

Centre of Environmental Technology, Limited

HK-BEAM (Residential)

An environmental assessment for new residential buildings

version 3/99

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HK-BEAM VERSION 3/99 (RESIDENTIAL)

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1 Building Environmental Assessment Method

1.1 INTRODUCTION TO HK-BEAM

The Hong Kong Building Environmental Assessment Method (HK-BEAM) is intended to provide authoritative guidance to developers, designers, contractors and building managers on practices which minimise the adverse effects of buildings on the environment, whilst promoting a healthy indoor environment. It has been developed to set criteria for good environmental performance in buildings; performance that would be recognised through an independently issued certificate.

The HK-BEAM scheme was conceived and financed by The Real Estate Developers Association of Hong Kong (REDA). The Department of Building Services Engineering at The Hong Kong Polytechnic University, with the assistance of the Welsh School of Architecture at Cardiff University, and the Centre for Environmental Technology Limited⁽¹⁾, developed the documentation. The scheme is operated by CET under the guidance of the HK-BEAM Steering Committee. An assessment under the scheme is voluntary.

The HK-BEAM scheme currently embraces office buildings and residential buildings. HK-BEAM version 1/96R⁽²⁾ is for new air conditioned office designs. HK-BEAM version 2/96R⁽³⁾ covers existing air-conditioned office buildings. This document describes HK-BEAM 3/99 for high-rise residential buildings.

HK-BEAM defines good practice criteria for a range of environmental issues relating to the design, operation, maintenance and management of buildings. New residential building designs are compared to these criteria by CET's Assessor. 'Credits' are awarded where standards or defined performance criteria are satisfied. Where these are not satisfied guidance is given on how performance can be improved. The outcome of the assessment is shown on the HK-BEAM certificate as a rating of "Fair," "Good," "Very Good," or "Excellent". Assessment of a high-rise residential building under HK-BEAM 3/99 may be carried out at any time during planning, design or construction stages. However, to obtain the greatest benefit it should be initiated as early as possible in the development process.

HK-BEAM 3/99 aims to reduce the environmental impact of new residential buildings using the best available techniques and within reasonable cost. It is not expected that a new residential building design can meet all of the target requirements. However, by meeting only some of the criteria the building will have less impact than one in which the requirements have not been met.

1.2 AIMS

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

- 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;
- reduce the unsustainable use of increasingly scarce resources such as water, timber, and natural materials;
- minimise pollution of the local environment;

¹ CET is the executive arm of the Private Sector Committee on the Environment

² HK-BEAM 1/96R, An Environmental Assessment Method for New Office Designs. CET 1999. ISBN 962-85076-2-1.

³ HK-BEAM 2/96R, An Environmental Assessment Method for Existing Office Buildings. CET 1999. ISBN 962-85076-4-8.

- improve waste management and to encourage recycling and reuse;
- improve the quality of the indoor environment 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, operators and users to respond to a demand for residential premises which have less impact on the environment, and to help stimulate such a market.

1.3 ASSESSMENT FRAMEWORK

The scheme addresses items for which there is good evidence of the environmental problems they cause, and for which effective performance criteria can be defined. These criteria have been developed so that they can be readily assessed or prescribed during an examination of the designs for a building, giving practical recommendations for improvements. Some environmental issues have yet to be included, either because the problems they cause are not well defined, or because effective performance criteria have not yet 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 will no doubt be measured in the extent to which it actually improves the environmental performance of buildings. In establishing the assessment criteria and standards of performance, local legal requirements establish the baseline for (zero) credit. The first level of credits are awarded for implementing good planning, design, construction and operation practices in line with local good design guidelines, such as the Hong Kong Planning Standards and Guidelines⁽⁴⁾. 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.

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.

The assessment is mainly carried out at the design stage, but with certain aspects 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 design and construction techniques where specific targets are met. Whilst innovative design solutions are encouraged, they do not necessarily justify credit. Innovation must demonstrate environmental gains, through improved efficiency and/or improvements in the internal 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.

International Context

The development of the HK-BEAM scheme has been guided by the existence of similar schemes found elsewhere. The first versions of HK-BEAM for offices^(5,6) were based on the UK Building

⁴ Planning Department, Hong Kong Government. Hong Kong Planning Standards and Guidelines. <http://www.info.gov.hk/planning/index.htm>

⁵ CET. HK-BEAM 1/96. An Environmental Assessment Method for New Air-conditioned Office Premises. ISBN 962-85076-2-1. 1996.

⁶ CET. HK-BEAM 2/96. An Environmental Assessment Method for Existing Air-conditioned Office Premises. ISBN 962-85076-4-6. 1996.

Research Establishment's BREEAM⁽⁷⁾. Similar schemes are in existence in Canada⁽⁸⁾ and the US⁽⁹⁾. There are initiatives afoot to provide for some form of standardisation of the assessment framework, although assessment criteria will remain localised. In the earlier versions of HK-BEAM for offices, the environmental issues were categorised under Global, Local and Indoor impacts, respectively. Consequently, the assessment framework adopted in HK-BEAM 3/99 seeks to retain this framework, whilst at the same time provides a design tool aligned to the building production process. This is achieved by summarising the environmental issues within the general framework (Table 1) and presenting the assessment criteria within the framework of a plan of work (Chapters 2 to 6).

Site Specific Criteria

HK-BEAM 3/99 is intended for application to a variety of new high-rise residential building designs, in both private and public developments. As such, a building under assessment may form part of a residential estate, located in either an urban or a rural setting, and built on a green field or brown field site.

HK-BEAM 3/99 encourages the client and the design team to consider the end use of residential units and the need to manage and maintain the whole building, whether it is a stand-alone block or part of an estate. HK-BEAM focuses on the design features of the whole building and those of the residential units 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 like buildings within the estate. Where the residential block forms a part of a building that includes other types of premises, only the residential premises and the design of attendant services provisions are assessed.

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. In addition, the Assessor may award discretionary credits for environmentally proactive features not covered by the documented criteria.

1.4 ISSUES CONSIDERED IN THE ASSESSMENT

The environmental issues covered are considered under three categories:

- Global issues and use of resources;
- Local issues; and
- Indoor issues.

Global issues and use of resources

This covers the effects that buildings have on the planet and it's atmosphere beyond the local region. The objective is to make buildings more efficient in the use of energy and materials.

- climate change due to greenhouse gas emissions;
- stratospheric ozone depletion;
- deforestation and loss of biodiversity;
- depletion of natural resources;
- deterioration of water resources, and
- diminished capacity for food production, etc.

⁷ Prior J. J. Ed. BREEAM/New Offices Version 1/93: An environmental assessment for new office designs. Building Research Establishment Report. 2nd Ed. 1993.

⁸ Canadian Standards Association. Plus 1132 BREEAM-Canada. An environmental performance assessment method for existing office buildings. June 1996.

⁹ U.S Green Building Council. LEEDTM. Leadership in Energy and Environmental Design. Green Building Rating System. www.usgbc.org.

Local issues

Local issues cover aspects that affect the Hong Kong environment in general, or the immediate surroundings of a building.

- ecological impacts and mitigation measures
- noise pollution during construction and from the building equipment;
- air pollution; and
- water conservation, water pollution and sewage, etc.

Indoor issues

Indoor issues include all aspects of building design, installation, finishes and operation which affect the health, comfort or well-being of the occupants.

- thermal comfort;
- indoor air quality;
- lighting quality;
- noise and vibration; and
- hazardous materials, etc.

The presentation of assessment criteria is to facilitate practitioners in adopting HK-BEAM 3-99. The environmental issues are covered under five main headings:

- Site Planning and Layout (Chapter 2);
- Building and Premises Design (Chapter 3);
- Materials Use and Specifications (Chapter 4);
- Construction Practice (Chapter 5);
- Operations and Maintenance (Chapter 6).

1.5 ASSESSMENT PROCESS

The HK-BEAM scheme is operated by the Centre of Environmental Technology, Limited (CET), an independent, non-profit, environmental information centre, under the guidance of the HK-BEAM Steering Committee.

CET will issue a questionnaire to interested developers which details the information required for assessment. Whilst designs can be assessed at any stage, the greatest benefit is derived if the assessment process begins at an early stage, allowing the Designer to make changes that will improve the building's environmental performance. CET will arrange to meet the design team to discuss the details of the design. The CET 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 modified design may then be re-submitted to be re-assessed, and the Final Report and a Provisional Certificate are then issued.

Given that some credits under HK-BEAM are based on actions taken during construction and upon certain deliverables provided upon completion, the confirmation of certification will be made upon building completion. 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 Final Certificate will then be issued.

Information on how to participate in the scheme is available from the Centre of Environmental Technology, Limited.

Table I: Summary of Credits and Checklist based on Global, Local and Indoor Issues

Global Issues

Sect:	Credit Requirement:	Credit Applicability	Credits Available	Credits Obtained
2.7	Transportation and Pedestrian Access			
a)	where no car parking is provided, except for disabled persons only, or restricted provision of car parking spaces to the minimum required for compliance with land use conditions.	<i>Where minimum requirements are stipulated</i>	1	
b)	for providing easy and substantially sheltered pedestrian access to a mainstream mass transport system.	<i>All Projects</i>	1	
c)	for providing cycle parking, cycling paths which link to local cycling pathways.		1	
3.2	Overall Thermal Transfer Value			
	for an OTTV in bedrooms and other living rooms of less than :	<i>All Projects</i>	1	
	12 W/m ² (in bedrooms), 32 W/m ² (in other rooms)	<i>(Count lowest OTTV in both Rooms)</i>	2	
	10 W/m ² (in bedrooms), 27 W/m ² (in other rooms)		3	
	8 W/m ² (in bedrooms), 22 W/m ² (in other rooms)		4	
	6 W/m ² (in bedrooms), 17 W/m ² (in other rooms)			
3.6	Flexible Design and Fit-Out			
a)	for design of de-mountable partitions which allow the partition wall to be reused.	<i>All Projects</i>	1	
b)	for designs that provide occupiers flexibility in the choice of bathroom and kitchen suites.		1	
3.9	Clothes Drying Facilities			
	for providing suitable clothes drying facilities for the majority of residential units which utilise the natural environment.	<i>All Projects</i>	1	
3.10	Energy Efficient Building Services and Equipment			
a)	for complying with the requirements of the Code of Practice for Energy Efficiency of Lift & Escalator Installations.	<i>All Projects</i>	1	
b)	for complying with the requirements of the Code of Practice for Energy Efficiency of Electrical Installations.		1	
3.11	Public Area Lighting			
a)	for specifying and confirming installation of energy efficient lighting, in areas under the control of the building management.	<i>All Projects</i>	1	
b)	for specifying and confirming installation of time switching or photoelectric switching lighting control for the lamps in areas where daylight is available.		1	
3.12	Exterior Lighting			
a)	for specifying and confirming installation of energy efficient lighting, in areas under the control of the estate management (playgrounds, footpaths, services areas, walkways, etc).	<i>All Projects</i>	1	
b)	for specifying and confirming installation, in areas under the control of the estate management, of time switching or photoelectric switching lighting control for the lamps in areas where daylight is available.		1	

4.1	Construction Materials			
	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.	<i>All Projects</i>	3	
	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.		2	
	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.		1	
4.2	Use of Recycled Materials			
a)	for use of recycled materials in site surfacing works, structures and features.	<i>All Projects</i>	1	
b)	for using 5% of recycled materials, other than PFA, in the construction of the building.		1	
c)	for full use of PFA in concrete in accordance with WBTC 14/90.		1	
4.3	Ozone Depleting Substances			
	for specifying thermal insulation in building fabric and services made only from materials with zero ozone depletion potential.	<i>All Projects</i>	1	
4.4	Use of Permanent Timber			
a)	for specifying solid timber which is entirely from well managed sustainable sources which may include re-used timber.	<i>All Projects</i>	1	
b)	for specifying timber panel products which are entirely from well managed sustainable sources which includes suitable re-used timber.		1	
5.7	Timber for Temporary Works			
a)	for using durable and reusable formwork systems to replace timber formwork, and for ensuring that timber formwork, where used, is properly maintained.	<i>All Projects</i>	1	
b)	for using durable and reusable hoarding to replace timber hoarding.		1	
c)	for using standardised prefabricated building elements to reduce the use of formwork.		1	
6.1	Commissioning			
a)	for allowing as a cost item in the contract documents, a specific cost for commissioning of all electrical and mechanical systems and equipment to be maintained by the building owner/operator.	<i>All Projects</i>	1	
b)	for allowing as a cost item in the contract documents, a specific cost for the preparation of fully documented operations and maintenance manual.		1	
6.3	Facilities			
a)	for specifying and installing metering which allows separate monitoring of electricity use (input power, energy and maximum demand) by the owner/operator of the building(s).	<i>All Projects</i>	1	
b)	for providing proper maintenance and storage facilities, as specified or equivalent.		1	

Local Issues

Sect:	Credit Requirement:	Credit Applicability	Credits Available	Credits Obtained
2.1	Contaminated Land			
	for undertaking a survey of a site which has previously been put to industrial use, with appropriate requirements specified in design and construction to avoid residual contamination of the land enclosed by and immediately adjacent to the site boundary.	<i>Previous industrial land usage.</i>	1	
2.2	Ecological Impact Assessment			
	for undertaking a survey of the ecological impacts arising from the development, with appropriate requirements specified in design and construction to ensure the change in ecological value is neutral (for a green-field site) or positive (for a brown-field site).	<i>Where an EIA is not mandatory.</i>	1	
2.3	Air Quality Assessment			
a)	for characterisation, assessment and evaluation of the local air quality impacts arising from the development, with appropriate requirements specified in design and construction to ensure their mitigation.	<i>Where an EIA is not mandatory.</i>	1	
b)	for evaluating the ambient air quality at the building location, with appropriate measures specified in design to ensure their mitigation.	<i>Where an EIA is not mandatory.</i>	1	
2.4	Noise Impact Assessment			
a)	for characterisation, assessment and evaluation of the local noise impacts arising from the development, with appropriate requirements specified in design and construction to ensure their mitigation.	<i>Where an EIA is not mandatory.</i>	1	
b)	for evaluating the noise impacts at the building façade, with appropriate measures specified in design to ensure their mitigation.	<i>Where recommended levels are exceeded.</i>	1	
	where all residential units in comply with the Hong Kong Planning and Standards Guidelines noise standard.	<i>An additional credit.</i>	1	
2.5	Water Pollution and Drainage			
a)	for characterisation, assessment and evaluation of physical, chemical and biological disruptions of fresh and ground water systems arising from the development, with appropriate requirements specified in design and construction to ensure their mitigation.	<i>Where EIA not mandatory.</i>	1	
b)	for undertaking a drainage impact assessment (DIA), with appropriate design measures to reduce flood risk and adverse drainage impacts on local storm drain systems.	<i>Where DIA not mandatory.</i>	1	
2.6	Microclimate Around Buildings			
a)	for undertaking studies that demonstrate that no pedestrian areas are subject to excessive wind velocities caused by amplification of the site layout or building design.	<i>All Projects</i>	1	
b)	for demonstrating that under normal wind conditions there are no stagnant areas which are not able to be 'flushed out' by wind flow.	<i>All Projects</i>	1	

3.13	Landscaping		
a)	for following Government policy and guidelines in respect of trees on site, or for providing a tree for every 100 square meters of impermeable surface on the building lot, including uncovered parking areas, podium, walkways and plazas, etc.	<i>All Projects</i>	1
b)	for designs which incorporate existing plants and ecological features into the new landscaping, and specify to replant or replace vegetation soon after construction.		1
c)	for 100 percent of exterior plantings that use plants tolerant of climate, soils, and natural water availability and do not receive watering from municipal potable water after a period of establishment is complete.		1
d)	for using pervious paving materials for a minimum of 50% of non-landscaped areas, exclusive of the building footprint (roadways, surface parking, plazas, pathways) on the site.		1
3.14	Planters on Building		
	for designs which provide appropriate planting on a building equivalent to at least 30% of the area of the building footprint.	<i>All Projects</i>	1
3.15	Water Conservation		
a)	for providing for the collection of rainwater for use in cleaning and irrigation or otherwise, which will reduce consumption of potable water supplies.	<i>All Projects</i>	1
	additional credit for the installation of an on-site grey water treatment system, to treat grey water for reuse in toilet flushing where sea water is not available.	<i>Where seawater is not available for flushing.</i>	1
b)	for specifying and installing any two of the prescribed, or equivalent low flow devices.	<i>All Projects</i>	1
3.16	Recycling Facilities		
	for providing communal facilities within the building for the sorting of waste and the recovery of recyclable materials.	<i>All Projects</i>	1
	for providing a mechanical system allowing for the transportation of household waste to the ground floor of the buildings, other than by labour		1
5.1	Environmental Management Plan		
	for contract documents which require the development and implementation of a Environmental Management Plan by the main contractor, including provisions for Environmental Monitoring and Auditing and reporting to the client representative.	<i>All Projects</i>	1
5.2	Air Pollution During Construction		
a)	for applying adequate mitigation measures for dust and air emissions during the construction as the recommended by CIRIA and Air Pollution (Construction Dust) Regulation.	<i>All Projects</i>	1
b)	for demonstrating compliance with the air quality management guidelines as detailed in the Environmental Monitoring and Audit Manual.		1
5.3	Noise During Construction		
a)	for applying the criteria and requirements laid down in the Environmental Protection Department Practice Note ProPECC PN 2/93.	<i>All Projects</i>	1

b)	for demonstrating compliance with the noise management guidelines as detailed in the Environmental Monitoring and Audit Manual.		1	
5.4	Water Pollution During Construction			
a)	for undertaking measures to reduce water pollution during construction, through adequately designed sediment retention and removal facilities, treatment of wastewater from concrete construction activities such as concreting, batching, etc., as outlined in ProPECC PN 1/94.	<i>All Projects</i>	1	
b)	for demonstrating compliance with the water management guidelines as detailed in the Environmental Monitoring and Audit Manual.		1	
5.5	Demolition Waste Management			
	for contract documents which require the sorting of demolition wastes on site for separate disposal as inert and non-inert materials, and the identification of licensed hauliers of recyclable materials.	<i>All Projects</i>	1	
5.6	Construction Waste Management			
	for contract documents which require the sorting of construction wastes on site for separate disposal as inert and non-inert materials, and the identification of licensed hauliers of recyclable materials.	<i>All Projects</i>	1	

Indoor Issues

3.1	Solar Heat Gains			
	for undertaking a thermal analysis of block design, assessing peak temperatures in selected dwellings, and indicating measures taken to address issues arising from the outcome of the assessment.	<i>All Projects</i>	1	
	for demonstrating uniformity of peak temperatures throughout the block, e.g. that the difference between the peak temperatures of the coolest and warmest dwelling is less than 2°C.		1	
3.3	Daylighting Design			
	for demonstrating that at least 80% of living rooms meets the room depth criterion.	<i>All Projects</i>	1	
	for demonstrating that at least 80% of living rooms, dining rooms and study rooms achieve an average daylight factor of 1.5%, and at least 80% of bedrooms achieve an average daylight factor of 1%.		1	
	for demonstrating that, for living rooms the sky can be seen from centre point the room; or daylight availability is greater than 50% on 80% of windows.		1	
3.4	Natural Ventilation			
	for undertaking an analysis of block and estate design, assessing wind pressures on ventilation openings for public/circulation areas, and indicating measures taken to address issues arising from that assessment.	<i>All Projects</i>	1	
	for demonstrating that each common area has ventilation openings capable, under average wind conditions, of providing sufficient ventilation.		1	
3.5	Radon Mitigation Measures			
a)	for designs which provide for the selection of construction materials (including the source of aggregates), surface finishes and treatments which reduce radon emissions.	<i>All Projects</i>	1	
b)	for designs which provide for natural ventilation of occupied areas by means of ventilators which do not require occupant attention, other than opening and closing.		1	
3.7	Indoor Noise			
a)	for demonstrating external noise levels transmitted through the building envelope are within prescribed limits.	<i>All Projects</i>	1	
b)	for demonstrating the indoor reverberation and vibration are within prescribed limits.		1	
3.8	Air Conditioning Units			
	for complying with the recommended installation positions for air-conditioners as detailed in Appendix B.	<i>All Projects</i>	1	
	for complying with not less than four items in the assessment check-list.		1	
	for complying with all items in the assessment check-list.		2	
4.5	Hazardous Materials			
	for minimising formaldehyde emissions.	<i>All Projects</i>	1	
	for ensuring that no paints are used which contain lead.		1	

	for ensuring that timber treated with wood preservative is not used, or if required the preservative is industrially pre-treated ready for finishing on site.		1	
6.2	Uncontrolled Ventilation			
	for undertaking tests on a representative sample of flats, to demonstrate that the air tightness is less than 2.0 ac.h ⁻¹ at 50 Pa.	<i>All Projects</i>	1	
6.4	Tenant/Owner s handbook			
	for a well compiled guide on environmental issues included in a tenant/owner's handbook.	<i>All Projects</i>	1	
Additional Credits				
3.17	Innovative and unconventional designs	<i>Excluded from credit total</i>	5 max	

2 Site Planning and Layout

In Hong Kong an Environmental Impact Assessment (EIA) is required for major developments. The EIA Ordinance⁽¹⁰⁾ provides the framework for assessing environmental impacts of designated projects defined under the Ordinance and for making the implementation of prevention and mitigation measures enforceable through the environmental permit system. An EIA is mandated for residential developments of not less than 2000 flats and not served by public sewerage networks by the time a flat is occupied. An EIA is required for residential developments within Deep Bay Buffer Zone 1 or 2 (other than New Territories exempted houses). Developments that fall outside the requirements of the EIA Ordinance may still have potential for causing a certain degree of adverse environmental impacts. The community expects proponents of projects to be environmentally conscious in the planning, design, construction and operation of building projects.

New buildings will modify an existing natural system or that adjacent to the site being developed. New construction should be extended to the surroundings, with the purposes of:

- mitigating the adverse environmental impacts of the building on the immediate surroundings;
- transforming the surrounding landscape to enhance the microclimatic conditions around the building, or vice versa; and
- maximising the use of site resources (impact of solar energy, access to daylight, use of rainfall, natural ventilation, prevailing winds, etc).

The environmental impact studies included here are intended to ensure that all environmental issues will be properly and satisfactorily dealt with, in order to achieve the best possible environment for residents and minimise the impact on the environment. The procedures are such that environmental requirements and necessary mitigating measures will be incorporated into the feasibility studies at the conceptual and feasibility stages of the work. The objectives are to:

- identify those elements of the community and environment likely to be affected by the proposed development, including both the natural and man-made environment;
- identify and quantify any potential losses or damage to flora, fauna and natural habitats, and opportunities to reinstate such resources;
- identify any potential landscape and visual impacts and to propose measures to mitigate impacts or improve the environment;
- identify and quantify emission sources during construction and operation of the building and determine the significance of impacts on sensitive receivers;
- propose the provision of mitigation measures so as to minimise pollution, environmental disturbance and nuisance during construction and operation of the building(s); and
- design and specify the environmental monitoring and audit requirements necessary to ensure the implementation and the effectiveness of the environmental protection and pollution control measures adopted.

Besides improving the quality of life for residents, the quality of the local amenities and communal facilities can reduce residents' travel requirements in fulfilling basic needs and daily necessities. The design of the surroundings can reduce environmental impacts and have a positive impact on the immediate outdoor environment.

2.1 CONTAMINATED LAND

Applies only to land previously used for industrial purposes, and which is not subject to Government imposed conditions for land use.

¹⁰ A Guide to Environment Impact Assessment Ordinance. Environmental Protection Department, Hong Kong Government. http://www.info.gov.hk/epd/eia/index_content.htm

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.

Objective of HK-BEAM

To encourage detailed environmental assessment of brown-field sites not already subject to mandatory requirements for land-use.

Maximum number of credits attainable: 1

Credit requirement

- ❖ 1 credit for undertaking a survey of a site which has previously been put to industrial use, with appropriate requirements specified in design and construction to avoid residual contamination of the land enclosed by and immediately adjacent to the site boundary.

Method of assessment

The Client shall provide evidence in the form of a report by an appropriately qualified professional person that the site is free from hazardous contamination, or that the extent of any contamination has been determined. The report shall confirm that proper remedial measures to restore the land to an acceptable condition for residential use have been completed. Due consideration to any disposal of contaminated waste shall be included. The report shall adhere to the guidelines given in ProPeCC PN 3/94⁽¹¹⁾.

2.2 ECOLOGICAL IMPACT ASSESSMENT

This applies where an Environmental Impact Assessment is not mandatory. Applies to brown-field site if improvements to the site ecology are intended.

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 to be 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 a site in a manner that protects salient ecological attributes. Redevelopment of a site can provide an opportunity to improve the ecology of the area involved.

The Technical Memorandum to the Environmental Impact Process⁽¹²⁾ 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.

Objective of HK-BEAM

To encourage the conduct of an environmental analysis prior to site planning and minimise damage to the local ecology or areas of natural beauty.

¹¹ Environmental Protection Department. Practice Note for Professional Persons. ProPECC PN 3/94. Contaminated Land Assessment and Remediation. December 1994.

¹² Environmental Protection Department. Technical Memorandum on Environmental Impact Assessment Process. <http://www.info.gov.hk/epd/eia/legis/index3.htm>

Maximum number of credits attainable: 1

Credit requirement

- ❖ 1 credit for undertaking a survey of the ecological impacts arising from the development, with appropriate requirements specified in design and construction to ensure the change in ecological value is neutral (for a green-field site) or positive (for a brown-field site).

Method of assessment

The Client shall provide evidence in the form of a report by an appropriately qualified professional person as to the impact on the flora, fauna and other components of the ecological habitats within the project area. The report shall identify means to protect, maintain or rehabilitate the natural environment. In particular, the proposed project shall avoid impacts on recognised sites of conservation importance and other ecological sensitive areas. The assessment shall identify and quantify as far as possible the potential ecological impacts associated with the proposed development.

Both on-site and off-site impacts shall be identified and evaluated. Off-site mitigation measures shall only be considered when the potential for providing on-site mitigation has been exhausted⁽¹³⁾.

For brown-field sites, the report shall identify, qualify and quantify means to improve the ecology of the site.

2.3 AIR QUALITY ASSESSMENT

Applies where an Environmental Impact Assessment is not mandatory.

The potential air quality impacts to a residential development may come from vehicular emissions due to the adjacent road network, chimney and industrial emissions due to the close proximity of factories, burning of liquid or gaseous fuels, etc. Measures are required to reduce the extent of such impacts. In addition, the impact of the development on the local environment during construction and operation need to be considered. Protection measures for developments adjacent to landfills are outlined in Chapter 9 of the Hong Kong Planning Standards and Guidelines. Practice Note PN 3/96⁽¹⁴⁾ provides guidance on the safety hazards. The purpose of the air quality assessment is to determine:

- the impact of the development on the immediate environment during construction and use;
- the overall air quality within and adjacent to the development for the purpose of determining any mitigation measures to be incorporated in the designs to reduce the impact of air pollution on residents.

Objectives of HK-BEAM

To establish the impact on local ambient air quality caused by the building during construction and operation, to determine if mitigation measures are required. To assess the ambient air quality at the site with the purpose of designing appropriate mitigation measures.

Maximum number of credits: 2

Credit requirement

¹³ 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.

¹⁴ Environmental Protection Department. Practice Note for Professional Persons. ProPECC PN 3/96. Landfill Gas Hazard Assessment for Developments Adjacent to Landfills. December 1996.

a) Impact on the local environment

- ❖ 1 credit for characterisation, assessment and evaluation of the local air quality impacts arising from the development, with appropriate requirements specified in design and construction to ensure their mitigation.

b) Air quality adjacent to the building

- ❖ 1 credit for evaluating the ambient air quality at the building location, with appropriate measures specified in design to ensure their mitigation.

Method of assessment

- a) The Client shall provide evidence of the investigation in the form of a report prepared by a suitably qualified professional person. The report shall confirm that the investigation followed the criteria and guidelines stated in Annexes 4 and 12 of the Technical Memorandum on Environmental Impact Assessment Process⁽¹⁵⁾. Where the air quality does not meet the criteria given in Annexe 4, the report shall detail the mitigation measures to be adopted, if any.
- b) The Client shall provide evidence of the investigation in the form of a report prepared by a suitably qualified professional person. The report shall confirm that the ambient air quality at the building location meets the Hong Kong Air Quality Objectives⁽¹⁶⁾. Where the air quality does not meet the criteria laid down in the Air Quality Objectives, the report shall indicate the mitigation measures to be adopted, if any.

2.4 NOISE IMPACT ASSESSMENT

Applies where an Environmental Impact Assessment is not mandatory and, for an additional credit, where a building development is subject to noise levels above the recommended levels given in the Hong Kong Planning and Standards Guidelines.

Noise pollution is a major issue of concern in Hong Kong. Many residential buildings are built close to roads and railway lines such that ground transportation noise affects many people in Hong Kong. Noise from fixed sources and aircraft may also pose a problem. Special mitigation measures should be taken during the design stage of a building to reduce the intensity of sound transmitted into residential units. Noise mitigation measures such as screening by non-noise sensitive blocks, 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. Where residential units are likely to be exposed to road or rail traffic noise exceeding the HKPSG standards even after adoption of noise mitigation measures, provision of acoustic insulation should certainly be considered in the building design.

Objectives of HK-BEAM

To reduce noise pollution caused by the development during construction and operation at nearby sensitive receivers, and noise impacting at building façades to determine appropriate mitigation measures.

Maximum number of credits: 3**Credit requirement**

a) Impact on the immediate environment

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

¹⁶ Hong Kong Air Quality Objectives. Refer Annex 4 of the Technical Memorandum, or Chapter 9 of the Hong Kong Planning Standards and Guidelines.

❖ 1 credit for characterisation, assessment and evaluation of the local noise impacts arising from the development, with appropriate requirements specified in design and construction to ensure their mitigation.

b) Noise impacts on the building

❖ 1 credit for evaluating the noise impacts at the building façade, with appropriate measures specified in design to ensure their mitigation.

❖ 1 additional credit where all residential units in comply with the Hong Kong Planning and Standards Guidelines noise standard.

Method of assessment

a) The Client shall provide evidence of the investigation in the form of a report prepared by a suitably qualified professional person. The report shall confirm that the investigation followed the criteria and guidelines stated in the appropriate sections of Annexes 5 and 13 of the Technical Memorandum on Environmental Impact Assessment Process. This includes construction noise and noise from vehicles on haul roads, as well as fixed noise sources on or in the building. For construction noise criteria reference shall be made to the technical memoranda^(17,18,19) issued under the Noise Control Ordinance and subsidiary regulations⁽²⁰⁾, and to BS 5228⁽²¹⁾. For fixed noise sources reference is made to the applicable technical memorandum⁽²²⁾. Where the noise levels do not meet the criteria laid down in Annexe 5, the report shall indicate the mitigation measures to be adopted.

b) The Client shall provide evidence of the investigation in the form of a report prepared by a suitably qualified professional person. The report shall confirm that the investigation followed the criteria and guidelines stated in the appropriate sections of Annexes 5 and 13 of the Technical Memorandum on Environmental Impact Assessment Process. Reference is made to the UK Department of Transport publications⁽²³⁾. The report shall confirm that the noise levels at the building facade meets the criteria given in Annex 5. Where the noise criteria is not met the report shall indicate the mitigation measures to be adopted, if any. The suggested noise mitigation method shall be tested by calculations.

Where undertaken for the additional credit, the noise impact assessment should inform any need to mitigate noise impacts, particularly from ground transport. The Designer shall submit details of any noise mitigation measures within or adjacent to the site of the type outlined in ProPECC PN 4/93⁽²⁴⁾ or other similar effective means. Credit shall be awarded where such measures are deemed appropriate and have been executed to mitigate noise at the façade of the residential building(s). Where all residential units fall within the noise standard given in the Hong Kong Planning and Standards Guidelines, the second credit shall be awarded.

¹⁷ Environmental Protection Department. Technical Memorandum on Noise from Construction Work other than Percussive Piling. <http://www.info.gov.hk/epd/E/epdinhk/noise/book5/book50.htm>

¹⁸ Environmental Protection Department. Technical Memorandum on Noise from Construction Work in Designated Areas. <http://www.info.gov.hk/epd/E/epdinhk/noise/book4/book40.htm>

¹⁹ Environmental Protection Department. Technical Memorandum on Noise from Percussive Piling. <http://www.info.gov.hk/epd/E/epdinhk/noise/book6/book60.htm>

²⁰ Noise Control Ordinance [Cap 400], Noise Control (General) Amendment Regulations, Noise Control (Construction) Regulations (1996).

²¹ British Standard BS 5288 Part 1 Noise control on construction and open sites.

²² Environmental Protection Department. Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites. <http://www.info.gov.hk/epd/E/epdinhk/noise/book3/book30.htm>

²³ UK Department of Transport. Calculation of Road Traffic Noise

²⁴ Environmental Protection Department. Practice Note for Professional Persons ProPECC PN 4/93. Planning and Designing Noise Sensitive Developments. September 1993.

Noise levels 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. Guidance on separation distances between road traffic and rail traffic and residential buildings is given in the Hong Kong Planning Standards and Guidelines.

2.5 WATER POLLUTION AND DRAINAGE

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. Both large and small-scale development projects arising from change of land use or changes to lease conditions have the potential to increase flood risks. Examples include filling the ground to a higher level, increasing paved areas, altering natural drainage paths and flood plains, etc. To safeguard the community from being affected by any increased flood risk that might arise, it is desirable to carry out the drainage impact assessment of a development. A Drainage Impact Assessment⁽²⁵⁾ is not normally required for developments without change in lease conditions or land use, or for those that do not have the potential to have an adverse drainage impact. An Advice Note⁽²⁶⁾ is available to assist in carrying out the procedures.

Drainage plans of development projects submitted to the Buildings Department are referred to the Environmental Protection Department for comment whenever there is a concern for pollution control. The approach for vetting of drainage plans referred to the Environmental Protection Department for comments are outlined in ProPECC PN 3/97⁽²⁷⁾. For drainage plans not requiring vetting by the Environmental Protection Department, it is a duty and responsibility on the owner and Authorised Person to provide proper facilities to treat all effluents and wastes generated, and to dispose of them in full compliance with all relevant legislative requirements.

Under the Building (Standards and Sanitary Fitments, Plumbing, Drainage works and Latrines) Regulations, foul water should be discharged to a foul sewer and surface water should be discharged via rainwater pipes to storm water drains. Discharge to foul sewers should always be kept to a minimum in order not to overload the foul sewerage system while preventing pollution to storm water systems. ProPECC PN 5/93⁽²⁸⁾ provides guidelines in preparing drainage plans.

Objectives of HK-BEAM

To reduce impacts on fresh water and ground water systems during construction and building use. To assess the impact of the of the site's storm water drainage changes on the existing catchment and public drainage and to reduce flood risk.

Maximum number of credits: 2

Credit requirement

- a) Assessment of water pollution

²⁵ Drainage Services Department. Information Paper, Drainage Impact Assessment (DIA) Requirements for Development Projects. Paper No. 2/98. 1998.

²⁶ Drainage Services Department. Advice Note No 1. Application of the Drainage Impact Assessment Process to Private Sector Projects. 1995.

²⁷ Environmental Protection Department. Practice Note for Professional Persons. ProPECC PN 3/97. A revised Streamlined Approach for Vetting of Drainage Plans Referred to EPD for Comments. December 1997.

²⁸ Environmental Protection Department. Practice Note for Professional Persons. ProPECC PN 5/93. Drainage Plans Subject to Comment by the Environmental Protection Department. September 1993.

❖ 1 credit for characterisation, assessment and evaluation of physical, chemical and biological disruptions of fresh and ground water systems arising from the development, with appropriate requirements specified in design and construction to ensure their mitigation.

b) Drainage impact assessment (Applies only when a Drainage Impact Assessment is not mandatory).

❖ 1 credit for undertaking a drainage impact assessment (DIA), with appropriate design measures to reduce flood risk and adverse drainage impacts on local storm drain systems.

Method of assessment

a) The Client shall provide evidence of the investigation in the form of a report prepared by a suitably qualified professional person. The report shall confirm that the investigation followed the criteria and guidelines stated in Annexes 6 and 14 of the Technical Memorandum on Environmental Impact Assessment Process⁽²⁹⁾. Where water pollution problems are identified which fall outside legislative requirements, the report shall detail the mitigation measures to be adopted, if any.

b) The Client shall undertake an assessment as outlined in Drainage Services Department Information Paper No. 2/98 and Advice Note No 1. The Client shall present the report and evidence in the form of specifications and contract documents detailing the mitigation measures for potential adverse impacts and flood risks.

2.6 MICROCLIMATE AROUND BUILDINGS

The microclimate between 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 indicates that mechanical discomfort sets in at wind speeds of about 5 ms⁻¹, with speeds above 8 ms⁻¹ being very uncomfortable and speeds above 20 ms⁻¹ being dangerous. Conversely, some areas may receive relatively low wind flow with free airflow being obstructed by buildings. 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

Objective of HK-BEAM

²⁹ Environmental Protection Department. Technical Memorandum on Environmental Impact Assessment Process. <http://www.info.gov.hk/epd/eia/legis/>

To ensure the microclimate around and adjacent to buildings has been adequately considered, and where appropriate, suitable mitigation measures are included in designs. To minimise the occurrence of pedestrian discomfort due to high wind speeds.

Maximum number of credits attainable: 2

Credit requirement:

- ❖ 1 credit for undertaking studies that demonstrate that no pedestrian areas are subject to excessive wind velocities caused by amplification of the site layout or building design.
- ❖ 1 credit for demonstrating that under normal wind conditions there are no stagnant areas which are not able to be 'flushed out' by wind flow.

Method of assessment

Relative wind speeds around buildings can 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 should have local wind speeds accelerated by factors greater than 2.

2.7 TRANSPORT AND PEDESTRIAN ACCESS

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, aggravated by the street canyon effect of high-rise buildings. Part of the solution to the air pollution problem is to reduce the use of private vehicles and taxis. Provision of pedestrian links which allow easy access to major public transport systems may discourage use of private transport, thereby reducing air and noise pollution and improving safety.

Objective of HK-BEAM

To encourage use of mass transit systems by residents, with the aim to reduce pollution, fuel use and noise from private cars and public taxis.

Maximum number of credits attainable: 3

Credit requirement

a) Car parking

- ❖ 1 credit where no car parking is provided, except for disabled persons only, or restricted provision of car parking spaces to the minimum required for compliance with land use conditions.

b) Public transport links

- ❖ 1 credit for providing easy and substantially sheltered pedestrian access to a mainstream mass transport system.

b) Cycling facilities

- ❖ for providing cycle parking, cycling paths which link to local cycling pathways.

Method of assessment

- a) The lease conditions and car parking provisions agreed and approved by the Transport Department or other government authority shall be checked. Credit shall be given where the developer demonstrates minimum provision of car parking to meet lease conditions, Approved Planning Brief or those of the Government's Master Development Plans. To obtain credit any car park(s) shall comply with the following conditions:
- be provided with access that ensures simultaneous free flow of vehicles in and out of the car park;
 - provisions to avoid ground and contamination from oil run-off, and
 - for car parks, whether enclosed or semi-enclosed, satisfy the air quality requirements given in ProPECC PN 2/96³⁰
- b) The design plans will be checked to ensure that residents have easy sheltered pedestrian access to and from a major transport interchange, such as a station, or mainstream mass transport. Credit will be awarded for provision of footbridge, covered walkway, or other substantial means of access. Alternatively, for sites not directly served by mainstream public transport, written confirmation by the Client that a private bus service will be provided for residents which links to a main stream mass transport interchange. The provision of a shuttle bus service of adequate capacity and frequency shall be deemed to satisfy the criteria. The Client shall submit to the Assessor details of the proposed service.
- c) It is expected that cycling facilities will be provided where a development is sited within an area served by an extensive system of cycling pathways.

³⁰ Environmental Protection Department. Practice Note for Professional Persons. ProPECC PN 2/96. Control of Air Pollution in Car Parks. June 1996.

3 Building and Premises Design

The Building (Planning) Regulations (Subsidiary Legislation of the Building Ordinance Cap 123) prescribes the requirements for the provision of open space and windows for providing natural light and ventilation. This has constrained the design of residential buildings and site layout. In general, residential buildings in Hong Kong have more indentations than similar buildings elsewhere, mainly to comply with regulations requiring windows for kitchens and bathrooms. This has often resulted in a high ratio of external wall to useable floor area. The resulting building plan form leads to increased use of materials, formwork, etc., and increased construction time and cost.

The prescriptive requirements of the Building (Planning) Regulations were mainly developed in the 1950's when Hong Kong building developments were predominantly low-rise and relying principally on natural lighting and natural ventilation for comfort and health. Government has recognised that strict adherence to the requirements may not be the only means of producing the desired result of sufficient light and effective ventilation. Against this background in mid-1999 the Buildings Department commissioned a one-year study for a comprehensive review of the standards of lighting and ventilation for all types of buildings and for all uses. The development of HK-BEAM 3-99 is influenced by the current circumstances and any future modifications to the statutory regulations.

3.1 SOLAR HEAT GAINS

Applies to the design and performance of residential units.

The OTTV analysis provides a whole building (or average) measure of performance. It is possible to have, within a high-rise block, some dwellings that are poorer and some better than average in terms of solar heat gains and internal temperature peaks, depending on, for example, orientation or height. This aspect seeks to examine the detailed thermal performance of individual dwellings, providing information on the variability of performance throughout a building. With such information, some variations in fabric design and solar control strategies may be considered, as appropriate.

Objective of HK-BEAM

To examine overheating due to solar gains in individual apartments, with a view to informing appropriate mitigation measures.

Maximum number of credits attainable: 2

Credits requirements

- ❖ 1 credit for undertaking a thermal analysis of block design, assessing peak temperatures in selected dwellings, and indicating measures taken to address issues arising from the outcome of the assessment.
- ❖ 1 credit for demonstrating uniformity of peak temperatures throughout the block, e.g. that the difference between the peak temperatures of the coolest and warmest dwelling is less than 2°C.

Method of assessment

The Designer will be required to undertake the analysis and demonstrate compliance. The thermal analysis shall be undertaken through dynamic thermal modelling, using appropriate modelling software. The thermal performance (daily peak temperature) within the living space of each dwelling on a floor shall be determined. This shall be done for representative floors of the block and residential units, e.g. at 10 floor intervals, from the 5th floor including the uppermost floor. 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 of an unoccupied building.

3.2 OVERALL THERMAL TRANSFER VALUE

Window and split type air conditioners have become common appliances in Hong Kong, contributing to a significant rise in electricity consumption in the domestic sector. The cooling load in residential buildings is dominated by heat gains from the building envelope. Therefore, designing for an energy efficient building envelope will be effective in reducing cooling load and energy use for air-conditioning in residential buildings, particularly more so than in commercial buildings. The overall thermal transfer value (OTTV) is a measure of heat gain from the building envelope and is used to assess energy efficiency of building envelope designs.

The OTTV calculation method is described in detail in Appendix A. The method is similar to that described in the Code of Practice for commercial buildings⁽³¹⁾. However, a significant difference in the pattern of use of air-conditioning equipment exists between residential and commercial buildings. In residential buildings, it is assumed that most air-conditioners are switched off during daytime but will be run in the evening in weekdays. Air-conditioners serving bedrooms are assumed to run overnight. Therefore, two different sets of coefficients and parameters have been established for use in the OTTV calculations for bedrooms and for other air-conditioned rooms, such as living and dining rooms, in residential buildings. The credits to be awarded in the assessment will be the lower of the two credits based on the OTTV values of the two types of rooms.

Objective of HK-BEAM

To reduce release of global warming gases into the atmosphere by reducing electricity consumption for air-conditioning residential units.

Maximum number of credits attainable: 4

Credit requirement

a) Bedrooms:

- ❖ 1 credit for an OTTV of less than 12 W/m²
- ❖ 2 credits for an OTTV of less than 10 W/m²
- ❖ 3 credits for an OTTV of less than 8 W/m²
- ❖ 4 credits for an OTTV of less than 6 W/m²

b) Other air-conditioned rooms:

- ❖ 1 credit for an OTTV of less than 32 W/m²
- ❖ 2 credits for an OTTV of less than 27 W/m²
- ❖ 3 credits for an OTTV of less than 22 W/m²
- ❖ 4 credits for an OTTV of less than 17 W/m²

Method of assessment

Credit shall be awarded based on the lowest score obtained in a) and b).

Compliance with the OTTV shall be demonstrated on the basis of calculations following the procedures laid down in Appendix A. The Designer will estimate the OTTV based on the design data applicable to the chosen design. Where data is not available for computations, the Designer will make appropriate assumptions. The Designer shall provide the Assessor with the input data

³¹ Building Authority Hong Kong. Code of Practice for Overall Thermal Transfer Value in Buildings. April 1995.

used for the computations, and the results of the computations. These shall be provided as a computer spreadsheet file and printed copies.

3.3 DAYLIGHTING DESIGN

This refers to daylight provisions to living spaces in residential units.

Access to daylight is an important aspect of residential building design from the perspectives of energy efficiency, 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 significant 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 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.

Objective of HK-BEAM

To encourage a holistic examination of site layout, building design, and fenestration design, such as to maximise access to daylight in order to reduce the use of electric lighting and to promote natural indoor environments for health and comfort.

Maximum number of credits attainable: 3

Credit requirement

- ❖ 1 credit for demonstrating that at least 80% of living rooms meets the room depth criterion.
- ❖ 1 credit for demonstrating that at least 80% of living rooms, dining rooms and study rooms achieve an average daylight factor of 1.5%, and at least 80% of bedrooms achieve an average daylight factor of 1%.
- ❖ 1 credit for demonstrating that, for living rooms:
 - ◇ the sky can be seen from centre point the room; or
 - ◇ daylight availability is greater than 50% on 80% of windows.

Method of assessment

The room depth criteria is given by: $d/w + d/h < 2/(1-R_B)$ where d = room depth, w = width, h = window head height, R_B = average reflectance of surfaces in the back half of the room.

The average daylight factor shall be calculated according to the method given in CIBSE window design manual⁽³²⁾, BS 8206⁽³³⁾, BRE Information Paper IP15/88⁽³⁴⁾, or equivalent. For a building with the same floor layout for all stories, the calculation of average daylight factor can start from the lowest floor upwards. If the above daylight factor criteria are met for a certain floor, then it can be assumed the criteria is met for all floors above. Alternatively, daylighting design software can be used to calculate the average daylight factor, provided the Designer can demonstrate the method employed by the software is not inconsistent with the quoted standard methods. The

³² The Chartered Institution of Building Services Engineers. Window Design Manual.

³³ British Standard Institution. Code of practice for daylighting. British Standard BS 8206:1992 Part 2. London, BSI, 1992.

³⁴ Building Research Establishment. Information Paper IP15/88.

Designer shall provide evidence that percentage of total floor area for living rooms, dining rooms, study rooms and bedrooms meeting the above criteria is achieved.

The daylight analysis shall be undertaken for overcast sky conditions, taking any glazing and solar control features into account. For the first phase, the block in isolation may be considered, but for the second phase, site obstructions (e.g. neighbouring buildings) must be taken into account. The assessment method may be any acceptable technique that can take these factors into account (e.g. daylighting software, artificial sky, etc).

Daylight availability can be predicted by a standard CIE overcast sky or computer simulation to determine the % reduction in daylight on the external face of a window. Sight of sky can be examined using an artificial sky or by computer modelling.

3.4 NATURAL VENTILATION

This applies to public areas and circulation routes of a building.

Cross ventilation of public and circulation areas 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

To ensure good ventilation for public areas and circulation routes within a building.

Maximum number of credits attainable: 2

Credits requirement

- ❖ 1 credit for undertaking an analysis of block and estate design, assessing wind pressures on ventilation openings for public/circulation areas, and indicating measures taken to address issues arising from that assessment.
- ❖ 1 credit for demonstrating that each common area has ventilation openings capable, under average wind conditions, of providing sufficient ventilation.

Method of assessment

The Designer will be required to undertake the analysis and demonstrate 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 block (e.g. 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 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 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.

3.5 RADON MITIGATION MEASURES

This refers to radon in living spaces of residential units, particularly bedrooms.

In Hong Kong, the materials used for constructing buildings have high radionuclide content⁽³⁵⁾ and are liable to emit radon gas in significant quantities, at all levels of a high-rise building. In the absence of adequate ventilation, radon in indoor air may accumulate to levels that present increased radiation health hazard. There is potential for reducing radon emissions using building materials with low radium content, using special anti-radon mortars or other radon inhibitors⁽³⁶⁾ or ensuring sufficient ventilation⁽³⁷⁾ to maintain radon levels within the limit of 200 Bqm⁻³ recommended by the World Health Organisation⁽³⁸⁾.

Objective of HK-BEAM

To reduce the likelihood of elevated levels of radon inside the building, but within residential units in particular.

Maximum number of credits attainable: 2

Credit requirement

a) Selection of construction materials

❖ 1 credit for designs which provide for the selection of construction materials (including the source of aggregates), surface finishes and treatments which reduce radon emissions.

b) Background ventilation

❖ 1 credit for designs which provide for natural ventilation of occupied areas by means of ventilators which do not require occupant attention, other than opening and closing.

Method of assessment

- a) A report by the Client's representative shall be provided. This shall identify clauses in contract documents that define the selection of materials and aggregates, floor finishes, ceiling finishes, wall finishes and any treatments. The Assessor will seek evidence that the materials used in the construction have been selected to minimise radon emissions. The type of wall and ceiling finishes and any treatments to reduce radon emissions shall be detailed. Evidence shall be presented which gives an estimate of the extent to which radon emissions will be reduced.
- b) The Client's representative shall provide details of any system of controlled ventilation that can provide a satisfactory air change rate to maintain radon levels below recommended levels, with all windows, doors and other opening to outside closed. Such measures shall not require a non-sustainable energy source, nor depend on leakage through the building envelope (such as window frames).

3.6 FLEXIBLE DESIGN AND FIT-OUT

Change of ownership and changing demography of family units require modifications to the space layout of premises. Quite large amount of solid waste is generated during each remodelling of residential units, from demolition of walls and partitions. The design of premises

³⁵ Man-yin W. Tso, Chor-yi Ng, and John K. C. Leung. Radon Release from Building Materials in Hong Kong. *Health Phys.* 67(4): 378-384; 1994.

³⁶ X.F. Gao, et al. The Principle of Radon Emission and the Development of Anti-Radon Mortar on the Suppression of Indoor Radon. Symposium on Indoor Environmental Quality; Hong Kong, 7 October, 1998.

³⁷ Derek R. Lane-Smith, et al. Elevated Residential Radon Levels at Night. Proceedings of the 7th International Conference on Indoor Air Quality and Climate. July 1996; Nagoya, Japan; Vol. 1: 117-122.

³⁸ World Health Organisation 1987. Indoor Air Quality for Europe. European Series Number 23, ISBN 92-890-1114-9.

with the inclusion of de-mountable and moveable partitions is feasible, available and practicable in Hong Kong. Perhaps because of the sameness which characterises much of Hong Kong's high-rise residences, owners frequently replace bathroom suites and kitchen units, even if new and of good quality. This generates large amounts of waste. Designs that allow occupiers flexibility in the choice of bathroom and kitchen suites could significantly reduce waste.

Objective of HK-BEAM

To reduce the consumption of energy and resources, reduce waste generation and landfill pressure and to encourage use of flexible building technologies in Hong Kong.

Maximum number of credits attainable: 2

Credit requirement:

a) De-mountable partitions

❖ 1 credit for design of de-mountable partitions which allow the partition wall to be reused.

b) Interior fit-out

❖ 1 credit for designs that provide occupiers flexibility in the choice of bathroom and kitchen suites.

Method of assessment

- a) The Client shall present specifications and detailed drawings illustrating the use of de-mountable partitions for the internal walls. The assessor may carry out the site inspections during construction. The materials for the internal wall should be the ones as outlined in the Green Guide⁽³⁹⁾.
- b) The Client shall provide details which demonstrate that, where appropriate, occupants can select from a range of standard fittings. The Assessor will seek to establish that the basic layout of kitchen and bathroom services are such as to permit installation of units and suites which comply with standard dimensions, and that this information is made available to purchasers.

3.7 INDOOR NOISE

This refers to noise and vibration within living spaces of residential units.

The design of the building façade is important in further reducing the propagation of noise into residential units, particularly where external noise levels are close to the limits given in the Hong Kong Planning Standards and Guidelines. Even where external sources of noise and/or noise mitigation measures on site are such as to satisfy the guidelines, further attention to noise attenuation is warranted on the grounds of comfort and privacy. The sound insulation properties of the floor slab and internal walls are crucial in controlling noise propagation inside a building.

Objective of HK-BEAM

To reduce the nuisance caused by noise intrusion into residential units, allowing speech intelligibility and achieving a comfortable noise climate, especially in bedrooms. Avoidance of excessive vibration from building services equipment and sources external to the building, such as traffic.

Maximum number of credits attainable: 2

³⁹ Building Research Establishment. The Green Guide to Specification. An Environmental Profiling System for Building Materials and Components. September 1998.

Credit requirement

a) Indoor noise levels

❖ 1 credit for demonstrating external noise levels transmitted through the building envelope are within prescribed limits.

b) Reverberation and vibration

❖ 1 credit for demonstrating the indoor reverberation and vibration are within prescribed limits.

Method of assessment

a) The prescribed limits are:

- into bedrooms under closed window conditions are at or below 30 dB $L_{Aeq,T=8hrs}$ and $L_{Amax} < 45dB$ during 23.00 h to 07.00 h, and
- into living rooms (other than bathroom, toilet and kitchen) under closed window conditions at or below 55 dB $L_{Aeq,T}$ during 07.00 h to 23.00 h.

The sound transmission loss of a façade is to be estimated according to British Standard BS 8233⁽⁴⁰⁾. Calculations shall be made by the design team in terms of $L_{Aeq,T}$ according to BS 8233, where T = 16 h (daytime) and 8 h (night time), appropriate to the criteria chosen for noise other than railway noise. For railway noise, calculations shall be made in terms of $L_{Aeq,T}$ using the methods described in Calculation of Railway Noise. For noise from industry which are more or less of steady level, $L_{Aeq,T}$ is estimated according to British Standard BS 4142⁽⁴¹⁾. T in the case can be 1 hr or 30 minutes.

b) The prescribed limits are:

- controlling indoor reverberation t_{rev} within the range $0.4s < t_{rev} < 0.6s$ after furnishing, and
- for ensuring no excessive vibration resulting from the building services equipment or outside sources.

The reverberation time may be assessed⁽⁴²⁾ using the method given by Sharland⁽⁴²⁾. Vibration levels (from building services equipment and external sources such as a nearby road) shall not exceed the recommendations in ISO2631-2⁽⁴³⁾.

The Client should provide evidence of compliance in the form of a report prepared by a suitably qualified professional person.

3.8 AIR-CONDITIONING UNITS

This refers to the provisions for installing air-conditioning units in residential units.

As mentioned elsewhere, air-conditioning in the domestic sector contributes significantly to growth in energy demand. Proper location of 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

⁴⁰ British Standards Institution. British Standard Code of Practice for Sound insulation and noise reduction for buildings. BS 8233: 1987. London.

⁴¹ British Standards Institution. Method for rating industrial noise affecting mixed residential and industrial areas. British Standard BS 4142:1990. London, BSI, 1990.

⁴² I.Sharland 1972 Woods practical guide to noise control. Colchester, England

⁴³ ISO2631-2:1989 Evaluation of human exposure to whole-body vibration – Part 2 : Continuous and shock-induced vibration in buildings (1 to 80Hz)

To reduce the consumption of energy for air-conditioning, to improve indoor environmental quality, avoid nuisance to neighbours, and to encourage good maintenance practice.

Maximum number of credits attainable: 3

Credit requirement

- ❖ 1 credit for complying with the recommended installation positions for air-conditioners as detailed in Appendix B, or equivalent alternatives.
- ❖ 1 credit for complying with not less than four items in the assessment check-list given below.
- ❖ 2 credits for complying with all items in the assessment check-list given below.

Method of assessment

The Designer may propose alternative approaches to those detailed in Appendix B, providing justification that the designs will be largely equivalent in outcome.

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

- to reduce penetration of noise units shall be located on walls which do not face major noise sources (road traffic, major pedestrian walkways, playgrounds, etc);
- to reduce intake of polluted air units shall be located in walls such that air is not drawn in from pollution sources such as roads, commercial activities, etc;
- for improved acoustics properties and better circulation, the internal discharge shall be close to the centre of the wall in which it is located;
- for the purpose of reducing noise from rain, and to reduce the potential for water dripping on to lower units, slabs shall be provided to as support and as cover;
- to help reduce the deterioration of units due to corrosion, to reduce bacteria growth in units and to avoid condensate drips, means for drainage shall be provided;
- to encourage proper maintenance, the installation of units shall be such to allow for safe and convenient removal;
- where air-conditioning units are provided by the developer, the units selected shall be labelled as Grade 1 or 2 under the Government's energy efficiency labelling scheme for room coolers⁽⁴⁴⁾.

The Designer 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 residential unit in a block.

Where split units are to be installed, the Designer shall present evidence by way of design details and specifications that the positioning of internal and external components are largely in compliance with Appendix B and the above check-list.

3.9 CLOTHES DRYING FACILITIES

Adequate provisions for clothes drying that can protect clothes from water droplets and debris falling from higher levels, and which are protected from smoke and fumes from water heaters and cooking exhausts. Provisions in many existing residential estates are such that people tend not to use them and resort to gas or electric drying machines, increasing energy consumption.

Objective of HK-BEAM

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

To 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 for the majority of residential units which utilise the natural environment.

Method of assessment

The Designer 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.

3.10 ENERGY EFFICIENT BUILDING SERVICES SYSTEMS AND EQUIPMENT

The energy required for building services systems that provide services (lifts, power supply, etc) in high-rise buildings is significant. There are opportunities to reduce energy use through optimised design of the systems and the sizing and selection of equipment.

Objective of HK-BEAM

To encourage energy efficiency in the design of base building services systems and equipment.

Maximum number of credits attainable: 2

Credit requirement

a) Lifts and escalators

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

b) Electrical distribution systems and equipment

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

Method of assessment

- a) The Client shall provide evidence in the form of a report from a Registered Professional Engineer that the lift and escalator installations comply with the current edition of the Code of Practice⁽⁴⁵⁾.
- b) The Client shall provide evidence in the form of a report from a Registered Professional Engineer that the electrical distribution systems and equipment comply with the current edition of the Code of Practice⁽⁴⁶⁾.

3.11 PUBLIC AREA LIGHTING

⁴⁵ Energy Efficiency Advisory Committee. Code of Practice for Energy Efficiency of Lift & Escalator Installations. Draft, to be issued end 1999

⁴⁶ Electrical and Mechanical Services Department, The Government of the Hong Kong Special Administrative Region. Code of Practice for Energy Efficiency of Electrical Installations. 1998 Edition.

Environmental factors that should be considered when considering the design of public area lighting⁽⁴⁷⁾ (lift lobbies, staircases, etc) include energy use, embodied energy of equipment, light spillage into residential units, etc. Choice of lighting levels, lamps and controls determine energy efficiency. Position and design of luminaires will influence light pollution. Artificial light should be directed where it is needed, and not spread randomly. It should be on only when it is needed.

Objective of HK-BEAM

To provide energy efficient lighting for occupant safety and security in public areas such as lift lobbies, passageways, staircases, etc., by utilising daylight, energy efficient artificial lighting equipment and automatic controls.

Maximum number of credits attainable: 2

Credit requirement

- ❖ 1 credit for specifying and confirming installation of energy efficient lighting, in areas under the control of the building management
- ❖ 1 credit for specifying and confirming installation of time switching or photoelectric switching lighting control for the lamps in areas where daylight is available.

Method of assessment

The following criteria shall be met:

- 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;
- 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⁽⁴⁸⁾. The assessment of the average circuit efficacy shall be based on the method given in Appendix C. The Designer shall submit details of the exterior lighting design using the forms and the calculation method prescribed.

3.12 EXTERIOR LIGHTING

Environmental factors should be considered when considering the design of exterior lighting^(49,50). These include energy use, embodied energy of equipment, light spillage on surrounding properties, skyglow, impact on plants, etc. Choice of lighting levels, lamps and controls determine energy efficiency. Position and design of luminaires will influence light pollution. Artificial light should be directed where needed, and not spread randomly, and should be on only when needed.

Objective of HK-BEAM

⁴⁷ The Building Research and Information Association. Technical Memorandum TM 18/98. Environmentally Friendly Lighting Products. Bracknell UK. 1998.

⁴⁸ Electrical and Mechanical Services Department, The Government of the Hong Kong Special Administrative Region. Code of Practice for Energy Efficiency of Lighting Installations. 1998.

⁴⁹ The Building Research and Information Association. Technical Memorandum TM 18/98. Environmentally Friendly Lighting Products. Bracknell UK. 1998.

⁵⁰ The Chartered Institution of Building Services Engineers. Lighting Division Factfile No. 7. Environmental Considerations for Exterior Lighting. December 1998.

To provide energy efficient lighting for occupant safety and security in public areas by utilising daylight, energy efficient artificial lighting equipment and automatic controls.

Maximum number of credits attainable: 2

Credit requirement

- ❖ 1 credit for specifying and confirming installation of energy efficient lighting, in areas under the control of the estate management (playgrounds, footpaths, services areas, walkways, etc).
- ❖ 1 credit for specifying and confirming installation, in areas under the control of the estate management, of time switching or photoelectric switching lighting control for the lamps in areas where daylight is available.

Method of assessment

The following criteria shall be met:

- 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 spaces should be assessed using the method and the standard forms published in the Code of Practice for Energy Efficiency of Lighting Installations⁽⁵¹⁾. The assessment of the average circuit efficacy shall be based on the method given in Appendix C, or equivalent alternative. All lighting used to illuminate outdoor areas shall be so located, shielded and directed upon the area to be lighted that they do not glare onto, or interfere with, street traffic, adjacent buildings, or adjacent users. Lighting devices for active recreational areas and uses shall be equipped with switching devices which allow lighting levels to be changed when the active recreational use ceases and a lower lighting level is sufficient. The Designer shall submit details of the exterior lighting design using the forms and the calculation method prescribed.

3.13 LANDSCAPING

Landscaping offers a major opportunity for the protection of, or improvements to, the existing site ecology. Landscaping strategies include:

- 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.);
- enhancing the site's microclimate (trees for shade and windbreaks, ponds and fountains, acoustic barriers, podium with gardens, etc.);
- using 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.);
- controlling run-off water (roof ponds, holding tanks, semi-permeable surfaces on open areas, etc., and
- limiting the use of fertilisers and pesticides harmful to the environment.

In Hong Kong a landscape clause is usually included in the lease conditions for large-scale developments and visually sensitive sites. The objective of a landscape clause is to improve the quality of the proposed development and ensure that the development takes account of the

⁵¹ Electrical and Mechanical Services Department, The Government of the Hong Kong Special Administrative Region. Code of Practice for Energy Efficiency of Lighting Installations. 1998.

surrounding landscape⁽⁵²⁾. HK-BEAM encourages a full consideration of landscape issues for sites not covered by lease conditions.

Planting of trees and hedges around buildings can contribute to making the city greener. Healthy plants serve the practical purpose of not only alleviating the summer heat, giving city dwellers much comfort, but also conserving soil erosion, reducing storm surface runoff, purifying air, generating oxygen, etc.

Large expanses of greenery are difficult to secure in densely built city centres. However, the planting of trees and hedges around building and on the rooftop in small scale can contribute to making the city greener. A building rooftop covered with greenery can significantly reduce surface temperatures in summer, compared with bare asphalt or concrete rooftops. Roof greenery may also reduce peak roof runoff and alleviate storm drainage pressure.

Objective of HK-BEAM

To encourage building development that preserves or expands urban greenery.

Maximum number of credits attainable: 4

Credit requirement

a) Trees

❖ 1 credit for following Government policy and guidelines in respect of trees on site, or for providing a tree for every 100 square meters of impermeable surface on the building lot, including uncovered parking areas, podium, walkways and plazas, etc.

b) Exterior planting

❖ 1 credit for designs which incorporate existing plants and ecological features into the new landscaping and specify to replant or replace vegetation soon after construction.

c) Plant tolerance

❖ 1 credit for 100 percent of exterior plantings that use plants tolerant of climate, soils, and natural water availability and do not receive watering from municipal potable water after a period of establishment is complete.

d) Surface runoff

❖ 1 credit for using pervious paving materials for a minimum of 50% of non-landscaped areas, exclusive of the building footprint (roadways, surface parking, plazas, pathways) on the site.

Method of assessment

- a) Reference shall be made to current Works Bureau and Planning, Environment and Lands Bureau promulgated technical guidance for professional persons. The Client shall provide a report prepared by a suitably qualified professional person detailing the justification for credit.
- b) The Client shall provide a report prepared by a suitably qualified professional person detailing the justification for credit.
- c) The Client shall provide details in the form of specifications and documents detailing the provisions which comply with the credit requirements.
- d) The Client shall provide details in the form of specifications and documents detailing the provisions which comply with the credit requirements.

⁵² Lands Administration Office, Land Department. Practice Note for Authorised Persons, Surveyors and Registered Structural Engineers, Issue No. APSRSE 3/94. Landscape Clause/Proposal. 1994.

3.14 PLANTERS ON BUILDINGS

Large expanses of greenery are difficult to secure in densely built city centres. However, the provision of plants on the outside and on rooftops contribute to making the city greener. A building rooftop covered with greenery can bring down the surface temperature by more than 20 degrees centigrade in summer, compared with bare asphalt or concrete rooftops⁽⁵³⁾. Roof greenery also can reduce peak roof runoff and alleviate storm drainage pressure.

Objective of HK-BEAM

To encourage the inclusion of greenery and vegetation in and upon buildings, to provide shade, absorb heat and provide a sink for carbon dioxide emissions.

Maximum number of credits attainable: 1

Credit requirement

- ❖ 1 credit for designs which provide appropriate planting on a building equivalent to at least 30% of the area of the building footprint.

Method of assessment

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 equivalent.

3.15 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.

Objective of HK-BEAM

To reduce the consumption of potable water and encourage the recycling of grey water and rainwater.

Maximum number of credits attainable: 3

Credit requirement:

a) Recycling water

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

- ❖ 1 additional credit for the installation of an on-site grey water treatment system, to treat grey water for reuse in toilet flushing where sea water is not available.

b) Low flow devices

- ❖ 1 credit for specifying and installing any two of the prescribed, or equivalent low flow devices.

Method of assessment

⁵³ Nikken Sekkei. Securing more greenery. <http://www.nikken.co.jp/midori/10e.html>. 1999.

- a) The Client shall provide details of any system designed and installed for the purpose of collecting rainwater, and details of the expectations in respect of savings in the consumption of potable water. To earn additional credit the Client shall provide details of any system designed and installed for the purpose of recycling grey water, and details of the expectations in respect of savings in the consumption of potable water. Recycled grey water or rainwater systems should satisfy water quality requirements⁽⁵⁴⁾.
- b) The prescribed low low-flow devices are:
- showerheads whose flow rate is less than 0.18 ls⁻¹, and
 - faucet aerators whose flow-rate is equal to or less than 0.15 ls⁻¹.
 - toilets requiring no more than 6 l per flush.

Equivalent devices that provide for water conservation can be considered for compliance. The design of residential building plumbing will reviewed and the specifications of all the showerheads, faucet aerators, and toilets will be checked against the credit requirements.

3.16 WASTE DISPOSAL AND RECYCLING FACILITIES

Well managed facilities for the recycling of household solid waste encourages recycling and results in reductions in the disposal at landfill sites. Residential 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

To reduce pressure on landfill sites, and to help to preserve non-renewable resources by promoting recycling of waste materials. To provide for hygienic disposal of household waste.

Maximum number of credits attainable: 2

Credit requirement

- ❖ 1 credit for providing communal facilities for the sorting of waste and the recovery of recyclable materials.
- ❖ 1 credit for providing a mechanical system allowing for the transportation of household waste to the ground floor of the buildings, other than by labour.

Method of assessment

The designs and specifications for the waste management facilities will be checked and assessed. The assessor may carry out site inspections for the compliance.

3.17 INNOVATIVE AND UNCONVENTIONAL DESIGNS

This aspect applies to advanced practices and new technologies that have not found application in Hong Kong. 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 that will improve the environmental performance of the building or buildings within an estate. The following are examples of what may be considered, but other designs are not excluded:

- Provision of a centralised condenser cooling water circulation system to facilitate the use of water cooled air-conditioning units in residential flats. The cooling water may either be

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

seawater drawn from the harbour for once through condenser cooling, or water circulated through cooling tower(s) located on roof of the building or other suitable location. Where a cooling tower is used, source of the make up water should be collected storm water or recycled water from waste water from the residential units, adequately treated for prevention of growth of legionella bacteria.

- Solar water heating system for providing hot water for use within the building or estate, providing it can be demonstrated that energy savings will result.
- Provision of refrigerators that are installed with de-superheaters for recovery of the condenser heat for pre-heating of domestic hot water in bathrooms or kitchens.
- Provision of ventilation systems that are powered by solar cells for ventilating the residential units during daytime when the units are unoccupied for lowering the indoor temperature and heat storage inside the units. This can reduce air-conditioning load and flush air pollutants such as radon.
- Provision of insect screens on openable windows to facilitate natural ventilation for comfort control in residential units and to help reduce use of air-conditioning.

Objective of HK-BEAM

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

Maximum number of credits attainable: 5**Credit requirement:**

The onus will be on the Designer 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 consider each aspect on its merits and award credit accordingly.

4 Materials Use and Specifications

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 (extraction, transportation, processing, etc). 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 choice of materials, designs and construction methods. Use of recycled materials and designing for longevity present immediate opportunities.

The production, use and disposal of building materials accounts for significant quantities of energy and resources. Of concern are:

- toxic pollutants arising from manufacturing and combustion;
- primary energy used in extraction, production and transport;
- emissions to air, mainly CO₂, NO_x, SO₂, and volatile organic compounds;
- use of mineral, water and oil resources;
- waste generated; and
- percentage of recycled material, percentage capable of being recycled, energy to recycle, etc.

4.1 CONSTRUCTION MATERIALS

The Green Guide⁽⁵⁵⁾ 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⁽⁵⁶⁾ and the Green Building Handbook⁽⁵⁷⁾ include life cycle assessments on many of the materials used in building construction.

Objective of HK-BEAM

To 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

- ❖ 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.
- ❖ 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.
- ❖ 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.

Method of assessment

The onus is on the Designer to justify the credit claimed following a review of the referenced documents. The elements covered by the assessment includes partitions, flooring, wall finishes, windows, etc. but not concrete elements cast on site. Details of specified materials shall be rated

⁵⁵ Building Research Establishment. The Green Guide to Specification. An Environmental Profiling System for Building Materials and Components. September 1998.

⁵⁶ The American Institute of Architects. Environmental Resources Guide. John Wiley & Sons, Inc. 1998.

⁵⁷ Tom Woolley et al. Green Building Handbook. E&F Spon 1997.

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 which demonstrates the use of environmentally friendly materials will be considered by the Assessor, but the Designer 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. Designers should seek to highlight the environmental benefits inherent in the choice of materials.

4.2 USE OF 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, such as bricks⁽⁵⁸⁾. 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, in particular pulverised fuel ash. For thick 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⁽⁵⁹⁾.

Objective of HK-BEAM

To minimise the use of non-renewable resources and to maximise the utility of non-renewable resources for use in the building structure and in fixed furnishings provided by the builder.

Maximum number of credits attainable: 3

Credit requirement

- ❖ 1 credit for use of recycled materials in site surfacing works, structures and features.
- ❖ 1 credit for using 5% of recycled materials, other than PFA, in the construction of the building.
- ❖ 1 credit for full use of PFA in concrete in accordance with WBTC 14/90.

Method of assessment

Site works and features includes paths, surfaces for recreational areas, structures such as seating, playground features, etc. The Designer 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.

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 Designer shall provide the necessary details of materials used in the structure.

Crushed concrete aggregate complying with the quality and grading requirements of British Standard BS 882⁽⁶⁰⁾ for use in concrete for foundations. The fills in foundations and for over-site

⁵⁸ British Standards Institution. Guide to Use of Industrial by-products and waste materials in building and civil engineering. BS 6543: 1985.

⁵⁹ Works Branch Technical Circular No. 14/90. The Use of PFA in Structural Concrete.

⁶⁰ British Standards Institution. Specification for aggregates from natural sources for concrete. British Standard BS 882:1983. London, BSI, 1983.

use of recycled materials should comply with the requirements of BS 6543⁽⁶¹⁾. The specifications and documents of design for recycled materials will be checked.

- b) 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% by mass of the cementitious content shall qualify for credit.

4.3 OZONE DEPLETING SUBSTANCES

CFC has been traditionally used as a blowing agent to expand insulation materials to create the foam structure. 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 through 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.

Objective of HK-BEAM

To reduce the release of CFCs (chlorofluorocarbons) and HCFCs (hydrochlorofluorocarbons) into the atmosphere and thus to reduce the rate of depletion of the ozone layer.

Maximum number of credits attainable: 1

Credit requirement

- ❖ 1 credit for specifying thermal insulation in building fabric and services made only from materials with zero ozone depletion potential.

Method of assessment

Several standards and guidelines are available for the selection and use of thermal insulation materials. BS 5970⁽⁶²⁾ describes the general principles that should be followed in selecting the most suitable insulating systems for specific requirements. BS 5422⁽⁶³⁾ gives a method for selecting suitable thickness based on the value of thermal conductivity at the appropriate temperature of use. Section 13 in the General Specification⁽⁶⁴⁾ gives recommendations for insulating ducting, pipework and HVAC equipment in Hong Kong.

The Designer shall provide details of the relevant materials specifications and confirm compliance. If there is any doubt about the ozone depletion potential of the material, the Designer shall ascertain details from the supplier.

4.4 USE OF PERMANENT TIMBER

Wood is an important material in the global context since it is a natural renewable material. Some of the timber used in construction is obtained from areas where forests are being harvested unsustainably, resulting in the extinction of indigenous species and the clearance of

⁶¹ British Standards Institution. British Standard Guide to use of industrial by-products and waste materials in building and civil engineering. BS 6543: 1985.

⁶² BS 5970. Code of Practice for Thermal Insulation of Pipework and Equipment (in the temperature range -100 °C to 870 °C. BSI 1992.

⁶³ BS 5422. Method for Specifying Thermal Insulating Materials on Pipes, Ductwork and Equipment (in the temperature range -40 °C to 700 °C. BSI 1992.

⁶⁴ Building Services Branch, Architectural Services Department. General Specification for Air Conditioning, Refrigeration, Ventilation and Central Monitoring and Control System Installation in Government Buildings.

forests that would otherwise help regulate the amount of CO₂ in the atmosphere. Deforestation contributes to global warming. Although largely due to clearance for agriculture, deforestation of the rain forests is exacerbated by commercial logging. Improved forestry practices can be encouraged by only specifying timber from sources where the forests are being managed sustainably.

Hong Kong uses only imported timber, and is one of the largest importers of tropical hardwoods. Most of this is used by the construction industry, with a large proportion discarded as waste that usually ends up in landfill sites. Timber is a natural and renewable resource that requires relatively little processing in preparation for use in construction. Timber should therefore originate only from well-managed sources and should be reused whenever possible.

Objective of HK-BEAM

To reduce the consumption of non-sustainable tropical timbers and encourage the use of timber from managed forests in general.

Maximum number of credits attainable: 2

Credit requirement

- ❖ 1 credit for specifying solid timber which is entirely from well managed sustainable sources which may include re-used timber.
- ❖ 1 credit for specifying timber panel products which are entirely from well managed sustainable sources which includes suitable re-used timber.

Method of assessment

Softwood timbers are assumed to be from sustainable sources. If tropical hardwoods have been specified, the design team will be asked to provide the following details:

- 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.

Designers 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.

The Client shall present evidence in the form of specifications and contract documents detailing the intention to use timber from sustainable sources, to use efficiently or to use alternatives. The Client's representative on site (e.g. Authorised Person) shall be responsible for monitoring and reporting on construction activities, and shall confirm in writing to the Assessor that the works were conducted in accordance with the specifications and contract documents. The Assessor may carry out site inspections during construction.

4.5 HAZARDOUS MATERIALS

Indoor emissions from building materials, surface finishes and treatments can cause discomfort and present potential health hazards. Opportunities exist to reduce exposure to certain harmful substances by more careful selection of building products and materials.

Objective of HK-BEAM

To eliminate minor or occasional health risks which are not at present covered by regulations.

Maximum number of credits attainable: 3

Credit requirement

- ❖ 1 credit for minimising formaldehyde emissions.
- ❖ 1 credit for ensuring that no paints are used which contain lead.
- ❖ 1 credit for ensuring that timber treated with wood preservative is not used, or if required the preservative is industrially pre-treated ready for finishing on site.

Method of assessment

If particleboard is to be specified it must conform to BS 5669⁽⁶⁵⁾ and if medium-density fibreboard is to be specified it must conform to BS 1142⁽⁶⁶⁾.

The materials specification must show the absence of paints containing lead.

It is a prerequisite that timber treatment be restricted to the provisions made in the relevant codes and standards which are applicable to particular building components.

To obtain credit the Client shall provide details of specifications and other relevant design and construction documents and instructions.

⁶⁵ British Standards Institution. Particleboard. British Standard BS5669: Parts 1-5: 1989. London, BSI, 1989.

⁶⁶ British Standards Institution. Specification for fibre building boards. British Standard BS1142: 1989. London, BSI, 1989.

5 Construction Practice

Construction site activities in Hong Kong is cited as a major contributor to urban pollution, including noise pollution, ambient air pollution and water pollution, and the generation of waste. HK-BEAM seeks to reduce nuisance and potential health impacts from air and water pollution caused by construction site activities. Hong Kong environmental regulations for air and water quality, noise and waste, and the Hong Kong Planning Standards and Guidelines⁽⁶⁷⁾ serve as guides to improved construction site practices.

5.1 ENVIRONMENTAL MANAGEMENT PLAN

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 waste and environmental pollution.

Objective of HK-BEAM

To encourage a higher standard of environmental management during construction.

Maximum number of credits attainable: 1

❖ 1 credit for contract documents which require the development and implementation of a Environmental Management Plan by the main contractor, including provisions for Environmental Monitoring and Auditing and reporting to the client representative.

Method of assessment

The Environmental Management Plan (EMP) shall be approved by the Client upon commencement of the works. The plan shall embrace all items listed in Appendix D. The EMP shall be reviewed periodically to ensure implementation and full compliance.

5.2 AIR POLLUTION DURING CONSTRUCTION

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 our quality of life and cost money. Good site practices are the major mitigation measures for prevention or minimisation of air pollution from construction activities.

Objectives of HK-BEAM

To minimise air pollution during the construction of buildings and the infrastructure serving buildings.

Maximum number of credits attainable: 2

Credit requirement

- a) Control of dust

⁶⁷ Planning Department, Hong Kong Government. Hong Kong Planning Standards and Guidelines, Chapter 9, Environment.

❖ 1 credit for applying adequate mitigation measures for dust and air emissions during the construction as the recommended by CIRIA and Air Pollution (Construction Dust) Regulation.

b) Monitoring and audit of Respirable and Total Suspended Particulates

❖ 1 credit for demonstrating compliance with the air quality management guidelines as detailed in the Environmental Monitoring and Audit Manual.

Method of assessment

a) Reference is made to CIRIA⁽⁶⁸⁾

- effective water sprays to be used to water exposed working areas that can generate dust at least twice a day and to water haulage roads at least every two hours;
- 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.

The Client shall present evidence in the form of specifications and contract documents detailing the intention to comply with the requirements as laid down above 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.

b) The Client shall present evidence in the form of a report prepared by a suitably qualified environmental auditor that the monitoring and audit of Respirable and Total Suspended Particulates (TSP) complies with the requirements stated in the Environmental Monitoring and Audit Manual.⁽⁶⁹⁾

5.3 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.

Objective of HK-BEAM

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

Maximum number of credits attainable: 2

Credit requirement

a) Control of noise

❖ 1 credit for applying the criteria and requirements laid down in the Environmental Protection Department Practice Note ProPECC PN 2/93.

b) Monitoring and auditing of noise

❖ 1 credits for demonstrating compliance with the noise management guidelines as detailed in the Environmental Monitoring and Audit Manual.

⁶⁸ Environmental handbook for building and civil engineering projects – Construction phase. Construction Industry Research and Information Association. 1998.

⁶⁹ Environmental Protection Department, Environmental Monitoring and Audit Manual, Chapter 2, Air Quality. <http://www.info.gov.hk/epd/index.htm>.

Method of assessment

- a) The Client shall present evidence in the form of specifications and contract documents detailing the intention to comply with the requirements laid down in ProPECC PN 2/93 to control construction noise. The Client's representative on site shall be responsible for monitoring and reporting on the execution of the instructions. The representative shall submit monthly reports to the Assessor confirming that the control of noise on site followed the requirements laid down in ProPECC PN 2/93. The Assessor may carry out site inspections during construction.
- b) The Client shall present evidence in the form of a report prepared by a suitably qualified environmental auditor that the monitoring and audit of noise complies with the requirements stated in the Environmental Monitoring and Audit Manual.⁽⁷⁰⁾

5.4 SITE DRAINAGE AND WATER POLLUTION

Hong Kong has separate systems for storm water drainage and for sewage. Storm water systems are often polluted with domestic and industrial waste. Some of the sewage and effluent reaches the sea by way of the storm drainage system with no treatment. Construction activities add to these problems by silting-up storm drains, causing visual nuisances and hazards from discharges, and polluting due to poor handling of site wastewater. These problems can be prevented or minimised by good site practices.

Objective of HK-BEAM

To encourage water conservation and reduce the environmental impact of wastewater discharge during construction.

Maximum number of credits attainable: 2

Credit requirement

- a) Water pollution
 - ❖ 1 credit for undertaking measures to reduce water pollution during construction, through adequately designed sediment retention and removal facilities, treatment of wastewater from concrete construction activities such as concreting, batching, etc., as outlined in ProPECC PN 1/94.
- b) Water conservation
 - ❖ 1 credit for demonstrating compliance with the water management guidelines as detailed in the Environmental Monitoring and Audit Manual.

Method of assessment

- a) The Client shall present evidence in the form of specifications and contract documents detailing the intention to undertake measures to reduce water pollution during construction laid down in ProPECC PN 1/94⁽⁷¹⁾. The Client's representative on site shall be responsible for monitoring and reporting the execution of the instructions. The representative shall confirm in writing to the Assessor that the works were conducted in accordance with the recommendations given in ProPECC PN 1/94 and appropriate site-specific measures, if any.

⁷⁰ Environmental Protection Department, Environmental Monitoring and Audit Manual, Chapter 3, Noise. <http://www.info.gov.hk/epd/index.htm>.

⁷¹ Environmental Protection Department. Construction Site Drainage. Practice Note for Professional Persons. ProPECC PN 1/94. August 1994.

- b) The Client shall present evidence in the form of a report prepared by a suitably qualified environmental auditor that the monitoring and audit of water complies with the requirements stated in the Environmental Monitoring and Audit Manual.

5.5 DEMOLITION WASTE MANAGEMENT

Applies to brown-field sites where demolition of existing structures is included in the works.

In 1997, Hong Kong generated more than 42 000 tonnes of solid waste and reusable materials daily, of which more than 68%⁽⁷²⁾ was construction and demolition waste. The Hong Kong Government's policy objectives for waste management include encouragement of waste reduction, reuse and recycling to minimise waste for disposal. Demolition waste is most effectively sorted on site to separate suitable materials for reuse. Some hazardous materials and toxic chemicals are also generally associated with the demolition works, and should be disposed off in an environmentally friendly and safe manner. Waste generation and environmental pollution during the demolition are most effectively minimised on site applying best management practices.

Landfills are being filled up far more rapidly than was programmed and apart from municipal waste, the source of much of the public fill is from construction and demolition sites. On-site sorting of surplus construction and demolition (C&D) material is therefore 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. Small quantities of timber mixed with otherwise suitable material may be permitted. The materials considered unsuitable for disposal at public filling areas have to go to a landfill⁽⁷³⁾.

Objective of HK-BEAM

To encourage best practice in respect of mitigating environmental impacts, in the demolition of buildings and the sorting and disposal of demolition waste.

Maximum number of credits attainable: 1

Credit requirement

- ❖ 1 credit for contract documents which require the sorting of demolition wastes on site for separate disposal as inert and non-inert materials, and the identification of licensed hauliers of recyclable materials.

Method of assessment

The Client shall present evidence in the form of specifications and contract documents detailing that all construction and demolition (C&D) materials arising from or in connection with the demolition work 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. All public fills to be disposed of at public filling areas shall be sorted according to the Dumping Licence conditions. The Client's representative on site shall be responsible for monitoring and reporting on the execution of the instructions. As a minimum, the plan shall detail plans for recycling of packaging materials, metals, timber and construction materials. The Client's representative on site shall be responsible for monitoring and reporting on the execution

⁷² Environmental Protection Department. Monitoring of solid waste in Hong Kong for 1997. 1998

⁷³ On Site Sorting of Construction Waste on Demolition Sites. Works Bureau Technical Circular No. 5/98. March 1998.

of the instructions. The representative shall confirm in writing to the Assessor the extent to which recycling and sorting has been achieved. This shall be in the form of monthly reports. The Assessor may carry out site inspections during construction.

In assessing the suitability of the arrangements reference shall be made to guidance notes on waste management to professional persons issued by the Works Bureau and Planning, Environment and Land Bureau, and to the Hong Kong Planning and Standards Guidelines. To qualify for credit the Client must confirm that all legislative requirements in respect of waste disposal have been met, particularly in respect of hazardous materials.

5.6 CONSTRUCTION WASTE MANAGEMENT

The Contractor is responsible for waste control within the construction site, removal of the waste material produced from the site and implementation of any mitigation measures to minimise waste, or redress problems arising from the waste from the site. The waste material includes sewage, waste-water or effluent containing sand, cement, silt or any other suspended or dissolved material. This can pollute adjoining land, travel storm sewers and sanitary sewers.

Objective of HK-BEAM

To encourage on-site sorting of waste for reuse and more environmentally friendly disposal.

Maximum number of credits attainable: 1

Credit requirement

- ❖ 1 credit for contract documents which require the sorting of construction wastes on site for separate disposal as inert and non-inert materials, and the identification of licensed hauliers of recyclable materials.

Method of assessment

The Client shall provide evidence in the form of contract documents that detail the methods and arrangements for sorting and disposal. The Client's representative on site shall be responsible for monitoring and reporting on the execution of the instructions. As a minimum, the plan shall detail plans for recycling of packaging materials, metals, timber and construction materials. 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 the extent to which recycling and sorting has been achieved. This shall be in the form of monthly reports. The Assessor may carry out site inspections during construction.

In assessing the suitability of the arrangements reference shall be made to guidance notes on waste management to professional persons issued by the Works Bureau and Planning, Environment and Land Bureau, and to the Hong Kong Planning and Standards Guidelines. To qualify for credit the Client must confirm that all legislative requirements in respect of waste disposal have been met, particularly in respect of hazardous materials.

5.7 TIMBER FOR TEMPORARY WORKS

Timber is a natural and renewable resource that requires relatively little processing in preparation for use in construction. Where forests are being harvested in an unsustainable manner, the result is the extinction of indigenous species and the clearance of vegetation that would otherwise help regulate the amount of CO₂ in the atmosphere, 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. Timber should therefore originate only from well-managed sources and should be reused whenever possible⁽⁷⁴⁾.

Objective of HK-BEAM

To reduce the consumption of non-sustainable tropical timbers during construction and encourage the use of alternatives, such as timber from managed sources, metal, etc.

Maximum number of credits attainable: 3

Credit requirement:

- ❖ 1 credit for using durable and reusable formwork systems to replace timber formwork, and for ensuring that timber formwork, where used, is properly maintained.
- ❖ 1 credit for using durable and reusable hoarding to replace timber hoarding.
- ❖ 1 credit for using standardised prefabricated building elements to reduce the use of formwork.

Method of assessment

Softwood timbers and temperate hardwoods are assumed to be from sustainable sources. If, however, tropical hardwoods have been specified, the design team will be asked to provide the following details:

- 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 shall present evidence in the form of specifications and contract documents detailing the intention to use timber from sustainable sources, to use efficiently or to use alternatives. The Client's representative on site (e.g. Authorised Person) shall be responsible for monitoring and reporting on construction activities, and shall confirm in writing to the Assessor that the works were conducted in accordance with the specifications and contract documents. The Assessor may carry out site inspections during construction.

⁷⁴ Building Authority. Tropical Hardwood Timber. Practice Note for Authorised Persons and Registered Structural Engineers, PNAP No. 153. July 1992.

6 Operation and Maintenance

High-rise residential buildings require substantial maintenance, of both the core and fabric, and the associated engineering systems. Energy and materials consumed during the life of a building have significant environmental impacts. Good operations and maintenance practices requires enabling provisions during design and commissioning, proper commissioning, adequate instructions for operators, metering and monitoring provisions to monitor consumption, and facilities for basic maintenance and care. HK-BEAM seeks to encourage greater awareness of the design, installation and commissioning needed for to allow good operations and maintenance.

6.1 COMMISSIONING

Effective commissioning and proper instructions on operations and maintenance procedures can help improve the life, operating efficiency and environmental performance of a building.

Objective of HK-BEAM

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

Maximum number of credits attainable: 2

Credit requirement

a) Commissioning

❖ 1 credit for allowing as a cost item in the contract documents, a specific cost for commissioning of all electrical and mechanical systems and equipment to be maintained by the building owner/operator.

b) Manuals

❖ 1 credit for allowing as a cost item in the contract documents, a specific cost for the preparation of fully documented operations and maintenance manual.

Method of assessment

- a) The Client's representative shall certify the contract sum allowed for commissioning. Details of the commissioning works and procedures shall be provided. These shall be checked against a check list derived from CIBSE and BSRIA documentation.
- b) The Client's representative shall certify the contract sum allowed for the preparation of the O&M manual. Contract documents and specifications shall be checked against a check list based on BSRIA⁽⁷⁵⁾ documentation. Instructions shall be given for the safe and efficient operation of each system and major item of equipment.

6.2 TESTS FOR UNCONTROLLED VENTILATION

This applies to residential units.

Installation of windows and similar openings in a building envelope will result in some air leakage, as well as additional noise penetration. Infiltration is air leakage into a building, and

⁷⁵ J H Armstrong. The Building Services Research and Information Association. Operating and Maintenance Manuals for Building Services Installations. Application Guide 1/87. December 1987.

exfiltration is air leakage out. Both represent a loss of conditioned air or an unwanted gain of unconditioned air, and resultant heat gains or losses. 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⁽⁷⁶⁾.

Objective of HK-BEAM

To reduce uncontrolled air movement in or out of the premises, 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 flats, to demonstrate that the air tightness is less than 2.0 ac.h^{-1} at 50 Pa.

Method of assessment

The practical aspects of performing a fan pressurisation measurement should be based on ASTM 779-87. Interpretation should follow the method given in the Swedish Building Code (1980) in which the air flow rate at 50 Pa is normalised to the volume of the flat/apartment to give 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. The Client shall present evidence of compliance by way of a report prepared by a suitably qualified professional person.

6.3 FACILITIES

Facilities to carry out basic maintenance equipment for monitoring consumption can help improve operating efficiency and environmental performance of a building.

Objective of HK-BEAM

To allow operators to monitor the performance of a building, and maintain the performance.

Maximum number of credits attainable: 2

a) Metering

- ❖ 1 credit for specifying and installing metering which allows separate monitoring of electricity use (input power, energy and maximum demand) by the owner/operator of the building(s).

b) Facilities

- ❖ 1 credit for providing proper maintenance and storage facilities, as specified or equivalent.

Method of assessment

The prescribed requirements are:

- demonstrating that proper maintenance facilities will be provided for operations and maintenance work in the form of workshop(s), office accommodation and control room;
- providing 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,
- providing drains plumbed for the appropriate disposal of liquid waste products, equipped with separate outside venting, and operated under negative pressure.

⁷⁶ The American Institute of Architects. Glazing Design: Handbook for Energy Efficiency. AIA 1997.

- a) The Designer shall provide details of the measuring equipment installed. Metering current transformers shall be specified to BS 7626:1993⁽⁷⁷⁾ to at least accuracy class 1. Electricity metering for indicating power and energy shall comply with BS EN60521:1995⁽⁷⁸⁾ to at least accuracy class 1.
- b) The Designer shall provide details of the facilities providing and how these credit requirement will be met.

6.4 TENANT/OWNER'S HANDBOOK

Environmental friendly use and operation of buildings can be increased with the co-operation of the tenants/owners. Very often, tenants/owners are not aware of the environmental issues or comfort and health issues. It is good practice for a Developer to provide a tenant/owner's handbook giving details about the facilities provided in the living units and within the building or estate. It may also contain guidance and regulations regarding internal decoration and fit-out by contractors, for example, approved installation details for air conditioning units.

Objective of HK-BEAM

To inform the tenants/owners on the environmental issues pertaining to their way of living, the operation of the facilities, selection of material and equipment, sorting of recyclable wastes, etc.

Maximum number of credits attainable: 1

Credit requirement

- ❖ 1 credit for a well compiled guide on environmental issues included in a tenant/owner's handbook.

Method of assessment

The Assessor shall be provided with copies of any guidance materials to be issued to tenants/owners. The Assessor will assess the material in respect of guidance given on environmentally friendly living, including, but not restricted to the following:

- guidance on how to select and install energy efficient equipment (for example using the various Energy Efficiency Labelling Schemes (fridges, room coolers, washing machines and compact fluorescent lamps) launched by the Electrical and Mechanical Services Department;
- guidance on energy efficient operation of equipment and facilities, for example, air conditioning units, ventilation fans, kitchen exhaust fans and hoods, etc;
- attention to be given to the operation of the passive facilities, such as trickle vents, if provided;
- discouraging wasteful disposal of elements such as toilet cubicles, wooden flooring, doors, main metal gate, etc.,
- encouraging the hygienic disposal and sorting of wastes;
- encourage water conservation;
- ways to maximise utilisation of daylight and natural ventilation;
- discourage emissions of indoor pollutants, etc.

⁷⁷ British Standard BS 7626. Specification for current transformers. 1993.

⁷⁸ British Standard BS 5685 Part 1: 1979. Electricity meters. Part 1. Specification for class 0.5. 1. 2 single-phase and polyphase, single rate and multi-rate watt-hour meters.

7 Appendices

7.1 APPENDIX A - OVERALL THERMAL TRANSFER VALUE (OTTV) CALCULATION METHOD

A.1 Introduction

Nowadays, air-conditioners are extensively used in all types of residential flats in Hong Kong for maintaining a comfortable indoor thermal environment. The increasing use of air-conditioning in residences has contributed to the increasing consumption of electricity in the domestic sector. Conservation of energy use for air-conditioning is therefore an important issue that needs to be addressed in the design of residential buildings.

In commercial buildings in Hong Kong, the heat gain from the building envelope would account for less than 20% the total cooling load. Cooling load due to envelope heat gain in residential buildings, however, may exceed 60% of the total cooling load.

The Overall Thermal Transfer Value (OTTV) of a building, as defined in equation (A.1), is a measure of the average heat gain through the envelope of a building over the operating period of the air-conditioning system in a year.

$$\text{OTTV} = \frac{\text{Total heat gain through building envelope during air - conditioned hours}}{\text{Total air - conditioned hours} \times \text{Envelope area}} \quad (\text{A.1})$$

OTTV may therefore be used as an indicator of whether or not a residential building design is energy efficient, and designing for a low OTTV will help reduce energy use for air-conditioning in such buildings.

Legislative control over the OTTV of new commercial and hotel buildings has been enforced in Hong Kong since 1995. The method to be used for determining OTTV of commercial buildings and hotel buildings is detailed in the Code of Practice for Overall Thermal Transfer Values in Buildings (hereafter referred to as CoP for OTTV).

Presently, there is no control over the OTTV of residential buildings in Hong Kong. However, controlling the OTTV of buildings would be far more effective in residential buildings than in commercial and hotel buildings in respect of reducing electricity consumption for air-conditioning. Therefore, in the HK-BEAM scheme, the energy performance of residential building designs is assessed based on building OTTV.

As shown in equation (A.1), the OTTV of a building is dependent on the time and duration of the air-conditioned use. In this respect, residential buildings are rather different from commercial and hotel buildings. Air-conditioning is seldom required in cool months in residential buildings but commercial buildings with high internal load intensities and extensive floor areas will require air-conditioning throughout the year. Many residential flats may be unoccupied during the daytime in weekdays with the air-conditioners switched off even in the hottest summer day. Operating periods of air-conditioners serving bedrooms and living rooms are also different. Those serving bedrooms would be run mainly in the evening and during night-time in the hot months. Therefore, the existing OTTV calculation method for commercial and hotel buildings, particularly the coefficients and parameters to be used in the calculation, need to be revised before it can be applied to residential buildings.

An OTTV calculation method has been established for use in the assessment of energy performance of building envelope designs of residential buildings in the HK-BEAM scheme. Details of the calculation procedures are given in the following sections of this Appendix.

To cope with the occupation conditions and patterns of use of air-conditioners in residential buildings, the assumption made in the development of the calculation method is that air-

conditioners would be run only from April to October in a year. Furthermore, air-conditioners serving bedrooms and other air-conditioned rooms in residential units were assumed to be operated according to two different schedules. Consequently, two sets of data are used separately in the OTTV calculation, one for bedrooms and for other air-conditioned rooms, yielding two different OTTV values.

In the HK-BEAM assessment, credits for the OTTV for bedrooms and other air-conditioned rooms will be determined separately according to the different sets of criteria. The credit to be awarded for a residential building design is the lesser of the credit scores obtained for bedrooms and for other air-conditioned rooms, respectively.

A.2 Calculation method

A.2.1 General principles

The OTTV of a building may be determined by summing the area weighted OTTV's of individual external walls and roofs as shown in equation (A.2).

$$OTTV = \frac{\sum_{i=1}^N (Ao_i \times OTTV_i)}{\sum_{i=1}^N Ao_i} \quad (A.2)$$

where: $OTTV_i$ = overall thermal transfer value of the i^{th} envelope element, W/m^2C

Ao_i = area of the i^{th} envelope element, m^2

The total heat gain from an envelope element comprises the following two major components:

1. the conduction heat gain from the opaque part of a wall or roof, and
2. the heat gain due to solar radiation incident upon the fenestration in the wall or roof.

The first component includes the heat transmission due to the temperature difference between the indoor space and the outdoors, and the effect of solar radiation incident upon the external surface of the wall or roof. The second component includes the solar radiation transmitted through a window or a sky light, and the convective heat gain from the internal glass surface that is effected by the solar energy absorbed by the glass. These two major heat gains are combined in the determination of the OTTV for an envelope element, as illustrated by equation (A.3) with reference to an external wall.

$$OTTV_w = \frac{A_w \times OTTV_w + Af_w \times OTTV_{fw}}{Ao_i}$$

(A.3)

where: $OTTV_w$ = overall thermal transfer value of the opaque part of a wall, W/m^2C

$OTTV_{fw}$ = overall thermal transfer value of fenestration in the wall, W/m^2C

A_{wi} = area of the opaque part of a wall, m^2

Af_i = area of fenestration in the wall, m^2

Ao_i = $A_{wi} + Af_i$, m^2

The OTTV of a roof element can be determined in a similar way. Details of the calculation method are described in the following section.

A.2.2 OTTV of external walls

The OTTV of an external wall in a residential building, $OTTV_w$, should be calculated using equation (A.3).

$$OTTV_w = \frac{(A_w \cdot U \cdot TD_{EQW}) + (A_{f_w} \cdot SC \cdot ESM \cdot SF)}{Ao_w} \quad (A.3)$$

- where: A_w = Area of opaque wall, m²
 U = Thermal transmittance of opaque wall, W/m²°C
 α' = Corrected absorptivity of the opaque wall (**Table A.1(a)**)
 TD_{EQW} = Equivalent temperature difference for wall, °C (**Table A.2(a) & A.2(b)**)
 A_{f_w} = Area of fenestration in wall, m²
 SC = Shading coefficient of fenestration in wall
 ESM = External shading multiplier (**Table A.3(a) & A.3(b) and A.4(a) & A.4(b)**)
 SF = Solar factor for the vertical surface, W/m² (**Table A.5(a) and A.5(b)**)
 Ao_w = Gross area of external walls = $A_w + A_{f_w}$, m²

A.2.3 OTTV of roofs

The OTTV of a roof in a residential building, $OTTV_r$, should be calculated using equation (A.4).

$$OTTV_r = \frac{(A_r \cdot U \cdot TD_{EQr}) + (A_{f_r} \cdot SC \cdot SF)}{Ao_r} \quad (A.4)$$

- where A_r = Area of opaque roof, m²
 U = Thermal transmittance of opaque roof, W/m²°C
 α' = Corrected absorptivity of the opaque roof (**Table A.1(b)**)
 TD_{EQr} = Equivalent temperature difference for roof, °C (**Table A.6(b) & A.6(b)**)
 A_{f_r} = Area of fenestration in roof, m²
 SC = Shading coefficient of fenestration in roof
 SF = Solar factor for the horizontal surface, W/m² (**Table A.5(a) & A.5(b)**)
 Ao_r = Gross area of roof = $A_r + A_{f_r}$, m²

A.3 Coefficients and parameters for OTTV calculation

A.3.1 Thermal transmittance (U)

The conventional method (equation A.5) for determining thermal transmittance of an opaque element (U) in the building envelope is applicable to the OTTV calculations. Data for a range of commonly used construction materials are also available in the COP for OTTV and can be used for this purpose. Such data include thermal conductivity of building materials (k), film resistance for inside and outside surfaces of walls and roofs (R_i , R_o), and air space resistance for walls and roofs (R_a).

$$U = \frac{1}{R_i + \frac{x_1}{k_1} + \frac{x_2}{k_2} + \dots + \frac{x_n}{k_n} + R_a + R_o} \quad (A.5)$$

- where: x_i = thickness of building material in the i^{th} layer, m
 k_i = thermal conductivity of material in the i^{th} layer, W/m°C
 R_i = inside surface film resistance, m²°C/W
 R_o = outside surface film resistance, m²°C/W
 R_a = air space thermal resistance, m²°C/W

A.3.2 Corrected absorptivity of wall and roof (a)

Absorptivity data for a range of wall or roof external surface materials can be found in the COP for OTTV. However, detailed simulation predictions showed that in the calculation of the OTTV of an opaque wall or roof, the absorptivity of the wall or roof external surface material could not be directly substituted into equations (A.3) & (A.4). Rather, the corrected values determined from the original value of absorptivity in accordance with the data given in Table A.1(a) and A.1(b) should be used. Corrected absorptivity for materials may need to be determined from the data in these tables by interpolation.

Table A.1(a) Corrected absorptivity of opaque wall (α')

Absorptivity	Corrected Absorptivity	
	Bedroom	Other rooms
0.10	0.62	0.15
0.30	0.70	0.34
0.58	0.82	0.60
0.88	0.95	0.89
1.00	1.00	1.00

Table A.1(b) Corrected absorptivity of roof (α')

Absorptivity	Corrected Absorptivity	
	Bedroom	Other rooms
0.65	0.86	0.49
0.88	0.95	0.83
1.00	1.00	1.00

A.3.3 Equivalent temperature difference for walls (TD_{EQW})

The equivalent temperature difference to be used for determining OTTV of external walls and roofs for a range of area mass densities are given in Table A.2(a) and Table A.2(b).

Table A.2(a) Equivalent temperature difference for Wall (TD_{EQW}) of bedrooms

Orientation	Mass of wall construction per unit area (kg/m^2)			
	154.7	285.5	475.5	765.5
N	2.31	3.91	4.84	9.54
NE	2.31	3.68	4.54	9.15
E	2.12	3.67	4.50	9.30
SE	2.15	3.56	4.40	9.35
S	2.37	3.78	4.72	9.62
SW	2.41	4.85	6.32	12.52
W	2.14	5.35	6.98	13.50
NW	1.75	5.02	6.41	12.21

Table A.2(b) Equivalent temperature difference for Wall (TD_{EQW}) of other rooms

Orientation	Mass of wall construction per unit area (kg/m^2)			
	154.7	285.5	475.5	765.5
N	7.39	8.36	8.56	7.37
NE	6.39	7.83	8.08	7.10
E	3.58	5.29	5.97	5.61
SE	3.81	5.70	6.36	5.98
S	7.67	8.54	8.81	7.67
SW	9.61	11.43	11.59	9.64
W	8.31	10.66	11.25	9.62

NW	6.55	9.31	9.88	8.53
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A.3.4 Shading coefficient of fenestration (SC)

Values of shading coefficients (SC) of glasses published by glass manufacturers may be used in the calculation.

A.3.5 External shading multiplier (ESM)

Effects of external shading by overhang or side fin projections can be accounted for by including the external shading multiplier (ESM) of a value less than 1 in the calculation of the OTTV for a wall. The value of ESM to be used should be determined as follows.

The ESM for overhang projections to window for bedrooms and other air-conditioned rooms should be obtained from Table A.3(a) and A.3(b) according to the overhang projection factor (OPF) and the orientation of the window. The OPF should be calculated as follows:

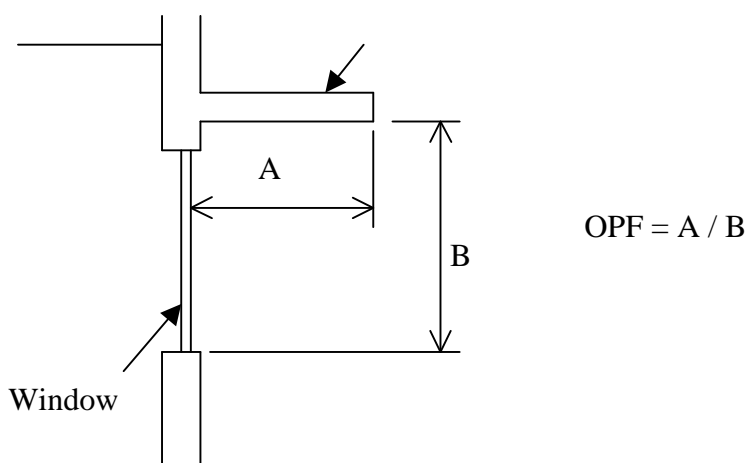


Table A.3(a) External shading multiplier (ESM) for overhang projections to windows for bedrooms

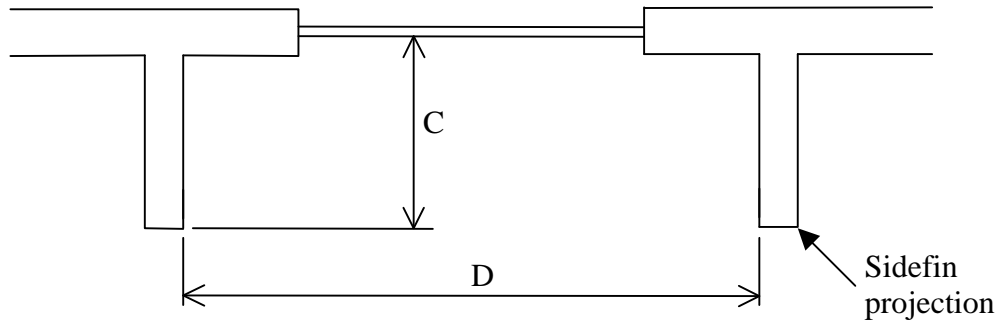
Orientation	OPF				
	0.2	0.4	0.6	0.8	1
N	0.622	0.521	0.473	0.446	0.429
NE	0.639	0.538	0.490	0.459	0.440
E	0.619	0.519	0.470	0.441	0.423
SE	0.619	0.514	0.469	0.444	0.429
S	0.624	0.525	0.477	0.449	0.433
SW	0.599		0.455	0.428	
W	0.602		0.459	0.435	
NW	0.606		0.462	0.437	

Table A.3(b) air-conditioned rooms

	OPF				
	0.2	0.4		0.8	1
	0.676	0.586		0.518	0.503
	0.677	0.581		0.506	0.489
	0.685	0.589		0.511	0.494
	0.681	0.582		0.507	0.492

S	0.669	0.553	0.492	0.462	0.449
	0.691	0.559		0.433	0.403
	0.742	0.622		0.484	0.441
	0.722	0.619		0.530	0.513

air-conditioned rooms should be obtained from Table A.4(a) & A.4(b) according to the side fin should be calculated as follows:



$$SPF = C / D$$

Table A.4(a) External shading multiplier (ESM) for side fin projection to windows for bedrooms

Orientation	SPF				
	0.2	0.4	0.6	0.8	1
N	0.825	0.772	0.743	0.726	0.713
NE	0.817	0.764	0.735	0.717	0.704
E	0.803	0.734	0.698	0.673	0.656
SE	0.784	0.714	0.675	0.653	0.645
S	0.831	0.778	0.749	0.732	0.720
SW	0.803	0.752	0.725	0.709	0.697
W	0.794	0.725	0.688	0.665	0.649
NW	0.782	0.717	0.681	0.660	0.645

Table A.4(b) External shading multiplier (ESM) for side fin projection to windows for other air-conditioned rooms

Orientation	SPF				
	0.2	0.4	0.6	0.8	1
N	0.860	0.824	0.804	0.792	0.784
NE	0.864	0.829	0.810	0.800	0.792
E	0.856	0.809	0.784	0.768	0.757
SE	0.847	0.801	0.776	0.763	0.752
S	0.868	0.832	0.815	0.804	0.797
SW	0.852	0.808	0.787	0.777	0.772
W	0.888	0.848	0.822	0.806	0.794
NW	0.840	0.777	0.737	0.715	0.699

For windows with both overhang and side fin projections, external shading multiplier should be determined separately and the smaller of the two values should be used in the OTTV calculation.

A.3.6 Solar factor (SF)

The solar factor for vertical surfaces at various orientations and that for horizontal surfaces should be obtained from Tables A.5(a) and A.5(b) for bedrooms and other air-conditioned rooms, respectively. Any sloping or angled wall or roof can be resolved into vertical and horizontal components. The vertical components of sloping and angled wall or roof can be treated as a vertical surface with a solar factor at that respective orientation, whereas the horizontal component can be treated as a horizontal surface.

Table A.5(a) Solar factor for vertical surfaces for bedroom

Orientation	N	NE	E	SE	S	SW	W	NW
Solar factor	3.6	3.7	2.6	2.6	3.6	3.5	2.5	2.5
Solar factor for horizontal surface	9.4							

Table A.5(b) Solar factor for vertical surfaces for other air-conditioned rooms

Orientation	N	NE	E	SE	S	SW	W	NW
Solar factor	77.7	79.1	53.0	54.7	89.8	120.0	86.7	71.3
Solar factor for horizontal surface	519.8							

A.3.7 Equivalent temperature difference for roof (TD_{EQr})

The equivalent temperature differences for roofs of various area mass densities should be obtained from Table A.6(a) and A.6(b) for bedrooms and other air-conditioned rooms.

Table A.6(a) Equivalent temperature difference for roofs for bedrooms

Thermal mass of roof (kg/m^2)	285.5	475.5	765.5
TD_{EQr}	21.38	29.50	23.73

Table A.6(b) Equivalent temperature difference for roofs for other air-conditioned rooms

Thermal mass of roof (kg/m^2)	285.5	475.5	765.5
TD_{EQr}	7.80	4.48	4.17

7.2 APPENDIX B- INSTALLATION OF AIR-CONDITIONERS IN HIGH-RISE RESIDENTIAL BUILDINGS

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 B1. Minimum dimensions specified in this table are as shown in Figures B.1 & B.2.

Table B1 Minimum distances from air-conditioners

Dimension	A	B	C
Minimum value (m)	1.5	0.75	1.5

Dimension	E	F	G
Minimum value (m)	0.75	2.0	See Table B2

Dimension	J	K	M
Minimum value (m)	0.3	1.7	0.6

Table B2 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

	$5 < S \leq 10$	2.0	3.0
	$10 < S \leq 20$	2.0	3.5
	$20 < S \leq 60$	2.5	Undesirable
$D \geq 10m$	$S \leq 20$	2.0	2.5
	$20 < S \leq 35$	2.0	3.0
	$35 < S \leq 60$	2.0	3.5

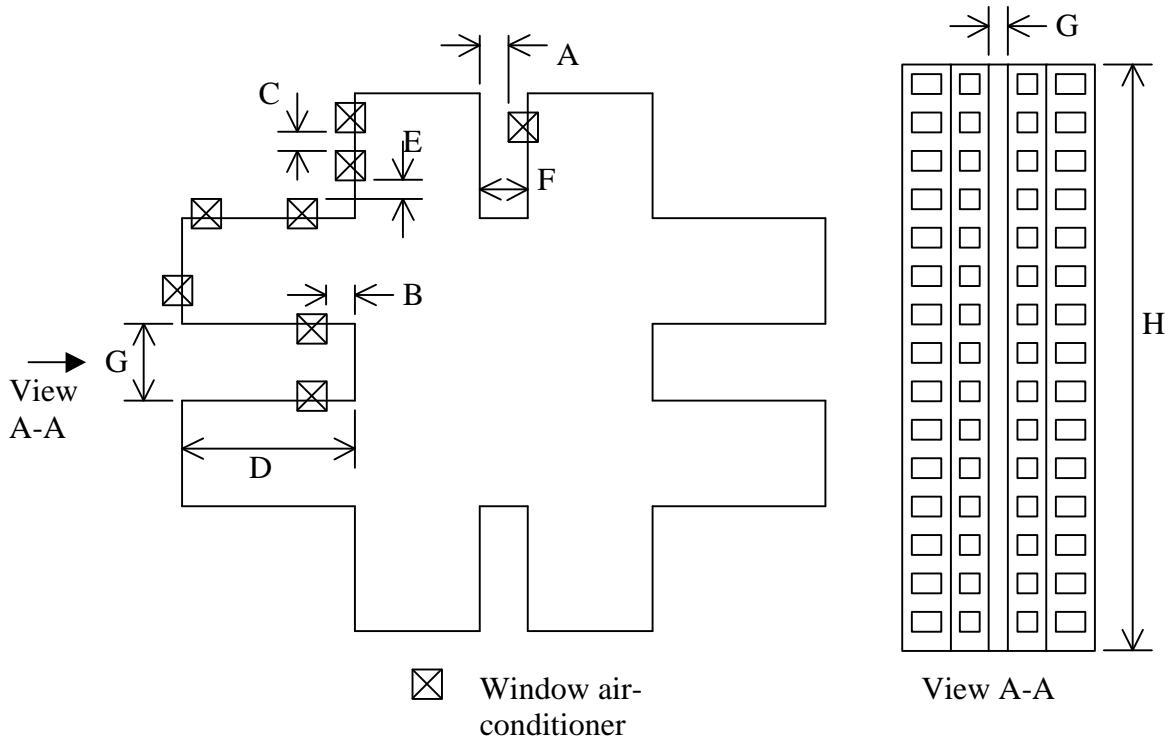


Figure B.1 Layout plan and elevation of building

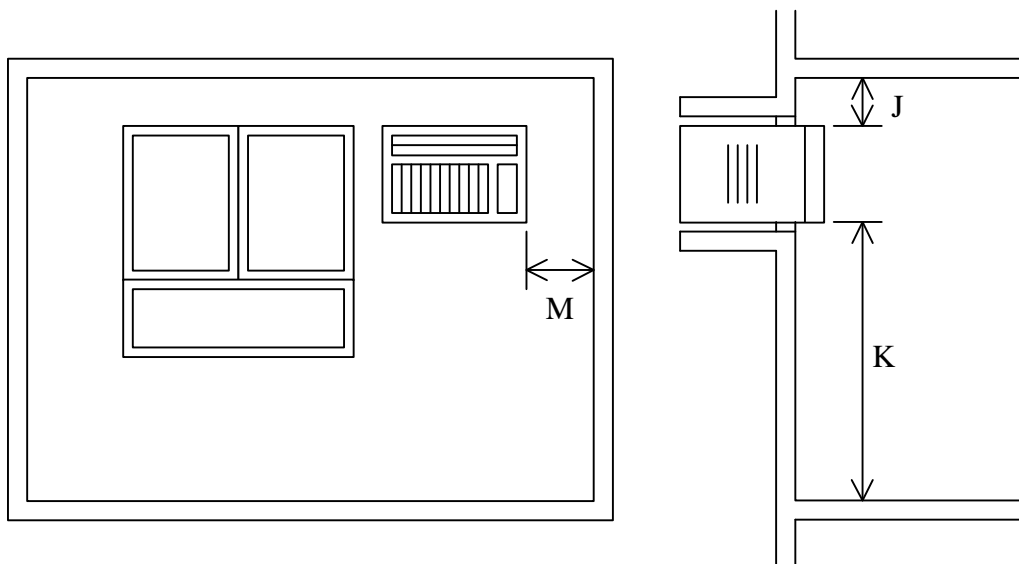


Figure B.2 Elevation and section of a room in a residential building

Legend for Figure B.1 & B.2:

- 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

7.3 APPENDIX C - EFFICACY OF LIGHTING INSTALLATIONS

Energy efficient lamps and control gear will be encouraged for lighting installations in public areas inside and outside buildings. While high efficacy lamps are recommended, assessing only on the average circuit efficacy will allow the use of a small percentage of less efficient lamps (e.g. incandescent lamps) for decorative purposes to enhance the living quality.

For the assessment of the average circuit efficacy, a schedule of light fittings is to be prepared as given in the following table:

Location	Daylight available? If Yes, type of lighting control installed.	Number of lamps	Lamp and control gear description	Circuit watts per lamp (W)	Lumen output per lamp (lm)	Total circuit watts (W)	Total lumen output (lm)
<i>e.g. lift lobbies</i>	<i>e.g. timer control</i>	<i>e.g. 100</i>	<i>e.g. 18W compact fluorescent fitted with high frequency ballast</i>	<i>e.g. 20</i>	<i>e.g. 1200</i>	<i>e.g. 2000</i>	<i>e.g. 120000</i>
Totals						CW	LO

The average circuit efficacy for the estate or the building is calculated by dividing **LO** with **CW**, i.e. $\frac{LO}{CW}$. The second column of the above table should be checked for the installation of lighting controls in areas where daylight is available.

7.4 APPENDIX D - ENVIRONMENTAL MANAGEMENT PLAN

For any construction project, an appropriate contractual framework is necessary for achieving the standards defined in Hong Kong environmental legislation. Similar in nature to a safety or quality plan, the preparation of an environmental management plan (EMP) by the successful contractor will increase awareness of his environmental responsibilities and those of his sub-contractors.

The EMP should be approved by the client upon commencement of the works and include :

- 1 an **environmental policy statement**, signed by the chairperson or other senior representative of the contractor, declaring the contractor's commitment to environmental protection for the project;
- 2 the contractor's **organisational structure** for environmental protection, including identification of its site environmental personnel (listing their responsibilities and authority to act against unacceptable working practices);
- 3 the means for the **communication** of environmental matters between the contractor's site environmental personnel and the client's site agent, the contractor's construction personnel, the contractor's director responsible for the contract, and sub-contractors of all levels;
- 4 provisions for an **environmental course** on contract commencement for the contractor's and sub-contractor's management and supervisory staff (with a record of persons trained to be held by the contractor);
- 5 a list of the expected **environmental impacts** (air, water, noise and waste) occurring from the works including their location, timing, extent and, where applicable, their sensitive receivers;
- 6 a list of the relevant **environmental regulations** which control the identified environmental impacts, and a list of the target levels to which the impacts should be controlled;
- 7 a list of the **mitigation measures** proposed by the contractor to minimise the identified environmental impacts with a programme for their implementation and the means by which they will be inspected, tested and maintained;
- 8 the identification of any **environmental emergencies** which may occur on site and formulation of procedures to deal with such situations;
- 9 the keeping of **environmental records** (current permits/licenses, exceedences, complaints, and waste removal trip tickets, etc.) by the contractor's environmental staff for the contractor and all sub-contractors (to be included in the monthly progress report);
- 10 a **site environmental checklist** which, when completed by the contractor's environmental staff (and approved by the client's site agent), will record compliance with statutory and contractual obligations at the time, with procedures for **corrective actions** where areas of non-compliance have been identified.

The EMP should be reviewed periodically during the construction process to ensure that licensing requirements, etc. remain up to date.

Notes: