## Centre of Environmental Technology, Limited

# HK-BEAM (New Offices)

# An environmental assessment for new office designs

## version 1/96R

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**Acknowledgements**

The HK-BEAM scheme is a significant private sector initiative in Hong Kong to promote environmentally friendly design, construction and management practices for buildings. HK-BEAM is the initiative of The Real Estate Developers Association of Hong Kong. This first edition of this document was prepared by the Department of Building Services Engineering, The Hong Kong Polytechnic University with the assistance of the Welsh School of Architecture, Cardiff University, and the Centre for Environmental Technology, Limited, under the direction of the HK-BEAM Steering Committee.

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Contributions from colleagues in the Department of Building Services Engineering and the Welsh School of Architecture are acknowledged.

**Revisions to HK-BEAM 1/96**

This version of HK-BEAM is a revised and updated version of the document issued in 1996. Other than the change of name, amendments include changes to layout, inclusion of a checklist of credits, minor revisions to assessment criteria and an updating of the reference material. The background material previously included in HK-BEAM 1/96 (Chapter 6) has been removed. It is proposed that a major revision to this document will take place during the next twelve months, with the object to align all three versions of HK-BEAM[1,2,3].

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

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

3 HK-BEAM 3/99, An Environmental Assessment Method for New Residential Buildings. CET 1999.

# 1 Building Environmental Assessment Method

## 1.1 INTRODUCTION TO HK-BEAM

Environmental issues are of fundamental importance world-wide. In Hong Kong there is growing concern about the quality of the local environment. Environmental impacts should be minimised and residents should be provided with a better quality of life. Building and real estate professionals are aware of the large impact buildings have on the global and local environments and how good building design and operation can reduce such impacts, whilst providing good quality indoor environments. Government and the private sector is being urged to improve the quality of Hong Kong's building stock, buildings of all types, both old and new. Improved environmental performance of buildings is economically justified, for society as a whole, for developers, owners, occupiers and users.

The Hong Kong Building Environmental Assessment Method (HK-BEAM) provides authoritative guidance to developers (and their consultants), owners, operators and users on practices which minimise the adverse effects of buildings on the global and local environments, 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. Developers and creditors can use the guidance to inform on building procurement. Prospective purchasers and tenants can obtain independent assessment of building performance to inform or obtain advice on purchase or leasing decisions.

The HK-BEAM scheme is an initiative of The Real Estate Developers Association of Hong Kong. The first two versions[4,5] were developed through a HK-BEAM Steering Committee with the assistance of the Department of Building Services Engineering, The Hong Kong Polytechnic University (BSE), the Welsh School of Architecture, University of Wales College of Cardiff (WSA), and ECD Energy and Environment Limited, UK. The scheme continues to be developed through the same Steering Committee, assisted by BSE, WSA, and the Centre for Environmental Technology Limited (CET). The scheme continues to be operated by CET, the executive arm of the Private Sector Committee on the Environment. An assessment under the HK-BEAM scheme is voluntary.

HK-BEAM defines good practice criteria for a range of environmental issues relating to the design, operation, maintenance and management of buildings. The HK-BEAM scheme currently embraces both new and existing air-conditioned office premises, and new residential buildings.

This document describes HK-BEAM version 1/96R for new air-conditioned office designs. Assessment under HK-BEAM 1/96R focuses on the design, construction and hand over of a building, and may be carried out at any time during the design stage. The design of the building and its engineering systems, construction practices and commissioning procedures are assessed against clearly defined criteria, by CET's Assessor. 'Credits' are awarded where the criteria are satisfied. Where these are not satisfied guidance is given on how performance can be improved. The results of the assessment are shown on the HK-BEAM certificate as a rating of "Fair," "Good," "Very Good," or "Excellent".

All of the criteria in HK-BEAM are set at a level over and above standards that are legally required. The HK-BEAM scheme documents, and assessment criteria, are updated periodically as new information becomes available and as legal requirements evolve.

The remainder of Chapter 1 of this document describes the approach taken in assessing new air-conditioned office premises. Chapters 2 to 4 describe in detail how credits are awarded for designs judged to follow improved environmental practices.

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

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

## 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;
- to raise awareness of the large contribution which buildings make to global warming, acid rain and depletion of the ozone layer, as well as local environmental issues;
- to promote and encourage energy efficient building designs, and inform best practice in the selection of systems and equipment;
- to reduce the use of increasingly scarce resources such as water, timber, and natural materials;
- to improve the quality of the indoor environment and hence the health and well-being of the occupants;
- to provide recognition for buildings where the environmental impact has been reduced;
- to set targets and standards which are independently assessed and so help to minimise false claims or distortions;
- to enable developers, owners and users to respond to a demand for buildings which have less impact on the environment, and to help stimulate such a market.

## 1.3 ASSESSMENT APPROACH

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 the building, giving practical recommendations for improvements. Many issues cannot at present be included, either because the environmental problems they cause are not yet well enough understood or because effective performance criteria have not yet been established. Additional issues may be included in future issues, as information that enables their objective assessment becomes available.

HK-BEAM 1/96R aims to reduce the environmental impact of new air-conditioned office premises using the best available techniques and within reasonable additional cost. Some of the actions needed to improve performance may have an economic return which justifies the action, for instance, the cost of investment in measures to achieve a reduction in carbon dioxide emission rates may be met through reduced electricity bills.

It is not at present practical to assess all the issues covered in HK-BEAM on a common scale. There is insufficient information available to carry out an objective weighting of all of the 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 the future value of our fossil fuel resources.

It is not expected that a new building design can meet all of the target requirements. However, meeting one or more means that the building will have less environmental impact than one in which the requirements have not been met.

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 design and construction where specific targets are met. Where the office premises form a part of a building that includes other types of premises, only the office designs and the design of attendant engineering services provisions are assessed.

Whilst innovative design solutions are encouraged, they do not in themselves give justification for 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, installation, commissioning and operating practices.

## 1.4 TENANT FITTING OUT SPECIFICATIONS

It is expected that the base building and engineering services will be designed for certain flexibility in the end use of the office space, but to meet specified indoor environmental performance requirements. The Designer will have these in mind when designing the building services systems. However, HK-BEAM recognises that in most commercial office buildings the final decision and responsibility for features such as the lighting, partitions and fittings in tenant areas rests with the tenants.

Consequently, HK-BEAM 1/96R encourages the Owner/Operator to provide prospective tenants with sufficient information and guidelines for fitting out the office spaces. Compliance with the so-called 'Tenants Fitting-Out Specifications' should ensure the indoor environmental conditions are satisfactory when the space is fully occupied, reinforcing the overall environmental performance of the building. Non-compliance would serve to alert the Tenant that the indoor environmental conditions may be compromised. Whilst the 'Tenant Fitting-Out Specifications' form an important part of the assessment, checks on actual compliance lies outside the scope of the assessment.

## 1.5 ISSUES CONSIDERED IN THE ASSESSMENT

The environmental issues covered are grouped under three main headings:

- Global issues and use of resources (Chapter 2)
- Local issues (Chapter 3)
- Indoor issues (Chapter 4)

A summary of the issues is given below. Table I summarises the criteria for the award of credits.

**Global issues and use of resources:**

- electrical energy consumption;
- ozone depletion;
- use of timber;
- facility for recycling materials.

**Local issues:**

- electricity maximum demand;
- construction wastewater discharge;
- water conservation;
- Legionella bacteria from wet cooling towers;
- recycled materials;
- noise during construction
- noise from the building;
- transport and pedestrian access;
- vehicular access for servicing and for waste disposal.

**Indoor issues:**

- metering and monitoring equipment;
- HVAC system commissioning;
- operation and maintenance;
- biological contamination;
- indoor air quality;
- hazardous materials;
- interior lighting;
- indoor noise.

## 1.6 ASSESSMENT PROCESS

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

CET will issue a questionnaire to interested developers which details the information required for assessment. Designs can be assessed 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 also 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 Designer (acting on behalf of the Owner) 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.

The assessor may award discretionary credits for any environmentally proactive feature not covered in any of the documented assessment points.

HK-BEAM certificate ratings (“Fair,” “Good,” “Very Good,” or “Excellent”) are based on the number of credits achieved in each of the three categories (Global Issues and Use of Resources, Local Issues and Indoor Issues), and the total number of credits which are achieved.

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

**Table 1: Summary of Credits and Checklist**

**GLOBAL ISSUES AND USE OF RESOURCES**

| Sect: | Credit requirement: | Obtainable Credit: | Credits Obtained: |
|---|---|---|---|
| **2.1** | **Electrical Energy Consumption:** | | |
| **a)** | for specifying and confirming installation of energy efficient lighting in areas such as plant rooms, lift lobbies, etc., which are under the control of the Owner/Operator | **1** | |
| **b)** | for designing to an office lighting power density of less than 21 W/$m^2$ (includes tube and ballast loss) | **1** | |
| | for designing to an office lighting power density of less than 18 W/$m^2$. | **2** | |
| | for designing to an office lighting power density of less than 15 W/$m^2$ | **3** | |
| **c)** | where heat recovery is provided on the general exhaust from the air-conditioned spaces | **1** | |
| | for providing heat reclaim on chillers for winter space heating or other hot water requirements, or where there is no provision of winter space heating | **1** | |
| **d)** | for air conditioning equipment electricity load of less than 150 kWh/$m^2$/year (in office areas) | **1** | |
| | for air conditioning equipment electricity load of less than 140 kWh/$m^2$/year | **2** | |
| | for air conditioning equipment electricity load of less than 130 kWh/$m^2$/year | **3** | |
| | for air conditioning equipment electricity load of less than 120 kWh/$m^2$/year | **4** | |
| | for air conditioning equipment electricity load of less than 110 kWh/$m^2$/year | **5** | |
| | for air conditioning equipment electricity load of less than 100 kWh/$m^2$/year | **6** | |
| | for air conditioning equipment electricity load of less than 90 kWh/$m^2$/year | **7** | |
| **2.2** | **Ozone Depletion:** | | |
| **a)** | for specifying and verifying the use of refrigerants with ozone depletion potential of 0.03 or less | **1** | |
| | for specifying and verifying the use of refrigerants with ozone depletion potential of zero | **2** | |
| **b)** | for specifying automatic refrigerant leak detection for indoor chiller plant, or for specifying six-monthly manual checking for leakage for outdoor plant, AND<br>specifying full refrigerant recovery during maintenance using approved refrigerant recovery equipment and containers | **1** | |
| **c)** | for specifying insulants in building fabric and services that avoids the use of ozone depleting substances in their composition or during their manufacture | **1** | |
| | for specifying insulants in roof constructions that avoids the use of ozone depleting substances in their composition or during their manufacture | **1** | |
| **2.3** | **Use of Timber:** | | |
| **a)** | for specifying use of durable and reusable formwork systems to replace timber formwork, and that timber formwork, where used, is properly maintained | **1** | |

| | | | |
|---|---|---|---|
| **b)** | for specifying solid timber which is obtained entirely from well-managed sources, which may include suitable re-used timber | **1** | |
| | for specifying timber panel products which are obtained entirely from well-managed sources, and which includes suitable re-used timber | **1** | |
| **2.4** | **Facility for Recycling Materials:** | | |
| | for designs which incorporate separate storage space for recyclable materials | **1** | |
| **Total Credits Under Global Issues** | | **22** | |

**Table 1: continued**

**LOCAL ISSUES**

| Sect: | Credit requirement: | Obtainable Credit: | Credits Obtained: |
|---|---|---|---|
| **3.1** | **Electricity Maximum Demand:** | | |
| | for demonstrating peak electricity demand will be less than 160 VA/$m^2$ (in office areas) | **1** | |
| | for demonstrating peak electricity demand will be less than 140 VA/$m^2$ | **2** | |
| | for demonstrating peak electricity demand will be less than 120 VA/$m^2$ | **3** | |
| **3.2** | **Construction Wastewater Discharge:** | | |
| | 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 | **1** | |
| **3.3** | **Water Conservation:** | | |
| | for providing an arrangement of water meters which permits the monitoring of fresh water consumption by the Owner/Operator for each of the major engineering services, separate from that of tenants | **1** | |
| | for specifying and detailing fresh water systems which are fitted with:<br>a flow control and balancing system to control flow characteristics of each faucet, for the purposes of water economy, or<br>devices to automatically control the operation of taps and urinals which use fresh water, for the purposes of water conservation | **1** | |
| **3.4** | **Legionella Bacteria from Wet Cooling Towers:** | | |
| | for a building in which:<br>wet cooling towers are not used, or<br>the wet cooling towers use seawater, or<br>wet cooling towers which use water from an acceptable source (e.g., well water) and are designed and maintained as specified in the Code of Practice for the Prevention of Legionnaires Disease[16] | **1** | |
| **3.5** | **Recycled Materials:** | | |
| **a)** | for specifying at least 50% (by volume) of materials in the walls or flooring to contain more than 50% (by volume) of waste material or by-products | **1** | |
| | for reusing suitable uncontaminated demolition materials wherever appropriate in fill and hard-core and/or granular base | **1** | |
| | for specifying crushed concrete aggregate complying with the quality and grading requirements of British Standard BS 882[12] for use in concrete for foundations, over-site slabs, hardstanding, paths or site roads | **1** | |
| **b)** | for sorting of waste on site for disposal as inert material and other non-inert materials and for the sorting of timber waste for reuse and disposal | **1** | |
| **3.6** | **Noise During Construction:** | | |
| | for applying the criteria and requirements laid down in the Environmental Protection Department Practice Note ProPECC PN 2/93 | **1** | |

| | | | |
|---|---|---|---|
| **3.7** | **Noise from the Building:** | | |
| | for a design for which calculations show that the rating level outside the nearest exposed noise sensitive receiver greater than 5 dB below the background level during any period of the day or evening (07.00 to 23.00 h) and does not exceed the background level during any period of the night (23.00 to 07.00 h) | **1** | |
| **3.8** | **Transport and Pedestrian Access:** | | |
| | for achieving at least one of the following:<br>No car parking provided.<br>Restricted provision of car parking space to the minimum required to comply with lease conditions with access which ensures simultaneous free flow of vehicles in and out of the car park. | **1** | |
| | for providing easy and substantially sheltered pedestrian access to a mainstream mass transport system | **1** | |
| **3.9** | **Vehicular Access for Servicing and for Waste Disposal:** | | |
| | for providing access for delivery vehicles to the service areas of the building which lies within the site boundary and which are enclosed and/or segregated from pedestrian access routes | **1** | |
| | for providing access for waste collection vehicles which lies within the site boundary and which are enclosed and/or segregated from pedestrian access routes | **1** | |
| **Total Credits Under Local Issues** | | **17** | |

**Table 1: continued**

**INDOOR ISSUES**

| Sect: | Credit requirement: | Obtainable Credit: | Credits Obtained: |
|---|---|---|---|
| **4.1** | **Metering and Monitoring Equipment:** | | |
| **a)** | for specifying metering which allows separate monitoring of electricity use (input power, energy and maximum demand) by Owner/Operator's building services systems, other than HVAC services equipment | **1** | |
| **b)** | for specifying metering which allows separate monitoring of electricity use (input power, energy and maximum demand) by the main chiller plant and auxiliaries, and for specifying metering which allows separate monitoring of cooling energy output from the main chiller plant | **1** | |
| **c)** | for metering which allows separate monitoring of electricity use (input power, energy and maximum demand) by the air side of the HVAC system | **1** | |
| **4.2** | **HVAC System Commissioning:** | | |
| | for specifying commissioning of air systems in accordance with CIBSE and BSRIA guidelines, by an independent commissioning specialist who shall be a Registered Professional Engineer | **1** | |
| | for specifying commissioning of water systems in accordance with CIBSE and BSRIA guidelines, by an independent commissioning specialist who shall be a Registered Professional Engineer | **1** | |
| | for specifying commissioning of HVAC control systems in accordance with CIBSE guidelines, by an independent commissioning specialist who shall be a Registered Professional Engineer | **1** | |
| **4.3** | **Operations and Maintenance:** | | |
| | for allowing as a cost item in the contract documents, a specific cost for the preparation of fully documented operations and maintenance manual to the detail specified by either ASHRAE or BSRIA | **1** | |
| | for demonstrating that proper maintenance facilities are to be provided for operations and maintenance work in the form of workshop(s), office accommodation and control room | **1** | |
| **4.4** | **Biological Contamination:** | | |
| | for complying with the design recommendations described in the Code of Practice Prevention of Legionnaires Disease | **1** | |
| **4.5** | **Indoor Air Quality:** | | |
| **a)** | for suitable positioning of outdoor air intake and exhaust to minimise pre-contamination, to prevent short-circuiting of exhaust back into air intakes, and to avoid nuisance to neighbours from exhaust discharge(s) | **1** | |
| **b)** | for designs for which the design ventilation rate is 8 l/s per person or above, AND which specifies smoking will NOT be allowed in the building, or<br>for designs for which the ventilation rate meets ASHRAE or CIBSE recommended ventilation rate for a smoking environment | **1** | |

| | | | |
|---|---|---|---|
| **c)** | for specifying filters for intake air and air handling units with dust spot efficiency ≥ 80% and, where areas are served by fan coil units with dust spot efficiency ≥ 35%, tested in accordance with ASHRAE Standard 52.1-92 or European Standard EN-799:1993, or<br>for demonstrating that the filtration system installed shall be capable of maintaining the indoor respirable suspended particulate level below 180 μg/$m^3$ for 24 hour time weighted average | **1** | |
| | for specifying filters for intake and recirculating air with dust spot efficiency ≥ 80% or otherwise showing that this higher efficiency is not necessary | **1** | |
| **d)** | for designs which include provision for separate ventilated system for areas where significant indoor pollution sources are present, such as print rooms, clinics, beauty parlours, etc | **1** | |
| **4.6** | **Hazardous Materials:** | | |
| **a)** | specifying particleboard, fibreboard, and similar composite boards conforming to European Standard EN 321-1, or alternative equivalent standards,<br>excluding use of treated timber where it is not recommended in any relevant codes and standards, and<br>specifying all preserved timber shall be industrially pre-treated ready for finishing on site | **1** | |
| **b)** | no paints are specified which contain lead, and<br>paint containing volatile organic compounds (VOC) conforms to British Standards relating to solvent | **1** | |
| **4.7** | **Interior Lighting:** | | |
| **a)** | for "Tenant Fitting Out Specifications" which specifies that:<br>fluorescent and other lamps with modulating (fluctuating) output should be fitted with high-frequency ballasts in all the areas used for office work, and<br>lamps shall have a CIE general colour rendering index 80 or above (i.e. colour rendering groups 1A or 1B) | **1** | |
| **b)** | where the "Tenant Fitting Out Specifications" demonstrates, by calculations for a typical office floor plan and surface finishes, that CIBSE guidelines in respect of maintained illuminance on the working plane, illuminance variation, and limiting glare index are followed | **1** | |
| **4.8** | **Indoor Noise:** | | |
| | for external noise levels transmitted through the building envelope at or below the following values:<br>private offices and small conference rooms: 40 dB $L_{Aeq,T=8hr}$ or 45 db $L_{Aeq,T=30min}$<br>large offices: 45 dB $L_{Aeq,T=8hr}$ or 50 db $L_{Aeq,T=30min}$ | **1** | |
| | for internal noise levels from air conditioning systems at or below the following values:<br>private offices and small conference rooms: 40 dB $L_{Aeq,T=8hr}$ or 45 db $L_{Aeq,T=30min}$<br>large offices: 45 dB $L_{Aeq,T=8hr}$ or 50 db $L_{Aeq,T=30min}$ | **1** | |
| **Total Credits Under Local Issues** | | **20** | |
| **Total Credits Available** | | **59** | |

# 2 Global Issues and Use of Resources

Apart from population growth the construction and use of buildings has a greater impact on the global environment than almost any other human activity. Environmental damage arises as a result of, for example, energy and materials used during construction, energy used for cooling and lighting, the chemicals present in materials used in building services and components, and waste streams during construction, operation, refurbishment and demolition.

This chapter covers the effects that buildings have on the planet and it's atmosphere beyond the local region: global warming, ozone depletion, acid rain and sustainable resources.

## 2.1 ELECTRICAL ENERGY CONSUMPTION

Energy is used in the construction and refurbishment of buildings to win raw materials, to manufacture products and transport them to site, and in demolition and disposal at the end of the building's life. For most office buildings the energy used for running the building over its lifetime is many times greater than the sum of the energy used during construction. Energy efficiency in operation is therefore the most effective means of reducing carbon dioxide emissions.

The main uses of energy during the occupied lifetime of an office building are electricity for air conditioning, ventilation, lighting, and office equipment. The generation of this electricity has a significant impact on the global environment:

- burning any fossil fuel leads to the production of carbon dioxide ($CO_2$) and so contributes to the potential for global warming through the greenhouse effect;
- oxides of nitrogen and sulphur are emitted when certain fossil fuels (particularly coal and oil) are burnt, thus contributing to acid rain and the potential of damage to the environment;
- extraction of fossil fuels represents the depletion of valuable natural resources and has its own environmental impact.

**Objective of HK-BEAM**

To reduce electrical energy consumption so as to reduce the release of carbon dioxide into the atmosphere and thus reduce the potential for global warming. Related benefits will be to reduce acid rain due to oxides of nitrogen and sulphur, and to reduce the rate of depletion of fossil fuels.

**Maximum number of credits attainable: 13**

**Credit requirement**

a) Owner/Operator installed lighting

❖ 1 credit for specifying and confirming installation of energy efficient lighting in areas such as plant rooms, lift lobbies, etc., which are under the control of the Owner/Operator.

b) Office lighting

Credit will be given on a 3 point scale to office designs which the 'Tenants Fitting Out Specifications' demonstrates a design lighting power density (in $W/m^2$ of office floor area) which is less than that achieved in a typical Hong Kong office building.

❖ 1 credit for designing to an office lighting power density of less than 21 $W/m^2$.
❖ 2 credits for designing to an office lighting power density of less than 18 $W/m^2$.
❖ 3 credits for designing to an office lighting power density of less than 15 $W/m^2$.

c) Heat recovery

❖ 1 credit where heat recovery is provided on the general exhaust from the air-conditioned spaces.
❖ 1 credit for providing heat reclaim on chillers for winter space heating or other hot water requirements, or where there is no provision of winter space heating.

d) Annual air conditioning electricity consumption

Credit will be given on a 7 point scale to offices which have a predicted annual electricity load for the air conditioning system (in kWh per square metre for a typical office floor area per year) less than would be achieved by a typical new Hong Kong office building.

- 1 credit for air conditioning equipment electricity load of less than 150 kWh/$m^2$/year.
- 2 credits for air conditioning equipment electricity load of less than 140 kWh/$m^2$/year.
- 3 credits for air conditioning equipment electricity load of less than 130 kWh/$m^2$/year.
- 4 credits for air conditioning equipment electricity load of less than 120 kWh/$m^2$/year.
- 5 credits for air conditioning equipment electricity load of less than 110 kWh/$m^2$/year.
- 6 credits for air conditioning equipment electricity load of less than 100 kWh/$m^2$/year.
- 7 credits for air conditioning equipment electricity load of less than 90 kWh/$m^2$/year.

**Method of assessment**

The method of assessment is directed at three major components associated with the air conditioning electricity load (see Figure 1). The first is the design office lighting load, which contributes to the space cooling load. The second is associated with provisions for recovering any energy used by the air-conditioning system, and the last concerns the overall efficiency of the building envelope and the air conditioning equipment. The latter involves the consideration of the combined efficiency of the refrigeration units, fans and pumps, and other related systems, e.g. the space/water heating system.

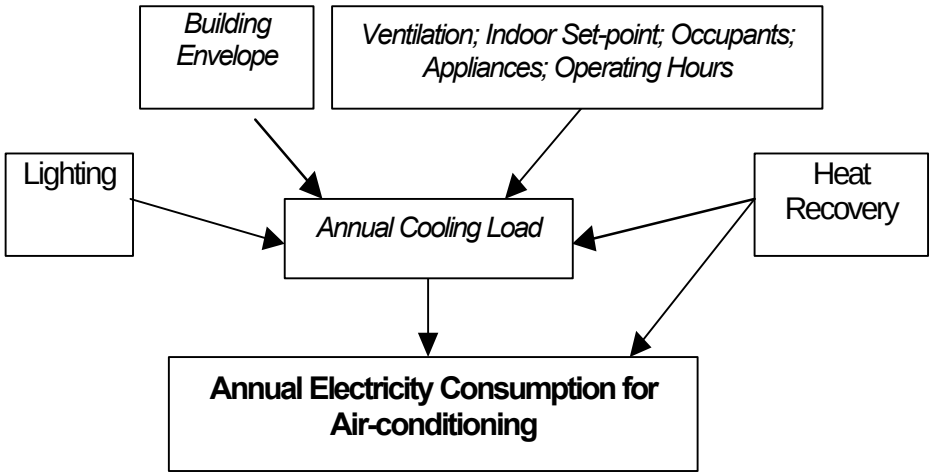


Figure 1 : Components of Method of Assessment

a) This applies to the lighting systems used in all areas of the building which serve the office premises and which are under the control of the Owner/Operator. This includes lift lobbies, staircases, plantrooms, services areas, public areas, etc. Given the variability of lighting needs in each type of space it is not intended to be too prescriptive as to the requirements for credit. HK-BEAM seeks to encourage levels of efficiency which are higher than those promulgated in the Government's Lighting Energy Code[6,7].

The Designer shall provide details of lighting systems specified for each of the areas and demonstrate that the installed lamps/luminaires use light sources which have high efficacy.

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

7 Electrical and Mechanical Services Department, The Government of the Hong Kong Special Administrative Region. Guidelines on Energy Efficiency of Lighting Installations. 1998.

The design illuminance in each applicable area should comply with the CIBSE Code for interior lighting[8]. Installation shall be confirmed upon completion.

b) The office design installed lighting load shall be demonstrated by calculations based on CIBSE Code for interior lighting (see also the section on Interior Lighting under Indoor Issues in Chapter 4). The Designer shall submit detailed calculations, drawings and specifications for a typical office floor plan to demonstrate the input power density for the lighting system specified in the 'Tenants Fitting Out Specifications'. Where more than one system is specified, the Designer shall submit the details for each system. In addition, the 'Tenants Fitting-Out Specifications' shall specify and show design details for a typical office floor layout, with no more than 20 $m^2$ of installed luminaires controlled from one switch point.

c) For the assessment of energy recovery the Designer shall provide specifications and design details. Installation shall be confirmed upon completion.

d) The annual air-conditioning equipment electricity load will be calculated by a two stage approach. The building energy simulation program HTB2 will be used to calculate the hourly space cooling loads for various building zones. The zone cooling loads predicted by HTB2 will then be used as input data to a plant performance simulation program BECON to calculate the corresponding air-conditioning equipment electricity consumption. In the calculation of both the zone cooling load and the equipment load, the assumption is made that the control systems are "perfect" in that they can always maintain the controlled variables at their respective set-point values. Also, equipment dynamics are ignored.

Default values used in determining the assessment criteria are as given in Appendix B. Building and equipment performance data required to be submitted for the assessment are set out in Appendix C.

8 The Chartered Institution of Building Services Engineers. Code for interior lighting. London. CIBSE, 1994.

## 2.2 OZONE DEPLETION

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

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

**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: 4**

**Credit requirement**

a) Refrigerants in air conditioning

- ❖ 1 credit for specifying and verifying the use of refrigerants with ozone depletion potential of 0.03 or less.
- ❖ 2 credits for specifying and verifying the use of refrigerants with ozone depletion potential of zero.

b) Reduction of refrigerant leakage

- ❖ 1 credit for;
- ♦ specifying automatic refrigerant leak detection for indoor chiller plant, or specifying six-monthly manual checking for leakage for outdoor plant, AND
- ♦ specifying full refrigerant recovery during maintenance using approved refrigerant recovery equipment and containers.

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

- ❖ 1 credit for specifying insulants in building fabric and services that avoids the use of ozone depleting substances in their composition or during their manufacture.
- ❖ 1 credit for specifying insulants in roof constructions that avoids the use of ozone depleting substances in their composition or during their manufacture.

**Method of assessment**

a) The ozone depletion potential of the refrigerant used in the air conditioning system will be checked at the design stage, and shall require confirmation following installation.

b) The specification will be checked for provision of automatic leak detection and suitable refrigerant recovery unit and containers. This provision shall be confirmed upon completion of the installations.

Automatic leak detection systems are not suitable for use with a system which is to be sited outdoors, or an enclosed plant with condensers outdoors. In these cases, a maintenance agreement for a 6-monthly manual inspection for leaks should be specified. If a reversible unitary heat-pump system (or any other system of small, sealed air conditioning units) is specified, a maintenance agreement must be drawn up covering a 6-monthly manual inspection for system leaks. The maintenance agreement should specify that full refrigerant recovery must be carried out before a unit is opened for repair.

Many systems allow the refrigerant to be pumped to the condenser of the chiller as part of the chiller shut-down process. This is not sufficient on its own to earn a credit under HK-BEAM. A separate refrigerant recovery unit should be provided. This is a portable or fixed unit which contains a pump for transferring refrigerant from the chiller circuits to a storage cylinder, where it can be held until maintenance is complete. A single chiller may have more than one refrigerant circuit, but it is unlikely that two or more will fail simultaneously. The capacity of the storage container, therefore, only needs to equal that of the largest refrigerant circuit. In some situations refrigerant recovery is not appropriate, for instance small, individual room air conditioners, or heat pumps which would normally be unplugged and returned to the manufacturers for maintenance. Where such systems are specified, the Designer shall provide details of the maintenance agreement, including the maintenance policy to be followed. Credit can be given where maintenance documents specify that all refrigerant must be recovered or reclaimed as part of the maintenance procedure.

c) A full description of all the insulation materials specified for walls, chilled water pipes, refrigerant pipes, ductwork, etc., will be checked for the presence of ozone-depleting agents.

The insulating materials used in roof constructions will be checked for the presence of ozone-depleting agents.

If there is any doubt about the ozone depletion potential of the material, the design team must provide details from the manufacturer.

## 2.3 USE OF 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 forests that would otherwise help regulate the amount of $CO_2$ 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: 3**

**Credit requirement**

a) Use during construction

❖ 1 credit for specifying use of durable and reusable formwork systems to replace timber formwork, and that timber formwork, where used, is properly maintained.

b) Use in the building fabric and finishes

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

**Method of assessment**

a) Specifications and contract documents shall be presented for the purpose of demonstrating compliance. The Client's authorised representative will confirm that a requirement of site supervision shall be to monitor and report on compliance. The Assessor may carry out site inspections during construction.

b) Softwood timbers and temperate hardwoods are assumed to be from well-managed sources. If tropical hardwoods have been specified, the designer shall 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 designer will be asked to produce written confirmation from the suppliers regarding the composition of wood-based panel products being used. 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 demonstrate that the 'Tenants Fitting-Out Specifications' will also contain relevant information and advice to encourage and enable tenants to meet the above criteria.

## 2.4 FACILITY FOR RECYCLING MATERIALS

Operation, maintenance, refurbishment, demolition and replacement of buildings and their services require significant use of energy and materials. The need for this can be reduced by ensuring that the fabric and services are maintained with longevity in mind and wherever possible use is made of recycled materials in construction, and provision is made for recycling materials during the building life. Day-to-day consumables such as paper and glass are more likely to be recycled if suitable separation and storage provision are available.

**Objective of HK-BEAM**

To reduce energy consumption during manufacture, to reduce pressure on landfill sites, and to help to preserve non-renewable resources by promoting recycling of waste materials.

**Maximum number of credits attainable: 1**

**Credit requirement**

- 1 credit for designs which incorporate separate storage space for recyclable materials.

**Method of assessment**

A dedicated storage space should be provided for separate storage of recyclable materials. The guideline is that 2 square metres of storage space for each 1000 $m^2$ of office floor area should be provided solely for the purpose of storage, with a maximum area of 20 $m^2$. The space should be clearly labelled as a recycling store and have good access for cleaners, and for removal of materials by recycling contractors or the local authority. It should also be enclosed and adequately ventilated.

# 3 Buildings and Local Issues

As a community Hong Kong must accept the principle that we have a responsibility for stewardship of the environment, a responsibility to ensure that it is properly sustained. It is necessary to overcome the environmental degradation caused by past practices, protect the environment from ourselves, and provide for future generations. It has been observed that Hong Kong's urban micro-climate is modified by the high density, high rise development, where temperatures are increasing, visibility decreasing, and air pollution levels are not being effectively reduced by the natural ventilation effects of the climate.

This chapter covers those issues that affect either the Hong Kong environment in general, or the immediate surroundings of a building.

## 3.1 ELECTRICITY MAXIMUM DEMAND

Power stations operate under licences issued by the Director of Environmental Protection, requiring operators to employ Best Practicable Means to control emissions to an acceptable level. However, a growth in peak demand is resulting in the development of further generation, transmission and distribution capacity, and may add to global and local emissions when less efficient plant needs to be operated.

Buildings are not only responsible for more than half of the electricity consumed in Hong Kong but also, due mainly to air-conditioning demand, are responsible for much of the peak load that occurs around midday during summer months. Reduction of maximum demand, by limiting building's peak cooling load, can reduce the rate of expansion of power station generating capacity and reduce overall flue gas emissions.

**Objective of HK-BEAM**

To reduce summer peak electricity demand in order to alleviate growth in power station generating capacity and construction of new power stations.

**Maximum number of credits attainable: 3**

**Credit requirement**

Credit will be given on a 3 point scale to offices which have a predicted electricity demand (in VA per square metre for a typical office floor area) less than would be achieved by a typical new Hong Kong office building.

- ❖ 1 credit for demonstrating peak electricity demand will be less than 160 VA/$m^2$.
- ❖ 2 credits for demonstrating peak electricity demand will be less than 140 VA/$m^2$.
- ❖ 3 credits for demonstrating peak electricity demand will be less than 120 VA/$m^2$.

**Method of assessment**

Credit shall be given on a 3 point scale for office designs which have a predicted maximum demand better than would be achieved by a typical new Hong Kong office building. The maximum demand will be calculated using:

- the computed peak electricity load of the air conditioning system (refer to the section on Electrical Energy Consumption in section 2.1);
- the lighting load based on the design figures supplied by the Designer (refer to the section on Electrical Energy Consumption in section 2.1);
- the appliance load design figure supplied by the Designer; and
- an allowance for other miscellaneous loads.

The sum of these loads (in W/$m^2$) are converted to maximum demand (in VA/$m^2$) using a default power factor of 0.85.

## 3.2 CONSTRUCTION WASTEWATER DISCHARGE

Hong Kong's rapid growth has left the territory with an overloaded and inadequate sewerage system so that much 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 by poor handling of site wastewater. These problems can all 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: 1**

**Credit requirement**

- 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.

**Method of assessment**

The Client's representative shall confirm in writing that construction specifications mandate that the recommendations given in ProPECC PN 1/94[9] shall be observed as far as practicable given the site circumstances. The Assessor may carry out site inspections during construction.

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

## 3.3 WATER CONSERVATION

Water shortages are always a possibility and it is important to conserve water. Potable water is used in office buildings predominantly for washing, cleaning and in some cases for kitchens, air-conditioning systems, showers and urinals. Whilst many flushing systems use seawater, there is an energy and sewage penalty for excessive consumption. Measures can be taken to restrict water usage in all aspects.

**Objective of HK-BEAM**

To reduce wastage of water, which is a valuable resource, and to increase awareness of its importance. To reduce the environmental impact of sewage discharged from office buildings.

**Maximum number of credits attainable: 2**

**Credit requirement**

- ❖ 1 credit for providing an arrangement of water meters which permits the monitoring of fresh water consumption by the Owner/Operator for each of the major engineering services, separate from that of tenants.
- ❖ 1 credit for specifying and detailing fresh water systems which are fitted with:
- ♦ a flow control and balancing system to control flow characteristics of each faucet, for the purposes of water economy, or
- ♦ devices to automatically control the operation of taps and urinals which use fresh water, for the purposes of water conservation.

**Method of assessment**

The assessment will seek to establish if mechanisms are in place that effectively limits wastage of water by shutting off faucets automatically when not in use, and/or reducing excessive flow at faucets. Various approaches are available and HK-BEAM is not intended to be too prescriptive as to which should be used. Examples of automatic shut-off devices are spring-loaded taps, electronic proximity sensors, pressure reducing valves, etc., but excluding timed shut-off devices. It is not intended to assess the efficiency of such measures, but to assess reasonable attempts to reduce fresh water consumption.

The measures to conserve water must be applied to all points where potable water is used, unless good reason is given as to why a water conserving feature is not warranted. The designer shall provide details of the systems used, and a sample selection may be checked upon completion.

## 3.4 LEGIONELLA BACTERIA FROM WET COOLING TOWERS

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

**Objective of HK-BEAM**

To minimise the threat of Legionnaires' disease arising from wet cooling towers associated with air conditioning systems.

**Maximum number of credits attainable: 1**

**Credit requirement**

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

**Method of assessment**

When wet cooling towers are to be specified they shall be designed to the specifications given the Code of Practice Prevention of Legionnaires Disease(10). The Designer shall confirm compliance in writing. Deviations from the specifications given in the CoP shall be identified.

[10] Prevention of Legionnaires' Disease Committee, Electrical and Mechanical Services Department, Hong Kong Government. "Code of Practice for the Prevention of Legionnaires' Disease in Hong Kong". November 1994.

## 3.5 RECYCLED MATERIALS

Hong Kong has long been experiencing problems due to the large quantities of construction and demolition (C&D) material going to landfills. According to the Environmental Protection Department more than 50% of waste deposited at landfills each year since 1990 was C&D waste. Even after implementation in 1996 of the new C&D waste management strategy the proportion of C&D waste remains too great.

**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. Metals, minerals and oil derivatives are non-renewable materials used in many building components.

**Maximum number of credits attainable: 2**

**Credit requirement**

a) Use of products containing waste or by-product material or uncontaminated demolition materials

- ❖ 1 credit for specifying at least 50% (by volume) of materials in the walls or flooring to contain more than 50% (by volume) of waste material or by-products.
- ❖ 1 credit for reusing suitable uncontaminated demolition materials wherever appropriate in fill and hard-core and/or granular base.
- ❖ 1 credit for specifying crushed concrete aggregate for use in concrete for foundations, over-site slabs, hardstanding, paths or site roads.

b) Waste sorting for reuse and disposal

- ❖ 1 credit for sorting of waste on site for disposal as inert material and other non-inert materials and for the sorting of timber waste for reuse and disposal.

**Method of assessment**

a) Where products such as lightweight blocks containing waste materials or by-products are used, the Designer will provide written confirmation that the composition of the product is greater than 50% waste material by volume. One credit is available for using such material in a significant proportion (over 50%) in either the walls or the flooring. Where demolition materials are to be used the Designer shall confirm how the criteria will be met. Details shall be provided on what material is being specified and where it is to be used. The specifications must be supported by evidence of fitness for purpose.

   Concrete aggregate shall comply with the quality and grading requirements of British Standard BS 882[11]. Similarly, where concrete aggregate is to be used the Designer shall confirm how the criteria will be met. Guidance should be taken from BRE Digests 276[12] (for hard-core) and 363[13] (for prevention of sulphate attack), and from British Standard BS 6543:1985[14].

b) The specifications and contract documents shall be checked to ensure the sorting of waste for disposal separates inert materials from non-inert materials for more efficient disposal at dumps and landfill sites. The Assessor may carry out site inspections during construction.

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11 British Standards Institution. Specification for aggregates from natural sources for concrete. British Standard BS 882:1992. London, BSI, 1992.

12 Building Research Establishment Hardcore Building Research Establishment Digest 276 Garston BRE 1983.

13 Building Research Establishment Sulphate and acid resistance of concrete in the ground Building Research Establishment Digest 363 Garston BRE 1991.

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

## 3.6 NOISE DURING CONSTRUCTION

Hong Kong is perhaps one of the noisiest cities in the world. The Government's policy objective for controlling noise pollution is to ensure that a satisfactory noise environment is maintained to safeguard the quality of life of the population. The construction and operation of commercial premises can generate noise at levels sufficient to cause speech interference and sleep disturbance.

**Objective of HK-BEAM**

To minimise nuisance to neighbours caused by noise during construction.

**Maximum number of credits attainable: 1**

**Credit requirement**

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

**Method of assessment**

Specification in contract documents of measures to control construction noise (not currently controlled by legislation), as cited in ProPECC PN 2/93(15).

15 Environmental Protection Department. Practice Note for Professional Persons. ProPECC PN 2/93. May 1993.

## 3.7 NOISE FROM THE BUILDING

The Government responds to noise problems through enforcement of noise control legislation, incorporation of noise mitigation measures in new projects and providing control measures to abate existing problems.

**Objective of HK-BEAM**

To reduce the nuisance caused by noise during construction, and subsequently noise from building services, disturbing neighbouring householders, particularly at night.

**Maximum number of credits attainable: 1**

**Credit requirement**

- 1 credit for a design for which calculations show that the rating level outside the nearest exposed noise sensitive receiver greater than 5 dB below the background level during any period of the day or evening (07.00 to 23.00 h) and does not exceed the background level during any period of the night (23.00 to 07.00 h).

**Method of assessment**

The noise measurements/calculations shall be carried out by the design team according to BS 4142[16] The building services shall be designed so that the rating of the noise does not exceed the limits given above. The background noise shall be measured according to the Environmental Protection Department's Technical Memorandum[(17)].

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

[17] Environmental Protection Department. Technical Memorandum for the Assessment of Noise from places Other Than Domestic Premises, Public Places or Construction Sites.

## 3.8 TRANSPORT AND PEDESTRIAN ACCESS

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 employees to reduce pollution, fuel use and noise from private cars and public taxis by encouraging the use of mass transit systems.

**Maximum number of credits attainable: 2**

**Credit requirement**

- 1 credit for achieving at least one of the following:
  - No car parking provided.
  - Restricted provision of car parking space to the minimum required to comply with lease conditions with access which ensures simultaneous free flow of vehicles in and out of the car park.
- 1 credit for providing easy and substantially sheltered pedestrian access to a mainstream mass transport system.

**Method of assessment**

The lease conditions and car parking provisions agreed and approved by the Authority shall be checked. Credit shall be given where the developer demonstrates minimum provision of car parking to meet lease conditions, or those of the Government's Master Development Plans.

The design plans will be checked to ensure that employees have easy sheltered pedestrian access to and from a major transport interchange, such as a station, or main stream mass transport, such as cross-harbour bus route stops. Credit will be awarded for provision of footbridge, covered walkway, or other substantial means of improving access over and above that already provided.

## 3.9 VEHICULAR ACCESS FOR SERVICING AND FOR WASTE DISPOSAL

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

**Objective of HK-BEAM**

To reduce traffic congestion caused by vehicles queuing to enter buildings. To encourage proper management of service vehicles requiring access to the building for the purposes of deliveries and waste disposal, etc.

**Maximum number of credits attainable: 2**

**Credit requirement**

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

**Method of assessment**

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

# 4 Indoor Issues

Outdoor air pollution is a matter for concern for building designers and operators. Ambient air quality in urban areas of Hong Kong often fails to meet the targets set by the Hong Kong Air Quality Objectives (AQO)[18]. This defines levels of air quality that are judged as necessary to protect the population-at-large and takes into consideration 24-hour per day exposure of the very young, the very old and the seriously ill. Although power stations in Hong Kong are major emitters of $SO_2$ and $NO_2$, the concern is global rather than local, as they do not contribute significantly to the levels of air pollution in urban areas. Much of the ambient air pollution in urban areas is attributable to motor vehicles, with diesel engines making a significant contribution to particulate levels. Building designers and operators should take account of outside air pollution when considering the location of 'fresh air' intakes, filtration and infiltration, and access points to buildings.

The indoor environment is known to play an important role in productivity. HVAC and lighting systems are key elements in the control of the environmental conditions. Thermal conditions in Hong Kong office buildings are on the cool side of the comfort boundary during summer months, when energy demand is greatest. Poor lighting, excessive noise and inadequate fresh air supply can exacerbate comfort conditions. Poor lighting reduces the efficiency and effectiveness with which people work, whilst noise is a frequent cause of complaint in offices. The poor location of fresh air intakes, filtration and openings (such as entrances) to buildings, and the distribution of air within the building all contribute to inadequate air quality. These problems can be avoided by careful design and improved though proper operation and management.

Buildings can have a significant influence on the health, comfort and well-being of the occupants. The highest concentrations of many airborne pollutants are found indoors, where the adult population typically spends around 90% of its time. These include formaldehyde, wood preservatives, volatile organic compounds, living organisms (e.g., bacteria, moulds, dust mites), particulate and fibres, combustion products (e.g., oxides of nitrogen), and lead. In some office buildings the occupants can experience building related illnesses.

Indoor issues include all those aspects of a building design, operation and fitting-out, such as thermal comfort, air quality, lighting and hazardous materials, which have an impact on the health, comfort or well-being of the occupants.

## 4.1 METERING AND MONITORING EQUIPMENT

**Objective of HK-BEAM**

To enable building operators to measure, monitor and develop measures to improve the performance of the building's engineering systems, particularly concerning energy use and indoor environmental conditions.

**Maximum number of credits attainable: 3**

**Credit requirement**

a) Non-HVAC services

❖ 1 credit for specifying metering which allows separate monitoring of electricity use (input power, energy and maximum demand) by Owner/Operator's building services systems, other than HVAC services equipment.

b) Chiller plant

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18 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 specifying metering which allows separate monitoring of electricity use (input power, energy and maximum demand) by the main chiller plant and auxiliaries, and for specifying metering which allows separate monitoring of cooling energy output from the main chiller plant.

c) Air handling plant

- ❖ 1 credit for metering which allows separate monitoring of electricity use (input power, energy and maximum demand) by the air side of the HVAC system.

**Method of assessment**

a) Metering provision shall identify the electricity use pattern for each major non-HVAC related system fed from the Owner/Operator's main switchboard(s), i.e., landlords light and small power, transportation, plumbing & drainage systems, etc.

b) Monitoring of central chiller plants will be assessed on the basis of BSRIA Technical Note TN 7/94[19]. The monitoring system shall allow the overall performance of the plant and individual chillers to be determined for all operating modes and range of operating conditions.

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

Metering current transformers shall be specified to IEC 185 [20] to at least accuracy class 1. Electricity metering for indicating power and energy shall comply with IEC 521[21] to at least accuracy class 1.

The Designer shall provide details of the measuring equipment installed and commissioning records of consumption and chiller plant performance, such as to demonstrate that electricity use and performance can be monitored as stipulated. The Assessor may undertake checks upon completion.

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

20 International Electrotechnical Commission, CEI/IEC 185:1987. Amended 1995. Current Transformers.

21 International Electrotechnical Commission, CEI/IEC 521:1988. Class 0.5, 1 and 2 alternating-current watthour meters. Equivalent is BS EN 60521:1995.

## 4.2 HVAC SYSTEM COMMISSIONING

**Objective of HK-BEAM**

To ensure all HVAC sub-systems, particularly environmental controls, equipment set points, and monitoring devices, perform as specified and allow the systems to operate as intended.

**Maximum number of credits attainable: 3**

**Credit requirement**

- 1 credit for specifying commissioning of air systems in accordance with CIBSE and BSRIA guidelines, by an independent commissioning specialist who shall be a Registered Professional Engineer.
- 1 credit for specifying commissioning of water systems in accordance with CIBSE and BSRIA guidelines, by an independent commissioning specialist who shall be a Registered Professional Engineer.
- 1 credit for specifying commissioning of HVAC control systems in accordance with CIBSE guidelines, by an independent commissioning specialist who shall be a Registered Professional Engineer.

**Method of assessment**

Credits will be only awarded if the commissioning of the HVAC system is identified as a separate cost item in the cost of works and the commissioning processes are put under the responsibility of a a Registered Professional Engineer with expertise in commissioning.

The contract documents shall be checked to determine what provision is made at the design stage for the proper commissioning of the HVAC systems. This shall include cost provisions for the appointment of an independent commissioning specialist and for the commissioning processes. The commissioning results shall be confirmed in writing by a Registered Professional Engineer.

The CIBSE[22,23,24] and BSRIA[25,26] guidance documents, or equivalents such as ASHRAE, provide a check-list of requirements, such as management, design for commissioning, access, test positions, measurements and tolerances, installed transducers, specification for portable measuring equipment, etc. This check list shall form the basis for assessing credit for water systems and air systems, respectively.

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

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

24 The Chartered Institution of Building Services Engineers. Automatic controls. CIBSE Commissioning Code Series C, 1973.

25 C Parsloe. The Building Services Research and Information Association. The Commissioning of Air Systems in Buildings. December 1992.

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

## 4.3 OPERATIONS AND MAINTENANCE

When employees are exposed to an environment that results in discomfort or illness, unnecessary costs may be incurred through absenteeism or loss of productivity. Measures taken to reduce the costs of owning and operating a building can easily be counter productive if they have only slightly negative impacts on absenteeism or lost productive concentration of the office employees.

An often quoted estimate is that building utility costs typically of the order of 1% of the total cost of running a business. Although attention is being paid to reducing the energy used in providing adequate indoor environmental conditions, a small percentage increase in worker productivity may provide savings equal to the total utility bill. Effective commissioning, monitoring and maintenance procedures can all help improve the operation of the 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**

- 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 to the detail specified by either ASHRAE or BSRIA.
- 1 credit for demonstrating that proper maintenance facilities are to be provided for operations and maintenance work in the form of workshop(s), office accommodation and control room.

**Method of assessment**

The Client's representative together with the Designer will 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 ASHRAE[27] and BSRIA[28] documentation. Instructions shall be given for the safe and efficient operation of each system and major item of plant, including a description of the operating modes, a recommended strategy for operation and control, control data and set points, interlocks between plant items, etc.

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

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

## 4.4 BIOLOGICAL CONTAMINATION

**Objective of HK-BEAM**

To significantly reduce biological contamination from air conditioning and water systems, and the risk of diseases, particularly Legionnaires' disease.

**Maximum number of credits attainable: 1**

**Credit requirement**

- 1 credit for complying with the design recommendations described in the Code of Practice Prevention of Legionnaires Disease.

**Method of assessment**

Design detail and specification will be checked against the Code of Practice Prevention of Legionnaires Disease[29].

[29] Prevention of Legionnaires' Disease Committee, Electrical and Mechanical Services Department, Hong Kong Government. "Code of Practice for the Prevention of Legionnaires' Disease in Hong Kong". November 1994.

## 4.5 INDOOR AIR QUALITY

**Objective of HK-BEAM**

To achieve a satisfactory level of indoor air quality while promoting energy efficiency.

**Maximum number of credits attainable: 5**

**Credit requirements**

a) Position of outside air intake(s) and exhaust(s)

❖ 1 credit for suitable positioning of outdoor air intake and exhaust to minimise pre-contamination, to prevent short-circuiting of exhaust back into air intakes, and to avoid nuisance to neighbours from exhaust discharge(s).

b) Ventilation rate

❖ 1 credit for designs for which the design ventilation rate is 8 l/s per person or above, AND which specifies smoking will NOT be allowed in the building.

or

❖ 1 credit for designs for which the ventilation rate meets ASHRAE or CIBSE recommended ventilation rate for a smoking environment.

c) Filter selection

❖ 1 credit for specifying filters for intake air and air handling units with dust spot efficiency ≥ 80% and, where areas are served by fan coil units with dust spot efficiency ≥ 35%, tested in accordance with ASHRAE Standard 52.1-92 or European Standard EN-799:1993.

or

❖ 1 credit for demonstrating that the filtration system installed shall be capable of maintaining the indoor respirable suspended particulate level below 180 $\mu g/m^3$ for 24 hour time weighted average.

in addition

❖ 1 credit for specifying filters for intake and recirculating air with dust spot efficiency ≥ 80% or otherwise showing that this higher efficiency is not necessary.

d) Separate ventilation system for significant indoor pollution sources

❖ 1 credit for designs which include provision for separate ventilated system for areas where significant indoor pollution sources are present, such as print rooms, clinics, beauty parlours, etc.

**Method of assessment**

This will include assessment of the system designs set against the Designer's design criteria. Key assumptions concerning tenant fitting out will need to be included. The 'Tenants Fitting Out Specifications' will be checked to ensure appropriate guidance and information is provided for tenants.

a) Unless the Designer can show otherwise, for buildings in high pollution zones air intakes shall be located at least 50 m above street level, and intake and exhaust points shall be at least 10 m apart. Air intakes shall be free of pollution from local sources such as car park exhaust, cooling towers discharges, etc.

   Alternatively, assessment shall be made against the recommendations given in Section 5.5 of ASHRAE 62[30] covering locations of exhaust air and vent outlets.

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30 American Society of Heating, Air-conditioning, and Refrigerating Engineers. Ventilation for Acceptable Indoor Air Quality. ASHRAE Standard 62-1989R, Public Review Draft, 1996.

The design must be able to demonstrate ability to provide fresh air into the premises, by suitable location of fresh air supply inlets, to minimise the effects of external pollution and without short-circuiting from the exhaust. The internal room air distribution should avoid supply air being exfiltrated before use or being distributed to unintentional areas. If some short-circuiting cannot be avoided, the calculation should show the necessary compensation to ensure the net fresh air can be supplied to the premises.

b) To obtain credit, the design of the system shall be demonstrated to conform to the ventilation rate specified.

c) To obtain credit, the specification of filters shall be demonstrated to take account of appropriate guidelines and outside air conditions for the site. Filter performance shall be specified according to ASHRAE Standard 52.1-92[31] or European Standard EN-779[32].

d) Areas so designated shall be physically separated from the rest of the occupied areas by full-height partitions and closed doors, shall have its own ventilation extract system distinct from that of the rest of the office zone. Provision shall be made to avoid recirculation of air from this separately ventilated area.

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31 American Society of Heating, Air-conditioning, and Refrigerating Engineers. Method of testing air filters in general ventilation for removing particulate matter. ASHRAE Standard 52-1, Atlanta(USA), ASHRAE.

32 European Standard EN-779:1993. Particulate Air Filters for general ventilation - Requirements, testing, marking. 1993.

## 4.6 HAZARDOUS MATERIALS

**Objective of HK-BEAM**

To reduce health impacts from pollutants released indoors.

**Maximum number of credits attainable: 2**

**Credit requirement**

❖ 1 credit for achieving items (a) and (b):

a) Formaldehyde emissions

♦ specifying particleboard, fibreboard, and similar composite boards conforming to European Standard EN 321-1, or alternative equivalent standards.

b) Wood preservatives

♦ excluding use of treated timber where it is not recommended in any relevant codes and standards, and
♦ specifying all preserved timber shall be industrially pre-treated ready for finishing on site.

❖ 1 credit for achieving items (c) and (d):

c) Lead in paint

♦ no paints are specified which contain lead, and

d) Volatile organic compounds in paints

♦ paint containing volatile organic compounds (VOC) conforms to British Standards relating to solvent.

**Method of assessment**

Specifications for the base building and the "Tenant Fitting Out Specifications' will be checked.

a) Where particleboards, fibreboards or similar types of composite wood products are specified they shall comply with EN 312-1[33] or similar specification[(34)] as far as formaldehyde emissions are concerned.

b) 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.

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

d) The materials specification must show that VOC in paints conform to British Standards[(35,36,37)] relating to solvent and using latex paint where possible in lieu of solvent based paint.

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[33] European Standard EN 312-1:1997. Particleboards – Specifications. Part 1. General requirements for all board types.

[34] British Standards Institution. Specification for fibre building boards. British Standard BS1142: 1989. London, BSI, 1989. (Superseeded).

[35] British Standards Institution. Mineral solvents (white spirit and related hydrocarbon solvents) for paints and other purposes. British Standard BS 245:1992. London, BSI, 1992.

[36] British Standards Institution. Water-borne priming paints for woodwork. British Standard BS 5082:1993. London, BSI, 1993.

[37] British Standards Institution. Solvent-borne priming paints for woodwork. British Standard BS 5358:1993. London, BSI, 1993.

## 4.7 INTERIOR LIGHTING

**Objective of HK-BEAM**

To improve the level of visual comfort produced by the lighting of offices.

**Maximum number of credits attainable: 2**

**Credit requirement**

a) Lamps and ballasts

- ❖ 1 credit for "Tenant Fitting Out Specifications" which specifies that:
  - ♦ fluorescent and other lamps with modulating (fluctuating) output should be fitted with high-frequency ballasts in all the areas used for office work, and
  - ♦ lamps shall have a CIE general colour rendering index 80 or above (i.e. colour rendering groups 1A or 1B).

b) Lighting design

- ❖ 1 credit where the "Tenant Fitting Out Specifications" demonstrates, by calculations for a typical office floor plan and surface finishes, that CIBSE guidelines in respect of maintained illuminance on the working plane, illuminance variation, and limiting glare index are followed.

**Method of assessment**

a) The Designer will provide a design and fitting out specification for the lighting system recommended to tenants, in the "Tenant Fitting Out Specifications". This will be checked for design information on luminaires fitted with high-frequency ballasts and good colour rendering (group 1A or 1B) lamps to be fitted in tenant areas to be used as offices.

b) The 'lumen method' formula will be used to calculate the maintained illuminance over the working plane according to the calculation procedure described in Section 4.5.3 of the CIBSE Code for Interior Lighting[38] or in Appendix 3 of the CIBSE Lighting Guide LG7[39]. The calculated maintained illuminance will be checked for compliance with the recommendations given in the Lighting schedule (Section 2.6.4) of the CIBSE Code for Interior Lighting or the recommendations given in Chapter 5 of the CIBSE Lighting Guide LG7.

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

The glare index will be calculated according to either of the two methods described in CIBSE TM10[40]. These methods are also summarised in Section 4.5.6 of the CIBSE Code for Interior Lighting. The calculated glare index will be checked for compliance with the recommendations given in the Lighting schedule (Section 2.6.4) of the CIBSE Code for Interior Lighting or the recommendations given in Chapter 5 of the CIBSE Lighting Guide LG7.

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38 The Chartered Institution of Building Services Engineers. Code for interior lighting. London. CIBSE, 1994.

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

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

## 4.8 INDOOR NOISE

**Objective of HK-BEAM**

To achieve a comfortable noise climate.

**Maximum number of credits attainable: 2**

**Credit requirement**

- ❖ 1 credit for external noise levels transmitted through the building envelope at or below the following values:
  - ♦ private offices and small conference rooms: 40 dB $L_{Aeq,T=8hr}$ or 45 db $L_{Aeq,T=30min}$.
  - ♦ large offices: 45 dB $L_{Aeq,T=8hr}$ or 50 db $L_{Aeq,T=30min}$.
- ❖ 1 credit for internal noise levels from air conditioning systems at or below the following values:
  - ♦ private offices and small conference rooms: 40 dB $L_{Aeq,T=8hr}$ or 45 db $L_{Aeq,T=30min}$.
  - ♦ large offices: 45 dB $L_{Aeq,T=8hr}$ or 50 db $L_{Aeq,T=30min}$.

**Method of assessment**

Calculations shall be made by the design team in terms of $L_{Aeq,T}$ according to British Standard BS 8233:1987[41], where T = 8 hours or T = 30 minutes, appropriate to the criteria chosen. Noise from all sources which are not under the control of the occupant shall be considered, e.g., noise from traffic (a site measurement will be necessary) and building services (obtained from manufacturer's literature). Sufficient numbers of calculations shall be made to ensure that the requirements are met in all the offices, but in particular offices near street level and major plant rooms.

Calculations shall be based on the Owners design recommendations given in the “Tenant Fitting Out Specifications”.

41 British Standards Institution. Sound insulation and noise reduction for buildings. British Standard BS8233: 1987. London, BSI, 1987.

# 5 Appendices

## 5.1 APPENDIX A ELECTRICITY CONSUMPTION FOR AIR-CONDITIONING

The electricity consumption of the air-conditioning system, it will be estimated using the building energy simulation programme HTB2 and a plant performance simulation programme BECON. The submitted data, together with those parameters that are pre-assigned with default values, will be input to these programmes for defining the characteristics and operating conditions of the building and the air-conditioning system. Figure A1 illustrates the computational processes involved. Table A1 gives the values used in establishing the air conditioning electricity consumption criteria. Table A2 gives operating schedules for the occupation density, lighting load profiles and fresh air supply system used in the simulation. Table A3 details the building and equipment performance data required for the simulation.

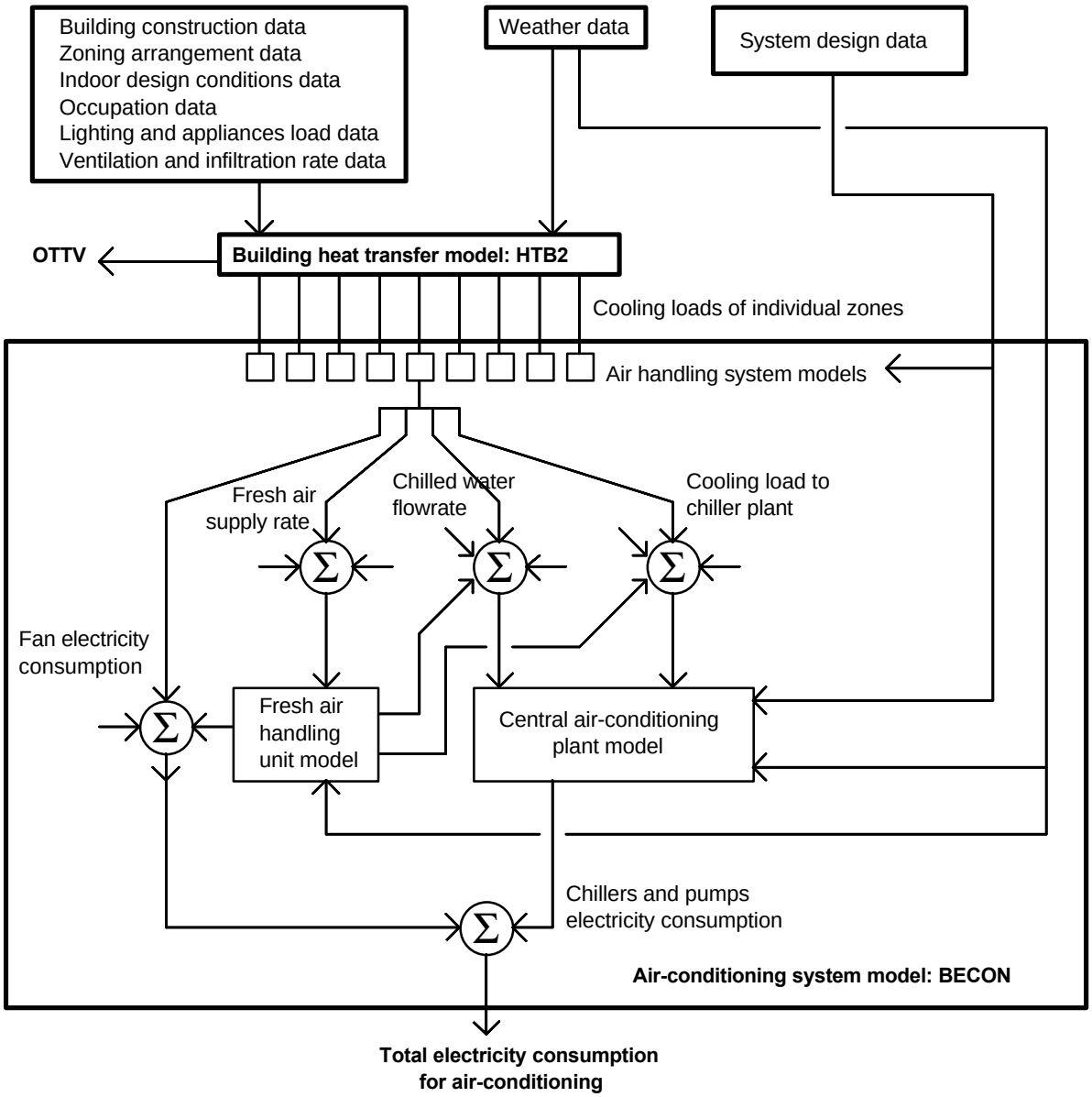


**Fig. A1: Illustration of procedures for air-conditioning equipment load calculation**

**Table A1: Values used in establishing air conditioning electricity consumption criteria**

| **Parameters** | | **For establishing criteria** | **For assessing a building** |
|---|---|---|---|
| Outdoor weather conditions | | Weather data of year 1989 | |
| Indoor design conditions: | | | |
| Cooling | Indoor dry-bulb temperature | 25.5 °C | Design criteria for |
| | Indoor relative humidity | 54 % | the building |
| Heating | Indoor dry-bulb temperature | 22.0 °C | |
| | Indoor relative humidity | Not specified | |
| Normal occupation periods: | | | |
| Weekdays | | 9:00 - 17:00 | |
| Saturdays | | 9:00 - 13:00 | |
| Sundays and public holidays | | Not occupied | |
| Maximum occupation density | | 9 $m^2$ per person | Design criteria for the building |
| Schedule of occupation densities for various hours in the day (in fractions of the maximum density) | | As shown in Table A2 | As shown in Table A2 |
| Ventilation rates: | | | |
| When ventilation system is on | | 10 l/s per person | Design criteria for |
| When ventilation system is off | | 0 | the building |
| Operating hours of ventilation system | | | As shown in Table A2 |
| Infiltration rates: | | | |
| When ventilation system is on | | 0.1 air change/hr. | |
| When ventilation system is off | | 0.5 air change/hr. | |
| Maximum lighting load and ratio of heat-of-light to space | | 25 $W/m^2$ | Design criteria for the building |
| Lighting load at various occupied and unoccupied hours in fraction of max. lighting load | | As shown in Table A2 | As shown in Table A2 |
| Maximum appliances load (assumed constant load) | | 25 $W/m^2$ | Design criteria for the building |

**Table A2: Occupation Density, Lighting Load Profiles and Fresh Air Supply System Operating Schedule**

| Hour | Day in the Week | Occupancy | Lighting (Perimeter) | Lighting (Interior) | Fresh Air Supply |
|---|---|---|---|---|---|
| 1-7 | Weekdays | 0.0 | 0.05 | 0.05 | Off |
| 7-8 | | 0.05 | 0.1 | 0.1 | Off |
| 8-9 | | 0.4 | 0.5 | 0.5 | On |
| 9-10 | | 0.95 | 0.9 | 1.0 | On |
| 10-11 | | 0.95 | 0.9 | 1.0 | On |
| 11-12 | | 0.95 | 0.9 | 1.0 | On |
| 12-13 | | 0.95 | 0.9 | 1.0 | On |
| 13-14 | | 0.45 | 0.8 | 0.9 | On |
| 14-15 | | 0.95 | 0.9 | 1.0 | On |
| 15-16 | | 0.95 | 0.9 | 1.0 | On |
| 16-17 | | 0.95 | 0.9 | 1.0 | On |
| 17-18 | | 0.5 | 0.8 | 0.8 | On |
| 18-19 | | 0.25 | 0.5 | 0.5 | On |
| 19-20 | | 0.1 | 0.3 | 0.3 | Off |
| 20-21 | | 0.05 | 0.2 | 0.2 | Off |
| 21-24 | | 0.0 | 0.05 | 0.05 | Off |
| 1-7 | Saturdays | 0.0 | 0.05 | 0.05 | Off |
| 7-8 | | 0.05 | 0.1 | 0.1 | Off |
| 8-9 | | 0.3 | 0.5 | 0.5 | On |
| 9-13 | | 0.6 | 0.75 | 0.8 | On |
| 13-17 | | 0.1 | 0.2 | 0.2 | Off |
| 17-18 | | 0.05 | 0.1 | 0.1 | Off |
| 18-24 | | 0.0 | 0.05 | 0.05 | Off |
| 1-9 | Sundays | 0.0 | 0.05 | 0.05 | Off |
| 9-17 | and Public | 0.05 | 0.1 | 0.1 | Off |
| 17-24 | Holidays | 0.0 | 0.05 | 0.05 | Off |

†Note: Values denote fractions of maximum occupancy or lighting power.

## Table A3: Building and equipment performance data

### General building data

The site plan, floor plans, elevations, building sectional views, and details of the plot ratio area calculations for the building.

The drawings and information should enable the following data to be determined:

- location of the building
- building orientation (exposure directions of individual facets of the building)
- number of storeys
- total gross floor area ($m^2$)

and for each floor:

- usage
- plot ratio gross floor area ($m^2$)
- floor to floor height (m)
- air-conditioned area ($m^2$), i.e. the total floor area less the plant room and pipe duct areas and the public areas where no air-conditioning is provided (e.g. toilets, staircases)

(Note: air-conditioned public areas such as lift lobby and corridors should be taken as part of the air-conditioned area)

### Building construction data

Drawings showing the construction details for each type of construction elements and the following data pertaining to these elements:

For each external wall and roof element of the building envelope on each floor:

- exposure direction (for walls)
- location
- net area (excluding window or sky-light area, if any) ($m^2$)
- type of construction

For each partition wall or floor slab on each floor:

- location
- area ($m^2$)
- type of construction

And, for each type of wall/roof/floor-slab construction:

- number of layers of materials
- type of material of each layer
- thickness (m), thermal conductivity (W/mK), density (kg/ $m^3$) and specific heat (kJ/kgK) of each layer of material
- for internal partitions and floor slabs, emissivities of the two surfaces
- for external walls and roofs, outer surface solar absorptance for the outermost layer of material and the inner surface emissivity of the innermost layer of material

For each window or skylight element of the building envelope on each floor:

- exposure direction (for windows)
- location
- area ($m^2$)
- type of window/sky-light construction

And, for each type of window/skylight construction:

- number of layers (for double or multi-pane windows/skylights)

- U-value and shading coefficient for each type of window or skylight

(Note: these are for checking consistency of related glass properties below)

- thickness (m), thermal conductivity (W/mK), density (kg/ $m^3$), specific heat (kJ/kgK), short-wave radiation absorptance and transmittance (for the range of incident angles from 0 to 90° in increments of 10°) and longwave emissivity for each glass layer

(Note: these are the required data for simulation using HTB2)

**Lighting load data**

Lighting system design data and drawings including:

- total designed/installed lighting load (W) for the air-conditioned area of each floor

(Note: see 1.1 for meaning of air-conditioned area)

- type(s) of luminaires used on each floor
- lighting layout for each floor with the type(s) of luminaire(s) indicated
- and for each type of luminaire :
- whether room air will flow through the lighting fixture before it returns to the air-handling unit
- number and type of lamps in each luminaire
- wattage of each type of lamp and that of the associated ballast, if any

**Air-conditioning design load data (for offices)**

- indoor design conditions for cooling and heating
- maximum occupancy density
- ventilation rates
- infiltration rates
- maximum appliance load

**System design data**

Documents (design reports or specifications) and drawings (schematic and layout plans) sufficient for providing the following information :

- design peak cooling load of the building
- design peak heating load of the building (if winter space heating is provided)

For the chillers:

- heat rejection method/medium used (e.g. direct/indirect seawater/air cooled)
- number of chillers and their equipment identification numbers (e.g. C01 for chiller no. 1)
- type(s) and model size(s) (capacities) of chillers
- for each type of chiller :
    - type of refrigerant
    - type of compressor (centrifugal/screw/reciprocating)
    - type of compressor motor (open/ hermetic)

(Note: the assumption is made here that electric motor driven vapour compression chillers are used. Different approach will have to be used should other type of drives or absorption chillers be used)

For each of the seawater, condenser water, and chilled water circuit:

- design total water flow rate
- design in/out temperatures
- circuit design including :
    - parallel or series arrangement for the equipment (chillers, heat exchangers and pumps)
    - single- or two-loop pumping

  - stepped or variable flowrate
  - constant or variable pump speed
- number of pumps and their model sizes
- equipment identification number of each pump (e.g. ChWP01 for chilled water pump no. 1)
- number of heat exchangers and their model sizes
- equipment identification number of each heat exchanger
- sequencing control strategy for the pumps (including those for the primary- and secondary-loop chilled water pumps if two loop pumping design is used)
- details of each water-side control system including :
  - function and method of control for each control loop (e.g. control of chilled water supply flowrate to match demand by sequencing on/off of pumps or varying the speed of the pumps or modulating the degree of opening of a differential pressure bypass control valve)

Where winter space heating is provided by heat recovery chillers with or without supplementary start-up heat sources:

- heat output capacity of each of heat recovery chiller and supplementary heating equipment (e.g. heat pumps)
- source of heat for heat pumps, if applicable

For each of the seawater, condenser water and chilled water piping systems:

- routing of the piping system
- size of each pipe section

For each of the air-side systems:

- location (and name) of the air-conditioned space (or zone) served by the system
- room sensible, latent and total cooling loads of the space
- system type (e.g. fresh air supply system, primary air fan-coil system, VAV system with terminal reheat, dual conduit VAV system, dual duct VAV system, etc.)
- type(s) of equipment involved (e.g. air-handling units, fan-coil units, VAV boxes, etc.)
- equipment identification number of each equipment (e.g. FAU01, AHU01) in the system
- model size of each equipment
- design supply air flow rate for the space
- design fresh air supply flow rate for the space
- design general exhaust air flow rate from the space
- supply air duct routing
- size of each duct section
- details of the control system, including
  - function and method of control for each control loop (e.g. control of indoor or supply air temperature by varying the air or water flowrate through fan speed, inlet guide vane, damper or control valve modulation)
  - for VAV systems, minimum air flow rate

**Equipment performance data**

For each type and model size of chiller:

- equipment identification nos. of chillers of the same type and model size
- rated cooling capacity
- power consumption at rated output
- design chilled water in/out temperatures and flow rate
- design condenser water (for air-cooled chillers, condenser air) in/out temperatures and flow rate
- water (and air) pressure drops across evaporator and condenser at design flow rates

- performance curves showing variations in power consumption with load changes under several condenser inlet water or air temperatures

For each type and model size of heat exchanger:

- equipment identification nos. of heat exchangers of the same type and model size
- kind(s) of primary and secondary fluids (fresh water/seawater)
- design heat exchange rate
- effectiveness at design heat exchange rate
- design in/out temperatures and flow rates of primary and secondary fluids
- primary and secondary side pressure drops
- variations in heat exchange performance with operating conditions

For each type and model size of pump:

- equipment identification nos. of pumps of the same type and model size
- design duty (flow rate and pumping pressure) of each pump
- design pump rotational speed
- performance curve showing variations in pump power consumption and pump total pressure with water flow rate at the design pump speed (and curves at reduced speeds for pumps under variable speed control)

For each type and model size of air-handling equipment (fresh air supply or general exhaust fans, fan coil units and air-handling units):

- equipment identification nos. of air-handling equipment of the same type and model size
- fan performance data on :
    - design fan rotational speed
    - design supply air flow rate
    - design supply fan total pressure at design flow rate and speed
    - type of air flow rate regulation device associated with the fan (e.g. inlet guide vane, discharge damper, variable speed motor drive, variable blade pitch angle etc.)
    - performance curve showing variations in fan power consumption and fan total pressure with supply air flow rate at the design fan speed
    - for variable flow fans, curves at reduced fan speeds, degree of opening of inlet guide vane or damper or blade pitch angle
- where applicable, cooling and dehumidifying coil performance/construction data including:
    - design sensible and total cooling capacities
    - chilled water flow rate under design conditions

For each type and model size of air-to-air heat recovery wheel:

- equipment identification nos. of heat recovery wheels of the same type and model size
- air flow rates of both air streams
- effectiveness of sensible and total heat exchange between the two air streams