-conditioned Office Premises. ISBN 962-85076-4-8. 1996.

3 Prior J. J. Ed. BREEAM/New Offices Version 1/93: An environmental assessment for new office designs. Building Research Establishment Report. 2nd Ed. 1993.

4 CET. HK-BEAM 1/96R. An Environmental Assessment Method for New Air-conditioned Office Premises. ISBN 962-85076-2-1. 1999.

5 CET. HK-BEAM 2/96R. An Environmental Assessment Method for Existing Air-conditioned Office Premises. ISBN 962-85076-4-8. 1999.

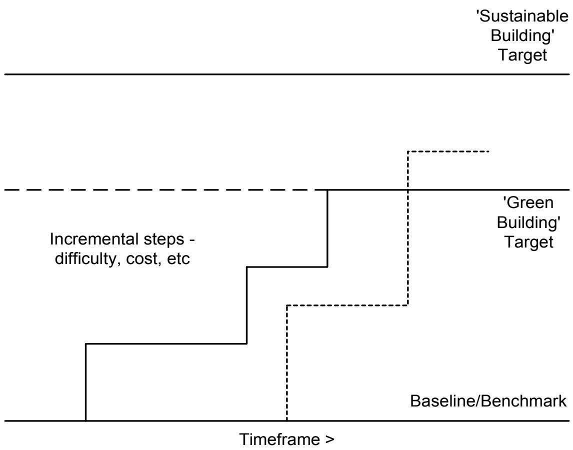
6 CET. HK-BEAM 3/99. An Environmental Assessment Method for New Residential Buildings. ISBN 962-85076-1-3. 1999.

(Ref. 4-6 available at http://www.bse.polyu.edu.hk/Research_Centre/BEP/hkbeam/main.html)

- to contribute to the development of buildings that are more sustainable;
- reduce the long-term impact that buildings have on the environment;
- raise awareness of the large contribution which buildings make to global warming, acid rain and depletion of the ozone layer;
- promote and encourage energy efficient buildings, systems and equipment;
- promote the use of renewable energy sources;
- reduce the unsustainable use of increasingly scarce resources such as water, timber, and natural materials;
- minimise pollution of the local environment;
- improve waste management and to encourage recycling and reuse;
- improve the quality of indoor environments and hence the health and well-being of the occupants;
- set targets and standards which are independently assessed and so help to minimise false claims or distortions;
- provide recognition for buildings where the environmental impact has been reduced; and
- enable developers, building operators and users to respond to demands for buildings that have less impact on the environment, and to help stimulate such a market.

1.2 ENVIRONMENTALLY SUSTAINABLE BUILDINGS

Responding to environmental priorities and to some extent social and economic issues, HK-BEAM strives to improve the environmental performance of buildings. 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 assessment, and the perceived benefits to Owner/Operators. The criteria included in HK-BEAM are considered to be realistic and attainable in practice. HK-BEAM is an instrument to enhance the 'greenness' of buildings.



Since the collective knowledge as to what constitutes an environmentally friendly building will continue to expand HK-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 an increasing number of stakeholders.

1.2.1 FRAMEWORK OF HK-BEAM 5/03

Building assessments should be performance based as far as possible. Assessment on the basis of prescriptive features would preclude building developments 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. The 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 consequent ratings. Assessment needs to take a holistic view of building performance with emphasis on life-cycle environmental impacts. Priorities need to be established for global, local and indoor environmental aspects, and weighted accordingly.

HK-BEAM embraces a wide range of building developments, variable in terms of scale, location and mix of uses (types of premises). It seeks to encourage progressively higher standards of performance and innovations that contribute to improved performance. The assessment criteria and methods of assessment need to be reasonably flexible and allow for alternative means of compliance, yet enable the HK-BEAM Assessor to arrive at decisions without controversy.

The costs of assessing an existing building development is usually met from management, operation and maintenance budgets, tending to limit the amount of resources available for performance evaluations. Operators of existing building developments may have difficulty in obtaining key design information, commissioning results, tenant data, etc, and limited staffing and physical resources to collect detailed technical data on the building and the performance of the engineering systems.

The purpose of HK-BEAM 5/03 is not only to assess the actual performance of a building development, 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 building developments there are two facets to actual performance. Building and system performance is a consequence of technical features of the building and is dependent 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 HK-BEAM 5/03 distinguishes between the potential impacts of these two facets on the performance of a building development.

Besides the size and complexity of a development, and the various uses to which it is put, the assessment needs to take into account the extent to which the building 'core and shell' (areas under the control of the building management) is assessed and the extent to which the various premises are assessed, be they occupied or unoccupied. The mix of premises types and their uses also need to be taken into account in deciding the overall rating for a development. The assessment needs to be explicit as to exactly what is covered by the assessment rating for particular building development. Clearly, it is the building performance which is being assessed, together with the quality of management, operation and maintenance, and not the tenants or their use of the premises they occupy.

1.2.2 ENVIRONMENTAL ASPECTS

An environmental aspect is defined in ISO 14004[7] as an element of an organisations activity, products or services than 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 HK-BEAM scheme addresses items for which there is good evidence of the environmental problems they cause, and for which effective performance criteria can be defined. Certain environmental aspects attributable to buildings and their use have yet to be included, either because the environmental impacts are not well defined, or because performance criteria have not been established. They may be included in future updates, when information becomes available to enable objective assessment. Notwithstanding its use in providing for the environmental labelling of buildings, the success of HK-BEAM should be measured in the extent to which it actually improves the environmental performance of buildings.

The environmental aspects covered are grouped under the following categories:

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7 International Organization for Standardization. ISO14004: Environmental management systems – General guidelines on principles, systems and supporting techniques. 1996.

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- Site Aspects;
- Materials Aspects;
- Energy Use;
- Water Use;
- Indoor Environmental Quality; and
- Innovations and Performance Enhancements.

The 'Innovations' section allows for the inclusion of additional aspects not already covered in other sections.

Site Aspects

Generally speaking site aspects, as categorised in HK-BEAM, will not vary significantly with the type of building development. However, the scale and location of the development will determine the extent to which environmental aspects associated with the site are significant and can be addressed in the assessment. Site Aspects include:

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

Materials Aspects

Similar to site aspects, materials aspects as defined in HK-BEAM, will be similar for all types of building developments, although the size of the development will have significance. Materials Aspects include:

- efficient use of materials;
- selection of materials; and
- waste disposal and recycling.

Energy Use

Assessment of energy use in a building development containing a variety of use, energy sources and building services systems and equipment is a somewhat complex process given the number of influencing variables. Due to a lack of detailed audit data for many premises types HK-BEAM 5/03 adopts a computational approach to determining the dominant energy uses, with additional features known to have impact on overall performance. However, levels of performance and award of credits is influenced by actual performance data obtained from building energy audits. Energy Use includes:

- building energy performance;
- energy management; and
- energy efficient systems and equipment

Water Use

Due to the very limited data available for building developments in Hong Kong, assessment of water use is currently limited to features that are known to improve utilisation, and these include:

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

Indoor Environmental Quality

Indoor issues included in HK-BEAM are those aspects of building operation and use which are likely to impact on the health, comfort or well-being of the occupants. 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. Where premises are classified as industrial workplaces it is taken that adequate provisions are provided in order to comply with occupational health and safety requirements prescribed by law. Indoor Environmental Quality includes:

- thermal comfort;
- indoor air quality;
- interior lighting; and
- acoustics, noise and vibration.

1.3 ASSESSMENT FRAMEWORK

The desirable outcome of a comprehensive scheme is the assessment of building environmental performance over its life cycle. In practice, however, buildings are assessed as either new building developments, or as existing building developments.

HK-BEAM 5/03 is one of the few tools in use world-wide which provides for an assessment of existing building developments. It is intended to form part of an integral scheme, dovetailing with HK-BEAM 4/03 which covers new building developments. It would be expected that a building rated under HK-BEAM 'new' and suitably operated and maintained would achieve a similar rating under HK-BEAM 'existing' some years later.

An HK-BEAM 5/03 assessment covers the building fabric, the engineering service systems (space cooling, ventilation, lighting, etc.), finishes and fitting-out, and the management, operation and maintenance of the building. It covers the 'fitting-out' and use of premises by users where this is possible, and reinforces co-ordination between management and user activities through contractual arrangements and co-operation.

It is recognised that both the operator and users of a building can contribute to improving the environmental impacts of the building. Both parties share a responsibility for efficient utilisation of resources and for the quality of the environment within the occupied space. Co-operation between building operator and tenants is an asset in improving a building's overall environmental performance. However, HK-BEAM 5/03 is presented as an environmental assessment which will be commissioned by the building Owner/Operator.

1.3.1 BASELINE PERFORMANCE

In establishing the assessment criteria and standards of performance, local legal requirements and industry norms establish the baseline for (zero) credit. The first level of credits are awarded for implementing good management, operation and maintenance practices in line with international and local good practice guidelines and codes. Further credits are awarded for achieving levels of performance commensurate with the size, complexity and age of the building being assesses. It is intended that the assessment criteria be updated periodically as new information becomes available and as legal requirements evolve.

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

1.3.2 ASSESSMENT METHODS

Many of the assessments verifying compliance with the prescribed criteria in HK-BEAM will be undertaken by a suitably qualified person acting on behalf of the Owner/Operator, who will submit evidence in the form of documents, data and reports confirming compliance. Others will be based on evidence collected by a HK-BEAM Assessor.

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HK-BEAM does not seek to be overly prescriptive in setting assessment criteria and in defining methods of compliance, and encourages building owners and operators to consider alternative approaches which meet the objectives of HK-BEAM. Owner/Operator 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 HK-BEAM for which the credit or credits are sought, the proposed alternative and equal criteria, and the proposed method for assessment. The proposal should be submitted at the earliest opportunity in the assessment process. It would be considered by the HK-BEAM Assessor and, if necessary, submitted for technical review to the HK-BEAM Steering Committee. A ruling shall 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 HK-BEAM Steering Committee it shall be incorporated in the guidance notes used by HK-BEAM Assessors, and in future revisions to the HK-BEAM documentation, as deemed appropriate by the Steering Committee.

1.3.3 SPECIAL CIRCUMSTANCES AND INNOVATIVE TECHNIQUES

It is possible that some building developments may not be fully embraced by the criteria currently presented in HK-BEAM 5/03, due to their unusual nature or variety of forms and system designs, etc. This may 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 agreement between the Owner/Operator and the HK-BEAM Assessor, to be endorsed by the HK-BEAM Steering Committee.

HK-BEAM 5/03 does not presume to be comprehensive in its coverage of environmental aspects. Under the heading of 'Innovation' the Owner/Operator is encouraged to submit proposals for the award of credits for aspects not covered elsewhere in HK-BEAM 5/03. In such circumstances the Owner/Operator shall submit a proposal in which the environmental gains are demonstrated. The HK-BEAM Steering Committee would examine the validity of the proposal and, weighting the environmental gains against others covered by the scheme, award an appropriate number of 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 HK-BEAM may incorporate such credits as part of the core assessment, and would then be counted within the total number of credits available.

Assessment of Occupied Areas

Wherever possible, a HK-BEAM 5/03 assessment will embrace an assessment of occupied premises in a building development, as this is considered to be in the best interests of the Owner/Operator of the development. However, HK-BEAM recognises that in some building developments the final decision and responsibility for certain features, such as the lighting, partitions, fittings and furnishings in tenant areas rests with the tenants.

Consequently, HK-BEAM 5/03 encourages the Owner/Operator to provide prospective tenants with sufficient information and guidelines for fitting out the office spaces. Compliance with the so-called 'Tenants Fitting-Out Specifications' should ensure the indoor environmental conditions are satisfactory, and reinforce the overall environmental performance of the building. Non-compliance would serve to alert the Tenant that the indoor environmental conditions may be compromised. Whilst the 'Tenant Fitting-Out Specifications' form an important part of the assessment, checks on actual compliance by tenants lies outside the scope of the assessment.

1.3.4 CREDIT WEIGHTINGS

The weighing system, i.e. the relative number of credits given for compliance with a particular environmental aspect, is a critical part of a building environmental performance assessment method. It is logical that a BEAM should seek to assign credits or weightings to assessment criteria somewhat in accordance with the significance of the environmental impact. However, it is not practical at present to assess all the issues covered in HK-BEAM on a common scale. There is insufficient information available to provide an objective weighting for all issues, because of the difficulty in assigning an economic cost to environmental effects as diverse as, for example, the health of individuals, ozone depletion, global warming and resource depletion. For a voluntary scheme there is also a need balance the credits awarded against technical difficulty and cost of implementation (set against any 'payback', such as savings from increased energy efficiency), otherwise take-up of the scheme may be affected.

For this version of HK-BEAM a suitable proportion of the total credits have been allocated to each grouping of environmental aspects, taking into account the international consensus indicated by an analysis of weightings used in similar BEAMs operating elsewhere, as well as informed opinions of those who have contributed to the development of HK-BEAM. Within the groupings of environmental aspects in HK-BEAM credits have been awarded, based either on an estimate of relative environmental impact or by the consensus of stakeholders.

1.3.5 SITE SPECIFIC CRITERIA

HK-BEAM 5/03 is intended for application to a variety of building developments. As such, a building under assessment may form part of a complex, be located in either an urban or rural setting, and comprise a variety of different types of premises. Given the variability of circumstances, not all assessment criteria will be applicable, and the range and number of credits that can be achieved will vary for each individual case.

Where the group of premises forms part of a building complex, it is possible for only a part of the complex to be included in the assessment. In addition, the scheme allows for the award discretionary credits for environmentally proactive features not covered by the documented criteria.

1.3.6 OVERALL ASSESSMENT GRADE

The Overall Assessment Grade is based on the PERCENTAGE of applicable credits gained. In addition, to highlight the importance of Indoor Environmental Quality, the IEQ score (as a percentage of applicable credits) will also weight in the overall grade. Given the importance of IEQ it is necessary to obtain a minimum percentage of credits for IEQ in order to qualify for the overall grade. Failure to obtain the same percentage of IEQ credits may result in a downgrading of the overall award. The award classifications are:

Platinum	75%	(Excellent)
Gold	65%	(Very Good)
Silver	55%	(Good)
Bronze	40%	(Satisfactory – above average)

The percentage credits for each award grade will be defined by the HK-BEAM Assessor taking into account the type and scale of the development.

Example:

Consider a large air-conditioned complex. Credits applicable and obtained are as follows:

	Available	Obtained	
Site	20	15	
Materials	14	8	
Water	6	4	
Energy	30	24	
Total	70	51	73%
IEQ	30	22	73%
	100	73	

On the basis that the percentage of credits obtained for IEQ is not less than the percentage gained overall, the overall award is not down graded.

1.3.7 DETERMINATION OF AVAILABLE CREDITS FOR A BUILDING COMPLEX

It is clear that there will be significant differences in both energy related impacts and indoor

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environmental quality aspects between buildings which are centrally air-conditioned and climate controlled, as opposed to buildings where natural ventilation is utilised. Centrally air-conditioned buildings can be expected to consume greater amounts of energy, so the relative weighting for energy use as compared to others environmental aspects is higher than for buildings which are less energy intensive. In additional, aspects such as thermal comfort and IAQ are subject to tighter controls. To cater for a mix of uses in a complex HK-BEAM weighs the available credits for energy and IEQ according to the floor area of the premises type, as illustrated in the following examples.

Energy Credits:

The energy credits break down into the following:

- performance based credits (calculation based on computer simulation);
- feature specific credits (specific to the type of use, e.g. boilers for water heating);
- feature specific credits, not specific to any type of use (e.g. energy efficient lifts); and
- renewable energy credits (considered as 'bonus' credits under HK-BEAM).

If air-conditioned premises dominate the building complex than the number of credits increased for both energy and IEQ aspects, and both weigh as higher proportions of the total available credits.

Example

A building complex consists of 3 parts, A an office tower, B a shopping mall, C an enclosed car park, with percentage gross floor area as indicated.

Premises type	% floor area	Performance credits available	Special credits available	Total credits available	Weighting by % floor area	Credits obtained	Weighting by floor area
A	60	10	2	12	7.2	8	4.8
B	15	8	2	10	1.5	8	1.2
C	25	6	2	8	2.0	5	1.25
		Weighted credits available			10.7		7.25
General		Common credits available			10	7	7
					20.7		14.25

The total credits available for this case (weighted by floor area) = 20.7 (counts to overall total). The total credits obtained for this case = 14.25 (counts to overall total of credits obtained)

IEQ Credits:

For circumstances where a building development consists of several different types of premises, with each type having different numbers of applicable IEQ credits, the IEQ score shall also be weighted according to floor area and number of credits, as follows:

Premises type	% floor area a	Available credits b	Weighted by % floor area (a x b)/100	Credits obtained c	Weighted by floor area (a x c)/100
A	20	6	1.2	4	0.8
B	30	24	7.2	16	4.8
C	50	28	14.4	20	10.0
	Weighted credits available		22.4	Credits obtained	15.6
	Proportion of IEQ credits assigned			15.6/22.4	70%

1.4 ASSESSMENT PROCESS

The HK-BEAM scheme is operated by the Business Environment Council (BEC), an independent, non-profit, environmental information centre, under the guidance of the HK-BEAM Steering Committee on behalf of the HK-BEAM Society.

The assessment process should be initiated at an early stage, since the issues raised requires a substantial review of management, operation and maintenance practices, as well as building and system performance data, covering at least the core building and possibly tenant areas. Not all information will be readily available. The method identifies and credits good management, operation and maintenance, and building and system performance where specific targets are met. Whilst innovative upgrade and retrofit solutions are encouraged, they do not necessarily justify credit. Such innovation must demonstrate environmental gains, such as through improved efficiency and/or improvements in the indoor environment. Indeed, it is anticipated that significant environmental benefits will be realised from full and proper implementation of sound management and operating and maintenance practices.

The Assessor will issue a questionnaire to potential Owner/Operators which details the information required for assessment. The BEC Assessor will subsequently undertake a provisional assessment based on the information gathered from the questionnaire and the discussion, and produce a provisional report. This report will identify which credits have been achieved, and outline enhancements necessary to obtain further credits. At this stage the Owner/Operator may wish to implement additional management, operation and maintenance procedures, or make changes to the building or installed equipment.

When a building development is registered for assessment the credits and assessment criteria current at the time of registration will be used in the assessment process, unless the Owner/Operator wishes to comply with credits and criteria introduced after registration.

HK-BEAM 5/03 ratings are based on the number of credits achieved (expressed as a percentage of the total applicable) in each of the two categories: Management, Operation and Maintenance, and Building and System Performance.

Information on how to participate in the scheme is available from the Business Environment Council[8].

1.4.1 CERTIFICATION

All commercial and institutional buildings are eligible for certification under HK-BEAM 5/03, including, but not limited to offices, retail, catering and service establishments, libraries, educational establishments, hotels and residential apartment buildings under single management. Whilst it is not expected that buildings used for primarily industrial purposes or residential developments will seek certification under this assessment method, the method is sufficiently flexible to embrace all types of building developments.

1.4.2 DISCLAIMER

The HK-BEAM Building Environmental Assessment Method is intended for use by stakeholders and project teams engaged in new building developments, 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 representatives from many organisations and individuals. The final outcome represents general consensus, but unanimous support from each and every organisation and individual consulted is not implied.

This document represents the HK-BEAM Society's efforts to develop a standard that improves environmental performance of buildings using the latest techniques, practices and standards compatible with prevailing economic constraints. These are subject to changes, which will be included through periodic updating.

It should be noted that none of the parties involved in the funding of the HK-BEAM Building Environmental Assessment Method, including the HK-BEAM Society and its members provide any warranties or assume any liability or responsibility to users of the Method, or any third parties

8 http://www.bec.org.hk/

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1.5 SUMMARY OF CREDITS

Sect:	Credit Requirement:	Credits Available
SITE ASPECTS		
2.1.1	**Land Use**	
	Site on contaminated land/or adjacent landfill: where the building development is an urban redevelopment or is located on reclaimed land	1
	additional credit where the development is located on previously contaminated land, or on land adjacent to a landfill site	1
2.1.2	**Local Transport and Amenities**	
a)	if no car parking is provided other than provisions intended for use by company vehicles and/or any shuttle service vehicles	1
b)	where there exists easy and pedestrian access to mainstream mass transport system; and local services and amenities are sufficient to provide for basic needs of the users of the building development	1
2.1.3	**Landscaping and Planters**	
a)	for using pervious paving materials for a minimum of 50% of non-landscaped areas	1
b)	for providing appropriate planting on site equivalent to at least 30% of the site area	1
2.1.4	**Vehicular Access**	
	for providing access for delivery vehicles and waste collection vehicles to the service areas of the building which lies within the site boundary and which are enclosed and/or segregated from pedestrian access routes	1
2.2.1	**Emissions from Wet Cooling Towers**	
	for a building in which wet cooling towers are not used, or use seawater, or use water from an acceptable source and are designed and maintained as specified in the Code of Practice for the Prevention of Legionnaires Disease	1
2.2.2	**Noise from Building Equipment**	
	for complying with the acceptable noise levels for neighbouring sensitive receivers in accordance with the Technical Memorandum for the Assessment of Noise from places Other Than Domestic Premises, Public Places or Construction Sites	1
2.2.3	**Light Pollution**	
	for exterior lighting installations demonstrating that the average illuminance for site lighting does not exceed 1.5 times the recommended maintained illuminance; and interior and exterior lighting installations are such that no direct beam of light from luminaires leaves the area that is intended to be lit	1
2.3.1	**Environmental Management Policy**	
	for having an established environmental policy endorsed at Directorate level	1
2.3.2	**Environmental Purchasing Policy**	
	for demonstrating the implementation of purchasing practices which encourages the supply and use of environmentally friendly materials, products and equipment	1

Sect:	Credit Requirement:	Credits Available
2.3.3	**Building Maintenance**	
a)	for a fully documented building maintenance manual appropriate for the building development	1
b)	for demonstrating the operation of a planned programme of regular inspection, cleaning, and maintenance of the building's fabric and structure	1
2.3.4	**Building Services Operation and Maintenance**	
a)	for having an easy-to-follow, regularly updated manual detailing the operating methods, instructions and standard control settings for HVAC systems and equipment	1
b)	for having an easy-to-follow, regularly updated manual detailing the operating methods, instructions and standard control settings for non-HVAC systems and equipment	1
c)	for an established programme of regular inspections, cleaning and maintenance of all building services engineering systems	1
d)	for having undertaken an audit of the effectiveness of the operation and maintenance practices for all building services engineering systems	1
2.3.5	**Staffing Resources**	
	where adequate staffing levels and skills exist to meet the requirements of the building development	1
2.3.6	**Building Users Handbook**	
	for a well compiled guide on environmental issues included in a building user's handbook	1
	additional credit where appropriate HK-BEAM performance criteria included in contractual arrangements with tenants	1

MATERIALS ASPECTS		
3.1.1	**Building Reuse**	
	where pre-existing foundations, building structural elements or other salvaged materials were used in the construction of the building development	1
3.1.2	**Adaptability and Deconstruction**	
a)	for designs providing flexibility through the choice of building structural system to allow for change in future use, and which is coordinated with interior planning modules	1
b)	for designs providing spatial flexibility that can adapt spaces for different uses, and allows for expansion to permit additional spatial requirements to be accommodated	1
c)	for designs providing building in-service flexibility through provision of building services elements that allows for change in the use of the building	1
3.1.3	**Modular and Standardised Design**	
	for demonstrating the application of modular design in buildings	1
3.2.1	**Sustainable Forest Products**	
	for using solid timber products and composite timber products which are entirely from well managed sustainable sources, including reuse of salvaged timber	1
3.2.2	**Ozone Depleting Substances**	
a)	where the refrigerants employed in the air conditioning system have an average ozone depletion potential of less than 0.03	1

Sect:	Credit Requirement:	Credits Available
	where the refrigerants employed in the air conditioning system have an average ozone depletion potential of zero	2
	Alternatively: for demonstrating a phased programme of refrigerant replacement to an average ozone depletion potential of zero	1
b)	for installing automatic refrigerant leak detection for indoor chiller plant, or carrying out monthly manual checking for leakage for outdoor plant, and for ensuring full refrigerant recovery during maintenance using approved refrigerant recovery equipment and containers	1
c)	Where no halon-based fixed or portable fire protection systems are used in the building, or a schedule of maintenance and testing of fixed halon fire protection systems has been drawn up with the specific aim of minimising unnecessary emissions of halon; and where a decommissioning programme of existing halon systems is in place	1
d)	for using insulation materials that avoids the use of ozone depleting substances in their composition or during their manufacture	1
3.3	**Waste Disposal and Recycling Facilities**	
	for providing adequate services for the collection, sorting, storage and disposal of waste and recovered materials that has no negative impact on the health and comfort of building users	1

ENERGY USE		
4.2.1	**Energy Use in Commercial Buildings**	
	for reduction in the annual energy consumption by 10% to 45%	10 max
4.2.2	**Maximum Electricity Demand in Commercial Buildings**	
	for a reduction in the maximum electricity demand by 15%	1
	for a reduction in the maximum electricity demand by 23%	1
	for a reduction in the maximum electricity demand by 30%	1
4.2.3	**Energy Use in Hotel Buildings**	
	for a reduction in the incurred annual CO_2 emission by 10% to 45%	10 max
4.2.4	**Energy Use in Residential Buildings**	
	for a reduction in the incurred annual CO_2 emission by 3% to 22%	8 max
4.2.5	**Energy Use in Educational Establishments**	
	for a reduction in the incurred annual CO_2 emission by 3% to 22%	8 max
4.3.1	**Ventilation Systems in Mechanically Ventilated Buildings**	
	for designing energy efficient ventilation systems that will consume less electricity than those meeting the zero credit requirements by 10% or more	1
	for installing control systems and devices that regulate the operation of the ventilation systems to reduce energy use whenever the operating conditions permit	1
4.3.2	**Interior Lighting Systems in Mechanically Ventilated Buildings**	
	for using lamps and, where applicable, ballasts that will consume less electricity than those meeting the zero-credit requirements by 15% or more	1
	for for installing control systems and devices that will switch off or dim the output of lighting installations when and where illumination is not required	1
4.3.3	**Natural Ventilation of Large Premises**	

Sect:	Credit Requirement:	Credits Available
	for undertaking an analysis of building design, assessing wind pressures on building facades to inform detailed building design on best locations to locate windows/openings to achieve cross ventilation	1
	for demonstrating that indoor spaces have ventilation openings/operable windows capable of providing sufficient ventilation under average wind conditions	1
4.3.4	**Lift and Escalator Installations**	
	for complying with the Code of Practice for Energy Efficiency of Lift and Escalator Installations	1
4.3.5	**Electrical Installations**	
	for complying with the Code of Practice for Energy Efficiency of Electrical Installations	1
4.3.6	**Hot Water Supply**	
	for complying with the Code of Practice for Energy Efficiency of Electrical Installations	1
4.4.1	**Positioning of Air-conditioning Units**	
	for complying with the recommended installation positions for air-conditioners as detailed in Appendix C, or equivalent alternatives	1
	for complying with not less than four items in the assessment check-list	1
	additional credit for complying with all items in the assessment check-list	1
4.4.2	**Energy Efficient Lighting in Public Areas**	
a)	for installation of energy efficient lighting equipment in areas under the control of the building/estate management	1
b)	for installation of time switching or photoelectric switching lighting control for the lamps in areas where daylight is available	1
4.5	**Renewable Energy**	
	Bonus credits: where 2% to 10 % of building energy use is generated by renewable energy sources	5 max
	In less densely populated areas: where 4% to 20 % of building energy use is generated by renewable energy sources	
4.6.1	**Energy Auditing**	
a)	for having an energy policy and an action plan with the responsibility for implementation vested at Directorate level	1
b)	for having carried out an energy audit of the building within the previous two years	1
c)	for an effective energy monitoring and targeting system, providing evidence showing movement towards energy/CO_2 targets over time	1
d)	for having in place a mechanism for accumulating funding and an annual budgetary plan for implementing energy efficiency enhancements	1
e)	for separate charging for energy costs	1
4.6.2	**Metering and Monitoring**	
a)	for providing meters which allow separate monitoring of electricity use by building services systems under the control of the Owner/Operator, other than HVAC systems and equipment	1
b)	for providing for monitoring of electricity use by the main chiller plant and auxiliaries; and adequate instrumentation for monitoring the cooling load and operating parameters of major equipment in the central chiller plant	1

Sect:	Credit Requirement:	Credits Available
c)	for providing meters which allow separate monitoring of electricity use by the air side equipment of the HVAC system	1
d)	Alternatively: buildings without central air-conditioning plant for providing energy metering for landlord's electricity consumption in common spaces/public areas	1
4.6.3	**Energy Management Manual**	
	for providing fully documented instructions that enables systems to operate at near optimum levels of energy efficiency	1

5	**WATER USE**	
5.1	**Water Quality**	
	for ensuring that potable water at the points consumption meet WSD's drinking water quality standards; and complying with the guidelines given in the Code of Practice for the Prevention of Legionnaire Disease that are applicable to domestic cold and hot water systems	1
5.2.1	**Water Management**	
a)	for having a water conservation policy and action plan to reduce consumption; undertaking a water audit for the whole building development; and maintaining a water use inventory	1
b)	for implementing a water conservation plan with appropriate targets and budget provisions	1
5.2.2	**Water Efficient Devices**	
	for use of water saving features and fixtures that in aggregate use 25% less water than conventional designs and fixtures	1
	for use of water saving features and fixtures that in aggregate use 40% less water than conventional designs and fixture	2
5.2.3	**Metering and Controls**	
	for installation of devices that automatically shut-off of faucets, taps, etc. that use potable water, for the purposes of water conservation; and water meters at key supply branches which permits the monitoring and audit of potable water consumption for each of the major water-using sectors	1
5.2.4	**Water Recycling**	
a)	for the collection of rainwater and condensate for use in cleaning and irrigation or otherwise, which will reduce consumption of potable water	1
b)	for providing plumbing systems that separates black water discharges from grey water discharges to allow for separate collection of grey water	1
c)	Bonus credit: for the installation of an on-site grey water treatment system to treat grey water for reuse in place of potable water	1
5.3	**Effluent**	
a)	for demonstrating an estimated reduction in sewage volumes by 25% through the use of water efficient fixtures and or recycling technologies	1
b)	for installing and maintaining grease traps, petrol interceptors and other means to reduce concentration of sewage	1

6	**INDOOR ENVIRONMENTAL QUALITY**	

Sect:	Credit Requirement:	Credits Available
6.2.1	**Thermal Comfort in Centrally Air-conditioned Premises**	
a)	for sustaining the air temperature at the design value within ±1°C when the air side system is operating at steady state under conditions of zero occupancy	1
	1 credit for sustaining the air temperature at the design value within ±1°C when the air side system is operating at steady state under full- or part-load conditions	1
b)	where room air diffusers satisfy the Air Diffusion Performance Index	1
6.2.2	**Thermal Comfort in Air-conditioned/Naturally Ventilated Premises**	
a)	for demonstrating worse case peak temperatures without mechanical cooling does not exceed 30°C in any occupied/habitable rooms	1
b)	for sustaining the air temperature at the design value within ±1°C when the air-conditioning unit is operating at steady state under conditions of zero occupancy	1
6.3.1	**Ventilation in Occupied Areas of Centrally Air-conditioned Premises**	
	for demonstrating that the corrected design ventilation rate meets the design intent for occupied premises	1
	for demonstrating that the ventilation effectiveness meets the design intent for occupied premises	1
6.3.2	**Background Ventilation in Air-conditioned/Naturally Ventilated Premises**	
	for demonstrating through appropriate modelling or commissioning tests that a minimum air change rate of 1 per hour is provided in occupied or habitable rooms under conditions of natural ventilation	1
6.3.3	**Localised Ventilation**	
	for provision of: separate ventilation system for areas where significant indoor pollution sources are generated; and local exhaust of premises undergoing fit-out and redecoration	1
6.4.1	**Outdoor Sources of Air Pollution**	
a)	for demonstrating compliance with the appropriate criteria for CO for each type of occupied premises included in the building development	1
b)	for demonstrating compliance with the appropriate criteria for NO_2 for each type of occupied premises included in the building development	1
c)	for compliance with the appropriate standards for ozone specified for each type of occupied premises in the building development	1
d)	for compliance with the appropriate standards for RSP specified for each type of occupied premises in the building development	1
6.4.2	**Indoor Sources of Air Pollution**	
a)	for compliance with the appropriate standards for VOCs specified for each type of occupied premises in the building development	1
b)	for compliance with the appropriate standards for formaldehyde specified for each type of occupied premises in the building development	1
c)	for compliance with the appropriate standards for radon specified for each type of occupied premises in the building development	1
6.4.3	**Airborne Bacteria**	
	for compliance with the appropriate standards for airborne bacteria specified for each type of occupied premises in the building development	1
6.4.4	**Odour Control and Hygiene**	
a)	for adequacy of plumbing and drainage installations to limit odours	1
b)	for for the provision of a hygienic refuse collection system	1

Sect:	Credit Requirement:	Credits Available
6.4.5	**Car Parks**	
	for compliance with the design requirements specified in ProPECC PN 2/96	1
6.4.6	**Public Transport Interchanges**	
	for compliance with the design requirements specified in ProPECC PN 1/98	1
6.5.1	**Daylighting, Windows and Views**	
a)	for demonstrating that at least 80% of windows to normally occupied areas achieve a VDF of 12%, and the remainder achieve a VDF of 8%	1
	Alternatively: for demonstrating that at least 80% of normally occupied areas achieve an average DF of 2.5%, and the remainder an average DF of 1.5%	
b)	for demonstrating that all normally occupied areas with windows have a window to floor area ratio of 25% or more, or at least 80% have a window to floor area of 35% or more	1
c)	for demonstrating at least 80% of normally occupied areas with windows achieve the room depth criterion; or the use of an advanced daylighting system that significantly improves daylight illuminance beyond 5 m from the window wall.	1
d)	for demonstrating that direct line of sight to a vision window is possible from at least 90% of area in habitable rooms and regularly occupied workspaces	1
6.5.2	**Interior Lighting Performance**	
a)	where interior lighting installations meet the specified performance in respect of maintained illuminance and illuminance variation	1
b)	where interior lighting installations meet the specified performance in respect of limiting glare index (or CIE unified glare rating) and minimum colour rendering	1
c)	for lighting installations in which fluorescent and other lamps with modulating (fluctuating) output are fitted with dimmable high-frequency ballasts where appropriate	1
d)	for demonstrating that the lighting and air-conditioning design demonstrates that performance of fluorescent lamps is not affected by the cool air from air-conditioning; and there is a planned programme of luminaire cleaning and group re-lamping that follows the recommendation in CIE publication No. 97	1
6.3.1	**Room Acoustics**	
	for demonstrating that the reverberation time in rooms meets the prescribed criteria	1
6.3.2	**Noise Isolation**	
	for demonstrating noise isolation between rooms, premises and/or floors meets the defined criteria	1
6.3.3	**Background Noise**	
	for demonstrating background noise levels are within the prescribed limits	1

7	**Innovations and Performance Enhancements**	5 max
7.1	**Innovative Techniques**	
7.2	**Performance Enhancements**	

2 SITE ASPECTS

The environmental aspects included in this part focuses on site management, the location of the building development, ecological aspects, and emissions from the site. 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, to reduce travel needs and reliance on private vehicles. There is often an opportunity to enhance the ecological qualities of building developments through more thoughtful 'greening' and other features. The impacts on neighbouring developments and the various discharges and emissions from the site can be significant and considerable when taken over a building's lifetime. There will be significant differences between large scale building developments, as compared to isolated buildings.

2.1 SITE LOCATION AND DESIGN

2.1.1 LAND USE

Due to the shortage of land on which to build the choice of site location for most existing buildings would have been limited. However, from an environmental perspective credit should be given where a building development has made use of a site that had already seen prior development, and/or utilises elements from any previous constructions. Additional credit should be given when contaminated land and land adjacent to landfill sites have been put to use, provided that appropriate steps were taken to reduce environmental and health hazards to users of the building development and neighbouring properties.

Objective of HK-BEAM

Encourage building on land that was previously developed or has been reclaimed.

Maximum number of credits attainable: 2

Credit requirement

- ❖ 1 credit where the building development is an urban redevelopment or is located on reclaimed land.
- ❖ 1 additional credit where the development is located on previously contaminated land, or on land adjacent to a landfill site.

Method of assessment

The Owner/Operator shall provide evidence as to the previous use of the land prior to the construction of the existing building development. The Owner/Operator shall also provide details of any historic or heritage sites in the vicinity prior to the construction of the development, and confirm that site preparation (including the process of reclamation) and construction use had no adverse impacts on these sites. Where it can be shown that the development used previously developed land (i.e., Brownfield site) and there was no negative impact on any heritage or historical site, or where use is made of reclaimed land, the first credit shall be awarded.

Where the land used for the development was previously classified as contaminated, but was subsequently decontaminated in accordance with ProPECC PN3/94[9] or similar, or where the land used is adjacent to a landfill site and has been designed with appropriate measures to protect users and neighbours[10,11], the second credit shall be awarded.

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9 Environmental Protection Department. Practice Notes for Professional Persons. ProPECC PN 3/94. Contaminated Land Assessment and Remediation.
http://www.epd.gov.hk/epd/textonly/english/resources_pub/publications/files/pn94_3.pdf

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

2.1.2 LOCAL TRANSPORT AND AMENITIES

The increasing number of private vehicles in Hong Kong not only increases pressure on the highway and urban traffic system, but also worsens local air pollution. The most urgent problem to be resolved comes from fossil fuel burning vehicles, often aggravated by the street canyon effect of high-rise buildings. Exhaust fumes from cars contain volatile organic compounds: some of these are known carcinogens while others contribute to photochemical smog by assisting in the rapid formation of ozone in the atmosphere. The exhaust fumes also contain CO, CO_2, NO_x and SO_2 which contribute a variety of environmental problems. Apart from the health effects of traffic fumes, motor vehicles also generate noise, another environmental nuisance.

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

Objective of HK-BEAM

Discourage the use of private vehicles and taxis by building users with the aim to reduce air pollution, fuel consumption and noise from traffic.

Maximum number of credits attainable: 2

Credit requirement

a) Car parking provisions

- ❖ 1 credit if no car parking is provided other than provisions intended for use by company vehicles and/or any shuttle service vehicles.

b) Public transport and local amenities

- ❖ 1 credit where:
- ✧ there exists easy and pedestrian access to mainstream mass transport system; and
- ✧ local services and amenities are sufficient to provide for basic needs of the users of the building development.

Method of assessment

a) The Owner/Operator shall provide details of any car parking facilities and the restrictions on use. To obtain credit any car park shall comply with the following conditions:

- be provided with access that ensures simultaneous free flow of vehicles in and out of the car park; and
- provisions to avoid ground and contamination from oil run-off.

b) The building will be checked to ensure that employees have easy pedestrian access to and from a major transport interchange such as a station, or main stream mass transport, such as multiple cross-harbour bus stops. Credit will be awarded for provision of footbridge, covered walkway, or other substantial means of improving access over and above that already provided by Government. In dense urban centres the provision of elevated walkways and linked buildings to reduce pedestrian exposure to traffic are deemed to satisfy this requirement. Alternatively, for sites not directly served by mainstream public transport, demonstration that a private bus service is provided for building users which links to a main stream mass transport interchange. The provision of a shuttle bus service of adequate capacity and frequency shall be deemed to satisfy the criteria. The Owner/Operator shall submit to the Assessor details of the service.

This second part is deemed to be satisfied if adequate facilities such as restaurants and shops that provide for the needs of building users and are within convenient walking distance. Guidance

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[11] Environmental Protection Department. Landfill Gas Hazard Assessment. http://www.epd.gov.hk/epd/textonly/english/environmentinhk/waste/guide_ref/guide_lgha.html

as the nature of facilities and locations with respect to a building development is provided in the Hong Kong Planning and Standards Guidelines[12].

2.1.3 LANDSCAPING AND PLANTERS

Landscaping and planters in and around buildings can enhance the existing site ecology. Landscaping strategies can:

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

Large expanses of greenery are difficult to secure in densely built city centres. However, the provision of plants on the outside and on rooftops contributes to making the city greener. A building rooftop covered with greenery can bring down the surface temperature in summer, and can reduce peak roof runoff and alleviate storm drainage pressure.

Objective of HK-BEAM

Encourage building development that preserves or expands urban greenery, and reduce impacts on fresh water and ground water systems during building use.

Maximum number of credits attainable: 2

Credit requirement

a) Hard landscaping

❖ 1 credit for using pervious paving materials for a minimum of 50% of hard landscaped areas.

b) Amount of greenery

❖ 1 credit for providing appropriate planting on site equivalent to at least 30% of the site area.

Method of assessment

The Owner/Operator shall provide details that shows the landscape layout for the site, identifying the hard landscaping areas and materials used, and the areas and nature of soft landscaping.

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

b) The Owner/Operator shall demonstrate compliance through quantification of the areas of greenery on the site and any building, including sky gardens, podium areas, roofs and other parts of the building.

2.1.4 VEHICULAR ACCESS

Traffic densities in Hong Kong are often very high. Traffic congestion and the pollution from exhausts are worsened by vehicles queuing to enter buildings. This can be alleviated by providing suitable access for vehicles.

Objective of HK-BEAM

Encourage proper management of service vehicles requiring access to the building for the purposes of deliveries and waste disposal, etc.

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12 Planning Department. http://www.info.gov.hk/planning/index_e.htm

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for providing access for delivery vehicles and waste collection vehicles to the service areas of the building which lies within the site boundary, and which are enclosed and/or segregated from pedestrian access routes.

Method of assessment

The building will be checked to ensure that a system is provided which allows for delivery of goods and removal of waste, etc., which does not require waiting or parking on streets adjacent to the building, and which does not impact on pedestrian access.

2.2 EMISSIONS FROM THE SITE

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

2.2.1 EMISSIONS FROM WET COOLING TOWERS

Where cooling towers form part of an air conditioning system and are not properly maintained, Legionella bacteria can be dispersed in airborne droplets up to several hundred metres from the building, with a risk of causing Legionnaires' Disease(13). This risk can be eliminated by the appropriate design of the cooling towers and their proper operation and maintenance.

Objective of HK-BEAM

Minimise the threat of Legionnaires' disease arising from wet cooling towers.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for a building in which wet cooling towers:
- ✧ are not used, or
- ✧ use seawater, or
- ✧ use water from an acceptable source and are designed and maintained as specified in the Code of Practice for the Prevention of Legionnaires Disease.

Method of assessment

When wet cooling towers are to be specified they shall be constructed and maintained to the specifications given the Code of Practice Prevention of Legionnaires Disease. This shall be confirmed in writing by the Owner/Operator, based on a survey conducted by a suitably qualified person. Deviations from the specifications given in the CoP shall be identified. The HK-BEAM Assessor may check the appropriate maintenance records.

2.2.2 NOISE FROM BUILDING EQUIPMENT

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:

- does not comply with the Acceptable Noise Levels as set out in a technical memorandum;

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13 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. 2000.

- is a source of annoyance to any person other than persons on the premises; and
- does not comply with any standard or limit contained in any current Regulations.

In practice the Authority will respond to complaints and compliance with the Acceptable Noise Levels will be required only after a Noise Abatement Notice has been served. Non-compliance with such a notice will be an offence. The Environmental Protection Department's Technical Memorandum(14) contains the technical procedures that should be adopted by the Authority when investigating a complaint regarding noise emanating from such premises to determine whether or not a noise abatement notice should be issued. Good practices on building services system noise control is published by the Environmental Protection Department(15,16).

Objective of HK-BEAM

Reduce the nuisance caused to neighbours by noise from building services equipment.

Maximum number of credits attainable: 1

Credit requirement

✧ 1 credit for complying with the acceptable noise levels for neighbouring sensitive receivers in accordance with the Technical Memorandum for the Assessment of Noise from places Other Than Domestic Premises, Public Places or Construction Sites.

Method of assessment

The building services shall be so installed that the rating of the noise does not exceed the limits given in the Technical Memorandum. The Owner/Operator shall provide evidence that the building complies with the criteria given in the Technical Memorandum through a survey carried out by a suitably qualified person. The general calibration and measurement procedures shall be in accordance with the Annex to the Technical Memorandum for the assessment of noise.

Alternatively, where the Owner/Operator has been issued with a Noise Abatement Notice within the past three years and has taken steps to rectify the situation, the outcome of a satisfactory response to the Authority shall be accepted for compliance for this credit.

2.2.3 LIGHT POLLUTION

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(17,18) may be regarded as waste light from lighting schemes that produce glare, obscures the night sky, adversely effects nocturnal ecosystems, and may intrude on neighbouring properties.

Objective of HK-BEAM

Ensure that exterior lighting does not create unwanted and unnecessary light pollution.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for exterior lighting installations demonstrating:

✧ that the average illuminance for site lighting does not exceed 1.5 times the recommended maintained illuminance; and

✧ interior and exterior lighting installations are such that no direct beam of light from luminaires

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14 Environmental Protection Department. Technical Memorandum for the Assessment of Noise from Places Other than Domestic Premises, Public Places or Construction Sites. 2nd Ed. June 1997.
http://www.epd.gov.hk/epd/english/environmentinhk/noise/guide_ref/files/tm_nondomestic.pdf

15 Environmental Protection Department. Good practices on pumping system noise control. 1999.

16 Environmental Protection Department. Good practices on ventilation system noise control. 1999.

17 http://www.darksky.org/resources/library.html

18 http://www.ile.org.uk/documents/Reduction_of_Light_Pollution.htm

leaves the area that is intended to be lit.

Method of assessment

The Owner/Operator shall provide evidence in the form of a survey carried out by a suitably qualified person demonstrating that the site and building lighting installations comply with the criteria through measurements, calculations and/or modelling studies based on the actual installed equipment.

The report shall detail the locations of all exterior luminaires with their beam direction and extent or area illuminated by the luminaires. Calculation of exterior area illuminance shall be carried out using either the calculation methods described in Appendix 1 of CIBSE Lighting Guide LG6(19), suitable computer software, or the approach given by the Illumination Engineering Society of North America(20).

2.3 SITE MANAGEMENT

This section embraces various management initiatives to improve on the environmental performance of a building development. It is expected that the Owner/Operator of the development will have in place a number of initiatives to reduce environmental impacts with appropriate levels of senior management support, staffing and resources, and can provide tangible evidence of the actions taken and results achieved.

2.3.1 ENVIRONMENTAL MANAGEMENT POLICY

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(21) 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(22). HK-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.

Objective of HK-BEAM

Encourage building management practices that acknowledge and promotes the need to reduce the environmental impacts of buildings.

Maximum number of credits attainable: 1

Credit requirement

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19 The Chartered Institution of Building Services Engineers. Lighting Guide LG6: The outdoor environment. London, CIBSE, 1992.

20 Illumination Engineering Society of North America Recommended Practice Manual: Lighting for Exterior Environments. IESNA, 2002.

21 International Organization for Standardization. ISO 14004 Environmental management systems – General guidelines on principles, systems and supporting techniques. 1996.

22 Environmental Protection Department. http://www.epd.gov.hk/epd/english/how_help/tools_ems/overview.html

❖ 1 credit for having an established environmental policy endorsed at Directorate level.

Method of assessment

The Owner/Operator will be required to provide a copy of the Company's overall policy with regard to the environment. HK-BEAM assessment focuses on the implementation of an effective Environmental Policy in respect of the environmental aspects associated with the management, operation and maintenance of existing buildings. Such commitments should seek to:

- reduce water consumption and effluents discharge;
- reduce material consumption, and to reuse or recycle wastes whenever practicable;
- promote the use of recycled and recyclable materials;
- encourage suppliers to reduce the environmental impacts of their goods and services;
- require suppliers to avoid unnecessary packaging, and encourage to use returnable, recycled, recyclable, biodegradable and non-toxic packaging materials;
- ensuring operational plant is so designed and operated as to minimise visual, noise and other impacts on the local environment;
- establishing objectives and targets for environmental performance improvements and actions; and
- provide a framework for setting and reviewing the environmental objectives and targets.

Where such a document has been produced and the Owner/Operator is able to demonstrate that it is published and openly available to customers, suppliers and staff, a credit shall be given.

If the Owner/Operator has an EMS in place that is currently certified under ISO 14001[(23)] then credit shall be awarded without further evidence of compliance.

2.3.2 Environmental Purchasing Policy

An organisation's purchasing policy forms part of environmental management. Where major consumers include environmental considerations in purchasing decisions, the market place does respond. HK-BEAM encourages purchasing practices that promotes the supply and use of environmentally friendly products, materials and equipment used in building operations and maintenance, redecoration, fit-out, etc. Subsequent sections of HK-BEAM 5-03 addresses the extent to which the declared policy is appropriate in its implementation and outcome.

There are no well-defined criteria to label materials as green or environmentally-friendly, although life-cycle analysis can be used to assess materials from an environmental perspective. 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 environmental impact from materials used in buildings are energy use and the possible impacts on the health and comfort of occupants. Many products used in buildings have green environmentally-friendly alternatives that can be substituted. The basic approach in selecting environmentally-friendly materials includes:

- choosing durable products and materials;
- choosing materials with low embodied energy, in particular if energy use in transportation is significant;
- avoiding the use of CFCs, HCFCs and halons, including use in the manufacture of products;
- selecting locally produced materials where available;
- using salvaged materials and products made from recycled materials;
- buying timber which is supplied from sustainable sources;

[23] International Organization for Standardization. ISO 14001: Environmental management systems – Specification with guidance for use. 1996

- using organic solvent-based finishes, paints, stains, and adhesives with low levels of pollutant emissions;
- minimize packaging; and
- purchasing energy and water efficient equipment, etc.

Objective of HK-BEAM

Encourage purchasing practices which seek to reduce the environmental impact of products used in the operation and maintenance of buildings.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for demonstrating the implementation of purchasing practices which encourages the supply and use of environmentally friendly materials, products and equipment.

Method of assessment

The environmental policy and practices adopted should address the key environmental goals, including but not limited to purchasing and supply of:

- virgin materials such as timber and timber products;
- products having significant recycled content;
- products that are recyclable after use;
- materials and products that are hazardous to the environment, such as CFCs;
- materials and products that have impact on the health and comfort of occupants; and
- equipment that is energy and water efficient, and with low levels of emissions.

The Owner/Operator shall demonstrate through records and correspondence that steps are taken to source, and where available at reasonable cost, to purchase materials, products and equipment which have reduced impacts on the environment. Credit shall be awarded where it can be demonstrated that actions are taken on an ongoing basis to target environmentally friendly materials, products and equipment for purchase.

If the Owner/Operator has an EMS in place that is currently certified under ISO 14001 then credit shall be awarded without further evidence of compliance.

2.3.3 Building Maintenance

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 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 building fabric inspections should be carried out by to set up and subsequently to monitor a long-term planned maintenance programme and to ensure that all maintenance will continue, to retain asset value of the building and meet the environmental requirements. Guidance on the management and selling up of a building maintenance programme is given in ISO and British standards[24,25].

24 International Organization for Standardization. ISO 15686 Buildings and constructed assets (3 parts).

25 British Standards Institution. BS 8210: 1986. Guide to building maintenance management.

Objective of HK-BEAM

Encourage proper planned maintenance of a building's fabric and structure, thus prolonging its life and avoiding unnecessary use of resources required for premature replacement.

Maximum number of credits attainable: 2

Credit requirement

a) Building maintenance manual

❖ 1 credit for a fully documented building maintenance manual appropriate to the building development.

b) Maintenance programme

❖ 1 credit for demonstrating the operation of a planned programme of regular inspection, cleaning, and maintenance of the building's fabric and structure.

Method of assessment

a) The Owner/Operator shall provide the HK-BEAM Assessor with access to the building maintenance manual for the purpose of assessment. Information contained in the manual needs to include that which assists persons carrying out work on the fabric and structure at any time and should include as a minimum:

- the design specifications;
- 'as built' drawings and plans;
- general details of the construction methods and materials used;
- details of the structure's equipment and maintenance facilities;
- maintenance procedures and requirements for the structure;
- operating and maintenance procedures and schedules for plant and equipment installed; and
- details on the location and nature of utilities and services.

b) The Owner/Operator shall to provide details of their maintenance programme for the building fabric, which shall include:

- a list of the elements of the building fabric that are subject to regular inspection and maintenance, for example window frames, cladding, etc.;
- a description of the planned maintenance procedures adopted for each item, including frequency of inspection and maintenance, and the position and technical qualifications of those responsible for undertaking the maintenance, including any outside contractors; and
- a log book or computer based system for recording and monitoring maintenance visits.

Where a planned programme of maintenance has been drawn up and documented in the form of an easy-to-follow manual and where it is demonstrated that it is being implemented in the manner it prescribes, credit shall be awarded.

2.3.4 Building Services Operation and Maintenance

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. To ensure the correct operation of the building's engineering services an easy-to-follow manual is required. This should list all the services contained within the building, giving for each a description of its function, operating instructions and the standard control settings to be adopted.

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[26,27]. Unfortunately, there is much evidence to show that this is not always adequate and that this lack of care for detail can have significant negative impact on the indoor environment and/or efficiency of energy use.

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[28]. The effectiveness of operation and maintenance practices may be assessed through a systematic audit[29].

Objective of HK-BEAM

Enable building operators to operate building services systems at or near optimum performance.

Maximum number of credits attainable: 4

Credit requirement

a) HVAC systems

❖ 1 credit for having an easy-to-follow, regularly updated manual detailing the operating methods, instructions and standard control settings for HVAC systems and equipment.

b) Other engineering systems

❖ 1 credit for having an easy-to-follow, regularly updated manual detailing the operating methods, instructions and standard control settings for non-HVAC systems and equipment.

c) Operations & maintenance programme

❖ 1 credit for an established programme of regular inspections, cleaning and maintenance of all building services engineering systems.

d) Assessment of operation & maintenance practices

❖ 1 credit for having undertaken an audit of the effectiveness of the operation and maintenance practices for all building services engineering systems.

Method of assessment

a) A credit shall be given when the Owner/Operator can demonstrate that an original or properly updated set of HVAC O&M manuals exist, which details the following:

- overview of the HVAC system and sub-systems and main equipment, and their integration;
- modes of operation;
- schematic diagram of the systems and sub-systems;
- automatic controls diagram and description;
- record drawings of the installations as built;
- safety procedures and instructions;
- manufacturers information on all major equipment (not just catalogue copies);
- relevant statutory regulations and codes of practice;
- commissioning results;
- the operating and maintenance strategy for the installation;

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26 American Society of Heating, Air-conditioning, and Refrigerating Engineers. ASHRAE Guideline 4. Preparation of Operating and Maintenance Documentation for Building Systems. ASHRAE, 1993.

27 Building Services Research and Information Association. Application Guide AG 1/87.1. Operating and maintenance manuals for building services installations. BSRIA 1990.

28 Building Services Research and Information Association. Application Guide AG 1/98. Maintenance programme set-up. BSRIA 1998.

29 Building Services Research and Information Association. Application Guide AG 24/97. Operation and maintenance audits. BSRIA 1997.

- the indoor environmental conditions for which the building is designed, covering seasonal variations;
- the control strategies to achieve this objective;
- equipment operating parameters and control settings to be monitored.;
- full maintenance instructions with access points, monitoring points, etc., identified; and
- maintenance schedules.

Material should be arranged in order of ascending detail, and with appropriate indexing. The final documentation should be capable of being used without other reference material.

b) The Owner/Operator shall confirm in writing that the original set of O&M manuals have been maintained, and can provide:

- a list of non-HVAC building services equipment and control systems requiring maintenance, e.g., lifts, escalators, generators, fans, pumps, etc.;
- a description of the maintenance procedures adopted for each item of equipment, including frequency of inspection and maintenance, and the name of the person(s) or company responsible for undertaking the maintenance; and
- details of the system used for recording and monitoring maintenance activities.

c) The programme shall detail the following:

- organisational structure identifying staff, job functions, duties and responsibilities, skill and competence levels, resources provided, information systems, responsibilities for maintaining records, etc;
- stores and stock control;
- statutory requirements for inspections and checks on all systems and equipment;
- system planning, scheduling and recording of maintenance activities;
- condition surveys and inspection;
- health and safety at work provisions, statutory and additions practices;
- disposal of hazardous waste and potentially harmful substances;
- allocation of budgets, financial controls, investment in upgrades;
- management of sub-contractors, service contractors, etc; and
- condition based maintenance practices, etc.

The programme should ensure updating of relevant information in O&M manuals (as-fitted drawings, equipment specifications, etc) as old equipment is replaced and new equipment introduced. The maintenance schedules, either in-house or under external contract, shall address on regular basis system efficiency and the setting and operation of controls. Means of checking the performance need to be in place and to be readily understandable by the organisation's management through regular reports A credit is given where an established O&M programme exists and is placed under the authority of a senior executive.

d) The Owner/Operator 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 that detailed in BSRIA's guide[(30)] or similar equivalent approach.

2.3.5 STAFFING RESOURCES

Staff skill and experience is an important factor in achieving improvements in building

[30] Building Services Research and Information Association. Application Guide AG 13/2000. Toolkit for Building Operation Audits. BSRIA 2000.

performance. 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 out-sourced the contractors should also be suitably qualified to undertake the work.

Objective of HK-BEAM

Ensure staffing resources are adequate for carrying out and maintaining improvements to building and system performance.

Maximum number of credits attainable: 1

Credit requirement

- 1 credit where adequate staffing levels and skills exist to meet the requirements of the building development.

Method of assessment

The Owner/Operator of the building development will be asked to provide details of the staffing arrangements to match management, operation and maintenance requirements, or where outsourcing is used, the contractual arrangements defining the experience and skills of contractors. Furthermore, the Owner/Operator shall provide details of training undertaken by operations and maintenance staff in the previous three years and details of current plans and budgets for further training.

It is expected that managers and engineers will have appropriate qualifications and/or experience, and that technical staff will have appropriate technical and/or trade qualifications befitting their assigned duties, and that continuing education and training matches the needs of their assigned duties.

2.3.6 BUILDING USERS HANDBOOK

Environmental friendly use and operation of buildings can be increased with the co-operation of the tenants or sub-owners of premises within a development. Very often they are not aware of the environmental issues or comfort and health issues. It is good practice to provide a users handbook giving details about the design and use of premises as they interface with the overall building development. It should contain guidance and information on regulations regarding internal decoration and fit-out work carried out in occupied areas, for example, advice on installation details to ensure proper ventilation.

Objective of HK-BEAM

Inform tenants/owners on the environmental, comfort and health impacts of their activities, and to encourage actions that reduce adverse impacts.

Maximum number of credits attainable: 2

Credit requirement

- 1 credit for a well compiled guide on environmental issues included in a building user's handbook.
- 1 additional credit where appropriate HK-BEAM performance criteria included in contractual arrangements with tenants.

Method of assessment

The Owner/Operator shall provide details of any instructions and guidance materials issued to tenants/users of the building development. Credit shall be awarded where it is demonstrated that the guidance given shall encourage environmentally friendly use and operating practices by users, including, but not limited to the following guidance on:

- the selection, installation and use of energy efficient equipment (for example equipment and appliances certified under the Energy Efficiency Labelling Scheme[31];
- energy efficient operation of equipment and facilities, for example, air conditioning units, ventilation fans, kitchen exhaust fans and hoods, etc;
- water conservation;
- the selection of sustainable materials for fit-out and redecoration, etc;
- cleaning, use of pesticides, etc;
- sorting, recycling, and hygienic disposal of waste materials, particularly hazardous waste; and
- control of indoor pollutant sources, etc.

Where contractual arrangements between the Owner/Operator and tenants reinforce HK-BEAM criteria in relation to materials use (indoor environmental quality), energy efficiency, and water use an additional credit may be awarded. The Owner/Operator shall state clearly where contractual arrangements have resulted in reduced environmental impacts.

31 Electrical and Mechanical Services Department. http://www.emsd.gov.hk/emsd/eng/pee/eels_pub.shtml

3 MATERIALS ASPECTS

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. Ambient air pollution arises from extraction, processing and transportation, and certain materials and finishes contribute to indoor air pollution and consequent impacts on health and comfort. There are opportunities to reduce environmental impacts through interior design methods, choice of materials, and installation methods. The production, use and disposal of materials accounts for significant quantities of energy and resources. Of concern are:

- toxic pollutants arising from manufacturing and combustion;
- primary energy used in extraction, production and transport;
- emissions to air, mainly CO_2, NO_x, SO_2, and volatile organic compounds;
- use of mineral, water and oil resources;
- waste generated; and
- percentage of recycled material, percentage capable of being recycled, energy to recycle, etc.

3.1 EFFICIENT USE OF MATERIALS

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

3.1.1 BUILDING REUSE

Rehabilitation of parts of existing buildings is a component of redevelopment practices in many cities around the world. Building developments that have taken advantage of pre-existing structures or made substantial use of salvaged materials have already reduced environmental impacts.

Objective of HK-BEAM

Encourage the reuse of building components and salvaged materials.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit where pre-existing foundations, building structural elements or other salvaged materials were used in the construction of the building development.

Method of assessment

The Owner/Operator shall provide evidence as to the extent to which major building elements from an existing building, or materials salvaged from any buildings, were used in the construction of the building redevelopment. The report shall include pre-construction and post-construction details highlighting the reused elements and materials. If construction of the building development comprises of at least 10% by volume of pre-existing or salvaged materials the credit shall be awarded.

3.1.2 ADAPTABILITY AND DECONSTRUCTION

Change of ownership, changing use of premises, changing demography of family units, etc require modifications to the layout of most types of premises. Quite large amount of solid waste is generated during the remodelling of premises, such as demolition of walls and partitions. Designs that allow users flexibility in the partitioning of premises and modular designs that allow for salvage during deconstruction can significantly reduce consumption of resources and generation of waste. Examples include:

- reducing the use of embedded infrastructure for power, data and HVAC systems;
- the use building systems that isolate structural and building enclosure systems used for housing and carrying building services equipment;
- the provision of lightweight partitions that can be moved to change layout; and
- design that allows interior fitting-out to use modular components, etc.

Objective of HK-BEAM

Encourage greater flexible in the design of building, interiors and building services, to reduce the consumption of natural resources and to reduce waste.

Maximum number of credits attainable: 3

Credit requirement

a) Structural flexibility

❖ 1 credit for designs providing flexibility through the choice of building structural system to allow for change in future use, and which is coordinated with interior planning modules.

b) Spatial flexibility

❖ 1 credit for designs providing spatial flexibility that can adapt spaces for different uses, and allows for expansion to permit additional spatial requirements to be accommodated.

c) Flexible servicing

❖ 1 credit for designs providing building in-service flexibility through provision of building services elements that allows for change in the use of the building.

Method of assessment

The Owner/Operator shall provide a report prepared by a suitably qualified person presenting arguments as to how and the extent to which building adaptability is provided. The report shall include drawings and documents including building plans and detail specifications together with elaboration and justification of specific design strategies that provide for assessment purpose. Where it can be demonstrated that the building development provides above average structural and/or spatial flexibility, and/or flexibility in servicing then credits shall be awarded.

3.1.3 MODULAR AND STANDARDISED DESIGN

This refers to use of standardised grid systems of design allowing standard size factory built and assembled components to be used. Examples include partitions, doors, cabinets, luminaires, etc. Standardisation of details goes hand in hand with optimisation of material quantity. It also generally has benefits for both quality and environmental cost. Materials should be dimensioned carefully to use standard-sized modules to the greatest extent to minimise construction off-cutting waste. The following aspects shall be considered as a minimum:

- structural modules e.g. pre-cast system of structural beams
- façade modules e.g. bay-window units, cladding units
- internal building elements e.g. internal partitions
- building services modules e.g. toilet cubicles

Objective of HK-BEAM

Encourage increased use of modular and standardised components in building designs in order to reduce waste.

Maximum number of credits attainable: 1

Credit requirement

- ❖ 1 credit for demonstrating the application of modular design in buildings.

Method of assessment

The Owner/Operator shall submit a report that includes 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 listed, the credit shall be awarded.

3.2 SELECTION OF MATERIALS

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 and fit-out.

3.2.1 SUSTAINABLE FOREST PRODUCTS

Wood is the most ecologically benign of construction materials. However, there are hardwoods which are being extracted from virgin forests in an unsustainable manner, destroying valuable forests and ecosystems. Similarly, some softwoods, such as redwood and cedar are being depleted. Where forests are being harvested in an unsustainable manner, the result is the extinction of indigenous species and the clearance of vegetation that would otherwise help regulate the amount of CO_2 in the atmosphere and global warming. Improved forestry practices can be encouraged by only specifying timber from sources where the forests are well managed.

Hong Kong uses only imported timber, and is one of the largest importers of tropical hardwoods. The construction and real estate sectors in Hong Kong are major consumers of hardwoods from tropical rainforests, with a large proportion used wastefully. Wood should therefore 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[32,33].

Objective of HK-BEAM

Reduce the consumption of non-sustainable forest products and encourage the use of timber from managed forests.

Maximum number of credits attainable: 1

Credit requirement:

- ❖ 1 credit for using solid timber products and composite timber products which are entirely from well managed sustainable sources, including reuse of salvaged timber.

Method of assessment

It is a pre-requisite for credits that tropical hardwoods, such as sapele, mahogany, ramin, etc. or products containing same from unsustainable sources or unknown origin are not used.

The Owner/Operator shall present evidence in the form of specifications and purchasing documents detailing the intention to use timber from sustainable sources, to use efficiently, or to

32 EcoWood@sia. http://www.ecowoodasia.org/

33 Certified Forest Products Council. Project Toolkit. Succeeding with Certified Wood. http://www.certifiedwood.org/documents/Certified_Wood_Project_Kit_C.PDF

use alternatives. The evidence shall demonstrate that preference has been given to timber from forests that are subject to an independent certification scheme or a national certification scheme that is compatible with generally accepted international principles. Evidence should include as far as practicable:

- the supplier's formal environmental policy with regard to wood products;
- the species and country of origin;
- the name of the concession or plantation within the country of origin supplying the timber;
- a copy of the forestry policy being pursued for the plantation or concession;
- shipping documents confirming that the timber supplier has indeed obtained their timber from that concession.

The Owner/Operator will be asked to obtain written confirmation from the suppliers regarding the composition of wood-based panel products being used on the building. Even birch-faced plywood may contain veneers of hardwood of tropical origin. If plywood does contain tropical hardwood, credit will only be given if the information listed above can be obtained, confirming its source.

3.2.2 OZONE DEPLETING SUBSTANCES

The stratospheric ozone layer reduces the amount of short-wavelength ultraviolet radiation from the Sun that reaches the Earth's surface. Exposure to this radiation can have harmful effects on plants, agricultural crops and marine organisms, and cause skin cancer and eye cataracts. A number of natural and man-made trace gases are known to decompose ozone in the stratosphere. Chlorofluorocarbons (CFCs), hydrochloro-fluorocarbons (HCFCs) and halons are man-made gases which have been released in increasing concentrations since the 1950s, and these have contributed to the holes in the ozone layer above the polar regions.

Buildings have contributed to this depletion partly through leaks of CFC and HCFC refrigerants from air conditioning and refrigeration systems. In addition CFCs and HCFCs are used as blowing agents for some thermal insulation materials, whilst halons are used in fire protection systems. Alternative systems and materials are available which avoid ozone-depleting substances.

Objective of HK-BEAM

Encourage proper management of the phase-out of ozone depleting substances, through replacement, conversion and good maintenance of refrigeration and air-conditioning plant.

Maximum number of credits attainable: 5

Credit requirement

a) Refrigerants in air conditioning and refrigeration systems and equipment

Where all refrigerants used are classified as having low ozone depletion potential (ODP):

❖ 1 credit where the refrigerants employed in the air conditioning system have an average ozone depletion potential of less than 0.03.

❖ 2 credits where the refrigerants employed in the air conditioning system have an ozone depletion potential of zero.

Alternatively, where only some of the refrigerants used are classified as having low ozone depletion potential (ODP) and the remainder are being replaced in a phased programme:

❖ 1 credit for demonstrating a phased programme of refrigerant replacement to an average ozone depletion potential of zero.

b) Refrigerant leak detection

❖ 1 credit for:

✧ installing automatic refrigerant leak detection for indoor chiller plant, or carrying out monthly manual checking for leakage for outdoor plant; and

- ensuring full refrigerant recovery during maintenance using approved refrigerant recovery equipment and containers.

c) Halon fire protection

- 1 credit where:
- no halon-based fixed or portable fire protection systems are used in the building, or
- a schedule of maintenance and testing of fixed halon fire protection systems has been drawn up with the specific aim of minimising unnecessary emissions of halon; and
- where a decommissioning programme of existing halon systems is in place.

d) Insulation material made only with agents of zero ozone depletion potential

- 1 credit for using insulation materials that avoids the use of ozone depleting substances in their composition or during their manufacture.

Method of assessment

a) The Owner/Operator shall provide documentation detailing the refrigerant(s) used in the air conditioning system(s). This shall include details of quantities of each refrigerant by trade name, chemical composition and ODP. Where the refrigerant replacement programme has not been completed the Owner/Operator shall provide details of the replacement 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.

b) A survey of the building shall reveal if automatic refrigerant detection systems have been installed. A credit will be given where sensors have been installed to sample the air at various points around the refrigeration system with the specific aim of detecting small refrigerant leaks. The sensors should be linked to alarm signals in the plant room and preferably the reception area and designed to trigger the alarm when refrigerant gases are detected. The intention of the system must be to detect leaks and therefore the sensors will need to be set to raise an alarm at refrigerant concentrations lower than those considered to be hazardous to health.

For circumstances where automatic refrigerant detection systems may prove unreliable, such as air cooled chillers or chillers with remote air cooled condensers, suitable alternatives can be considered. For example, the use of a fluorescent dye added to the refrigerant to allow leaks to be detected using an ultra-violet lamp, and where checks are carried out on a regular basis. The Owner/Operator shall provide details of the system used.

The recovery equipment should consist of either a fixed or a portable recovery unit with suitable connections to match the valves on the refrigeration system. Portable refrigerant storage cylinders must also be provided, with sufficient capacity to hold the full refrigerant charge from the largest refrigeration circuit. These cylinders should be correctly labelled to match the refrigerant in the system. Alternatively, if the Owner/operator can demonstrate compliance through an acceptable maintenance agreement with a suitably qualified contractor, then credit shall be awarded.

c) A survey of the building shall reveal if halon fire protection systems have been installed. These may take the form of either hand-held extinguishers or fixed fire protection systems serving, for example, computer rooms or electricity switch rooms. Where either hand-held or fixed halon fire protection systems are present in the building, the Owner/Operator will be asked to provide written details of their practices for ensuring that emissions are reduced to a minimum.

The practices covering any maintenance, filling or decommissioning of the systems shall be carried out in accordance with the guidelines given in ISO Standard 72101-2[34]. Testing and inspection procedures for portable fire extinguishers should be carried out according to British Standard BS 5306: Part 3:1985: Section 8.12[35]. For total flooding systems the fan pressure

[34] International Standard ISO 72101-2: 1991. Fire extinguishing media – Halogenated hydrocarbons – Part 2: Code of practice for safe handling and transfer procedures of halon 1211 and halon 1301. (IBS EN 27201-2: 1994).

[35] British Standards Institution. Fire extinguishing installations and equipment on premises. Part 3. Code of practice for selection, installation and maintenance of portable fire extinguishers. British Standard BS 5306: Part 3: 1985.

testing procedure set out in British Standard BS 5306: Section 5: 1992[36] should be specified. Written agreements will need to have been drawn up with any contractor undertaking work on the system, to ensure that these requirements are being met.

Where staff are trained in the use of hand-held extinguishers, the policy should require that training does not proceed to discharge of the halon contents. The policy should also require that all halon contained within the fire protection system is recovered for recycling or proper disposal at the end of its life or when equipment is replaced.

d) The Owner/Operator shall full description of all the insulation materials currently purchased and used for building operation and maintenance, e.g., for roofs, chilled water pipes, refrigerant pipes, ductwork, etc., to demonstrate that none contain ozone-depleting agents, or such agents are used in their manufacture.

3.3 WASTE DISPOSAL AND RECYCLING FACILITIES

Hong Kong is running out of land for waste disposal, and without concerted effort the existing landfill sites could be exhausted by 2015. In 2001 the average daily amount of solid waste disposed of at landfills was 16820 t, 38% of which was non-inert Construction & Demolition Waste (C&D). In addition, reclamation sites accepted over 35 000 tonnes per day of inert construction waste such as earth and rocks. Although an environmentally-preferable alternative to landfills, they will be in short supply after 2003.

Well managed facilities for the recycling of domestic solid waste encourage recycling and results in reductions in the disposal at landfill sites. Buildings should provide adequate facilities for waste separation and sorting, and short term storage at appropriate locations.

Objective of HK-BEAM

Reduce pressure on landfill sites and help to preserve non-renewable resources by promoting recycling of waste materials.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for providing adequate services for the collection, sorting, storage and disposal of waste and recovered materials that has no negative impact on the health and comfort of building users.

Method of assessment

A prerequisite for credits is that the management system provides for the proper identification, collection and sorting of hazardous waste from all premises within the building development in accordance with Regulations.

The Owner/Operator shall provide details of the system that provides for the collection and sorting of waste from premises within the building development and demonstrate the adequacy of the waste storage, sorting and recycling facilities. The system shall provide information to tenants/occupants as to what constitutes good practice in recycling waste, and encourage users to separate their waste by providing appropriate containers and a regular system of collection. The management system shall monitor the waste collection and disposal system, including the practices of waste collection contractors to ensure recycling takes place within the framework available.

36 British Standards Institution. Fire extinguishing installations and equipment on premises. Part 5. Halon systems. Section 5.1. Halon 1301 total flooding systems. British Standard BS 5306: Part 5: Section 5.1: 1992.

4 ENERGY USE

An objective of HK-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.

This version of HK-BEAM is intended to be a comprehensive scheme for covering nearly all types of existing buildings. A generic framework for assessing the energy performance of buildings has been established to serve this purpose. However, due to the large variety of types of premises and buildings that may be encountered it was not possible to establish and incorporate into this document all the variables required for a full and comprehensive assessment for all permutations. The scheme itself needs to be evolving, drawing from experience of its implementation. Therefore, for an assessed building where there are premises for which detailed data for establishing the zero-credit and best achievable performance is not available, the HK-BEAM Assessor will need to develop appropriate criteria for the assessment, with assistance from the building management and tenants concerned.

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.

4.1 ASSESSMENT OF ENERGY USE

The general framework and procedures for assessing energy performance of new building designs, and the relevant data for use in the assessment, are described in detail in Appendix A. To cope with the wide range of buildings that may be encountered, buildings/premises are considered as one of three types according to the provisions for air-conditioning and ventilation. This classification is needed as the operational needs of buildings together with the different air-conditioning and ventilation systems that serve their needs results in large variations in energy use between buildings.

The assessment criteria for energy use and maximum electricity demand are given in Section 4.2. Sections 4.3 to 4.6 describe assessments on various energy specific features that are applicable to various types of existing buildings.

Air-conditioned buildings/premises

This refers to buildings such as commercial buildings/complexes and hotels that are predominantly 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. Such buildings may include areas that are mechanically or naturally ventilated. The assessment of mechanical ventilation systems and the provisions for natural ventilation are covered in Section 4.3.

Air-conditioned/naturally ventilated buildings/premises

This refers to buildings such as residential buildings and some schools that use natural ventilation for indoor thermal environment and/or air quality control whenever the outdoor conditions permit, but may be air-conditioned when natural ventilation fails to provide adequate indoor comfort conditions. Assessments of features specific to this classification of premises are given in Sections 4.3 and 4.4.

Mechanically ventilated buildings/premises

This refers to buildings such as car parks, public transport interchanges, factories, warehouses etc., where the major areas are not air-conditioned but rely on mechanical ventilation for indoor thermal environment and/or air quality control. The particular approach for this category of buildings is described in Section 4.2.6, and the assessment of features specific to this classification of premises are given in Sections 4.3 and 4.4.

Other buildings/premises

Notwithstanding that many buildings in Hong Kong would belong to one of the above categories, there are others that comprise a mix of premises found in all three. For instance, a university complex could include air-conditioned offices and classrooms, mechanically ventilated laboratories and naturally ventilated car parks while an urban complex may include a naturally ventilated market, an air-conditioned library and mechanically ventilated sports halls. Special buildings may comprise premises that are different from any in the three categories. Such buildings are categorised here as 'other buildings' and would be assessed based on either the generic framework for energy performance assessment, with benchmarks and parameters for quantification of energy performance determined as the first step of the assessment, and/or feature specific assessments, as described in Sections 4.3 to 4.6.

4.2 ANNUAL ENERGY USE

Electricity generation accounts for around 60% of the total CO_2 emissions in Hong Kong while buildings, particularly air-conditioned buildings, are responsible for consuming more than half of the electrical energy each year. For most buildings, the energy use for running the building over its lifetime will be many times greater than the sum of the energy used for constructing the buildings. Ensuring buildings are efficiently operated and maintained and consistently upgraded for improving efficiency is, therefore, a crucial means to energy conservation and reducing carbon dioxide and other emissions.

4.2.1 ENERGY USE IN COMMERCIAL BUILDINGS

The number of credits to be awarded under the building energy performance assessment will be determined with reference to the percentage of reduction in annual energy use of the assessed building relative to the respective zero-credit criteria evaluated from the baseline building model.

Objective of HK-BEAM

Reduce consumption of natural energy resources, and reduce harmful emissions to the atmosphere.

Maximum number of credits attainable: 10

Credit requirement

- 1 credit for a reduction in the annual energy consumption by 10%.
- 2 credits for a reduction in the annual energy consumption by 14%.
- 3 credits for a reduction in the annual energy consumption by 18%.
- 4 credits for a reduction in the annual energy consumption by 22%.
- 5 credits for a reduction in the annual energy consumption by 26%.
- 6 credits for a reduction in the annual energy consumption by 30%.
- 7 credits for a reduction in the annual energy consumption by 34%.
- 8 credits for a reduction in the annual energy consumption by 38%
- 9 credits for a reduction in the annual energy consumption by 42%
- 10 credits for a reduction in the annual energy consumption by 45%.

Method of assessment

An existing commercial building/complex, which may be an office-only building, an office/commercial building or a commercial building with no offices (such as a standalone shopping centre and the commercial portion of a residential development), will be assessed based on the method for air-conditioned buildings, as described in Appendix A. The assessment embraces the overall energy use in the building except, for multi-tenanted buildings, the individual consumption of tenants. Fan energy use in air-handling equipment powered by tenants' supply, however, is included.

The determination of annual energy use and maximum electricity demand of the baseline building model shall 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 A.4 and A.5 in Appendix A. Performance of air-conditioning equipment shall be taken as being at a level that it barely complies with the minimum requirements stipulated in the Code of Practice for Energy Efficiency of Air Conditioning Installations.

For relatively simple 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. The available regression models and their applicable limits are described in Appendix B.

The zero-credit criteria for the annual energy use and maximum electricity demand of the assessed building shall then be determined by scaling up the annual energy use and maximum electricity demand of the baseline building model by 150% and 125%, respectively.

4.2.2 MAXIMUM ELECTRICITY DEMAND IN COMMERCIAL BUILDINGS

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.

The number of credits to be awarded will be determined with reference to the percentage of reduction in the maximum electricity demand of the assessed building relative to the respective zero-credit criteria evaluated for the baseline building model.

Objective of HK-BEAM

Encourage energy efficiency and other means to reduce maximum electricity demand.

Maximum number of credits attainable: 3

- 1 credit for a reduction in the maximum electricity demand by 15%.
- 2 credits for a reduction in the maximum electricity demand by 23%.
- 3 credits for a reduction in the maximum electricity demand by 30%.

Method of assessment

Refer to Section 4.2.1.

4.2.3 ENERGY USE IN HOTEL BUILDINGS

Besides electricity, a hotel may use gas and/or oil for cooking, water heating, steam production and winter space heating. Since these fuels are an alternative of one another as an input for producing heat, the mix of these fuels being used in one hotel can be significantly different from that of another hotel, depending on the types of heating systems the hotels use. Hotel energy surveys indicated that electricity use in hotels in Hong Kong can vary between 41% and 91% of the total energy use. This highlights that rather than focusing on the electricity use, there is a need to base the assessment of the environmental impacts due to energy use in hotels on the incurred CO_2 emission per annum. The energy surveys also revealed that the energy use for air-conditioning in hotels accounted for, in average, 31% of the total energy use. Although this is less dominant compared to other types of commercial buildings, it is still a significant portion of the total energy use.

The number of credits to be awarded to an existing hotel for its energy performance shall be determined on the basis of the percentage reduction in the CO_2 emissions relative to the zero-benchmark value.

Since alternative fuels can be used, no assessment will be made on the maximum electricity demand in an existing hotel.

Maximum number of credits attainable: 10

Credit requirement

- 1 credit for a reduction in annual CO_2 emission by 10%.
- 2 credits for a reduction in annual CO_2 emission by 14%.
- 3 credits for a reduction in annual CO_2 emission by 18%.
- 4 credits for a reduction in annual CO_2 emission by 22%.
- 5 credits for a reduction in annual CO_2 emission by 26%.
- 6 credits for a reduction in annual CO_2 emission by 30%.
- 7 credits for a reduction in annual CO_2 emission by 34%.
- 8 credits for a reduction in annual CO_2 emission by 38%.
- 9 credits for a reduction in annual CO_2 emission by 42%.
- 10 credits for a reduction in annual CO_2 emission by 45%.

Method of assessment

In view of the more complex energy characteristics of hotels, the method for assessing air-conditioned buildings, as described in Section A.1, has been expanded for application to an existing hotel building. Instead of setting a zero-credit 'energy use' benchmark for an existing hotel, the zero-credit benchmark is to with reference to the incurred CO_2 emission per annum that embraces all fuel types being used in the hotel.

A baseline value for the annual electricity use of air-conditioning and lighting installations shall be predicted based on a baseline building model following the method as described in Appendix A, including the mark-up by 50%. This prediction shall embrace all lighting installations in the hotel.

A baseline value for the annual electricity use of ventilation systems shall be predicted following the method for assessing mechanically ventilated buildings, as described elsewhere.

The baseline annual electricity use of vertical transportation systems shall be taken as 106 kWh per m² of the gross floor area of the hotel.

The total of the baseline annual electricity use values for the air-conditioning, lighting, ventilation and vertical transportation installations shall then converted into an equivalent CO_2 emission per annum using the conversion factor as given in Section A.5 in Appendix A.

The zero-credit benchmark, in kg of CO_2 emission incurred per m² of the gross floor area of the hotel per annum, shall be the value evaluated above plus 16.4 kg/m²-year (equivalent to the emission incurred by using around 1,000 MJ/m^2 of heat energy generated from burning town gas), which is to account for the emission incurred by using town gas or fuel oil for cooking, water heating and other processes. With this allowance made for the use of town gas, use of other fuels that will generate more CO_2 per unit heat energy derived may lead to lower assessment scores.

The total CO_2 emission incurred due to energy use in the assessed hotel shall be determined from the annual consumption of electricity and other fuels, as reflected by the billing records in the past year, converted into total incurred CO_2 emission using the conversion factors given in Section A.5 in Appendix A and normalised by the gross floor area of the hotel.

The Code of Practice for Energy Efficiency of Air Conditioning Installations (Clause 7.4.2 in the Code) specifies that each hotel guestroom should be provided with a single master switch that will turn off conditioned air supply or reset the thermostat setting upward with or without simultaneously reducing the fan speed during the unoccupied periods to save energy. Since compliance with the Code is not yet a mandatory requirement, the effect of equipping guestrooms with such control devices will not be taken into account in predicting the annual electricity use for air-conditioning for the baseline building model. In this prediction, the patterns of occupation, lighting load and equipment load, as given in Table A.5.4 a), shall be used. The assumption shall be made in the energy use prediction that all the guestrooms will be air-conditioned 24 hours a day keeping indoor temperatures steadily at 22ºC throughout the year.

4.2.4 ENERGY USE IN RESIDENTIAL BUILDINGS

It is not expected that an existing residential building containing individually owned units will be submitted for assessment. However, rented, vacant or refurbished buildings can be assessed in the same away as for new buildings. The reasons for basing the assessment of existing residential buildings on the method for assessing new residential buildings include:

- the large variations in energy usage amongst flat owners/tenants;
- the difficulty in obtaining energy bills from all flat owners/tenants for assessing actual energy use;
- management companies can do little to affect the way in which owners/tenants use energy; and
- assessment of the energy performance of landlord services for new buildings applies equally well to existing residential buildings.

The number of credits to be awarded under the building energy performance assessment will be determined with reference to the percentage reduction in annual energy use of the assessed building relative to the respective zero-credit criteria evaluated from the baseline building model.

Maximum number of credits attainable: 8

Credit requirement

- ❖ 1 credits for a reduction in the annual energy consumption by 3%.
- ❖ 2 credits for a reduction in the annual energy consumption by 6%.
- ❖ 3 credits for a reduction in the annual energy consumption by 9%.
- ❖ 4 credits for a reduction in the annual energy consumption by 12%.
- ❖ 5 credits for a reduction in the annual energy consumption by 15%.
- ❖ 6 credits for a reduction in the annual energy consumption by 18%.
- ❖ 7 credits for a reduction in the annual energy consumption by 20%.
- ❖ 8 credits for a reduction in the annual energy consumption by 22%.

Method of assessment

For residential buildings, the assessment method will follow generally the method used for assessing buildings accommodating predominantly air-conditioned premises, as described in Section A.1 in Appendix A. There are specific conditions that apply to residential buildings, such as the method for quantifying the building envelope performance of the baseline building model and the use of standardised internal load intensities (see Appendix A, Section A.2). Where the estate development includes a commercial portion, the commercial and the residential portions will be separately assessed, with the commercial portion assessed according to the approach used for commercial buildings.

In the prediction of the annual energy use for air-conditioning in a residential tower, the months in the year that air-conditioners will be run to serve living rooms and bedrooms (the air-conditioned premises in a residential building) is taken to be April to October inclusive. The assessment assumes that no air-conditioning will be needed outside this period. The annual energy use for lighting and equipment in these rooms, however, shall be their total energy use throughout the year. The patterns of occupancy and the patterns of operation of the air-conditioners and the lighting and equipment shall be as given in Tables A.5.5 and A.5.6 in Appendix A.

In predicting the annual air-conditioning energy use in various flats in a high-rise residential building, the inter-shadowing effects among different parts of the same building and among different building blocks in the same development shall be taken into account. For simplicity, simulation calculations will need to be carried out, for a N-storey building, only for the Nth floor (the top floor), the (N-1)th floor, the (N-3)th floor (representing the (N-4)th to the (N-2)th floor), and the (N-10)th floor (representing the 1st floor to the (N-5)th floor). Such inter-shadowing effects will be ignored in predicting the annual air-conditioning energy use in the baseline building model.

4.2.5 ENERGY USE IN EDUCATIONAL ESTABLISHMENTS

The criteria and method of assessment for existing school and similar establishments shall be the same as for new educational establishments. This is appropriate when an existing school is submitted for assessment having not been assessed when new, or those for which significant improvement work has been undertaken, such as a major retrofit, conversion from predominantly non-air-conditioned to air-conditioned, etc. The reasons for basing the assessment of existing schools on the method for assessing new schools include:

- schools may utilise natural ventilation as far as practicable, but the durations during which adequate indoor environmental conditions could be maintained with natural ventilation varies from facility to facility and from year to year, and is beyond the control of the management;
- other than the building envelope design, which is often difficult to change, the energy performance of educational establishments is dependent on the efficiency of various equipment and appliances, such as air-conditioners, lighting installations, lifts, and various other equipment (e.g. computers and laboratory equipment); and
- there is insufficient information for determining energy use benchmarks for all the types of equipment and installations that are found in various educational establishments.

The number of credits to be awarded under the building energy performance assessment will be determined with reference to the percentage reduction in the annual energy use of the assessed building relative to the respective zero-credit criteria evaluated from the baseline building model.

Maximum number of credits attainable: 8

Credit requirement

- ❖ 1 credit for a reduction in the annual energy consumption by 5%.
- ❖ 2 credits for a reduction in the annual energy consumption by 9%.
- ❖ 3 credits for a reduction in the annual energy consumption by 13%.
- ❖ 4 credits for a reduction in the annual energy consumption by 17%.
- ❖ 5 credits for a reduction in the annual energy consumption by 21%.
- ❖ 6 credits for a reduction in the annual energy consumption by 24%.
- ❖ 7 credits for a reduction in the annual energy consumption by 27%.
- ❖ 8 credits for a reduction in the annual energy consumption by 30%.

Method of assessment

Assessment of the energy performance of an air-conditioned educational establishment follows generally the method for buildings accommodating predominantly air-conditioned premises if the major teaching and learning areas, particularly the classrooms, are air-conditioned. Otherwise, the method for assessing buildings accommodating predominantly non-air-conditioned premises shall apply.

For an establishment comprising predominantly air-conditioned premises, standard/default occupation densities and schedules, lighting and equipment power densities and operation patterns shall be used for the prediction of the annual energy use for air-conditioning in both the assessed building and the baseline building model (the zero credit level). The occupancy and lighting and equipment power densities shall be the standard provisions defined by the Government's Education Department. For buildings of non-standard designs, the design values for the lighting and equipment power densities shall be used for determining the annual energy use for air-conditioning in the assessed building. The default patterns of occupation and lighting and equipment load are as summarised in Table A.5.7.

In the prediction of the annual electricity use for air-conditioning, the rooms to be included in the simulation are those rooms that will be consistently air-conditioned, such as classrooms, staff offices and common rooms, libraries, computer rooms, special teaching rooms, etc. The months in the year that air-conditioning is provided shall be from September to December and from April to June. Classrooms are assumed to be occupied only for five days per week, following the Summer Schedule in the first two weeks in September and in May and June; and following the Normal Schedule for other days (see Table A.5.7 in Appendix A).

The energy use of air-conditioning equipment that will only be intermittently operated, e.g. equipment serving assembly halls, shall be excluded. However, as a basic requirement for credits, such equipment shall comply, where applicable, with the minimum performance requirements as stipulated in the Code of Practice for Energy Efficiency of Air Conditioning Installations or, where appropriate those shown in Table A.6 in Appendix A.

4.2.6 ENERGY USE MECHANICALLY VENTILATED BUILDINGS

For buildings where the majority of spaces therein are not air-conditioned, the assessment will be limited to the energy performance of the mechanical ventilation and lighting installations, according to the assessment method detailed in Section 4.3. The assessment requires fulfilment of some basic requirements as pre-requisite for credits and includes performance assessments on the ventilation and lighting systems. Furthermore, trade-offs of performance between the ventilation and the lighting systems are allowed. The assessment, however, will not include maximum electricity demand.

Apart from the basic requirements, assessment of the energy performance will be based on component-performance and feature specific criteria, but trade-offs of performance among components within the same system and between the ventilation and the lighting systems are allowed. Where any one of the criteria for ventilation system or lighting system performance cannot be met but the criterion of either system is exceeded by a large margin, trade-off is allowed. The basic requirements include:

- the air leakage limit on ductwork as stipulated in Section 5.1 in the Code of Practice for Energy Efficiency of Air Conditioning Installations[37]; and
- where there are limited air-conditioned premises in the assessed building, the air-conditioning equipment shall comply with the minimum performance requirements as stipulated in the Code of Practice for Energy Efficiency of Air Conditioning Installations and, where applicable, those in Table A.6; and
- the assessment of energy use in this category of buildings/premises is given in Sections 4.3 to 4.6, with Sections 4.3.1 to 4.3.3 particular to this category.

4.2.7 ENERGY USE IN OTHER BUILDINGS

Buildings falling outside the types already listed will be assessed on individual case basis. For buildings that are pre-dominantly air-conditioned, the method shall follow generally that described in Section A.1, while criteria given in Section 4.3 shall apply to buildings that are pre-dominantly mechanically ventilated. If a building comprises a mix of premises that fall into different categories of buildings, the method appropriate to each type will apply, and a weighted total score will be determined for the building according to the method described in Section 1.3.7. The principle of the assessment remains that it is a comparison of the energy performance of the assessed building against what would be achieved if any relevant regulatory requirements are barely met or the design would be just on a par with common practice locally, taking into consideration the constraints on the building owner in making improvements.

Where a comparison with the performance of a baseline building model is involved but default values for defining the baseline are unavailable, suitable criteria will be established for the assessed building based on the above-mentioned principle. The maximum number of credits achievable and the assessment scale, however, would have to be established taking into

37 Electrical and Mechanical Services Department, The Government of the Hong Kong Special Administrative Region. Code of Practice for Energy Efficiency of Air Conditioning Installations. 2002.

consideration the typical intensity of energy use and maximum electricity demand in the type of building being assessment, the least possible energy use and maximum electricity demand, and the financial implications of implementing the energy efficient measures for reducing energy use and maximum demand in such buildings.

For special buildings where the establishment of the benchmark and the assessment scale proves to be difficult, the assessment may have to be based solely on feature specific criteria. For any buildings that fall into the category of 'other buildings', the scope and method of assessment will be developed and agreed upon between the Owner/Operator and the HK-BEAM Assessor prior to commencement of the assessment.

4.3 ENERGY EFFICIENT SYSTEMS

The following sections details the award of credits based on system specific performance features.

4.3.1 VENTILATION SYSTEMS IN MECHANICALLY VENTILATED BUILDINGS

Examples of control systems referred to in the credit requirements below include variable fan speed control, duty cycling of multiple ventilation fans according to the CO concentration in car parks, etc.

Maximum number of credits attainable: 2

Credit requirement

- ❖ 1 credit for designing energy efficient ventilation systems that will consume less electricity than those meeting the zero credit requirements by 10% or more.
- ❖ 1 credit for installing control systems and devices that regulate the operation of the ventilation systems to reduce energy use whenever the operating conditions permit.

Method of assessment

The zero credit performance criteria for mechanical ventilation systems shall be determined based on the following:

- a mechanical ventilation system that consumes a fan power of 2 W per l/s of the total ventilation flow rate maintained in the ventilated spaces in the building; and
- where a space is served by both a supply and an extraction system, the system fan power shall be the sum of the fan power of the supply and the extraction system whilst the ventilation flow rate shall either be the total supply or the total extraction flow rate, whichever is the larger.

The Owner/Operator shall submit the following information to demonstrate that the installations meet the basic requirements and the requirements for credits:

- the criteria adopted in the design of the ventilation systems;
- the calculated ventilation rates;
- the design performance and operating patterns of the ventilation equipment;
- the energy use predictions for the zero-credit case and the as designed case for the ventilation system installation;
- reports of air leakage tests on selected ducting systems (to be confirmed subsequently if the assessment is conducted prior to on-site testing and commissioning of the ventilation systems); and
- the specified performance of any air-conditioning equipment for the building.

The air leakage test method shall conform to that given in the Code of Practice for Energy

Efficiency of Air Conditioning Installations, or DW143[38], or SMACNA's method[39].

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

4.3.2 INTERIOR LIGHTING SYSTEMS IN MECHANICALLY VENTILATED BUILDINGS

Maximum number of credits attainable: 2

Credit requirement

- ❖ 1 credit for using lamps and, where applicable, ballasts that will consume less electricity than those meeting the zero-credit requirements by 15% or more.
- ❖ 1 credit for installing control systems and devices that will switch off or dim the output of lighting installations when and where illumination is not required.

Method of assessment

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:

- the use of 40W fluorescent tubes, each with a 10W control gear and will produce 2,400 lm;
- 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; and
- 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[40]. 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.

The Owner/Operator shall submit the following information to demonstrate that the installations will meet the basic requirements and the individual requirements above for the related credits:

- the criteria adopted in the design of the lighting systems;
- the quantity of lighting fittings designed for various premises, the wattage of each fitting and the operation patterns of the lighting systems; and
- the energy use predictions for the zero-credit case and the as designed case for the lighting installations.

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

4.3.3 LIFT AND ESCALATOR INSTALLATIONS

In Hong Kong buildings are usually high-rise and/or large scale developments. Vertical transportation can consume up to 8% of total electrical energy consumption. Consequently, the Electrical & Mechanical Services Department has issued a code of practice for the energy

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38 Heating and Ventilation Contractors Association, UK. DW143 A Practical Guide to Ductwork Leakage Testing. 2000.

39 Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guideline for Occupied Buildings under Construction. 1995. www.smacna.org.

40 The Chartered Institution of Building Services Engineers. Code for interior lighting. London. CIBSE, 2002.

efficiency of lift and escalators[41]. Compliance with the code, and for using feature specific criteria in the assessment, is endorsed by HK-BEAM because the:

- the code is not yet regulatory requirements;
- the code provides for good practices that are worth promoting; and
- alignment between the energy assessments in the building energy codes and HK-BEAM is thereby established.

However, for consistency within the framework of HK-BEAM, should the code of practice become a regulatory requirement, no credit shall be given for compliance. The requirements therein would then become either 'basic' or 'baseline' criteria in HK-BEAM.

Objective of HK-BEAM

Encourage the use of energy efficient lift and escalator installations in buildings with significant provisions for vertical transportation.

Maximum number of credits attainable: 1

Credits requirement

❖ 1 credit for complying with the Code of Practice for Energy Efficiency of Lift and Escalator Installations.

Method of assessment

The Owner/Operator shall provide a report detailing the systems and equipment installed and the outcome of surveys by a suitably qualified person confirming whether or not there is compliance with the cited code. Certification under EMSD's Energy Efficiency Registration Scheme for Buildings[42] will satisfy the requirement.

4.3.4 ELECTRICAL INSTALLATIONS

As Hong Kong buildings are usually high-rise and/or large scale developments, distribution of large amounts of electrical energy also involves distribution losses, which are often not insignificant. Consequently, the Electrical & Mechanical Services Department has issued a code of practice for the energy efficiency for electrical installations[43]. Compliance with the code is endorsed in HK-BEAM for the same reasons and with the same caveat as for lift and escalator installations.

Objective of HK-BEAM

Encourage the use of energy efficient electrical installations in high-rise buildings.

Maximum number of credits attainable: 1

Credits requirement

❖ 1 credit for complying with the Code of Practice for Energy Efficiency of Electrical Installations.

The Owner/Operator shall provide a report detailing the systems and equipment installed and the outcome of surveys by a suitably qualified person confirming whether or not there is compliance with the cited code. Certification under EMSD's Building Energy Labelling Scheme will satisfy the requirement.

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41 Electrical and Mechanical Services Department. Code of Practice for Energy Efficiency of Lift and Escalator Installations. 1998. http://www.emsd.gov.hk/emsd/e_download/pee/lift_esccop.pdf

42 Electrical and Mechanical Services Department. Energy Efficiency Registration Scheme for Buildings. http://www.emsd.gov.hk/emsd/e_download/pee/sch_c_v19.pdf

43 Electrical and Mechanical Services Department. Code of Practice for Energy Efficiency of Electrical Installations. http://www.emsd.gov.hk/emsd/e_download/pee/eleccop.pdf

4.3.5 HOT WATER SUPPLY

This is applicable to buildings/premises such as hotels where the energy used for supplying hot water is significant (typically in excess of 2% of the total estimated energy use for a building development).

Objective of HK-BEAM

Promote the use of energy efficient hot water supply systems to conserve energy.

Maximum number of credits attainable: 1

Credits requirement

❖ 1 credit for installing energy efficient hot water supply equipment and devices that save hot water.

Method of assessment

The Owner/Operator shall provide details of hot water system design showing the energy performance of the chosen system and equipment compared to systems used in typical building designs. Details of the water saving devices employed shall also be submitted.

4.4 ENERGY EFFICIENT EQUIPMENT

4.4.1 POSITIONING OF AIR-CONDITIONING UNITS

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.

Objective of HK-BEAM

Ensure the installation of air-conditioning units provides for near optimum performance.

Maximum number of credits attainable: 3

Credit requirement

❖ 1 credit for complying with the recommended installation positions for air-conditioners as detailed in Appendix C, or equivalent alternatives.

❖ 1 credit for complying with not less than four items in the assessment check-list.

❖ 1 additional credit for complying with all items in the assessment check-list.

Method of assessment

The HK-BEAM Assessor will use the following check-list in respect of the use of air-conditioning units:

- to reduce penetration of noise units shall be located on walls which do not face major noise sources (road traffic, major pedestrian walkways, playgrounds, etc);
- to reduce intake of polluted air units shall be located in walls such that air is not drawn in from pollution sources such as roads, commercial activities, etc;
- for improved acoustics properties and better circulation, the internal discharge shall be close to the centre of the wall in which it is located;
- for the purpose of reducing noise from rain, and to reduce the potential for water dripping on to lower units, slabs shall be provided to as support and as cover;

- to help reduce the deterioration of units due to corrosion, to reduce bacteria growth in units and to avoid condensate drips, means for drainage shall be provided;
- to encourage proper maintenance, the installation of units shall be such to allow for safe and convenient removal;
- where air-conditioning units are provided by the developer, the units selected shall be labelled as Grade 1 or 2 under the Government's energy efficiency labelling scheme for room coolers(44).

The Owner/Operator shall demonstrate that each of the above issues have been considered in the design process, and shall provide evidence by way of suitable analysis, where compliance has been achieved. Credits shall be awarded based on the Assessors adjudication of the number of issues that have been satisfactorily addressed in the designs. Compliance with the requirements shall be demonstrated for each type of domestic unit in a block, or room in other types of premises.

4.4.2 ENERGY EFFICIENT LIGHTING IN PUBLIC AREAS

The assessment of energy use for lighting in air-conditioned spaces is taken into account in the energy estimation. The use of energy efficient lighting will reduce the air-conditioning load and increase the number of credits that can be obtained. The use of energy efficient lighting in non air-conditioned areas is encouraged through the award of additional credits.

Environmental factors to be considered when designing exterior lighting include energy use, light spillage to surrounding properties, sky glow, and impact on plants, etc. The required lighting levels, luminaire design and controls determine energy efficiency.

Objective of HK-BEAM

Ensure energy efficient lighting equipment and robust energy conserving controls are used to meet the needs for user safety, security and accessibility in all exterior, public and service areas of buildings.

Maximum number of credits attainable: 2

Credit requirement

a) Energy efficient luminaires

❖ 1 credit for installation of energy efficient lighting equipment in areas under the control of the building/estate management.

b) Automatic controls

❖ 1 credit for installation of time switching or photoelectric switching lighting control for the lamps in areas where daylight is available.

Method of assessment

a) The Owner/Operator shall submit a report prepared by suitably qualified person demonstrating that the following criteria has been met for lighting in exterior play areas, footpaths, services areas, walkways, etc:

- all lamps have luminous efficacy greater than the minimum values specified in the Code of Practice for Energy Efficiency of Lighting Installations;
- fluorescent lamp control-gear loss less than the maximum allowable lamp controlgear loss specified in the Code of Practice for Energy Efficiency of Lighting Installations; and
- the average circuit efficacy for all areas not less than 65 lm/W.

[44] Electrical & Mechanical Services Department, the Government of the Hong Kong SAR. The Hong Kong Voluntary Energy Efficiency Labelling Scheme for Room Coolers.

The lamp luminous efficacy, lamp control-gear loss and installed lighting power density for outdoor areas and spaces should be assessed using the method and the standard forms published in the Code of Practice for Energy Efficiency of Lighting Installations[45]. The assessment of the average circuit efficacy shall be based on the method given in Appendix D of the Code, or equivalent alternative.

The Owner/Operator shall submit a report prepared by suitably qualified person demonstrating that the following criteria has been met for lighting in interior public areas such as lift lobbies, staircases, etc., and service areas such as plant rooms:

- lighting power density is less than 85% of the maximum allowable lighting power density specified for "Spaces for Common Activities" (Space Code A) in Table LG4 of the Code of Practice for Energy Efficiency of Lighting Installations; and
- the average circuit efficacy for all areas not less than 65 lm/W.

The lamp luminous efficacy, lamp control-gear loss and installed lighting power density for indoor spaces should be assessed using the method and the standard forms published in the Code of Practice for Energy Efficiency of Lighting Installations. The assessment of the average circuit efficacy shall be based on the method given in Appendix C of the Code.

b) The Owner/Operator shall submit a report detailing the provisions for daylighting controls in all applicable areas demonstrating that artificial lighting will be maintained at a level required for the intended use of the space, and will be dimmed or switched-off when daylight is adequate.

4.5 RENEWABLE ENERGY

Although large scale application of renewable energy in buildings does not exist yet in Hong Kong, its use should be promoted in the interest of sustainable development. To ensure credits will only be awarded to meaningful installations, the criteria of assessment have been set with reference to the percentage of the energy use in the assessed building that has been 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, wind turbines, etc.

The credits that will be awarded under this assessment will be regarded as bonus credits, i.e. any credits obtained will add to the total credits achieved in other aspects of the energy performance assessment without affecting the total number of achievable credits. This will allow buildings incorporated with means for capturing renewable energy sources to obtain a better assessment outcome without affecting other buildings without such means. To encourage investments into renewable energy systems for existing buildings, credits will be awarded even if the systems are still being installed.

Objective of HK-BEAM

Encourage the wider use of renewable energy sources in buildings.

Maximum number of credits attainable: 5

Credits requirement

Credits will be given on a 5-point scale to buildings using energy from renewable sources to the extent that equal or exceed the percentages of total building energy use as listed below:

a) Densely populated urban centres

- ❖ 1 credit where 2% of building energy is supplied from renewable energy sources.
- ❖ 2 credits where 4% of building energy is generated from renewable energy sources.

45 Electrical and Mechanical Services Department, The Government of the Hong Kong Special Administrative Region. Code of Practice for Energy Efficiency of Lighting Installations. 1998.

- ❖ 3 credits where 6% of building energy is generated from renewable energy sources.
- ❖ 4 credits where 8% of building energy is generated from renewable energy sources.
- ❖ 5 credits where 10% of building energy is generated from renewable energy sources.

b) Less densely populated areas

Less densely populated areas means areas where buildings are separated by the height of the tallest adjacent building on at least two sides.

- ❖ 1 credit where 4% of building energy is generated from renewable energy sources.
- ❖ 2 credits where 8% of building energy is generated from renewable energy sources.
- ❖ 3 credits where 12% of building energy is generated from renewable energy sources.
- ❖ 4 credits where 16% of building energy is generated from renewable energy sources.
- ❖ 5 credits where 20% of building energy is generated from renewable energy sources.

Method of assessment

The Owner/Operator shall submit a report to show the achievement made or will be made if the installation work of the renewable systems is still ongoing:

- In the case of using systems that generate electricity from renewable sources (e.g. photovoltaic panels and wind turbines), the amount of electricity that can be generated by the system and can be usable by plants and equipment in the building, either instantaneously or from an associated storage system
- In the case of using systems that produce services direct from renewable sources, which would 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 would have been avoided

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 of the systems shall be discounted from their output.

4.6 ENERGY MANAGEMENT

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.

4.6.1 ENERGY AUDITING

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 saving 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.

Objective of HK-BEAM

Encourage concerted action to improve the utilisation of energy in the building development.

Maximum number of credits attainable: 5

Credit requirement

a) Policy and plan

❖ 1 credit for having an energy policy and an action plan with the responsibility for implementation vested at Directorate level.

b) Energy auditing

❖ 1 credit for having carried out an energy audit of the building within the previous two years.

c) Monitoring and targets

❖ 1 credit for an effective energy monitoring and targeting system, providing evidence showing movement towards energy/CO_2 targets over time.

d) Financial resources

❖ 1 credit for having in place a mechanism for accumulating funding and an annual budgetary plan for implementing energy efficiency enhancements.

e) Energy charge

❖ 1 credit for separate charging for energy costs.

Method of assessment

a) The Owner/Operator shall submit documentation demonstrating the commitment at directorate level to energy management, and an action plan aimed at achieving greater energy efficiency throughout the building, and its main building services engineering systems and equipment. With the objective to reduce as far as practicable the consumption of fossil fuels and the impact on the environment, the energy policy shall include commitment to control energy consumption, such as(46):

- avoiding unnecessary expenditure;
- improving cost-effectiveness, productivity and plant operating condition; and
- investing in the clean, energy efficient technologies.

The action plan shall include details of:

- the channels of communication with staff at all levels responsible for energy use;
- monitoring of consumption;
- quantification of savings;
- the ways of communication with tenants on energy use and costs; and
- financial plans for capital investments into energy efficiency enhancement measures.

Where the policy and action plan are under regular review, are integrated into the

[46] UK Department of the Environment's Energy Efficiency Best Practice programme. BRESCU, Building Research Establishment. http://www.bre.co.uk/bre/otherprg/eebp/default.html. Good Practice Guide 186. Developing an effective energy policy. June 1996.

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Owner/Operator's management structure, and responsibility for implementation is vested at Directorate level, credit shall be awarded.

b) The Owner/Operator shall provide a written report, endorsed by a suitably qualified person, confirming that an audit has been completed essentially in accordance with the practice outlined in CIBSE Applications Manual AM5[(47)] or similar authoritative document. The audit result should include breakdowns of energy use by individual major services systems and equipment. The evidence shall include energy consumption records, operation and maintenance records, and other documentation. The audit should embrace, where possible, energy consumption by tenants. Where the report shows evidence of auditing practices appropriate to the size and complexity of the development, the credit shall be awarded.

c) The submitted audit report should verify where actions to improve energy efficiency or reduce energy consumption were 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 Section 4.2 of this document. Where the Owner/Operator can demonstrate that appropriate monitoring, record keeping and target setting is in place the credit shall be awarded.

d) Documents shall be submitted to provide information about how financial and other resources are deployed for building energy management. The submission shall include data on expenditures on energy use and on the costs to implement measures to enhance the energy performance of the building development over at least the previous three years. Credit shall be awarded where energy efficient measures are financed at an appropriate level, either from recurrent incomes or saved costs.

e) Credit shall be awarded where energy costs to tenants or customers in the building development are charge separately and are not including in base rental fees. The accounting details shall be transparent.

4.6.2 METERING AND MONITORING

Surveys of a large number of buildings in Hong Kong[(48)] revealed that buildings are in general insufficiently equipped with measuring and monitoring devices for measurement of energy performance. This makes it particularly difficult when attempting to improve the energy efficiency of buildings and major plants, such as central chiller plants. It is often the practice to install the minimum of metering, and often this is of relatively low accuracy and reliability.

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, but which 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 to 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.

Objective of HK-BEAM

Enable building operators to measure, monitor and develop measures to improve the performance of the building's engineering systems, particularly concerning energy use.

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47 The Chartered Institution of Building Services Engineers. Energy Audits and Surveys, Application Manual AM5: 1991.

48 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.

Maximum number of credits attainable: 3

Credits requirement

a) Non-HVAC services in buildings with central air-conditioning plants:

- ❖ 1 credit for providing meters which allow separate monitoring of electricity use by building services systems under the control of the Owner/Operator, other than HVAC systems and equipment.

b) Chiller plant

- ❖ 1 credit for providing for:
- ✧ monitoring of electricity use by the main chiller plant and auxiliaries; and
- ✧ adequate instrumentation for monitoring the cooling load and operating parameters of major equipment in the central chiller plant.

c) Air handling plant

- ❖ 1 credit for providing meters which allow separate monitoring of electricity use by the air side equipment of the HVAC system.

ALTERNATIVELY

d) Buildings without central air-conditioning plant

- ❖ 1 credit for providing energy metering for landlord's electricity consumption in common spaces/public areas.

Method of assessment

As a prerequisite metering provisions shall meet the requirements of the Government's energy codes.

a) The Owner/Operator shall provide details of the measuring and monitoring equipment installed and commissioning records of consumption and chiller plant performance, to demonstrate that electricity use and performance can be monitored as stipulated.

b) Monitoring of central chiller plants shall be assessed on the basis of BSRIA Technical Note TN 7/94[(49)] 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.

c) Metering provision shall identify electricity use patterns for major air handling equipment, such as centralised air handling units for floors/zones, large designated areas, etc.

d) Metering provision shall identify the electricity use pattern for each major system fed from the Owner/Operator's main switchboard(s), i.e., landlords lighting and small power, transportation, plumbing & drainage systems, major air handling equipment, such as centralized air handling units for floors/zones, large designated areas, etc.

Electricity metering, together with associated measuring transducers/transformers for indicating power and energy, shall comply with an appropriate standard such as BS EN[(50)] 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[(51)] or similar equivalent.

The HK-BEAM Assessor may undertake checks during a site survey.

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

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

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

4.6.3 ENERGY MANAGEMENT MANUAL

Effective maintenance and operation of the building services can have a significant effect on both indoor environmental performance and energy efficiency. To ensure the correct operation of the building's engineering services an easy-to-follow manual is required. 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.

Objective of HK-BEAM

Enable building operators to achieve near optimum use of energy in servicing a building.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for providing fully documented instructions that enables systems to operate at near optimum levels of energy efficiency.

Method of assessment

The following details shall be included in the energy management part of the operations and maintenance manual, unless detailed elsewhere in the manual:

- descriptions of the final design intent and basis of design, including brief descriptions of each system;
- final sequences of operations for all equipment;
- procedures for seasonal start-up and shutdown, manual and restart operation;
- as-built control drawings;
- for all energy-saving features and strategies, rationale description, operating instructions, and caveats about their function and maintenance relative to energy use;
- recommendations and brief method for appropriate accounting of energy use of the whole building.
- specifications for re-calibration frequency of sensors and actuators by type and use;
- recommendations for continuous commissioning or recommended frequency for re-commissioning by equipment type, with reference to tests conducted during initial commissioning;
- recommendations regarding seasonal operational issues affecting energy use;
- list of all user-adjustable set points and reset schedules, with a discussion of the purpose of each and the range of reasonable adjustments with energy implications;
- schedules of frequency for reviewing the various set points and reset schedules to ensure they still are near optimum;
- list of time-of-day schedules and a frequency to review them for relevance and efficiency;
- guidelines for establishing and tracking benchmarks for building energy use and primary plant equipment efficiencies;
- guidelines for ensuring that future renovations and equipment upgrades will not result in decreased energy efficiency and will maintain the design intent;
- list of diagnostic tools, with a description of their use, that will assist facility staff for the building in operating equipment more efficiently; and
- a copy of the commissioning report; and
- index of all commissioning documents with notation as to their location.

5 WATER USE

In Hong Kong 99.9 per cent of the population is now supplied with piped water from the Water Supplies Department (WSD). About 80 per cent of the population is supplied with sea water for flushing. Total freshwater consumption is well over 900 million cubic metres, with domestic consumption accounting for almost 50%, and over 20% by the service trade. The supply from Guangdong continued to be the major source of raw water, providing for around 70% of total consumption. With increased industrialisation of Guangdong Province there is likely to be increased competition for water supply, meaning that water conservation is likely to become a significant issue for Hong Kong in the future.

5.1 WATER QUALITY

In Hong Kong the WSD controls water quality, such as taste, odour, hardness, sediment, pH, the quantity of dissolve 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 quality of potable water delivered at taps is often perceived to be unsatisfactory by consumers. The problems may be due to the corrosion of water pipes or the cleanliness of water tanks. As a consequence the use of bottled water is widespread, but is not considered to be an environmentally preferred solution on account of the production and transport requirements. To ensure the health of consumers' building developments need to ensure optimal water quality at the tap - water that is both safe and acceptable in terms of taste, colour and odour.

Objective of HK-BEAM

Ensure that the quality of potable water delivered to occupants is satisfactory.

Maximum number of credits attainable: 1

Credit requirement:

❖ 1 credit for

✧ complying with the recommendations described in the Code of Practice for the Prevention of Legionnaire Disease that are applicable to domestic cold and hot water systems; and

✧ installing measures for treatment of potable water supplies to ensure quality to WSD (WHO) drinking water quality standards at points of use.

Method of assessment

The Owner/Operator shall provide details of the potable water system to demonstrate prevention of water contamination and provision of access of water tanks for maintenance. All water holding tanks should be designed and constructed to allow regular cleaning and draining throughout the building life to avoid contamination, sludge, slime, algae, fungi, rust, scale, dust, dirt and other foreign material.

The Owner/Operator shall provide details of the measures taken to ensure potable water quality meets WSD's criteria, and the design, operation and maintenance practices for the installed hot and cold water systems. This shall include analysis of samples taken from a selection of potable water outlets used to supply human consumption. Samples shall be taken at the furthest point of delivery in the supply from the storage tank, and shall include sampling for each water supply tank used in the building. If water quality meets with WSD Guidelines(52), and there is compliance with the guidelines given in the CoP(53) as far as they are applicable, the credit shall be awarded.

52 Water Supplies Department Circular Letter No. 4/2002. Fresh Water Plumbing Quality Maintenance Recognition Scheme. http://www.info.gov.hk/wsd/circltrs/docs/english/cir0402.pdf

53 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". November 1994.

5.2 WATER 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 storm water in order to reduce the use of potable water. Additional benefit of potable water conservation is reduced energy use for transport and the cost of treatment of raw water.

Currently there is little available data in Hong Kong to benchmark water consumption by various uses. Consequently, it is not possible to provide meaningful targets for reducing consumption. However, there is sufficient evidence to show that any devices which improve the efficient use of water can significantly reduce consumption.

5.2.1 WATER MANAGEMENT

The management and operation of a building can have a major impact on water consumption, and consequent sewage discharge. The implementation of 'good housekeeping' practices by staff and involving tenants in water conservation can be effective in reducing water consumption. Reducing the cost of water, sewage charges and trade effluent charges will add to the profitability of building operations, but financial support for an action plan for implementing water conservation measures is essential. This may derive from existing budgets or adoption of a 'payment by saving' approach. Water conservation practices should:

- be fully integrated into the management of the facility;
- have monitoring and targeting systems in place based on sub-metering of water use;
- include regular reports and reviews of the monitored data;
- set targets for efficient utilisation of water; and
- be supported with appropriate resource provisions.

Objective of HK-BEAM

Raise awareness as to the importance of potable water as a resource and the need to reduce consumption.

Maximum number of credits attainable: 2

Credit requirement

a) Water audit and inventory

❖ 1 credit for:

✧ having a water conservation policy and action plan to reduce consumption;

✧ undertaking a water audit for the whole building development; and

✧ maintaining a water use inventory.

b) Conservation plan

❖ 1 credit for implementing a water conservation plan with appropriate targets and budget provisions.

Method of assessment

a) The Owner/Operator shall submit documentation demonstrating commitment at directorate level to responsible water management, and a report 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:

- frequency of floor cleaning and water volume per use;
- frequency of garden irrigation and water volume per use;
- frequency, duration and water volume per use of each fixture in kitchens and laundry;
- frequency of male and female daily uses of the water-using fixture, duration per use, and the water volume per use.

b) The Owner/Operator shall provide details of the water conservation measures, and the credentials of the staff who are undertaking implementation. The conservation 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:

- details of the channels of communication for staff at all levels, and building users;
- monitoring of consumption;
- details of actions taken to reduce water consumption, including those already completed, those in progress, and those for future implementation; and
- provide a quantification of the savings.

The assessment will seek to establish if mechanisms are in place effectively limit wastage of water, and to set targets for water saving with an appropriate budget for upgrading the installations.

5.2.2 WATER EFFICIENT DEVICES

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.

Objective of HK-BEAM

Reduce the consumption of potable water through the application of water saving devices that have proven performance and reliability.

Maximum number of credits attainable: 2

Credit requirement:

❖ 1 credit for use of water saving features and fixtures that in aggregate use 25% less water than conventional designs and fixtures.

❖ 2 credits for use of water saving features and fixtures that in aggregate use 40% less water than conventional designs and fixtures.

Method of assessment

The Owner/Operator shall provide a report prepared by a suitably qualified person detailing the water-efficient system design features and the demonstrated savings arising from the use of efficient fixtures installed in the building development in the form of water consumption and/or monitoring records.

Where the installation of water efficient devices has been recent, or is being undertaken, credits can be awarded if the Owner/Operator can submit evidence of the estimated savings through calculations taking into account:

- each potable water using device;
- frequency, duration and water consumption per use;
- estimated water used by each fixture;

- sum of water volumes used for each fixture for male and female users, service use for cleaning, irrigation, etc;
- estimated daily water use;
- defined number of days of use of the facilities (work days, school days, etc) to annualise water consumption in the building development; and
- any deduction of annual use of recycled water (used for cleaning, flushing, engineering services, etc) that replaces use of potable water.

5.2.3 METERING AND CONTROLS

Generally in Hong Kong buildings there is very limited provision of water meters other than for utility billing purposes. The provision of water meters for major uses can assist facility managers to audit water use and can encourage the introduction of water saving measures. The provision of automatic shut-off devices, particular 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.

Objective of HK-BEAM

Reduce wastage of water and allow for water auditing by building management teams.

Maximum number of credits attainable: 1

Credit requirement:

❖ 1 credit for installing:

✧ devices that automatically shut-off the operation of faucets, taps and urinals which use fresh water, for the purposes of water conservation; and

✧ water meters at key supply branches which permits the monitoring and audit of fresh water consumption.

Method of assessment

The Owner/Operator shall submit a report detailing the measures used to reduce the wastage of water, and evidence to show that water use by the building operator is being monitored. The assessment will seek to establish if mechanisms are in place that effectively limits wastage of water by shutting off fixtures automatically when not in use. Various approaches are available and HK-BEAM is not intended to be too prescriptive as to which should be used.

The provision of water meters to measure consumption by the Owner/Operator for each of the major water using sectors shall be identified by a survey of the building, or other evidence provided by the Owner/Operator.

5.2.4 WATER RECYCLING

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 (including rainwater) for treatment and distributes the treated water to the points of use, such as for irrigation, cleaning, or for toilet flushing, particularly 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 recycling.

Objective of HK-BEAM

Encourage recycling of grey water and rainwater in order to reduce consumption of potable water.

Maximum number of credits attainable: 3

Credit requirement

a) Recycled rainwater and/or condensate

❖ 1 credit for the collection of rainwater and condensate for use in cleaning and irrigation or otherwise, which will reduce consumption of potable water.

b) Provisions for grey water recycling

❖ 1 credit for providing plumbing systems that separates black water discharges from grey water discharges to allow for separate collection of grey water.

c) Bonus credit

❖ 1 credit for the installation of an on-site grey water treatment system to treat grey water for reuse in place of potable water.

Method of assessment

a) The Owner/Operator shall provide a report detailing the system or systems installed for the purpose of collecting rainwater and, where available, condensate, and details of the expectations in respect of savings in the consumption of potable water.

b) The Owner/Operator shall provide a report detailing the system or systems installed for the purpose of recycling grey water, and details of the expectations in respect of savings in the consumption of potable water.

Recycled water should satisfy water quality requirements, such as detailed by the Building Research and Information Association(54) or similar authoritative guidance, for the intended reuse, including cleaning, washing, irrigation, use in heat rejection systems, toilet flushing, etc.

c) The bonus credit shall be counted as described in Section 7.

5.3 EFFLUENT

Whilst some 80% of users 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.

Objective of HK-BEAM

Reduce the volumes of sewage discharged from buildings thereby reducing burdens on municipal sewage supply and treatment facilities.

Maximum number of credits attainable: 2

Credit requirement:

a) Reduction in sewage volume

❖ 1 credit for demonstrating an estimated reduction in sewage volumes by 25% through the use of water efficient fixtures and or recycling technologies.

b) Reduction in sewage loading

❖ 1 credit for installing and maintaining grease traps, petrol interceptors and other means to reduce concentration of sewage.

Method of assessment

a) The Owner/Operator shall provide a report prepared by a suitably qualified person detailing the

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54 BSRIA, Greywater and Rainwater Systems: Recommended UK Requirements, The Building Services Research and Information Association, Final Report 13034/1, March 1997.

estimated savings arising from the use of the efficient fixtures and recycling facilities installed in the building development. The report shall follow a format that details:

- each device using flushing water;
- frequency, duration and water consumption per use;
- estimated water used by each fixture;
- sum of water volumes used for each fixture for male and female users;
- estimated daily flushing water use;
- defined number of days of use of the facilities (work days, school days, etc) to annualise water consumption in the building development;
- any deduction of annual use of recycled water.

Where the installation of water efficient devices has been recent, or is being undertaken, credits can be awarded if the Owner/Operator can submit evidence of the estimated savings through calculations taking into account:

Toilet flushing	6.0 L/flush
Urinals	3.8 L/flush

To estimate the water use for the assessed building development the manufacturers confirmed performance data for the installed water closets and urinals shall be used.

All assumptions as to the number and gender of users, duration and frequency of use, etc. shall be stated and used for both the baseline case and the assessed building. Where potable water is used for flushing purposes then water closets shall be included in the calculation.

b) The Owner/Operator shall provide a report prepared by a suitably qualified person detailing all means to reduce concentrations of solids and liquid discharges to the sewage system.

6 INDOOR ENVIRONMENTAL QUALITY

Given that on average a person in Hong Kong spends over 90% of their time indoors the quality of the indoor environment has a significant impact on our quality of life. Building should provide for a safe and healthy indoor environment. Indoor environmental quality (IEQ), defined in terms of thermal comfort conditions, indoor air quality (IAQ), lighting and acoustical properties, has a significant impact on the comfort, health and well-being of building occupants. Poor IEQ in commercial and institutional buildings can impact on productivity and may impose health risks to users. Poor IEQ in other types of premises impacts on the overall quality of life. The design, management, operation and maintenance of buildings should seek to provide for adequate IEQ, but with optimum use of energy and other resources.

Achieving good IEQ in buildings will depend on the adequacy of the design of the building and the building services installations to meet user requirements, and the extent to which operation and maintenance practices has maintained building performance. The specified thermal comfort conditions can be achieved where systems can cater for part-load operation. IAQ is best dealt with through the control of pollutants at source. Lighting quality is not simply a matter of lighting level, but also needs to consider quality, such as glare, distribution, daylight and views, etc. The acoustics properties of spaces impact on audibility and unwanted noise can impact on comfort.

Analytically, 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(55) 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 environments for a matter of minutes (e.g. car parks), an hour or two (e.g. entertainment establishments) or continuously over a working day (e.g. offices, classrooms, etc) can be different for most parameters depending on dose and response. For example, limits of the exposure tolerable for the general public, include the young and infirm, are different from exposures considered acceptable for the sedentary workplace, and certainly the industrial workplace.

Sources of indoor pollutants include outdoor pollutants, building fabric materials, interior finishes, building systems and equipment, appliances, consumer products, and the occupants and their activities. To some extent building orientation in respect of outdoor pollution sources, particularly traffic and industrial sources, can influence pollutant transport into a building. The selection of building materials is important, as pollutants can be emitted for weeks, months or even years after installation. Ventilation systems should not introduce pollutants, and filtering should be effective in removing outdoor pollutants. Ventilation rates should match occupancy levels, and the location of supply and return air vents should ensure adequate ventilation effectiveness. All ventilation systems should be accessible for cleaning and maintenance.

6.1 ASSESSMENT FRAMEWORK

In keeping with the HK-BEAM assessment approach the assessment of IEQ is mainly performance based, with the majority of credits awarded for meeting performance specifications. This approach also allows the assessment under HK-BEAM 5/03 to dovetail closely with assessments under HK-BEAM 4/03 'new building developments', thereby providing continuity in performance expectations. In addition to performance, credits are also awarded for compliance with certain installation features with known potential to enhance IEQ.

Assessment is not intended to cover the impacts of user activities. HK-BEAM 5/03 seeks to ensure that a building and its systems can achieve the intended level of performance, providing that tenants/occupants follow the fitting-out specifications and guidance for use, appropriate to the type of the premises they occupy.

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[55] American Society of Heating, Refrigeration and Air-conditioning Engineers. ASHRAE 62-2001: Ventilation for Acceptable Indoor Air Quality. Atlanta 2001.

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The assessment of thermal comfort and IAQ 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 take into account the differences in environmental conditions likely to be found in different buildings/premises, for the purposes of assessment HK-BEAM separates buildings as follows:

- Air-conditioned Buildings - buildings/premises intended to rely exclusively on full air-conditioning (typically commercial buildings);
- Air-conditioned/Naturally Ventilated Buildings - buildings/premises which may air-conditioned but are intended to utilise natural ventilation when outside climatic conditions permit (residential buildings, schools, etc); and
- Mechanically Ventilated Buildings - buildings/premises provided only with mechanical ventilation (car parks, etc).

Air-conditioned Buildings

Thermal comfort conditions and ventilation in buildings/premises which are designed on the principle of 'build tight, ventilate right' are intended to be controlled within prescribed design limits. The thermal comfort criteria used for design, such as ISO 7730[(56)], ASHRAE[(57)] etc, will have been defined for the type and use of premises included in the development, and is a basic performance specification or benchmark. These standards identify the range of design values for temperature, humidity and air movement that should provide satisfactory thermal comfort conditions for a minimum of 80% of building occupants.

HK-BEAM 5/03 takes into account the Government's proposed Indoor Air Quality Certification Scheme[(58)] and the accompanying Guidance Note[(59)], as implementation of the Scheme is likely to have a significant impact on the performance of air-conditioned buildings through improved design, construction, and operating practices. Assessment of indoor air quality allows for the use of the simplified protocol described in Appendix D, or full compliance with the protocol described in the Guidance Note.

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. If installed, air-conditioning units may be operated even under relatively favourable climatic conditions. Thermal comfort conditions when operating air-conditioning will also depend on user preference, which can be met providing units are sized and installed to meet the required cooling load. Considerations for thermal comfort and IAQ in occupied/habitable rooms need to take into account conditions when premises are air-conditioned or otherwise 'closed' because of cold or inclement weather, and when more 'open' to take advantage of natural ventilation. Consideration is given to worst case conditions that might impact on the health of building users.

Reduced use of air-conditioning is encouraged by good building design that captures natural cooling and ventilation. Control of concentrated pollutant sources is achieved by local ventilation to exhaust pollutants from specific rooms before they enter the general environment. Whole-premises ventilation is intended to bring fresh air into the general environment to dilute the

56 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.

57 American Society of Heating, Refrigeration and Air-conditioning Engineers. ASHRAE 55-1992: Thermal Environmental Conditions for Human Occupancy. Atlanta 1992.

58 Indoor Air Quality Management Group, Hong Kong Government. Certification Scheme for the Management of Indoor Air Quality. November 1999.

59 Indoor Air Quality Management Group, Hong Kong Government. Guidance Note on the Management of Indoor Air Quality in Offices and Public Places. Draft. November 1999.

pollutants that cannot be effectively controlled at the source. Unlike the whole-premises rates, which are most effective when continuous, source control through exhaust is best operated when the source of pollution is active.

6.2 THERMAL COMFORT

6.2.1 THERMAL COMFORT IN CENTRALLY AIR-CONDITIONED PREMISES

The ability of the HVAC system to respond to part-load demand (i.e. partial occupancy and activity levels) is a key determinant for maintaining thermal comfort (as well as saving energy). It should be possible to maintain room conditions (within acceptable tolerances) with no occupants present and with full occupancy, if necessary using simulated load conditions. Measurements under such circumstances can demonstrate compliance with the operating requirements.

Objective of HK-BEAM

Demonstrate that the air-conditioning system can provide the required operating conditions in occupied spaces under changing load conditions.

Maximum number of credits attainable: 3

a) Temperature

- ❖ 1 credit for sustaining the air temperature at the design value within ±1°C when the air side system is operating at steady state under conditions of zero occupancy.
- ❖ 1 credit for sustaining the air temperature at the design value within ±1°C when the air side system is operating at steady state under full- or part-load conditions.

b) Room air distribution

- ❖ 1 credit where room air diffusers satisfy the Air Diffusion Performance Index.

Method of assessment

The Owner/Operator shall provide evidence in the form of a report prepared by a suitably qualified person detailing the design criteria with respect to thermal comfort conditions for all categories of premises included in the development and the results of the measurements in the specified sample of premises.

a) 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, relative humidity and relative humidity) are undertaken in i) with no occupants and ii) with full or simulated full occupancy. The results shall demonstrate in compliance with the prescribed design criteria within the prescribed limits, for a minimum of 90% of the prescribed locations. In the case of i) it will demonstrate that the HVAC system is capable of 'turn-down' to the lower limit and for ii) it will demonstrate the ability to meet the design load. The sensors used in the measurement survey shall have an accuracy that complies with ASHRAE 55-1992 or ISO 7726[60].

b) The measurement locations shall be as for a). The assessment of performance shall be in accordance with ASHRAE 113[61] or equivalent standard method.

Alternatively, where the Owner/Operator can demonstrate compliance with the requirements of the Government's IAQ Certification Scheme and Guidance Note in respect of the thermal comfort parameters all three credits shall be awarded.

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60 International Standard Organization. International standard 7726, Thermal Environments – Specifications Relating to Appliance and Methods for Measuring Physical Characteristics of the Environment. Geneva: International Organization for Standardization. 1985

61 American Society of Heating, Refrigerating and Air-conditioning Engineers. ASHRAE 113-1990: Method of Testing for Room Air Diffusion. Atlanta, 1990.

6.2.2 THERMAL COMFORT IN AIR-CONDITIONED/NATURALLY VENTILATED PREMISES

It is likely that some of the premises within a building development will be subject to higher than average solar heat gains, with consequent higher internal temperatures during summer months. It is appropriate to examine the detailed thermal performance of the most susceptible premises, and based on detailed analysis employ mitigation measures, such as changes in fabric design and other solar control strategies, and utilisation of natural cooling.

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 load conditions.

Objective of HK-BEAM

Promote the application of measures that reduce elevated temperatures caused by solar gains, and ensure installed air-conditioning can provide adequate control of comfort.

Maximum number of credits attainable: 2

Credits requirements

a) Performance with natural ventilation

❖ 1 credit for demonstrating worse case peak temperatures without mechanical cooling does not exceed 30°C in any occupied/habitable rooms.

b) Performance with air-conditioning

❖ 1 credit for sustaining the air temperature at the design value within ±1°C when the air-conditioning unit is operating at steady state under conditions of zero occupancy.

Method of assessment

The Owner/Operator shall provide evidence in the form of a report prepared by a suitably qualified person detailing the means to achieve solar control, the design criteria with respect to thermal comfort conditions for all types of premises included in the development, and the results of the measurements in the specified sample of premises.

a) The report shall detail the method of modelling and the outcome of the analysis. The thermal analysis shall be undertaken through dynamic thermal modelling, using appropriate modelling software. The thermal performance (daily peak temperature) within the occupied or habitable space of each type of premises most affected by solar gains shall be determined. The modelling can be undertaken for a full annual simulation, using a standard Hong Kong weather year, or simulate only the warmest period. The modelling will include the effect of solar control features (e.g. glazing, internal or external shading components), fabric and infiltration specification, and site obstructions. The modelling shall not include any internal gains or services, e.g. a simulation for unoccupied premises is required.

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

b) The measurement locations shall include at least one representative sample of each type of premises (occupied spaces) as defined by the type of air-conditioner used, design occupancy density, nature of usage, zoning, etc. The main physical parameters of the indoor climate (air temperature and relative humidity) are undertaken with no occupants. The results shall demonstrate compliance with the prescribed design criteria within the prescribed limits, for a minimum of 90% of the prescribed locations. The sensors used in the measurement survey shall have an accuracy that complies with ASHRAE 55-1992 or ISO 7726.

6.3 VENTILATION

The outside air ventilation to an air-conditioned building should be adequate for the levels of occupancy expected. The marker often used to indicate satisfactory provision of ventilation in occupied premises is the level of CO_2 at design occupancy. In Hong Kong it is usual that the minimum values for ventilation are rates for various spaces will be specified in accordance with a version of ASHRAE 62, or appropriate equivalent design standard. The criteria may have changed over time and will depend on the age of the building. What is critical to the adequacy of the ventilation is the amount of supply reaching the breathing zone of occupants. Inadequate distribution within zones or within rooms can result in dissatisfaction at a local level, event if the total ventilation supplied to a space meets specification. It is relatively easy to measure CO_2 in rooms that are occupied and use this as a measure of ventilation performance. It is not possible to use CO_2 as a measure of performance in unoccupied premises, but it is possible to determine if ventilation will be satisfactory through measurement of ventilation rate and ventilation (air change) effectiveness.

There are three basic requirements for ventilation of rooms used for habitation(62,63); background ventilation, local exhaust, and source control. The concepts can also 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 reduce 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.

6.3.1 VENTILATION IN OCCUPIED AREAS OF CENTRALLY AIR-CONDITIONED PREMISES

The design ventilation rate will be defined by the Owner/Operator appropriate to the type and use of premises in the building development. The corrected design ventilation rate should be used, being the design ventilation rate divided by the ventilation (air change) effectiveness. Air change effectiveness is a measurement based on a comparison of the age of air in the occupied areas to the age of air that would exist under ideal conditions of perfect mixing (effectiveness = 1). ASHRAE 129-1997(64) provides a method for measuring air change effectiveness in mechanically ventilated spaces, however, the standard places limitations on the characteristics of the spaces that can be tested. Therefore, it is appropriate to use the method as a guide to determining ventilation effectiveness.

Objective of HK-BEAM

Demonstrate that ventilation systems provide for effective delivery to support the comfort and health of occupants.

Maximum number of credits attainable: 2

Credit requirements

- ❖ 1 credit for demonstrating that the corrected design ventilation rate meets the design intent for occupied premises.
- ❖ 1 credit for demonstrating that the ventilation effectiveness meets the design intent for occupied premises.

Method of assessment

a) Unoccupied premises

The Owner/Operator shall provide evidence in the form of a report prepared by a suitably qualified person detailing the design criteria with respect to ventilation provisions for all categories of premises included in the development and the results of the measurements in the specified

62 Department of the Environment and Welsh Office. The Building Regulations Part F Ventilation.

63 American Society of Heating, Refrigerating and Air-conditioning Engineers. BSR/ASHRAE Standard 62.2P. Ventilation and Indoor Air Quality for Low-rise residential Buildings. Atlanta 2002.

64 American Society of Heating, Refrigerating and Air-conditioning Engineers. ASHRAE Standard 129-1997: Measuring Air- change Effectiveness. Atlanta, 1997.

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sample of premises.

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. Measurements are required at the occupied zone in each representative test space in accordance with ASHRAE 129-1997. The measurements shall be undertaken under simulated full occupancy conditions. All airstreams of the air-side system serving the test space shall have a constant flow rate to the degree practical (e.g. the difference between the maximum and minimum should be within 10%).

A tracer gas is used to label the indoor air at the start of a decay or step-up measurement. ASTM standard E741-95(65) provides guidance on the selection and properties of the tracer gas. In the decay method, used to establish the average air-exchange rate of a space, a tracer gas is injected into the supply air fan of the air-handling unit which allows the tracer gas to mix, and then the decay of tracer gas concentration is monitored in order to calculate the average air exchange rate from the logarithmic gradient of the decay in tracer gas concentration. In the constant emission technique, the space initially contains no tracer gas and tracer gas is releasing at a constant rate. The injection of the tracer gas is continued until steady state concentration is achieved. When the tracer gas is emitted a flow meter is needed to measure the flow of tracer gas emitted into the room, and the test, the general continuity equation can be used to obtain the air-exchange rate.

Where the air change (ventilation) effectiveness is demonstrated to be equal or greater than 1.8 in 90% of sampled premises, and not less than 1.6 in any sampled premises, credit shall be awarded. Displacement (e.g. under floor HVAC systems) may be assumed to have an air change effectiveness greater than 1.8. Ventilation effectiveness = 2 x air change efficiency(66).

b) Occupied premises

The ventilation rate may be determined from measurements taken of CO_2 with full occupancy.

Alternatively, where the Owner/Operator can demonstrate compliance with the requirements of the Government's IAQ Certification Scheme and Guidance Note in respect of CO_2 both credits shall be awarded.

6.3.2 BACKGROUND VENTILATION IN AIR-CONDITIONED/NATURALLY VENTILATED PREMISES

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 reduce possibility of mould growth under conditions of high humidity.

Objective of HK-BEAM

Ensure that premises that are designed to utilise natural ventilation are provided with sufficient ventilation to protect the health of occupants.

Maximum number of credits attainable: 1

Credits requirements

- 1 credit for demonstrating through appropriate modelling or commissioning tests that a minimum air change rate of 1 per hour is provided in occupied or habitable rooms under conditions of natural ventilation.

Method of assessment

The Owner/Operator shall provide evidence in the form of a report by a suitably qualified person that the appropriate analysis has been undertaken and that the outcomes demonstrate

65 American Society for Testing and Materials. ASTM Standard E741-95, Standard Test Methods for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution. Philadelphia, 1995.

66 Air Infiltration and Ventilation Centre. AIVC TN 28. A guide to air change efficiency. 1990.

compliance.

A wind pressure analysis may be undertaken through boundary layer wind tunnel modelling. Wind pressure coefficients shall be measured for representative floors of the assessed building (e.g. at 5 floor intervals, from the 5th floor). The measurements shall be taken for at least the prevailing wind conditions (e.g. NE, E, SE, SW winds). The modelling technique will show a boundary layer as appropriate for the site, and the model will include any significant buildings and site obstructions within a distance of approximately 6 building heights. The pressure data shall be used with standard calculation procedures to estimate flows through the habitable rooms, arising from an average wind condition. Buoyancy or turbulence driven flows need not be considered.

Alternatively, compliance with the assessment criteria may be demonstrated through measurement in a sample of premises using techniques similar to that described in Section 6.3.1 a). The measurements should be undertaken during a period of 'near average' wind conditions with only those openings intended for providing background ventilation left open, and other means of ventilation rendered inoperative.

6.3.3 LOCALISED VENTILATION

Concentrated pollution sources are best managed at source. The provision of localised ventilation, segregated from the general ventilation, is an appropriate strategy. In commercial and similar premises sources such as photocopying equipment, smoking lounges, etc. should be provided with dedicated exhaust systems. It is also appropriate to provide a system that allows for localised exhaust of premises during fit-out and redecoration, to avoid entrainment to occupied areas. It could be part of the fixed ventilation system, or a simple approach that allows temporary exhaust provisions. In other buildings local exhaust is intended to remove contaminants from specific rooms such as kitchens, in which concentrated sources are expected.

Objective of HK-BEAM

Prevent exposure of building occupants to concentrated indoor sources of pollutants.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for provision of:

✧ separate ventilation system for areas where significant indoor pollution sources are generated; and

✧ local exhaust of premises undergoing fit-out and redecoration.

Method of assessment

The Owner/Operator shall provide details of the ventilation system design providing local exhaust where concentrated pollutant sources are likely to be present (such as smoking rooms, print rooms, clinics, beauty parlours, etc) and the system for exhausting pollutants arising from redecoration and fit-out, such that there will be minimal entrainment to adjacent occupied premises, i.e. demonstrate through appropriate testing 99% isolation between areas with concentrated pollutant sources and occupied areas.

6.4 INDOOR AIR QUALITY

6.4.1 OUTDOOR SOURCES OF AIR POLLUTION

This section deals with pollutants found in indoor air which are mainly attributable to outdoor sources. In the case of occupied/habitable rooms in air-conditioned/naturally ventilated buildings the concern is indoor air pollutant from outdoor sources whilst operating in the naturally ventilated mode.

Carbon monoxide (CO) is toxic gas which interferes with the oxygen transport capacity of the blood, and at levels to which people can be exposed in buildings, leads to symptoms such as headaches, nausea, chest constriction, etc, as well as affecting concentration. Exposure to oxides of nitrogen (NO_x, 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. Ozone irritates the eyes and respiratory system. Sources of ozone in occupied areas include infiltration from outside occupied areas, and from equipment which utilises ultra-violet light or causes ionisation of air.

Respirable Suspended Particles are suspended airborne particles with a nominal aerodynamic diameter of 10 µm or less. The health impacts from inhalation of particles depend on size, shape and chemical reactivity. Outdoor sources are numerous, but vehicular exhaust and construction activity are significant sources. Particulate 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 areas.

Objective of HK-BEAM

Demonstrate that infiltration from external sources or adjacent premises do not give rise to unacceptable levels of the specified indoor air pollutants in occupied areas.

Maximum number of credits attainable: 4

Credit requirement

a) Carbon monoxide

❖ 1 credit for demonstrating compliance with the appropriate criteria for CO for each type of occupied premises included in the building development.

b) Nitrogen dioxide

❖ 1 credit for demonstrating compliance with the appropriate criteria for NO_2 for each type of occupied premises included in the building development.

c) Ozone

❖ 1 credit for compliance with the appropriate standards for ozone specified for each type of occupied premises in the building development.

d) Respirable suspended particulate

❖ 1 credit for compliance with the appropriate standards for RSP specified for each type of occupied premises in the building development.

Method of assessment

The Owner/Operator shall provide a report prepared by the suitably qualified person detailing the criteria adopted for each type of occupied premises within the building development, the measuring equipment used and details of the sampling points, the measurement results, and overall conclusions of the survey. Where indoor sources are part of the building systems they shall be operated during the time of measurements.

The criteria for offices and public places shall be that defined under Level 1 in Table 3-2 of the Guidance Note. For other occupied areas the criteria shall be that defined in the Guidance Note, in ASHRAE 62-2001, or other equivalent standard.

The sampling protocol (number and locations of samples) shall follow that prescribed in Appendix D as a minimum. For RSP the instrument type used shall be of gravimetric type, such as cyclone elutricator 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_2, ozone and RSP are solely from outside, measurements can be taken at the outdoor air intake locations where CO, NO_2, ozone and RSP are likely to infiltrate. Alternatively, the sampling may follow the requirements of the Guidance Note, or any other protocol demonstrated to be of equal rigour appropriate to the nature of the premises surveyed.

Alternatively, where the Owner/Operator can demonstrate compliance with the requirements of the Government's IAQ Certification Scheme and Guidance Note in respect of the thermal comfort parameters all three credits shall be awarded.

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.

6.4.2 INDOOR SOURCES OF AIR POLLUTION

This section deals with pollutants found in indoor air which are mainly attributable to indoor sources. In the case of occupied/habitable rooms in air-conditioned/naturally ventilated buildings the concern is indoor air pollutant from outdoor 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 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 indoor.

Objective of HK-BEAM

Demonstrate that internal sources or infiltration from outside or adjacent premises do not give rise to unacceptable levels in occupied areas of the specified air pollutants.

Maximum number of credits attainable: 3

Credit requirement

a) Volatile organic compounds

- ❖ 1 credit for compliance with the appropriate standards for VOCs specified for each type of occupied premises in the building development.

b) Formaldehyde

- ❖ 1 credit for compliance with the appropriate standards for formaldehyde specified for each type of occupied premises in the building development.

c) Radon

- ❖ 1 credit for compliance with the appropriate standards for radon specified for each type of occupied premises in the building development.

Method of assessment

The Owner/Operator shall provide a report prepared by the suitably qualified person detailing the criteria adopted for each type of occupied premises within the building development, the measuring equipment used and details of the sampling points, the measurement results, and overall conclusions of the survey.

The criteria for offices and public places shall be that defined under Level 1 in Table 3-2 of the Guidance Note. For other occupied areas the criteria shall be that defined in the Guidance Note, in ASHRAE 62-2001, or other equivalent standard.

The sampling protocol (number and locations of samples) shall follow that prescribed in Appendix D as a minimum. Alternatively, the sampling may follow the requirements of the Guidance Note, or any other protocol demonstrated to be of equal rigour appropriate to the nature of the premises surveyed. 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.

Alternatively, where the Owner/Operator can demonstrate compliance with the requirements of the Government's IAQ Certification Scheme and Guidance Note in respect of the thermal comfort parameters all three credits shall be awarded.

In the case of air-conditioned/naturally ventilated rooms the measurement of indoor air pollution shall be undertaken when operating in the background ventilation mode, that is, with all other means of ventilation rendered inoperative.

6.4.3 AIRBORNE BACTERIA

Micro-organisms in indoor air can cause more serious problems than some chemical air pollutants. The three main types of contaminants are bacteria, fungi (moulds and yeasts) and viruses. Water and condensation in ventilation systems can be a source of harmful bacteria which can be dispersed into occupied areas. Fungal growth is encouraged by high humidity and materials having high moisture content. Viruses are normally found in aerosols emitted by infected persons, but do not survive very long in ventilation systems.

The Guidance Note considers airborne bacteria to be adequately quantified by counts of Colony Forming Units (CFU/m^3) in air, measured by collecting bacteria and allowing them to grow on a suitable medium. Airborne bacteria are generated from indoor and outdoor sources. Indoor sources include the human bio effluents, plants and nursery beds in the building and the services systems containing stagnant foul water.

Objective of HK-BEAM

Demonstrate that upon completion operation of the HVAC system does not give rise to unacceptable levels of airborne bacteria in occupied areas.

Maximum number of credits attainable: 1

Credit requirement

- ❖ 1 credit for compliance with the appropriate standards for airborne bacteria specified for each type of occupied premises in the building development.

Method of assessment

The Owner/Operator shall provide a report prepared by the suitably qualified person detailing the criteria adopted for each type of occupied premises within the building development, the measuring equipment used and details of the sampling points, the measurement results, and overall conclusions of the survey.

The criteria for offices and public places shall be that defined under Level 1 in Table 3-2 of the Guidance Note.

The sampling protocol (number and locations of samples) shall follow that prescribed in Appendix D as a minimum. Common instrument for colony collections include Andersen multi-hole impactors, Reuter Centrifugal Sampler (RCS), Surface Air System (SAS) sampler, and cyclone scrubber. The samples should be kept to avoid contamination in transit to the laboratory where the sample is cultured and the colonies counted.

Alternatively, where the Owner/Operator can demonstrate compliance with the requirements of the Government's IAQ Certification Scheme and Guidance Note in respect of ozone the credit shall be awarded.

6.4.4 ODOURS AND HYGIENE

In centrally air-conditioned buildings odour generated from the metabolism of bacteria in drain pans of fan coil units and air handling units are common and can result in serious odour problems. Similarly, the metabolism of bacteria in connections to vent pipes from any system such as intermediate water tanks, under-floor plenum drains, floor drains, can be a source of odour and potential health problems unless fitted with effective U-traps to limit the possibility of foul air entering into indoor spaces.

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.

Objective of HK-BEAM

Ensure that the design, installation and facilities for operation and maintenance of plumbing and drainage systems and means of refuse disposal are such as to reduce the risk of odours entering occupied areas or public areas.

Maximum number of credits attainable: 2

Credit requirement

a) Plumbing and drainage systems

❖ 1 credit for adequacy of plumbing and drainage installations to limit odours.

b) Refuse disposal system

❖ 1 credit for the provision of a hygienic refuse collection system.

Method of assessment

a) The Owner/Operator shall provide evidence demonstrating that all connections to vent pipes from any system such as drain pans of air-side systems, intermediate water tanks, under-floor plenum drains, floor drains, etc, or potential added system when the building is use, such as in the pantries of tenants, are all fitted with self re-filled U-traps to stop the foul air from entering into indoor spaces. The design of these drain pans should be such that germ-killing biocides can easily be filled up the drain pans to reduce such nuisance.

b) The Owner/Operator shall submit details of the refuse collection system to demonstrate that refuse is disposed of in an hygienic manner and prevents any significantly discernable odours from entering occupied or public areas in or immediately adjacent to the building development.

6.4.5 IAQ IN CAR PARKS

This applies to enclosed and semi-enclosed car parks that rely on mechanical ventilation or mechanically assisted natural ventilation.

Objective of HK-BEAM

Meet the minimum requirements of performance in respect of air quality.

Maximum number of credits attainable: 1

Credit requirement

- ❖ 1 credit for compliance with the design requirements specified in ProPECC PN 2/96.

Method of assessment

The Owner/Operator 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[(67)], 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.

6.4.6 IAQ IN PUBLIC TRANSPORT INTERCHANGES

This applies to semi-enclosed public transport facilities that rely on mechanical ventilation, although this may be assisted by natural ventilation.

Objective of HK-BEAM

Meet the minimum requirements of performance in respect of air quality.

Maximum number of credits attainable: 1

Credit requirement

- ❖ 1 credit for compliance with the design requirements specified in ProPECC PN 1/98.

Method of assessment

The Owner/Operator 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 1/98[(68)], including any 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 1/98.

6.5 INTERIOR LIGHTING

For a building development housing a variety of premises the lighting requirements will vary with the layout and the particular use of the premises. Whenever practicable it is advantageous to utilise natural lighting to illuminate interiors, but this will depend on the extent of overshadowing by neighbouring structures and the orientation and design of windows, particularly in dense built environments. Good lighting designs will achieve a good measure of integration of natural and artificial light sources to satisfy functional needs and the comfort and health for building users, and improve energy efficiency.

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. Although interior lighting in workplaces presents 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. Certainly, to simply focus on luminance level on the horizontal plane is insufficient. A consequence of poor lighting in work places is discomfort and loss of working efficiency. Improved light sources and high frequency dimmable ballasts lend credibility to down lit work places, but with lighting further enhanced using task lighting. Modern lamps and luminance can improve indoor lighting quality and energy efficiency. Besides choice of light

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

68 Environmental Protection Department. Practice Notes for Professional Persons. ProPECC PN 1/98. Control of Air Pollution in Semi-confined Public Transport Interchanges. 1998.

source and light distribution, and system layout, consideration should be given to colour rendering, reflectance of room surfaces, arrangement of partitions, etc. A degree of local control of lighting by users is preferable whenever practicable.

For areas such as offices and classrooms where people spend long periods working the important consideration is quality of lighting for comfort and health, as this affects productivity. For shopping malls, retail outlets, catering establishments, and the like, lighting requirements differ significantly, and although performance criteria is available, actual design may be influenced by factors such as aesthetic quality and cost considerations. Premises for special uses such as indoor sports, exhibition and display areas will have particular requirements. Consequently, defining assessment criteria for interior lighting quality in a building complex is somewhat problematic. HK-BEAM 5-03 assessment is based on whether premises within a development take advantage of daylight where it is available, and meet basic performance criteria for interior (artificial) lighting.

6.5.1 DAYLIGHTING, WINDOWS AND VIEWS

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

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

Some rooms 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. However, where daylight is accessible some form of control at windows may be required to avoid glare from direct sunlight.

Objective of HK-BEAM

Provide building users with as much access as possible to daylight and views to the outdoors.

Maximum number of credits attainable: 4

Credit requirement

a) Daylight availability for windows with significant external obstructions

❖ 1 credit for demonstrating that at least 80% of windows to normally occupied rooms achieve a VDF of 12%, and the remainder achieve a VDF of 8%.

Alternatively, for windows not subject to significant obstruction

❖ 1 credit for demonstrating that at least 80% of normally occupied rooms achieve an average DF of 2.5%, and the remainder an average DF of 1.5%.

b) Window to floor area

❖ 1 credit for demonstrating that 80% of all occupied/habitable rooms with windows have a window to floor area ratio of 35% or more, and the remainder 25% or more.

c) Daylight penetration

❖ 1 credit for demonstrating:

✧ at least 80% of normally occupied rooms with windows achieve the room depth criterion; or

✧ the use of an advanced daylighting system that significantly improves daylight illuminance beyond 5 m from the window wall.

d) Views

❖ 1 credit for demonstrating that direct line of sight to a vision window is possible from at least

90% of area in habitable rooms and regularly occupied workspaces.

Method of assessment

The Owner/Operator shall submit evidence in the form of a report by a suitably qualified person demonstrating compliance with the assessment criteria. To qualify for credits the glazing transmittance shall be equal or greater than 70%. Visible transmittance of glazing shall be obtained from manufacturer's specification of the glazing product or by measurement.

a) Daylight availability shall be assessed by either one of the following methods:

- On-site measurements starting from the window that is shown by calculations to have the greatest external obstructions. An illuminance meter should be placed at the centre of the window and another illuminance meter on a horizontal plane under an unobstructed sky. (In practice, a completely unobstructed horizontal plane may be difficult to achieve in the Hong Kong urban environment and the roof of the building may be a good approximation to an unobstructed horizontal plane.) The two illuminance meters should be read simultaneously and the ratio of the illuminance on the window and the illuminance on the unobstructed horizontal plane is taken as the vertical daylight factor. The measurements should be carried out during a stable overcast sky condition. This sky condition may be difficult to get in practice and hence the following non-measurement methods are acceptable alternatives.
- Use of the skylight indicator and the method described in a Building Research Establishment Report(69).
- Use of lighting simulation software such as RADIANCE(70) that is capable of calculating the vertical sky component of building facades in dense urban settings. The CIE standard overcast sky shall be used in computer simulations.

The average daylight factor (DF) shall be calculated according to the method given in the CIBSE design guide(71) or any equivalent from an authoritative source. Alternatively, daylighting design software can be used to calculate the average DF provided the Designer can demonstrate that the method of computation employed by the software is not inconsistent with the prescribed method of DF calculation.

b) Window to floor area ratio shall be calculated for each room with windows and the percentage of rooms with the ratio greater than 25% or 35% can then be determined.

c) Room depth criteria is given by $d/w + d/h < 2/(I-R_B)$ where d = room depth, w = width, h = window head height, R_B = average reflectance of surfaces in the back half of the room.

Each room with windows shall be tested for compliance with the room depth criterion. If the reflectance's of room surfaces are unknown, then R_B=0.5 can be assumed for walls of light colour and R_B=0.3 should be used for walls with dark colours.

d) Views

To qualify for credit the glazing transmittance shall be equal or greater than 70%. Windows above 2.2 m and below 0.8 m do not qualify as vision windows.

The Owner/Operator shall provide a copy of the floor plan for normally occupied areas of each distinct type of premises in the development upon which are drawn lines of sight from each room to the horizontal extremities of each window. The angles of sight to each window shall take into account walls and fixed partitions, but not internal partitions or other obstructions installed by the user of the premises. For each room the total area provided with direct views shall be compared with the total area without. If the area with view is greater than 70% of the room area then the total area of the room counts towards the calculation of the credit. The credit is awarded if the percentage of the area of all qualifying rooms to the total area of the normally occupied spaces is

69 Littlefair, P.J. Site layout planning for daylight and sunlight: A guide to good practice. BRE Report. 1991.

70 Ward Larson, G. and Shakespeare, R. Rendering with RADIANCE. Morgan Kaufmann. San Francisco. 1998.

71 The Chartered Institution of Building Services Engineers. Lighting Guide LG10. daylighting and window design. CIBSE 1999.

80%.

6.5.2 INTERIOR LIGHTING PERFORMANCE

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 judgement. It is also related to economics and the environment in respect of the installation, maintenance and operation of the lighting system.

HK-BEAM 5-03 assumes that lighting installations in an existing building will be designed to CIBSE code[72] guidelines, or equivalent authority such as IESNA[73] and ISO/CIE[74], and may have been upgraded to the requirements for maintained illuminance, limiting glare index and minimum colour rendering specified in recent editions. Given the changes that may have taken place over time, it is accepted that full compliance with the performance criteria is unlikely to be achieved in all premises contained within an existing building development, so some latitude is allowed.

Headaches and eyestrain have been reduced in offices when high-frequency ballasts have been substituted for conventional ballasts used in fluorescent lights. High-frequency ballasts also reduce energy consumption and cooling load, and extend lamp life producing a return on their extra cost. A range of compact fluorescent lamps with high-frequency ballasts is available as direct replacements for tungsten lamps.

Proper lighting maintenance is important to maintain good lighting quality throughout the whole life of the lighting installation. A well maintained lighting installation will have clean lamps and luminaires. It should also have lamps replaced periodically to avoid the depreciation of lighting level due to lamp aging. The light output of discharge lamps, such as fluorescent tubes, decreases throughout their life while the power consumed remains constant. Their efficacy (light output per watt consumed) therefore declines. A maintenance schedule giving details of cleaning and lamp replacement is therefore essential for a well maintained lighting installation. In most cases cleaning intervals will depend on the rate of soiling likely to occur.

Objective of HK-BEAM

Ensure the adequacy of visual comfort conditions achieved by the artificial lighting provisions in indoor spaces and to maintain the design level of visual performance.

Maximum number of credits attainable: 4

Credit requirement

a) Light output levels

- ❖ 1 credit where interior lighting installations meet the specified performance in respect of maintained illuminance and illuminance variation.

b) Light output quality

- ❖ 1 credit where interior lighting installations meet the specified performance in respect of limiting glare index (or CIE unified glare rating) and minimum colour rendering.

c) High-frequency ballasts

- ❖ 1 credit for lighting installations in which fluorescent and other lamps with modulating (fluctuating) output are fitted with dimmable high-frequency ballasts where appropriate.

d) Luminaire installation and maintenance

- ❖ 1 credit for demonstrating that:

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72 The Chartered Institution of Building Services Engineers. Code for interior lighting. London. CIBSE.

73 Illuminating Engineering Society of North America. Lighting Handbook, Reference & Applications. 9th edition., New York. 2000.

74 International Organization for Standardization. ISO 8995. Lighting of indoor work places. 2nd Ed. 2002. International Commission on Illumination CIE S 008/E:2001

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- ✧ the lighting and air-conditioning design demonstrates that performance of fluorescent lamps is not affected by the cool air from air-conditioning; and
- ✧ there is a planned programme of luminaire cleaning and group re-lamping that follows the recommendation in CIE publication No. 97

Method of assessment

a) The Owner/Operator shall provide for each type of premises in the building development details of the 'as installed' lighting systems and demonstrate compliance through a report issued by a suitably qualified person.

Horizontal and vertical illuminance can be measured using a lux meter, and a luminance meter can be used to measure luminance.

For premises fitted out by tenants compliance shall be confirmed if the technical details and contractual arrangements with tenants in respect of lighting installations meet the criteria. Where measurement is not possible for operational reasons, the 'lumen method' formula can be used to calculate the maintained illuminance over the working plane according to the calculation procedure described in the CIBSE Code or in Appendix 3 of the CIBSE Lighting Guide[75]. The calculated maintained illuminance shall comply with the recommendations given in the CIBSE Code or as prescribed in IESNA's handbook.

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 the CIBSE 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.

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.

Where at least 80% of the development (based on floor area of occupied spaces) meets the criteria, and the remainder is within 30% of the specified criteria the credit shall be awarded.

b) The glare index can be calculated according to either of the two methods described in the CIBSE Technical Memoranda[76]. These methods are also summarised the CIBSE Code. The calculated glare index shall comply with the recommendations given in the Code or using IESNA equivalents.

Lamps shall have a CIE general colour rendering index 80 or above (i.e. colour rendering groups 1A or 1B) unless otherwise recommended in CIBSE Code. Colour appearance (correlated colour temperature) can be checked from the lamp labels or by measurement using a colour meter.

Where at least 80% of the development (based on floor area of occupied spaces) meets the criteria, and the remainder is within 30% of the specified criteria the credit shall be awarded.

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75 The Chartered Institution of Building Services Engineers. Lighting Guide LG7: Lighting for offices. London, CIBSE, 1993.

76 The Chartered Institution of Building Services Engineers. Technical Memoranda TM10. Calculation of glare indices. London, CIBSE, 1985.

c) The Owner/Operator shall provide details of where such equipment is used.

Where at least 80% of the applicable types of luminaires in the development meets the criteria the credit shall be awarded.

d) Air diffusers located near to fluorescent luminaires with open lamp compartments may result in cool air blowing over the lamps directly causing decrease light output and lamp efficacy. Distance of air diffusers from luminaires should be at least 500 mm; otherwise, the designer should demonstrate that the cool air from diffusers will not enter directly into lamp compartments.

The Owner/Operator should provide a lighting maintenance plan which shows the period for luminaire cleaning and group re-lamping. These periods can follow the recommendations given by CIE(77), or other equivalent specification.

Where at least 80% of luminaires meet the specification, and the lighting maintenance plan follows the specified guidelines the credit shall be awarded.

6.6 Acoustics, Noise and Vibration

Above certain levels indoor noise can cause discomfort, irritation and interference with workplace activities. In addition, poor acoustics in various premises will interfere with speech intelligibility. Background noise inside buildings comes from a number of sources, including noise break-in from the surrounding environment and noise produced inside the building, such as from building services equipment and adjoining premises. Many Hong Kong building developments containing noise sensitive premises 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.

6.6.1 Room Acoustics

Whilst reverberation time of a room continues to be regarded as a significant indicator of its acoustical properties, but there is reasonable agreement that other types of measurements are needed for a more complete evaluation of acoustical quality of rooms. Nonetheless, reverberation time measurements are important in the field of noise control in rooms as well as for the assessment of rooms for speech. ISO 3382(78) specifies methods for the measurement of reverberation time in rooms. It is applicable to rooms intended for speech or music where noise protection is a consideration. It describes the measurement procedure and method of evaluating data.

Objective of HK-BEAM

Improve the acoustical properties of rooms in which speech intelligibility is important.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for demonstrating that the reverberation time in applicable rooms meets the prescribed criteria for given types of premises.

a) Office type spaces

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

b) Classrooms and similar premises

[77] Commission Internationale de l'Eclairage (CIE). Maintenance of indoor electric lighting systems. CIE Technical Report. Publication No. 97. Vienna. 1992.

[78] International Standard Organization.ISO 3382. Acoustics - Measurement of the reverberation time of rooms with reference to other acoustical parameters. 1997.

The reverberation time of A-weighted sound pressure level in teaching rooms, other than specialist teaching rooms such as laboratories, shall be 0.6 s or below.

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.

d) Other types of normally occupied rooms shall meet the requirements of Table 8 of BS8233(79) or values prescribed by an appropriate authority.

Method of assessment

The Owner/Operator shall submit details in the form of a report by a suitably qualified person detailing the method used, underlying assumptions and measurement or calculation appropriate to the types of premises covered by the assessment. Measurements shall be undertaken in a representative number of each type of room or space in the building development. The reverberation time shall be measured using an appropriate method such as that given in ISO 3382 or similar. Alternatively, where it is not possible to undertake measurements, reverberation time may be assessed using Sabine's formula(80) or similar alternative. Where 80% of the measurements comply with the appropriate criteria for reverberation time, and the remainder do not deviate from the criteria by more that 25% the credit shall be awarded.

6.6.2 NOISE ISOLATION

Hong Kong's Building Regulations has not legislated for internal noise or for the design of buildings to mitigate noise transmission between rooms or premises, with the result that noise generated by neighbouring occupants can be a serious cause of annoyance. The extent to which walls and floor attenuate unwanted noise from neighbours and building equipment is an important aspect of controlling noise levels in interiors.

Objective of HK-BEAM

Improve the noise isolation of rooms to reduce impact of unwanted noise.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for demonstrating noise isolation between rooms, premises and/or floors meets the prescribed criteria.

a) Office premises

Provide for a Noise Isolation Class (NIC) of at least 40 for modular (private) offices.

b) Classrooms and similar rooms

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 Noise Insulation Class(81) IIC46 between floors.

c) Habitable rooms

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

79 British Standards Institution. BS 8233:1999. Sound insulation and noise reduction for buildings – Code of practice.

80 I.Sharland 1972 Woods practical guide to noise control. Colchester, England

81 International Standard Organization.ISO 140. Acoustics - Measurement of Sound Insulation in Buildings and of Building Elements. 1998

Method of assessment

The Owner/Operator shall submit details in the form of a report by a suitably qualified person detailing the method used, underlying assumptions and calculations appropriate to the premises covered in the assessment, as follows:

Measurements shall be undertaken in a representative number of each type of room or space in the building development. The measurements shall follow an appropriate method such as that given in ASTM 336[82] or similar. Alternatively, where it is not possible to undertake measurements, calculations can be made using ASTM E413[83] or similar alternative.

Where 80% of the measurements comply with the appropriate criteria for isolation, and the remainder do not deviate from the criteria by more that 25% the credit shall be awarded.

6.6.3 BACKGROUND NOISE

Background noise sources include that from external sources as well as from the building services equipment. The Environmental Protection Department provides guidelines on practical noise control measures for ventilation systems[84], and for pumping systems[85].

Objective of HK-BEAM

Control as far as practicable the background noise in premises at levels appropriate to their intended use.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for demonstrating background noise levels are within the prescribed limits.

a) Office Premises

- 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 and similar rooms

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) Habitable rooms

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

d) Other types of normally occupied rooms shall meet the requirements of Table 5 of BS8233 or values prescribed by an appropriate authority.

Method of assessment

The Owner/Operator shall submit details in the form of a report by a suitably qualified person detailing the method used, underlying assumptions and calculations appropriate to the premises covered in the assessment, as follows:

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82 American Society for Testing and Materials. ASTM E 336. Standard Test Method for Measurement of Airborne Sound Insulation in Buildings. 1997.

83 American Society for Testing and Materials ASTM E 413. Classification for Rating Sound Insulation. 1999.

84 Environmental Protection Department. Good Practices on Ventilation System Noise Control. January 1999.

85 Environmental Protection Department. Good Practices on Pumping System Noise Control. January 1999.

Site measurement according to ISO140[86] or equivalent. Measuring equipment shall comply with IEC 60804[87]. Measurements shall be undertaken in a representative number of each type of room or space in the building development, and shall include rooms closed to external (e.g. traffic) and internal (equipment) noise sources.

Where 80% of the measurements comply with the appropriate criteria for reverberation time, and the remainder do not deviate from the criteria by more that 25% the credit shall be awarded.

86 ISO 140 Acoustics - Measurement of Sound Insulation in Buildings and of Building Elements, International Standard Organization, Geneva, 1998.

87 International Electrotechnical Commission. IEC 60804:2001. Integrating-averaging sound level meters. BS EN 60804:2001.

7 INNOVATIONS AND PERFORMANCE ENHANCEMENTS

This section allows for the Owner/operator to submit any innovative techniques which the Owner/Operator deems to provide environmental benefits additional to those already covered in HK-BEAM 5-03.

Maximum number of credits attainable: 5

7.1 INNOVATIVE TECHNIQUES

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.

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.

Objective of HK-BEAM

Encourage adoption of practices, new technologies and techniques that have yet to find application in Hong Kong.

Credit requirement

The onus will be on the Owner/operator to present evidence of the application of new practices, technologies and techniques and the associated environmental benefits. The benefits may be considered in relation to energy use, materials use, improved comfort, reduced pollution, etc. The Assessor will refer the proposal to the HK-BEAM Steering Committee who will consider each aspect on its merits and award credits accordingly.

The Owner/operator 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 would be considered in the light of existing weightings under the various environmental impacts categorised in HK-BEAM, i.e. a technique which can demonstrate a resource saving or reduced environmental loading would be compared to existing criteria deemed to achieve similar levels of benefit.

7.2 PERFORMANCE ENHANCEMENTS

An alterative approach to achieving bonus credits under HK-BEAM is to demonstrate significant performance enhancements, i.e. strategies and techniques that greatly exceed the requirements of existing HK-BEAM credits. For example, features that result in significantly higher levels of energy, water or materials savings. Any credits gained under this heading shall be regarded as 'bonus' credits, counting towards the total credits obtained, but not towards the total credits obtainable.

Objective of HK-BEAM

Encourage adoption of practices, technologies and techniques that provide for performance enhancements over and above stated performance criteria in HK-BEAM 5-03.

Credit requirement

The onus will be on the Owner/operator to present evidence of the performance gains as compared to existing criteria. The Assessor will refer the proposal to the HK-BEAM Steering Committee who will consider each aspect on its merits and award credits accordingly.

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

A METHODS AND DATA FOR USE IN BUILDING ENERGY PERFORMANCE ASSESSMENTS

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 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 framework that applies to existing air-conditioned building developments, including buildings accommodating a single type or a mix of premises, building blocks in the same development served by a central air-conditioning plant, and air-conditioned buildings that also utilise natural ventilation, is described in Section A.1 to A.5. It covers the types of buildings defined in Section 4.2, the assessment framework for mechanically ventilated buildings defined in Section 4.2.6, and 'other buildings' as described in Section 4.2.7.

A.1 ASSESSMENT FRAMEWORK: AIR-CONDITIONED BUILDINGS

Here, air-conditioned buildings include buildings that are air-conditioned throughout the year (e.g. commercial buildings) and those that will utilise air-conditioning only when natural ventilation fails to satisfy the requirements on the indoor environment (e.g. residential buildings). 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_2 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.

As the specific characteristics that affect building energy use vary from one type of building development to another, the assessments and total number of credits also varies with the size and nature of the building being assessed. A building complex may comprise of a variety of building types, each accommodating different types of premises. To cope with the various scenarios that may be encountered, the method described in Section 1.3.7 is used for determining the overall score for energy aspects.

A.1.1 THE ASSESSMENT TOOL

The energy performance benchmark for existing air-conditioned buildings is determined based primarily on simulation predictions. Although the benchmarks and criteria for credits have been established using a detailed building heat transfer simulation program HTB2 and an air-conditioning system simulation program BECON, for the purpose of HK-BEAM assessment, building energy use predictions may be performed with the use of any suitable building energy simulation program. A simulation program/package will be regarded as a recognised simulation tool for use in the assessment if it fulfils the requirements stated in Section A.4 in this Appendix. Documents shall be submitted to confirm that the specific program used will have all the simulation capabilities required for modelling the building development being assessed and that the requirements stated in Section A.4 are met.

A.1.2 GENERIC ASSESSMENT METHOD

In order to allow Owners/Operators the greatest flexibility in achieving the energy performance targets for their buildings, the assessment will be based primarily on the 'total energy budget approach', supplemented by a range of basic requirements. There are also issues that will be assessed separately based on feature specific or component-performance based criteria. 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 façade), 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 baseline building model will be incorporated with a range of standard (default) parameters that characterise the performance of the services systems and the operating conditions in the building. Such parameters are either the minimum requirements stated in relevant energy code of practices or design guides (e.g. indoor thermal environment set points, lighting load intensities, coefficient of performance of chillers, ventilation rates etc.) or those that can represent situations in "average" buildings in Hong Kong, ascertained from previous surveys (e.g. occupation density, hours of occupation, non-air-conditioning energy use, etc). Where buildings are equipped with services installations with energy efficiency that exceeds the "average" buildings (e.g. use of energy efficient lamps and ballast, variable speed drives for VAV systems and chilled water pumping systems, smart control over lift banks, etc), the effects of such energy efficient measures will be ignored in the prediction of the annual energy use and maximum electricity demand of the baseline building model.

The zero-credit benchmark for an existing building will equal 150% of the predicted annual energy use of the baseline building model. 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.

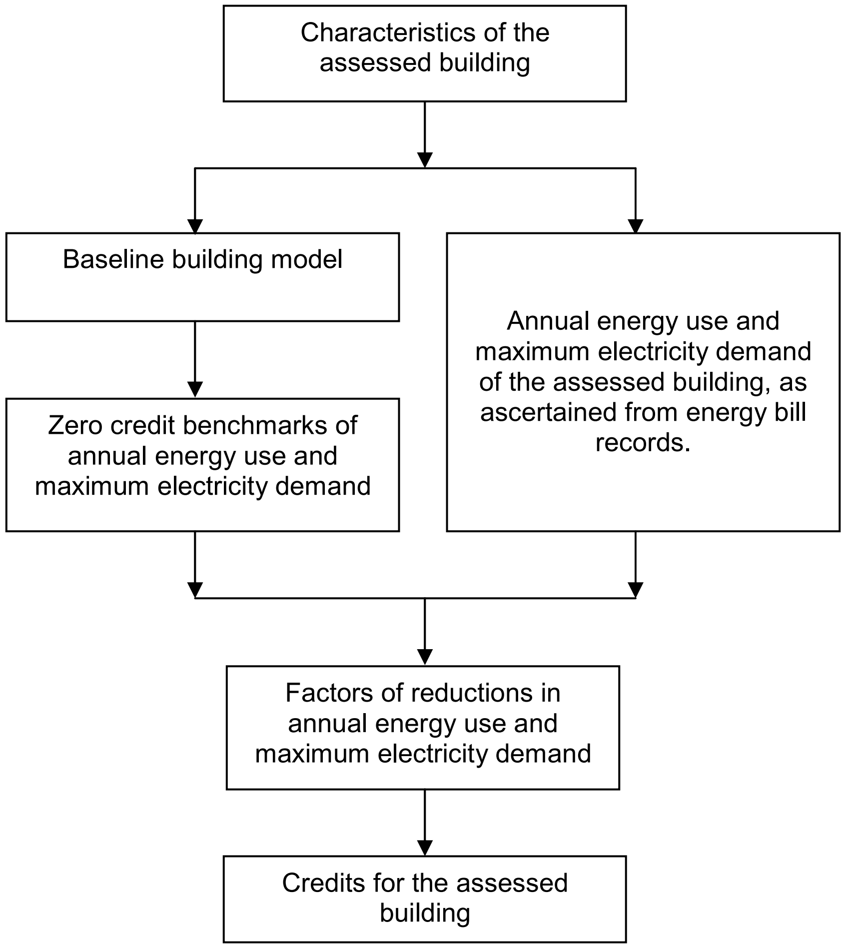

Figure A.1 Processes of building energy performance assessment

The number of credits to be awarded to the assessed building will be determined with reference to the percentage of reduction in the annual energy use of the assessed building relative to that of the baseline building model.

Besides the annual energy use, the assessment of the energy performance of a building includes, where applicable, an assessment of its maximum electricity demand. This will be undertaken in a way similar to the energy use assessment. The zero-credit benchmark for maximum 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 maximum 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 of their maximum electricity demand (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 A.2.

Computer simulation is taken as the generic method for the prediction of the annual energy use and maximum electricity demand of the air-conditioning installations in the baseline building model for an assessed building. Where simplified models are available as an alternative to the detailed simulation method, the simplified models can be used only if the assessed building possesses characteristics that fall within their applicable range (see Appendix B for descriptions of the regression models for commercial/office buildings).

The energy use and maximum 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 maximum 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.

A.1.3 ASSESSMENT OF A BUILDING COMPLEX

For a large development that includes several major parts, such as a number of building blocks with or without a common podium, all of which are served by a centralised chiller plant (as illustrated in Figure A.2), each part of the complex will be assessed according to the criteria for the building type to which each part belongs. A baseline building model with its own central chiller plant shall be devised for determining the zero-credit energy use and maximum electricity demand benchmarks for each part of the complex.

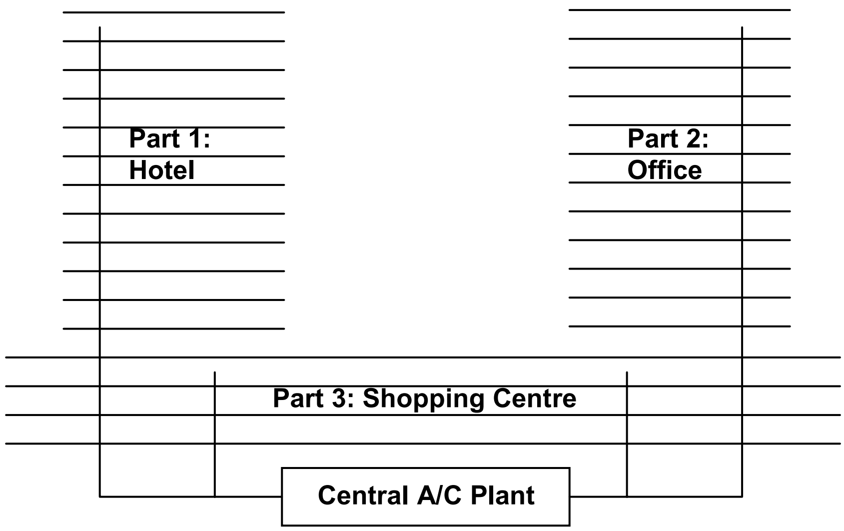

Figure A.2 Illustrating a building complex served by a central air-conditioning plant

The annual energy use and maximum electricity demand of the central plant shall be predicted based on the simultaneous hourly cooling loads from all parts of the complex throughout the year, and the central plant performance characteristics. The predicted annual energy use and maximum electricity demand of the central chiller plant shall then be apportioned to individual parts of the complex based on the ratio of the annual cooling load of each part of the complex to the total annual cooling load of the entire complex. The share of each part of the complex in the annual energy use and the maximum electricity demand of the central plant shall be added respectively to the annual energy use and the maximum electricity demand of the air-conditioning and other installations in the corresponding part of the complex. The result will then be compared with the predicted annual energy use and maximum electricity demand of the baseline building model for that part of the complex for the determination of the number of credits to be awarded to each part of the complex.

For residential developments that include residential towers resting upon a common podium that accommodates commercial premises, or an estate development comprising both residential and commercial blocks, the residential blocks and the commercial portions in the development will be separately assessed, according to the assessment methods that apply to the respective types of buildings, and a weighted overall score will then be determined for the overall development.

A.1.4 ADDITIONAL ENERGY CONSERVATION MEASURES

If any extra measures are adopted to effectively reduce the cooling load or enhance the efficiency of the air-conditioning systems in a building, their effects will be ignored in predicting the annual energy use and maximum electricity demand of the baseline building model (i.e. the zero-credit levels will remain unchanged), allowing higher credits commensurate with the enhanced performance to be achieved. Such measures may include but not be limited to:

- the use of air-to-air heat recovery devices;
- total enthalpy economiser cycles;
- demand controlled ventilation systems;
- chilled ceilings or chilled beams;
- desiccant dehumidification systems;
- variable speed fans or pumps;
- reduced duct static pressure reset or terminal regulated air volume control methods for variable air volume systems;
- chilled water temperature reset control for chillers, etc.

A.1.5 BASIC REQUIREMENTS

Compliance with the basic requirements, which include, wherever applicable, the specific items in the following existing building energy codes, is a pre-requisite to obtaining any credits under the total energy budget assessment:

- The Code of Practice for Energy Efficiency of Lighting Installations on those issues listed in Table A.1.
- The Code of Practice for Energy Efficiency of Air Conditioning Installations[i] on those issues listed in Table A.2.

Where applicable, those requirements labelled as "basic" in Table A.1 for lighting installations and in Table A.2 for air-conditioning installations shall be strictly complied with as a pre-requisite for credits under the building energy performance assessment. Substitutes or trade-offs in performance for such requirements will not be accepted.

Other building type specific requirements are given in relevant sections that define the assessment method and criteria for the respective types of buildings.

A.2 BASELINE BUILDING MODEL AND STANDARD/DEFAULT DESIGN PARAMETERS

A.2.1 ENVELOPE CHARACTERISTICS OF THE BASELINE BUILDING MODEL FOR AN EXISTING BUILDING

Since the building façade 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 (see Appendix B) were established.

A.2.2 INDOOR DESIGN CONDITIONS, OCCUPANCY DENSITIES AND VENTILATION AND INFILTRATION RATES

The default indoor design conditions to be used for various types of premises in the baseline building model for assessing an existing building shall be as shown in Table A.4. These design indoor conditions correspond to the threshold design conditions as stipulated in the Code of Practice for Energy Efficiency of Air Conditioning Installations or, for those types of premises for which such threshold values are unavailable in the Code, to typical conditions observed in existing buildings.

The default occupancy density and pattern, and ventilation and infiltration rates, for various types of premises in the baseline building model for assessing an existing building shall be as summarised in Tables A.4 and A.5. The default per-occupant ventilation rates are higher than those used in the design of some existing buildings, particularly those older ones. The application

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[i] Electrical and Mechanical Services Department. Code of Practice for Energy Efficiency of Air Conditioning Installations. http://www.emsd.gov.hk/emsd/e_download/pee/accop.pdf

of these higher ventilation rates to the baseline building model will, therefore, make allowances for such existing buildings to upgrade their ventilation provision from the sub-standard rates to the acceptable rates being used in designing new buildings.

A.2.3 INTERNAL LOADS

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 Code of Practice for Energy Efficiency of Lighting Installations for the respective types of premises. For those types of premises that the lighting energy code does not cover, default values established from previous surveys will be used. The relevant default values for lighting power intensity for use with the baseline building model are as summarised in Table A.4. Likewise, default values of equipment power density as summarised in Table A.4 will be applied to the baseline building model.

A.2.4 AIR-CONDITIONING SYSTEM DESIGN AND EQUIPMENT PERFORMANCE

The minimum permissible energy performance of air-conditioning system designs and equipment, as stipulated in the Code of Practice for Energy Efficiency of Air Conditioning Installations, will be assumed to be the performance of the air-conditioning installations in the baseline building model.

Where unitary air-conditioners or window- or split-type air-conditioners of capacities that fall outside the control of the air-conditioning energy code, performance data as summarised in Table A.6 will be assumed for both the baseline building model.

A.3 METHOD FOR ADJUSTMENT OF ENVELOPE PERFORMANCE FROM THE AS-DESIGN CONDITION TO THE MINIMUM ACCEPTABLE CONDITION

Other than those stated in A.2.1, no adjustment to the envelope performance will be applied to the baseline building model for assessing an existing building.

A.4 REQUIREMENTS ON THE BUILDING ENERGY SIMULATION PROGRAM FOR USE AS A BUILDING ANNUAL ENERGY USE PREDICTION TOOL

The annual energy use and the maximum electricity demand of a new building, and those of the baseline building model, shall be the predictions of a recognised building energy simulation program. A building energy simulation program will be recognised as a suitable tool for use in the building energy performance assessment provided that:

- it has all the simulation capabilities required for modelling the features of the building being assessed, including its air-conditioning system;
- when it is applied to model the cases described in ASHRAE Standard 140 according to the method and conditions of test stipulated therein, its predictions fall within the range of predictions by the range of simulation programs as given in the ASHRAE Standard; and
- its predictions for an existing building in Hong Kong have been compared with measured energy data of that building and the predictions are in good agreement with the measured data.

Evidence demonstrating fulfilment of requirement 1 above must be included in the submission for each building. Those for requirements 2 and 3 above need not be submitted if the program has already been recognised in a previous HK-BEAM assessment.

A.5 CONVERSION OF ELECTRICITY AND GAS CONSUMPTION INTO EQUIVALENT CARBON DIOXIDE EMISSION

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 HK-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:

Electricity: 0.615 kg CO_2 per kWh electricity consumed

Town gas: 0.279 kg CO_2 per m^3 of town gas consumed

Natural gas: 2.31 kg CO_2 per kg of natural gas consumed

Table A.1 Requirements for lighting installations (as in the Code of Practice for Energy Efficiency of Lighting Installations)

Section (1)	Requirements in the Code (2)	Nature of the requirement in HK-BEAM	
		New Buildings	Existing Buildings
4.1	Minimum allowable luminous efficacy of lamps	Basic (3)	Basic (3)
4.2	Maximum allowable lamp control gear loss	Basic (3)	Basic (3)
4.3	Maximum allowable lighting power density	Component-performance (4)	Base-line setting (4,5)
4.4	Interior lighting control points to meet minimum requirements and to be accessible to the occupants	Basic	Basic (6)

(1) Section numbers as in the Code

(2) Refer to the Code for the Scope of application of the requirements, details of the criteria and exceptions

(3) For HK-BEAM, the requirements in Sections 4.1 and 4.2 in the Code shall be applicable to all types of buildings

(4) Refer to Table A.4 for maximum allowable lighting power densities for premises types not covered by the Code

(5) Used as the lighting power density in premises for the prediction of the annual energy use of the baseline building model for determining the zero-credit level

(6) 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

Table A.2 Requirements for air-conditioning installations (as in the Code of Practice for Energy Efficiency of Air Conditioning Installations)

Section (1)	Energy efficiency requirements in the Code of Practice for Energy Efficiency of Air Conditioning Installations (2)	Nature of the requirement in HK-BEAM	
		New Buildings	Existing Buildings
4.1	Load calculation & plant sizing methods	Basic	Base-line setting (4)
4.2 & 4.3	Indoor and outdoor design conditions	Basic	Base-line setting (4)
5.1	Air distribution system: requirement for separate distribution systems for zones with special temperature requirements and air leakage limit on ductwork	Basic	Basic
5.2.2	Constant air volume (CAV) fan system power ≤ 1.6 W per l/s	Component-performance	Base-line setting (4)
5.2.3.1	Variable air volume (VAV) fan system power ≤ 2.1 W per l/s	Component-performance	Base-line setting (4)
5.2.3.2	VAV fan power no more than 55% of design wattage at 50% design flow rate	Basic	Base-line setting (4)
6.1	Variable flow water pumping system to be capable of reducing system flow to ≤ 50% of design flow	Basic	Base-line setting (4)
6.2	Water pipe frictional loss ≤ 400 Pa/m	Component-performance	Base-line setting (4)
7.1.1	Provision of at least one automatic temperature control device per system	Basic	Basic
7.1.2	Thermostatic controls for comfort should allow setting set point up to 29ºC or above	Basic	Basic
7.1.3	Thermostatic controls for comfort should allow setting set point down to 16ºC or below	Basic	Basic
7.1.4	Thermostatic controls for comfort should allow setting a dead-band of at least 2ºC between cooling and heating operation	Basic	Basic
7.2	Active humidity control, where used for comfort control, should be capable of preventing humidifying to above 30% and dehumidifying to below 60% in relative humidity	Basic	Basic
7.3.1	Each air-conditioned zone should be controlled by individual thermostatic control corresponding to temperature within the zone	Basic	Basic
7.3.2	The controls should not permit heating and cooling to take place in sequence or simultaneously	Basic	Basic
7.4.1	AC systems should be equipped with automatic setback control or could be shut down during non-use periods	Optional feature (3)	N/A (5)
7.4.2	Each hotel guestroom should be provided with a single master switch that will turn-off conditioned air supply or reset thermostat setting with or without reduction in fan speed	Optional feature (3)	N/A (5)
8	Minimum insulation thickness for chilled water and refrigerant pipes, ductworks and air handling unit casings	Basic	Basic
9	Minimum AC equipment efficiency	Component-performance	Base-line setting (4)

(1) Section numbers as in the Code

(2) Refer to the Code for the Scope of application of the requirements, details of the criteria and exceptions

(3) The prediction of the annual energy use for the assessed building will take the effect of the feature into account

(4) Applicable to the prediction of the annual energy use of the baseline building model for determining the zero-credit level

(5) Effects to be reflected in the metered energy consumption in the assessed building

Table A.3 Default construction characteristics for the building envelope of a baseline building model [1]

External walls	Thickness (m)	Material	k (W/mK)	ρ (kg/m³)	Cp (J/kgK)	α (-)
Layer 1	0.005	Mosaic Tiles	1.5	2500	840	0.58
Layer 2	0.01	Cement/Sand Plastering	0.72	1860	840	
Layer 3	0.1	Heavy Concrete	2.16	2400	840	
Layer 4	0.01	Gypsum Plastering	0.38	1120	840	0.65

Roofs	Thickness (m)	Material	k (W/mK)	ρ (kg/m³)	Cp (J/kgK)	α (-)
Layer 1	0.025	Concrete Tiles	1.1	2100	920	0.65
Layer 2	0.02	Asphalt	1.15	2350	1200	
Layer 3	0.05	Cement/Sand Screed	0.72	1860	840	
Layer 4	0.05	Expanded Polystyrene	0.034	25	1380	
Layer 5	0.15	Heavy Concrete	2.16	2400	840	
Layer 6	0.01	Gypsum Plaster	0.38	1120	840	0.65

Windows	Thickness (m)	Material	k (W/mK)	ρ (kg/m³)	Cp (J/kgK)	SC (-)
Layer 1	0.006	Tinted Glass	1.05	2500	840	0.95

Window to wall area ratio	0.65

Symbols:

k	Thermal conductivity
ρ	Density
Cp	Specific heat
α	Solar absorptivity of exposed surface
SC	Shading coefficient of glazing

(1) This applies to all types of buildings except commercial and hotel buildings. The envelope of the baseline building model for such buildings will be set to achieve an OTTV that barely meets the threshold value stipulated in the OTTV Code[ii].

ii Buildings Department. Code of Practice for Overall Thermal Transfer Value in Buildings 1995. http://www.info.gov.hk/bd/english/documents/index_pnap.html

Table A.4 Default indoor design conditions for various types of premises a baseline building model

Type of Premises	Indoor design condition	Occupancy density	Ventilation rate	Lighting power intensity	Equipment power intensity
	(Temp. ºC / RH %)	(m²/person)	(l/s-person)	(W/m²)	(W/m²)
Offices	23 / 50%	9	10	25	25
Retails	22 / 50%	4.5	7	70	30
General retail shops:					
Area < 28 m²	22 / 50%	4.5	7	85	50
28 m² ≤ Area < 43 m²	22 / 50%	4.5	7	60	40
Area > 43 m²	22 / 50%	4.5	7	40	40
Clothing	22 / 50%	4.5	7	50	30
Jewellery	22 / 50%	4.5	7	95	25
Restaurants	22 / 50%	2.5	7	35	55
Eastern	22 / 50%	2.0	7	35	55
Western	22 / 50%	3.0	7	20	35
Fast food	22 / 50%	1.6	7	40	220
Cinemas					
Concert halls					
Hotel guestrooms	22 / 50%	2 (per Rm)	35 (l/s-Rm)	600 (W/Rm)	100 (W/Rm)
Residential flats					
Bedrooms	22 / 50%	Note (1)	Note (2)	17	Note (1)
Living/dinning rooms	22 / 50%	Note (1)	Note (2)	14	Note (1)
Schools					
Classrooms	23 / 50%				
Assembly halls					
Staff offices	23 / 50%				
Laboratories					
Libraries					
Pubic libraries					

(1) Quantified on per room basis; see Tables A.5.5 and A.5.6.

(2) The assumption is made that there will not be a dedicated ventilation supply for living and dining rooms and bedrooms in residential buildings. Also see footnotes in Tables A.5.5 and A.5.6.

Table A.5 Default daily patterns of occupancy, fresh air supply, lighting load and equipment load

A.5.1 Office premises [(1)]

a) Weekdays

Hour From	To	Occupancy	Fresh Air Supply	Infiltration rate (ach)	Lighting (Perimeter)	Lighting (Interior)	Equipment
0	6	0.00	Off	0.50	0.05	0.05	0.10
6	7	0.00	Off	0.50	0.05	0.05	0.10
7	8	0.05	Off	0.50	0.10	0.10	0.15
8	9	0.40	On	0.10	0.50	0.50	0.50
9	10	0.95	On	0.10	0.90	1.00	1.00
10	11	0.95	On	0.10	0.90	1.00	1.00
11	12	0.95	On	0.10	0.90	1.00	1.00
12	13	0.95	On	0.10	0.90	1.00	1.00
13	14	0.45	On	0.10	0.80	0.90	0.80
14	15	0.95	On	0.10	0.90	1.00	1.00
15	16	0.95	On	0.10	0.90	1.00	1.00
16	17	0.95	On	0.10	0.90	1.00	1.00
17	18	0.50	On	0.10	0.80	0.80	0.60
18	19	0.25	On	0.10	0.50	0.50	0.40
19	20	0.10	Off	0.50	0.30	0.30	0.20
20	21	0.05	Off	0.50	0.20	0.20	0.15
22	23	0.00	Off	0.50	0.05	0.05	0.10
23	24	0.00	Off	0.50	0.05	0.05	0.10

b) Saturdays

Hour From	To	Occupancy	Fresh Air Supply	Infiltration rate (ach)	Lighting (Perimeter)	Lighting (Interior)	Equipment
0	7	0.00	Off	0.50	0.05	0.05	0.05
7	8	0.05	Off	0.50	0.10	0.10	1.00
8	9	0.30	On	0.10	0.50	0.50	1.00
9	13	0.60	On	0.10	0.75	0.80	1.00
13	17	0.10	Off	0.50	0.20	0.20	0.20
17	18	0.05	Off	0.50	0.10	0.10	0.10
18	24	0.00	Off	0.50	0.05	0.05	0.05

c) Sundays and Public Holidays

Hour From	To	Occupancy	Fresh Air Supply	Infiltration rate (ach)	Lighting (Perimeter)	Lighting (Interior)	Equipment
0	9	0.00	Off	0.50	0.05	0.05	0.05
9	17	0.05	Off	0.50	0.10	0.10	0.10
17	24	0.00	Off	0.50	0.05	0.05	0.05

(1) Occupancy, lighting load and equipment load patterns are in fractions of their respective peak values.

Table A.5 Cont'd

A.5.2 Retail premises (all days) (1)

Hour From	To	Occupancy	Fresh Air Supply	Infiltration rate (ach)	Lighting	Equipment
0	9	0.00	Off	0.50	0.00	0.05
9	10	0.00	Off	0.50	0.00	0.05
10	11	0.25	On	0.10	0.95	0.75
11	12	0.25	On	0.10	0.95	0.75
12	13	0.75	On	0.10	0.95	0.75
13	14	0.75	On	0.10	0.95	0.75
14	15	0.25	On	0.10	0.95	0.75
15	16	0.25	On	0.10	0.95	0.75
16	17	0.25	On	0.10	0.95	0.75
17	18	0.25	On	0.10	0.95	0.75
18	19	0.75	On	0.10	0.95	0.75
19	20	0.75	On	0.10	0.95	0.75
20	21	0.75	On	0.10	0.95	0.75
21	22	0.75	On	0.10	0.95	0.75
22	23	0.00	Off	0.50	0.00	0.05
23	24	0.00	Off	0.50	0.00	0.05

(1) Occupancy, lighting load and equipment load patterns are in fractions of their respective peak values.

A.5.3 Restaurant premises (all days) (1)

Hour From	To	Occupancy	Fresh Air Supply	Infiltration rate (ach)	Lighting	Equipment
0	5	0.00	Off	0.50	0.10	0.10
5	6	0.00	Off	0.50	0.10	0.10
6	7	0.60	On	0.10	0.90	0.75
7	8	0.60	On	0.10	0.90	0.75
8	9	0.60	On	0.10	0.90	0.75
9	10	0.60	On	0.10	0.90	0.75
10	11	0.60	On	0.10	0.90	0.75
11	12	0.90	On	0.10	0.90	0.75
12	13	0.90	On	0.10	0.90	0.75
13	14	0.90	On	0.10	0.90	0.75
14	15	0.05	On	0.10	0.90	0.60
15	16	0.05	On	0.10	0.50	0.60
16	17	0.05	On	0.10	0.50	0.60
17	18	0.05	On	0.10	0.50	0.60
18	19	0.75	On	0.10	0.95	0.75
19	20	0.75	On	0.10	0.95	0.75
20	21	0.75	On	0.10	0.95	0.75
21	22	0.75	On	0.10	0.95	0.75
22	23	0.05	On	0.10	0.75	0.10
23	24	0.05	On	0.10	0.25	0.10

(1) Occupancy, lighting load and equipment load patterns are in fractions of their respective peak values.

Table A.5 Cont'd

A.5.4 Hotel guestrooms (all days) (1)

a) Default patterns for rooms without energy saving controls over lighting, air-conditioning and power supply during unoccupied periods

Hour From	To	Occupancy	Fresh Air Supply	Infiltration rate (ach)	Lighting	Equipment
0	7	0.95	On	0.10	0.20	0.30
7	8	0.95	On	0.10	0.20	0.30
8	9	0.20	On	0.10	0.35	0.35
9	10	0.20	On	0.10	0.35	0.35
10	11	0.20	On	0.10	0.35	0.35
11	12	0.20	On	0.10	0.35	0.35
12	13	0.20	On	0.10	0.35	0.35
13	14	0.20	On	0.10	0.35	0.35
14	15	0.20	On	0.10	0.35	0.35
15	16	0.20	On	0.10	0.35	0.35
16	17	0.20	On	0.10	0.35	0.35
17	18	0.20	On	0.10	0.35	0.35
18	19	0.20	On	0.10	0.35	0.35
19	20	0.20	On	0.10	0.35	0.35
20	23	0.95	On	0.10	0.90	0.60
23	24	0.95	On	0.10	0.90	0.60

b) Default patterns for rooms with energy saving controls over lighting, air-conditioning and power supply during unoccupied periods (2)

Hour		Occupancy			Fresh Air Supply	Infiltration rate	Lighting			Equipment			Indoor temperature		
From	To	(i)	(ii)	(iii)		(ach)	(i)	(ii)	(iii)	(i)	(ii)	(iii)	(i)	(ii)	(iii)
0	7	1.0	1.0	0.0	On	0.10	0.20	0.20	0.00	0.30	0.30	0.30	22	22	28
7	8	1.0	1.0	0.0	On	0.10	0.20	0.20	0.00	0.30	0.30	0.30	22	22	28
8	9	0.0	1.0	0.0	On	0.10	0.00	0.80	0.00	0.30	0.50	0.30	28	22	28
9	10	0.0	1.0	0.0	On	0.10	0.00	0.80	0.00	0.30	0.50	0.30	28	22	28
10	11	0.0	1.0	0.0	On	0.10	0.00	0.80	0.00	0.30	0.50	0.30	28	22	28
11	12	0.0	1.0	0.0	On	0.10	0.00	0.80	0.00	0.30	0.50	0.30	28	22	28
12	13	0.0	1.0	0.0	On	0.10	0.00	0.80	0.00	0.30	0.50	0.30	28	22	28
13	14	0.0	1.0	0.0	On	0.10	0.00	0.80	0.00	0.30	0.50	0.30	28	22	28
14	15	0.0	1.0	0.0	On	0.10	0.00	0.80	0.00	0.30	0.50	0.30	28	22	28
15	16	0.0	1.0	0.0	On	0.10	0.00	0.80	0.00	0.30	0.50	0.30	28	22	28
16	17	0.0	1.0	0.0	On	0.10	0.00	0.80	0.00	0.30	0.50	0.30	28	22	28
17	18	0.0	1.0	0.0	On	0.10	0.00	0.80	0.00	0.30	0.50	0.30	28	22	28
18	19	0.0	1.0	0.0	On	0.10	0.00	0.80	0.00	0.30	0.50	0.30	28	22	28
19	20	0.0	1.0	0.0	On	0.10	0.00	0.80	0.00	0.30	0.50	0.30	28	22	28
20	23	1.0	1.0	0.0	On	0.10	0.90	0.90	0.00	0.60	0.60	0.30	22	22	28
23	24	1.0	1.0	0.0	On	0.10	0.90	0.90	0.00	0.60	0.60	0.30	22	22	28

(1) Occupancy, lighting load and equipment load patterns are in fractions of their respective peak values.

(2) Three groups of patterns have been defined: i) for hired rooms that will not be occupied during day time; ii) for hired rooms that will be occupied all day long; and iii) for spare rooms, as denoted by the column sub-headings (i), (ii) & (iii) respectively. The assumption shall be made in the energy use prediction that 75% of the rooms belong to pattern group (i), 20% to group (ii) and 5% to group (iii).

Table A.5 Cont'd

A.5.5 Living and dining rooms in residential flats (all days) (1)

Hour From	To	Occupancy (No./Rm)	AC Operation (2)	Fresh Air Supply	Infiltration rate (ach)	Lighting	Equipment (W/Rm)
0	5	0.00	Off			0.00	27
5	6	0.00	Off			0.00	27
6	7	0.00	Off			0.30	52
7	8	0.50	Off			0.50	77
8	9	1.00	Off			0.00	77
9	10	1.00	Off			0.00	77
10	11	1.00	Off			0.00	77
11	12	1.00	Off			0.00	77
12	13	0.90	Off			0.00	77
13	14	1.00	**On**			0.50	89
14	15	1.00	**On**	Note (3)	Note (4)	0.00	61
15	16	1.00	**On**			0.00	61
16	17	1.00	**On**			0.00	61
17	18	1.00	**On**			0.00	61
18	19	1.00	**On**			0.50	61
19	20	1.50	**On**			1.00	142
20	21	2.00	**On**			1.00	142
21	22	2.00	**On**			1.00	142
22	23	2.00	Off			1.00	142
23	24	0	Off			0.5	142

(1) Lighting load pattern is in fractions of the peak values. Occupancy and equipment load patterns are defined directly in number of persons per room and Watt per room.

(2) 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.

(3) Fresh air supply assumed to be absent.

(4) Infiltration rate assumed to be 0.5 air change per hour (ach) during air-conditioned periods and unoccupied periods. Infiltration rate assumed to be 3 ach during non-air-conditioned periods while indoor temperature stays at or below 22 ºC and to be 12 ach when this temperature is exceeded.

Table A.5 Cont'd

A.5.6 bedrooms in residential flats (all days) (1)

Hour From	To	Occupancy (No./Rm)	AC Operation (2)	Fresh Air Supply	Infiltration rate (ach)	Lighting	Equipment (W/Rm)
0	1	2.00	**On**			0.30	36
1	5	2.00	**On**			0.00	0
5	6	2.00	**On**			0.00	0
6	7	2.00	**On**			0.50	0
7	8	0.50	Off			0.20	0
8	9	0.00	Off			0.30	0
9	10	0.00	Off			0.00	0
10	11	0.00	Off			0.00	0
11	12	0.00	Off			0.00	0
12	13	0.00	Off			0.00	0
13	14	0.50	**On**	Note (3)	Note (4)	1.00	0
14	15	0.50	**On**			1.00	15
15	16	0.50	**On**			1.00	15
16	17	0.50	**On**			1.00	15
17	18	0.50	**On**			0.00	15
18	19	0.50	**On**			1.00	15
19	20	0.50	**On**			1.00	36
20	21	1.00	**On**			1.00	36
21	22	1.00	**On**			1.00	36
22	23	1.00	**On**			1.00	45
23	24	2.00	**On**			0.6	45

(1) Lighting load pattern is in fractions of the peak values. Occupancy and equipment load patterns are defined directly in number of persons per room and Watt per room.
(2) 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.
(3) Fresh air supply assumed to be absent.
(4) Infiltration rate assumed to be 0.5 air change per hour (ach) during air-conditioned periods and unoccupied periods. Infiltration rate assumed to be 3 ach during non-air-conditioned periods while indoor temperature stays at or below 22 ºC and to be 12 ach when this temperature is exceeded.

Table A.5 Cont'd

A.5.7 Classrooms in schools (1)

a) Summer Schedule, Monday to Friday

Hour From	To	Occupancy	Fresh Air Supply	Infiltration rate (ach)	Lighting	Equipment
0	8	0.00			0.00	0.00
7	8	0.00			0.00	0.00
8	9	0.90			0.95	0.95
9	10	0.90			0.95	0.95
10	11	0.90			0.95	0.95
11	12	0.90	Note (2)	Note (3)	0.95	0.95
12	13	0.90			0.95	0.95
13	14	0.45			0.50	0.50
14	15	0.00			0.00	0.00
15	16	0.00			0.00	0.00
16	24	0.00			0.00	0.00

b) Normal Schedule, Monday to Friday

Hour From	To	Occupancy	Fresh Air Supply	Infiltration rate (ach)	Lighting	Equipment
0	8	0.00			0.00	0.00
7	8	0.00			0.00	0.00
8	9	0.90			0.95	0.95
9	10	0.90			0.95	0.95
10	11	0.90			0.95	0.95
11	12	0.45	Note (2)	Note (3)	0.75	0.75
12	13	0.45			0.75	0.75
13	14	0.90			0.95	0.95
14	15	0.90			0.95	0.95
15	16	0.90			0.95	0.95
16	17	0.45			0.50	0.50
17	24	0.00			0.00	0.00

(1) Occupancy, lighting load and equipment load patterns are in fractions of the peak values. Classrooms will be occupied only for five days per week, following the Summer Schedule in the first two weeks in September and in May and June, and following the Normal Schedule for other school days.

(2) Fresh air supply assumed to be maintained by infiltration for replenishing exhaust by fan(s) during air-conditioned periods

(3) Infiltration rate assumed to be 5 air change per hour (ach) during occupied periods and 1 ach during unoccupied periods.

Table A.6 Minimum acceptable rated coefficient of performance (COP) of air-conditioning equipment (1)

Rated Input Power		Window type	Split Type and Floor Standing
0.56 - 2.24 0.75 - 3.0	(kW) (hp)	2.3	2.4
> 2.24 > 3.0	(kW) (hp)	n/a	2.5

(1) The rated COP shall be based on 35ºC outdoor dry-bulb temperature; 27ºC indoor dry-bulb temperature and 19ºC indoor wet-bulb temperature; and power supply at 220V, 50Hz.

B REGRESSION MODELS FOR PREDICTING ANNUAL ENERGY USE AND MAXIMUM ELECTRICITY DEMAND

B.1 OFFICE-ONLY BUILDINGS

The regression models shown in equations (B.1.1) and (B.1.2) are for predicting the annual electricity consumption (AEC_{AC}) and the maximum electricity demand (MED_{AC}) of the air-conditioning system in an office building. Values of the model coefficients are summarised in Table B.1.1.

These models apply only to NEW commercial buildings that comprise SOLELY OFFICES premises, and with characteristics that fall within the applicable ranges for the respective independent variables in the model, as summarised in Table B.1.2. They can be used to determine the air-conditioning components in the zero credit energy use and maximum electricity demand benchmarks for assessing a building, as well as the annual energy use and maximum electricity demand of the assessed building.

$$\begin{aligned} AEC_{AC} = {} & a_0 + a_1(AG \times UG \times Ta / COP) + a_2(AG \times UG / COP) + a_3(VR / COP) + \\ & a_4(W_{LGT} / COP) + a_5(W_{EQP} / COP) + a_6(CPP \times PP) + a_7(CFP \times FP) \end{aligned} \tag{B.1.1}$$

$$\begin{aligned} MED_{AC} = {} & b_0 + b_1(AG \times SC / COP) + b_2(VR / COP) + b_3(VR \times Wa / COP) + \\ & b_4(W_{LGT} / COP) + b_5(W_{EQP} / COP) + b_6(FP) \end{aligned} \tag{B.1.2}$$

Where:

AEC_{AC}	=	the annual electricity consumption for air-conditioning per square meter gross floor area of the building (kWh/m²-yr)
AG	=	total window area per square meter gross floor area of the building (m²/m²)
a_i & b_i	=	coefficients in the models (see Table B.1.1 for values of the coefficients)
CFP	=	air handling system control parameter (= 1 for constant air volume systems; = 0.67 for variable air volume systems with inlet guide vane control; = 0.4 for variable air volume systems with variable fan speed control)
COP	=	rated coefficient of performance of chillers
CPP	=	pumping system control parameter (= 1 for constant speed constant flow pumps; = 0.9 for using two-loop chilled water pumping system with constant speed pumps; = 0.6 for using two-loop chilled water pumping system with variable speed secondary-loop pumps)
FP	=	installed fan power per square meter gross floor area of the building (W/m²)
MED_{AC}	=	the maximum electricity demand of the air-conditioning system in the year per square meter gross floor area of the building (VA/m²)
PP	=	installed pumping power per square meter gross floor area of the building (W/m²)
SC	=	area (of windows) weighted average shading coefficient of glazing
Ta	=	indoor design temperature (ºC)
UG	=	area (of windows) weighted average heat-transfer coefficient of window glasses (W/m²K)

VR = fresh air supply flow rate per square meter gross floor area of the building (l/s·m²)

Wa = indoor design moisture content (g/kg dry air)

W_{EQP} = area (of floor) weighted average equipment power per square meter gross floor area of the building (W/m²)

W_{LGT} = area (of floor) weighted average lighting power per square meter gross floor area of the building (W/m²)

Table B.1.1 Coefficients in equations (B.1.1) and (B.1.2)

Coefficients	i	a_i	b_i
	0	4.763	9.404
	1	–13.84	125.5
	2	364.7	160.5
	3	75.68	–8.114
	4	2.359	0.813
	5	1.484	0.865
	6	0.688	1.856
	7	4.966	-

Table B.1.2 Applicable range of the regression models (equations (B.1.1) and (B1.1.2))

Variable	Description	Unit	Range
AG×SC	total glazed area per unit GFA × area weighted shading coefficient of window glasses	-	0.03 – 0.21
AG×UG	total glazed area per unit GFA × area weighted average heat-transfer coefficient of window glasses	W/m²·ºC	0.19 – 1.58
AG×UG×Ta	total glazed area per unit GFA × area weighted average heat-transfer coefficient of window glasses × design indoor temperature	W/m²	8.6 – 68.8
COP	rated coefficient of chiller performance	-	2.4 – 5.1
FP	installed fan power per square meter GFA	W/m²	8.3 – 20.1
PP	installed pumping power per square meter GFA	W/m²	4.5 – 23.3
VR	fresh air supply flow rate per square meter GFA	l/s·m²	0.36 – 2.7
VR×Wa	VR × design indoor air moisture content	g·l/kg·m²·s	3.7 – 30.7
W_{EQP}	area weighted average equipment power per square meter GFA	W/m²	18 – 29
W_{LGT}	area weighted average lighting power per square meter GFA	W/m²	14 – 29

Note: GFA = Gross Floor Area (m²)

The annual electricity consumption (AEC) and maximum electricity demand (MED) with reference to which the energy performance of a new office building will be assessed shall include also the annual electricity consumption and the maximum electricity demand of the lighting and equipment in all tenants' premises and those of the lighting installations in all air-conditioned public areas, as follows:

$$AEC = AEC_{AC} + AEC_{TENANT} + AEC_{LACPA} \quad (B.1.3)$$

$$MED = MED_{AC} + MED_{TENANT} + MED_{LACPA} \quad (B.1.4)$$

Where:

AEC = the annual electricity consumption of the central air-conditioning system, the lighting and equipment in tenants' premises and the lighting installations in air-conditioned public areas in the building per square meter gross floor area of the entire building (kWh/m²-yr)

AEC_{LACPA} = the annual energy consumption of lighting in air-conditioned public areas in the building per square meter gross floor area of the entire building (kWh/m²-yr)

AEC_{TENANT} = the annual electricity consumption of lighting and equipment in tenants' premises in the building per square meter gross floor area of the entire building (kWh/m²-yr)

MED = the maximum electricity demand of the central air-conditioning system, the lighting and equipment in tenants' premises and the lighting installations in air-conditioned public areas in the building in the year per square meter gross floor area of the entire building (VA/m²)

MED_{LACPA} = the maximum electricity demand of lighting in air-conditioned public areas in the building in the year per square meter gross floor area of the entire building (VA/m²)

MED_{TENANT} = the maximum electricity demand of lighting and equipment in tenants' premises in the building in the year per square meter gross floor area of the entire building (VA/m²)

AEC_{TENANT}, MED_{TENANT}, AEC_{LACPA} and MED_{LACPA} are to be evaluated as described in Section B.3.

B.2 COMMERCIAL COMPLEXES COMPRISING OFFICES, RETAIL SHOPS AND RESTAURANTS

The regression models shown in equations (B.2.1) and (B.2.2) are for predicting the annual electricity consumption (AEC) and the maximum electricity demand (MED) of the baseline building model for a commercial complex that accommodates only offices, restaurants and retail shops, or any one or two of these premises types. These models are to be used to determine the respective zero credit benchmarks for the assessed building complex, which may be either a new or an existing commercial complex. However, the models CANNOT be used for predicting the annual electricity consumption and the maximum electricity demand in the assessed complex; these energy performance indicators are to be evaluated by computer simulation for a new commercial complex or be ascertained from billing records for an existing commercial complex.

The AEC and MED values predicted by the regression models cover the entire range of landlord's services systems in the building complex and the electricity end-uses in the tenants' premises. The last term in each equation (AEC_{TENANT} or MED_{TENANT}), however, can be ignored (set to zero) when applied to assess a multi-tenanted existing commercial complex, in which case the predicted AEC and MED values will only be those of the landlord's services systems and, where applicable, the air-side equipment within tenants' premises in the complex.

$$AEC = a_0 + a_1(WWRSC) + a_2(U_{BLD}) + a_3(RPR) + a_4(SPR) + a_5(HRS) + AEC_{TENANT} \quad \text{(B.2.1)}$$

$$MED = b_0 + b_1(WWRSC) + b_2(U_{BLD}) + b_3(RPR) + b_4(SPR) + b_5(HRS) + MED_{TENANT} \quad \text{(B.2.2)}$$

Where:

AEC = the annual electricity consumption per square meter gross floor area of the building (kWh/m²)

AEC_{TENANT} = the annual electricity consumption of lighting and equipment in premises occupied by the tenants/premises owners per square meter gross floor area of the building (kWh/m²)

a_i & b_i = coefficients in the models shown in equations (B.2.1) and (B.2.2) (see Table B.2.1) for values of the coefficients for buildings with different area mixes of office, retail shop and restaurant premises in the building)

HRS = type of heat rejection system used in the chiller plant; = 1 for air-cooled; = 0 for water cooled

MED = the maximum electricity demand in the year per square meter gross floor area of the building (VA/m²)

MED_{TENANT} = the maximum electricity demand of lighting and equipment in premises occupied by the tenants/premises owners per square meter gross floor area of the building (VA/m²)

RPR = faction of the gross floor area of the building occupied by restaurants

SPR = faction of the gross floor area in the building occupied by retail shops

U_{BLD} = envelope thermal transmittance factor as defined in equation (B.2.3)

WWRSC = window performance factor as defined in equation (B.2.4)

The factors U_{BLD} and WWRSC are to be evaluated as follows:

$$U_{BLD} = \left(\sum_{i=1}^{n} U_{W,i} \cdot (1 - WWR_i) \cdot A_{W,i} + \sum_{i=1}^{n} U_{F,i} \cdot WWR_i \cdot A_{W,i} \right) \Big/ GFA \qquad (B.2.3)$$

$$WWRSC = \left(\sum_{i=1}^{n} SC_i \cdot WWR_i \cdot A_{W,i} \right) \Big/ GFA \qquad (B.2.4)$$

Where:

$A_{W,i}$ = area of the i^{th} wall or roof in the building envelope (m²)

GFA = gross floor area of the entire building (m²)

n = number of external wall and roof in the building envelope

SC_i = shading coefficient of fenestration at the i^{th} wall or roof in the building envelope (m²)

$U_{F,i}$ = U-value of the fenestration of the i^{th} wall or roof in the building envelope (W/m²K)

$U_{W,i}$ = U-value of the opaque part of the i^{th} wall or roof in the building envelope (W/m²K)

WWR_i = fenestration to wall area ratio of the i^{th} wall or roof in the building envelope

AEC_{TENANT} and MED_{TENANT} are to be evaluated as described in Section B.3.

Table B.2.1 Coefficients in equations (B.2.1) and (B.2.2)

a) For a commercial building with less than 50% of its GFA occupied by restaurants and retail shops (RPR+SPR < 0.5)

Coefficients	i	a_i	b_i
	0	93.44	55.58
	1	102.3	44.41
	2	4.404	4.158
	3	241.9	31.96
	4	93.72	5.606
	5	26.46	22.32

b) For a commercial building with 50% or more of its GFA occupied by restaurants and retail shops (RPR+SPR ≥ 0.5)

Coefficients	i	a_i	b_i
	0	127.4	60.72
	1	81.48	31.24
	2	7.104	4.196
	3	157.4	30.71
	4	55.68	6.658
	5	31.21	25.64

c) For commercial buildings with a mix of restaurants and retail shops but no offices (RPR+SPR = 1.0)

Coefficients	i	a_i	b_i
	0	226.2	78.94
	1	81.94	26.61
	2	10.67	5.597
	3	0	0
	4	0	0
	5	49.26	33.22

d) For a commercial building with 100% of its GFA occupied by retail shops (SPR = 1.0)

Coefficients	i	a_i	b_i
	0	169.2	68.24
	1	97.57	38.26
	2	9.348	5.493
	3	0	0
	4	0	0
	5	34.13	26.24

e) For a commercial building with 100% of its GFA occupied by restaurants (RPR = 1.0)

Coefficients	i	a_i	b_i
	0	285.1	95.17
	1	132.89	36.19
	2	14.62	5.499
	3	0	0
	4	0	0
	5	63.37	39.82

B.3 EVALUATION OF AEC_{TENANT}, MED_{TENANT}, AEC_{LACPA} AND MED_{LACPA} FOR COMMERCIAL BUILDINGS

The overall electricity consumption and maximum electricity demand of lighting and equipment in tenants' premises shall be determined as follows:

$$AEC_{TENANT} = \left(\sum_{i=1}^{nT} GFA_i \cdot (AEC_{LGT,i} + AEC_{EQP,i}) \right) \Big/ GFA \qquad (B.3.1)$$

$$MED_{TENANT} = \left(\sum_{i=1}^{nT} GFA_i \cdot (MED_{LGT,i} + MED_{EQP,i}) \right) \Big/ GFA \qquad (B.3.2)$$

Where:

$AEC_{EQP,i}$ = the annual electricity consumption of equipment per square meter gross floor area of the i^{th} premises in the building (kWh/m²)

$AEC_{LGT,i}$ = the annual electricity consumption of lighting per square meter gross floor area of the i^{th} premises in the building (kWh/m²)

GFA_i = gross floor area of the i^{th} premises in the building (m²)

$MED_{EQP,i}$ = the maximum electricity demand of equipment in the year per square meter gross floor area of the i^{th} premises in the building (VA/m²)

$MED_{LGT,i}$ = the maximum electricity demand of lighting in the year per square meter gross floor area of the i^{th} premises in the building (VA/m²)

nT = number of tenants in the building

The electricity consumption and maximum electricity demand of lighting and equipment in individual tenants' premises shall be determined as follows:

$$AEC_{EQP,i} = \left(\sum_{j=1}^{nEQP} N_{EQP,j} \cdot W_{EQP,j} \cdot UF_{EQP,j} \cdot OPH_{EQP,j} \right) \Big/ GFA_i \qquad (B.3.3)$$

$$AEC_{LGT,i} = \left(\sum_{j=1}^{nLGT} N_{LGT,j} \cdot W_{LGT,j} \cdot UF_{LGT,j} \cdot OPH_{LGT,j} \right) \Big/ GFA_i \qquad (B.3.4)$$

$$MED_{EQP,i} = \left(\sum_{j=1}^{nEQP} N_{EQP,j} \cdot VI_{EQP,j} \cdot UF_{EQP,j} \right) \Big/ GFA_i \qquad (B.3.5)$$

$$MED_{LGT,i} = \left(\sum_{j=1}^{nLGT} N_{LGT,j} \cdot VI_{LGT,j} \cdot UF_{LGT,j} \right) \Big/ GFA_i \qquad (B.3.6)$$

Where:

nEQP = number of equipment types in premises i

$N_{EQP,j}$ = number of the j^{th} type of equipment in premises i

nLGT = number of lamp types in premises i

$N_{LGT,j}$ = number of the j^{th} type of lamps in premises i

$OPH_{EQP,j}$ = annual operating hours of the j^{th} type of equipment in premises i (hr/yr)

$OPH_{LGT,j}$ = annual operating hours of the j^{th} type of lamps in premises i (hr/yr)

$UF_{EQP,j}$ = utilisation factor of the j[th] type of equipment in premises i

$UF_{LGT,j}$ = utilisation factor of the j[th] type of lamps (including the control gears where applicable) in premises i

$VI_{EQP,j}$ = maximum electricity demand of the j[th] type of equipment in premises i (VA)

$VI_{LGT,j}$ = maximum electricity demand of the j[th] type of lamp (including the control gear where applicable) in premises i (VA)

$W_{EQP,j}$ = installed power of the j[th] type of equipment in premises i (W)

$W_{LGT,j}$ = installed power of the j[th] type of lamp (including the control gear where applicable) in premises i (W)

The electricity consumption and maximum electricity demand of lighting in air-conditioned public areas shall be determined as follows:

$$AEC_{LACPA} = \left(\sum_{j=1}^{nLACPA} N_{LACPA,j} \cdot W_{LACPA,j} \cdot UF_{LACPA,j} \cdot OPH_{LACPA,j} \right) \Big/ GFA \qquad (B.3.7)$$

$$MED_{LACPA} = \left(\sum_{j=1}^{nLACPA} N_{LACPA,j} \cdot VI_{LACPA,j} \cdot UF_{LACPA,j} \right) \Big/ GFA \qquad (B.3.8)$$

Where:

nLACPA = number of lamp types in air-conditioned public areas in the building

N_{LACPA},j = number of the j[th] type of lamps in air-conditioned public areas in the building

$OPH_{LACPA,j}$ = annual operating hours of the j[th] type of lamps in air-conditioned public areas in the building (hr/yr)

UF_{LACPA},j = utilisation factor of the j[th] type of lamps in air-conditioned public areas in the building

VI_{LACPA},j = maximum electricity demand of the j[th] type of lamps in air-conditioned public areas in the building (W)

W_{LACPA},j = installed power of the j[th] type of lamps (including the control gears where applicable) in air-conditioned public areas in the building (W)

C 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 would be 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 HK-BEAM. Credits will be awarded for buildings designed to provide air-conditioner installation locations that comply with the minimum dimensions specified in Table C1. Minimum dimensions specified in this table are as shown in Figures C1 and C2.

Table C1 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 C2	0.3	1.7	0.6

Table C2 Minimum width (G) of recessed space into which air-conditioners reject heat

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

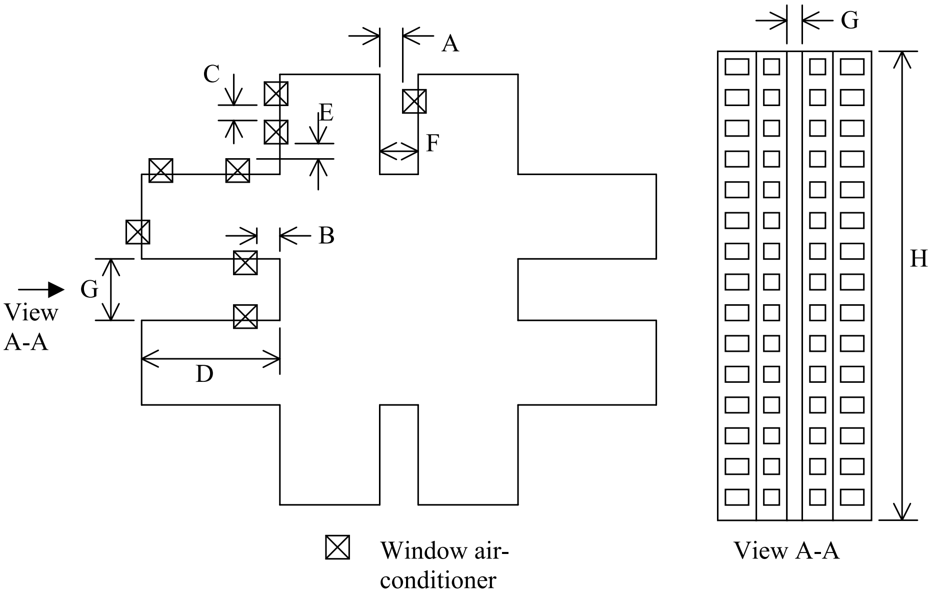

Figure C1 Layout plan and elevation of building

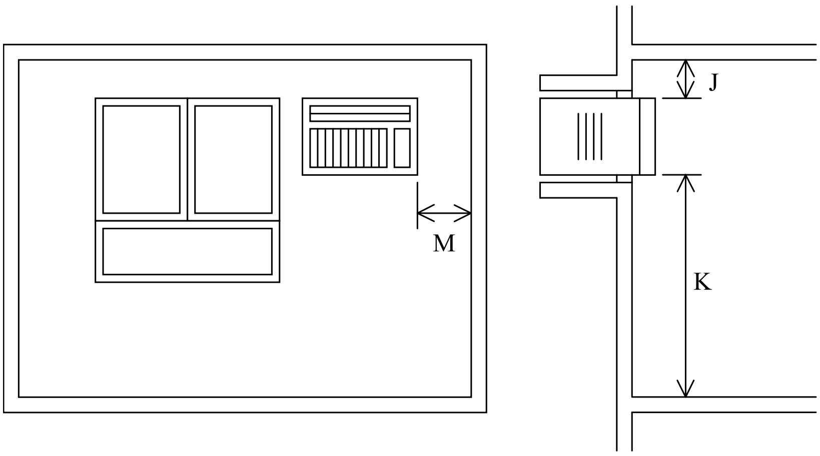

Figure C2 Elevation and section of a room in a residential building

Legend for Figure C1 & C2:

- 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

D SAMPLING PROTOCOL FOR INDOOR AIR QUALITY 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).

$$N = \frac{t^2 S^2}{d^2} \qquad (1)$$

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.