HK - BEAM

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May 2003

HONG KONG BUILDING ENVIRONMENTAL ASSESSMENT METHOD
香港建築環境評估法

An Environmental Assessment for New Building Developments

HK-BEAM Society

HK-BEAM Society

HK-BEAM 4/03 (New Buildings)

An environmental assessment for new building developments
Version 4/03

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It is intended that this pilot version of HK-BEAM 4/03 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 & 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 4/03 for new building developments. Assessment under HK-BEAM 4/03 focuses on the planning, design, construction and commissioning of the building and engineering systems, and should be initiated at the early stages of planning. HK-BEAM 4/03 aims to reduce the environmental impacts of new 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 4/03 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)

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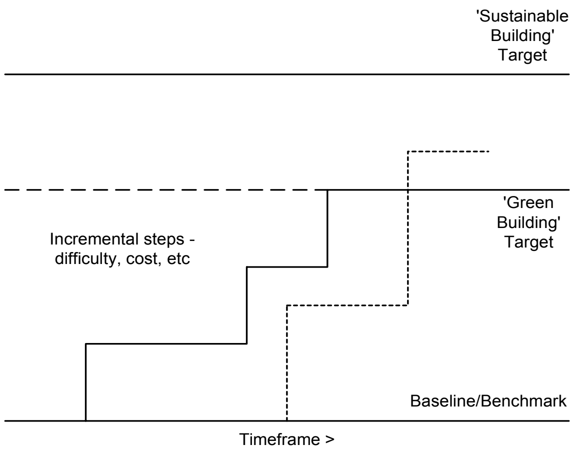
- to contribute to the development of buildings that are more sustainable;
- reduce the long-term impact that buildings have on the environment;
- raise awareness of the large contribution which buildings make to global warming, acid rain and depletion of the ozone layer;
- promote and encourage energy 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 clients. 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 buildings will continue to develop HK-BEAM will need to respond, requiring in 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 4/03

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.

HK-BEAM 4/03 assessments for new buildings are finalised upon completion of the works and prior to occupancy and handover, as opposed to simply assessing the designs and specifications. This enables construction activities to be monitored and commissioning to demonstrate certain key aspects of performance when in the building is use. Assessment methods must take into account the fact that a building or some premises may not be completely fitted out, and will be unoccupied and unfurnished.

The diversity of mix, uses and types of premises means that some environmental aspects may not apply to a particular building development. This is taken into account in the overall rating for a development, which will also clarify exactly what part of the development is covered by the final assessment rating.

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:

- 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:

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

- site location;
- planning and design; 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 management.

Energy Use

Assessment of energy use in a building development containing a variety of uses, energy sources and building services systems and equipment is a somewhat complex process given the number of influencing variables. HK-BEAM 4/03 adopts a computational approach to determining the dominant energy uses, with assessment of additional features known to have impact on overall performance. Energy Use includes:

- energy consumption;
- energy efficient systems and equipment; and
- provisions for energy management.

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.

A notable feature of HK-BEAM 4/03, as compared to other similar schemes in use elsewhere is that an assessment for new building is not finalised until a building development is completed, ensuring that 'green' and 'sustainable' design features are actually implemented and construction practice meets the required environmental standards. Besides being in the interests of the Client in defining the performance of the finished product, this approach also serves to 'dovetail' assessment with that used for existing building developments. It would be expected that a building graded under HK-BEAM 4/03 and suitably operated and maintained would achieve a similar grade under HK-BEAM 5/03 some years later.

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 planning, design, construction, and commissioning practices, and provisions for operation and maintenance, in line with international and local good practice guidelines and codes. Further credits are awarded for achieving an even higher level of performance. 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 Client, who will submit evidence in the form of documents, data and reports confirming compliance. Others will be based on evidence collected by the HK-BEAM Assessor.

HK-BEAM does not seek to be overly prescriptive in setting assessment criteria and in defining methods of compliance, and encourages the design team to consider alternative approaches which meet the objectives of HK-BEAM. Client representatives are invited to submit a 'method statement' if a credit is sought using an alternative approach. The statement shall address the stated objective of 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 4/03, due to their unusual nature or variety of forms and system designs, etc. This will be particularly true in respect of assessment of energy use. In such circumstances certain assessment criteria or the method of demonstrating compliance may need to be modified. This would require agreement between the Client and the HK-BEAM Assessor, to be endorsed by the HK-BEAM Steering Committee.

HK-BEAM 4/03 does not presume to be comprehensive in its coverage of environmental aspects. Under the heading of 'Innovation' the Client are encouraged to submit proposals for the award of credits for aspects not covered elsewhere in HK-BEAM 4/03. In such circumstances the Client 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.

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 4/03 is intended for application to a variety of new building developments. As such, a building under assessment may form part of a residential estate, 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.

HK-BEAM 4/03 encourages the client and the design team to consider the end use of the premises and the need to manage and maintain the whole building, whether it is a stand-alone building or part of an estate or a complex. HK-BEAM 4/03 focuses on the design features of the whole building and those of the premises within. However, when a building forms part of an estate then certain features of the estate design will be included in the assessment. In an estate containing several residential buildings of essentially similar design, certification for one building can apply to all similar buildings within the estate. 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.

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)

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 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 mechanically ventilated premises, 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:

Pilot - May 2003

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 the planning stage, but with many issues requiring confirmation during construction or upon completion of the core building and engineering services. It is based on readily available and generally accepted information. The method identifies and credits good planning, design, construction and commissioning techniques where specific targets are met. Whilst innovative design solutions are encouraged, they do not necessarily justify credit. 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 design, construction, installation, and operating practices.

The Assessor will issue a questionnaire to interested developers which details the information required for assessment. Whilst building developments can be assessed at any stage in the production process, the greatest benefit is derived if the assessment process begins at an early stage, allowing designers to make changes that will improve the building's environmental performance. The Assessor will arrange to meet the design team to discuss the details of the design. The 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 changes necessary to obtain further credits. At this stage the client may wish to make changes to the design or specification of the building. The Client shall confirm in writing to the assessor that no changes affecting the environmental assessment (as defined in the Final Report) have been made, or will advise of any changes that may affect the assessment credit ratings. The Assessor will be empowered to check that no changes are made which affect the award of credits and the overall assessment. The modified design may then be re-submitted to be re-assessed, with the obvious exception of those credits awarded for meeting construction and commissioning criteria.

Given that a significant number of credits under HK-BEAM are based on actions taken during construction and upon confirmation of deliverables provided upon completion, certification can only be issued upon building completion.

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 Client wishes to comply with credits and criteria introduced after registration.

HK-BEAM 4/03 ratings are based on the number of credits achieved (expressed as a percentage of the total applicable).

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

1.4.1 CERTIFICATION

All residential, commercial and institutional buildings are eligible for certification under HK-BEAM

8 Business Environment Council. http://www.bec.org.hk/

4/03, including, but not limited to offices, retail, catering and service establishments, libraries, educational establishments, hotels and residential apartment buildings. Whilst it is not expected that buildings used for primarily industrial purposes or low-rise 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 for the accuracy, completeness or use of, or reliance on, any information contained in the HK-BEAM Building Environmental Assessment Method, or from any injuries, losses, or damages arising out of such use or reliance.

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

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1.5 SUMMARY OF CREDITS

Sect:	Credit Requirement:	Credits:
2	**SITE ASPECTS**	
2.1.1	**Urban Redevelopment**	
a)	where the building development uses land that has been redeveloped or reclaimed	1
b)	where development did not have a negative impact on sites of historic or heritage value	1
2.1.2	**Contaminated Land**	
	Land previously used for industrial purposes, or adjacent to landfills: for implementing measures for the rehabilitation of previously contaminated land, or proper preparation of sites and structures adjacent to landfill sites	1
2.1.3	**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 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
2.2.1	**Site Design Appraisal Report**	
	for a site design proposal which demonstrates a proactive approach to achieve greater integration of site planning issues	1
2.2.2	**Ecological impact**	
	for designs that demonstrate how the landscaping and other site design strategies minimises ecological impact for Greenfield sites, or contributes positively to the ecological value of Brownfield sites	1
2.2.3	**Landscaping and Planters**	
a)	for using pervious materials for a minimum of 50% of hard landscaped areas	1
b)	for exterior plantings that use plants tolerant of climate, soils, and natural water availability	1
c)	for designs which provide appropriate planting on a building equivalent to at least 30% of the area of the building footprint	1
2.2.4	**Microclimate Around Buildings**	
a)	for demonstrating that no pedestrian areas will be subject to excessive wind velocities caused by amplification due to the site layout and/or building design	1
b)	for demonstrating that steps have been taken to reduce heat island effects through various design strategies	1
2.2.5	**Overshadowing and Views**	
	for a master planning scheme takes into consideration the solar access for individual buildings to minimise overshadowing; and demonstrates optimisation of view potential for the site whilst preserving the views of surrounding developments	1
2.2.6	**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
2.2.7	**Construction Management**	

Sect:	Credit Requirement:	Credits:
	for implementation of an Environmental Management Plan by the main contractor, including provisions for Environmental Monitoring and Auditing and reporting to the client representative	1
2.3.1	**Air Pollution During Construction**	
	for applying adequate mitigation measures for dust and air emissions during the construction as the recommended by the Environmental Protection Department; and demonstrating compliance with the air quality management guidelines as detailed in the Environmental Monitoring and Audit Manual	1
2.3.2	**Noise During Construction**	
	for demonstrating and confirming that the criteria and requirements laid down in ProPECC PN 2/93; and demonstrating compliance with the noise management guidelines as detailed in the Environmental Monitoring and Audit Manual	1
2.3.3	**Water Discharges During Construction**	
	for undertaking measures to reduce water pollution during construction as outlined in ProPECC PN 1/94	1
2.3.4	**Emissions from Wet Cooling Towers**	
a)	for a building development in which wet cooling towers are not used, or use seawater, or water from an acceptable source and are designed and maintained as specified in the Code of Practice for the Prevention of Legionnaires Disease	1
2.3.5	**Noise from Building Equipment**	
	for demonstrating that the level of the intruding noise at the facade of the nearest sensitive receiver is in compliance with the criteria recommended in the Hong Kong Planning Standards and Guidelines	1
2.3.6	**Light Pollution**	
	for 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
2.4	**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

3	**MATERIALS ASPECTS**	
3.1.1	**Building Reuse**	
	for reuse of existing building elements from the building structure or shell	1
3.1.2	**Adaptability and Deconstruction**	
a)	for designs providing flexibility through the choice of building structural system that allows for change in future use, and which is coordinated with interior planning modules	1
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

Sect:	Credit Requirement:	Credits:
3.1.3	**Envelope Durability**	
	for demonstrating the integration of building envelope systems which optimises the integrity of the envelope over the building life	1
3.1.4	**Modular and Standardised Design**	
	for demonstrating the application of modular design in buildings	1
3.1.5	**Off-site Fabrication**	
	when the manufacture of 50% of listed building elements has been off-site	1
	additional credit where the manufacture of 80% of listed building elements has been off-site	1
3.2.1	**Rapidly Renewable Materials**	
	for demonstrating that in applications where rapidly renewable materials can be employed at least 50% are used in the development	1
3.2.2	**Sustainable Forest Products**	
a)	for using durable and reusable formwork and hoarding systems to replace timber formwork and hoardings	1
b)	for using solid and composite timber products which are entirely from well managed sustainable sources, including reuse of salvaged timber	1
3.2.3	**Green Building Materials**	
	for the choice of building materials for over 50% of key building elements which rank an Overall Rating A in the Green Guide, or GOOD in Environmental Resource Guide	3 max
	for the choice of building materials for over 75% of key building elements which rank an Overall Rating A in the Green Guide, or GOOD in Environmental Resource Guide	
	for the choice of building materials for all key building elements which rank an Overall Rating A in the Green Guide, or GOOD in the Environmental Resource Guide	
3.2.4	**Use of Recycled Materials**	
a)	for use of recycled materials in site surfacing work, structures and features	1
b)	for using 5% of recycled materials, other than PFA, in the construction of the building; and full use of PFA in concrete in accordance with WBTC 14/90 or better	1
3.2.5	**Ozone Depleting Substances**	
a)	for using refrigerants with ozone depletion potential of zero	1
b)	for the use of insulation materials and products in the building fabric and services that avoids the use of ozone depleting substances in their composition or during manufacture	1
3.3.1	**Construction Waste**	
a)	for demonstrating that construction waste was sorted for the purposes of efficient recycling and disposal	1
b)	for implementing the Trip Ticket System for disposal of waste	1
c)	additional credit where demolition waste is also included with construction waste management	1
3.3.2	**Waste Disposal and Recycling Facilities**	
	for providing adequate facilities 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

Sect:	Credit Requirement:	Credits:
4	**ENERGY USE**	
4.2.1	**Energy Use in Commercial Buildings**	
	reduction in the annual energy consumption by 10% to 45% (1 to 10 credits)	10 max
4.2.2	**Energy Use in Hotel Buildings**	
	reduction in the annual energy consumption by 10% to 45% (1 to 10 credits)	10 max
4.2.3	**Energy Use in Residential Buildings**	
	reduction in the annual energy consumption by 3% to 22% (1 to 8 credits)	8 max
4.2.4	**Energy Use in Educational Establishments**	
	reduction in the annual energy consumption by 5% to 30% (1 to 8 credits)	8 max
4.3.1	**Maximum Electricity Demand in Commercial Buildings**	
	reduction in the maximum electricity demand by 15%	1
	reduction in the maximum electricity demand by 23%	2
	reduction in the maximum electricity demand by 30%	3
4.3.2	**Maximum Electricity Demand in Hotel Buildings**	
	reduction in the maximum electricity demand by 15%	1
	reduction in the maximum electricity demand by 23%	1
	reduction in the maximum electricity demand by 30%	1
4.3.3	**Maximum Electricity Demand in Residential Buildings**	
	reduction in the maximum electricity demand by 8%	1
	reduction in the maximum electricity demand by 12%	1
	reduction in the maximum electricity demand by 15%	1
4.3.4	**Maximum Electricity Demand in Educational Establishments**	
	reduction in the maximum electricity demand by 8%	1
	reduction in the maximum electricity demand by 12%	1
	reduction in the maximum electricity demand by 15%	1
4.4.1	**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 15% 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
4.4.2	**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 installing control systems and devices that will switch off or dim the output of lighting installations when and where illumination is not required	1
4.4.3	**Natural Ventilation of Large Premises**	
	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
4.4.4	**Lift and Escalator Installations**	
	for complying with the Code of Practice for Energy Efficiency of Lift and Escalator Installations	1

Sect:	Credit Requirement:	Credits:
4.4.5	**Electrical Installations**	
	for complying with the Code of Practice for Energy Efficiency of Electrical Installations	1
4.4.6	**Hot Water Supply**	
	for installing energy efficient hot water supply equipment and devices that save hot water	1
4.4.7	**Mechanical Ventilation in Hotel Buildings**	
	for using energy efficient ventilation fans that will consume less electricity than those meeting the zero credit requirements by 15% or more	1
4.5.1	**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
4.5.2	**Clothes Drying Facilities**	
	for providing suitable clothes drying facilities which utilise the natural environment for the majority of residential units	1
4.5.3	**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
4.5.4	**Use of Heat Reclaim Chillers or Heat Pumps**	
	for using heat reclaim chillers or heat pumps for pre-heating domestic hot water supply; or pre-heating hot water supply for winter space heating	1
4.5.5	**Energy Efficient Appliances**	
	for specifying the use of certified energy efficient appliances	1
4.6	**Embodied Energy**	
	for demonstrating the embodied energy of the assessed building is at least 15% less than for a conventional building design	2 max
	for demonstrating the embodied energy of the assessed building is at least 25% less than for a conventional building design	
4.7	**Renewable Energy**	
a)	Buildings in densely populated areas: for demonstrating 2 to 10% % of building energy use is generated from renewable energy sources	5 max
b)	Buildings in less densely populated areas for demonstrating 4 to 20% % of building energy use is generated from renewable energy sources	5 max
4.8.1	**Testing and Commissioning**	
a)	for provision of detailed specifications and cost provisions in contract documents detailing the commissioning requirements for all systems, equipment and components that impact on energy use and indoor environmental quality	1
b)	for the appointment of a commissioning authority and provision of a detailed commissioning plan that embraces all specified commissioning work	1

Sect:	Credit Requirement:	Credits:
c)	for ensuring full and complete commissioning of all systems, equipment and components that impact on energy use and indoor environmental quality	1
d)	for providing fully detailed commissioning reports for all systems, equipment and components that impact on energy use and indoor environmental quality	1
4.8.2	**Operation and Maintenance**	
a)	for providing a fully documented operations and maintenance manual to the minimum specified	1
b)	for providing fully documented instructions that enables systems to operate at a high level of energy efficiency	1
c)	for providing training for operations and maintenance staff to the minimum specified; and demonstrating that adequate maintenance facilities are provided for operations and maintenance work in the form of workshop(s), office accommodation and control room	1
4.8.3	**Metering and Monitoring**	
	for installation of: metering that allows monitoring of electricity use by the main chiller plant and auxiliaries; instruments for monitoring building cooling load and operating parameters of major chiller plant; metering which allows separate monitoring of electricity use by the air side of the HVAC system; and metering for landlord's electricity consumption in common space/public areas.	1

5	**WATER USE**	
5.1	**Water Quality**	
	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	1
5.2.1	**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 fixtures	2
5.2.2	**Metering and Controls**	
	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	1
5.2.3	**Water Efficient Irrigation**	
	for the use of an irrigation system which does not require the use of municipal potable water supply after a period of establishment is complete	1
5.2.4	**Water Recycling**	
a)	for providing for the collection of rainwater or 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
	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**	
	for demonstrating an estimated reduction in sewage volumes by 25% through	1

Sect:	Credit Requirement:	Credits:
	the use of water efficient fixtures and or recycling technologies	

6	**INDOOR ENVIRONMENTAL QUALITY**	
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
	for sustaining the air temperature at the design value within ±1°C when the air side system is operating at steady state under simulated full-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**	
	for demonstrating worse case peak temperatures without mechanical cooling does not exceed 30°C in any occupied/habitable rooms	1
	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 areas	1
	for demonstrating that the ventilation effectiveness in occupied areas meets the specified performance	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	**Uncontrolled Ventilation in Air-conditioned/Naturally Ventilated Premises**	
	for undertaking tests on a representative sample of units, to demonstrate that the air tightness is less than 2.0 $ac.h^{-1}$ at 50 Pa	1
6.3.4	**Localised Ventilation**	
	for provision of: an adequate ventilation system for rooms/areas where significant indoor pollution sources are generated; and a system of local exhaust of premises undergoing fit-out and redecoration	1
6.3.5	**Natural Ventilation in Public Areas**	
	for undertaking an analysis of building and adjacent building forms to assess wind pressures on ventilation openings in public/circulation areas	1
	for demonstrating that each common area has ventilation openings capable, under prevailing wind conditions, of providing adequate ventilation	1
6.4.1	**Construction IAQ Management for Centrally Air-conditioned Buildings**	
a)	for implementing a Construction IAQ Management Plan	1
b)	for a building 'flush out' and 'bake out'; or replacing all filters prior to occupancy	1
6.4.2	**Outdoor Sources of Air Pollution**	
a)	for demonstrating compliance with the appropriate criteria for CO for each type of occupied premises in the building development	1
b)	for demonstrating compliance with the appropriate criteria for NO_2 for each type of occupied premises 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	1

Sect:	Credit Requirement:	Credits:
	of occupied premises in the building development	
6.4.3	**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
6.4.4	**Biological Contamination in Centrally Air-conditioned Buildings**	
	for complying with the design recommendations described in the Code of Practice Prevention of Legionnaires Disease in respect of air-conditioning and ventilation	1
6.4.5	**Odours and Hygiene**	
a)	for adequacy of plumbing and drainage installations to limit odours	1
b)	for the provision of a hygienic refuse collection system	1
6.4.6	**IAQ in Car Parks**	
	for compliance with the design requirements specified in ProPECC PN 2/96	1
6.4.7	**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 in occupied/habitable rooms achieve a VDF of 12%, and the remainder achieve a VDF of 8% or	1
	Alternatively, for windows not subject to significant obstruction: for demonstrating that at least 80% of occupied/habitable rooms achieve an average DF of 2.5%, and the remainder an average DF of 1.5%	
b)	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	1
c)	for demonstrating at least 80% of occupied/habitable 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	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 Design**	
a)	where the prescribed lighting performance in each type of premises in respect of maintained illuminance, illuminance variation, and limiting glare index is achieved	1
b)	for lighting installations in which: fluorescent and other lamps with modulating (fluctuating) output are fitted with dimmable high-frequency ballasts in all work areas where appropriate; and lamps have a CIE general colour rendering index 80 or above (i.e. colour rendering groups 1A or 1B)	1
c)	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 the maintained illuminance takes into account the planned programme of luminaire cleaning and group re-lamping	1
6.4.1	**Room Acoustics**	
	for demonstrating that the reverberation time in applicable rooms meets the prescribed criteria for given types of premises	1

Sect:	Credit Requirement:	Credits:
6.4.2	**Noise Isolation**	
	for demonstrating noise isolation between rooms, premises and/or floors meets the prescribed criteria	1
6.4.3	**Background Noise**	
	for demonstrating background noise levels are within the prescribed criteria	1
6.4.3	**Indoor Vibration**	
	for demonstrating vibration levels shall not exceed the prescribed criteria	1

7	**INNOVATIONS AND PERFORMANCE ENHANCEMENTS**	
7.1	**Innovative Techniques**	5 max
7.2	**Performance Enhancements**	

2 SITE ASPECTS

The environmental aspects included in this part focuses on site location, site planning and layout, site ecology, and emissions from the site during both construction and use. There will be significant differences between large scale developments, such as estates, as compared to single buildings. Site location is important in respect of adequacy of local amenities and public transport provisions, in order to reduce travel needs and reliance on private vehicles. Urban redevelopment, including remediation and use of contaminated land, is encouraged, whereas Greenfield site development should seek to minimise disturbance, including the ecology of the site, impacts on local heritage, etc.

Planning and design needs to take into account and allow for adverse impacts during construction. The various discharges and emissions from the site should be considered over a building's lifetime.

2.1 SITE LOCATION

Due to the shortage of land on which to build the choices for site location are limited. However, from an environmental perspective credit should be given where building developments make use of sites that have already been developed or reclaimed, thereby preserving natural environments and reducing habitat encroachment. Additional credit may be awarded when contaminated land and land adjacent to landfill sites are put to use, provided that appropriate steps are taken to reduce environmental and health hazards to users of the building development and to neighbouring properties.

2.1.1 URBAN REDEVELOPMENT

The use of previously developed sites is encouraged. However, the new building development will sit within the site surrounding it, and these surroundings will also help define the character of the building, providing the first impression for users and visitors. Site designs should be such as to provide synergy with neighbouring developments, landscape and the local community.

Objective of HK-BEAM

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

Maximum number of credits attainable: 2

Credit requirement

a) Reuse of land

❖ 1 credit where the building development uses land that has been redeveloped or reclaimed.

b) Historic or heritage value

❖ 1 credit where development did not have a negative impact on sites of historic or heritage value.

Method of assessment

a) The Client shall provide evidence in the form of a report by an appropriately qualified person as to the previous uses of the land prior to the construction of the building development. Where the development uses previously developed land (Brownfield site), or where use is made of reclaimed land and no significant adverse impacts on the environment arose during reclamation, the credit shall be awarded.

b) The Client shall provide details of any historic or heritage sites in the vicinity of the development, and confirm that site preparation (including the process of reclamation), construction and building use has no adverse impacts on these sites. Where there is evidence that site reclamation or clearance has had no negative impact on such sites, the credit shall be awarded.

2.1.2 CONTAMINATED LAND

This is applicable only to land previously used for industrial purposes, or to sites adjacent to landfills.

To cope with demand for land, sites which may have been contaminated due to their former usage should be redeveloped. Land which has been contaminated by hazardous substances as a result of industrial operations pose risks or cause detrimental effects to users, the adjacent environment or even the building materials, possibly undermining the integrity of the building. Special attention and rehabilitation may be required. In order to avoid or minimize any risks or hazards associated with these sites, the project proponent should have carried out a site contamination assessment and implement remediation measures to clean up the land if necessary prior to any redevelopment.

ProPECC PN3/94[(9)] sets out requirements for proper assessment and management of potentially contaminated sites, and suggests practical remedial measures that can be adopted for the clean-up of a contaminated site. Requirements set out in this Practice Note are incorporated through the land use planning process, either as conditions to planning permission, or as special conditions in relevant land-title documents for cases associated with potential land contamination problems. Detailed guidelines are available for conducting contaminated land assessments and remediation work for sites previously used for purposes such as petrol filling stations, boatyards and vehicle repair/dismantling workshops[(10)].

It is recognised that building developments on land adjacent to landfill sites may be affected by migrating landfill gas and/or leachate unless specific precautions are taken to control the potential hazards. A Practice Note [(11)] sets out the conditions when a landfill gas hazard assessment may be required and provides general guidelines on how such an assessment should be undertaken. A Guidance Note[(12)] describes in more detail the process which should be followed in evaluating the risks and designing appropriate protection measures. The Guidance Note is not intended to provide comprehensive guidance on all aspects of risk assessment or design of precautionary/protection measures, but rather to give general guidance on important issues such as the factors to be considered when assessing the level of risk and the procedures which should be followed in undertaking the assessment.

Objective of HK-BEAM

Ensure proper remediation of redevelopment sites that are contaminated or potentially contaminated, or are adjacent to landfill sites.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for implementing measures for the rehabilitation of previously contaminated land, or proper preparation of sites and structures adjacent to landfill sites.

Method of assessment

a) Contaminated sites

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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. Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol Filling Stations, Boatyards, and Car Repair/Dismantling Workshops.
http://www.epd.gov.hk/epd/textonly/english/environmentinhk/waste/guide_ref/guide_contamsite.html

11 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

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

The Client shall provide evidence in the form of a report by a suitably qualified person that the site and immediate environs is free from hazardous contamination. The report shall confirm that the required remedial measures have been completed to restore the land to an acceptable condition for use for the building redevelopment. Due consideration to any disposal of contaminated waste shall be included. The report shall address the issues and requirements outlined in ProPeCC PN 3/94.

b) Sites adjacent to landfill

The Client shall provide evidence in the form of a report by a suitably qualified person that the site has been properly assessed and all necessary protection measures implemented. The report shall confirm that all issues and requirements outlined in ProPeCC PN 3/96 have been adequately addressed. Due consideration to gas hazards that may arise during the construction phase shall be included.

2.1.3 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 Client 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. 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 also be deemed to satisfy the criteria. The Client 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 as the nature of facilities and locations with respect to a building development is provided in the Hong Kong Planning and Standards Guidelines[(13)].

2.2 SITE PLANNING AND DESIGN

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

- disposition of individual blocks within the site;
- spatial relationship of the blocks to the immediate built and natural environment;
- relationship of the blocks to the site topography and ground conditions;
- overall massing of the proposed development;
- built form of individual blocks;
- orientation of buildings in relationship to view factors and ambient forces;
- balance of built-up and landscaped/open area;
- environmental enhancement to the surrounding of the subject site; and
- master landscaping strategy.

To ensure optimum use of land within the framework of development plans, lease conditions, whether drawn up for lots offered for sale by auction, tender or private treaty grant, contain requirements which control the use and the extent of the development. A 'Comprehensive Landscape' clause is usually included in Conditions of Grant for visually sensitive sites. The aim is to ensure that appropriate landscape treatment is provided on site to ameliorate visual impact, and conserve natural features. A 'Master Landscape' clause is for large sites at visually non-sensitive locations where new landscape feature will be created. A 'Simple Landscape' clause is usually included in Conditions of Grant for small sites where the landscape treatment has no impact on adjacent environment. In addition, a "Preservation of trees" clause will be included to ensure proper tree felling or tree transplanting before commencement of site formation work[(14)].

2.2.1 SITE DESIGN APPRAISAL REPORT

HK-BEAM seeks to encourage the Client and the design team to adopt a more integrated and proactive approach to the site planning matters. A site design appraisal report to demonstrate how the various aspects of site and architectural planning issues can collectively contribute to the enhancement of the site and its surrounding neighbourhood.

Objective of HK-BEAM

Encourage a proactive approach to achieve greater integration of site planning issues.

Maximum number of credits attainable: 1

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

14 Lands Administration Office, Lands Department. Practice Note Issue No. 6/2000. Landscape Clause/Proposal. 2000.

Credit requirement

❖ 1 credit for a site design proposal which demonstrates a proactive approach to achieve greater integration of site planning issues.

Method of assessment

To obtain credit the Client shall demonstrate that adequate site design considerations and design strategies were taken to take full account of the physical and environmental aspects of the site surroundings, covering as a minimum:

- scale (height, skyline and massing);
- materials and finishes;
- maximization of the green space in relation to the built-up area;
- heritage value of the site and its environs;
- protection and/or use of pre-existing site features; and
- mixed –use development for regeneration of urban fabric.

2.2.2 Ecological Impact

Ecological impact refers to a habitat or species being affected directly or indirectly due to changes in the environment brought about by a development. Besides magnitude and scale, the significance of an ecological impact is also related to the asserted importance of the habitat or species affected. The principle is first to minimise damage to the existing local ecology, and then to enhance it as far as practicable. Damage can be minimised either by selecting a site of low ecological value or by developing the site in a manner that protects salient ecological attributes.

The Technical Memorandum to the Environmental Impact Process(15) describes a general approach and methodology for assessment of ecological impact arising from a development. The objective of an ecological assessment is to provide sufficient data to allow a complete identification, prediction and evaluation of the potential ecological impacts, and/or opportunities to restore or improve matters. The methodology adopted will vary from site to site depending on the natural environment affected, the scale of building, and the opportunities to improve on the local ecology.

It is expected that the project team will undertake a survey of the ecological impacts arising from the development, with appropriate requirements specified in design and construction to minimise the change in ecological value. The assessment should identify and quantify as far as possible the potential ecological impacts associated with the proposed development. Both on-site and off-site impacts shall have been evaluated. Off-site mitigation measures shall only be considered when the potential for providing on-site mitigation has been exhausted(16).

Objective of HK-BEAM

Encourage site planning and design that minimises damage to the local ecology or areas of natural beauty.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for designs that demonstrate how landscaping and other site design strategies minimises ecological impact for Greenfield sites, or contributes positively to the ecological value of Brownfield sites.

Method of assessment

[15] Environmental Protection Department. Technical Memorandum on Environmental Impact Assessment Process. http://www.info.gov.hk/epd/eia/legis/index3.htm

[16] Guidelines for Implementing the Policy on Off-site Ecological Mitigation Measures. Planning, Environment & Lands Technical Circular No. 1/97. Works Branch Technical Circular No. 4/97. February 1997.

The Client shall provide a master landscape plan prepared by an appropriately qualified person which illustrates the various design strategies in relation to the ecological value of the site. Details of the impact on the flora, fauna and other components of the ecological habitats within and immediately adjacent to the development area shall be provided. The report shall also detail the means adopted to protect, maintain or rehabilitate the natural environment. In particular, it shall be demonstrated that development had no negative impacts on recognised sites of conservation importance, and on other ecological sensitive areas.

Landscaping offers a major opportunity for the protection of, or improvements to, the existing site ecology, such as restoring as far as possible natural ecology - existing water courses and drainage, connections to adjacent habitats, establishment of biodiversity, supplementing natural vegetation with native species, plant protection from wind and sun, etc. Where it can be demonstrated that all practical measures have been taken to conserve the ecology of a Greenfield site or to increase the ecological value of a Brownfield site, the credit shall be awarded.

2.2.3 LANDSCAPING AND PLANTERS

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

- enhance a site's microclimate (trees for shade and windbreaks, ponds and fountains, acoustic barriers, podium with gardens, etc.);
- provide for efficient irrigation (efficient use of direct rainfall, plant selection, water retention, materials in walkways allowing percolation to sub-soil, using well water, drip irrigation systems, etc.); and
- control 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. For example, a building rooftop covered with greenery can significantly reduce surface temperature in summer, compared with bare asphalt or concrete rooftops. Roof greenery also can reduce peak roof runoff and alleviate storm drainage pressure. To protect and improve the built and natural environment the Government in promoting the construction of green and innovative buildings has identified communal sky gardens and communal podium gardens[17,18].

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

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: 3

Credit requirement

a) Hard landscaping

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

b) Planters

❖ 1 credit for exterior plantings that use plants tolerant of climate, soils, and natural water availability.

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[17] Buildings Department et al. Joint Practice Note No. 1. Green and Innovative Buildings. February 2001. http://www.info.gov.hk/bd/english/documents/joint/JPN01.pdf

[18] Buildings Department et al. Joint Practice Note No. 2. Second Package of Incentives to Promote Green and Innovative Buildings. February 2002. http://www.info.gov.hk/bd/english/documents/joint/JPN02.pdf

c) Amount of greenery

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

Method of assessment

The Client shall provide a report prepared by a suitably qualified person that outlines the Master Landscape Plan for the site and provides a dialogue that demonstrates how soft landscaping has addressed the guidelines and recommendations provided in the HKSPG Chapter 4 Section 2 Greenery[19], appropriate to the type and scale of the building development and the immediate surroundings. The report shall detail the landscape treatment of the development including the planting and hard finishes of all landscaped areas, slopes and retaining structures, including but not limited to details of:

- compliance with existing legislation and administrative measures relevant to preservation of vegetation, including the felling of trees;
- trees retained, replanted or removed, and work undertaken to protect existing trees both during construction and permanently;
- site formation with specific details of slope treatment;
- the choice of finishes in qualitative terms for all hardwork elements, indicating any perceived or quantifiable environmental benefits;
- planting plans with the character and planting densities for all softworks elements, details of the species used, and assessment of environmental benefits;
- the adequacy of soil depth and drainage for all planted areas;
- the method of irrigation used and source of water supply; and
- future maintenance provisions; and

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) A pre-requisite is that the management of any trees on site follow Government stipulated requirements. The Client shall provide evidence in the form of specifications and details for the planting to be provided on the building. It is expected that due account shall be taken of the plant type and planter designs to minimise watering and maintenance requirements. The species, density, topsoil, fertiliser, pesticide, planting maintenance, etc. should comply with the General Specification for Building Section 25: Landscape, or at least equal equivalent.

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

2.2.4 MICROCLIMATE AROUND BUILDINGS

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

There can be considerable variation of wind speed and direction at pedestrian levels around high-rise buildings. Wind flow around a site can be accelerated or decelerated due to the building form, typically 2 to 3 times greater than for open ground. Of particular concern are localised areas of accelerated wind around corners and between narrow canyons. Accelerated winds can give rise to problems of pedestrian discomfort and in more extreme cases, danger from impeded walking and flying objects.

The following table[20] indicates that mechanical discomfort sets in at wind speeds of about 5 ms^{-1},

19 http://www.info.gov.hk/planning/tech_doc/hkpsg/english/ch4/ch4_text.htm

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

with speeds above 8 ms^{-1} being very uncomfortable and speeds above 20 ms^{-1} being dangerous. Conversely, some areas may receive relatively low wind flow with free airflow being obstructed by buildings. Although these areas can produce relative calm for walking, they are areas where windblown debris settles and accumulates. They may become stagnant with a build-up of pollutants and heat.

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

The use of non-reflective surfaces for external surfaces contribute to so-called heat island effects created when solar heat gains are absorbed and then radiated back to the surroundings. The effect may be local to pedestrian and recreational areas, or major contributions to urban heat islands from large buildings. As a result, local ambient and effective temperatures can rise by several degrees or more when compared to more open and better ventilated areas. Penalties include local discomfort, an increased need for mechanical cooling, detrimental effects on site vegetation and wildlife, etc. Heat island effects can be mitigated through the choice of finishes on buildings and horizontal hard surfaces that reflect heat or the application of shading.

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

Objective of HK-BEAM

Ensure the microclimate around and adjacent to buildings has been adequately considered, and where appropriate, suitable mitigation measures are included in designs.

Maximum number of credits attainable: 2

Credit requirement

a) Wind amplification

- ❖ 1 credit for demonstrating that no pedestrian areas will be subject to excessive wind velocities caused by amplification due to the site layout and/or building design.

b) Heat island effects

- ❖ 1 credit for demonstrating that steps have been taken to reduce heat island effects through various design strategies.

Method of assessment

a) The Client shall submit a report prepared by a suitably qualified person demonstrating compliance.

Relative wind speeds around buildings shall be assessed by placing a suitable scale model of the building and surrounding large structures in a boundary layer wind tunnel. Profiles of relative wind flow can be predicted at pedestrian levels. Measurement may be through multiple point measurement or through erosion techniques. The wind amplification factor - the developed site ground (~1m) wind speed relative to the open ground site wind speed - can be estimated at pedestrian areas. These include entrances and exits to buildings, car parks, pedestrian routes, play areas, etc.

Alternatively, wind flow around the estate can be simulated using computer airflow modelling (CFD), and areas of relative wind speed predicted. Tests should be carried out for average wind speed for the site and the main prevailing wind directions. No pedestrian areas on or immediately adjacent to the site shall have local wind speeds accelerated by factors greater than 2.

b) The microclimate should include sky and podium gardens, walkways, etc.

The Client shall submit a report detailing strategies and design solutions to mitigate heat islands effects. This should consider adverse impacts on the microclimate within and immediately adjacent to the site, demonstrating the benefits through:

- appropriate choices of materials on the building;
- site surface finishes and landscaping features;
- shading devices;
- demonstrating that under prevailing wind conditions there are no stagnant areas which are not 'flushed' by the wind; and
- use of water features, etc.

2.2.5 OVERSHADOWING AND VIEWS

Tall buildings can cause substantial overshadowing of neighbouring developments and amenities, affecting both direct and indirect sunlight and light from the sky. The impact of a new building on all neighbouring buildings where daylight is of value, such as residential buildings, hospitals, schools, etc should be assessed, as well as land which is likely to be developed for such purposes. Wherever possible the access to daylight and views should be safeguarded.

Objective of HK-BEAM

Encourage building development which is sensitive to the needs of neighbours in respect of preserving daylight and views.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for a master planning scheme that:

✧ takes into consideration the solar access for individual buildings to minimise overshadowing; and

✧ demonstrates optimisation of view potential for the site whilst preserving the views of surrounding developments.

Method of Assessment

The Client shall provide evidence in the form of a master planning design report prepared by a suitably qualified person. The report shall include the study of building massing and layout design which minimizes the overshadowing problem and the analysis of the view aspect of the proposal which balances the view and privacy requirements of both the proposed and surrounding developments. Where due consideration has been given to preserving as far as possible the views and privacy of adjacent habitable properties, and reducing overshadowing the credit shall be awarded.

2.2.6 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.

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.

2.2.7 CONSTRUCTION MANAGEMENT

The environmental impacts arising during construction are often very significant, affecting site ecology, air, noise and water quality as well as nuisance from waste within and outside the site. The appointment of contractors who are environmentally aware and who are able to implement good environmental practices on site should make a significant contribution to reducing environmental pollution and waste. Appropriate pollution control clauses should be included in construction contracts in accordance with recommendations by the Environmental Protection Department(21). Contractors should take appropriate steps to minimise the impacts of construction activities on the surrounding environment(22).

Objective of HK-BEAM

Encourage a higher standard of environmental management during construction.

Maximum number of credits attainable: 1

❖ 1 credit for implementation of an Environmental Management Plan by the main contractor, including provisions for Environmental Monitoring and Auditing and reporting to the client representative.

Method of assessment

A prerequisite for credit is compliance with all relevant environmental protection and pollution control ordinances. Any evidence of non-compliance shall nullify the award of any credits.

The Client shall provide copies of relevant contract documents highlighting the clauses appropriate to the construction activities for the building development in accordance with recommendations set out by the Environmental Protection Department. The Environmental Management Plan should take into account the Checklist and practical advice given in PNRC 17 Appendix A. The Client shall confirm through a report derived from appropriate site management and monitoring that environmental management practices on site are such as to comply with legislative requirements and to minimise nuisance. Appendix A of PNRC 17 should be used as a point of reference in reporting on implementation of the environmental management on site.

2.3 EMISSIONS FROM THE SITE

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

21 Environmental Protection Department. Recommended Pollution Control Clauses for Construction Contracts. http://www.epd.gov.hk/epd/english/environmentinhk/eia_planning/guide_ref/rpc.html

22 Buildings Department. Practice Note for Registered Contractors PNRC 17. Control of Environmental Nuisance from Construction Sites. August 1997. http://www.info.gov.hk/bd/english/documents/pnrc/Pnrc17.pdf

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

2.3.1 AIR POLLUTION DURING CONSTRUCTION

The Air Pollution Control Ordinance (APCO) is the main legislative framework governing the control of air pollution activities. Air pollution control regulations are enacted under the APCO for specific air pollution control purposes. Under the APCO, air pollution emissions from construction activities are subject to control under five regulations:

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

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

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

Objectives of HK-BEAM

Minimise air pollution during the construction of buildings and the infrastructure serving buildings.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit:

✧ for applying adequate mitigation measures for dust and air emissions during the construction as the recommended by the Environmental Protection Department; and

✧ demonstrating compliance with the air quality management guidelines as detailed in the Environmental Monitoring and Audit Manual.

Method of assessment

A prerequisite for award of credit is that there is compliance with applicable legislation governing air pollution and no conviction or complaint about air pollution from the site has been upheld by the Environmental Protection Department.

The Client shall present evidence in the form of specifications and contract documents detailing the requirements to control dust and air emissions generated by construction activities. The Client's representative on site shall be responsible for monitoring and reporting on the execution of the instructions. The representative shall confirm in writing to the Assessor that the control of dust on site followed the requirements as laid down in the specifications and contract documents. The assessor may carry out site inspections during construction.

The Client shall also present evidence in the form of a report prepared by a suitably qualified person that the monitoring and audit of Respirable and Total Suspended Particulates (TSP) complies with the requirements stated in the EPD's Environmental Monitoring and Audit Manual[23].

2.3.2 NOISE DURING CONSTRUCTION

Due to the high density of buildings, traffic and people, Hong Kong is perhaps one of the noisier cities in the world. The Government's policy objective for controlling noise pollution is to ensure that a satisfactory noise environment is maintained to safeguard the quality of life of the population. Noise caused by construction activity is a major target for attention. Noise related to construction activities is controlled under the Noise Control Ordinance (Chapter 400). Despite the introduction of controls on construction noise under the Noise Control Ordinance (NCO)[24] and general tightening of the controls, construction noise remains a problem. Guidance is given practice notes issued by EPD[25] and the Buildings Department[26].

General requirements[27] and practical guidance[28] on meeting the requirements is available from the Environmental Protection Department (EPD). Apart from the Noise Control Authority (i.e. EPD), the police is also authorized to enforce the sections of product noise and construction noise under the Noise Control Ordinance. Under the NCO, construction activities are grouped into two main categories:

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

A Technical Memorandum[29] details the procedures for determining (on the basis of the number of pile drivers used, distance separation, and the calculated noise level) any permitted hours of operation for percussive piling. Control of construction noise for general works can be further categorised into:

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

For construction work other than percussive piling other technical memoranda[30,31] detail the procedures for determining (on the basis of equipment used, distance separation, and the calculated noise level) whether a CNP for general works should be granted. The noise impacts on nearby Noise Sensitive Receivers (NSRs, e.g. dwellings, school) are assessed in accordance with the Technical Memoranda. Under the Noise Control Ordinance, there is no statutory control on the noise from general works during the unrestricted hours (i.e. 7 am - 7 pm on weekdays).

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23 Environmental Protection Department, Generic Environmental Monitoring and Audit Manual, Chapter 2, Air Quality. May 1996.

24 A Concise Guide to the Noise Control Ordinance. Environmental Protection Department. 8th Ed. July 2000. http://www.epd.gov.hk/epd/english/environmentinhk/noise/guide_ref/guide_nco.html

25 Environmental Protection Department. Practice Note for professional Persons. ProPECC PN 2/93. Noise from Construction Activities – Non-statutory Controls.
http://www.epd.gov.hk/epd/english/resources_pub/publications/files/pn93_2.pdf

26 Buildings Department. Practice Note for Authorized Persons and Registered Structural Engineers. PNAP 144. Control of Environmental Nuisance from Construction Sites. August 1997.
http://www.info.gov.hk/bd/english/documents/pnap/Pnap144.pdf

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

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

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

30 Environmental Protection Department. Technical Memorandum on Noise from Construction Work other than Percussive Piling.

31 Environmental Protection Department. Technical Memorandum on Noise from Construction Work in Designated Areas.

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

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

Objective of HK-BEAM

Minimise nuisance to the immediate neighbourhood caused by noise during the construction of buildings and the infrastructure serving buildings.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for:

✧ demonstrating and confirming that the criteria and requirements laid down in ProPECC PN 2/93: and

✧ demonstrating compliance with the noise management guidelines as detailed in the Environmental Monitoring and Audit Manual.

Method of assessment

The Client shall submit confirmation in the form of a report from suitably qualified person that the works have been carried out without violation of the Noise Control Ordinance, and that no complaint about noise form the site has been upheld by the Authority (Environmental Protection Department) or the Police leading to the issue of a fine or prosecution. The Client's representative on site, who shall be a suitably qualified person, shall be responsible for monitoring and shall submit monthly reports confirming that the control of noise on site followed the requirements laid down in ProPECC PN 2/93, and confirming compliance with the noise management guidelines.

2.3.3 WATER DISCHARGES DURING CONSTRUCTION

Construction activity can pose a major pollution threat to the environment if discharges from construction sites are not properly handled. Such discharges are subject to control under the Water Pollution Control Ordinance[32]. The major types of discharges have been identified as follows:

- muddy underground water and bentonite slurries from excavation work and/or bore piling activities;
- run-off from site watering and wheel washing effluent as a result of adopting dust control measures;
- domestic sewage generated from canteen and toilet facilities on site; and
- contaminated surface run-off during wet weather.

Construction site wastewater contains mainly silt, sand and gravel. Indiscriminate discharge of untreated or partially treated wastewater will have a major impact on the receiving water bodies. Common pollution threats include:

32 Environmental Protection Department. A Guide to the Water Pollution Control Ordinance. May 2001. http://www.epd.gov.hk/epd/english/environmentinhk/water/guide_ref/guide_wpc_wpco.html

- siltation in drainage pipes which may lead to blockage and eventually flooding risks;
- visual nuisance and hazard to the aquatic life e.g. fish gills blocked up causing suffocation to death;
- increase in turbidity of the receiving water which may adversely affect the ecosystem.

Prior to making a discharge, the responsible person for the discharge should submit an application to EPD for a discharge licence. Under the Water Pollution Control Ordinance, it is an offence to discharge polluting matter in a water control zone without a valid license, or to discharge effluent in breach of the terms and conditions specified in the discharge license granted by the Authority. The contractor has the responsibility to ensure compliance with all legislative control requirements. Apart from obtaining a valid discharge license before the commencement of any discharge, the contractor must take all necessary steps to comply with the terms and conditions of the license. This requires due consideration be given at the planning stage of a construction project. Attention should be paid to the wastewater characteristics, minimize the quantity of pollution loads (both in terms of flow and concentration), plan and install proper site drainage to intercept stormwater run-off from outside the side and collect silt carrying site run-off to silt removal facilities; design and construct appropriate wastewater treatment facilities, provide the necessary training to the site personnel as well as constant on-site supervision and monitoring of the environmental performance. All wastewater treatment facilities should be well maintained to achieve the desired performance. ProPECC PN 1/94[(33)] provides guidance on good practice for dealing with discharges from construction sites.

Objective of HK-BEAM

Ensure the proper management of construction site discharges.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for undertaking measures to reduce water pollution during construction as outlined in ProPECC PN 1/94.

Method of assessment

The Client shall present evidence in the form of specifications and contract documents detailing the requirements to undertake measures to reduce water pollution during construction, as laid down in ProPECC PN 1/94. The Client's representative on site shall be responsible for monitoring and reporting the execution of the instructions. The Client shall confirm in writing to the HK-BEAM Assessor that the works were conducted in accordance with the recommendations given in ProPECC PN 1/94 as appropriate to the particular circumstances of the site.

2.3.4 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[(34)]. 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

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33 Environmental Protection Department. Practice Note for Professional Persons. ProPECC PN 1/94. August 1994. http://www.epd.gov.hk/epd/english/resources_pub/publications/files/pn94_1.pdf

34 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.

- ❖ 1 credit for a building development in which wet cooling towers:
- ✧ are not used, or
- ✧ use seawater, or
- ✧ 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 and do not use seawater they shall be designed to the specifications outlined in the Code of Practice Prevention of Legionnaires Disease. The Client shall submit details of the installation and confirm compliance with the Code of Practice. Any deviations from the specifications given in the CoP shall be identified together with confirmation that there is no increased risk of dispersal of airborne droplets or mists.

2.3.5 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;
- 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(35) contains the technical procedures that should be adopted by the Authority when investigating a complaint regarding noise emanating from such premises to determine whether or not a noise abatement notice should be issued. BS 4142(36) suggests methods for noise prediction and a generalized description of prediction is given in ISO 9613-2(37). Good practices on building services system noise control is published by the Environmental Protection Department(38, 39).

Objective of HK-BEAM

Encourage proactive design techniques intended to reduce the nuisance caused to neighbours by noise from building services equipment.

Maximum number of credits attainable: 1

Credit requirement

- ❖ 1 credit for demonstrating that the level of the intruding noise at the facade of the nearest sensitive receiver is in compliance with the criteria recommended in the Hong Kong Planning Standards and Guidelines.

Method of assessment

On the basis of promoting good environmental design assessment shall assume that a noise

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35 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

36 British Standards Institution. Method for rating industrial noise affecting mixed residential and industrial areas. British Standard BS 4142:1997. London, BSI, 1997.

37 International Standards Organisation. ISO 9613-2. Attenuation of Sound During Propagation Outdoors Part 2. General Method of Calculation 1st Ed. 1996.

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

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

sensitive development already exists or has the potential to exist and be affected by the building development. Ideally, therefore, assessment should be made at the façade of the nearest or most affected adjacent building, or site boundary.

The noise assessments shall be conducted in accordance with the Technical Memorandum. The Technical Memorandum lays down statutory Acceptable Noise Levels (ANL). However, in order to plan for a better environment, all fixed noise sources should be so located and designed that when assessed in accordance with the Technical Memorandum, the level of the intruding noise at the facade of the nearest sensitive receiver should be at least 5 dB(A) below the appropriate ANL shown in Table 3 of the Technical Memorandum or, in the case of the background being 5 dB(A) lower than the ANL, should not be higher than the background. This is in accordance with paragraph 4.2.13 of the Hong Kong Planning and Standards Guidelines.

The Client shall provide evidence that the building development complies with the criteria as demonstrated by report from a suitably qualified person based a site survey by that person.

2.3.6 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[40,41] 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 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.

Method of assessment

The Client shall provide evidence that the site and building lighting installations comply with the criteria through submission of detailed calculations and/or modelling studies carried out by a suitably qualified person.

The submission shall include an exterior lighting design plan that illustrates 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[42], suitable computer software, or the approach given by the Illumination Engineering Society of North America[43].

2.4 BUILDING USERS HANDBOOK

Environmental friendly use and operation of buildings can be increased with the co-operation of the tenants and owners of individual units. Very often, tenants/owners are not aware of the impacts that their own activities have on the environment or comfort and health. It is good practice

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

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

42 The Chartered Institution of Building Services Engineers. Lighting Guide LG6: The outdoor environment. 1992.

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

to provide a tenant/owner's handbook giving details about the facilities provided within the building development. It should also contain guidance 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(44);
- 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.

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

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3 MATERIALS ASPECTS

The amount and range of materials used in the construction of buildings represents a significant use of natural resources, in terms of extracted raw materials 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 design techniques, choice of materials, and construction methods. The production, use and disposal of building elements require significant quantities of energy and natural 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
- the percentage of recycled material, percentage capable of being recycled, and energy used to recycle, etc.

There remains the prospect of reducing materials use and waste arising through lean construction techniques, modular designs allowing off-site prefabrication, etc. Modern construction calls for use of metal formwork, and waste reducing techniques such as spray plastering. Improved materials management and on-site sorting can achieve significant reductions in waste generation and reduce construction costs. It is noted that whilst basic fitments and fittings required until the building regulations should be installed prior to the issue of an occupation permit, the Building Authority in the interests of waste minimisation has relaxed requirements in respect of sanitary and plumbing fittings in premises such as restaurants and hotels, and in respect of fittings in residential premises, etc., which are likely to be replaced by owners upon occupancy[45].

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

With greater flexibility in planning approvals opportunities exist to rehabilitate existing buildings. The rehabilitation of old industrial buildings is as an example of successful commercial redevelopment in many cities around the world. There is potential to lower building costs and provide a mix of desirable building characteristics. However, the reuse of existing structural elements depends on many factors, not least fire safety, energy efficiency, and regulatory requirements, all of which need to be critically reviewed to determine the advantages and feasibility of reuse as opposed to demolition.

Objective of HK-BEAM

Encourage the reuse of major elements of existing buildings, to reduce demolition waste, conserve resources and reduce environmental impacts during construction.

Maximum number of credits attainable: 1

45 Buildings Department. Practice Note for Authorized Persons and Registered Structural Engineers 245. Waste Minimization Provision of Fitments and Fittings in New Buildings. December 2000.

Credit requirement

❖ 1 credit for the reuse of existing building elements from the building structure or shell.

Method of assessment

The Client shall provide a report prepared by a suitably qualified person outlining the extent to which major building elements from an existing building were used in the building redevelopment. The report shall include pre-construction and post-construction details highlighting the reused elements, be it foundations, structure or facades. If original building elements are reused and comprise at least 25% of the total of the works for the development 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 amounts of solid waste can be generated during the remodelling of premises, such as demolition of walls and partitions. Designs that allow users flexibility in the 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 of 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 that allows 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 Client 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 ENVELOPE DURABILITY

In general, durability is a building's ability to maintain its performance over its lifetime. The advantages are well-known: durable materials and building systems are long lasting, can reduce maintenance and repair costs, and are often cost-effective from a life-cycle perspective. Additional benefits include minimized disruption of building operations due to repairs and maintenance, and environmental benefits resulting from the reduced disposal and replacement of materials

Provision of good detail design in constructive protection measure are significant to promote longer life of a building, the measures may include preservation treatments, choice of suitable material specifications, 'breathing' wall detailing, condensation control, etc. Material products with compatible maintenance requirements should be chosen to optimize building life. Materials requiring dry maintenance should have adequate separation from materials requiring wet maintenance.

Objective of HK-BEAM

Encourage good design detailing and use of materials to promote longevity of the building envelope.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for demonstrating the integration of building envelope systems which optimises the integrity of the envelope over the building life.

Method of assessment

The Client shall submit a report detailing the design with supporting drawing documents that explains how the materials and detailed design of the building envelope can achieve longer life and low maintenance, thereby minimising the use of energy and material during the life of the building. Adequate construction measures which provide effective protection against building failure shall also be considered in the assessment.

3.1.4 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 design 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 Client shall submit a design 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.

3.1.5 OFF-SITE FABRICATION

The possibility of factory fabrication of building elements where they are produced under controlled conditions allows for more efficient disposal of debris and waste. Noise, dust, site traffic and other environmental nuisances can also be reduced. Prefabrication includes facades, staircases, slabs, external elements, bridge-decks, footbridges, pavement paving, partition walls, internal fittings, etc. Interior millwork and custom metalwork should be detailed to be shop-finished and installed to the highest degree to limit the need for on-site painting and finishing work.

Objective of HK-BEAM

Encourage off-site fabrication of building elements in order to reduce wastage of materials and quantities of on-site waste.

Maximum number of credits attainable: 2

Credit requirement

- 1 credit when the manufacture of 50% of listed building elements has been off-site.
- 1 additional credit where the manufacture of 80% of listed building elements has been off-site.

Method of assessment

The listed building elements include facades, staircases, slabs, external elements, bridge-decks, footbridges, pavement paving and partition walls. Off-site in this context means a factory or similar purpose built facility but not a temporary site set up for the purpose of producing said elements.

The Client shall demonstrate through the submission of contract specifications, drawings and other supporting documents the quantities of those building elements fabricated off-site. The assessment shall take into account the number and quantities of building elements in the building development that can be fabricated off-site and award credits where the assessment criteria has been met.

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 at the earliest stages of planning and design of building developments, and carried over to fit-out and subsequent redecoration.

3.2.1 RAPIDLY RENEWABLE MATERIALS

Most building materials necessitate the consumption of large amounts of natural resources. Rapidly renewable materials (produced within a ten year cycle), such a bamboo, wool, natural linoleum, etc. require fewer inputs, have reduced environmental impacts, and can provide economic benefits. Rapidly renewable materials may be used for flooring, fittings and other applications.

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

Objective of HK-BEAM

Encourage the wider use of rapidly renewable materials in appropriate applications.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for demonstrating that in applications where rapidly renewable materials can be employed at least 50% are used in the development.

Method of assessment

The Client shall submit a report providing written documentation from manufacturers, declaring the rapidly renewable materials contained in the products employed, confirming where the specified rapidly renewable materials have been used, and quantifying the total percentage of rapidly renewable materials against the total potential of applications and uses.

The report should highlight where rapidly renewable materials could be used, and where they have been used to replace other more commonly used materials. Provide calculations demonstrating that rapidly renewable building materials have been in at least 50% of possible applications. The percentage can be based on either cost or volume of materials.

3.2.2 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 sector in Hong Kong is a major consumer of hardwoods from tropical rainforests, with a large proportion used wastefully, often being discarded after minimal use, and ending up at landfill sites. 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[46,47].

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: 2

Credit requirement:

a) Timber use during construction

❖ 1 credit for using durable and reusable formwork and hoarding systems to replace timber formwork and hoardings.

b) Timber used in the building

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

Method of assessment

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

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

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.

a) The Client shall provide a report highlighting those parts of contract documents and specifications which cover the use of timber for form work and site hoardings, together with evidence such as site photos demonstrating that there has been minimal use of new timber. Where there has been some use of new timber evidence shall be provided to show that it was obtained from a sustainable source. The Client's representative on site shall be responsible for monitoring and reporting on construction activities, and shall confirm in writing that the works were conducted in accordance with the specifications and contract documents. The Assessor may carry out site inspections during construction.

b) The Client shall present evidence in the form of specifications and contract documents detailing the intention to use timber from sustainable sources, or to 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 Client 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.

3.2.3 GREEN BUILDING MATERIALS

The Green Guide[48] assigns weighting factors to the environmental impacts. As a general principle, the lower the mass of material and the less energy and resource required, the more favourable to environmental profile. The Environmental Resource Guide[49] include life cycle assessments on many of the materials used in building construction.

Objective of HK-BEAM

Reduce the consumption of energy and resources, emissions and waste generated in the production of building materials, and to encourage use of products containing recycled materials.

Maximum number of credits attainable: 3

Credit requirement

- ❖ 1 credit for the choice of building materials for over 50% of key building elements which rank an Overall Rating A in the Green Guide, or GOOD in Environmental Resource Guide.
- ❖ 2 credits for the choice of building materials for over 75% of key building elements which rank an Overall Rating A in the Green Guide, or GOOD in Environmental Resource Guide.
- ❖ 3 credits for the choice of building materials for all key building elements which rank an Overall Rating A in the Green Guide, or GOOD in the Environmental Resource Guide.

Method of assessment

The onus is on the Client to justify the credit claimed following a review of the referenced

48 Building Research Establishment. The Green Guide to Specification. An Environmental Profiling System for Building Materials and Components. September 1998.

49 The American Institute of Architects. Environmental Resources Guide. John Wiley & Sons, Inc. 1998.

documents. The elements covered by the assessment include partitions, flooring, wall finishes, windows, etc. but not concrete elements cast on site. Details of specified materials shall be rated using the environmental profiling system. The percentages of the final Summary Ratings for each group can be accounted based on the assessments for each material.

Alternative criteria that demonstrate the use of environmentally friendly materials will be considered by the Assessor, but the Client is required to show equivalence to the criteria used in the referenced documents. Given the paucity or variability of available data, the Assessor may exercise considerable judgement in the application of the assessment criteria. Client representatives should seek to highlight the environmental benefits inherent in the choice of materials.

3.2.4 RECYCLED MATERIALS

Waste materials and industrial by-products can be used in building construction in an unprocessed form, e.g. as fill material, or processed to a limited degree for use as aggregates in concrete, or used as raw material for manufacturing building products. This reduces the extraction of virgin materials. The basic properties required for technical acceptance are that they can perform their intended functions throughout the design life without being deleterious on the environment or associated constructional features. There are many opportunities for using recycled materials in structural and non-structural elements of a building and the surrounding site works. For large sections, high strengths, where shrinkage and cracking are critical, where resistance to sulphate attack is required, and where surface finish is particularly important, PFA concrete should be specified(50).Crushed concrete aggregate complying with the quality and grading requirements of British Standard BS 882(51) for use in concrete for foundations. The fills in foundations and for over-site use of recycled materials should comply with the requirements of BS 6543(52).

Objective of HK-BEAM

Minimise the use and maximise the utility of non-renewable resources and to maximise the utility of non-renewable resources.

Maximum number of credits attainable: 2

Credit requirement

a) Recycled materials in surface work and structures

❖ 1 credit for use of recycled materials in site surfacing work, structures and features.

b) Recycled materials in the building

❖ 1 credit for:

✧ using 5% of recycled materials, other than PFA, in the construction of the building; and

✧ full use of PFA in concrete in accordance with WBTC 14/90 or better.

Method of assessment

a) Site works and features including paths, surfaces for recreational areas, structures such as seating, playground features, etc. The Client shall provide details of recycled materials used (minerals, plastics, etc), their quantities by weight, percentage and/or volume, and technical or economic reasons for not using elements made from recycled materials. The Assessor shall consider the total of recycled materials, in relation to the total use of materials for the said purposes. Credit will be awarded where there is sufficient evidence that the use of recycled materials has been considered in full.

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50 Works Branch Technical Circular No. 14/90. The Use of PFA in Structural Concrete.

51 British Standards Institution. Specification for aggregates from natural sources for concrete. British Standard BS 882:1992.

52 British Standards Institution. Guide to use of industrial by-products and waste materials in building and civil engineering. BS 6543: 1985.

b) Recycled materials in the building works such as foundations, structural elements, etc excluding PFA use in concrete, shall account for no less than 5% by volume. The Client shall provide the necessary details of materials used in the structure.

PFA can be counted as a maximum of 25% in any specified minimum cementitious content, but this does not limit the total PFA content to that quantity. Additional PFA can be used but should be regarded as an admixture or fine aggregate grading corrector. The use of PFA at 25% or greater by mass of the cementitious content shall qualify for credit.

3.2.5 Ozone Depleting Substances

The stratospheric ozone layer reduces the amount of short-wavelength ultraviolet radiation from the Sun which 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), hydrochlorofluorocarbons (HCFCs) and halons are man-made gases which have been released since the 1950s, and these have contributed to the holes in the ozone layer.

CFC has been traditionally used as a blowing agent to expand insulation materials to create the foam structure. Polyurethane foams, extruded polystyrene and phenolic foams have traditionally been blown using CFCs. With the reduced production of CFCsm manufacturers then resorted to the use of HCFCs, but alternatives such a carbon dioxide and nitrogen are being used. The material traps CFC and HCFC gases in the tiny cells that are created. However, these gases do not remain in the insulation, but slowly diffuse though the insulation cell walls and the gas in the cells is exchanged with air. The diffused CFC and HCFC gases will reach the ozone layer.

Unless confirmed otherwise polyurethane and urethane foams, extruded polystyrene products, phenolic foam, polyethylene foam, and polyisocyanurate foam are likely to be blown using HCFC.

Objective of HK-BEAM

Reduce the release of chlorofluorocarbons and hydrochlorofluorocarbons into the atmosphere.

Maximum number of credits attainable: 2

Credit requirement

a) Refrigerants in air conditioning

- ❖ 1 credit for using refrigerants with ozone depletion potential of zero.

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

- ❖ 1 credit for the use of insulation materials and products in the building fabric and services that avoids the use of ozone depleting substances in their composition or during manufacture.

Method of assessment

a) The Client shall submit details of the equipment installed and confirm that the ozone depletion potential of the refrigerants used met the specified requirement.

b) The Client shall provide a full description and specifications of all major insulation materials specified in roof constructions, walls, chilled water pipes, refrigerant pipes, ductwork, etc., advising the presence or otherwise of ozone-depleting agents. Where there is any doubt as to the ozone depletion potential of a material or product, the Client shall ascertain details from the supplier. Credit shall be awarded where it can be demonstrated that reasonable effort has been made to avoid the use of products that do not meet the assessment criteria.

3.3 Waste Management

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.

3.3.1 CONSTRUCTION WASTE

On-site sorting of surplus construction and demolition (C&D) material is desirable so that inert material can be disposed of at public filling areas as far as practicable, and the remaining C&D waste disposed of at landfills. Dumping Licences for public filling areas require that material to be disposed of at public filling areas must comprise only earth, building debris, broken rock and concrete. Such materials shall be free from marine mud, household refuse, plastic, metal, industrial and chemical waste, animal and vegetable matter and other matter considered unsuitable by the Filling Supervisor. The materials considered unsuitable for disposal at public filling areas should go to a landfill(53).

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

Chemical wastes are liquid, semi-solid and solid wastes which are hazardous in nature or constitute a risk of pollution to the environment. Chemical waste is defined by reference to a list of chemicals which forms Schedule 1 of the Waste Disposal (Chemical Waste) (General) Regulation. The Regulation provides for the definition of chemical waste, the registration of persons producing chemical waste and the control of the possession, storage, collection, transport and disposal of chemical waste. There are seven types of chemical wastes which are commonly generated at construction sites; lubricating oil, paint, organic solvents, batteries, acid, alkali and asbestos. Improper handling of these chemical wastes may result very serous health, safety and environmental consequence. Regulation requires waste producers to arrange proper packaging, labelling and storage of chemical waste before they are transported off-site to disposal facilities, in order to safeguard the health and safety of workers and the general public and to minimize potential hazards arising from improper handling of chemical waste.

Objective of HK-BEAM

Encourage best practices in the management of waste, including sorting, recycling and disposal of construction and demolition waste.

Maximum number of credits attainable: 3

Credit requirement

a) Sorting and recycling of waste

❖ 1 credit for demonstrating that construction waste was sorted for the purposes of efficient recycling and disposal.

b) Disposal of waste

❖ 1 credit for implementing the Trip Ticket System for disposal of waste.

c) Demolition waste

❖ 1 additional credit where demolition waste is also included with construction waste management.

53 Works Bureau Technical Circular No. 5/98. On Site Sorting of Construction Waste on Demolition Sites. March 1998.

Method of assessment

a) The Client shall demonstrate through the submission of contract documents that the contractor was required to prepare and implement a waste management plan in accordance with the guidelines provided in WBTC 29/2000(54). As a minimum, the plan shall cover the items listed in the Buildings Department's PN 243(55),detailing that all materials arising from or in connection with the works shall be sorted on-site and be separated into different groups for disposal at landfills, public filling areas, in filling areas provided by the Contractor, or recycling as appropriate. The Client's representative on site shall be responsible for monitoring and reporting on the execution of the instructions and shall confirm through monthly reports the extent to which recycling and sorting has been achieved. The Client shall present evidence in the form a report by a suitably qualified person that the contractor complied with all requirements in the submitted waste management plan during the execution of the works.

b) A pre-requisite for this credit is compliance with the regulations applicable to the packaging, labelling, storage, collection and disposal of chemical and other hazardous waste materials.

The Client shall provide evidence that disposal has been in accordance with the requirements of WBTC No. 21/2002(56), including the WBTCs referenced therein, as they apply to the nature of the development work.

c) To comply with the credit items a) and b) shall cover also demolition waste.

The HK-BEAM Assessor may undertake site inspections during construction.

3.3.2 WASTE DISPOSAL AND RECYCLING FACILITIES

Well managed facilities for the recycling of household solid waste encourage recycling and results in reductions in the disposal at landfill sites. Buildings should be designed with the provision of facilities for waste separation and sorting, and short term storage at appropriate locations.

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 facilities 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

The Client shall submit details of estimated waste steams and quantities for the building development, and demonstrate the adequacy of the waste storage, sorting and recycling facilities. The facilities shall be provided with adequate ventilation and cleaning facilities such that the sorting and disposal of waste and recycled materials shall not have any detrimental effect on the health or comfort of building users. The HK-BEAM Assessor shall scrutinise designs and specifications for the waste management facilities and may carry out inspections to check compliance.

54 Works Bureau Technical Circular No. 29/2000. Waste Management Plan. November 2000.

55 Buildings Department. Practice Note for Authorized Persons and Registered Structural Engineers 243. Construction and Demolition Waste. June 2000.

56 Works Bureau Technical Circular No. 21/2002. Trip-ticket System for Disposal of Construction and Demolition Material. June 2002.

4 ENERGY USE

An objective of HK-BEAM includes encouraging thorough evaluation of the performance of building and services system designs and greater investment into energy performance enhancement measures that will help reduce energy consumption and summer peak electricity demand, and the associated environmental impacts.

This version of HK-BEAM is intended to be a comprehensive scheme embracing all types of new buildings. A generic framework for assessing the energy performance of buildings has been established to serve this purpose, the details of which are described in Appendix A. However, due to the large variety of buildings and types of premises that may be encountered in practice, it was not possible to establish and incorporate into this document all the variables required for a full and comprehensive assessment for all permutations. Comprehensive data defining internal heat gains and patterns of use for all types of equipment in the wide range of premises that may be found in various developments is not yet available. Consequently, for HK-BEAM to be a truly comprehensive scheme, the scheme itself needs to evolve by drawing from the experience gained through its implementation. Therefore, for a building development that includes premises for which detailed data for establishing the zero-credit benchmark and the best achievable performance is not available, the HK-BEAM Assessor will need to develop appropriate criteria for the assessment, in collaboration with the Client's representatives.

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 Sections 4.2 and 4.3, respectively. Sections 4.4 to 4.7 describe assessments on various energy specific features that are applicable to various types of new building designs.

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 4.4.

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 4.4 and 4.5.

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 4.2.5, and the assessment of features specific to this classification of premises are given in Sections 4.4 and 4.5.

Other buildings/premises

Notwithstanding that many buildings in Hong Kong would belong to one of the above three categories of buildings, there are other buildings that comprise a mix of premises found in all three of the above categories. 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 4.4 to 4.7.

4.2 ANNUAL ENERGY USE

Electricity generation accounts for around 60% of the total CO_2 emissions in Hong Kong and buildings, particularly air-conditioned buildings, account for more than half of the electricity consumed each year. Ensuring buildings are designed for good energy performance is a key energy conservation and environmental protection measure.

Objective of HK-BEAM

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

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.

Maximum number of credits attainable: 10

Credit requirements

- 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

A new commercial building or commercial complex, which may be an office-only building, an office/commercial building, a commercial building (such as a standalone shopping centre, or the commercial portion of a residential development) will be assessed based on the method for air-conditioned buildings, as described in Section A.1 in Appendix A. The assessment is limited to the electricity use in air-conditioned areas and that for air-conditioning provision in the building whilst other energy end-uses, e.g. for winter space heating, or vertical transportation, etc, are excluded from this part of the assessment.

For conventional building designs, regression models may be used as an alternative to the generic simulation method, for the prediction of the zero-credit energy use and maximum electricity demand criteria (based on the baseline building model), and for the prediction of the annual energy use and the maximum electricity demand of the assessed building. The available regression models and their applicable limits are described in Appendix B.

In the assessment of a new commercial building, prediction of the annual energy use and maximum electricity demand will be based on the design lighting power densities for various premises in the building, as ascertained from the lighting installation designs. Where the lighting installations will be provided by tenants or owners of individual premises, the default lighting power densities will also apply to the assessed building, unless the developer can confirm that the prospective tenants or owners of premises will not install lighting that exceeds the design lighting power intensities. In this case, the design values used and the evidence that such values will not be exceeded, such as given in a 'Tenants Fitting-out Specification', shall be included in the submission. Likewise, the default equipment power densities will be used to assess the energy performance of the building, but design values provided by the building owner will be used instead if sufficient details are provided.

4.2.2 ENERGY USE IN HOTEL BUILDINGS

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: 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

A new hotel building or complex will be assessed based on the method for air-conditioned buildings, as described in Section A.1 in Appendix A. It should be noted that the total energy budget assessment covers only the energy use in air-conditioned areas and that for air-conditioning; it does not cover the energy used for other purposes or elsewhere, such as for winter space heating, water heating, cooking, kitchen ventilation, or energy use in a laundry.

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 be taken into consideration in the prediction of the energy use for the assessed hotel, but not for the baseline building model.

In predicting the annual energy use in the baseline building model, the patterns of occupation, lighting load and equipment load, as given in Table A.5.4 a), shall be used. The assumption made in the energy use prediction is that all the guestrooms will be air-conditioned 24 hours a day keeping indoor temperatures steadily at 22ºC throughout the year.

For the hotel being assessed, patterns given in Table A.5.4 b) shall be used if the guestrooms in the hotel are equipped with master switches that control the air-conditioning, lighting and equipment inside the guestrooms. The effects of the 'as-installed' control actions will be considered when rooms become unoccupied, such as turning off lights, temperature reset, fan speed reset or fan on/off cycling, shall be included in predicting the energy use in the assessed hotel. Three groups of patterns of use are defined for:

- rented rooms that will not be occupied during day time;
- rented rooms that will be occupied all day long; and
- for vacant rooms.

The assumption made in the energy use prediction is that 75% of the rooms belong to the first group, 20% to the second group and 5% to the third group. However, if the guestrooms in the assessed hotel are not equipped with such master control switches the patterns set for the baseline building model in Table A.5.4 a) shall be used in conjunction with the 'as-designed' installed lighting and equipment load intensities.

4.2.3 ENERGY USE IN 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.

4.2.4 ENERGY USE IN 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.

4.2.5 ENERGY USE IN MECHANICALLY VENTILATED BUILDINGS

For buildings where the majority of spaces therein are not air-conditioned, such as schools without air-conditioning for classrooms, multi-storey car parks, bus terminus, platform concourses in rail stations, factories, warehouses, cargo handling facilities, etc., the dominant energy end-uses will include the mechanical ventilation systems, the lighting installations, and the various types of equipment and appliances. Except where equipment/machines for production purposes are present (e.g. an industrial building), such buildings will typically consume much less energy per unit floor area compared to air-conditioned buildings. Since the range of equipment and appliances that may be found in this category of buildings can vary significantly from one building to another, the assessment will be limited to the energy performance of the mechanical ventilation and lighting installations. The assessment 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[57]; 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.

The assessment of energy use in this category of buildings/premises is given in Sections 4.4 to 4.7, with Sections 4.4.1 to 4.4.3 particular to this category.

4.2.6 ENERGY USE IN OTHER BUILDINGS

Buildings falling outside the types already covered 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 the method described in Section A.2 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 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 in the local construction industry.

Where a comparison with the performance of a baseline building model is involved but default values for defining the baseline building model 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 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 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 worked out and agreed upon between the Client and the HK-BEAM Assessor prior to commencement of the assessment.

4.3 MAXIMUM ELECTRICITY DEMAND

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.

57 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.

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 under the building energy performance assessment 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 from the baseline building model.

Objective of HK-BEAM

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

4.3.1 MAXIMUM ELECTRICITY DEMAND IN COMMERCIAL BUILDINGS

Maximum number of credits attainable: 3

Credit requirement

- 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.

4.3.2 MAXIMUM ELECTRICITY DEMAND IN HOTEL BUILDINGS

Maximum number of credits attainable: 3

Credit requirement

- 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 4.2.2.

4.3.3 MAXIMUM ELECTRICITY DEMAND IN RESIDENTIAL BUILDINGS

Maximum number of credits attainable: 3

Credit requirement

- 1 credit for a reduction in the maximum electricity demand by 8%.
- 2 credits for a reduction in the maximum electricity demand by 12%
- 3 credits for a reduction in the maximum electricity demand by 15%.

Method of Assessment

Refer to Section 4.2.3.

4.3.4 MAXIMUM ELECTRICITY DEMAND IN EDUCATIONAL ESTABLISHMENTS

Maximum number of credits attainable: 3

Credit requirement

- 1 credit for a reduction in the maximum electricity demand by 8%.
- 2 credits for a reduction in the maximum electricity demand by 12%

❖ 3 credits for a reduction in the maximum electricity demand by 15%.

Method of Assessment

Refer to Section 4.2.4.

4.4 ENERGY EFFICIENT SYSTEMS

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

4.4.1 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 15% 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 Client 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[(58)], or SMACNA's method[(59)].

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

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

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

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.

4.4.2 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; and

- The use of the minimum number of lighting fittings with lamps of performance as given above that will allow the required illumination levels in various premises in the building to be achieved
- 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[60]. 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 Client shall submit the following information to demonstrate that the installations will meet the basic requirements and the individual requirements above for the related credits:

- 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.

4.4.3 NATURAL VENTILATION OF LARGE PREMISES

In non-air-conditioned premises, maximising utilisation of natural ventilation can reduce reliance on mechanical ventilation systems for indoor environment control, and thus save energy. Utilisation of natural ventilation can be maximised only if the building design has taken this into account and adequate provisions made for openings and windows.

Maximum number of credits attainable: 2

Credits requirement

- ❖ 1 credit 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.

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

❖ 1 credit for demonstrating that indoor spaces have ventilation openings/operable windows capable of providing sufficient ventilation under average wind conditions.

Method of assessment

The Client shall provide evidence that the necessary analysis has been undertaken and compliance is demonstrated. The wind pressure analysis may be undertaken through boundary layer wind tunnel modelling. Wind pressure coefficients at inlet/outlet areas for representative occupied spaces shall be measured 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 six building heights. The pressure data will be used with standard calculation procedures to estimate flows through the indoor spaces, arising from an average wind condition. Buoyancy or turbulence driven flows need not be considered.

As an alternative the performance may be demonstrated through the application of appropriate computer modelling techniques.

4.4.4 LIFT AND ESCALATOR INSTALLATIONS

In Hong Kong buildings are usually high-rise and/or large scale developments. Vertical and horizontal 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 efficiency of lift and escalators(61). 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 of the building energy codes and HK-BEAM is thereby established.

A building that achieves the above credits and other additional credits in the energy performance assessment under HK-BEAM will, therefore, be of an energy performance standard over and above the minimum compliance standard set in the codes. However, for consistence with the philosophy 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(62) will satisfy the requirement.

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61 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

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

4.4.5 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 (63). Compliance with the code is endorsed in HK-BEAM for the same reasons, and with the same caveat as for lift and escalator installation.

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 Energy Efficient Registration Scheme for Buildings will satisfy the requirement.

4.4.6 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 Client 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.

4.4.7 MECHANICAL VENTILATION IN HOTEL BUILDINGS

Fans of mechanical ventilation systems serving the bathrooms in guestrooms, the kitchens, and other utilities and plant rooms will be assessed based on component-performance criteria.

Maximum number of credits attainable: 1

Credit requirement

- ❖ 1 credit for using energy efficient ventilation fans that will consume less electricity than those meeting the zero credit requirements by 15% or more.

Method of assessment

[63] Electrical and Mechanical Services Department. Code of Practice for Energy Efficiency of Electrical Installations. 2000. http://www.emsd.gov.hk/emsd/e_download/pee/eleccop.pdf

The method of assessment shall be similar to that given in Section 4.4.1.

4.5 Energy Efficient Equipment

4.5.1 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[64].

The Client 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.

4.5.2 Clothes Drying Facilities in Residential Buildings

Provisions of clothes drying facilities in many existing residential buildings are inadequate such

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

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that people tend not to use them and resort to gas or electric drying machines, increasing energy consumption.

Objective of HK-BEAM

Encourage greater use of natural resources in place of gas or electrical energy for clothes drying purposes.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for providing suitable clothes drying facilities which utilise the natural environment for the majority of residential units.

Method of assessment

The Client shall demonstrate the adequacy of the clothes drying facilities for efficient drying by sun and breeze, which is adequately protected from water droplets and debris falling from higher levels, and not adversely affected by smoke, fumes and pollutants emitted from water heaters, cooking exhausts, discharges from air-conditioning units, etc.

4.5.3 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 premises is encouraged through the award of additional credits.

Environmental factors to be considered when designing exterior lighting include energy use, the embodied energy of equipment, 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 Client 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.

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[65]. The assessment of the average circuit efficacy shall be based on the method given in Appendix D of the Code, or equivalent alternative.

The Client 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 Client 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.

4.5.4 USE OF HEAT RECLAIM CHILLERS OR HEAT PUMPS

In a hotel hot water supply is maintained throughout the year for bathrooms, kitchens and any laundry. The shops and restaurants will require air-conditioning throughout the year while some guestrooms may call for heating in winter. Utilising the condenser heat chillers reject for pre-heating the hot water supply to guestrooms or for winter space heating can significantly reduce the energy use for such purposes. Therefore, in addition to using energy efficient equipment or solar energy for hot water supply, credits are given for the use of heat reclaim chillers and/or heat pumps for pre-heating hot water for space heating or domestic hot water supply.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for using heat reclaim chillers or heat pumps for:

✧ pre-heating domestic hot water supply; or

✧ pre-heating hot water supply for winter space heating.

Method of assessment

The Client shall provide details of the equipment installed showing the energy performance of the chosen equipment compared to that used in typical building designs.

4.5.5 ENERGY EFFICIENT APPLIANCES

Objective of HK-BEAM

Encourage the wider use of energy efficient appliances

Maximum number of credits attainable: 1

Credits requirement

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

❖ 1 credit for specifying the use of certified energy efficient appliances.

Method of assessment

The Client shall provide evidence for the use of energy efficient appliances such as products with Grade 1 or 2 under EMSD Energy Efficiency Labelling Scheme, USEPA Energy Star Products or other equal alternative.

4.6 EMBODIED ENERGY

The energy used in the extraction, processing and transportation of materials used in building construction can be a significant part of the total energy used over the life cycle of a building.

Objective of HK-BEAM

Encourage the design and use of materials in core elements of a building that have lower values of embodied energy than traditional designs.

Maximum number of credits attainable: 2

Credits requirement

❖ 1 credit for demonstrating the embodied energy of the assessed building is at least 15% less than for a conventional building design.

❖ 2 credits for demonstrating the embodied energy of the assessed building is at least 25% less than for a conventional building design.

Method of assessment

The assessment covers only the elements and materials used in the building foundations, building core, walls, partitions, the main elements that comprise the building façade, and the roof. Interior services and fit-out elements are not included.

The Client shall provide a report detailing where the design of the building development provides for alternative construction methods, reductions in material quantities, and the substitution of materials that provides for a reduction in embodied energy. Where it can be demonstrated through analysis that the construction of the main elements of the assessed building reduces the embodied energy by the amount specified then credit shall be awarded. The method to estimate reduction in embodied energy can be that proposed by Chen et al[66] or similar method proposed by the Client which is of equal or greater rigor.

4.7 RENEWABLE ENERGY

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

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

The credits that will be awarded under this assessment will be regarded as bonus credits, i.e. any

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

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.

Objective of HK-BEAM

Encourage the wider application of renewable energy sources in buildings.

Maximum number of credits attainable: 5

Credits requirement

Credits will be given on a 5-point sliding scale to building developments for which the predicted energy supply from renewable sources (solar, wind, etc) meets the following criteria:

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.
- 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 Client shall submit a report providing details of the installations, and calculations showing the estimated energy use provided from renewable energy sources.

- In the case of using systems that generate electricity from renewable sources (e.g. photovoltaic panels and wind turbines), the amount of electricity that will be generated by the system and will 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 will otherwise require the use of fuel or electricity to produce those services (e.g. hot water supply from solar panels or chilled water supply from absorption chillers powered by solar heat), the equivalent amount of electricity use that will be avoided

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.

4.8 PROVISIONS FOR ENERGY MANAGEMENT

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

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

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

4.8.1 TESTING AND COMMISSIONING

CIBSE[67,68,69] and BSRIA[70,71] publications and others such as from ASHRAE, provide a guidance on commissioning requirements and procedures, such as management, design for commissioning, access, testing, measurements and tolerances, installed transducers, specification for portable measuring equipment, etc. Effective commissioning and proper instructions on operations and maintenance procedures have shown to improve the operating efficiency and environmental performance of a building over its life cycle.

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

- chillers;
- cooling towers;
- controls for central plant and for HVAC, including, if present, the energy management system or building automation system (BAS);
- unitary and split-air conditioners;
- fans;
- pumps;
- heat exchangers;
- boilers:
- domestic hot water and hot water heaters;
- ducts and associated dampers;
- piping and associated valves;
- monitoring systems as they relate to HVAC systems;
- renewable and alternative energy technologies;
- waste heat recovery;
- thermal storage; and
- any other systems, equipment and components that are used for heating, cooling, or ventilation and that affect energy use or indoor environmental quality.

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67 The Chartered Institution of Building Services Engineers. Air distribution systems. CIBSE. Commissioning Code Series A, 1996.

68 The Chartered Institution of Building Services Engineers. Water distribution systems. Code W. CIBSE. Commissioning Code, 1994.

69 The Chartered Institution of Building Services Engineers. Automatic controls. CIBSE Commissioning Code Series C, 2001.

70 C Parsloe. The Building Services Research and Information Association. The Commissioning of Air Systems in Buildings. December 1998.

71 The Building Services Research and Information Association. The Commissioning of Water Systems in Buildings. December 1992.

The commissioning requirements do not apply to systems and equipment that do not affect the energy use of the building, such as security systems.

Objectives of HK-BEAM

Ensure that basic commissioning of electrical and mechanical systems that impact on energy use and electricity maximum demand is properly addressed, and all building services systems, perform as specified and can be operated as intended.

Maximum number of credits attainable: 4

Credits requirement

a) Commissioning specifications

❖ 1 credit for provision of detailed specifications and cost provisions in contract documents detailing the commissioning requirements for all systems, equipment and components that impact on energy use and indoor environmental quality.

b) Commissioning plan

❖ 1 credit for the appointment of a commissioning authority and provision of a detailed commissioning plan that embraces all specified commissioning work.

c) Commissioning

❖ 1 credit for ensuring full and complete commissioning of all systems, equipment and components that impact on energy use and indoor environmental quality.

d) Commissioning report

❖ 1 credit for providing fully detailed commissioning reports for all systems, equipment and components that impact on energy use and indoor environmental quality.

Method of assessment

a) Credits shall be awarded only if the commissioning of the specified systems is identified as a separate cost item in the cost of the works. The contract documents shall be checked to determine what provision is made at the detailed design stages for the proper commissioning of the electrical and mechanical systems specified.

The Client shall provide evidence that the commissioning specifications meet the requirements detailed in Appendix D1 as a minimum.

b) There shall be appropriate cost provisions for the appointment of an independent commissioning authority and for the commissioning processes. The commissioning authority shall be a Registered Professional Engineer with adequate expertise in the commissioning or electrical and mechanical systems, equipment and components. A suitably qualified member of the organisation that performed the design may act as the commissioning authority; however, such an individual must not be responsible for any aspect of the project design, or construction management or supervision for the subject building. In addition, reporting of all conditions and findings must be immediate and direct from the commissioning authority to the Client. The commissioning authority shall be responsible for:

- review and approval of commissioning specifications;
- the development of a commissioning plan;
- determining and documenting whether systems, equipment and components are functioning in accordance with the design intent and in accordance with the construction documents.

The Client shall provide evidence that the commissioning specifications meet the requirements detailed in Appendix D2 as a minimum.

c) The Client shall appoint a commissioning agent to be responsible for performing the functional testing of systems and equipment, documented by the commissioning authority, using forms approved by the commissioning authority, all of which must meet the requirements of Appendix D3 as a minimum.

d) After all commissioning tasks except seasonally deferred testing have been completed, a commissioning report shall be provided, and shall cover as a minimum the items given in Appendix D4.

4.8.2 OPERATION AND MAINTENANCE

Facilities to carry out basic maintenance and equipment for monitoring consumption can help improve operating efficiency and environmental performance of a building. ASHRAE(72) and BSRIA(73) provide advice on the preparations for operation and maintenance to ensure the safe and efficient operation of each system and major item of plant, including a description of the operating modes, a recommended strategy for operation and control, control data and set points, interlocks between plant items, etc.

Objective of HK-BEAM

Enable building operators to implement the design intent, be able to monitor the performance of the building, and maintain the performance.

Maximum number of credits attainable: 3

Credit requirement

a) Operations and maintenance manual

❖ 1 credit for providing a fully documented operations and maintenance manual to the minimum specified.

b) Energy management manual

❖ 1 credit for providing fully documented instructions that enables systems to operate at a high level of energy efficiency.

c) Operator training and facilities

❖ 1 credit for:

✧ providing training for operations and maintenance staff to the minimum specified; and

✧ demonstrating that adequate maintenance facilities are provided for operations and maintenance work in the form of workshop(s), office accommodation and control room.

Method of assessment

a) The Client shall certify the contract sum allowed for the preparation of the operations and maintenance manual.

The design intent and basis of design shall be included as a defining part of the operations and maintenance manual and the energy management manual. The manual shall include the details given in Appendix D5 as a minimum.

b) The details listed in Appendix D6 shall be included in the energy management part of the operations and maintenance manual, unless detailed elsewhere in the manual.

c) The appointed commissioning authority shall verify that training of the Owner's operations and maintenance staff was completed for all commissioned features and systems, using the operations and maintenance manual, and the energy management manual as the basis for the training. The training program shall cover at least the items listed in Appendix D7.

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72 American Society of Heating, Air-conditioning, and Refrigerating Engineers. Preparation of Operating and Maintenance Documentation for Building Systems. ASHRAE Guideline 4. Atlanta(USA), ASHRAE, 1993.

73 J H Armstrong. Building Services Research and Information Association. Operating and Maintenance Manuals for Building Services Installations. Application Guide 1/87. Dec. 1990.

4.8.3 METERING AND MONITORING

Surveys of a large number of buildings in Hong Kong[(74)] 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 plant, such as central chiller plant.

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

Maximum number of credits attainable: 1

Credit requirement

- 1 credit for installation of:
  - metering that allows monitoring of electricity use by the main chiller plant and auxiliaries;
  - instruments for monitoring building cooling load and operating parameters central chiller plant;
  - metering that allows separate monitoring of electricity use by the air side of the HVAC system; and
  - metering for landlord's electricity consumption in common space/public areas.

Method of assessment

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

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. The Assessor may undertake checks during a site survey.

Monitoring of central chiller plants will be assessed on the basis of BSRIA Technical Note TN 7/94[(75)] 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.

Electricity metering (for input power, energy and maximum demand), together with associated measuring transducers/transformers for indicating power and energy, shall comply with an appropriate standard such as BS EN[(76)] and to at least accuracy class 1. Sensors for temperature, flow rate and pressure measurements shall meet the minimum accuracy requirements in

[74] Yik FWH, Chiu TW. Measuring instruments in chiller plants and uncertainties in performance evaluation, Transactions, The Hong Kong Institution of Engineers, 5(3) 95-99.

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

[76] British Standard BS EN 60521:1995. Class 0.5, 1 and 2 alternating-current watthour meters.

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ASHRAE Standard 114[77] or similar equivalent.

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.

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.

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

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, particularly residents and operators of catering establishments. 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' new building developments need to ensure optimal potable water quality at the tap - potable water that is both safe and acceptable in terms of taste, colour and odour.

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

All water holding tanks have to 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 Client shall provide details of the potable water system to demonstrate prevention of water contamination and provision of access of water tanks for maintenance.

The Client shall submit a report prepared by a suitably qualified person detailing the 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(78), and there is compliance with the guidelines given in the CoP(79) as far as they are applicable, the credit shall be awarded.

[78] 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

[79] Prevention of Legionnaires' Disease Committee, 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 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 has 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 Client shall provide a report prepared by a suitably qualified person detailing the water-efficient system design features and the estimated savings arising from the use of the high efficiency fixtures installed in the building development. The report shall follow a format that details:

- 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;
- any deduction of annual use of recycled water (used for cleaning, flushing, engineering services, etc) that replaces use of potable water.

To estimate water use for the baseline case the consumption data provided in the following table shall be used:

Showerheads	9.5 L/min at 550 kPa
Washroom/lavatory faucets	9.5 L/min at 550 kPa
Kitchen taps	9.5 L/min at 550 kPa
Toilet flushing	6.0 L/flush
Urinals	3.8 L/flush
For other uses the report shall detail water use for standard products used in the market, and for the water efficient product used in the assessment building development	

To estimate the water use for the assessed building development the manufacturers confirmed performance data for the installed plumbing fixtures 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. Where the savings are demonstrated to exceed 25% over the baseline case 1 credit shall be awarded. Where savings are estimated to be in excess of 40% two credits shall be awarded.

5.2.2 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 Client shall submit a report detailing the measures used to reduce the wastage of water, and evidence to demonstrate that use by the building operator is capable of being fully 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 (but excluding the provisions required for metering individual users) shall be identified by a review of drawings and specifications, or other evidence provided by the Client.

5.2.3 WATER EFFICIENT IRRIGATION

Where a building development contains significant landscaping and water using planters there is likely to be a significant consumption of potable water. Irrigation by lower quality water can be equally effective. Native plants can survive without additional watering, and require less fertilizer and pesticides, thereby reducing impacts on local waters.

Objective of HK-BEAM

Reduce the reliance on potable water for irrigation.

Maximum number of credits attainable: 1

Credit requirement:

- ❖ 1 credit for the use of an irrigation system which does not require the use of municipal potable water supply after a period of establishment is complete.

Method of assessment

The Client shall provide a report prepared by a suitably qualified person describing the landscape design, species of plants, etc, and details of the irrigation system and/or recycled site water demonstrating the non use of municipal potable water supply after a period of establishment is complete.

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 providing for the collection of rainwater or 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
- ❖ 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 Client 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 Client 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(80) or similar authoritative guidance, for the intended reuse,

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

including cleaning, washing, irrigation, use in heat rejection systems, toilet flushing, etc.

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: 1

Credit requirement:

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

Method of assessment

The Client shall provide a report prepared by a suitably qualified person detailing the estimated savings arising from the use of the high efficiency 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.

To estimate water use for the baseline case the consumption data provided in the following table shall be used:

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.

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 the quality of life. Buildings should provide 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. 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(81) defines 'Acceptable Indoor Air Quality' as "air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction."

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

Sources of indoor pollutants include outdoor pollutants, building fabric materials, interior finishes, building systems and equipment, appliances, consumer products, and the occupants and their activities. To some extent building orientation in respect of outdoor pollution sources, particularly traffic and industrial sources, can alleviate 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. The design of the building envelope should consider moisture and vapour penetration, and infiltration. Air intakes should be sited away from pollutant sources and avoiding short-circuiting with exhausts. Ventilation system design 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 OF IEQ

In keeping with the HK-BEAM assessment approach the assessment of IEQ is mainly performance based, with the vast majority of credits awarded for meeting performance specifications at the commissioning stage before handover and occupancy. This approach also allows the assessment under HK-BEAM 4/03 to dovetail closely with assessments under HK-BEAM 5/03 'existing 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 embrace the impacts from the use of the premises by occupants.

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

Clients will appreciate that a building that is not yet fully fitted-out, furnished and occupied cannot be fully tested for compliance to all performance specifications. HK-BEAM 4/03 seeks to ensure that buildings and systems are tested are far as possible to ensure that intended performance is likely to be achieved, providing that tenants/occupants follow the fitting-out specifications and guidance for use, appropriate to the type of the premises they occupy.

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 considers 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 the design of air-conditioned buildings, such as ISO 7730[(82)], ASHRAE 55[(83)] 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 4/03 takes into account the Government's proposed Indoor Air Quality Certification Scheme[(84)] and the accompanying Guidance Note[(85)], 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

82 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.

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

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

85 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.

is given to worst case conditions that might impact on the health of building users.

Reduced use of air-conditioning can be 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 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. For intermittently operated exhaust fans in kitchens a rate of 50 l/s is considered appropriate, with half this for other rooms requiring local exhaust(86).

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. Measurements under such circumstances can demonstrate compliance with the operating requirements.

Objective of HK-BEAM

Ensure that the air-conditioning system can provide the stated design 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 simulated full-load conditions.

b) Room air distribution

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

Method of assessment

The Client shall provide evidence in the form of a report prepared by a suitably qualified person detailing the design criteria with respect to thermal comfort conditions for all types of premises included in the 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 and relative humidity) are undertaken: i) with no occupants, and ii) with simulated full occupancy. The results shall demonstrate 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 can 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(87).

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86 BSR/ASHRAE Standard 62.2P. Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings. Third Public Review, April 200

87 International Standard Organization. International standard 7726, Ergonomics of the thermal environment — Instruments for measuring physical quantities. 1998.

b) The measurement locations shall be as for a). The assessment of performance shall be in accordance with ASHRAE 113[(88)] or equivalent standard method.

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^{o}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 Client 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

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

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 a centrally air-conditioned building should be adequate for the intended levels of occupancy. The criteria often used to indicate satisfactory provision of ventilation in occupied premises is the level of 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 other equivalent design standard. However, 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 not possible to use CO_2 as a measure of satisfactory performance in unoccupied premises, but it is possible to determine if ventilation will be satisfactory through measurement of ventilation rate and ventilation (air change) effectiveness.

There are three basic requirements for ventilation of rooms used for habitation(89,90); background ventilation, local exhaust, and source control. The concepts can be applied to workplaces, classrooms and similar workplaces where people spend long periods of time. Background ventilation is intended to dilute the unavoidable contaminant emissions from people and materials. Background ventilation should be provided for control of radon levels in occupied and habitable rooms, and 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 Client appropriate to the type and use of premises in the 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(91) 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

Ensure 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 areas.
- ❖ 1 credit for demonstrating that the ventilation effectiveness in occupied areas meets the specified performance.

Method of assessment

The Client shall provide evidence in the form of a report prepared by a suitably qualified person

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

90 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.

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

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 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 shall be used to label the indoor air at the start of a decay or step-up measurement. ASTM standard E741-95(92) 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 corrected ventilation rate is achieved in 90% of sampled premises, and the design ventilated rate is achieved in all sampled premises, credit shall be awarded.

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(93).

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 Client 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 compliance.

A wind pressure analysis may be undertaken through boundary layer wind tunnel modelling. Wind pressure coefficients at inlet/outlet areas for common areas shall be measured for representative

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92 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.

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

floors of the assessed building (e.g. at 5 floor intervals, from the 5^{th} 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.

6.3.3 UNCONTROLLED VENTILATION IN AIR-CONDITIONED/NATURALLY VENTILATED PREMISES

Installation of windows and similar openings in a building envelope will result in some air leakage, either infiltration or exfiltration. This results in a loss of conditioned air or an unwanted gain of unconditioned air, and resultant heat gains or losses in occupied rooms. Infiltration can increase the levels of outdoor pollutants that enter indoors. Leakage occurs as a result of differentials between indoor and outdoor air pressure, caused by winds, stack effect, etc. This can be reduced by properly installed high-quality window systems with proper sealing of cracks and joints[(94)].

Objective of HK-BEAM

Reduce uncontrolled air movement in or out of the premises, thereby reducing cooling load, infiltration of contaminated air and external noise penetration.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for undertaking tests on a representative sample of units, to demonstrate that the air tightness is less than 2.0 $ac.h^{-1}$ at 50 Pa.

Method of assessment

The Client 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 compliance.

The practical aspects of performing a fan pressurisation measurement shall be based on ASTM 779[(95)] or similar equivalent method. The air flow rate at 50 Pa is normalised to the volume of the flat/apartment to give the rate in $ac.h^{-1}$ at 50 Pa. The value quoted should be the arithmetic mean of the air leakage rates measured for pressurisation and depressurisation tests.

6.3.4 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:

94 The American Institute of Architects. Glazing Design: Handbook for Energy Efficiency. AIA 1997.

95 ASTM International. E779. Standard Test Method for Determining Air Leakage Rate by Fan Pressurization. 1999.

- an adequate ventilation system for rooms/areas where significant indoor pollution sources are generated; and
- a system of local exhaust of premises undergoing fit-out and redecoration.

Method of assessment

The Client 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, kitchens, 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. The ventilation provisions shall be adequate to exhaust to outside air any combustion products, excess moisture, etc. The design shall demonstrate that the exhaust is discharged such that it does not re-enter the premises or enter adjacent premises under typical wind conditions.

The alternative is to demonstrate compliance through the conduct of appropriate tests in a sample of units.

6.3.5 NATURAL VENTILATION IN PUBLIC AREAS

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

Objective of HK-BEAM

Ensure good ventilation in public areas and circulation routes within premises not provided with mechanical cooling or ventilation.

Maximum number of credits attainable: 2

Credits requirement

- 1 credit for undertaking an analysis of building and adjacent building forms to assess wind pressures on ventilation openings in public/circulation areas.
- 1 credit for demonstrating that each common area has ventilation openings capable, under prevailing wind conditions, of providing adequate ventilation.

Method of assessment

The Client shall submit a report prepared by a suitably qualified person demonstrating compliance. The wind pressure analysis may be undertaken through boundary layer wind tunnel modelling. Wind pressure coefficients at inlet/outlet areas for common areas shall be measured for representative floors of the assessed building. In the case of buildings of height greater than six storeys this shall be at 5 floor intervals, from the 5th floor. The measurements will be taken for at least the prevailing wind conditions (e.g. NE, E, SE, SW winds).

The modelling technique shall show a boundary layer as appropriate for the site, and the model will include any significant buildings and site obstructions within a distance of approximately 6 building heights. The pressure data will be used with standard calculation procedures to estimate flows through the common areas, arising from an average wind condition. Buoyancy or turbulence driven flows need not be considered.

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6.4 INDOOR AIR QUALITY

6.4.1 CONSTRUCTION IAQ MANAGEMENT FOR CENTRALLY AIR-CONDITIONED BUILDINGS

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

Objective of HK-BEAM

Ensure that building ventilation systems are not contaminated as a result of residuals left over from construction activities.

Maximum number of credits attainable: 2

Credit requirements

a) Construction IAQ management

❖ 1 credit for implementing a Construction IAQ Management Plan.

b) Filter replacement and flush-out

❖ 1 credit for:

✧ a building 'flush out' or 'bake out'; or

✧ replacement of all filters prior to occupancy.

Method of assessment

a) The Client shall submit a report prepared by a suitably qualified person that includes a copy of the Construction IAQ Management Plan, and construction specification provisions in respect of IAQ management highlighting the six requirements of SMACNA's IAQ guidelines(96), and evidence, such as photographs of construction IAO management measures showing protection of ducts, on-site storage or protection of installed absorptive materials, etc. Where the Client can demonstrate IAQ management actions have met or exceeded the minimum requirements of the SMACNA guidelines up to the period immediately prior to occupancy the credit shall be awarded.

b) The Client shall provide a report prepared by a suitably qualified person confirming that filtration media shall have a Minimum Efficiency Reporting Value (MERV) of 13 as determined by ANSI/ASHRAE 52.2-1999(97), or conduct a minimum two-week building flush-out with new filtration media at 100% outside air after construction ends and prior to occupancy of the effected space. The report shall detail technical information of filtration media used during construction and installed immediately prior to occupancy with MERV values highlighted. The report shall detail building flush-out procedures including actual dates of the flush-out.

6.4.2 OUTDOOR SOURCES OF AIR POLLUTION

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

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

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.

Survey data for Hong Kong buildings shows that if design and construction is adequate it should be possible to meet Level 1 of the Guidance Note for CO, NO_2, ozone and RSP in new air-conditioned buildings.

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 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 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 Client 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 in air-conditioned buildings shall be that defined under

Level 1 in Table 3-2 of the Guidance Note. For other occupied areas and habitable rooms 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 outlined in Appendix D. 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.

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.

6.4.3 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 occupied 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 Client 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 and habitable rooms 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 outlined in Appendix D. 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, 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.

In the case of occupied/habitable rooms in air-conditioned/naturally ventilated buildings the measurement of indoor air pollutants shall take place whilst operating in the background ventilation mode.

6.4.4 BIOLOGICAL CONTAMINATION IN CENTRALLY AIR-CONDITIONED BUILDINGS

Measurements in a new building may not reveal problems with air pollution caused by air-conditioning and water systems so HK-BEAM 4/03 prescribes design details to reduce the possibility of problems arising during use of the building.

Objective of HK-BEAM

Ensure that the design, installation and facilities for operation and maintenance of air conditioning systems are such as to reduce the risk of biological contamination.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for complying with the design recommendations described in the Code of Practice Prevention of Legionnaires Disease in respect of air-conditioning and ventilation.

Method of assessment

The Client shall submit a report prepared by a suitably qualified person detailing the provisions made in the air-conditioning installations to ensure compliance with the requirements and recommendation contained in the Code of Practice Prevention of Legionnaires Disease[(98)].

6.4.5 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

98 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.

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 Client 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 Client 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 areas or public areas in or immediately adjacent to the building development.

6.4.6 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 Client shall submit a report prepared by a suitably qualified person demonstrating that the design of the ventilation system meets or exceeds the guidelines given in ProPECC PN 2/96(99), 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.

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

6.4.7 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 Client shall submit a report prepared by a suitably qualified person demonstrating that the design of the ventilation system meets or exceeds the guidelines given in ProPECC PN 1/98[100], 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

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

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 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.

6.5.1 DAYLIGHTING WINDOWS AND VIEWS

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

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

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. The desire for daylight can conflict with the

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

desire to exclude solar heat, so that careful design, taking solar control measures into account, is required. Whilst it is difficult to take into account the overshadowing by adjacent buildings, various design tools are available for predicting availability of daylight where sight of sky is not obstructed.

In Hong Kong, Building (Planning) Regulations CAP123 - Lighting and Ventilation sets out prescriptive requirements of a minimum window to floor area ratio of 10% and a maximum obstruction angle of 71.5° for habitable rooms. The Building Department has recently issued a revision Practice Note(101) that allows use of the vertical daylight factor (VDF) at the centre of the window pane as an alternative to demonstrate adequacy of natural lighting provisions. It requires a VDF of 8% or above for habitable rooms and offices, and a VDF of 4% for kitchens. The Practice Note recommends the use of the "Unobstructed Vision Area" (UVA) method as a reliable tool to demonstrate compliance with the performance requirements. However, the correlation between VDF and UVA is not entirely convincing. In fact, VDF assesses only one factor determining the indoor daylight environment, namely the external daylight availability. The internal daylight levels depend also on the window size and configuration and the transmission property of the window glazing. The total daylight environment of a room depends also on the depth of the room. Daylight penetration in side lit rooms is limited to a shallow perimeter area adjacent to the window. For deep rooms, the back of the room looks gloomy unless some advanced daylight redistribution systems such as light shelves exist in the room.

Objective of HK-BEAM

Encourage a holistic examination of site layout, building design, and fenestration design, such as to maximise access to daylight for the purposes of improved health and comfort.

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 in occupied/habitable 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 occupied/habitable 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 occupied/habitable 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 Client 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.

101 Building Department. Practice Note for Authorised Persons No. 241. (Draft).

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 obtain 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(102).
- Use of lighting simulation software such as RADIANCE(103) 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(104) or similar equivalent method. Alternatively, daylighting design software can be used to calculate the average DF provided it can be demonstrated that the method of computation employed by the software is not inconsistent with the prescribed calculation method.

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

c) Room depth criteria is given by $d/w + d/h < 2/(l-R_B)$ 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

On the floor plan of each floor of the building, line of sight lines to each window to identify areas without direct view of the window. Measure these areas on the floor plan and calculate the ratio of the area with direct line of sight to a vision window to the total floor area. Windows above 2 m and below 0.8 m do not qualify for vision windows.

6.5.2 INTERIOR LIGHTING PERFORMANCE

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

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.

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

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

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

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Maximum number of credits attainable: 3

Credit requirement

a) Lighting performance

❖ 1 credit where the prescribed lighting performance in each type of premises in respect of maintained illuminance, illuminance variation, and limiting glare index is achieved.

b) Lighting quality

❖ 1 credit for lighting installations in which:

✧ fluorescent and other lamps with modulating (fluctuating) output are fitted with dimmable high-frequency ballasts in all work areas where appropriate; and

✧ lamps have a CIE general colour rendering index 80 or above (i.e. colour rendering groups 1A or 1B).

c) Luminaire installation and maintenance

❖ 1 credit 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

✧ the maintained illuminance takes into account the planned programme of luminaire cleaning and group re-lamping.

Method of assessment

The Client shall provide details of the 'as installed' lighting systems and demonstrate compliance through a report issued by a suitably qualified person. For premises to be fitted out by tenants compliance shall be confirmed if the technical details and contractual arrangements with tenants in respect of lighting installations meets the criteria.

a) The 'lumen method' formula can be used to calculate the maintained illuminance over the working plane according to the calculation procedure described in Section 4.5.3 of the CIBSE Code[(105)] or in Appendix 3 of the CIBSE Lighting Guide[(106)]. The calculated maintained illuminance will be checked for compliance with the recommendations given in Section 2.6.4 of the Code or the recommendations given in Chapter 5 Lighting Guide.

The illuminance variation consists of 'unifomity' which is concerned with illuminance conditions on the task and immediate surroundings, and 'diversity' which expresses changes in illuminance across a larger space. The uniformity and diversity can be calculated according to that described in Section 4.5.4 of the 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.

The glare index can be calculated according to either of the two methods described in the CIBSE Technical Memoranda[(107)]. These methods are also summarised in Section 4.5.6 of the CIBSE Code. The calculated glare index shall be checked for compliance with the recommendations given in Section 2.6.4 of the Code or Chapter 5 of the Lighting Guide.

For assessment using the IESNA Lighting Criteria, the calculation methods described in Chapter 9 of the IESNA Lighting Handbook[(108)] can be used for the calculation of the following parameters:

- horizontal and vertical illuminance;

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

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

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

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

- 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.

For lighting installations that are already installed, horizontal and vertical illuminance and luminance can be measured using a lux meter and a luminance meter.

b) The colour quality of lamps can be assessed from the lamp specifications. Flicker can be assessed by whether the specified ballasts are magnetic or electronic.

For lighting installations that are already installed, colour appearance (correlated colour temperature) can be checked from the lamp labels or by measurement using a colour meter. Flicker can be tested using a simple "flicker meter".

c) 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 maintained lighting performance shall assume the implementation of a lighting maintenance plan which defines the period for luminaire cleaning and group re-lamping, following the recommendations given by CIE(109).

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. Good planning and design is especially important to mitigate external noise. Noise mitigation measures such as appropriate road surface design, screening by non-noise sensitive building structures, podium structures or purpose built barriers, orientation, or disposition and internal layout of buildings should be explored in an effort to minimise rail and road traffic noise.

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

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

Background noise should be limited to levels suitable for the use of the premises in a building development, expressed as appropriate criteria.

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

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6.6.1 ROOM ACOUSTICS

There is no single all-encompassing set of criteria that will define good acoustical properties for all types of rooms and uses. However, an important acoustical measurement called reverberation time is used to determine how quickly sound decays in a room, and is used here as a criteria for improved acoustical design.

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 premises

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

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.

Method of assessment

The reverberation time shall be assessed using Sabine's formula[(110)] or similar alternative, or measured during commissioning using the decay method similar to that given in ISO 3382[(111)]. The Client shall submit details in the form of a report by a suitably qualified person detailing the method used, underlying assumptions and calculations or measurement appropriate to the premises covered in the assessment.

6.6.2 NOISE ISOLATION

The Building Regulations does not legislate for internal noise or for the design of buildings to mitigate noise transmission between rooms or premises. 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

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

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

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

b) Classrooms

Sound Transmission Class of walls between classrooms to be equal to or greater than STC37 for classrooms on the same floor and equal or greater than STC50, Impact Noise Insulation Class(112) IIC46 between floors.

c) Residential premises and hotel 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)

Method of assessment

The calculations should be done with reference to an appropriate standard, such as ISO 140. The Client 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.

6.6.3 BACKGROUND NOISE

Background noise sources include that from external sources as well as from the building services equipment. Table 4.1 in Chapter 9 of the Hong Kong Standards and Planning Guidelines provides a summary of maximum permissible noise levels at the external facade applicable to building uses which rely on operable windows for ventilation. Guidance on separation distances between road traffic and rail traffic and residential buildings is given in the Guidelines. The Environmental Protection Department also describes practical measures that can be taken at the design stages to achieve an acceptable noise environment in new noise sensitive developments(113), and for planning residential developments against road traffic noise(114). The Environmental Protection Department also provides guidelines on practical noise control measures for ventilation systems(115), and for pumping systems(116).

Objective of HK-BEAM

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

Maximum number of credits attainable: 1

Credit requirement

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

a) Offices

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

b) Classrooms

Background noise shall be below 45dB L_{Amax} in schools in urban areas, otherwise at or below

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

113 Environmental Protection Department. Practice Note for Professional Persons. ProPECC PN 4/93. Planning and Designing Noise Sensitive Developments. September 1993.

114 Environmental Protection Department. Practice Note for Professional Persons. ProPECC PN 1/97. Streamlined Approach for the Planning of Residential Developments Against Road Traffic Noise.

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

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

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40dB L_{Amax}, effective between the hours of 08:00 to 16:00.

c) Residential premises and hotel rooms

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

Method of assessment

Noise levels at the façade can be established by measurement or prediction by simulation methods approved by the Environmental Protection Department. Predictions should take into consideration future as well as existing land uses.

Estimation of road traffic noise can be made using the UK Department of Transport's prediction method(117). For railway noise, calculations shall be made in terms of $L_{Aeq,T}$ using the UK Department of Transport's prediction method(118). For noise from industry which are more or less of steady level, $L_{Aeq,T}$ is estimated according to British Standard BS 4142(119). T in the case can be 1 hr or 30 minutes. Calculations can be made in terms of $L_{Aeq,T}$ according to BS 8233(120), where T = 16 h (daytime) and 8 h (night time), appropriate to the criteria chosen for noise other than railway noise. Calculations using the statistical energy analysis(121) are also acceptable. Site measurement during testing and commissioning according to ISO140(122) or equivalent shall be accepted as an alternative. Sufficient numbers of calculations shall be made to ensure that the requirements are met in all specified premises, but in particular premises near street level and major plant rooms.

The Client 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.

6.6.4 INDOOR VIBRATION

Excessive vibration is buildings can also be a source of annoyance to users. It is possible to mitigate against vibration caused external sources, such as traffic, and internal sources, such as building services equipment, through good design.

Objective of HK-BEAM

Avoidance of excessive vibration from building services equipment and external sources.

Maximum number of credits attainable: 1

Credit requirement

❖ 1 credit for demonstrating vibration levels shall not exceed the prescribed criteria.

Method of assessment

The Client shall provide evidence of the investigation in the form of a report prepared by a suitably qualified person demonstrating compliance with the criteria given in ISO 2631-2(123).

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117 UK Department of Transport. The Calculation of Road Traffic Noise. HM Stationary Office. 1988.

118 UK Department of Transport. The Calculation of Railway Noise. HM Stationary Office. 1995.

119 British Standards Institution. Method for rating industrial noise affecting mixed residential and industrial areas. British Standard BS 4142:1990. London, BSI, 1990.

120 British Standard Institution. BS 8233 Code of Practice for sound insulation and noise reduction for buildings. 1999.

121 European Committee for Standardization. CEN EN 12354 Building Acoustics – Estimation of acoustic performance of buildings from the performance of elements. Bruxelles, 2000.

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

123 International Standard Organization.. ISO2631-2:1989 Evaluation of human exposure to whole-body vibration – Part 2 : Continuous and shock-induced vibration in buildings (1 to 80Hz)

7 INNOVATIONS AND PERFORMANCE ENHANCEMENTS

This section allows for a Client to submit any innovative techniques which the Client deems to provide environmental benefits additional to those already covered in HK-BEAM 4-03.

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 Client 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 Client shall make a submission for granting additional credits that identifies the intent of the proposed innovative technique, the proposed criteria for assessing compliance, and the assessment criteria. The weighting (number of credits) proposed 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 4-03.

Credit requirement

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

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The Client shall make a submission for granting additional credits which identifies the level of enhancement in performance in any environmental aspect. The weighting (number of credits) proposed 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 that applies to all types of new 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 4.1 and buildings of similar nature grouped under "other buildings" as described in Section 4.2.6.

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 an air-conditioned building development comprises three parts. The first part is on the energy performance, which is dependent on the specific characteristics of the development, such as the types of premises it houses and the range and operational characteristics of services systems required to meet the functional needs of the users. This part includes an energy use assessment that is based on predicted/calculated annual energy use and assessment of relevant features specific to particular types of buildings, based either on component-performance or feature specific criteria.

The second part is on aspects that are generally applicable to all types of buildings, such as the use of energy efficient equipment. Included in this part is the application of renewable energy to buildings, such as the use of solar panels for water heating and photovoltaic panels, fuel cells and wind turbines for electricity generation. Whilst there is potential for increasing renewable energy applications in buildings in Hong Kong there are significant technical and economic barriers to implementation. Consequently, to encourage application of renewable energy sources HK-BEAM awards 'bonus' credits which do not count towards the total available credits, but count towards the award classification. The third part covers provisions that facilitate energy efficient operation and maintenance, including the testing and commissioning of systems.

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 assessment of the energy performance of new air-conditioned building developments is based on predictions obtained from computer simulations. The criteria for the award of credits have been established using a detailed building heat transfer simulation program HTB2 and an air-conditioning system simulation program BECON. However, for the purpose of 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. The Client shall submit documentation to confirm that the specific program used will have all the simulation capabilities required for modelling the building development being assessed and that the stated requirements are met.

A.1.2 GENERIC ASSESSMENT METHOD

Buildings accommodating predominantly air-conditioned premises, such as malls, offices, hotels and high-rise residential apartments, are the dominant electricity consumers in Hong Kong. In order to allow designers flexibility in achieving the energy performance target for a building development, the assessment is based primarily on the 'total energy budget approach', supplemented by a range of basic requirements. As already mentioned, there are also aspects that will be assessed separately based on feature specific or component-based performance criteria that experience has shown to have significant impact on building energy performance.

The key features of the assessment framework developed for assessing this category of building development is illustrated in Figure A.1 and the following.

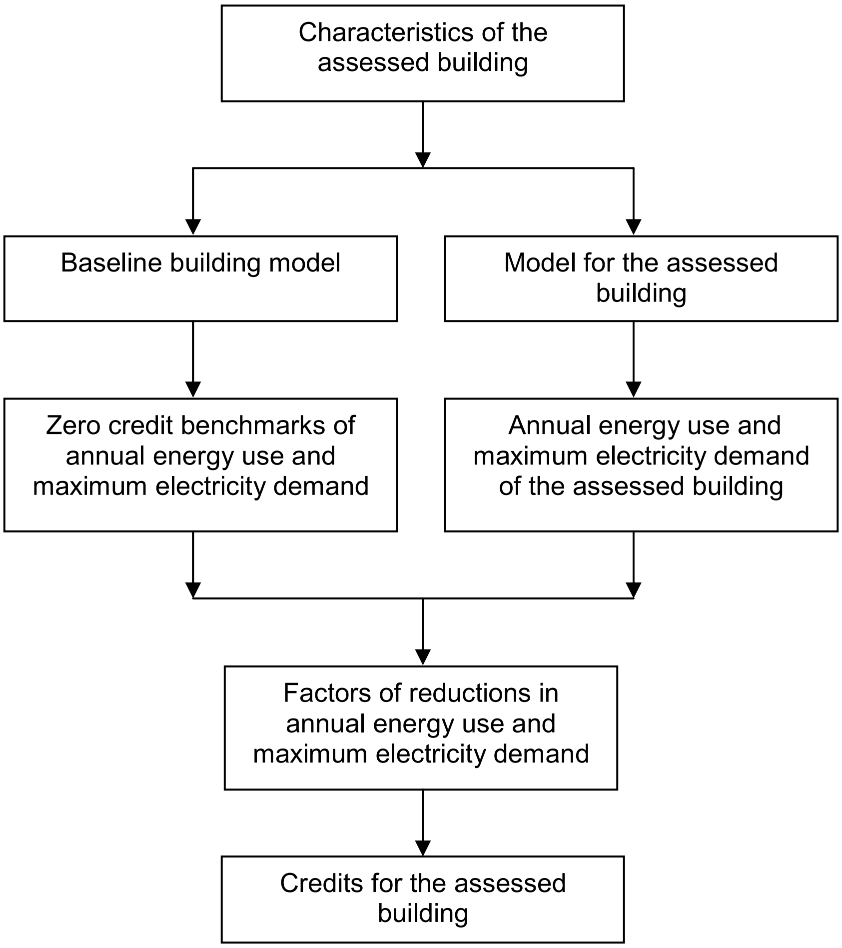

Figure A.1 Processes of building energy performance assessment

- the 'energy budget' for an assessed building 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 assessed building;
- the zero-credit benchmark will be determined from the predicted annual energy use of a baseline building model, which would have the same shape and dimensions, and would comprise the same mix of areas for the same range of types of premises as the assessed building;
- the baseline building model will be incorporated with a range of standard (default) characteristics such that the model would represent a building with energy performance that barely meets the relevant regulatory requirements or is on a par with the standard of common practice in the local building industry;
- the zero-credit benchmark for the assessed building will be equal to the predicted annual energy use of the baseline building model;
- the annual energy use of the assessed building will be predicted based on, as far as possible, the design characteristics of the building (there are some parameters for which the use of default values is specified in the assessment method - see the descriptions in Section A.2 and, where applicable Section A.3); and

- the number of credits to be awarded to the assessed building will be determined by the percentage reduction in the predicted annual energy use relative to that of the baseline building model.

The assessment of maximum electricity demand is conducted in a way similar to the energy use assessment, as follows:

- the zero-credit benchmark for maximum electricity demand will be that of the baseline building model; and
- credits for the 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.

A.1.3 BASELINE BUILDING MODEL

The characteristics to be incorporated into the baseline building model, including the envelope design features, indoor design conditions, ventilation rates, occupation density and patterns, internal load intensities and patterns, and the performance of air-conditioning equipment shall be as described in Section A.2 in this Appendix.

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 a building, including the baseline building model and the assessed building development. 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 a particular range. Appendix B provides 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 (see Section A.1.4 for the range of installations that will be included in the total energy budget assessment). 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.1.4 ENERGY USES INCLUDED IN THE TOTAL ENERGY BUDGET ASSESSMENT

The building energy use and maximum electricity demand assessment for new air-conditioned building developments will embrace only the following energy uses:

- lighting and equipment energy use in air-conditioned premises occupied by the tenants and/or owners of premises in the building;
- lighting energy use in air-conditioned public areas; and
- air-conditioning energy use in the entire building complex.

The performance of the building envelope design will be indirectly assessed as the air-conditioning energy use is dependent on the heat gains from the envelope.

The energy uses covered in this part of the assessment are interrelated and together dominate the overall energy use in an air-conditioned building. Other energy uses in buildings that do not have an impact on the air-conditioning energy use, such as for lighting installations in non-air-conditioned public areas and services plant rooms, for lift and escalator installations, hot water supply, etc., and energy losses in the electrical installations are, for simplicity, assessed based on component-performance or feature specific criteria (see Sections 4.4 and 4.5).

A.1.5 ASSESSMENT OF A BUILDING COMPLEX

For a large complex 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 HVAC plant (such as illustrated in Figure A.2), each part will be assessed according to the criteria for the building type to which each part belongs. A baseline building model with its own central air-conditioning plant shall be devised for determining the zero-credit energy use and maximum electricity demand benchmarks for each part of the complex.

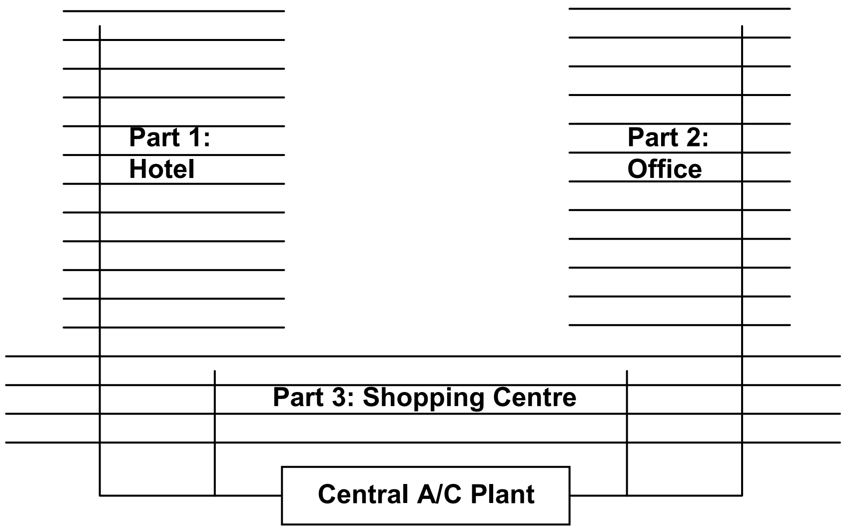

Figure 4.2 Illustrating a building complex served by a central air-conditioning plant

The annual energy use and maximum electricity demand of the central air-conditioning plant shall be predicted, being based on the simultaneous hourly cooling loads from all parts of the complex throughout the year, together with the plant performance characteristics. The predicted energy use and maximum electricity demand is then 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 for each part of the complex of the energy use and the maximum demand of the central plant shall be added to the energy use and the maximum 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 located 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 shall first be separately assessed, according to the assessment methods that apply to the respective types of premises, and a weighted overall score will then be determined for the overall development.

The credits awarded to various parts of a complex will then be weighted, according to the method described in Section 1.3.7, to yield an overall score for the assessed complex.

A.1.6 ADDITIONAL ENERGY CONSERVATION MEASURES

If additional measures are adopted to effectively reduce the cooling load or enhance the efficiency of the air-conditioning systems in a building, their effects are 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) but their impacts will be taken into account in the prediction of the annual energy use and maximum electricity demand for air-conditioning in the assessed building development, allowing higher credits commensurate with the enhanced performance likely to be achieved. Such measures may include but are not 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.1.7 BASIC REQUIREMENTS

A pre-requisite for obtaining credits under the total energy budget assessment is compliance with specific items in the Government's energy efficiency codes, as follows:

- items listed in Table A.1 for the Code of Practice for Energy Efficiency of Lighting Installations; and
- items listed in Table A.2 for the Code of Practice for Energy Efficiency of Air Conditioning Installations.

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.

Items covered in the referenced codes not defined here as basic requirements are regarded as the minimum (benchmark) performance for the relevant systems or components, but trade-off in performance of such systems or components with other systems or components is allowed within the overall energy performance assessment.

Other building specific requirements are given in relevant sections that define the assessment method 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 A NEW BUILDING

The baseline building model for assessing a new building will not be incorporated with any specific features or measures for enhancing the energy performance of the building other than those required by relevant regulations or those that would be adopted as a common industrial practice.

Since there is currently regulatory control over the overall thermal transfer value (OTTV) of new commercial and hotel buildings, this regulatory requirement is taken as the benchmark envelope design for these two categories of buildings. It follows that the envelope construction of the baseline building model for a commercial or hotel building will be assigned with characteristics that barely comply with the OTTV requirement as stipulated in Buildings Department's Practice Note 172[i]. Calculation of OTTV shall be based on the method and data given in the Code of Practice for Overall Thermal Transfer Value in Buildings[ii]. Since, according to this OTTV calculation method, the heat gain from fenestration dominates the OTTV of a building, adjustment of the envelope characteristics from the "as designed" condition to the baseline condition shall be made by varying the fenestration area at the external walls or roofs. The method for this envelope design adjustment shall be as described in Section A.3.

For other types of new buildings, the baseline building model will be assumed to have envelope components (windows, walls, roofs, etc.) of construction characteristics as summarised in Table A.3. The method described in Section A.3 shall apply in setting the envelope characteristics of the baseline building model. Note that the baseline building model will not be incorporated with skylights even if there are skylights in the assessed building.

In devising the baseline building model for a new residential building, the major façade of each flat in the building will be identified, which will be the group of external walls that are exposed to the

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[i] Buildings Department. PNAP 172. Energy Efficiency of Buildings Building (Energy Efficiency) Regulation. june 2000. http://www.info.gov.hk/bd/english/documents/pnap/Pnap172.pdf

[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

same direction in which the aggregate window area is the largest amongst all groups of external walls (grouping determined with reference to the orientation of walls). Only external walls that enclose air-conditioned rooms in the flats shall be considered. In predicting the annual energy use and maximum electricity demand for the baseline building model, each flat in the building model will be rotated such that its major façade will be facing west, the worst orientation in respect of solar heat gain in the flats. However, the layout design of flats in the building, including their respective orientations, will be modelled "as designed" in the prediction of the annual energy use of the assessed building. This assessment method is intended to allow good layout designs of flats to be reflected in the assessment outcome.

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 either a new building or 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 either a new or an existing building shall be as summarised in Tables A.4 and A.5.

When assessing a new building, prediction of the energy use in the assessed building will be based on the corresponding occupation densities and ventilation rates adopted in the air-conditioning system design for the building, but the default occupancy pattern will still apply.

Note that although the use of design ventilation rates that are lower than the default values will lead to a better outcome in the energy performance assessment, this is not advisable as it will also lead to a worse outcome in the indoor air quality assessment.

A.2.3 INTERNAL LOADS

The lighting power intensities to be used for various types of premises in the baseline building model shall be the threshold compliance values as stipulated in the 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.

For both the assessed building and its baseline building model, the default utilisation patterns of lighting and equipment, as summarised in Table A.5, shall be used in the energy use and maximum electricity demand predictions.

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. Design values will be adopted in predicting the annual energy use in the assessed building.

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 and the assessed building. If the developer can provide evidence that air-conditioners of better performance will be adopted in the assessed building, the annual energy use prediction for the assessed building will be based on such performance.

Where a central air-conditioning plant is used to serve multiple types of premises in the same building, prediction of the annual energy use and the maximum electricity demand of the central air-conditioning plant will be based on the simultaneous total cooling load on the plant from all the served premises, taking into account also the periods of air-conditioning provisions for different types of premises, and the sequencing control strategy that will be applied to control the operation of the chillers and pumps in the plant.

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

The modification of the envelope design of the assessed building into that of the baseline building model shall be made through adjusting the window-to-wall area ratio (WWR, the ratio of the total window area in the building façade to the total façade area). For commercial and hotel buildings, the WWR shall be adjusted such that the OTTV of the envelope of the baseline building model will just meet the relevant regulatory requirement (30 W/m² for the building tower and 70 W/m² for the podium; PN 172, Buildings Department). For other types of buildings, the default WWR area ratio of the baseline building model shall be 0.65.

Since many different ways can be used to adjust the envelope WWR, a standardised method is needed for maintaining consistence of the assessment. The standardised method that shall be used in devising the baseline building model was derived as described below, which will ensure that when the window areas are enlarged, the ratio of the area of the opaque part of each external wall to the total opaque surface area of the envelope will remain unchanged.

Assuming that a floor or flat in the assessed building is enclosed by N external walls, and let:

$AWIN_i$ = area of the window on the i^{th} wall on the floor or in the flat, m^2
$AOPW_i$ = opaque wall area of the i^{th} wall on the floor or in the flat, m^2

The total area of the i^{th} external wall, $AWAL_i$, would be:

$$AWAL_i = AWIN_i + AOPW_i \tag{A.1}$$

The ratio of the opaque area of the i^{th} external wall to the total opaque area of all external walls of the room, $ROPW_i$, would be:

$$ROPW_i = AOPW_i \Big/ \sum_{i=1}^{N} AOPW_i \tag{A.2}$$

The overall window-to-wall area ratio of the room, $WWR_{overall}$, would then be:

$$WWR_{overall} = \sum_{i=1}^{N} AWIN_i \Big/ \sum_{i=1}^{N} AWAL_i \tag{A.3}$$

When the overall window-to-wall ratio (WWR) of the floor or flat is adjusted to the required value, WWR_{Req}, while the total wall area would remain unchanged, the new window area and opaque area of the i^{th} wall, denoted by $AWIN_i'$ & $AOPW_i'$, which would be the window and opaque areas of the corresponding wall in the baseline building model, would bear the following relation:

$$AWAL_i = AWIN_i' + AOPW_i'$$

It follows that:

$$AWIN_i' = AWAL_i - AOPW_i' \tag{A.4}$$

Note that:

$$WWR_{Req} = \sum_{i=1}^{N} AWIN_i' \Big/ \sum_{i=1}^{N} AWAL_i$$

Hence:

$$\sum_{i=1}^{N} AWIN_i' = WWR_{Req} \cdot \sum_{i=1}^{N} AWAL_i \tag{A.5}$$

Substitute equation (A.4) into equation (A.5):

$$\sum_{i=1}^{N} \left[AWAL_i - AOPW_i'\right] = WWR_{Req} \cdot \sum_{i=1}^{N} AWAL_i$$

It follows that:

$$\sum_{i=1}^{N} AOPW_i' = (1 - WWR_{Req}) \cdot \sum_{i=1}^{N} AWAL_i \qquad (A.6)$$

Assuming the ratio of the opaque area of the i^{th} wall to the total opaque area of all the external walls on the floor or in a flat in the baseline building model ($ROPW_i$, equation (A.2)) would be identical to that in the assessed building, then:

$$ROPW_i = AOPW_i' \bigg/ \sum_{i=1}^{N} AOPW_i'$$

Hence:

$$AOPW_i' = ROPW_i \cdot \sum_{i=1}^{N} AOPW_i' \qquad (A.7)$$

Equations (A.2), (A.6), (A.7) and then (A.4) can be used to determine the opaque and window areas of each of the external walls in the baseline building model.

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.

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	Infiltr-ation 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.

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

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

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.

$$AEC = a_0 + a_1(WWRSC) + a_2(U_{BLD}) + a_3(RPR) + a_4(SPR) + a_5(HRS) + AEC_{TENANT} \quad (B.2.1)$$

$$MED = b_0 + b_1(WWRSC) + b_2(U_{BLD}) + b_3(RPR) + b_4(SPR) + b_5(HRS) + MED_{TENANT} \quad (B.2.2)$$

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:

$$AEC_{TENANT} = \left(\sum_{i=1}^{nT} GFA_i \cdot (AEC_{LGT,i} + AEC_{EQP,i}) \right) \Big/ GFA \quad \text{(B.3.1)}$$

$$MED_{TENANT} = \left(\sum_{i=1}^{nT} GFA_i \cdot (MED_{LGT,i} + MED_{EQP,i}) \right) \Big/ GFA \quad \text{(B.3.2)}$$

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:

$$AEC_{EQP,i} = \left(\sum_{j=1}^{nEQP} N_{EQP,j} \cdot W_{EQP,j} \cdot UF_{EQP,j} \cdot OPH_{EQP,j} \right) \Big/ GFA_i \quad \text{(B.3.3)}$$

$$AEC_{LGT,i} = \left(\sum_{j=1}^{nLGT} N_{LGT,j} \cdot W_{LGT,j} \cdot UF_{LGT,j} \cdot OPH_{LGT,j} \right) \Big/ GFA_i \quad \text{(B.3.4)}$$

$$MED_{EQP,i} = \left(\sum_{j=1}^{nEQP} N_{EQP,j} \cdot VI_{EQP,j} \cdot UF_{EQP,j} \right) \Big/ GFA_i \quad \text{(B.3.5)}$$

$$MED_{LGT,i} = \left(\sum_{j=1}^{nLGT} N_{LGT,j} \cdot VI_{LGT,j} \cdot UF_{LGT,j} \right) \Big/ GFA_i \quad \text{(B.3.6)}$$

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

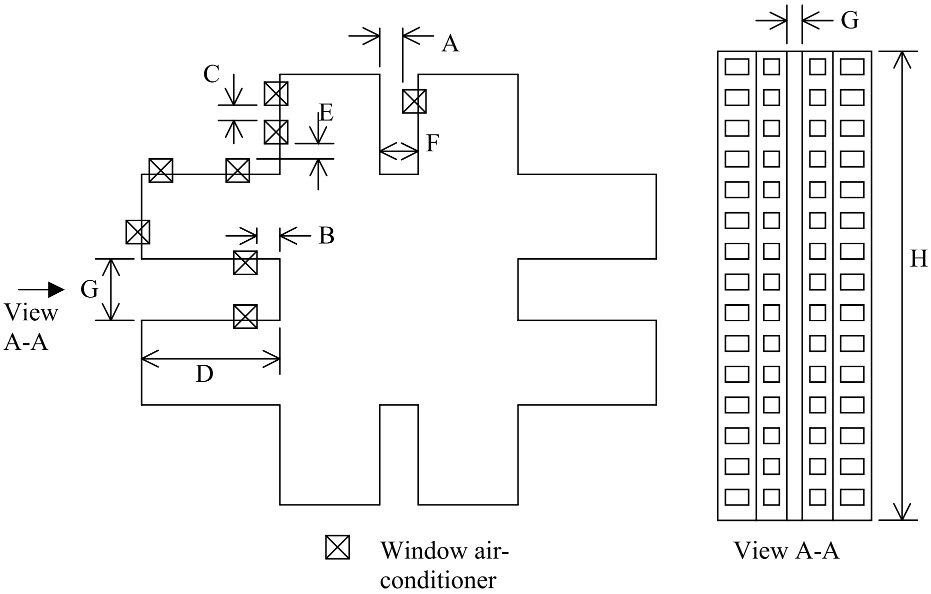

Figure C1 Layout plan and elevation of building

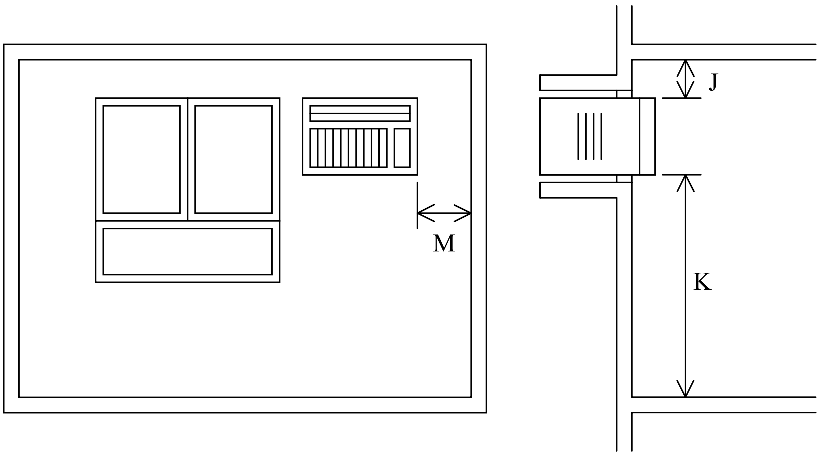

Figure C2 Elevation and section of a room in a residential building

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 PROVISIONS FOR ENERGY MANAGEMENT

D1 COMMISSIONING SPECIFICATIONS

Functional performance testing procedures shall be defined and must be used to functionally test systems, equipment, components, and modes of operation. Test procedures must be documented to describe the individual test procedure, the expected system response, and acceptance criteria for each procedure. Testing documentation must identify the actual system response and must provide any pertinent observations.

Commissioning specifications shall be included in the construction documents and embrace:

- scope and details of the commissioning process;
- qualifications and skills required by the commissioning agent;
- detailed description of the responsibilities of all parties included in the commissioning process;
- systems, equipment and components to be commissioned;
- requirements for functional checklists and start-up;
- the functional performance testing process;
- specific functional performance test requirements, including testing conditions and acceptance criteria for each piece of equipment being commissioned;
- provisions for resolving deficiencies;
- requirements for reporting and documentation for commissioning;
- requirements for training;
- requirements for an operations and maintenance manual, and for systems and an energy management manual.

D2 COMMISSIONING PLAN

To execute commissioning in a comprehensive and orderly manner a commissioning plan, covering a given system, equipment or component shall be prepared. The plan shall include:

- start-up and inspection checklists and procedures;
- functional performance testing procedures and checklists;
- testing, adjusting, and balancing;
- development of a comprehensive operations and maintenance manual and energy management manual; and
- completion of the commissioning report.

For each system commissioned the plan shall provide:

- an overview of the tasks to be executed during commissioning;
- a list of all features to be commissioned;
- a list of reference documents related to commissioning, including specification references, drawing list, and submittal drawings;
- a list of primary participants in the commissioning process and their responsibilities;
- a plan for management, communication and documentation;
- description of checklists and tests to be performed, with reference to specific
- pre-start and start-up checklists;
- list of the functional performance tests to be performed; and
- description of the training to be provided to the operations and maintenance personnel;

D3 COMMISSIONING

Start-up and inspection checklist should comprise the checks and tests to determine that all components, equipment, subsystems, systems, and interfaces between systems operate in accordance with specifications and construction documents, including all modes and sequences of control operation, interlocks and conditional control responses, and specified responses to abnormal or emergency conditions.

The results of the start-up and check-out should be documented and must be performed according to the manufacturer's written instructions for the systems and equipment being commissioned, and the as-fitted construction documents.

Certificates of readiness should be prepared by the commissioning agent verifying that start-up and inspections have been successfully completed and that all equipment, systems, and controls are complete and ready for functional performance testing.

After initial inspection and checking has been verified each sequence in the sequence of operations shall be tested, including the following:

- start-up;
- shutdown;
- unoccupied and manual modes;
- modulation up and down the unit's range of capacity, if applicable;
- staging, if applicable;
- power failure/power down;
- alarms;
- backup upon failure; and
- interlocks with other equipment.

The commissioning authority shall verify that:

- initial inspections, start-up and checking were successfully completed;
- every point of the control system has been checked and that a minimum sample of each type of control point is commanding, reporting and controlling as specified in the as-fitted construction documents;
- if any control point in the sample is not functioning as specified, then an additional sample shall be checked, until all control points in the sample are found to be performing as specified;
- a minimum sample of each type of sensor has been calibrated so that the value reported in the control system represents the actual local value;
- if any sensor in the sample is out of calibration, then an additional sample shall be re-calibrated, until all sensors in a the sample are found to be in calibration;
- a minimum sample of each type actuators have been adjusted and observed to fully close and open dampers and valves, and that the reported values in the control system are correct;
- if any actuator, valve, or damper in the sample does not operate as required, then an additional sample of each type of actuator, valve, or damper shall be checked until all actuators, valves, or dampers in the sample are found to be to be operating as required;
- testing, adjusting and balancing by re-measuring a minimum sample of values reported for each type of component, equipment, subsystem, or system in the testing, adjusting and balancing reports;
- if any re-measured value in the sample deviates from requirements by more than 10 percent, then an additional samples shall be re-measured for each type part for which there is a deviation;
- any chimneys, chimney connectors and stacks are free of cracks, blockages and leaks;
- ensure that proper combustion air is provided to equipment; and

- ensure that all appliances are installed in accordance with applicable fire safety and local building codes.

The functional performance of each type of system, equipment, and component shall be tested based on a minimum sample for each type. If any part is found not to operate as required then additional samples shall be tested to ensure satisfactory performance has been achieved.

As far as practicable equipment shall be tested to demonstrate performance at near-design conditions (details of seasonally deferred testing can be submitted as an alternative).

The efficiency of central plant shall be recorded for reference by operations staff.

Functional performance testing can carried out using manual methods, control system trend logs, stand-alone data loggers, etc, as considered appropriate.

D4 COMMISSIONING REPORT

The report shall contain:

- an executive summary;
- list of participants and their respective roles;
- a brief building description;
- an overview of the scope of commissioning and testing;
- a general description of testing and verification methods; and
- a list of each feature or system commissioned.
- for each piece of commissioned equipment, the determination of the commissioning authority regarding the adequacy of the equipment, documentation and training.

The commissioning report shall address the following areas:

- adequacy of equipment with respect to construction documents and design intent;
- equipment installation;
- functional performance and efficiency;
- equipment documentation;
- operations and maintenance review and recommendations; and
- operator training.

The functional performance and efficiency section for each piece of equipment shall identify the verification method used observations and conclusions from the testing.

The report must also include a list of outstanding commissioning issues and any testing that is scheduled for a later date.

All outstanding deficiencies identified during or as a result of commissioning activities shall have been corrected or must be separately listed and highlighted in the commissioning report.

Each non-compliance issue must be referenced to where the deficiency is documented.

Verification and documentation of installation of systems, equipment and components shall ensure:

- that they are installed according to construction documents and manufacturer's instructions;
- or any differences between the final installation and the original construction documents are documented;
- that other building systems or components are not compromising the efficiency of the systems or features being commissioned;
- the start-up and inspection ckeck-lists were completed and performed as required;
- that functional performance tests are completed as required.
- that HVAC piping testing and duct testing is completed and documentation is included in

operations and maintenance manuals.

- sufficient functional testing of any control systems.
- that testing record include any deficiencies and corrections;
- final testing outcomes are included in the commissioning report and in operations and maintenance manuals;
- documentation of any seasonally deferred testing and corrections of any deficiencies;
- the operations and maintenance manual and energy management manual are complete for all components, equipment, subsystems, and systems that have been commissioned; and
- adequacy of training provided for the Owner's management, operations and maintenance personnel.

If components, equipment, subsystems, or controls, or sequences of operations as-built are differ from the original construction documents, the report shall detail these differences.

If seasonally deferred testing is completed to be under the original contract, the commissioning authority shall issue an addendum to the report, arranged in the same manner as in the initial report.

D5 OPERATIONS AND MAINTENANCE MANUAL

The parties responsible for the design each system to be commissioned shall provide in writing:

- the design intent;
- the basis of design; and
- full sequences of operation for all equipment and systems, all of which must meet the legal requirements and industry wide standards.

The description of the design intent should include as a minimum:

- space temperature and humidity criteria (refer also to the section on IEQ);
- levels operator and/or occupant control over HVAC systems;
- ventilation requirements and related indoor air quality criteria (refer also to the section on IAQ);
- performance criteria related to energy efficiency;
- environmental responsiveness of the facility; and
- commissioning criteria.

The basis of design shall include at a minimum:

- details of occupancy;
- space activity and any process requirements;
- applicable regulations, codes, and standards;
- design assumptions;
- performance standards and benchmarks; and
- control system appropriate for the skill of the operations and maintenance staff.

The operations and maintenance manual must include for each piece of equipment and each system:

- the name and contact information of the manufacturer or vendor and installing contractor;
- submittal data; and
- operations and maintenance instructions with the models and features for the subject site clearly marked.

The manual shall include only data for equipment that is actually installed, and include the following:

- instructions for installation, maintenance, replacement, start-up;
- special maintenance requirements and sources for replacement parts/equipment;
- parts list and details of and special tooling requirements;
- performance data; and
- warranty information.

The manual shall include an as-built documentation package for controls covering the following:

- control drawings and schematics;
- normal operation;
- shutdown;
- unoccupied operation;
- seasonal changeover;
- manual operation;
- controls set-up and programming;
- troubleshooting;
- alarms; and
- final sequences of operation.

D6 ENERGY MANAGEMENT MANUAL

The details shall include:

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

- list of diagnostic tools, with a description of their use, that will assist facility staff for the building in operating equipment more efficiently; and
- a copy of the commissioning report; and
- index of all commissioning documents with notation as to their location.

D7 OPERATOR TRAINING AND FACILITIES

The training program shall cover the following:

- general purpose of each building system including basic theory of operation, capabilities and limitations, and modes of control and sequences of operation;
- review of control drawings and schematics;
- procedures for start-up, shutdown, seasonal changeover, normal operation, unoccupied operation, and manual operation;
- controls set-up and programming;
- troubleshooting;
- alarms;
- interactions with other systems;
- operational monitoring and record keeping requirements, and the use of data for analyzing system performance;
- adjustments and optimizing methods for energy conservation;
- any relevant health and safety issues;
- inspection, service, and maintenance requirements for each system, including any need for specialized services;
- sources for replacement parts/equipment; and
- any tenant interaction issues.

The demonstration portion of the training program shall include at least the following:

- operation typical examples of each system;
- start-up and shutdown procedures;
- operation under all specified modes of control and sequences of operation;
- procedures under emergency or abnormal conditions; and
- procedures for effective operational monitoring.

The Client shall submit details in the form of drawings and a report demonstrating:

- that proper maintenance facilities are provided for operations and maintenance work in the form of workshop(s), office accommodation and control room;
- adequate provision of chemical storage and mixing areas for housekeeping products (central storage facilities and janitors closets, where appropriate) to allow for adequate and secure product storage with water in the space for mixing concentrated chemicals; and
- adequate provision of drains plumbed for the appropriate disposal of liquid waste products, equipped with separate outside venting, and operated under negative pressure.

E 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.

Also available from BEC

HK-BEAM, Version 5/03
An Environmental Assessment for Existing Building Developments

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

Business Environment Council
77 Tat Chee Avenue,
Kowloon,
Hong Kong
Telephone (852) 2784-3900
Facsimile (852) 2784-6699