DEVELOPING A FRAMEWORK FOR ASSESSING SUSTAINABILITY OF TALL-BUILDING PROJECTS

By

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Volume II

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TALL-BUILDING **P**ROJECTS **S**USTAINABILITY **I**NDICATOR

TECHNICAL MANUAL – 2012 VERSION

The University Of Sheffield.

Preface

'TPSI – Tall-building Projects Sustainability Indicator' is a Sustainability Rating System specialised for tall-building projects. TPSI is the end product of a PhD research within the School of Architecture, the University of Sheffield. The principal researcher is Binh Nguyen Khanh, under the supervision of Dr. Hasim Altan. Refer to Section '1. Introduction' for more information on TPSI Rating System.

Basically, the TPSI System comprises of two components:

- The 'TPSI Calculator': in form of a Microsoft Excel Tool. The TPSI Calculator is the main assessment software.
- The 'TPSI Technical Manual': in form of a booklet. The TPSI Technical Manual provides guidance on assessment criteria/procedure and required evidence according to the issues presented in the TPSI Calculator.

This Volume presents the completed TPSI Technical Manual – 2012 Version. It can be used separately from Volume I (or the main thesis).

Contents

--- VOLUME II---

1. INTRODUCTION

1.1. WHAT IS TPSI?

The market place of the design and construction of high performance buildings is dynamic and evolving. Professionals throughout the building industry use assessment/rating systems to evaluate and differentiate their products or designs. After 20 years of development, sustainability rating systems have become inevitable, as sustainable development is now the global trend. Among the extensive development of hundreds of rating tools, tall-buildings' sustainability evaluation is a neglected area. As there is no specialised rating system for tall-buildings so far, most of the existing systems are used for all type of projects, which causes major inappropriateness and inaccuracy.

TPSI - Tall-building Projects Sustainability Indicator is a tool for evaluating and rating high-rise buildings in terms of their environmental performance. TPSI was developed as the main outcome of a PhD research at the University of Sheffield, UK. The research is an effort to improve the quality of sustainable tall-building assessment activities.

TPSI offers comprehensive assessments of tall-buildings' performance, covering various aspects of sustainability. Assessments are ranked in five grades (A, B, C, D, and E) as well as graphs, charts and other outcomes.

This Technical Manual presents the 2012 Version – the first version of TPSI.

A unique standard that defines tall-building sustainability
TPSI provides users with a single performance label that demonstrates the overall qualities of a high-rise building. It can be used for new, refurbished or in-use projects. TPSI embraces a range of good practices in planning, design, construction, management, operation, maintenance and demolition of a tall-building project. It emphasises indoor environmental quality and amenities as key performance indicators, with proper consideration of the local, regional and global environmental impacts. Especially, TPSI takes into account the balance between a tall-building's performance and the loadings to the environment in order to achieve that level of performance.

A management tool
TPSI is intended to be used from the very first stages of a project; however, it can be integrated into any stage throughout a project's life cycle. Using the TPSI Calculator alone can produce quick and sufficient evaluations, which are suitable at early stages when comparing different design schemes and making decisions. At the same time, incorporating this Technical Manual into the evaluation process would ensure a more rigorous and thorough assessment. A tall-building project that follows TPSI's guidance will be safer, healthier, more comfortable, more functional and more efficient.

An International tool
TPSI has a dynamic assessment mechanism that allows efficient function in various location and climate zones (see Section 1.8 for more information).

Purpose
TPSI seeks to:

- Enhance the quality of tall-buildings worldwide in multiple aspects.
- Stimulate demand for tall-buildings that are more sustainable, giving recognition for improved performance and minimising false claims.
- Provide a comprehensive set of performance standards for tall-building projects that can be pursued by developers and owners.
- Reduce the environmental impacts of tall-buildings throughout their life cycle.
- Ensure that sustainability considerations are integrated right from the onset of a tall-building project rather than retrospectively.

1.2. ACKNOWLEDGEMENT

The contents of TPSI Technical Manual were developed base on references from the following rating schemes:

Table 1.1: TPSI's development bases

No.	Tools	Website
1	BEES (US)	http://www.bfrl.nist.gov/oae/software/bees.html
2	BREEAM (UK)	http://www.breeam.org
3	CASBEE (Japan)	http://www.ibec.or.jp/CASBEE/english/
4	CEEQUAL (UK)	http://www.ceequal.co.uk
5	CEPAS (Hong Kong)	http://www.bd.gov.hk/english/documents/index_CEPAS.html
6	DQI (Design Quality Indicator) (UK)	http://www.dqi.org.uk
7	Earth Advantage (US)	http://www.earthadvantage.org
8	EEWH (Taiwan)	http://gsp.stsipa.gov.tw/eng/main03_2.html
9	Envest 2 (UK)	http://envestv2.bre.co.uk/
10	Green Building Certification System (Korea)	http://www.greenbuilding.or.kr
11	Green Globes (US, Canada, UK)	http://www.greenglobes.com/
12	Green Leaf Eco-Rating Program (US, Canada)	http://greenleaf.audubooninternational.org/
13	Green Mark (Singapore)	http://greenmark.sg/
14	Green Star (Australia)	http://www.gbca.org.au/
15	HK BEAM (Hong Kong)	http://www.hk-beam.org.hk
16	HQE (France)	http://www.assohqe.org
17	LEED (US)	http://www.usgbc.org/
18	Living Building Challenge (US)	http://ilbi.org/
19	M4i (UK)	http://www.m4i.org.uk/
20	MSBG (US)	http://www.msbg.umn.edu/
21	NABERS (Australia)	http://www.nabers.com.au
22	"Quality of Life Counts" Indicator (UK)	http://www.defra.gov.uk
23	SBTool/GBTool (International)	http://www.iisbe.org/sbtool
24	SBAT (Africa)	n/a
25	SE Checklist (UK)	http://southeast.sustainability-checklist.co.uk/
26	SPeAR (UK)	http://www.arup.com/Services/Sustainability_Consulting.aspx
27	SPiRiT (Sustainable Project Rating Tool) (US)	https://eko.usace.army.mil/fa/sdd/
28	Scottsdale's Green Building Program (US)	http://www.scottsdaleaz.gov/greenbuilding
29	TERI GRIHA (India)	http://www.grihaindia.org/

1.3. HOW TPSI CAN BE USED?

TPSI can be used in the following ways:

1. *In construction administration:* TPSI can be used as a tool for announcing a tall-building's efforts for the environment, as an element in construction and environmental administration of tall-buildings.
2. *As a sustainability design tool for architects:* TPSI can be used at the design stage to check environmental performance, set goals, form consensus with parties involved in design (architecture, structure, services), and indicate design performance to the client.
3. *As an environmental labelling and management tool.*
4. *During the selection of contractors for design competitions and proposals:* designers can use TPSI to propose overall environmental efficiency targets to public or private owners, and TPSI can assign high grades to designs which deliver the maximum environmental efficiency from limited funds. TPSI can be used internationally or can be modified to serve a particular country.

1.4. THE STRUCTURE OF TPSI

Basically, the TPSI system comprises of 2 components:

- *The 'TPSI Calculator':* in form of a Microsoft Excel Tool. The TPSI Calculator is the main assessment software.
- *The 'TPSI Technical Manual':* in form of a booklet. The TPSI Technical Manual provides guidance on assessment criteria/procedure and required evidence according to the issues presented in the TPSI Calculator.

Users will claim 'credits' for their tall-building project by demonstrating compliance with the assessment criteria that are detailed in the 'TPSI Technical Manual.' The achieved credits will be inputted into the 'TPSI Calculator' accordingly. The 'TPSI Calculator' will then produce assessment results in form of ratings (percentage), charts, graphs, comments and recommendations on how to improve the design.

1.5. SCOPE OF ASSESSMENT

This section describes the scope of TPSI. During an assessment, when using the TPSI Calculator, users are asked to input information about building types, stages of assessment, types of projects, etc. These data would radically affect the final results. The information provided in this section will help clear up potential confusions.

1.5.1. Types of Buildings that can be Assessed by TPSI

TPSI is specialised for buildings of *more than 20 stories or more than 60 meters height*, regardless of their functions.

1.5.2. Stages of Assessment

TPSI is most suitable to be used during the following stages:

- **Design Stage:** a Design Stage Assessment represents the performance of the tall-building prior to the beginning of operations on site. To complete an assessment at this stage the design must be advanced to the point where the relevant information is available to enable user to demonstrate, in a robust manner, the building's performance against the reporting and evidential criteria of the TPSI Technical Manual. A design stage assessment cannot be verified by a third party due to the lack of actual documental evidences.
- **Post-Construction Stage:** the Post-Construction Assessment represents the final 'as built' performance and TPSI Rating. A post-construction assessment can be verified by a third party if all documental evidences are available.

1.5.3. Types of Projects that can be Assessed by TPSI

A TPSI assessment can be carried out at the above stages for the following types of tall-building project:

- Whole new tall-building;
- Major refurbishments of existing tall-buildings;
- New build extensions to existing tall-buildings;
- A combination of new-build and existing building refurbishment;
- New build or refurbishments which are part of a larger mixed-use building;
- Existing building fit-out.

Major refurbishments to existing tall-buildings

For the purposes of a TPSI assessment, a major refurbishment project is a project that results in the provision, extension or alteration of thermal elements and/or building services and fittings. TPSI is not designed to assess a minor refurbishment of an existing building (i.e. works that do not result in the provision, extension or alteration of thermal elements and/or building services and fittings); or a change of use.

- Thermal elements include walls, roofs and floors;
- Fittings include windows (including roof-lights), entrance doors;
- Building services include lighting, heating, mechanical ventilation/cooling, vertical transportations and other tall-building specified services.

New build extensions to existing buildings

TPSI can be used to assess new building extensions to existing buildings and, where the existing building is undergoing major refurbishment, the new build extension and existing building. When assessing only a new-built extension to an existing building, in some TPSI Issues it is necessary to consider services/facilities within the existing building, where such services/facilities will be integral to the new extension or used by the occupants of the new extension. Guidance is provided in the 'Background and Notes' section within the specific TPSI Issue where relevant.

Building fit-out

TPSI can be used to assess a fit-out of an existing building, whether it is the first fit-out of the shell of a new building/unit or subsequent re-fit of an existing building/unit. Although there is no standard definition, typically a tall-building fit-out will include:

- Raised floors;
- Suspended ceilings;
- General lighting;
- Extension of the mechanical and electrical services above the ceiling from the riser across the lettable space;
- Finishes to walls;
- Window blinds;
- Vertical transportations;
- Safety services;
- Communication, IT and other tall-building specified services.

1.6. ASSESSMENT CRITERIA SYSTEM – THE 'TPSI TECHNICAL MANUAL'

1.6.1. Assessment Criteria System

TPSI covers eight 'Categories' of sustainability. These eight Categories are divided up further into two main Groups. There is one additional category that allows users to earn extra credits for innovative features of their project or for exceeding the design standard put forth by TPSI. Each category is detailed in this Technical Manual and consists of a number of 'Sub-categories.' Under the Sub-categories are 'Issues.'

There are 119 default TPSI Issues in total, covering all aspects of sustainable tall-buildings development. Each Issue seeks to improve an aspect of sustainability of a tall-building by defining a performance target and assessment criteria that must be met to confirm the target has been achieved. A certain number of 'credits' are available for each Issue. By default, there are 223 available credits. Where a performance target has been achieved the number of available credits will be awarded.

Table 1.2 summarises the Groups, Categories, and Sub-categories. Refer to Section 1.10 for summary of TPSI's Issues and according available credits.

Table 1.2: Summary of TPSI Groups, Categories and Sub-Categories

B-Building Performance	**E-Environmental Performance**
B1. Project Management (PM) B1.1. Overall Management B1.2. Design Process B1.3. Construction Issues B1.4. Contractual and Commission Process B1.5. Operation B1.6. Demolition	**E1. Resources Consumption (RC)** E1.1. Land Use E1.2. Water Use E1.3. Energy Use
B2. Indoor Environmental Quality (IEQ) B2.1. Prerequisite B2.2. Water Quality B2.3. Hygiene B2.4. Indoor Air Quality (IAQ) B2.5.Ventilation B2.6. Thermal Comfort B2.7. Lighting and View B2.8. Acoustics and Noise B2.9. Other Issues	**E2. Material Aspects (MA)** E2.1. Selection of Materials E2.2. Efficient Use of Materials
B3. Building Services (BS) B3.1. Building Amenities B3.2. Basic Building Equipment B3.3. Security and Safety B3.4. Vertical Transportation B3.5. Earthquake Resistance	**E3. Environmental Loading (EL)** E3.1. Waste E3.2. Pollution E3.3. Ecology and Microclimate
B4. Design Features (DF) B4.1. Design for Energy Efficient B4.2. Design for Functionality and Usability B4.3. Design for Flexibility and Adaptability	**E4. Social & Economic Aspects (SE)** E4.1. Social Aspects E4.2. Economic Aspects
Innovations IN1. Innovative Strategies and Technologies IN2. Exemplary Performance	

1.6.2. The 'TPSI Technical Manual'

In the TPSI Technical Manual, the contents of each TPSI Issue are structured into the following headings:

- **Issue information:** Category, Sub-category, Issue ID, Issue title.
- **Aim**: broadly outlines the objective of the Issue i.e. the aspect of sustainability it intends to improve.
- **Credits available**: maximum number of credits available for meeting the performance target.
- **Issue summary**: outlines the performance target and how credits are awarded.
- **Exclusion**: outlines the cases when the Issue (or part of the Issue) can be 'scoped-out' from the assessment.

- **Assessment**: details the performance target/benchmark, assessment criteria and evidence required. To prove that an Issue is fulfilled, the design team /client must provide adequate data and documents as 'evidence.' This section outlines the typical examples of the types of information that must be collected. This procedure is only necessary when a TPSI assessment needs to be verified by a third party. During a self-assessment process evidence can be ignored.
- **Background and Notes**: provides relevant information, definitions and footnotes to support the assessment and compliance of the project.

Figure 1.1 and Figure 1.2 show a sample TPSI Issue. Please note that this TPSI Issue has been edited for the purpose of demonstration.

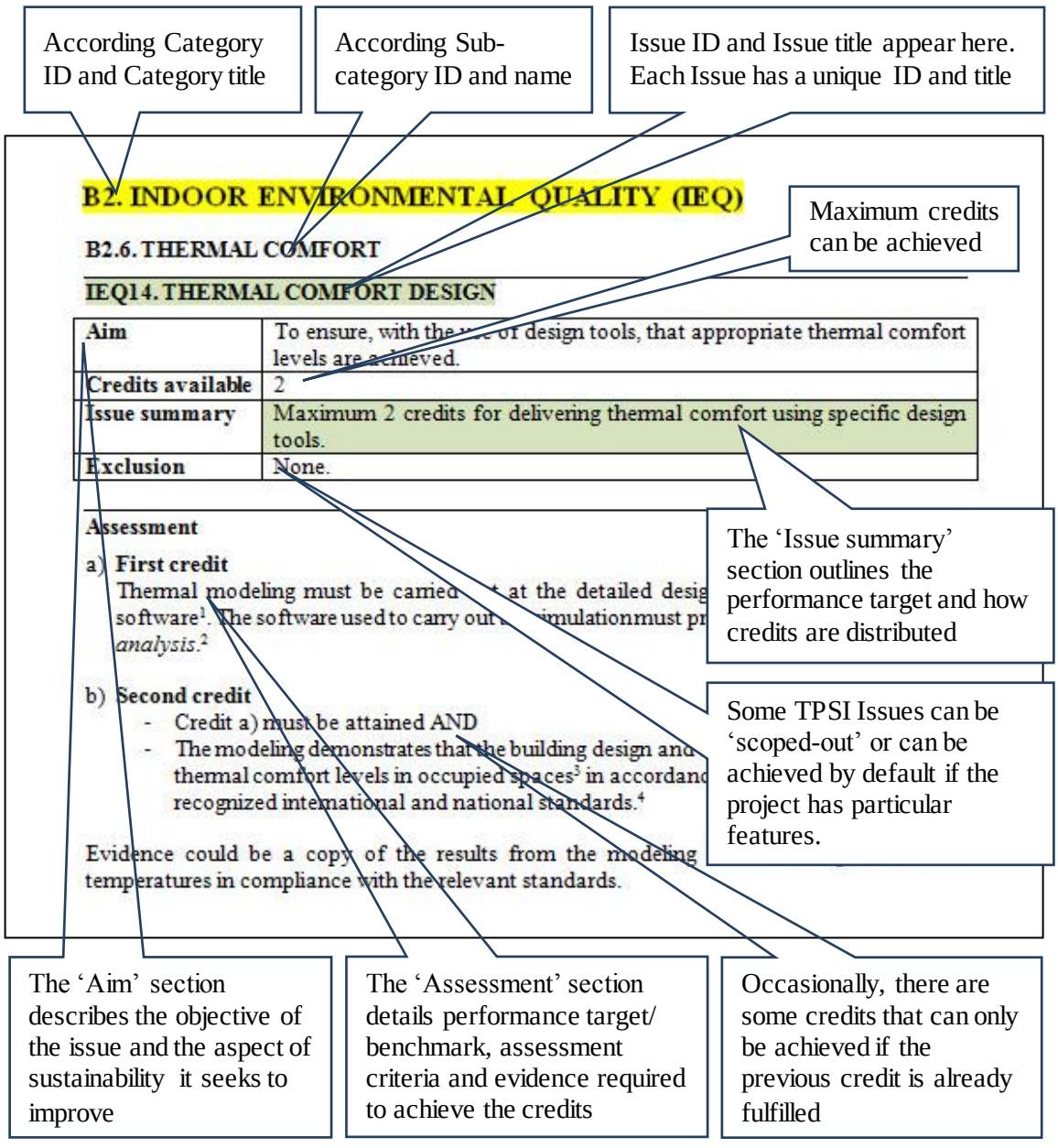


Figure 1.1: Example of a TPSI Issue 1

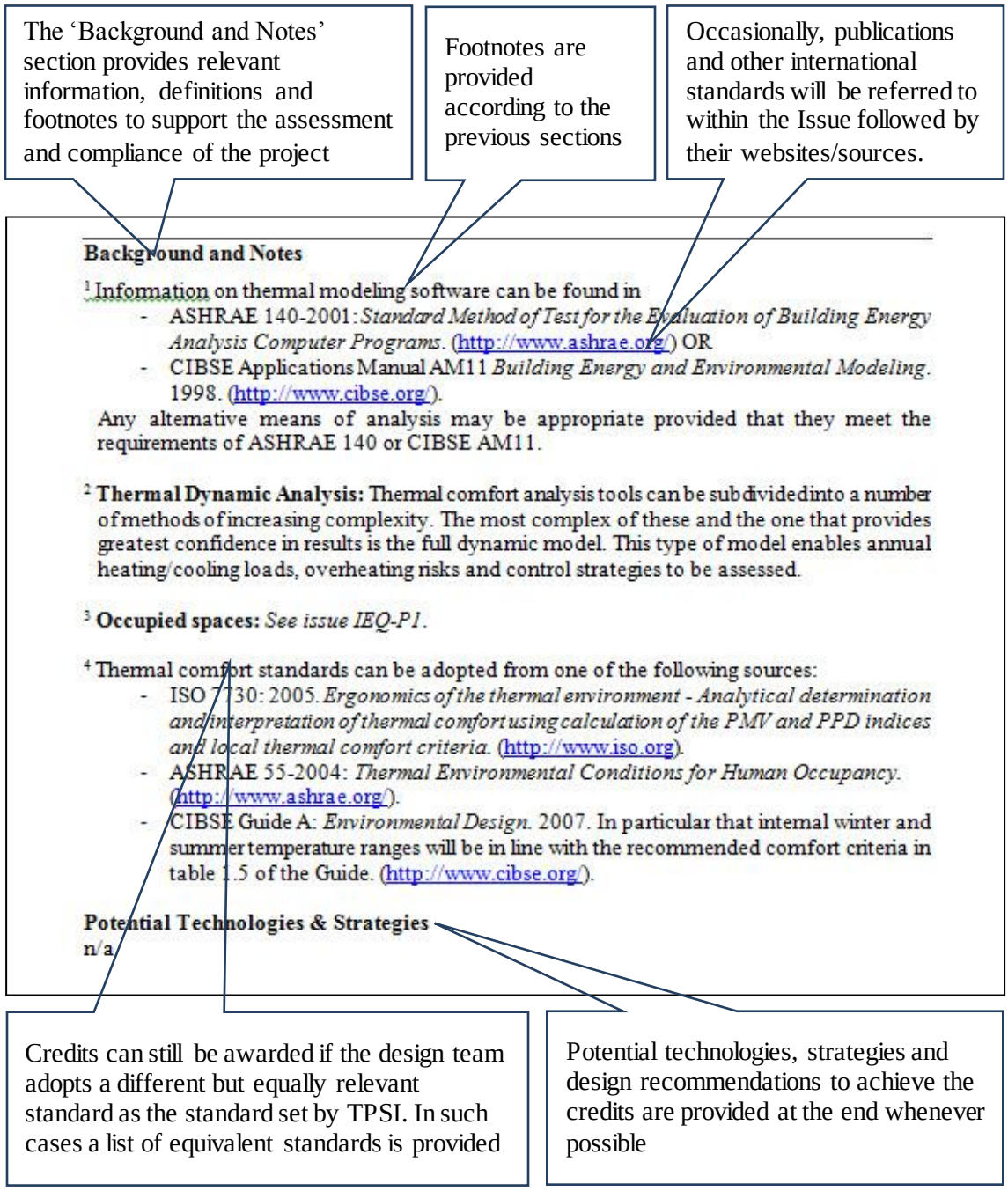
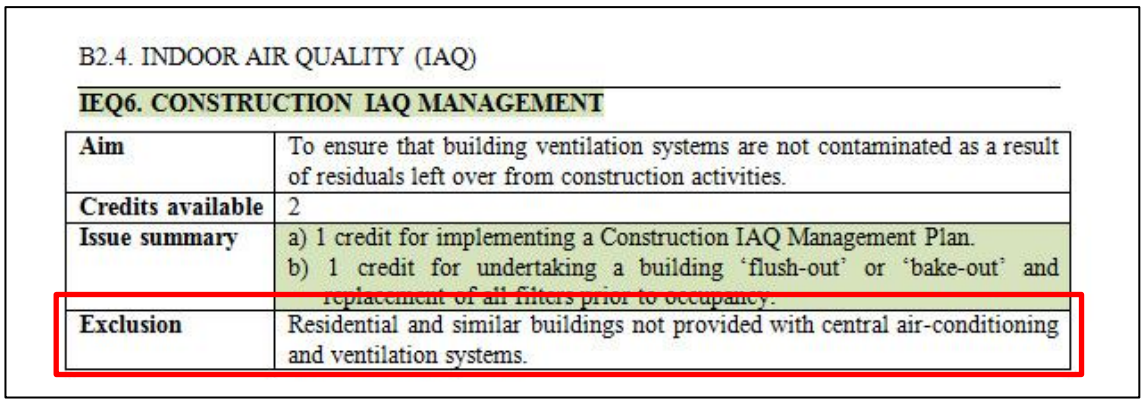


Figure 1.2: Example of a TPSI Issue 2

1.6.3. Issues that can be 'Scoped-out'

Occasionally, there are some Issues that can be 'scoped-out' if the project has specific features/characteristics. This means that particular Issue is not applicable for such a project. When this is the case, that Issue is excluded from the assessment and that Issue's credits do not contribute to the overall result. The conditions under which an Issued can be scoped-out are described in the 'Exclusion' section of that Issue.

For example, Issue 'IEQ6. Construction IAQ Management' (see Section B2.4) can be scoped-out for 'Residential and similar buildings not provided with central air-conditioning and ventilation systems.' When this is the case, 2 credits of this Issue are subtracted from the total credits. The number of available credits now would be: 223 – 2 = 221 credits (see Figure 1.3).



B2.4. INDOOR AIR QUALITY (IAQ)

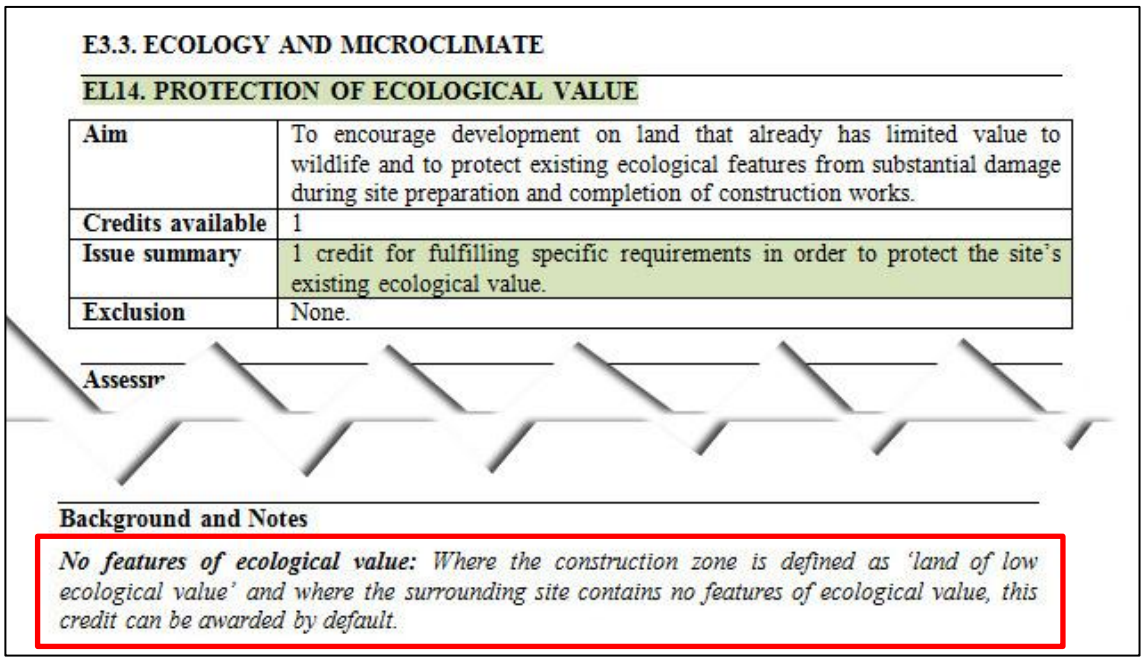
IEQ6. CONSTRUCTION IAQ MANAGEMENT

Aim	To ensure that building ventilation systems are not contaminated as a result of residuals left over from construction activities.
Credits available	2
Issue summary	a) 1 credit for implementing a Construction IAQ Management Plan. b) 1 credit for undertaking a building 'flush-out' or 'bake-out' and replacement of all filters prior to occupancy.
Exclusion	Residential and similar buildings not provided with central air-conditioning and ventilation systems.

Figure 1.3: Example of a TPSI Issue that can be scoped-out

1.6.4. Issues that can be Achieved by Default

Occasionally, there are some Issues that can be achieved by default if the project has specific features/characteristics. This means all or a part of that Issue's available credits are awarded without going through the assessment process. The conditions under which an Issued can be achieved by default are described in the 'Background and Notes' section of that Issue. Issue 'EL14. Protection of Ecological Value' (see Section E3.3) is an example of these cases (see Figure 1.4).



E3.3. ECOLOGY AND MICROCLIMATE

EL14. PROTECTION OF ECOLOGICAL VALUE

Aim	To encourage development on land that already has limited value to wildlife and to protect existing ecological features from substantial damage during site preparation and completion of construction works.
Credits available	1
Issue summary	1 credit for fulfilling specific requirements in order to protect the site's existing ecological value.
Exclusion	None.

Assessm

Background and Notes

No features of ecological value: *Where the construction zone is defined as 'land of low ecological value' and where the surrounding site contains no features of ecological value, this credit can be awarded by default.*

Figure 1.4: Example of a TPSI Issue that can be achieved by default

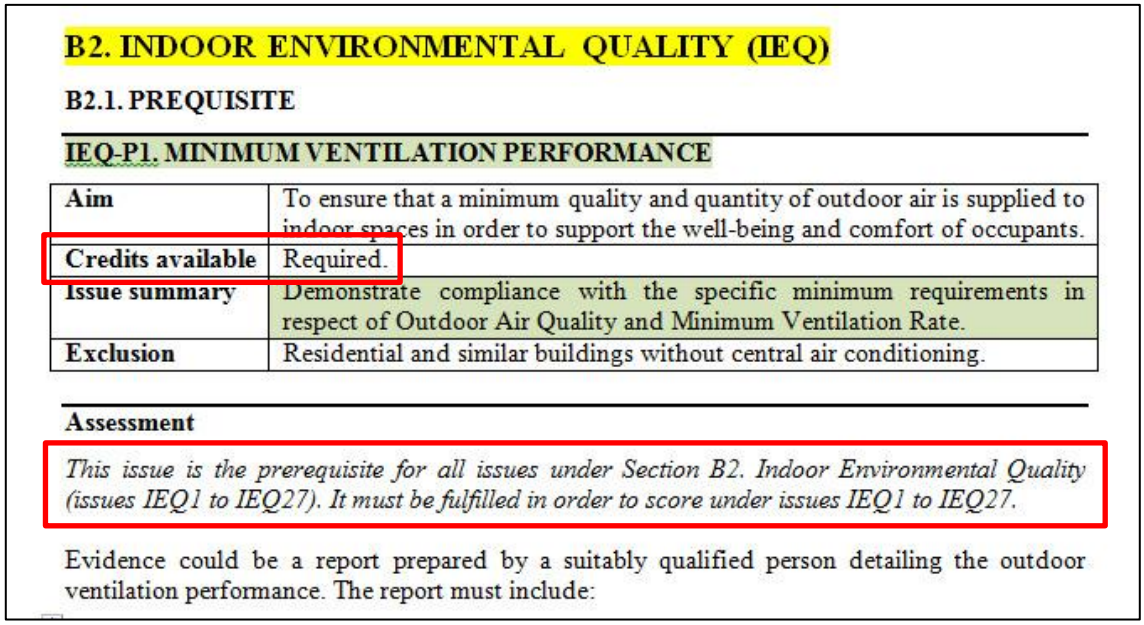
1.6.5. Prerequisite Issues

Among TPSI Issues, there are three 'Prerequisite Issues':

- IEQ-P1. Minimum Ventilation Performance;
- RC-P1. Basic Energy Performance;
- MA-P1. Timber Used for Temporary Works.

Prerequisite Issues have no available credit, which means users get no credits for fulfilling these Issues. A Prerequisite Issue is placed at the top of a Category; they need to be fulfilled in order to achieve all other Issues under that Category.

For example, Issue IEQ-P1 is the prerequisite for all Issues under Section 'B2. Indoor Environmental Quality' (Issues IEQ1 to IEQ27). If Issue IEQ-P1 is not fulfilled, user will get 0 credits for all Issues from IEQ1 to IEQ27 without going through the assessment process, user will then have to skip to the next section (see Section 'B3. Building Services'). Figure 1.5 shows a sample Prerequisite Issue.



B2. INDOOR ENVIRONMENTAL QUALITY (IEQ)

B2.1. PREQUISITE

IEQ-P1. MINIMUM VENTILATION PERFORMANCE

Aim	To ensure that a minimum quality and quantity of outdoor air is supplied to indoor spaces in order to support the well-being and comfort of occupants.
Credits available	Required.
Issue summary	Demonstrate compliance with the specific minimum requirements in respect of Outdoor Air Quality and Minimum Ventilation Rate.
Exclusion	Residential and similar buildings without central air conditioning.

Assessment

This issue is the prerequisite for all issues under Section B2. Indoor Environmental Quality (issues IEQ1 to IEQ27). It must be fulfilled in order to score under issues IEQ1 to IEQ27.

Evidence could be a report prepared by a suitably qualified person detailing the outdoor ventilation performance. The report must include:

Figure 1.5: Example of a TPSI Prerequisite Issue

1.6.6. Innovation Issues

Beside eight main Categories, users can earn extra credits under 'Innovations' Category. 'Innovation' Category is weighted like every other Category. There are two ways to earn Innovation credits, according to two Innovation Issues types:

- **Issue 'IN1. Innovative Strategies and Technologies':** this Issue gives maximum 5 credits for the adoption of practices, new technologies, techniques and strategies that are not currently recognised by existing TPSI Issues.
- **Issue 'IN2. Exemplary Performance':** this Issue gives maximum 11 credits for the achievement of exceptional performance over and above the stated performance criteria under TPSI Issues.

1.7. ASSESSMENT METHODOLOGY

There are two elements that determine a building's rating: the *Total Score* and the *TPSI Factor*.

1.7.1. The Total Score

The Total Score is calculated as follow:

- For each TPSI Issues, users must determine the number of credits achieved in accordance with TPSI's assessment criteria (detailed in this Technical Manual).
- The percentage of the credits achieved is calculated for each TPSI Category (i.e. 'Category Score').
- A weighting system is applied to all Categories to reflect the importance of each Category towards overall sustainability.
- Each Category Score is then multiplied by its corresponding weighting factor. This gives the 'Weighted Category Score.'
- Weighted scores of eight main Categories and Innovation Category are added together to give the 'Total Score.'

1.7.2. The TPSI Factor

The TPSI Factor is calculated as follow:

- As shown in Table 1.2, the assessment criteria are divided into 2 main groups: the 'B Group' which stands for 'Building Performance;' and the 'E Group' which stands for 'Environmental Performance.' The main idea behind this is to assess the balance between the building's performance and the loadings to the environment in order to achieve that performance level.
- The percentage of the credits achieved is calculated for both groups. These are expressed as the *Total Score for B* and the *Total Score for E*.
- The TPSI factor is defined as B/EL (EL - Environmental Loadings = 100% - Total Score for E).
- B and EL are plotted on a graph, with EL on the X axis and B on the Y axis. The higher the B value and the lower the EL value, the steeper the gradient and the more sustainable the building is.
- A TPSI Factor can fall into one of five areas (A, B, C, D and E) according to five TPSI rating levels (see Section 1.7.3).

Figure 1.6 describes the idea behind TPSI Factor. Figure 1.7 shows a sample calculation of TPSI Factor.

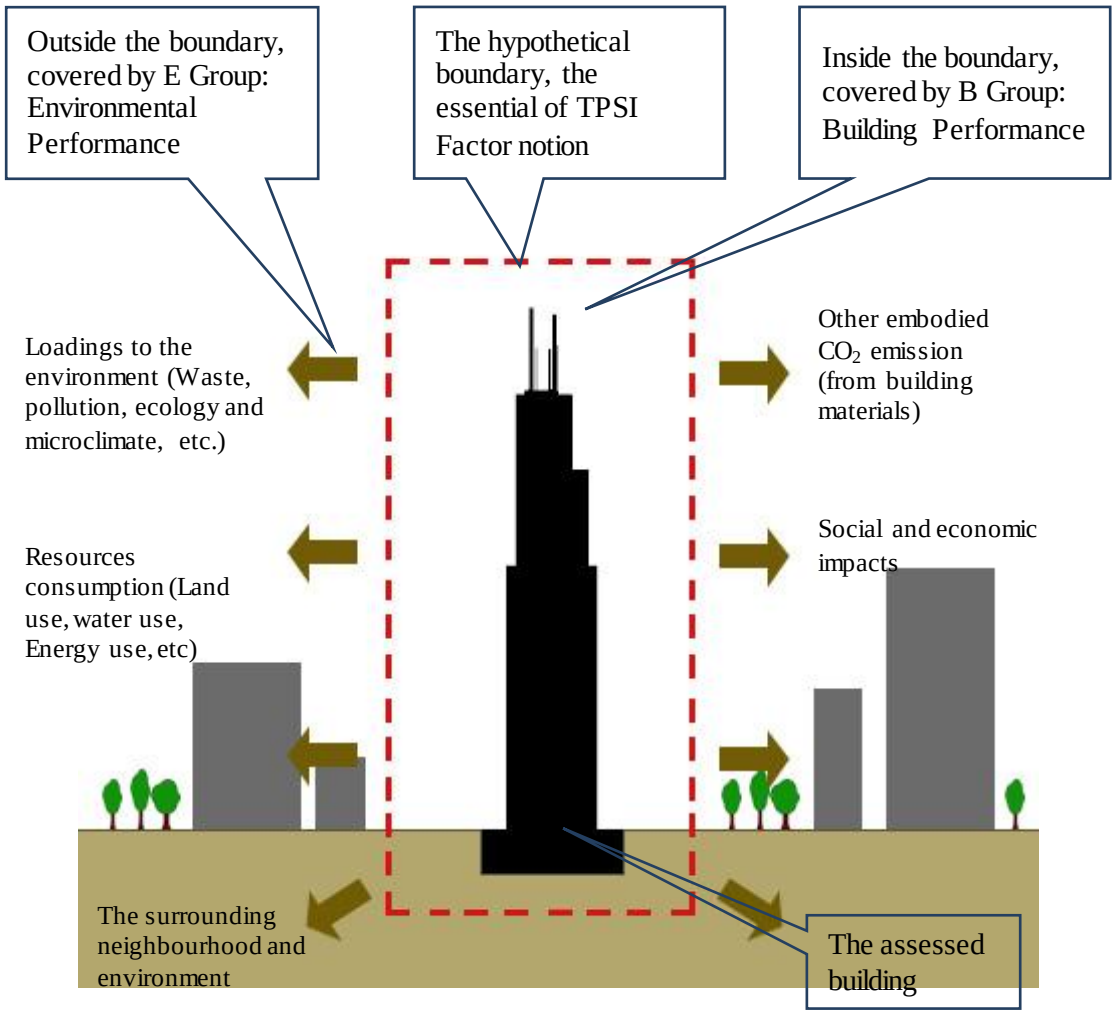


Figure 1.6: The idea behind TPSI Factor

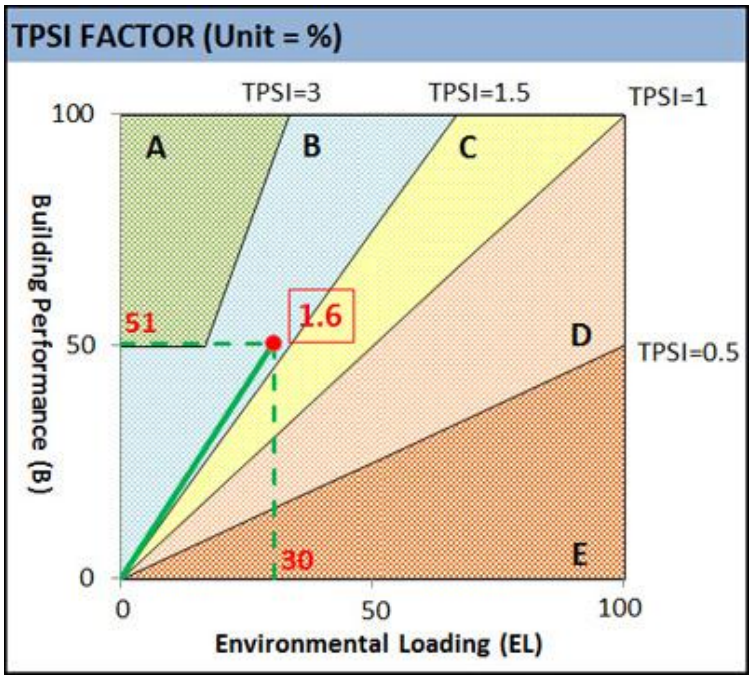


Figure 1.7: A sample calculation of TPSI Factor

1.7.3. Rating

TPSI introduces a labelling classification of five levels to rate the sustainable performance of a tall-building project (A, B, C, D, E - with 'A' being the best practice). The ranking of a project is dependent on its 'Total Score' and the 'TPSI Factor.' The rankings associated with their assessment are shown in Table 1.3:

Table 1.3. TPSI ranking

Rank	Total Score	TPSI Factor	Comments
E	< 25 %	< 0.5	Unclassified
D	≥ 35 %	≥ 0.5	Pass
C	≥ 50 %	≥ 1	Good
B	≥ 75 %	≥ 1.5	Excellent
A	≥ 85 %	≥ 3.5	Outstanding

1.8. ASSESSMENT PROCESS – THE 'TPSI CALCULATOR'

1.8.1. Overview of the TPSI Calculator

TPSI Calculator is a Macros-enriched Microsoft Excel tool. In order to run TPSI Calculator, users must have Microsoft Excel 97-2003 or later versions installed on their computer. Macros contents must be enabled for full functions of the tool.

TPSI Calculator tool is protected so users cannot change the core contents of the software, they can only input the project information and claim credits where allowed. There are 13 tabs in total as summarised in Table 1.4. Figure 1.8 shows a screenshot of TPSI Calculator.

Table 1.4: Summary of TPSI Calculator tabs

No.	Tab's name	Notes
1	INTRODUCTION	• What is TPSI? • What does TPSI do? • Conditions of Use • Credits
2	HOW TO USE	• Step-by-step instruction • Introduction on Result Presentation • What do TPSI rankings mean?
3	PROJECT INFO.	Project Information Input
4	B1. PM	Assessment criteria according to four Categories of **Group B-Building Performance**
5	B2. IEQ	
6	B3. BS	
7	B4. DF	
8	E1. RC	Assessment criteria according to four Categories of **Group E-Environmental Performance**
9	E2. MA	
10	E3. EL	
11	E4. SE	
12	IN	Assessment criteria according to 'Innovation' category
13	RESULT	Result Presentation

'Assessment' Tabs

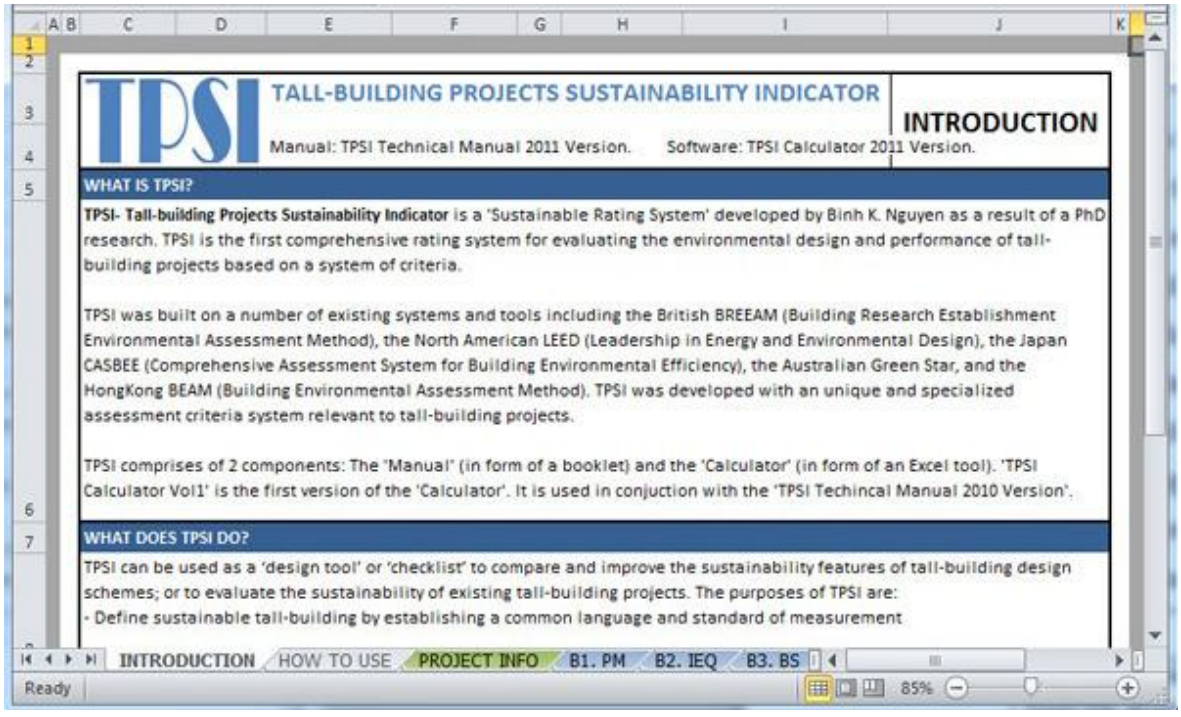


Figure 1.8: 'Introduction' tab – screenshot

1.8.2. How to Use

Step-by-step instruction is available in the second tab of the Excel tool.

1.8.3. Default Weighting Factors

A weighting system is applied to all 'Section Score' to reflect the importance of each category. The default weighting factors applied to each assessment criteria category is as in Table 1.5. However, this weighting system is not fixed, it can automatically change based on the project's characteristics (see Section 1.8.4). The default weighting factors were determined after consulting the criteria systems of prominent rating schemes such as BREEAM, LEED and CASBEE.

Table 1.5. Default weighting factors

Categories	B1	B2	B3	B4	E1	E2	E3	E4	IN
Weighting factors	11%	14%	9%	8%	18%	8%	15%	9%	8%

1.8.4. 'Project Info' Tab and the Dynamic Weighting System

This is where users fill in information about their tall-building project (project name, location, completion date, construction and gross floor area, number of floors, height, occupancy, climate zone, building type, special technical systems, structure types, etc. - see Figure 1.9 and Figure 1.10. All these data will be used to calculate the *weighting factor* for each assessment criteria category.

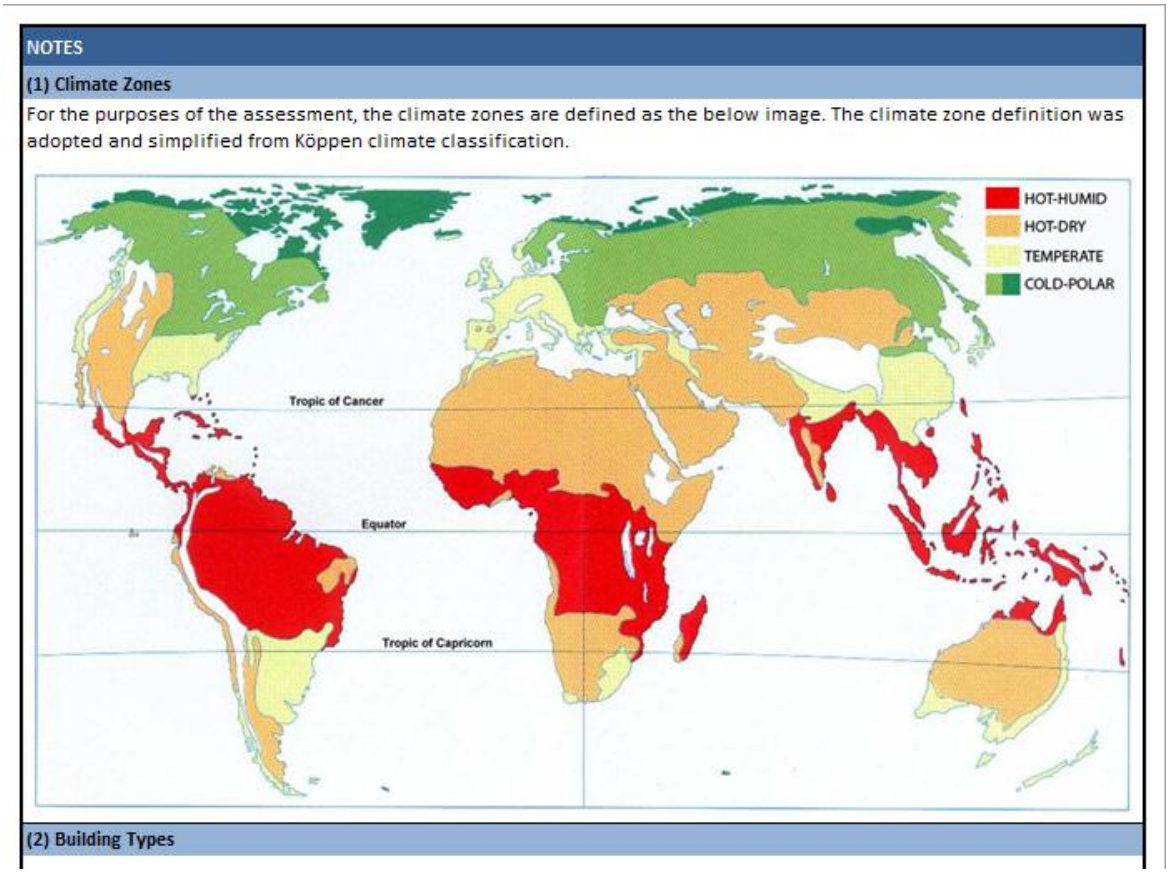


Figure 1.9: 'Project Info' Tab – screenshot 1

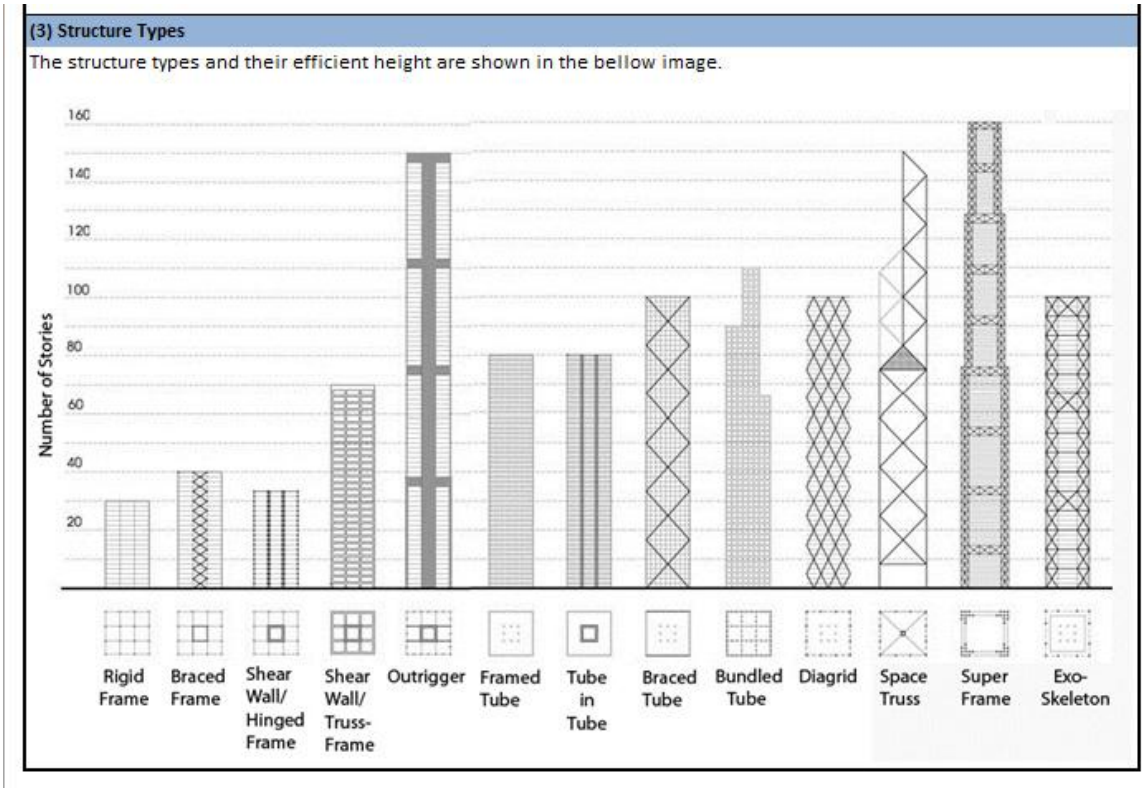


Figure 1.10: 'Project Info' Tab – screenshot 2

By applying a dynamic weighting system, TPSI can adapt itself to different contexts and different types of tall-building projects. In other words, a high-rise office building in a hot-humid country is fundamentally different than a high-rise residential in a cold climate. The same assessment criteria should not be used for both buildings. Changing the weighting factor of each category means changing its contribution towards the overall score and also reflecting its varied importance in different contexts, and therefore it produces a more accurate evaluation. This is a highly importance advantage of TPSI over other existing rating systems.

At the moment, TPSI 2012 Version's weighting factors are dependent on three factors:

- Climate zones (Cold-polar, Hot-humid, Hot-dry or Temperate);
- Project's social context (City-centres or Rural Areas);
- Building types (Mixed-use, Office, Commercial, Residential, Hotel, Health-care or Education).

In the future, this weighting system can be developed further to take into account other factors such as structure type, building's occupancy, floor area, or number of floors.

1.8.5. 'Assessment' Tabs

Users will claim credits for their project using nine 'Assessment' tabs equivalent to eight main categories and Innovation category. These nine 'Assessment' tabs are similar in term of layout. Figure 1.11 shows a sample screenshot of one of the 'Assessment' tabs.

Users claim credits by choosing from the drop-down lists. The total available credits of the current category and the credits achieved are shown in the bottom of the tab. The Section Score or Category Score (updated automatically as users claiming the credits) is shown in the top left corner. The Section's weighting factor and Section Score after weighted is shown in the top right corner.

In an 'Assessment' tab, each TPSI Issue is structured as followed (see Figure 1.11):

- **Sub-category ID and Name.**
- **Issue ID.**
- **Issue Name.**
- **Issue Aim**: broadly outlines the objective of the Issue as shown in the TPSI Technical Manual.
- **Issue Summary**: outlines the performance target and how credits are awarded (only briefly, users will have to refer to the TPSI Technical Manual for full contents of the Issues).
- **Issue's available credits:** shows maximum credits that can be awarded and options to scope out credits.
- **Issue's achieved credits:** here is where users claim credits for their project.
- **Note.**

TPSI is structured for Design stage; it is therefore very suitable for a project in-progress. Users do not have to finish off an 'Assessment' tab before switching to another one. They can freely examining and working with TPSI Issues in the provided order or by their own priority, thus gradually improve their project's aspects as it is being developed.

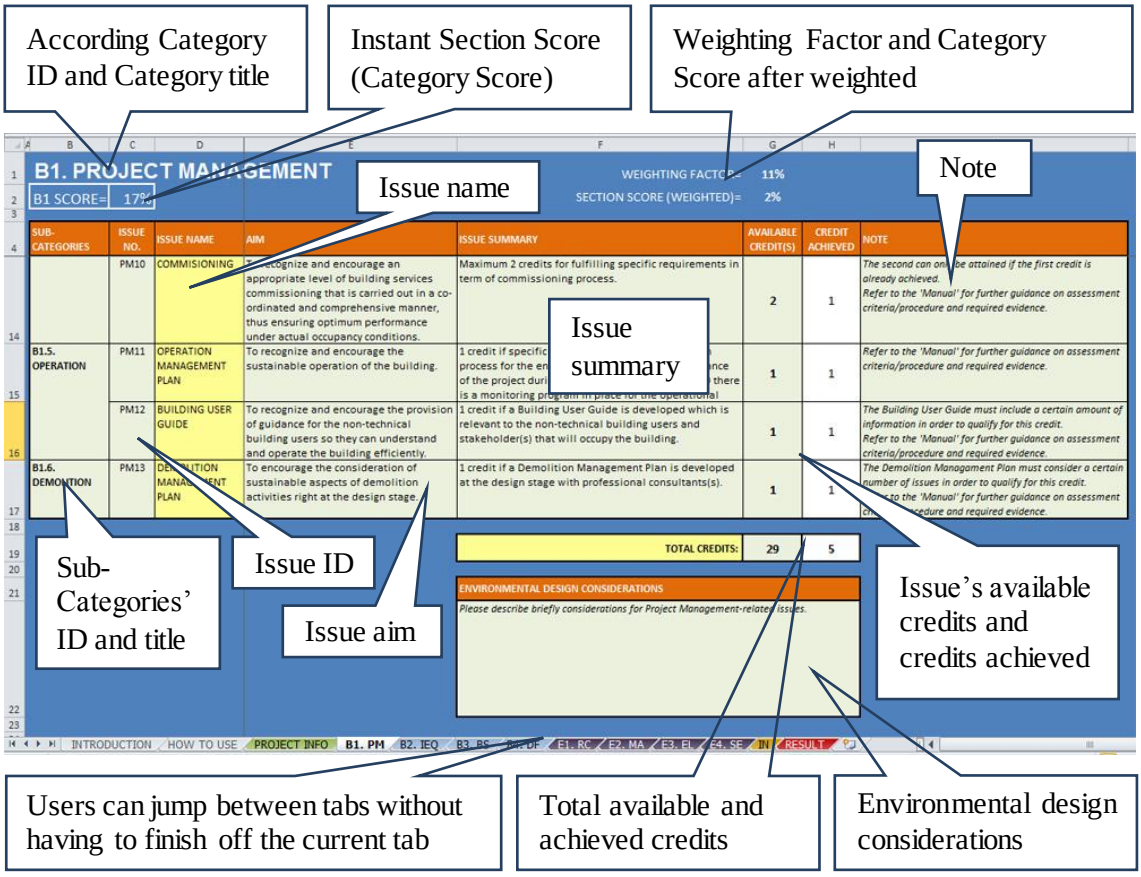


Figure 1.11: A sample screenshot of one of the 'Assessment' tab

Prerequisite Issues

For Prerequisite Issues, there is no credit to earn, instead the Drop-down list provides 2 options: 'Achieved' or 'Not-Achieved.' Figure 1.12 shows an example of how a Prerequisite Issue works in TPSI Calculator:

- By default the option 'Not-achieved' is always picked. In this case, users cannot score under Issues that are covered by this Prerequisite Issue – the cells to claim credits are locked and turned to grey.
- Once the Prerequisite Issue is fulfilled and the option 'Achieved' is picked, the locked cells will return to normal.

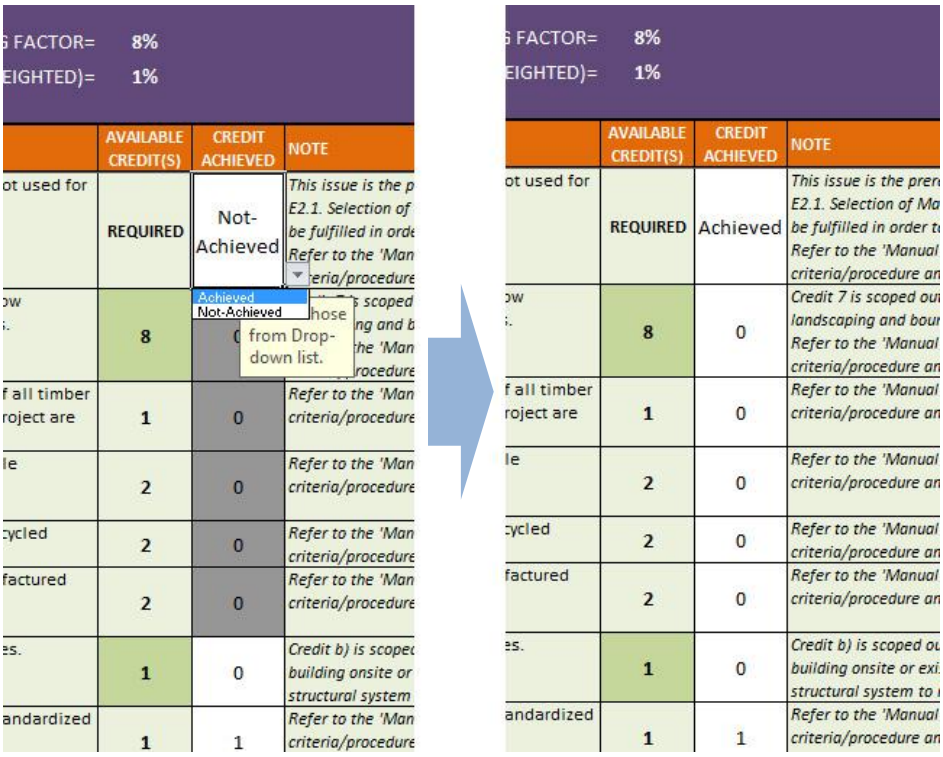


Figure 1.12: How a Prerequisite Issue works in TPSI Calculator

Issues that can be scoped-out

When an Issue can be fully or partly scoped-out, its' 'Available Credit(s)' box is coloured in dark green as an indication – see Figure 1.13 for example. When clicking this box, users will be able to choose the available credits option that is suitable to their current situation. TPSI will automatically update the change in total available credits and assessment results accordingly. The according 'Note' box and this TPSI Technical Manual will provide further relevant information.

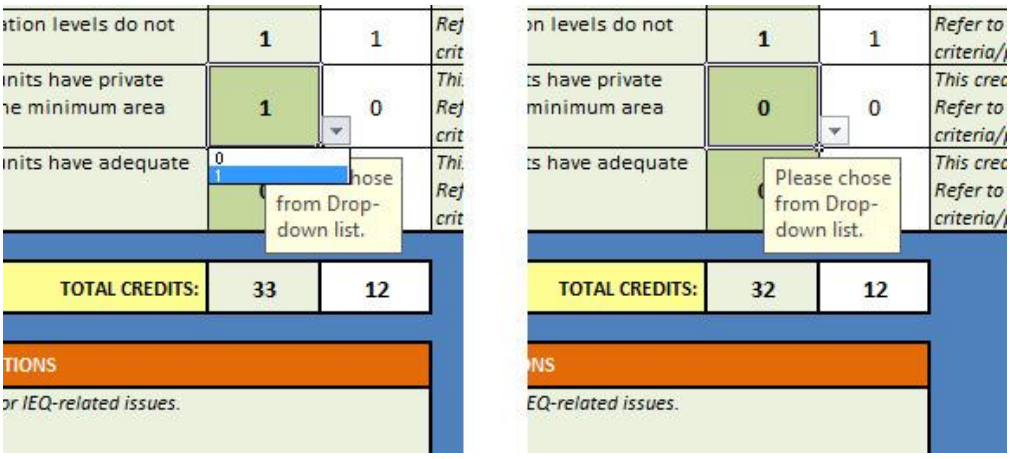


Figure 1.13: Example of how to fully or partly scope-out an Issue in TPSI Calculator

1.8.6. 'Result' Tab

The 'Result' tab presents the assessments, evaluations, charts, graphs, design recommendations, Issues summary, overall ranking and other outcomes of the evaluation process. Figure 1.14 shows sample screenshots of the 'Result' tab and different types of result presentations available.

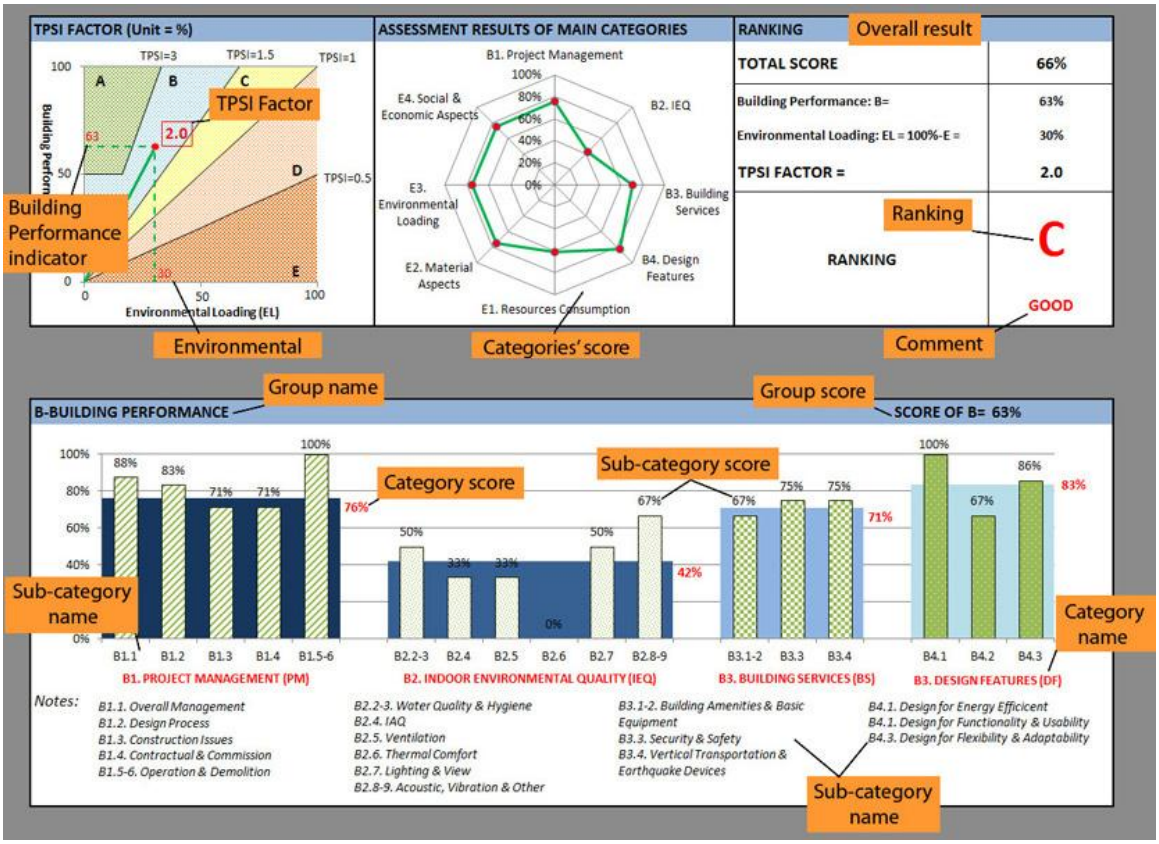


Figure 1.14: A sample screenshot of the 'Result' tab showing various outputs for the assessments.

1.9. CONDITIONS OF USE AND CREDITS

1.9.1. Conditions of Use

1) TPSI System (including TPSI Technical Manual and TPSI Calculator) is protected by copyright laws. It may not be duplicated or transferred (even in modified form) without the consent of the developer and publishers.

1) 'TPSI Calculator 2012 Version' was developed using Microsoft Excel 2010 for Windows 7. Although it was designed to work with older versions of Excel and Windows (as far as Excel 2003 and Windows XP), we do not guarantee its operation on all computers and operation systems. Microsoft Excel 2010 is a registered trademark of Microsoft Corporation in the United States of America and other countries.

3) This restriction does not apply to the use of input data and output results prepared on this tool by its users. In such cases, the data concerned should include a statement to the effect that it was produced using this TPSI assessment system in general and 'TPSI Calculator 2012 Version' in particular. Note that the additional consent of Microsoft Corporation may be required for the use of screen images.

4) The developer and publishers accept no liability for the results of using TPSI System

5) The TPSI Calculator and TPSI Technical Manual are subject to change without prior notice.

1.9.2. Credits

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1.10. TPSI'S ISSUES SUMMARY

Table 1.6: TPSI's Issues summary

ISSUES		Possible credit(s)
B1. PROJECT MANAGEMENT (PM)		**29**
B1.1. Overall Management	PM1. Basic Principles	3
	PM2. Environmental Management	5
B1.2. Design Process	PM3. Site Investigation	3
	PM4. Whole Life Approach	2
	PM5. Site Design Appraisal	1
B1.3. Construction Issues	PM6. Choice of Construction Process	1
	PM7. Construction Site impacts Management	4
	PM8. Construction Safety	2
B1.4. Contractual and Commission Process	PM9. Contractual and Procurement Process	3
	PM10. Commissioning	2
B1.5. Operation	PM11. Operation Management Plan	1
	PM12. Building User Guide	1
B1.6. Demolition	PM13. Demolition Management Plan	1
B2. INDOOR ENVIRONMENTAL QUALITY (IEQ)		**36**
B2.1. Prerequisite	IEQ-P1. Minimum Ventilation Performance	Required
B2.2. Water Quality	IEQ1. Water Quality	1
B2.3. Hygiene	IEQ2. Plumbing and Drainage	1
	IEQ3. Biological Contamination	1
	IEQ4. Waste Disposal Facilities	1
B2.4. Indoor Air Quality (IAQ)	IEQ5. Environmental Tobacco Smoke (ETS) Control	1
	IEQ6. Construction IAQ Management	2
	IEQ7. Outdoor Sources of Air Pollution	2
	IEQ8. Indoor Sources of Air Pollution	3
	IEQ9. IAQ in Car Parks	1
B2.5.Ventilation	IEQ10. Increased Ventilation Performance	1
	IEQ11. Potential for Natural Ventilation	1
	IEQ12. Localised Ventilation	2
	IEQ13. Ventilation in Common Areas	2
B2.6. Thermal Comfort	IEQ14. Thermal Comfort Design	2
	IEQ15. Thermal Zoning	1
B2.7. Lighting and View	IEQ16. Natural Lighting and Glare Control	2
	IEQ17. Interior Lighting in Normally Occupied Areas	2
	IEQ18. Interior Lighting in Areas not Normally Occupied	1
	IEQ19. High Frequency Lighting	1
	IEQ20. Lighting Zones and Control	1
	IEQ21. View Out	1
B2.8. Acoustics and Noise	IEQ22. Room Acoustics	1
	IEQ23. Noise Isolation	1
	IEQ24. Background Noise	1
B2.9. Other Issues	IEQ25. Indoor Vibration	1
	IEQ26. Private Open Space	1
	IEQ27. Visual Privacy	1
B3. BUILDING SERVICES (BS)		**17**
B3.1. Building Amenities	BS1. Access for Persons with Disability	1
	BS2. Amenity Features	1
B3.2. Basic Building Equipment	BS3. Water Supply and Drainage System	1
	BS4. Electrical Equipment	1

	BS5. HVAC System	1
	BS6. Communications and IT Equipment	1
	BS7. Service Life of Components	2
	BS8. Maintenance of Core Building Functions during Power Outages	1
B3.3. Security and Safety	BS9. Security	1
	BS10. Fire Safety and Evacuation	3
B3.4. Vertical Transportation	BS11. Lifts	1
	BS12. Escalator and Travelling Walkways	1
B3.5. Earthquake Resistance	BS13. Earthquake Resistance	2
B4. DESIGN FEATURES (DF)		**12**
B4.1. Design for Energy Efficient	DF1. Energy Efficient Building Layout	2
B4.2. Design for Functionality and Usability	DF2. Provision of Space	1
	DF3. Maintenance Management	2
B4.3. Design for Flexibility and Adaptability	DF4. Spatial Flexibility	3
	DF5. Spatial Margin	2
	DF6. Floor Load Margin	1
	DF7. Adaptability of Facilities	1
E1. RESOURCES CONSUMPTION (RC)		**44**
E1.1. Land Use	RC1. Land Use and Reuse	2
	RC2. Land Use Efficiency	1
	RC3. On-site Resources	1
E1.2. Water Use	RC4. Annual Water Consumption	4
	RC5. Monitoring and Control	2
	RC6. Water Efficient Irrigation	1
	RC7. Water Harvesting and Recycling	3
	RC8. Water Efficient Facilities and Appliances	1
	RC9. Innovative Wastewater Technologies	1
E1.3. Energy Use	RC-P1. Basic Energy Performance	Required
	RC10. Energy Use Reduction	18
	RC11. Energy Use in Car Parks and Public Areas	2
	RC12. Low or Zero Carbon Technologies	4
	RC13. Clothes Drying Facilities	1
	RC14. Energy Efficient Appliances	1
	RC15. Metering and Monitoring	2
E2. MATERIAL ASPECTS (MA)		**21**
E2.1. Selection of Materials	MA-P1. Timber Used for Temporary Works	Required
	MA1. Materials Specification	8
	MA2. Certified Wood	1
	MA3. Rapidly Renewable Materials	2
	MA4. Recycled Content	2
	MA5. Regional Materials	2
E2.2. Efficient Use of Materials	MA6. Building Reuse	2
	MA7. Modular and Standardised Design	1
	MA8. Prefabrication	1
	MA9. Efficient Structure Design	1
	MA10. Design for Robustness	1
E3. ENVIRONMENTAL LOADING (EL)		**32**
E3.1. Waste	EL1. Construction/Demolition Waste Management	2
	EL2. Recycled and Secondary Aggregates	1
	EL3. Waste Recycle Facilities	1
	EL4. Compactor/Baler	1

	EL5. Compositing	1
E3.2. Pollution	EL6. Land Pollution	1
	EL7. Refrigerant Use and Leakage	3
	EL8. NO_X Emissions	3
	EL9. Water Pollution	1
	EL10. Flood Risk	3
	EL11. Noise Pollution	1
	EL12. Light Pollution	1
	EL13. Overshadowing and Views	1
E3.3. Ecology and Microclimate	EL14. Protection of Ecological Value	1
	EL15. Mitigation of Ecological Impacts	2
	EL16. Enhancement of Ecological Value	3
	EL17. Long-term Impact on Bio-diversity	2
	EL18. Surrounding Microclimate	4
E4. SOCIAL AND ECONOMIC ASPECTS (SE)		**16**
E4.1. Social Aspects	SE1. Public Transport	3
	SE2. Pedestrian and Cyclist	3
	SE3. Maximum Car Parking Capacity	1
	SE4. Travel Plan	1
	SE5. Neighbourhood Amenities	1
	SE6. Local Character	1
	SE7. Historic Environment	1
E4.2. Economic Aspects	SE8. Life Cycle Cost and Payback Time	2
	SE9. Affordability of Rental/Cost Levels	1
	SE10. Support of Local Economy	1
	SE11. Mixed-use Development	1
INNOVATION (IN)		**16**
	IN1. Innovative Strategies and Technologies	5
	IN2. Exemplary Performance	11

B1. PROJECT MANAGEMENT (PM)

B1.1. OVERALL MANAGEMENT

PM1. BASIC PRINCIPLES

Aim	To encourage the systematically incorporation of environmental and sustainable issues into the overall management of the project.
Credits available	3
Issue summary	a) 1 credit if there is an Environmental Management System (EMS)[1] to consider and assess the environmental aspects for each stage of the project. b) 1 credit if a member of the project team is identified as responsible for managing the environmental aspects of the project and is aware of the duties and responsibilities involved.[2] c) 1 credit if environmental impacts, opportunities for environmental enhancements and associated social issues are:[3] - Identified and clearly recorded for each stage; AND - Prioritised according to significance.
Exclusion	None.

Assessment

Evidence could be in form of report prepared by a suitably qualified person detailing the EMS and the plan to incorporate this system during the development (i.e. the life cycle of the building).

The identified person must be a dedicated Environmental Manager or Coordinator (i.e. not responsible for other duties). Detailed duties and responsibilities in relation to the project must have been set out on appointment for specific goals to be achieved. Evidence could be a formal note of the appointment, records of meetings where the role is clearly set out, or reports from the identified person to the project team.

a) Evidence should be an Environmental Impact Assessment report (EIA).[4]

Background and Notes

[1] An ***Environmental Management System (EMS)*** is a mechanism for managing the environmental impacts of a business, development project or operational process. Its complexity and scope are dependent on:

- The extent of environmental risk and opportunity;
- Its importance to the organisation with responsibility for that risk opportunity.

The EMS can be developed based on ISO 14001:2004 *Environmental management systems - Requirements with guidance for use. (http://www.iso.org/iso/iso_14000_essentials).*

[2] Every project, irrespective of size, should have someone designated as being responsible for environmental aspects. On smaller projects, a member of the project team may be responsible for this along with their other duties. On larger-scale project it is likely to be a dedicated person. On partnership projects, it may be the same person at each stage.

[3] All adverse environmental impacts and associated social issues of the project should be identified, as well as positive impacts and opportunities for environmental and social improvements.

- The significance of adverse impact is assessed by a combination of the potential severity and the likelihood of the impact occurring if no action is taken to avoid it.

The result of this assessment then enables prioritisation of impacts according to significance, which assists in setting the priorities for mitigation measures.

- The significance of positive impacts and opportunities is similarly assessed according to the expected environmental benefit and the likelihood of their occurring or being carried out as part of the project. This will then guide decision on which opportunities to take.

[4] An **Environmental Impact Assessment (EIA)** is an assessment of the possible impact – positive or negative – that a proposed project may have on the environment, together consisting of the natural, social and economic aspects. An EIA is often a part of the EMS.

PM2. ENVIRONMENTAL MANAGEMENT

Aim	To encourage actual actions on environmental issues and the systematic management of those actions.
Credits available	5
Issue summary	a) 1 credit if appropriate mechanisms[1] are put in place to manage project's environmental issues, impacts and opportunities. 1 additional credit if regular checks[2] are made to ensure that these mechanisms are implemented. 1 additional credit if there is a record of actions to be taken as a result of these checks. b) 1 credit if the results (success or otherwise) of the implementation of these mechanisms are assessed.[3] c) 1 credit if there is a program of training[4] on environmental and social issues relevant to the project delivered at an appropriate level for those engaged in the project.
Exclusion	None.

Assessment

a) Evidence to attain 3 credits of this part:
- Evidence of mechanisms could be procedures, flowcharts, checklists and/or documented control measures, and would form part of an EMS[5] if there were one in place. Appropriate mechanisms could have been put in place without the existence of a full EMS. However, they do need to be documented in some form and should clearly state the steps to be taken and any roles and responsibilities to be assumed. They also need to match the level of complexity of environmental issues relevant to the project.
- The output from an Environmental Impact Assessment (EIA)[6] that include discussion of how the project's environmental issues, impacts and opportunities are to be managed would not be sufficient to earn this credit. It is required that such EIA outputs have to be *translated into actions*.
- Evidence of regular check could be meeting report, inspection checklist or equivalent.
- Evidence of record of actions could be a report detailing how and when these actions were undertook.

b) *This credit can only be attained if all 3 credits of part a) are already achieved.*
Evidence for this part would be a review that took place routinely as opposed to being only as a result of a check that has taken place in part a). For instance, a standing item in project progress meetings or reports, which routinely review environmental performance and the success of control mechanisms established, would be acceptable. Evidence could also include the achievement of appropriate project targets set for environmental performance.

c) Evidence for this part could include records of site inductions or toolbox talks, more formal environmental training workshops for the project, briefings or other training on specific issues for the project (e.g. on use of new equipment or construction safety).

Background and Notes

[1] It should be stressed that 'appropriate mechanisms' does not mean that a full compliant system, such as ISO 14001, is required. The complexity of these mechanisms depends on environmental issues of the projects. The key thing to demonstrate is that there is a mechanism by which the key actions to be taken are documented along with the responsibility of taking them.

- At design stage, 'appropriate mechanisms' could be in the form of a Project Environmental Management Plan (PEMP) or Action Plan.
- At construction stage, 'appropriate mechanisms' could be in form of a Sustainable Environmental Management Plan (SEMP) or an Integrated Site Management Plan that includes coverage and management of environmental issues. Such a plan would cover the management of all significant environmental aspects of the construction process and would be specifically drawn up for the relevant site and project. It should also include procedures for monitoring its implementation and emergency response plans as well as operational control procedures.

[2] For a regular tall-building project, a 'regular check' frequency should be from 3 to 6 months. However, in any case, it is essential that this frequency must be appropriate to the environmental risks.

[3] As oppose to the *regular checks of implementation* referred to in part a) of this issue, this question asks about the *review of the results of implementation*, which implies a further step and a more proactive review, looking at the *outcome* of the implemented mechanisms, not just whether they have been taken.

[4] **Project-specific environmental training** should, at a minimum, cover the significant environmental impacts identified (as covered by Issue PM1), as well as instructions on how to deal with these. Sample common issues of a tall-building project can be named:

- Material sourcing;
- Energy performance over the life cycle of the completed building;
- Water consumption minimisation;
- Building operation (Vertical transportation system, renewable energy systems and other building services, special systems such as damping devices);
- Pollution;
- Security and Safety.

These issues can be dealt with in a wide range of training sessions, including formal courses for the project team(s), sessions within project team meetings, or via site inductions and toolbox talks. Records of these should be available.

[5] **Environmental Management System (EMS):** *see Issue PM1.*

[6] **Environmental Impact Assessment (EIA):** *see Issue PM1*.
The purpose of the assessment is to ensure that decision makers consider the ensuing environmental impacts when deciding whether to proceed with a project. The International Association for Impact Assessment (IAIA) defines an environmental impact assessment as "the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made."

B1.2. DESIGN PROCESS

PM3. SITE INVESTIGATION

Aim	To encourage the thorough study of the site conditions for high-rise structure construction and reactions to potential issues.
Credits available	3
Issue summary	a) Maximum 2 credits for carrying out a Site Investigation at design stage. b) 1 credit for the incorporation of the sequenced site investigation activities during the project development.
Exclusion	None.

Assessment

a) The following information must be obtained at a minimum in the course of the Site Investigation:

1	The general topography of the site as it affects foundation design and construction, e.g. surface configuration, adjacent property, the presence of watercourses, ponds, hedges, trees, rock outcrops; and the available access for construction vehicles and plants.
2	The location of buried services (e.g. electric power, telephone cables, and water mains sewers.).
3	The general geology of the area with particular reference to the main geological formations underlying the site and the possibility of subsidence from mineral extraction or other causes.
4	The previous history and use of the site including information on any defects or failures of existing or former buildings attributable to foundation conditions.
5	Any special features such as the possibility of flooding, seasoning swelling and shrinkage, and soil erosion.
6	A detailed record of the soil and rock strata and ground conditions within the zones affected by foundation bearing pressures and construction operations.
7	Results of laboratory test on soil and rock samples appropriate to the particular foundation design or constructional problems.

1 credit if at least five items are achieved.
2 credits if all seven items are achieved.

b) This credit can be achieved if the project team adopts the process provided in *Appendix 1: The Investigation Sequence of Events* or equivalent mechanisms.

Background and Notes

Many projects exceed their budgets and their completion dates due to unforeseen problems during the excavation and construction of their foundations. To ensure that these problems are kept to a minimum, a thorough site investigation is required for every tall-building project. A site investigation is a study of the environment and the ground conditions. It is a process by which geological, geotechnical, topographical, social, environmental, economic and other relevant information are collated and analysed.

The extend of the work depends on the importance and foundation arrangement of the structure, the complexity of the soil conditions, and the information which may be available in the behaviour of existing foundations on similar soils. A detailed site investigation involving deep boreholes and laboratory testing of soils is mandatory for heavy structure such as tall-buildings.

Any alternative Site Investigation Plan and Incorporation Plan of Site Investigation activities must be based on the 'Stages of Site Investigation' and 'The Investigation Sequence of Events' provided in Appendix 1.

PM4. WHOLE LIFE APPROACH

Aim	To encourage the incorporation of sustainable aspects in the design process in a holistic manner (throughout the life of the project).
Credits available	2
Issue summary	a) 1 credit if the design team adopts a whole life approach[1] to sustainable aspects of the project. b) 1 credit if the whole life approach includes consideration of the potential effects of predicted climate change scenarios, leading to appropriate adaptation strategies.[2]
Exclusion	None.

Assessment

a) Evidence could be in the form of a report detailing the whole life approach to social, economic and environmental aspects of the project.

b) Evidence could be any reference to reports of studies undertaken by or on behalf of the design team, or records of project team meeting to consider the issues.

Background and Notes

[1] The terminology surrounding 'Whole Life Costing,' 'Life Cycle Costing,' 'Life Cycle Analysis,' 'Whole Life Environmental Assessment' and 'Full Life Costing' can be confusing. However, the important feature of them all is that *impacts at different phases must be accounted for,* right through to the end of the useful life of the buildings, and *including the indirect effects* such as those associated with winning raw materials and manufacture of components. It is important to recognise that, in the context of TPSI, what is being looked for is consideration of the *environmental costs and benefits* of a tall-building project from inception through design and construction, to the operational and demolition phases. The whole life exercise therefore should also consider indirect operational issues such as nuisance and natural environmental enhancement.

The principals of Life Cycle Costing for construction are set out in the international standard BS ISO 15686-5:2008 *Buildings and constructed assets - Service life planning – Part 5: Life cycle costing*. *(http://www.iso.org)*. Different countries and regions may have supplement for this standard.

[2] Apart from trying to reduce the release of CO_2 and other 'green house' gases into the atmosphere, to avert the predicted change in climate, all high-rise structures should be designed in such a way that the potential impacts of climate change can be alleviated or, at a minimum, are not worsened, and/or that the project can be adapted to cope with predicted changes in climate.

This might, for example, include very flexible energy and Indoor Environmental Management Systems that will cope easily with significant changes in outside temperatures, systems designed to cope with heavier and more frequent storms, very high wind speeds, higher rainfall in winter and longer periods of drought in summer, and precautions against flooding on the site and downstream, as well as emissions-reduction facilities.

More guidance on the potential impacts of climate change and adaptation method is available from the United Nations Framework Convention on Climate Change (UNFCCC) (http://www.unfccc.int).

PM5. SITE DESIGN APPRAISAL

Aim	To encourage a proactive approach in order to achieve greater integration of site planning issues.
Credits available	1
Issue summary	1 credit for a Site Design Appraisal report that demonstrates a proactive approach to achieve greater integration of site planning issues.
Exclusion	None.

Assessment

Evidence must be a report that explains and details the design team's efforts in achieving integration of the development with the physical and environmental aspects of the immediate surroundings. The appraisal can make reference to local government's design guidelines or planning standards. It must consider ALL of the following issues at a minimum:

Special Major Urban Design Issues	
- Massing and intensity in urban fringe areas and rural areas. - Developing height profile. - Waterfront sites. - Public realm.	- Streetscape. - Heritage. - View Corridors. - Stilted Structures.
Special Major Land Uses Issues	
- Create appropriate size of the development. - Minimise adverse visual impact of building's height on surrounding areas. - Create interesting built form and mass. - Enhance privacy of occupants and minimise the negative visual, noise and air quality impacts. - Create an efficient, comfortable, safe, and convenient pedestrian circulation system throughout the neighbourhood. - Create an efficient vehicular circulation system with minimal negative impacts on pedestrian circulation. - Provide adequate and easily accessible parking facilities. - Provide open space and G/IC facilities that are usable, accessible and valuable to occupants.	- Minimise negative impacts on surrounding natural environment. - Create a recognisable identity. - Establish self-contained neighbourhoods and communities to encourage occupants' civic pride and sense of belonging. - Respect topographical/ landscape setting and the harmony of the surrounding layout. - Create a focus for village and enhance its individual identity. - Provide efficient pedestrian and vehicular circulation system suitable for the surrounding setting. - Preserve historical and cultural characteristics of the area. - Maintain the vibrant streetscape character.

Background and Notes

This Issue seeks to encourage the client and the design team to adopt a more integrated and proactive approach to the site planning matters. A Site Design Appraisal report is to demonstrate how the various aspects of site and architectural planning issues can collectively contribute to the enhancement of the site and its surrounding neighbourhood.

Please note that this Issue's aim is the holistic approach to Site Design process. It raises separate concerns to the assessment of specific Issues regarding surrounding microclimate and community, which are covered by Issue EL18, and Section E4.1.

B1.3. CONSTRUCTION ISSUES

PM6. CHOICE OF CONSTRUCTION PROCESS

Aim	To encourage the incorporation of the best construction methods and technologies.
Credits available	1
Issue summary	1 credit if the design team considers the environmental and social implications of different construction methods and technologies.
Exclusion	None.

Assessment

Evidence could be a report[1] that evaluates in details the whole life cycle implications (environmental, social, and economical) of different construction methods and technologies. This report must express how sustainable issues affect the choice of certain construction methods and technologies.

Background and Notes

The construction process - including issues such as the choice of methods and technologies, fabrication on or off site, use of modular construction, minimisation of temporary works, etc. – can have a great influence on the overall environmental performance of a project, especially tall-building projects. By having systems in place that examine the potential environmental impacts of alternative means of construction, the ability to select the best option for the environment and the project will be maximised.

Note that this Issue's only concern is the comparison between different construction methods/technologies. It does not deal with specific sustainable aspects, which are assessed under individual Issues.

[1] This report can be a part of the EMS report, which is referred to in Issue PM1.

B1.3. CONSTRUCTION ISSUES

PM7. CONSTRUCTION SITE IMPACTS MANAGEMENT

Aim	To recognise and encourage construction sites managed in an environmentally sound manner.
Credits available	4
Issue summary	Maximum 4 credits if a Construction Impact Management Plan[1] with specific targets are set during the design process for the environmental and social performance of the project *during construction* and progress toward the Plan is monitored.
Exclusion	None.

Assessment

Evidence could be a report detailing the Construction Impacts Management Plan or relevant materials[2] confirming the compliance with following items:[3]

1	Monitor, report and set targets for CO_2 or energy arising from the site activities.
2	Monitor, report and set targets for CO_2 or energy arising from transport to and from site.
3	Monitor, report and set targets for water consumption arising from site activities.
4	Implement best practice policies in respect of air (dust) pollution arising from the site.
5	Implement best practice policies in respect of water (ground and surface) pollution occurring on the site, including storm water design issues.
6	Main contractor has an environmental materials policy, used for sourcing of construction materials to be utilised on site.
7	Main contractor operates an Environmental Management System.
8	Implement best practice policies in respect of ground-generated gases risk arising from site activities.

1 credit if at least two items are achieved.
2 credits if at least four items are achieved.
3 credits if at least six items are achieved.
4 credits if all eight items are achieved.

Background and Notes

This Issue deals with the Management of Construction Site Impacts only. Some aspects such as water consumption, air pollution, and material policies are assessed in more details under individual Issues.

[1] This report can be a part of the EMS report, which is referred to in Issue PM1.

[2] Relevant materials can be:

- A copy of the relevant sections from the main contract specification confirming the contractor's obligations in respect to each item on the checklist. Where the main contract specification is not yet available, a formal letter from the client/developer including a completed *Checklist 1: Construction Site Impact Management (Appendix 2: Technical Checklists)* identifying which items will form part of the main contractor's obligations is acceptable.
- Site records demonstrating monitoring and recording of the following (where relevant):
  - Site energy/CO_2 consumption;
  - Site deliveries;
  - Site water consumption.
- Project targets set for water and energy consumption.

- Copies of the documented procedures used on site for working to best practice pollution management guidelines.
- A letter from the main contractor confirming:
    - Procedures for pollution management and mitigation were implemented;
    - Name/job title or individual responsible for monitoring and managing construction site impacts throughout the project.

[3] The assessment criteria for items 1-8 are described in details in relevant sections of *Checklist 1: Construction Site Impact Management (Appendix 2: Technical Checklists)*. Project team should use *Checklist 1* to show that they have achieved adequate requirements to earn these credits.

PM8. CONSTRUCTION SAFETY

Aim	To recognise and encourage the implementation of best practices in term of Construction Safety.
Credits available	2
Issue summary	a) 1 credit for adopting an Accident Prevention Scheme. b) 1 credit for providing a Safe Working Environment.
Exclusion	None.

Assessment

a) The adopted Accident Prevention Scheme must, at a minimum, consist ALL of the following four basic activities:

1	A Risk Assessment analysis[1] of all working areas to quantify and control physical or environmental hazards that can contribute to accidents.
2	A study of all operating methods and practices.
3	Provide education, instruction, training incentives and discipline (e.g. by imposing a fine) to minimise human factors that contribute to accidents.
4	Carry out thorough investigations of every accident, including accidents that do not result in personal injury (so called 'near-misses').[2]

b) A Safe Working Environment must fulfil the following requirements at a minimum:

1	Falls of person prevention	- A proper working platform should be provided to workers whenever practicable. The working platform should be of adequate width, carrying capacity and with sufficient guardrails to afford a safe and steady foothold and handhold. The width should not be less than 25 inches (635 mm) and toe-boards must be provided. - In case a platform cannot be provided due to e.g. space constraint, safety belts and lifelines, signage and handrails, which are adequately anchored, should be provided.
2	Falling objects prevention	- Good housekeeping and minimising debris being generated, hence less falling materials. - Systematic and regular disposal of accumulated debris, provision of perimeter overhead shelters. - Access and egress shelters to building, provision of safety nets, provision of pedestrian walkway or hoarding. - The compulsory wearing of safety helmets. - Segregate activities that are likely to generate falling objects away from potential victims working at the ground level.

Background and Notes

Safety is a critical issue in high-rise construction. It was a common practice in the early years of tall-building construction to assume in cost estimating that accidents would claim one life for say every two floor or each million dollars/pounds of general construction work performed. Nowadays nearly every country and major region has its own regulations and standards for high-rise construction.

Project team can adopt any local regulations, standards or mechanisms and still score the full 2 credits as long as they can prove that the listed requirements are fulfilled.

Any regulations, standards or mechanisms adopted must be systematised into a Safety and Health Management System (SHMS). A standard SHMS should comprise the following (the most important component of a SHMS is the risk assessment):

1	Declarations of policies related to safety and health.
2	Investigation of risks and/or hazards and determination of countermeasures to be taken based on the results of the investigation.
3	Adoption of targets for health and safety.
4	Formulation, implementation, evaluation and improvement of plans for health and safety.

[1] A **Risk Assessment** is a careful examination of the potential risks that could harm to workers in a workplace, so as to evaluate if sufficient precautions have been taken or should more be done to eliminate or minimise the occurrence of accidents. The risk assessment may be conducted by the employers, self-employed persons or principals themselves or they may engage a risk assessment consultant to carry out the risk assessment. The roles and responsibilities of persons involved in the implementation of the risk control measures and safe work procedure must be specified. A Risk Assessment must have following features:

1	Review period	The risk assessment must be reviewed or revised at least once every three years or in the event of the following: - After an accident as a result of exposure to a hazard. - When there is a significant change in work processes that could affect the safety and health of the workers, for example, the introduction of new machinery or chemicals.
2	Record maintenance	The record of risk assessments conducted must be maintained for at least three years. The record should include: - The results or findings recorded in risk assessment forms. - Risk control measures taken or to be taken. - Any safe work procedures.
3	Communication	Every employee or person at the workplace who may be exposed to safety and health risk should be informed of the following: - The nature of the risk involved. - The measures implemented to control the risk. - Applicable safe work procedures. - Whenever the risk assessment is revised, or when there is a significant change in work practices or procedures, the employees or other persons who may be at risk must be informed accordingly.
4	Offences and Penalties	There must be an appropriate offence and penalty mechanism for employees or other persons who fail to comply with safety regulations.

[2] **Accident Investigation** is a defence against hazards that are overlooked in the first three activities, those that are less obvious, or hazards that are the result of combinations of circumstances that are difficult to foresee.

B1.4. CONTRACTUAL AND COMMISSION PROCESS

PM9. CONTRACTUAL AND PROCUREMENT PROCESS

Aim	To encourage the awareness of sustainable issues of all parties engaged in the project.
Credits available	3
Issue summary	a) 1 credit if all parties directly engaged in the project are informed of the significant environment impacts and associated social issues of their part and/or stage of the project.[1] b) 1 credit if the selection procedure for the following parties consider their past and potential environmental performance: - The principal designer; - The main contractor; - The key sub-contractor(s). c) 1 credit if the contract requirements for the designers and contractors expressly include achievement of specific environmental and social performance.
Exclusion	None.

Assessment

a) Evidence to attain 1 credit of this part:
- Evidence for the client could include communication of environmental impacts within tender documents and specifications.
- Evidence for designer could include how they have briefed their team in the environmental issues that require consideration.
- Evidence for contractor could include the incorporation of environmental mitigation actions in method statements, toolbox talks or other site briefings such as communication the requirements of the SEMP.[2]
- For any stage it could also include more project workshops, such as on value management and value engineering, which includes consideration of the environmental impacts for the project.

An EIA[3] must be carried out in order to attain this credit

b) Evidence could include supplier appraisals, quality submissions information on environmental issues during tender stage.

c) Evidence could include output from any contract strategy meetings or reports that show consideration of environmental issues as a factor in the choice of procurement method.[4]

Background and Notes

Contract and procurement processes play a very important role in determining the importance of environmental issues and how people will be motivated to minimise adverse environmental impacts and maximise positive ones, to maintain quality standards throughout the project and to play a role in enhancing standards as the project proceeds. Simply put, the greater the equity share or benefit people have throughout the supply chain, the more motivated they will be to consider the risks and opportunities associated with environmental impacts of the project.

Detailed requirements on environmental matters, specifications and designer and/or contractor performance are now regularly included in contract documentation. The following question can be asked about the underpinning principles and intentions of the contract and procurement process:
- Do they seek to increase partnership and ownership throughout the process by aiming to share both risk and rewards?

- Do they seek to extend the timescale over which parties are responsible for the outcomes of the project and over which success is to be measured?

Other key questions include the following:

- Is there evidence of environmental criteria being used in the selection of designers, contractors and operators?
- Is there provision for environmental issues to be considered throughout the supply chain?
- What targets, measures and checks are put in place to demonstrate how environmental criteria have been used in the selection?
- To what extend are environmental issues included in the project reporting and review process?

[1] 'All parties directly engaged in the project' includes project manager, design team, contractors and sub-contractors, and anyone else actively engaged, but *not extractive and/or factory or office sites of* suppliers or materials or services.

[2] **Sustainable Environmental Management Plan (SEMP):** *see Issue PM2*.

[3] **Environmental Impacts Assessment (EIA):** *see Issue PM1.*

[4] It is well-known that different forms of contract can significantly influence the behaviour of the contracting parties, especially to those issues that are implied as being necessary rather than expressly stated. What is being sought here is that environmental and social performance requirements are *expressly* stated so that there is no doubt as to those requirements and the designers and contractors are properly resourced to deliver them.

PM10. COMMISSIONING

Aim	To recognise and encourage an appropriate level of building services commissioning that is carried out in a co-ordinated and comprehensive manner, thus ensuring optimum performance under actual occupancy conditions.
Credits available	2
Issue summary	Maximum 2 credits for fulfilling specific requirements in term of commissioning process.
Exclusion	None.

Assessment

a) First credit

The project team must demonstrate compliance with ALL of the following requirements:

1	An appropriate project team member(s) is appointed to monitor and program pre-commissioning, commissioning and, where necessary, re-commissioning on behalf of the client.[1]
2	Commissioning to be carried out in line with current local building regulations.[2]
3	The main contractor accounts for the commissioning program, responsibilities and criteria within the main program of works.
4	A specialist commissioning manager[3] is appointed (by either client or contractor) for complex systems such as: - Air conditioning. - Mechanical ventilation, displacement ventilation, complex passive ventilation. - Building Management Systems (BMS).[4] - Renewable energy sources. - Microbiological safety cabinets and fume cupboards. - Cold storage enclosures and refrigeration plant. - Vertical transportation systems. - Earthquake and damping systems/devices. - Every other tall-building specialised system. The specialist commissioning manager must be appointed during the design stage and the scope of their responsibility includes: - Design input: commission ability design reviews. - Commissioning management input to construction programming. - Commissioning management input during installation stages. - Management of commissioning, performance testing and handover/post-handover stages.
5	Where BMS specific, the following commissioning procedures must be carried out: - Commissioning of air and water systems is carried out when all control devices are installed, wired and functional. - In addition to air and water flow results, commissioning results include physical measurements of room temperatures, off coil temperatures and other key parameters as appropriate. - The BMS/controls installation should be running in auto with satisfactory internal conditions prior to handover. - All BMS schematics and graphics (if BMS is present) are fully installed and functional to user interface before handover. - The occupier will be fully trained in the operation of the system.

Evidence required:

For 1&4	A copy of a letter or commissioning responsibilities schedule confirming the appointment of (or commitment to appoint): - Design team member(s) as commissioning monitor and scope of their commissioning role - Specialist commissioning manager and scope of their commissioning role.
2	A copy of the specification clause stating the standards and codes of practice to which commissioning procedures are to comply with.
3	A copy of the specification clause confirming the managing contractor's responsibilities with respect to this requirement. OR A copy of a commissioning schedule highlighting managing contractor's commissioning responsibilities.
5	A copy of the specification clause/commissioning schedule confirming the stages of the BMS/Controls commissioning procedures.

b) Second credit

The project team must demonstrate compliance with ALL of the following requirements:

1	Credit a) has been achieved
2	The above appointment(s) include the following seasonal commissioning responsibilities over a minimum 12 month period, once the building becomes occupied: <u>Complex Systems – Specialist commissioning manager:</u> - Testing of all building services under full load conditions, i.e. heating equipment in midwinter, cooling/ventilation equipment in mid-summer, and under part load conditions (spring/autumn). - Where applicable, testing should also be carried out during periods of extreme (high or low) occupancy. - Interviews with building occupants (where they are affected by the complex services) to identify problems or concerns regarding the effectiveness of the systems. - Re-commissioning of systems (following any work needed to serve revised loads), and incorporating any revisions in operating procedures into the O&M[5] manuals. - Where specialist building services systems such as earthquake damping devices, fume cupboards, microbiological safety cabinets, cold storage systems, and other tall-building-specialised systems are present then the assessor must ensure that these systems are included in the specialist commissioning agent's responsibilities. <u>Simple Systems (naturally ventilated)[6] – External Consultant/Facilities Manager</u> - Review thermal comfort, ventilation, and lighting, at three, six and nine month intervals after initial occupation, either by measurement or occupant feedback. - Take all reasonable steps to re-commission systems following the review and incorporate any relevant revisions in operating procedures into the O&M manuals.

Evidence required:

1	Evidence (as outlined above) confirming compliance with credit a).
2	As evidence criteria for [1] & [3] of credit a). This evidence must confirm the scope of seasonal commissioning responsibilities/tasks (as required).

Background and Notes

[1] The commissioning monitor can be a person from within the contractor or sub-contractor organisation, provided they are not involved in the general installation works.

[2] Where local building regulations are not available, commissioning process can be carried out based on international standards such as ISO 14000 series or ISO 19011. (http://www.iso.org)

[3] The commissioning manager for complex systems must be a specialist contractor rather than a general sub-contractor.

[4] **Building (Energy) Management System (BMS):** is a central computer controlling, monitoring and optimising building services and systems such as heating, air-conditioning, lighting, security, water, and electricity.

[5] **O&M manuals**: Operation and Maintenance manuals.

[6] Where the building is largely naturally ventilated, using simple cross-flow ventilation relying solely on openable windows and/or trickle vents (except in areas where mechanical ventilation is legally required), the appointment of a specialist commissioning agent is not required to award this credit. If a BMS system is employed, however, to control the natural ventilation and/or if renewable energy sources are utilised in the development, the requirement for a specialist commissioning agent remains.

B1.5. OPERATION

PM11. OPERATION MANAGEMENT PLAN

Aim	To recognise and encourage the sustainable operation of the building.
Credits available	1
Issue summary	1 credit if specific targets are set during the design process for the environmental and social performance of the project *during operation* or once in use, AND there is a monitoring program in place for the operational phase.
Exclusion	None.

Assessment

Evidence could be the completed Operation Management Plan. The project team must demonstrate that targets have to be set for the operational phase AND a monitoring program to be undertaken once construction is complete has to be in place. Target-setting without monitoring progress is considered to be of little or no use.

Background and Notes

Operational targets are likely to relate to quantifiable measures, such as waste production, energy consumption, carbon dioxide production, natural resource consumption or pollution prevention. Targets should also refer to time scale where possible. For example, an operational target might state that 50% of waste produced in tones during the first year of operation is to be recovered through reuse, recycling or composting. Targets may also cover maintenance issues such as paints to be used or how to deal with waste arising through maintenance. Note that *'Compliance with legislation'* cannot be regarded as an appropriate operational target. The following formula can be applied:

SMART Targets = **S**pecific, **M**easurable, **A**chievable, **R**epeatable/**R**ealistic, within a **T**imeframe

Although any Environmental Statement (ES) may include targets or equivalent statements on a wide range of issues such as operational noise and air pollution control, the presence of the ES is not considered sufficient evidence here. Evidence needs to demonstrate that such targets have been *positively adopted* by the design team, for example through project team meeting minutes or equivalent.

PM12. BUILDING USER GUIDE

Aim	To recognise and encourage the provision of guidance for the non-technical building users so they can understand and operate the building efficiently.
Credits available	1
Issue summary	1 credit if a Building User Guide is developed which is relevant to the non-technical building users and stakeholder(s) that will occupy the building.
Exclusion	None.

Assessment

Evidence to attain this credit could include:

1	The completed Building User Guide.[1] This Guide has to be user-friendly so non-technical building users and stakeholder(s) can easily understand.
2	Written confirmation from design team that the Guide has been distributed to the building's owner, users and stakeholder(s).[2]

Background and Notes

[1] **User Guide Contents:** in order to meet the needs of the Facilities Management (FM) Team/Building Manager and the General Users, the information given in *Appendix 3: Building User Guide Contents* must be included at a minimum.

The presence of an Operation & Maintenance (O&M) manual does not meet this requirement. The O&M manual provides the detailed specialist information required by technical Facilities Managers (FMs) and maintenance staff/contractors. The Building User Guide can be contained in the O&M manual, but must be an extractable or 'stand-alone' section.

[2] If the building is divided in to multiple tenancies (mixed-use development), one central building user guide should be provided covering the scope of landlord controlled areas/responsibilities. A separate subsidiary guide should be provided for each tenant's space, appropriate to the status/responsibility of the tenant(s) and their building/unit.

B1.6. DEMOLITION

PM13. DEMOLITION MANAGEMENT PLAN

Aim	To encourage the consideration of sustainable aspects of demolition activities right at the design stage.
Credits available	1
Issue summary	1 credit if a Demolition Management Plan is developed at the design stage with professional consultants(s).
Exclusion	None.

Assessment

Evidence to attain this credit could include:

- A completed Demolition Management Plan.[1] The Demolition Management Plan has to be carried out by professional demolition contractor(s), so does every demolition activities.
- Written confirmation from project team that the Plan has been fully implemented.

Background and Notes

[1] **Demolition Management Issues:** *Appendix 4: Demolition Management Issues* indicates aspects that must be considered in order to develop a Demolition Management Plan.

B2. INDOOR ENVIRONMENTAL QUALITY (IEQ)

B2.1. PREQUISITE

IEQ-P1. MINIMUM VENTILATION PERFORMANCE

Aim	To ensure that a minimum quality and quantity of outdoor air is supplied to indoor spaces in order to support the wellbeing and comfort of occupants.
Credits available	Required.
Issue summary	Demonstrate compliance with the specific minimum requirements in respect of Outdoor Air Quality and Minimum Ventilation Rate.
Exclusion	Residential and similar buildings without central air conditioning.

Assessment

This Issue is the prerequisite for all Issues under Section 'B2. Indoor Environmental Quality.' (Issues IEQ1 to IEQ27). It must be fulfilled in order to score under Issues IEQ1 to IEQ27.

Evidence could be a report prepared by a suitably qualified person detailing the outdoor ventilation performance. The report must include:

1	Completion of Table H-1 of ASHRAE Standard 62.1-2007[1] in respect of regional outdoor air pollutants and local outdoor air quality survey.
2	Confirmation that the outdoor air quality meets the local primary air quality standards, otherwise indicate any action taken to compensate.
3	Completion of Table H-2 of ASHRAE Standard 62.1-2007 demonstrating compliance with the minimum ventilation rate(s) provided.

Background and Notes

The purpose of this Issue is to provide the minimum outdoor air ventilation to provide for the control of odours, that is, the supply, distribution and control of ventilation to maintain carbon dioxide (CO_2) levels within design targets in normally occupied spaces,[2] and the control of indoor pollutants such as TVOC's and formaldehyde.

The assessment of this Issue is based on ASHRAE62.1:2007.[1] The standard includes significant requirements other than outdoor air rates, such as requirements for equipment to reduce the potential for microbial growth, air cleaning requirements, and start-up and commissioning requirements. All of these requirements must be met to comply with this prerequisite. The project team can use other international standards and still qualified for this prerequisite as long as the equivalency of the adopted standard(s) can be demonstrated.

[1] American Society of Heating Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE Standard 62.1-2007: *Ventilation for Acceptable Indoor Air Quality*. (http://www.ashrae.org/).

[2] **Occupied spaces:** for the purpose of TPSI, an occupied space is a room or space within the assessed building that is likely to be occupied for 30 minutes or more by a building user. The definition excludes the following:

- Atria/concourses;
- Entrance halls/reception areas;
- Ancillary space such as circulation areas;
- Store rooms and plant rooms.

B2.2. WATER QUALITY

IEQ1. WATER QUALITY

Aim	To ensure that the quality of potable water delivered to building users is satisfactory.
Credits available	1
Issue summary	1 credit if the quality of potable water meets the referenced drinking water quality standards at all points of use.
Exclusion	None.

Assessment

The project team must provide details of the analysis of samples taken from a selection of potable water outlets used to supply human consumption.

- Sampling should be systematic, such as described in ICS 13.060,[1] and at a minimum samples should be taken at all the farthest point(s) of use in the distribution system from the storage tank, and shall include sampling for each water supply tank used in the building.
- Water quality at all sample points must meet with the local standard or international standards as described in ISO's ICS 13.060.[2]

Background and Notes

[1,2] Water quality regulated by ISO is covered in various sections of ICS 13.060: *Water Quality*, ranging from water sampling, drinking water, industrial class water, sewage water, and examination of water for chemical, physical or biological properties (http://www.iso.org). Project team must prove that:

- The sampling procedure fulfils the requirements described in various sections of ICS 13.060.45: *Examination of water in general (including sampling).*
- Sample quality fulfils the requirements described in various sections of ICS 13.060.01: *Water quality in general* AND ICS 13.060.20*: Drinking water.*

The project team can use other international or local standards and still qualified for this credit as long as the equivalency of the adopted standard(s) can be demonstrated.

B2.3. HYGIENE

IEQ2. PLUMBING AND DRAINAGE

Aim	To reduce the potential for contamination of plumbing and drainage systems, the ability of systems to carry infections, and the likelihood of odours.
Credits available	1
Issue summary	1 credit for designs that eliminate the potential for transmission of harmful bacteria viruses and odours.
Exclusion	None.

Assessment

Evidence could be in form of:

- Drawings and specifications for the plumbing and drainage systems, and confirmation that installation of the systems was carried out according to the specifications; AND
- A summary report highlighting where appropriate means have been included to allow for safe and hygienic operation over the expected lifespan of the systems and components. The 'appropriate means' should include, but is not limited to, reference to the following:

1	Adequacy of flushing water supply to meet the pattern of demand.
2	Design of drainage stacks of adequate capacity for peak loading.
3	Venting of stacks.
4	Access to pipework and ducts for maintenance purposes.
5	Installation of buried pipework that pays attention to leaks at joints, seals, etc. for the expected life of the installation.
6	Design of floor drains.
7	Maintenance of water seals.

Where it can be demonstrated that the design and installation of the plumbing and drainage systems, and any other provisions that can impact on performance (e.g. ventilation of bathrooms) have been given due attention, e.g. comply with local or international standards,[1] then the credit shall be awarded.

Background and Notes

[1] Where local regulations or standards are not available, design and installation of plumbing and drainage systems should be carried out based on the following international standards (http://www.iso.org):

- ICS 91.140.60: *Water supply systems.*
- ICS 91.140.80: *Drainage systems.*
- ICS 93.030: *External sewage systems.*

Installation and maintenance

Leaky joints and broken drainage pipes are the result of the lack of regular inspection and maintenance. Pipework needs to be as accessible as possible in order to carry out such work, and building management should be provided with means for regular inspection, maintenance and repair of building drainage systems.

A common problem is the difficulty in gaining access to systems from public or common areas. Locating pipework on the exterior of a building has the advantage that maintenance can be carried out with minimal disturbance to users. However, locating pipework internally is acceptable if adequate duct space is provided with proper access from a public area, such as a common corridor.

As drainage and other service pipes are often placed in light-wells and re-entrants, when designing these designers should pay special attention to access for repair and maintenance. The lowest level of re-entrants and light-wells housing soil and waste pipes or stacks should be designated as common areas with access, including access through cat-ladder where appropriate, to facilitate maintenance and clearance of any refuse.

Water seal

Water seal traps are required to be provided for all sanitary fitments, including floor drains (if provided), before they are connected to a common drainage stack. Trap seal retention can be a problem in multi-level drainage systems. The main ways that air passes a trap are:

- System pressure variations cause air-entrained bubbles to pass through the water seal; and/or
- Complete or partial trap seal loss.

Unless water is replenished, from time to time, by the building users or through discharge of wastewater cross-contamination is likely. Viruses can enter in indoor spaces through water traps if water seals are dried out or contaminated, or there is leakage in pipework. Under working and test conditions traps should retain a minimum seal of 1 inch (~ 25 mm) of water or equivalent. Self-priming type drainage traps or drainage pipe connections which ensure trap priming may be considered, e.g. connection of washbasin discharge to the pipe between the floor drain grating and its U-trap. Care should also be taken to prevent back flowing at the floor drain.

Two-pipe system

Use of two pipes for drainage - one for foul water and one for grey water - may also be a consideration (note that such an arrangement can allow for grey water recycling). Separation of soil and waste pipes can reduce the chance of cross contamination between systems, the connection of wash basin; bath and floor drain to the same waste stack can still permit cross contamination within the waste system. A more effective measure is to provide an independent stack for floor drains.

Ventilation

Where mechanical ventilation in the form of extractor fan is provided, such as in bathrooms and lavatories, care should be taken to ensure that water seals are intact and operate according to the design intent. Consideration should be given to the quality and quantity of air intake, air-flow path and fan capacity. The Environmental Health Team of the World Health Organisation (WHO) has advised that the optimum volume for bathroom ventilation is 2 cfm/ft^2 (10.2 l/s per m^2). A larger volume does not add much on the comfort side and has the hidden risk of building up negative pressure. Designers are advised to provide an opening to bathrooms and lavatories for make-up air, such as an undercut to the door or an opening with a louver at the door or wall, in order to minimise the build-up of negative pressure where an extractor fan is used for ventilation. The airflow path created should avoid circuiting of the ingress and exhaust air.

IEQ3. BIOLOGICAL CONTAMINATION

Aim	To ensure the building services are designed to reduce the risk of legionellosis[1] in operation.
Credits available	1
Issue summary	1 credit for complying with specific recommendations in respect of Legionnaires' disease[1] prevention.
Exclusion	None.

Assessment

Evidence could be in form of drawings and specifications of all water systems and humidification, and confirmation that installation of the systems was carried out according to the specifications. Project team must demonstrate that:

- The design and installation of all water systems[2] are complied with local or international standards[3] in respect of Legionnaires' disease prevention; AND
- No humidification is specified or only steam humidification is provided.[4]

Background and Notes

[1] **Legionnaires disease:** Legionnaires disease is a type of pneumonia caused by the bacterium Legionella pneumophila. People catch Legionnaires' disease by inhaling small droplets of water suspended in the air, which contain the bacteria.

[2] **All water systems**: for the purpose of this Issue, this refers to:

- Cooling towers;
- Evaporative condenser;
- Domestic hot and cold water systems;
- Other plant and systems containing water which is likely to exceed 20°C and which may release a spray or aerosol during operation/maintenance, for example:
  - Humidifiers and air washers;
  - Spa baths and pools;
  - Car/bus washes and wet scrubbers;
  - Indoor fountains and water features.

[3] Every countries and major regions should have their own Code of Practice, regulations or standards in respect of Legionnaires' disease prevention. Where local standards are not available, project team must comply with international standards such as:

- UK Health and Safety Executive's. *Legionnaires' disease - The control of legionella bacteria in water systems*. Approved Code of Practice and guidance. 2000. (http://www.hse.gov.uk).
- ISO 11731: *Water quality - Detection and enumeration of Legionella* (http://www.iso.org).

[4] **Humidification units**: humidification options fall into two broad groups:

- The first group relies on a heated air stream evaporating water vapour either from a pond or stream of water. This includes so-called 'trickle-down' systems. These are dependent on sterilisation technologies such as UV, ultrasonic, etc., to ensure that the water vapour is not contaminated. Whilst these systems are effective when working properly, any partial failure will allow untreated water into a warmed air stream; and the health-related consequences are likely to be significant.
- The second group relies on failsafe systems that minimise risk if the plant fails. The only option in this group is steam humidification. This process sterilises the water vapour and ensures that untreated water cannot enter the air stream when no steam is being produced.

IEQ4. WASTE DISPOSAL FACILITIES

Aim	To ensure that the design and installation of waste disposal and recycling facilities are adequate in order to reduce the risk of odours entering occupied areas or public areas.
Credits available	1
Issue summary	1 credit for the provision of a hygienic refuse collection system.
Exclusion	None.

Assessment

Evidence could be in form of drawings and specifications for the refuse collection system, and confirmation that installation of the system was carried out according to the specifications. Project team must demonstrate that refuse is disposed of in a hygienic manner and prevents any significantly discernable odours from entering occupied areas or public areas in or immediately adjacent to the building development.

The system must comply with those recommendations contained in local or international regulations and standards[1] in respect of refuse storage and recovery chambers appropriate to the given circumstances.

Background and Notes

[1] Where local regulations or standards are not available, design and installation of waste disposal and recycling facilities should be carried out based on ISO's ICS 13.030.40: *Installations and equipment for waste disposal and treatment* (http://www.iso.org).

Where refuse contains large amounts of food and other organic waste there are potential odours and health problems if refuse is not well contained from the points of disposal by users to the place of final collection. Automatic systems are available to isolate refuse from users.

Refuse chambers

Where a centralised ventilation system is adopted, a single air purifier may be installed before final discharge into the atmosphere. Alternatively where there is no particular odour problem a mechanical fan coupled with a particulate filter at each Refuse Storage and Material Recovery Room or Material Recovery Chamber (RS&MRR/MRC) may be considered. The main exhaust outlet for a centralised ventilation system should be located at upper roof level away from other buildings; however, in the case where the building is surrounded by taller buildings or the building itself is too tall, the discharge may be located at the main RS&MRC.

The noise level of the system should be at an acceptable level *(see Issue EL11)*. Fire dampers should be provided if the system has exhaust grilles and ducting at each floor. Air purifying devices such as 'Chemical Air Scrubber,' 'Bio-oxygen Generator,' 'Photo-oxidation Generator' or other appropriate devices should be provided within a RS&MRC.

B2.4. INDOOR AIR QUALITY (IAQ)

IEQ5. ENVIRONMENTAL TOBACCO SMOKE (ETS) CONTROL

Aim	To prevent or minimise exposure of building occupants, indoor surfaces, and ventilation air distribution systems to ETS.
Credits available	1
Issue summary	1 credit for complying with specific recommendations in respect of ETS Control.
Exclusion	None.

Assessment

If the building has a zero lot line condition, or cannot establish a 25-foot non-smoking boundary around the building, prohibit smoking on the property and choose one of the following options:

CASE 1. All types of buildings

OPTION 1:

- Prohibit smoking in the building.
- Prohibit on-property smoking within 25 feet (~ 7.6 m) of entries, outdoor air intakes and operable windows. Provide signage to allow smoking in designated areas, prohibit smoking in designated areas or prohibit smoking on the entire property.

OR

OPTION 2:

- Prohibit smoking in the building except in designated smoking areas.
- Prohibit on-property smoking within 25 feet (~ 7.6 m) of entries, outdoor air intakes and operable windows. Provide signage to allow smoking in designated areas, prohibit smoking in designated areas or prohibit smoking on the entire property.
- Provide designated smoking rooms designed to contain, capture and remove ETS from the building. At a minimum, the smoking room must be directly exhausted to the outdoors, away from air intakes and building entry paths, with no recirculation of ETS-containing air to non-smoking areas and enclosed with impermeable deck-to-deck partitions. Operate exhaust sufficient to create a negative pressure differential with the surrounding spaces of at least an average of 5 Pascals (Pa) (0.02 inches of water gauge) and a minimum of 1 Pa (0.004 inches of water gauge) when the doors to the smoking rooms are closed.
- Verify performance of the smoking rooms' differential air pressures by conducting 15 minutes of measurement, with a minimum of one measurement every 10 seconds, of the differential pressure in the smoking room with respect to each adjacent area and in each adjacent vertical chase with the doors to the smoking room closed. Conduct the testing with each space configured for worst-case conditions of transport of air from the smoking rooms (with closed doors) to adjacent spaces.

CASE 2. Residential and health-care projects only

- Prohibit smoking in all common areas of the building.
- Locate any exterior designated smoking areas, including balconies where smoking is permitted, at least 25 feet (~ 7.6 m) from entries, outdoor air intakes and operable windows opening to common areas.
- Prohibit on-property smoking within 25 feet (~ 7.6 m) of entries, outdoor air intakes and operable windows. Provide signage to allow smoking in designated areas, prohibit smoking in designated areas or prohibit smoking on the entire property.
- Weather-strip all exterior doors and operable windows in the residential units to minimise leakage from outdoors.
- Minimise uncontrolled pathways for ETS transfer between individual residential units by sealing penetrations in walls, ceilings and floors in the residential units and by sealing vertical chases adjacent to the units.
- Weather-strip all doors in the residential units leading to common hallways to minimise air leakage into the hallway.[1]

- Demonstrate acceptable sealing of residential units (e.g. by a blower door test)
- Residential units must demonstrate less than 1.25 in^2 (~ 806 mm^2) leakage area per 100 ft^2 (~ 9.3 m^2) of enclosure area (i.e., sum of all wall, ceiling and floor areas).

The project team must provide evidence in form of design plans, drawings, specifications, photos, and/or other relevant materials to demonstrate compliance with the strategies in the chosen option.

Background and Notes

[1] If the common hallways are pressurised with respect to the residential units, then doors in the residential units leading to the common hallways need not be weather-stripped provided that the positive differential pressure is demonstrated as in Option 2 above, considering the residential unit as the smoking room.

Potential Technologies & Strategies

Prohibit smoking in commercial buildings or effectively control the ventilation air in smoking rooms. For residential buildings, prohibit smoking in common areas and design building envelope and systems to minimise ETS transfer among dwelling units.

IEQ6. CONSTRUCTION IAQ MANAGEMENT

Aim	To ensure that building ventilation systems are not contaminated as a result of residuals left over from construction activities.
Credits available	2
Issue summary	a) 1 credit for implementing a Construction IAQ Management Plan. b) 1 credit for undertaking a building 'flush-out' or 'bake-out' and replacement of all filters prior to occupancy.
Exclusion	Residential and similar buildings not provided with central air-conditioning and ventilation systems.

Assessment

a) Construction IAQ management

Evidence could be a report prepared by a suitably qualified person documenting effective implementation of a Construction IAQ Management Plan appropriate to the scale and extent of the development including, but not limited to, the following:

1	A copy of the completed Plan.
2	Evidence of measures showing protection of ducts, on-site storage or protection of installed absorptive materials, etc.
3	Checklists, worksheets, notifications, deficiencies, resolutions, etc., related to construction IAQ issues, including a completed *Checklist 2 (Appendix 2: Technical Checklists)*.[1]
4	Documentation that demonstrates implementation of construction IAQ management measures during construction.
5	Details of filtration media used during construction and installed immediately prior to occupancy.
6	Documentation for duct cleaning and testing.

b) Filter replacement and flush-out

Evidence could be a report prepared by a suitably qualified person detailing the technical information for the filtration media[2] used during construction and installed immediately prior to occupancy. The report must also detail building flush-out procedures including actual dates of the flush-out.

Background and Notes

Please note that this Issue raises separate concerns from Construction Site Impacts Management, which is covered in Issue PM7.

Tall-buildings, especially those with extensive ventilation systems, can suffer from indoor air pollution problems arising from residuals left in HVAC[3] and mechanical ventilation systems after construction. Proper management during construction, followed by cleaning and replacement strategies can significantly reduce air pollution. Designers should specify containment control strategies including protecting the HVAC systems, controlling pollutant sources, interrupting pathways for contamination, enforcing proper housekeeping and coordinating schedules to minimise disruption. The construction sequencing to install absorptive materials after the prescribed dry or cure time of wet finishes should be specified to minimise adverse impacts on indoor air quality. Materials directly exposed to moisture through precipitation, plumbing leaks, or condensation is susceptible to microbial contamination. Absorptive materials to be protected and sequenced during installation include: insulation, fabrics, ceiling tiles, and gypsum products. During construction the IAQ management should be monitored and reported.

Flush-out
The flush-out may begin only after all construction work and finishing is completed; all cleaning finalised and all fixed furniture installed. Final test and balancing should be completed and HVAC control should be functional, particularly if the occupants will be moving in during the second phase of flush-out.

The flush-out procedure may use the building's HVAC system, but alternatives are acceptable providing they meet the air quantity, temperature and humidity requirements. For example, one approach uses temporary supply and exhaust systems placed into windows or window openings. Care must be taken to ensure the airflow is not short circuited, potentially leaving remote corners within the project spaces with less than adequate circulation, or other parts of the building with unanticipated increases, such as a stack effect up elevator shafts.

If the building's HVAC system is used, any temporary filters and duct coverings installed should be removed. The filtration media should be replaced with new media unless the system is configured such that filters filter only the outside air. Depending upon the season, outside air can be cold or humid. Appropriate internal temperature and relative humidity must be maintained during flush-out procedure.

[1] The project team must complete *Checklist 2: Construction IAQ Management (Appendix 2: Technical Checklists)* to demonstrate that due attention has been paid to construction IAQ management issues.

[2] Although not compulsory to attain this credit, all filtration media used during the project should meet the standard detailed in ISO/TS 21220:2009 *Particulate air filters for general ventilation - Determination of filtration performance* (http://www.iso.org); or equivalent standards.

[3] **Heating, Ventilating, and Air Conditioning (HVAC)** is the technology of indoor or automotive environmental comfort. HVAC system design is a major sub-discipline of mechanical engineering, based on the principles of thermodynamics, fluid mechanics, and heat transfer. Refrigeration is sometimes added to the field's abbreviation as HVAC&R or HVACR, or ventilating is dropped as in HACR (such as the designation of HACR-rated circuit breakers). HVAC is particularly important in the design of large buildings such as skyscrapers, where safe and healthy building conditions are regulated with temperature and humidity, as well as fresh air from outdoors.

IEQ7. OUTDOOR SOURCES OF AIR POLLUTION

Aim	To ensure that airborne contaminants from external sources will not give rise to unacceptable levels of indoor air pollution in normally occupied spaces.
Credits available	2
Issue summary	a) 1 credit for demonstrating compliance with appropriate criteria for Carbon monoxide (CO), Nitrogen dioxide (NO_2) and Ozone (O_3). b) 1 credit for demonstrating compliance with the appropriate criteria for Respirable Suspended Particle (PM_{10}).
Exclusion	None.

Assessment

Evidence could be a report prepared by the suitably qualified person detailing the criteria adopted[1] for indoor air quality for each type of normally occupied premises within the building development.

Compliance must be demonstrated by measurement. The report must identify the measurement protocol, i.e. the measuring equipment used, duration of measurements, number and details of the sampling points, the measurement results, and overall conclusions from the measurements survey.[2]

Project team must demonstrate that the identified pollutants are unlikely to exceed the limits prescribed, as determined from an appropriate sample of measurements, in order to attain these 2 credits.

Background and Notes

This Issue deals with pollutants found in indoor air, which are mainly attributable to outdoor sources. In the case of occupied/habitable rooms in air-conditioned/naturally ventilated buildings the concern is indoor air pollutant from outdoor sources whilst operating in the naturally ventilated mode. Undertaking appropriate measurements in air-conditioned buildings will demonstrate that the design and construction of the building and services serve to reduce indoor air pollution from outdoor sources.

CO is toxic gas which interferes with the oxygen transport capacity of the blood, and at levels to which people can be exposed in buildings, leads to symptoms such as headaches, nausea, chest constriction, etc., as well as affecting concentration. Exposure to **oxides of nitrogen (NO_X, NO_2)** can result in irritations to the eyes and respiratory system. Sources in occupied areas include infiltration from vehicle exhausts and enclosed car parks, and incomplete combustion within premises. **Ozone (O_3)** irritates the eyes and respiratory system. Sources of ozone in occupied areas include infiltration from outside occupied areas, and from equipment that utilises ultra-violet light or causes ionisation of air.

Respirable Suspended Particles or RSP (PM_{10}) are suspended airborne particles with a nominal aerodynamic diameter of 10 μm or less. The health impacts from inhalation of particles depend on size, shape and chemical reactivity. Outdoor sources are numerous, but vehicular exhaust and construction activity are significant sources. Particulates from outside sources are carried into air-conditioned buildings through outside air intakes and through uncontrolled infiltration. Indoor sources include air ducts, equipment and user activities. Levels of RSP may be used as an indicator of the effectiveness of the air filtration system, so sampling should be carried out at one representative zone in each type of premises.

[1] If the project team does not offer criteria, the criteria for air-conditioned buildings must be those defined under Good Class in *Table 1: IAQ Objectives (Appendix 5: Tables)*. For other occupied areas and habitable rooms the criteria can be what defined in ASHRAE 62.1-2007: *Ventilation for Acceptable Indoor Air Quality* (http://www.ashrae.org/) or ISO's ICS 13.040: *Air Quality* (http://www.iso.org) or equivalent standards.

[2] The sampling protocol (number and locations of samples) must follow at a minimum what given in *Appendix 6: Sampling Protocol for Indoor Air Quality Assessment*. Any other protocol demonstrated to be of equal rigor appropriate to the nature of the premises surveyed would be acceptable.

For RSP the instrument type used must be of gravimetric type, such as cyclone elutriator or impactor. An instrument based on the optical scattering method is acceptable with a referenced calibration curve with respect to a gravimetric instrument. In a zone where it can be demonstrated that CO, NO_2, O_3 and RSP are solely from outside, measurements can be taken at the outdoor air intake locations where CO, NO_2, O_3 and RSP are likely to infiltrate.

In the case of occupied/habitable rooms in air-conditioned/naturally ventilated buildings the measurement of indoor air pollutants must take place whilst operating in the naturally ventilated mode. Given that air and pollutant exchange with the outside depends on prevailing climatic conditions, particularly wind speed and direction, it is expected that due account is taken and that measurements will be taken under typical or average climatic conditions.

IEQ8. INDOOR SOURCES OF AIR POLLUTION

Aim	To ensure that airborne contaminants from internal sources will not give rise to unacceptable levels of indoor air pollution in normally occupied spaces.
Credits available	3
Issue summary	a) 1 credit for demonstrating compliance with appropriate criteria for Volatile Organic Compounds (VOCs). b) 1 credit for demonstrating compliance with appropriate criteria for Formaldehyde (HCHO). c) 1 credit for demonstrating compliance with appropriate criteria for Radon (Rn).
Exclusion	None.

Assessment

Evidence could be a report prepared by the suitably qualified person detailing the criteria adopted[1] for indoor air quality for each type of normally occupied premises within the building development.

Compliance must be demonstrated by measurement. The report must identify the measurement protocol, i.e. the measuring equipment used, duration of measurements, number and details of the sampling points, the measurement results, and overall conclusions from the measurements survey.[2]

Project team must demonstrate that the identified pollutants are unlikely to exceed the limits prescribed, as determined from an appropriate sample of measurements, in order to attain these 3 credits.

Background and Notes

This Issue deals with pollutants found in indoor air that are mainly attributable to indoor sources. In the case of occupied/habitable rooms in air-conditioned/naturally ventilated buildings the concern is indoor air pollutant from indoor sources whilst operating in the background ventilation mode, i.e. all openings other than those provided for background ventilation are 'closed.'

Volatile Organic Compounds (VOCs) includes hundreds of chemical compounds found in indoor environments from trace levels to levels that can cause various symptoms such as eye and throat irritations, respiratory problems, headaches, etc. Reactions can occur as a result of exposure to a single sensitizing dose or sequence of doses, even at low levels. VOCs may enter from outdoors, but are more likely to be emitted from building materials, finishes and furnishings, pesticides and cleaning products.

Formaldehyde (HCHO) is a type of VOCs that is separately identified due to its abundance in many tall-building materials, adhesives, fabrics and carpets, etc. Formaldehyde is a suspected human carcinogen, and in sufficiently high concentrations is known to cause eye, nose and respiratory irritation and sensitisations. Since formaldehyde is most likely to come from indoor sources, sampling should be carried out in at least one representative zone of each type of occupied area.

Radon (Rn) is a colourless radioactive gas that exhibits no taste or smell. There is concern that exposure to elevated levels of radon indoors increases the risk of lung cancer. Radon is mainly emitted from granite and marble that are very common in tall-building projects. The concentration of radon may accumulate to an unaccepted level in an enclosed space without

adequate ventilation. Choice of building materials and surface coverings can have significant impact on emission rates. Since outdoor radon infiltration is minimal. Radon and its progenies are mainly generated indoor.

[1] If the project team does not offer criteria, the criteria for air-conditioned buildings must be those defined under Good Class in *Table 1: IAQ Objectives (Appendix 5: Tables)*. For other occupied areas and habitable rooms the criteria can be what defined in ASHRAE 62.1-2007: *Ventilation for Acceptable Indoor Air Quality* (http://www.ashrae.org/) or ISO's ICS 13.040: *Air Quality* (http://www.iso.org) or equivalent standards.

[2] The sampling protocol (number and locations of samples) must follow at a minimum what given in *Appendix 6: Sampling Protocol for Indoor Air Quality Assessment*. Any other protocol demonstrated to be of equal rigor appropriate to the nature of the premises surveyed would be acceptable. A sample at the lowest outdoor air intake location can help to identify the relative contribution of VOCs from indoor and outdoor. However, the common alpha track detector and gamma ray detector for radon detection are not regarded as suitable for measurement. Scintillation cells and electronic monitors are more suitable for both grab sampling and continuous measurements. In the case of occupied/habitable rooms in air-conditioned/naturally ventilated buildings the measurement of indoor air pollutants must take place whilst operating in the background ventilation mode, or where there is no specific provision for background ventilation, with all windows and doors closed.

IEQ9. IAQ IN CAR PARKS

Aim	To ensure the design of car parks meets the minimum requirements of performance in respect of air quality.
Credits available	1
Issue summary	1 credit for demonstrating compliance with the specific design requirements in respect of car parks air quality.
Exclusion	Buildings without enclosed or semi-enclosed car parks.

Assessment

Evidence could be a report prepared by the suitably qualified person demonstrating that the design of the ventilation system meets or exceeds the guidelines given in *Appendix 7: 'Control of Air Pollution in Car Park' Guide*, including provisions for the monitoring and automatic control of air pollution. The report must include an estimation of peak pollutant loading and the ventilation system performance to meet the maximum concentration of pollutants as listed *Appendix 7*.

Background and Notes

This Issue applies to enclosed and semi-enclosed car parks that rely on mechanical ventilation or mechanically assisted natural ventilation. It is scoped out otherwise.

B2.5. VENTILATION

IEQ10. INCREASED VENTILATION PERFORMANCE

Aim	To ensure that ventilation systems provide for effective delivery to support the wellbeing and comfort of occupants in normally occupied spaces.
Credits available	1
Issue summary	1 credit for demonstrating an outdoor ventilation rate that exceeds the minimum ventilation performance requirements[1] by at least 30%.
Exclusion	Residential and similar buildings without central air-conditioning and ventilation systems.

Assessment

Evidence could be a report prepared by the suitably qualified person detailing that the project team's specific criteria have been adopted for each category of space included in the project, through the submission of calculations and/or measurements in the specific sample of premises to demonstrate compliance. Calculations should be presented in the form given in *Table 2: Increased Ventilation Assessment (Appendix 5: Tables)*.

The outcome of measurements must demonstrate that the required amount of outdoor air corresponding to the corrected design ventilation rate is actually provided (i.e. exceeding the minimum requirements in Issue IEQ-P1 by at least 30%). Airflow measurements may be made using conventional procedures, such as described in ASHRAE 111,[2] ISO's ICS 17.120,[3] or equivalent.

Background and Notes

This Issue aims to demonstrate the potential for improving indoor air quality through increased outdoor ventilation. It is a follow-up step from what already achieved in Issue IEQ-P1. It seeks for extra and sophisticate efforts to provide better ventilation quality. This credit is scoped out for residential and similar buildings that are not provided with central air-conditioning and ventilation systems.

The current version of ASHRAE 62.1 is world-widely considered a 'code - minimum' standard. There is a concern that the ventilation rates calculated under the standard will have a negative impact on productivity and occupant wellbeing. As an example, consider a typical high-rise office building of 10763 ft^2 (1000 m^2) and an occupant density of 95 ft^2 (8.8 m^2) per occupant; using the ASHRAE 62.1-2007 criteria results in a ventilation rate of 5.2 l/s/person, much less than previously accepted values of 8 or even 10 l/s/person.

Synergies

Increased ventilation rates will have a negative impact on energy use, particularly in hot humid climate. Consideration should be given to using heat recovery techniques to lessen the impact or utilising CO_2 sensors in conjunction with the BMS to affect Demand Control Ventilation (DCV).

[1] ANSI/ASHRAE Standard 62.1-2007: *Ventilation for Acceptable Indoor Air Quality*. (http://www.ashrae.org/) is adopted by TPSI as the minimum ventilation performance requirements. *See Issue IEQ-P1* for relevant information.

[2] American Society of Heating Refrigeration and Air Conditioning Engineers. ASHRAE Standard 111-98: *Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air Conditioning and Refrigeration Systems*. (http://www.ashrae.org/).

[3] ICS 17.120: *Measurement of fluid flow* (http://www.iso.org).

IEQ11. POTENTIAL FOR NATURAL VENTILATION

Aim	To recognise and encourage adequate cross flow of air in naturally ventilated buildings and flexibility in air-conditioned/mechanically ventilated buildings[1] for future conversion to a natural ventilation strategy.
Credits available	1
Issue summary	1 credit where it can be demonstrated that adequate ventilation can be achieved by natural means.
Exclusion	None.

Assessment

The project team must show evidence in form of design plans, drawings, specifications, and other relevant documents to demonstrate that:

1	Occupied spaces[2] of the building are designed to be capable of providing fresh air entirely via a natural ventilation strategy.[3]
2	The strategy is capable of providing at least two levels of user-control on the supply of fresh air to the occupied space with higher rates of ventilation achievable to remove short-term odours and/or prevent summertime overheating.[4]

Background and Notes

[1] Buildings that employ a mechanically ventilated/cooled strategy are still able to achieve the credit, provided they can demonstrate compliance with the above criteria (for future adaptability).

[2] **Occupied spaces:** *see Issue IEQ-P1.*

[3] **The natural ventilation strategy** can be demonstrated via EITHER of the following:

- The openable window area in each occupied space is equivalent to 5% of the gross internal floor area of that room/floor plate. For room/floor plates between 7-15 m (or 23-50 ft) depth, the openable window area is on opposite sides and evenly distributed across the area to promote adequate cross-ventilation. OR
- The design demonstrates - by calculation, using ventilation design tool types recommended by CIBSE AM10: *Natural Ventilation in Non-Domestic Buildings* (http://www.cibse.org) - that the natural ventilation strategy provides adequate cross flow of air to maintain required thermal comfort conditions and ventilation rates.

For a strategy which does not rely on openable windows or which has occupied spaces with a plan depth greater than 15 m (or 50 ft), the design team must demonstrate (by calculation in accordance with CIBSE AM10) that the ventilation strategy can provide adequate cross flow of air to maintain the required thermal comfort conditions and ventilation rates.

The openable window area is defined as the geometric free ventilation area created when a ventilation opening, e.g. window, is open to its normal operational fully designed extent (i.e. this excludes open areas created when reversible windows are opened for cleaning etc.). It is not the glazed area of a façade or the glazed area of the part of the window that is openable (unless it opens fully).

[4] This would typically be demonstrated by providing a large enough area of manually opening windows or powered window actuators. Any opening mechanisms must be easily accessible and provide adequate user-control over airflow rates to avoid draughts.

IEQ12. LOCALISED VENTILATION

Aim	To prevent exposure of building occupants to concentrated indoor sources of pollutants.
Credits available	2
Issue summary	a) 1 credit for the provision of an adequate ventilation system for rooms/areas where significant indoor pollution sources are generated. b) 1 credit for the provision of a general exhaust system for future tenants.
Exclusion	Credit b) is scoped out for residential buildings.

Assessment

a) Source control

Evidence could be in form of a report prepared by a suitably qualified person detailing the design criteria that have been adopted and details of the ventilation system designs providing local exhaust where concentrated pollutant sources are likely to be present. The report must provide details of tests and the results demonstrating that the design performance is achieved. Where the design ventilation rate specified is lower than that specified in a recognised international or national standard the project team must demonstrate through appropriate testing that there is 99% isolation between areas with concentrated pollutant sources and occupied areas.

b) General exhaust system

The report must provide technical details to demonstrate how the ventilation system design(s) may be temporarily adapted so that air from any areas undergoing fit out or renovation can be exhausted to the outside without re-circulation or entrainment to occupied areas. The ventilation provisions must be adequate to exhaust to outside air any material off-gassing, combustion products, excess moisture, etc., and the exhaust is discharged such that it does not re-enter the premises or enter adjacent premises under typical wind conditions. Compliance maybe demonstrated by conducting appropriate tests in a sample of units.

Background and Notes

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

Rooms/areas where concentrated pollutant sources are likely to be present are:

- Domestic and commercial kitchens;
- Bathrooms and toilets;
- Utility and laundry rooms;
- Plant rooms;
- Refuse areas;
- Garages;
- Chimneys and flues.

IEQ13. VENTILATION IN COMMON AREAS

Aim	To ensure adequate ventilation in common areas and circulation routes within premises and to avoid cross-contamination between areas.
Credits available	2
Issue summary	a) 1 credit for demonstrating that all enclosed common areas in a building are provided with adequate ventilation. b) 1 additional credit where the provision for ventilation is by natural means.
Exclusion	None.

Assessment

Evidence could be in form of a report prepared by a suitably qualified person detailing the design criteria that have been adopted for each type of common area, and the results of calculations, simulations and/or measurements in the specified sample of spaces to demonstrate compliance with the assessment criteria. Common areas include corridors, lift lobbies, entrance lobbies, etc. *Staircases and spaces covered under Issue IEQ12 are excluded from the assessment.*

a) Ventilation by any means

Design ventilation rates shall be defined by the project team, but should comply with recommendations from recognised authorities.[1] Compliance must be demonstrated by measurements on a representative sample of each type of space, including worst cases, under average wind conditions.

b) Use of natural ventilation

- Credit a) must be attained; AND
- Where natural ventilation is employed it must be demonstrated that the ventilation rate specified is achieved under average wind conditions in at least 80% of the common areas, aggregated by floor area.

Compliance may be demonstrated by suitable commissioning measurements such as a tracer gas test[2] on a representative sample of spaces, including worst cases, or by appropriate modelling techniques, such as wind-tunnel test, CFD[3] or other computer models.[4] Compliance is conditional that outside air brought in to common areas should be free from known or potential localised sources of pollution (e.g. motor vehicle exhaust, workshops, etc.); and exhausted air contain does not contaminate public areas or occupied areas.

Background and Notes

In order to improve tall-building designs in the context of environmental hygiene, designers are recommended to consider the provision of ventilation to common areas, such as corridors, lift lobbies, entrance lobbies, etc. Where design constraints render the provision of natural ventilation as not feasible, mechanical ventilation should be provided to improve the indoor environment. Good practices when designing mechanical ventilation in public areas require:

- The ventilation system to be capable of providing sufficient fresh air taking into account the anticipated population.
- Intake and exhaust points to be properly designed to prevent contamination of fresh air supply and avoid short-circuiting.
- The ventilation system and its associated ductwork, where provided, should be conveniently accessible for maintenance.

Ventilation for bathrooms, kitchens, refuse rooms, etc., as covered in Issue IEQ12, may be sources of pollution affecting common areas.

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

Measurement approach
A suitable commissioning test may be performed. The test should be carried out in representative sample, including worst-case spaces as defined above and performed under average wind conditions. In the case of naturally ventilated spaces, measurements should be made under conditions when windows are closed and purpose designed ventilators are open.

Modelling approach
Boundary layer wind tunnel modelling may be used for wind pressure analysis. Wind pressure coefficients at inlet/outlet areas for common areas shall be measured for at least one representative floor, including worst case, for each type of occupied premise in the assessed building. These may be site specific depending on the building's height in relation to nearby buildings and local terrain. The measurements will be taken for at least the prevailing wind conditions that are likely to be site specific and therefore should be determined case by case.

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

ASTM 2267[4] states that building ventilation rates can be predicted using approaches that range in complexity from simple single zone models to elaborate multi-zone models. The underlying principles of model operation are discussed in the ASHRAE Handbook.[4] The modelling should take into account average wind speed conditions. In the case of naturally ventilated premises, the simulation should be performed for windows are closed and purpose designed ventilators are open.

[1] ASHRAE 62.1-2007: *Ventilation for Acceptable Indoor Air Quality* (http://www.ashrae.org/) OR ISO's ICS 13.040: *Air Quality* (http://www.iso.org) OR equivalent standards. *See Issue IEQ-P1* for minimum ventilation requirements.

[2] **Tracer gas test:** procedure of a tracer gas test are detailed in ASTM International. ASTM E741-00. *Standard Test Method for Determining Air Change in a Single Zone by means of a tracer Gas Dilution*. (http://www.astm.org/).

[3] **CFD**: Computational Fluid Dynamics.

[4] Procedures for Wind-tunnel tests, CFD, and other modelling techniques are provided in:
- ASTM International. ASTM E2267-03. *Specifying and Evaluating Performances of Single Family Attached and detached Dwellings – Indoor Air Quality.* (http://www.astm.org/); OR
- ASHRAE *Fundamentals Handbook*, Chapter 26, 2001. (http://www.ashrae.org/).

B2.6. THERMAL COMFORT

IEQ14. THERMAL COMFORT DESIGN

Aim	To ensure, with the use of design tools, that appropriate thermal comfort levels are achieved.
Credits available	2
Issue summary	Maximum 2 credits for delivering thermal comfort using specific design tools.
Exclusion	None.

Assessment

a) **First credit**
Thermal modelling must be carried out at the detailed design stage using design-aided software.[1] The software used to carry out the simulation must provide *full dynamic thermal analysis*.[2]

b) **Second credit**
- Credit a) must be attained; AND
- The modelling demonstrates that the building design and services strategy can deliver thermal comfort levels in occupied spaces[3] in accordance with the criteria set out in recognised international and national standards.[4]

Evidence could be a copy of the results from the modelling demonstrating the internal temperatures in compliance with the relevant standards.

Background and Notes

[1] Information on thermal modelling software can be found in
- ASHRAE 140-2001: *Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs*. (http://www.ashrae.org/); OR
- CIBSE Applications Manual AM11 *Building Energy and Environmental Modelling*. 1998. (http://www.cibse.org/).

Any alternative means of analysis may be appropriate provided that they meet the requirements of ASHRAE 140 or CIBSE AM11.

[2] **Thermal Dynamic Analysis:** thermal comfort analysis tools can be subdivided into a number of methods of increasing complexity. The most complex of these and the one that provides greatest confidence in results is the full dynamic model. This type of model enables annual heating/cooling loads, overheating risks and control strategies to be assessed.

[3] **Occupied spaces:** *see Issue IEQ-P1*.

[4] Thermal comfort standards can be adopted from one of the following sources:
- ISO 7730: 2005. *Ergonomics of the thermal environment - Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria.* (http://www.iso.org).
- ASHRAE 55-2004: *Thermal Environmental Conditions for Human Occupancy.* (http://www.ashrae.org/).
- CIBSE Guide A: *Environmental Design*. 2007. In particular that internal winter and summer temperature ranges will be in line with the recommended comfort criteria in Table 1.5 of the Guide. (http://www.cibse.org/).

IEQ15. THERMAL ZONING

Aim	To recognise and encourage the provision of user controls which allow independent adjustment of heating/cooling systems within the building.
Credits available	1
Issue summary	1 credit for the design of the heating/cooling system that allows flexible control of different areas within the building.
Exclusion	None.

Assessment

Evidence could be in form of drawings and specifications detailing the design of the heating/cooling system and confirmation that installation of the systems was carried out according to the specifications. The project team must demonstrate that:

1	The heating/cooling system is designed to allow *occupant control*[1] of zoned areas within all occupied spaces in the building.
2	The zoning allows *separate occupant control*[2] (within the occupied space) of each perimeter area (i.e. within 7 m or ~ 23 ft of each external wall) and the central zone (i.e. over 7 m from the external walls).[3]

Background and Notes

[1,2] **Separate occupant control:** heating/cooling controls for a particular area/zone of the building that can be accessed and operated by the individual(s) occupying that area/zone. Such controls will be located within, or within the vicinity of, the zone/area they control.

[3] **Distance requirement:** the distance requirement is approximate; however, the assessor must use sound judgement considering fully the aims of this Issue, before accepting solutions that do not strictly meet the above criteria.

Long-lag systems

These low temperature systems use the thermal mass of the building to provide a consistent supply of heat to the space during the occupied period. As the mass of the building is used to regulate and supply the heat, the temperature in the space lags behind any change required by the occupants via the systems controls. An example of a long-lag system is under-floor heating. Where long-lag systems are specified, the criteria can be met where they are designed to service the base load only and a responsive secondary heating system and controls are provided, zoned in compliance with the above criteria

Controls for wet heating systems

Adequate TRVs (thermostatic radiator valves) placed in zones around the building perimeter, and the provision of local occupant controls to internal areas, such as fan coil units, would satisfy the criteria to achieve this credit.

B2.7. LIGHTING AND VIEW

IEQ16. NATURAL LIGHTING AND GLARE CONTROL

Aim	To encourage a holistic examination of site layout, building design, and fenestration design, such as to maximise access to daylight for the purposes of improved health and comfort.
Credits available	2
Issue summary	a) 1 credit if at least 80% of floor area[1] in all normally occupied spaces is adequately lit with an average daylight factor[2] (DF) of ≥ 2%. b) 1 credit for providing suitable daylight glare control and maintaining the average DF of 2%.
Exclusion	None.

Assessment

Evidence could be in form of a report prepared by a suitably qualified person demonstrating compliance with the given criteria. Daylight availability, based on 'worst-case' scenarios, i.e., the most obstructed windows, shall be demonstrated by either *Measurement of DF* or *Estimation of DF*.

Measurement of DF

Measurement of average DF must be by the methods recommended by CIBSE,[3] or equal equivalent. Given that the specified sky condition can be difficult to obtain in practice the following modelling methods (estimation) are acceptable alternatives.

Estimation of DF

The average DF must be estimated according to the preferred method that given in the CIBSE design guide[4] or similar equivalent method. Alternatively, daylighting design software such as Radiance[5] can be used to calculate the average DF provided it could be demonstrated that the method of computation employed by the software used is not inconsistent with the preferred calculation method.

The report must identify the key parameters used in the computations/modelling, especially with regard to glazing transmittance, and the reflectance of external and internal surfaces, and the suitable daylight glare control. The values of the parameters shall reflect the nature and type of surfaces on the external vertical obstructions and horizontal surfaces, and likely internal finishes. The room dimensions shall be taken to be a typical perimeter room for the building, be it a habitable room, office, living room, etc.

Where at least 80% of floor area in all normally occupied spaces is adequately lit with an average daylight factor of 2% or more, credit a) shall be awarded. Credit b) shall be awarded for provision of suitable daylight glare control and maintaining the average daylight factor of 2%.

Background and Notes

Access to daylight is an important aspect of tall-building design from the perspectives of comfort and health. The amount of daylight available for specific rooms is related to:

- Window and room geometry and room surface finishes;
- Sky obstruction due to the form of the building and its overshadowing from neighbouring high-rise structures, especially in high-density urban area;
- Glazing transmittance.

In high-density urban area, it is very common that rooms on lower floors of a tall-building may be considerably overshadowed. This can result insignificantly reductions in natural light, and will incur increased electricity consumption for artificial lighting, and degradation of internal

comfort and health conditions. It is possible to take into account the overshadowing by adjacent buildings using appropriate design tools.

[1] **Percentage of assessed area:** where the compliance requirement specifies that 80% of occupied space floor area must be adequately day-lit, it refers to 80% of the total floor area of all the rooms that must be assessed i.e. the compliant area. If, for example, a development has 6 rooms that must be assessed, each 150 m^2 (~ 1614 ft^2) (total area 900 m^2 or ~ 9687 ft^2) then 720 m^2 (~ 7750 ft^2) must comply with the criteria; this is equal to 4.8 rooms. The number of rooms that must comply must always be rounded up; therefore in this example, five rooms must have an average daylight factor of 2% or more (plus meet the other criteria) to achieve this credit.

Average daylight factor: the average daylight factor is the average indoor illuminance (from daylight) on the working plane within a room, expressed as a percentage of the simultaneous outdoor illuminance on a horizontal plane under an unobstructed 'CIE (Commission Internationale de l'Eclairage) Standard Overcast Sky.'

[2] **Working plane**: CIBSE LG10 defines the working plane as the horizontal, vertical or inclined plane in which a visual task lies. The working plane is normally taken as 0.7 m (27.5 in) above the floor.

[3,4] CIBSE Lighting Guide 10 *Day-lighting and window design.* (http://www.cibse.org/)

[5] Ward Larson, G. & Shakespeare, R. 1998. *Rendering with RADIANCE*. San Francisco: Morgan Kaufmann.

IEQ17. INTERIOR LIGHTING IN NORMALLY OCCUPIED AREAS

Aim	To ensure the adequacy and maintenance of visual comfort conditions achieved by the electric lighting provisions in occupied spaces.
Credits available	2
Issue summary	a) 1 credit where the prescribed lighting performance in each type of premises in respect of illuminance and lighting quality is achieved. The following requirements are compulsory: - Prescribed lighting performance in respect of maintained illuminance and illuminance variation is achieved; AND - The limiting unified glare rating is achieved and light sources have an appropriate colour rendering index. b) 1 additional credit for providing automatic control of artificial lighting such as daylight sensors at perimeter zone and/or occupancy sensor.
Exclusion	Residential buildings, hotels and apartment buildings.

Assessment

The design criteria for interior lighting must embrace both 'quantity' and 'quality' of the lighting system performance including: maintained horizontal, and where appropriate vertical, illuminance, illuminance variation, limiting glare index, colour rendering, and modulation of light output appropriate to the type and use of the premises/indoor spaces.

The criteria adopted shall be based on authoritative guidance, such as that provided in CIBSE *Code for Lighting*,[1] or equivalent. As the focus is on lighting for comfort and productivity, lighting for performing arts, display decoration, ambience, etc., is excluded from consideration.

Compliance with the assessment criteria must be demonstrated either by *measurements* using a standardised measurement protocol appropriate to the parameter being assessed, and/or by *modelling (calculation)*, providing the calculation method or software used is based on a standardised method, and uses data/assumptions appropriate to the circumstances.

Evidence could be a report prepared by a suitably qualified person detailing the 'as installed' lighting systems or, for premises/spaces yet to be fitted-out, the technical details of the proposed lighting systems for each type of normally occupied space within the development. The report must detail the design criteria and the results of measurements or other means demonstrating compliance. For premises to be fitted out by tenants compliance must be confirmed if the technical details and contractual arrangements with tenants in respect of lighting installations is deemed to meet the assessment criteria.

Credit b) can only be attained if credit a) has been already earned. The project team must submit a report prepared by a suitably qualified person detailing the automatic control of artificial lighting such as daylight sensors at perimeter zone and/or occupancy sensor.

Background and Notes

This Issue deals with the lighting quality and maintenance aspects of lighting. Energy efficiency aspects of electric lighting are dealt with in *Section 'E1.2. Energy Use.*' Lighting quality is a complicated subject and is an integration of task performance, visual comfort, social communication, mood, health, safety and wellbeing and aesthetic judgment. It is also related to economics and the environment in respect of the installation, maintenance and operation of the lighting system. Proper lighting maintenance (clean lamps and luminaires, lamps replaced periodically to avoid the depreciation) is important to maintain good lighting quality throughout the whole life of the lighting installation.

Measured performance
For lighting installations that are already installed, horizontal and vertical illuminance and luminance can be measured using a lux meter and a luminance meter. The colour quality of lamps can be assessed from the lamp specifications. Colour appearance (correlated colour temperature) can be checked from the lamp labels or by measurement using a colour meter.

Air diffusers located near to fluorescent luminaires with open lamp compartments may result in cool air blowing over the lamps directly causing decrease light output and lamp efficacy. The design details should demonstrate that the cool air from diffusers will not adversely impact on lamp performance.

Computation
The 'lumen method' can be used to calculate the maintained illuminance over the working plane according to the calculation procedure described in Section 4.5.3 of the CIBSE *Code for Lighting*[2] or in Appendix 3 of the CIBSE Lighting Guide.[3] The calculated maintained illuminance will then be checked for compliance with the recommendations given in Section 2.6.4 of the Code, or the recommendations given in Chapter 5 of the Guide.

The illuminance variation consists of 'uniformity' which is concerned with illuminance conditions on the task and immediate surroundings, and 'diversity' which expresses changes in illuminance across a larger space. The uniformity and diversity can be calculated according to that described in Section 4.5.4 of the Code. The calculated uniformity (minimum to average illuminance) over any task area and immediate surround should not be less than 0.8. The diversity of illuminance expressed as the ratio of the maximum illuminance to the minimum illuminance at any point in the 'core area' of the interior should not exceed 5:1. (The core area is that area of the working plane having a boundary 0.5 m or 1.65 ft from the walls).

The glare index can be calculated according to the methods summarised in Section 4.5.6 of the CIBSE Code. The calculated glare index must be checked for compliance with the recommendations given in Section 2.6.4 of the Code or Chapter 5 of the Lighting Guide.

[1,2] CIBSE: *Code for Lighting*. 2002. (http://www.cibse.org/)

[3] CIBSE Lighting Guide LG7: *Office Lighting.* 2005. (http://www.cibse.org/)

Note that this Issue does not concern with high-frequency lighting matters, which are dealt with separately under Issue IEQ19.

IEQ18. INTERIOR LIGHTING IN AREAS NOT NORMALLY OCCUPIED

Aim	To ensure the adequacy of artificial lighting provisions in common areas and service areas such as plant rooms.
Credits available	1
Issue summary	1 credit if the prescribed lighting performance in each type of common or service space in respect of light output and lighting quality is achieved.
Exclusion	None.

Assessment

Here the focus is on lighting for safety, security and work activities required for operation and maintenance. The design criteria must embrace both 'quantity' and 'quality' of the lighting system performance including: maintained horizontal, and where appropriate vertical, illuminance, illuminance variation, limiting glare index, colour rendering, and modulation of light output appropriate to the type and use of the premises/indoor spaces. The criteria adopted must be based on authoritative guidance, such as that provided in CIBSE *Code for Lighting*,[1] or equivalent.

Evidence could be a report prepared by a suitably qualified person detailing the 'as installed' lighting systems or, for spaces yet to be fitted-out, the technical details of the proposed lighting systems for each type common or service space within the development. The report must detail the design criteria and the results of measurements or other means demonstrating compliance.

Compliance with the assessment criteria shall be demonstrated either by measurements using a standardised measurement protocol appropriate to the parameter being assessed, and/or by modelling (calculation), providing the calculation method or software used is based on a standardised method, and uses data/assumptions appropriate to the circumstances.

Background and Notes

This Issue deals with the lighting quality and maintenance aspects of lighting systems provided in both common areas and service areas of a building. Energy efficiency aspects of electric lighting are dealt with in *Section 'E1.2. Energy Use.*' Reference should be made to Issue IEQ17 for further information on measurements and modelling of interior lighting systems.

[1] CIBSE: *Code for Lighting*. 2002. (http://www.cibse.org/)

Note that this Issue does not concern with high-frequency lighting matters, which are dealt with separately under Issue IEQ19.

IEQ19. HIGH FREQUENCY LIGHTING

Aim	To reduce the risk of health problems related to the flicker of fluorescent lighting.
Credits available	1
Issue summary	1 credit if all fluorescent and compact fluorescent lamps are fitted with high frequency ballast.
Exclusion	None.

Assessment

Evidence could be a copy of the specification clause or room data sheets confirming a compliant lighting strategy OR a building/site inspection and photographic evidence confirming the Installation of high frequency ballasts.

Background and Notes

High frequency ballast: high frequency ballasts increase the frequency of the power coming from the grid (50Hz) to a frequency optimising the performance of fluorescent lamps, typically around 30 kHz.

There are several advantages to running fluorescent lamps at higher frequencies. At 30 kHz, the frequency of re-ignition of a fluorescent lamp is too quick to be detected by the human eye, therefore reducing visible flicker that some fluorescent lamps running on mains frequency fail to do. Additionally, 30 kHz being above the audible range of the human ear, the buzzing noise coming out of low quality main frequency ballasts is avoided. Finally, the luminous efficacy of fluorescent lamps increases with frequency; it can be optimised by up to 10% when they are running at 30 kHz compared to those operating at 50Hz.

IEQ20. LIGHTING ZONES AND CONTROL

Aim	To ensure occupants have easy and accessible control over lighting within each relevant building area.
Credits available	1
Issue summary	1 credit if lighting is zoned to allow separate occupant control of different functional areas.
Exclusion	Residential buildings, hotels and apartment buildings.

Assessment

Evidence could include:

- Design plans for each floor of the building highlighting space arrangement and room type; AND
- Specification or design plans confirming:
  - Lighting zones;
  - Location and scope of user-controls.

It must be demonstrated that lighting is zoned to allow *separate occupant control* of the following areas (where applicable):

- Office and circulation spaces.
- In office areas, zones of no more than four workplaces.
- Workstations adjacent to windows/atria and other building areas separately zoned and controlled.
- Seminar and lecture rooms: zoned for presentation and audience areas.
- Library spaces: separate zoning of stacks, reading and counter areas.
- Dining, restaurant, and café areas: separate zoning of serving and seating/dining areas.
- Retail: separate zoning of display and counter areas.

For rooms/spaces not listed above, it is up to the assessor's judgement to decide whether an area should have separate control of lighting. Normally any area with major functional differences with surrounding areas should be counted.

Background and Notes

Occupancy/workstation layout unknown: where occupancy/workstation layout is not known, lighting control can be zoned on the basis of 40 m^2 (~ 430 ft^2) grids i.e. an assumption of 1 person/workspace per 10 m^2 (~ 108 ft^2).

Separate occupant control: light switches/controls for a particular area/zone of the building that can be accessed and operated by the individual(s) occupying that area/zone. Such controls will be located within, or within the vicinity of, the zone/area they control.

Small spaces: where the building consists entirely of small rooms/spaces (less than 40 m^2) that do not require any subdivision of lighting zones/control or meet the criteria by default, then this credit may be awarded.

IEQ21. VIEW OUT

Aim	To provide occupants with adequate external views, thus reducing the risk of eyestrain and breaking the monotony of the indoor environment.
Credits available	1
Issue summary	1 credit for design that delivers adequate external views to the occupants.
Exclusion	None.

Assessment

The design team must demonstrate that: the *relevant building areas*[1] are within 7 m or ~ 23 ft distance of a wall with a window or permanent opening providing an *adequate view out*,[2] where the window/opening is ≥ 20% of the total inside wall area.

Evidence could include:

- Design plan and elevation showing:
  - All relevant building areas and room depths;
  - Actual or notional furniture layout;
  - Window/open areas.
- Site plan showing building location and proximity to external obstructions.

Background and Notes

[1] **Relevant building areas**: the term 'relevant building areas' refers to any areas of the building where there are, or will be, workstations/benches or desks for building users. In case of residential buildings main living room spaces must be counted.

[2] **Adequate view out:** the view out should ideally be through an external window providing a view of a landscape or buildings (rather than just the sky) at seated eye level (1.2-1.3 m or 3.9-4.2 ft) in the relevant building areas. A view in to an internal courtyard or atrium will comply provided the distance from the opening to the back wall of the courtyard/atrium is at least 10 m or 32.8 ft (therefore allowing enough distance for the eyes to refocus). The view cannot be an internal view across the room, as this is likely to become obstructed by partitions, filing cabinets etc.

Roof lights and high level windows that do not provide an adequate view out do not meet the criteria to achieve this credit.

B2.8. ACOUSTIC AND NOISE

IEQ22. ROOM ACOUSTIC

Aim	To improve the acoustical properties of rooms in which speech intelligibility is important.
Credits available	1
Issue summary	1 credit for demonstrating that internal noise levels are within the prescribed criteria and the mid-frequency reverberation time in applicable rooms meets the prescribed criteria for give types of premises.
Exclusion	Buildings/premises where speech intelligibility is not important, and rooms of a special acoustical nature.

Assessment

There is no single all-encompassing set of criteria that will define good acoustical properties for all types of rooms and uses. The design team must define the criteria appropriate to the type and use of the premises/rooms in the building. The criteria for intruding noise level will be expressed in terms of NC level.[1]

However, for the purposes of assessment, account should be taken of the criteria given in *Table 3: Acoustic Performance Criteria (Appendix 5: Tables)*. Where alternative criteria are used, the project team must provide evidence as to the suitability of the alternative, e.g. by making reference to authoritative guidance. Likewise, where criteria appropriate to the type and use of premises/spaces are not stated in *Table 3*, the project team must provide evidence as to the suitability of the criteria adopted. Mid-frequencies refer to 500 Hz, 1 kHz and 2 kHz. The internal noise sources include air conditioning units, breakout noise from air ducts, and air grills.

Compliance must be demonstrated by detailed calculations, or measurement, or both. The reverberation time shall be assessed using Sabine's formula[2] or similar alternative taking into account the room details and appropriate assumptions about the materials in the space. Measurements during commissioning can refer to the method given in ISO 18233[3] or equal equivalent.

Evidence could be in form of a report prepared by a suitably qualified person providing a schedule of the premises and spaces in the building, relevant design details as they impact on acoustical properties, the rooms/premises subject to field tests or for which detailed calculations have been made, the acoustical criteria used, underlying assumptions, and the results of tests or calculations demonstrating compliance with the criteria.

Where it can be demonstrated that the acoustical quality in a sample of each type of room in which speech intelligibility is important, as measured or calculated, meets appropriate performance criteria, the credit shall be awarded.

Background and Notes

A first step in architectural acoustic design is to identify appropriate values of reverberation time for the intended use of a room and then to specify materials to be used in the construction which will achieve the desired value of the reverberation time for a given space and use. The focus of this Issue is on the acoustical qualities in workplaces such as offices and classrooms, libraries, and places of residence, etc. Whilst the matter of room acoustics is complex, and defining performance by a single indicator is problematic, an important acoustical measurement is the reverberation time. It is used to determine how quickly sound decays in a room, and offers a relatively simple assessment of acoustical design. This Issue is not intended to substitute acoustic design standards. It sets criteria for good acoustical quality while the design guidelines and standards established in other countries can also be considered.

Whilst reverberation time continues to be regarded as a significant parameter, there is reasonable agreement than other types of measurements are needed for a more complete evaluation of acoustical quality of rooms. With respect to the standards and guides recommendations, ANSI[4] suggests the maximum reverberation time of A-weighted sound pressure level in classrooms and similar learning spaces. However, the offices type premises, residential premises, hotel and apartment there seems to be little available in the way of standards or guides. ASTM[5] gives alternative parameter, speech privacy in open offices, for an average speech spectrum using the Articulation Index Method.

[1] **NC level** (Noise Criteria level): is a standard that describes the relative loudness of a space, examining a range of frequencies (rather than simply recording the decibel level). This level illustrates the extent to which noise interferes with speech intelligibility. See http://www.engineeringtoolbox.com for more information.

[2] **Sabine's formula:** $T = 0.161\ V/A$

Where: T = *Reverberation time*
V = *Room volume* (m^3)
A = *Total absorption in* m^2

See http://www.engineeringtoolbox.com for more information.

[3] ISO 18233:2006 *Acoustics -- Application of new measurement methods in building and room acoustics*. (http://www.iso.org).

[4] ANSI/ASA S12.60-2002: *Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools*. (http://asastore.aip.org/).

[5] ASTM International. Designation E1130-02. *Standard Test Method for Objective Measurement of Speech Privacy in Open Offices Using Articulation Index*. . (http://www.astm.org/).

IEQ23. NOISE ISOLATION

Aim	To improve the noise isolation of normally occupied premises/rooms to reduce impact of unwanted noise.
Credits available	1
Issue summary	1 credit for demonstrating: - Airborne noise isolation between rooms, spaces and premises meets the prescribed criteria; AND - Impact noise isolation between floors meets the prescribed criteria (for residential projects only).
Exclusion	Buildings/premises which are inherently noisy and unaffected by noise from adjacent premises/spaces.

Assessment

As there are a number of ways to quantify or classify noise isolation (insulation) in buildings, the exact performance criteria used to define both airborne noise isolation and impact noise isolation must be stated. However, for the purposes of assessment account should be taken of the criteria given in *Table 4: Noise Isolation Performance Criteria (Appendix 5: Tables)*. Where alternative criteria is used the project team must provide evidence as to the suitability of the alternative, e.g. by making reference to authoritative guidance. Likewise, where criteria appropriate to the type and use of premises/spaces is not stated in *Table 4*, the project team must provide evidence as to the suitability of the criteria adopted.

Compliance must be demonstrated by measurement or by detailed calculations, or both. Measurements must follow the protocols given in the referenced standards. Calculations should be done with reference to appropriate standards *(see Background and Notes)*.

Evidence could be in form of a report prepared by a suitably qualified person providing a schedule of the premises and spaces in the building, the noise isolation criteria adopted, relevant structural details as they impact on noise isolation, the rooms/premises subject to field tests or for which detailed calculations have been made, underlying assumptions, and the results of tests or calculations demonstrating compliance with the criteria (expressed in parameters that are consistent with the test and/or calculation methods).

Where it can be demonstrated that airborne noise isolation, as measured or calculated for the most susceptible spaces/rooms/premises, meets appropriate performance criteria, the credit shall be awarded. For residential development only, it must be ALSO demonstrated that impact noise isolation (insulation) meets appropriate performance criteria in the most susceptible spaces/ rooms/premises.

Background and Notes

Noise from outside sources, and consequently the noise isolation provided by the building envelope, is covered under the assessment of background noise (Issue IEQ24). Noise from building equipment is also covered under the assessment of background noise, and to some extent under the assessment of vibration (Issue IEQ24, IEQ25). There remains the problem of noise transmitted between spaces, through walls and through floors.

The extent to which walls and floor can attenuate unwanted noise from neighbours and neighbouring spaces is an important aspect of controlling noise levels in interiors. Ventilation openings, doors, etc., are likely to be the weakest part of the envelope enclosing a space as far as airborne noise transmission is concerned.

Measurements
Procedures for measuring the sound isolation between rooms must follow what given in either ISO,[1] ASTM[2] or equal equivalent. The measurements must be undertaken in at least one sample of each type of normally occupied space, but shall include the worst-case circumstances likely to occur (e.g., conference rooms adjacent to corridors, hotel rooms adjacent to lift lobbies, etc.). No special preparation of the tested spaces or rooms is permitted, i.e., tests are carried out in as-built premises/rooms. The measurements shall be interpreted to a single number indicator using either ISO,[3] ASTM,[4] or equal equivalent.

Similar considerations shall apply to the measurement of impact noise isolation, following the methods given in either ISO,[5] ASTM[6] or equal equivalent. No floor coverings, such as carpets, shall be used during the measurements. The measurements shall also be interpreted as a single number using either ISO,[7] ASTM[8] or equivalent.

[1] ISO 140-4: 1998 *Acoustics - Measurement of sound insulation in buildings and of building elements - Part 4: Field measurements of airborne sound insulation between rooms*. OR ISO 15186-2:2003 *Acoustics - Measurement of sound insulation in buildings and of building elements using sound intensity - Part 2: Field measurements*. (http://www.iso.org).

[2] ASTM International. ASTM E336 - 97. *Standard Test Method for Measurement of Airborne Sound Insulation in Buildings*. (http://www.astm.org/).

[3] ISO 717-1:1996 *Acoustics - Rating of sound insulation in buildings and of building elements - Part 1: Airborne sound insulation*. (http://www.iso.org).

[4] ASTM International. ASTM E413 - 04. *Classification for Rating Sound Insulation.* (http://www.astm.org/).

[5] ISO 140-7:1998 *Acoustics - Measurement of sound Insulation in buildings and of building elements. Part 7: Field measurements of impact sound insulation of floors.* (http://www.iso.org).

[6] ASTM International. ASTM E 1007 – 97. *Standard test method for field measurement of tapping machine impact sound transmission through floor-ceiling assemblies and associated support structures*. (http://www.astm.org/).

[7] ISO 717-2:1996. *Acoustics – Rating of sound Insulation in buildings and of building elements. Part 2 – Impact sound insulation*. (http://www.iso.org).

[8] ASTM International. ASTM E 989 -89. *Standard Classification for determination of Impact Insulation Class (IIC)*. (http://www.astm.org/).

IEQ24. BACKGROUND NOISE

Aim	To control as far as practicable the background noise in premises at levels appropriate to the intended use of the premises.
Credits available	1
Issue summary	1 credit for demonstrating background noise levels are within the prescribed criteria.
Exclusion	Buildings/premises in which speech intelligibility is not important.

Assessment

Given that different criteria maybe used the project team must define the criteria appropriate to the type and use of the premises/rooms in the building. However, for the purposes of assessment account should be taken of the criteria given in *Table 5: Background Noise Performance Criteria (Appendix 5: Tables)*. Where alternative criteria are used, the project team must provide evidence as to the suitability of the alternative, e.g. by making reference to authoritative guidance. Likewise, where criteria appropriate to the type and use of premises/spaces are not stated in *Table 5*, the project team must provide evidence as to the suitability of the criteria adopted.

Compliance must be demonstrated by detailed calculations or measurements, or both. Sufficient numbers of calculations and/or measurements must be made to ensure that the requirements are met in all specified premises, but in particular for premises near street level and major outdoor sources. Some relaxation of the noise criterion for residential units may be considered. The intruding noise sources shall include external noise sources such as traffic noise, noise from surrounding buildings, etc.

Site measurements on the completed building should be on at least one sample of each type of premises/room, taking account the worst-case conditions of exposure to noise sources external to the space, and undertaken during periods appropriate to the usage pattern for the space. Measuring equipment should conform to the accuracy requirements given in IEC 60804[1] to type 2 or better, or equivalent standard.

For centrally air-conditioned buildings, the assessment must take into account noise from building services equipment; while for de-centralised air-conditioned buildings, the assessment should only consider the external noise sources.

Evidence could be in form of a report prepared by a suitably qualified person providing a schedule of the premises and spaces in the building, relevant design details as they impact on noise isolation, the rooms/premises subject to field tests or for which detailed calculations have been made, the background noise criteria used, underlying assumptions, and the results of tests or calculations demonstrating compliance with the criteria (expressed in parameters that are consistent with the test and/or calculation methods).

Where it can be demonstrated that background noise isolation, as measured or calculated for the most susceptible spaces/rooms/premises, meets appropriate performance criteria, the credit shall be awarded.

Background and Notes

Background noise sources include that from external sources as well as from the building services equipment. Calculations can be made in terms of $L_{Aeq,T}$ according to BS 8233,[2] where T = 16 h (daytime) and 8 h (night time), appropriate to the criteria chosen. Calculations using the statistical energy analysis[3] are also acceptable. In centrally air-conditioned premises while NC, NR, PNC, NCB and RC are acceptable criteria for noise from air-conditioning equipment, the

presence of outside noise sources renders $L_{Aeq,T}$ a better performance indicator for the aural environment.

Noise levels at the façade of a building can be established by measurement or prediction by simulation methods. Predictions should take into consideration future as well as existing land uses. Estimation of road traffic noise can be made using the UK Department of Transport's prediction method.[4] For railway noise, calculations shall be made in terms of $L_{Aeq,T}$ using the UK Department of Transport's prediction method.[5] For noise from industry which are more or less of steady level, $L_{Aeq,T}$ is estimated according to British Standard BS 4142.[6] T in the case can be 1 h or 30 minutes.

[1] International Electrotechnical Commission. IEC 61672-1: 2002. *Electroacoustics- Sound level meters- Part 1: Specifications*. (http://www.iec.ch/).

[2] British Standard Institution. BS 8233:1999 *Sound insulation and noise reduction for buildings. Code of Practice*. (http://www.bsigroup.com/).

[3] European Committee for Standardization. CEN EN 12354 *Building Acoustics – Estimation of acoustic performance of buildings from the performance of elements*. (http://www.cen.eu).

[4] UK Department of Transport. (1988). *The Calculation of Road Traffic Noise*. HM Stationary Office.

[5] UK Department of Transport. (1995). *The Calculation of Railway Noise*. HM Stationary Office.

[6] British Standards Institution. BS 4142:1990 *Method for rating industrial noise affecting mixed residential and industrial areas*. (http://www.bsigroup.com/).

B2.9. OTHER ISSUES

IEQ25. INDOOR VIBRATION

Aim	To avoid excessive vibration from building services equipment and external sources.
Credits available	1
Issue summary	1 credit for demonstrating that vibration levels do not exceed the prescribed criteria.
Exclusion	None.

Assessment

The project team must provide evidence of the investigation in the form of a report prepared by a suitably qualified person demonstrating compliance with the criteria given in:

- ISO 6879[1] or BS 6611[2] (for low-frequency vibrations); AND
- ISO 2631-2[3] or BS 6472[4] (for high-frequency vibrations).

Background and Notes

Excessive vibration is a major source of annoyance to users in tall-buildings, especially at the upper levels. People might respond to vibration in a variety of ways, including distraction, fear, annoyance, sleep disturbance or, alternatively, precision activities might be compromised. There are 4 main sources that cause vibration in high-rise structures:

- Vibrations induced by human activities;
- Machinery-induced vibrations;
- Wind-induced and earthquake vibrations;
- Vibrations induced by traffic and construction activities.

Winds tend to cause low-frequency (under 1 Hz) vibrations (or swinging motions); while sources such as traffic, earthquake and machineries are likely to cause high-frequency vibrations (1 to 80 Hz).

Two technically identical standards, ISO 6879 and BS 6611 provide guidance for assessing the motion of tall-buildings to low-frequency vibrations (0.063 to 1 Hz). For vibrations between 1 and 80 Hz, ISO 2631-2 and BS 6472 apply. ISO and BS approach is identical but there are slight differences in detailed criteria. These standards provide methods for measurement and evaluation, comprising the determination of the measurement direction and measurement location. They also provide 'satisfactory' magnitudes of vibration.

[1] ISO 6879:1984 *Guidelines for the evaluation of the response of occupants of fixed structures, especially buildings and off-shore structures, to low-frequency horizontal motion (0,063 to 1 Hz)*. (http://www.iso.org).

[2] BS 6611:1985 *Guide to evaluation of the response of occupants of fixed structures, especially buildings and offshore structures, to low-frequency horizontal motion (0.063 Hz to 1 Hz)*. (http://www.bsigroup.com/).

[3] ISO 2631-2:2003 *Mechanical vibration and shock -- Evaluation of human exposure to whole-body vibration - Part 2: Vibration in buildings (1 Hz to 80 Hz)*. (http://www.iso.org).

[4] BS 6472:2008 *Guide to evaluation of human exposure to vibration in buildings*. (http://www.bsigroup.com/).

Note that this Issue only deals with actual vibration levels. It raises a separate concern from the use of vibration-damping systems, which is dealt with under Issue BS13.

IEQ26. PRIVATE OPEN SPACE

Aim	To promote the designs that provide dwelling units with easy access to private outdoor spaces.
Credits available	1
Issue summary	1 credit if at least 70% of dwelling units have private open space meeting or exceeding the minimum area criteria.
Exclusion	Non-residential buildings.

Assessment

Evidence could be in form of a report prepared by a suitably qualified person reviewing the design of all dwelling units. The project team must demonstrate that at least 70% of dwelling units have direct and convenient access to private outdoor space.

Private outdoor space is defined for apartment units as having a minimum area of 6 m^2 (or 65 ft^2) and a minimum dimension of 1.5 m (or 5 ft), and for ground-level units as having a minimum area of 12 m^2 (or 130 ft^2) and a minimum dimension of 3 m (or 10 ft).

Background and Notes

This Issue only applies to residential buildings. In case of Mixed-use buildings only residential units are assessed. It is scoped out if the building has no residential units. The 'percentage of all dwelling units' refers to the number of residential units, not area.

Providing open spaces for occupant of tall-buildings has always been a critical issue because of the compact form and other characteristic of high-rise structures. The provision of adequate and well-designed communal and private open space for each apartment is crucial in meeting the amenity needs of residents; in particular, usable outdoor space is a high priority for families. Regardless of the amount of open space that can be achieved, new tall-buildings should strive to provide occupants with high quality private open space. Such spaces give occupants vital breathing space, and can contribute to a more human scale perception of the development.

Private open space can be provided in the form of rear gardens or patios for ground floor units, and balconies at upper levels. It is important that in the latter case adequate semi-private or communal open space, in the form of landscaped areas, should also be provided. Private open space at ground floor level needs some form of boundary treatment to ensure privacy and security.

Balconies (or glass-screened 'winter gardens,' separated from living spaces) need to be of a certain minimum depth to be useful from an amenity viewpoint, being able to accommodate chairs and a small table. A minimum depth of 1.5 m (or 5 ft) is recommended, generally extending for the full length of the external living room wall. While deeper balconies might be desirable in certain cases, this has to be balanced against the need to avoid overshadowing the living room. Balconies should be accessed from living rooms, not bedrooms. Balustrading to balconies should be safe for children. Vertical privacy screens should be provided between adjoining balconies.

Site conditions, such as elevations facing north or overlooking busy streets, or other tall-buildings, may diminish the amenity value of balconies. In such cases, it will be the designer's responsibility to provide some form of compensating amenity for the occupants. This might take the form, for instance, of above average sized living rooms and generous landscaped communal open spaces.

IEQ27. VISUAL PRIVACY

Aim	To promote the designs which provide dwelling units with adequate visual privacy in bedroom and living areas.
Credits available	1
Issue summary	1 credit if at least 70% of dwelling units have adequate visual privacy.
Exclusion	Non-residential buildings.

Assessment

Evidence could be in form of a report prepared by a suitably qualified person reviewing the design of all dwelling units. The project team must demonstrate that at least 70% of dwelling units have adequate visual privacy.

A dwelling unit is considered to have adequate visual privacy if its bedrooms and living areas are NOT open to horizontal or downward views from a point within 20 m (~ 65 ft) of the exterior windows.

Background and Notes

This Issue only applies to residential buildings. In case of Mixed-use buildings only residential units are assessed. It is scoped out if the building has no residential units. The 'percentage of all dwelling units' refers to the number of residential units, not area.

B3. BUILDING SERVICES (BS)

B3.1. BUILDING AMENITIES

BS1. ACCESS FOR PERSONS WITH DISABILITY

Aim	To ensure full access to pertinent building facilities for persons with disability.
Credits available	1
Issue summary	1 credit for providing adequate and enhanced provisions for access for disabled persons.
Exclusion	None.

Assessment

The project team must provide evidence that details the designs to demonstrate full compliance with the criteria given in BS 8300[1] or equivalent local or international standards in respect of access for persons with disability.

Background and Notes

[1] BS 8300:2009 *Design of buildings and their approaches to meet the needs of disable people. Code of practice*. (http://www.bsigroup.com/).

Access for persons with disability is a major yet common issue in tall-building projects. Nowadays nearly every country and major region has its own regulations and standards for this issue. *Project team can adopt any local regulations, standards or mechanisms* and still score this credit. However, BS 8300 is recommended due to its long-lasting prestige. Equivalent standards can be named:

- Hong Kong's Code of Practice for Barrier Free Access. http://www.bd.gov.hk/english/documents/code/e_bfa.htm
- ICS 11.180: *Aids for disabled or handicapped persons*. (http://www.iso.org).

Where no standard is available the following requirements must be met at a minimum:

Premises type	Performance criteria
Residential premises, hotel and apartments	Design documentation indicates that all key facilities in the Residential occupancy, including entry points, laundry facilities, washrooms and vertical circulation systems, are accessible to wheelchair users and visually impaired persons. Design documentation indicates that the percentage of dwelling units with accessible entry points, bathrooms and kitchens, and with easy access from ground floor entry points, will be at least 30%.
Non-residential premises	Design documentation indicates that all key facilities in the occupancy, including entry points, washrooms, vertical circulation systems and support facilities are accessible to wheelchair users and visually impaired persons.

Full access for disabled persons means more than just being able to enter and leave a building, or use the toilets. It enables persons with a disability to make full use of the basic facilities in a building without assistance and undue difficulties. Facilities that cater for the special needs of the physically impaired should be provided, which include but not limited to shaded areas for walking and sitting; accessibility to public toilets; adequate lighting; emergency phones; visual-free walking areas; ramps with handrails; and car or bus dropping-off points near to venues. As the advice provided cannot be exhaustive, developers and designers should exercise forethought and creativity to cater for the wellbeing of disabled persons when designing buildings, allowing greater independence of disabled persons, the elderly, and other less physically able persons using the facilities.

BS2. AMENITY FEATURES

Aim	To encourage the provision of amenity features for the benefit of building users as well as the improved operation and maintenance of the building.
Credits available	1
Issue summary	1 credit for providing adequate and enhanced amenity features for the benefit of building users and for improved operation and maintenance of the building.
Exclusion	None.

Assessment

The project team must provide evidence in form of design plans, drawings, specifications, photos, and other relevant materials to demonstrate compliance with the criteria given in *Checklist 3: Amenity Features (Appendix 2: Technical Checklists)*. The project team must demonstrate that all four compulsory features and at least five out of eight enhanced features in *Checklist 3* are provided.

Background and Notes

Amenity features are loosely defined as those elements of design that whilst not statutory requirements are desirable to improve the standard and quality of a building or a development project. To be more specific the provision of such features would:

- Encourage efficient and effective building management;
- Enhance the quality of life for residents and users;
- Obviate the desire or temptation for unauthorised building works; and
- Improve environmental compatibility with the neighbourhood.

This Issue does not deal with substantial luxury amenity facilities such as clubs, restaurants and other facilities obviously meant for an exclusive membership and commercial takings, rather than for the general benefit of occupants and the building operation itself.

B3.2. BASIC BUILDING EQUIPMENT

BS3. WATER SUPPLY AND DRAINAGE SYSTEM

Aim	To encourage the enhanced performance of water supply and drainage system, especially in case of incident/disaster/shortage.
Credits available	1
Issue summary	1 credit for applying specific efforts to improve the performance of water supply and drainage system.
Exclusion	None.

Assessment

The project team must provide evidence in form of design plans, drawings, specifications, photos, and other relevant materials to demonstrate compliance with at least four out of six following criteria:

1	Water-saving equipment is used.[1]
2	Plumbing systems are separated as far as possible to reduce the portions that become unserviceable in the event of an incident/disaster.
3	The building has a pit for temporary wastewater storage, in case mains sewerage is unavailable after an incident/disaster.
4	The building has two separate tanks, one for water reception and one elevated tank.[2]
5	Planning enables the use of well water, grey water and etc.
6	The building is equipped with a simple filtration system allowing conversion of rainwater to potable water in the event of a shortage.

Background and Notes

This Issue raises the concern of enhancing the performance of water supply and drainage system. It differs from water use subjects, which are dealt with under Section E1.2.

[1] The terms 'water-saving equipment' or 'water-efficient equipment' refer to WC suites, taps, shower controls, cisterns, shower handsets, baths, grey water products, etc. which are designed for water efficiency (i.e. with low flow rate, sensors, etc.). Some countries and international organisation have been developing 'labels' for water-efficient equipment to promote the use of them instead of normal water-consuming equipment. Examples can be named:

- Eco Mark Program (Japan) (http://www.ecomark.jp/english/)
- Water Efficient Product Labelling Scheme (UK) (http://www.water-efficiencylabel.org.uk/)

See ISO 14024:1999 *Environmental labels and declarations – Type I environmental labelling – Principles and procedures* (http://www.iso.org/) for more information.

This Issue has no specific requirement for water-saving equipment, as the actual efficiency of water systems is assessed under Section E1.2. However, it must be demonstrated that the building is fitted with water-efficient equipment instead of normal water-consuming equipment.

[2] An intake sump with a central partition cannot be regarded as two sumps.

BS4. ELECTRICAL EQUIPMENT

Aim	To encourage the enhanced performance of electrical equipment, especially in case of incident/disaster/shortage.
Credits available	1
Issue summary	1 credit for applying specific efforts to improve the performance of electrical equipment.
Exclusion	None.

Assessment

The project team must provide evidence in form of design plans, drawings, specifications, photos, and other relevant materials to demonstrate compliance with at least three out of four following criteria:

1	The building is equipped with emergency generators.
2	The building is equipped with uninterruptible power source systems.
3	Power input equipment for important equipment systems has redundancy.
4	Countermeasures (i) and (ii) have been taken or (iii) applies, in order to avoid power outages due to water percolation into power supply equipment or precision machinery, and to avoid damage to data networks: (i) Installation of power supply equipment and precision machinery below ground is avoided. (ii) Devices to prevent the groundwater percolation (waterproof doors, waterproof panels, embankments, dry ditches) and drainage equipment (pumps) are installed. (iii) No danger of water percolation.

Background and Notes

This Issue raises the concern of enhancing the performance of electrical equipment. It differs from energy use subjects, which are dealt with under Section E1.3.

BS5. HVAC SYSTEM

Aim	To encourage the enhanced performance of HVAC[1] system, especially in case of incident/disaster.
Credits available	1
Issue summary	1 credit for applying specific efforts to improve the performance of HVAC system.
Exclusion	Buildings without a HVAC system.

Assessment

The project team must provide evidence in form of design plans, drawings, specifications, photos, and other relevant materials to demonstrate compliance with at least three out of four following criteria:

1	Circuits are divided according to the importance of their ventilation equipment, and more important circuits are given priority in operation after an incident/disaster. Also, ways of running the ventilation with reduced load capacity have been examined.
2	Dispersion and duplication of heat source types (electricity, gas, etc.), with backups
3	Countermeasures (such as suspended pipes) have been taken to ensure that overall function can continue even when the building is partially damaged by an incident/natural disaster, or is going through major refurbishments.
4	Circuits are divided according to the importance of their air conditioning equipment, and more important circuits are given priority in operation after an incident/disaster. Also, ways of running the air conditioning with reduced load capacity have been examined.

Background and Notes

This Issue raises the concern of enhancing the performance of HVAC system. It differs from energy use subjects that are dealt with under Section E1.3.

[1] **Heating, Ventilating, and Air Conditioning (HVAC)** is the technology of indoor or automotive environmental comfort. HVAC system design is a major sub-discipline of mechanical engineering, based on the principles of thermodynamics, fluid mechanics, and heat transfer. Refrigeration is sometimes added to the field's abbreviation as HVAC&R or HVACR, or ventilating is dropped as in HACR (such as the designation of HACR-rated circuit breakers). HVAC is particularly important in the design of large buildings such as skyscrapers, where safe and healthy building conditions are regulated with temperature and humidity, as well as fresh air from outdoors.

BS6. COMMUNICATIONS AND IT EQUIPMENT

Aim	To encourage the enhanced performance of communications and IT equipment, especially in case of incident/disaster.
Credits available	1
Issue summary	1 credit for applying specific efforts to improve the performance of communications and IT equipment.
Exclusion	None.

Assessment

The project team must provide evidence in form of design plans, drawings, specifications, photos, and other relevant materials to demonstrate compliance with ALL of the following criteria:

1	Communications methods are diversified, using optical fibre cable, metal cable, cellular telephone network, PHS network and others.
2	Connections are made from two telephone exchanges to secure two communications links.
3	Countermeasures (i) and (ii) have been taken or (iii) applies, in order to avoid damage to data networks due to water percolation into precision machinery: (i) Installation of precision machinery below ground is avoided. (ii) Devices to prevent the groundwater percolation (waterproof doors, waterproof panels, embankments, dry ditches) and drainage equipment (pumps) are installed. (iii) No danger of water percolation.

Background and Notes

None.

BS7. SERVICE LIFE OF BUILDING COMPONENTS

Aim	To encourage the project team to take into consideration the service life of building components at the design stage.
Credits available	2
Issue summary	Maximum 2 credits for complying with specific refurbishment/renewal/replacement interval for building service components.
Exclusion	None.

Assessment

The project team must demonstrate that service life of building components meets the criteria given below:

1	Service life of structural frame materials[1]	75 years or more.
2	Necessary refurbishment interval for exterior finishes[2]	20 years or more.
3	Necessary renewal interval for main interior finishes[3]	15 years or more for Residential buildings, 10 years or more for Non-residential buildings.
4	Necessary replacement interval for air-conditioning and ventilation ducts[4]	At least 90% of exposed exterior ducts, kitchen venting ducts, high-humidity venting ducts and similar applications that would have shorter service lives than other applications when made from zinc-plated steel sheet are made from stainless steel or Galvalume to extend service life.
5	Necessary renewal interval for HVAC and water supply and drainage pipes[5]	20 years or more.
6	Necessary renewal interval for major equipment and services[6]	30 years or more.

1 credit if at least four items are achieved.
2 credits if all six items are achieved.

Background and Notes

Assessment standards for necessary renewal/refurbishment/replacement intervals are set separately for different building components. The service life evaluated here is NOT the social lifespan of construction materials (for example, the service life of construction materials used in a project with a limited lifespan ends when the period of use of the building expires), but rather, the service life until the building materials and equipment become dilapidated or loses their required physical functions. Thus the 'necessary renewal interval' evaluated here refers to the interval before the physical durability of the materials and equipment is exhausted, and replacement is required.

Assessment method

Service life settings for components should ideally be determined by the assessor through detailed consideration of the lifespan of materials in each category under the life cycle plan for the building project, but instead, the values in *Table 6*: *Durability (years) of Building Elements (Appendix 5: Tables)* should be applied, in order to eliminate inconsistency between assessors.

The values in *Table 6* are for anticipated service life (the interval at which renewal is required in practice), not legally-defined service life. They are collected and synthetised from various sources, so some components have more than 1 values.

If there are materials or special deteriorative external forces (such as location in a coastal region with high likelihood of salt damage) that do not appear in *Table 6* check individually with manufacturers and other sources to make the assessment. When evaluating service equipment not included in *Table 6*, and there are no special deteriorative external forces, evaluate using the necessary renewal intervals for a normal office building (used for around 250 h/month). If there are multiple subject materials, evaluate according to the one with the shortest necessary renewal interval.

Although using Table 6 is recommended. The project team can use other ways to demonstrate that the building components' service life meet the requirement, such as manufacturers' specifications, etc. Any methods to extend the building components' service life must be demonstrated.

[1] The boundary condition for the subject of assessment under this item is 'structural frame materials,' not 'structural frame.' The 'service life of structural frame materials' referred to here is the interval at which large-scale refurbishment work is required under normally expected natural conditions and maintenance management. The expected life of normal steel reinforced concrete structural skeleton is about 65 years, as in *Table 6*. In order to achieve this item, the project team must demonstrate that adequate methods are applied to *extend* the life of the building's structural system.

[2] The 'necessary refurbishment interval for exterior finishes' referred to here is the interval at which failure of exterior walls to fulfil their functions necessitates repair works, with the erection of scaffolding, to maintain function.

[3] The 'necessary refurbishment interval for main interior finishes' referred to here is the interval at which internal surface finishes require re-covering or replacement of surface materials.

[4] This item evaluates the longevity of air conditioning and ventilation ducts. The assessment method is based on the countermeasures used in duct specifications to lengthen the lifespan of ducts likely to have reduced service lives if they were built with standard specification (zinc-plated steel, etc.).

[5] The 'Necessary renewal interval for HVAC and water supply and drainage pipes' referred to here is the interval at which these system require major renovation or replacement (at least 75% of all machineries and pipes).

[6] 'Major equipment and services' refers to major equipment and services necessary for the building to function, specifically power receiver and transformer equipment, generators, boilers, chillers, air conditioners, water tanks, pumps and other equipment. 'Necessary renewal interval for major equipment and services': considering the building functions and building types, take the one for which the equipment is likely to have the shortest interval for renewal construction, and reference the number of years for that application to the table. If it can be judged that the renewal of the equipment with the shortest service life could be postponed until other construction work also becomes necessary, take the realistic number of years until construction would be required as the representative value for assessment.

BS8. MAINTENANCE OF CORE BUILDING FUNCTION DURING POWER OUTAGES

Aim	To encourage the provision of features, such as back-up systems and thermal mass, that will allow the building to function outside of anticipated design conditions for temperature, rainfall, power and fuel supply.
Credits available	1
Issue summary	1 credit if the building can continue to provide minimally acceptable service for at least four day under conditions of temperature, rainfall, power and fuel supply that fall outside of anticipated design conditions.
Exclusion	None.

Assessment

Evidence could be in form of a report prepared by a suitably qualified person reviewing the design and specification of the building and its service systems. Design documentation must indicates that that ventilation, temperature, lighting, sanitation and internal transportation systems will continue to provide minimally acceptable service for at least four days under conditions of temperature, rainfall, power and fuel supply that fall outside of anticipated design conditions.

Background and Notes

None.

B3.3. SECURITY AND SAFETY

BS9. SECURITY

Aim	To create a feeling of wellbeing amongst building users.
Credits available	1
Issue summary	1 credit for scoring at least 75% of the applicable security measures and facilities for the building.
Exclusion	None.

Assessment

Evidence could be in form of a report prepared by a suitably qualified person which includes: a completed checklist of the security measures and facilities provided in *Checklist 4: Security Measures and Facilities (Appendix 2: Technical Checklists),* justification for each checked item, details of the physical security systems provided, and a detailed security manual explaining how the physical provisions (hardware) integrates with the management system (software) for the building.

Where compliance with at least 75% of applicable items in *Checklist 4* is demonstrated, the credit shall be awarded. Alternatively, the project team may provide detailed rationale and arguments to demonstrate that security systems are integrated and an enhanced standard of security can be provided.

Background and Notes

Security is a serious concern for tall-building occupants. This may be in the context of personal safety and in the context of loss of belongings. For commercial and institutional buildings security is also an issue, in public buildings where strangers congregate, in common areas such as staircases and toilets, etc.

The design of building, landscape and the implementation of security facilities can effectively reduce most burglaries and other crimes by influencing the behaviour of offenders, guardians and potential victims. The security facilities and measures required depend on the type of premises and level of security needed. In general, effective security incorporates three elements: natural and architectural barriers that discourage access, human security, and electronic security.

Security can be enhanced through the integrated use of reliable hardware (surveillance cameras, security barriers, etc.) coupled to a sound management system (watchman tour, etc.). Security systems also need to be integrated with fire safety management and communications systems *(see Issue BS10)*.

Assessment should take into account the guidelines provided in ASTM,[1] BS,[2] and similar authoritative guidance, and the extent to which the security provisions 'score' against the assessment grid provided in *Checklist 4*.

[1] ASTM International. E1665-95a. *Standard Classification for Serviceability of an Office Facility for Facility Protection*. AND
ASTM International. E1693-95a. *Standard Classification for Serviceability of an Office Facility for Occupant Assets*. (http://www.astm.org).

[2] British Standards Institution. BS 8220. *Standard Guide for Security of Buildings against Crime*. (http://www.bsigroup.com/).

BS10. FIRE SAFETY AND EVACUATION

Aim	To recognise and encourage the implementation of best practices in respect of Fire Safety and Evacuation.
Credits available	3
Issue summary	a) 1 credit for design that complies with recognised Fire Safety and Evacuation standards. b) 1 credit for demonstrating design integration between fire services systems and non-fire services systems. c) 1 credit for the provision of a Fire Safety manual based on a fire-risk assessment of the building.
Exclusion	None.

Assessment

a) Fire Safety and Evacuation design

The project team must demonstrate that all fire services provisions (both passive construction designs and active protection systems) are complied with local or international standards/Code of Practices/Regulations, covering the means of escape, access for firefighting, and fire resistant construction. Evidence could be in form of a report prepared by a suitably qualified person detailing the design criteria that have been adopted and details of all fire services provisions.

b) System integration

This credit can only be attained if credit a) has been already earned.

The project team must submit a report detailing the provision of passive and active safety systems provided for the building:

- Highlighting compliance with the relevant regulations.
- Interaction with non-fire systems in the event of an alarm or fire emergency.
- Interaction with security and communications systems that will support safe egress of occupants in the event of a fire.

The credit shall be awarded where it can be demonstrated that the following aspects of whole building performance and fire safety design have been taken into account:

- The stability of the structure will be maintained under all assumed uses of the building (i.e. adequate fire resistance period).
- Integration between security and fire safety.
- The extent that any provisions for natural ventilation, or the degree of airtightness, will influence the movement of smoke.
- The interactions between air handling and smoke movement.
- Air quality in refuges during a fire event.
- Adequacy of emergency warning systems in the acoustical environment.
- Signage and way finding in the event of poor visibility due to smoke, including provisions for the visibility impaired and disabled.
- Door opening where pressurisation systems are employed.
- Durability of fire safety systems, equipment and components.

c) Fire Safety manual

Evidence must be a completed Fire Safety manual, written in appropriate language for end-user, which describes the specific aspects of fire safety management for the building. The manual must be based on a risk assessment of the building, and must include the following:

- A set of relevant documents (standards, codes, guides, etc.) covering fire safety, fire safety system design, and on-going certification requirements.
- Relevant details of building design, construction and layout.

- Details of hydrants, access for fire appliances, exits from the building, exterior lighting, hazards, etc.
- Location of significant ignition sources.
- Presence and influence of inter-spatial openings.
- Characteristic responses of occupants to fire emergencies.
- Techniques of fire detection employed.
- Communications and warnings systems.
- Provisions for smoke management.
- Emergency lighting, signs and notices for way finding.
- Provisions for firefighting by building operators and users.
- Operation and maintenance requirements for all systems.

Background and Notes

Fire safety is a key performance characteristic of sustainable tall-buildings. The functions of fire safety systems interact with other building services systems, particularly environmental control systems. However, fire safety systems are often treated as an isolated set of technical systems that have limited interaction with other systems. Design of fire services installations (FSI) needs to take into account the important links between systems, and provisions for security and communications systems serving a building. Operation and maintenance manuals should make it clear to building operators how systems interact in the event of an alarm or fire situation. An aspect of relationship between FSI and the normal operation of a building is a fire risk assessment. Contributions to fire safety from non-fire services systems can have a significant influence on the degree and level of improvements that may be needed to FSI.

Whilst, in most countries, fire safety legislation covers most aspects of fire safety system design and operation; the proper management, operation and maintenance of buildings and fire safety systems is essential to limiting the impacts of fires on occupants, contents and structures.

The provisions for means of escape and other fire safety measures should be based on an assessment of the risk to the occupants should an event occur. The assessment should take into account the nature of the building structure, the use of the building, the processes undertaken and/or materials stored in the building, the potential sources of fire, the potential of fire spread through the building, and the standard of fire safety management proposed. Where it is not possible to identify with any certainty any of these elements a judgment as to the likely level of provision must be made.

There are four major fire safety objectives:

- Life safety.
- Property protection, including protection of the building fabric and the contents of the building.
- Non-disturbance of business activities.
- Minimisation of the impacts on the environment.

The need for easy and rapid evacuation of a building in case of fire may conflict with the control of entry and exit in the interest of security. Measures intended to prevent unauthorised access can also hinder entry of the fire service to rescue people trapped by fire. Potential conflicts should be identified and resolved at the design stage and not left to ad hoc expedients after completion.

For environmental protection the two most important aspects of fire safety are the impact of the products of combustion on the surroundings (people and buildings in urban areas and the flora and fauna in rural areas) and the degree of contamination that may be caused by the modification of the chemical and physical properties of the firefighting water due to the effects of the combustion process on the water. Fire safety should not be compromised by the inappropriate introduction of measures that are regarded as ‘green and sustainable.’

[1] Recommended international standards include:

- BS 9999:2008 *Code of practice for fire safety in the design, management and use of buildings*. (http://www.bsigroup.com/).
- Various sets of standards under ISO's ICS 13.220.01: *Protection against fire in general*. (http://www.iso.org).
- Hong Kong Building Authority's set of standards (http://www.bd.gov.hk/english/documents/index_crlist.html), including:
    - *The Provision of Means of Escape in Case of Fire*. 1996.
    - *Code of Practice for the Provision of Means of Access for Firefighting and Rescue*. 2004.
    - *Fire Resisting Construction*. 1996.

B3.4. VERTICAL TRANSPORTATION

BS11. LIFTS

Aim	To recognise and encourage the specification of energy-efficient vertical transportation systems.
Credits available	1
Issue summary	1 credit for applying specific efforts to improve the performance of lifts system.
Exclusion	None.

Assessment

The project team must demonstrate that:

1	An analysis of transport demand and patterns for the building has been carried out by the design team to determine the optimum number and size of lifts and *counterbalancing ratio*[1] on the basis of anticipated passenger demand.
2	The energy consumption for at least two types of lift or lift strategy 'fit for purpose' has been estimated and the system with the lowest energy consumption specified.
3	Of four following energy-efficient features, the three that offer the greatest potential energy saving are specified: (i) The lifts operate in a stand-by mode during off-peak and idle periods. For example the power side of the lift controller and other auxiliary equipment such as lift car lighting and ventilation fan switch off when the lift is not in motion. (ii) Where lift motors use a drive controller capable of variable-speed, variable-voltage, and variable-frequency control of the drive motor. (iii) The lift has a regenerative unit so that energy generated by the lift (due to running up empty and down full) is returned back to the grid or used elsewhere on site. (iv) The lift car uses energy-efficient lighting and display lighting (> 60 Lumens/watt or fittings that consume less than 5W e.g. LEDs).

Evidence could include:

- A report prepared by a suitably qualified person detailing the analysis undertaken and findings/recommendations.
- A copy of the lift specification.
- Evidence from the lift manufacture/supplier confirming that the lift to be installed on the project meets the relevant criteria in [3].

Background and Notes

[1] **Counterbalancing ratio**: lifts use a counterweight to balance the weight of the car plus a proportion of the maximum weight of the passengers; this reduces the size of the drive motor required for the lift. Lowering the counterbalancing ratio means smaller motor and controlling drive units are required, thus saving energy.

ISO/DIS 25745-1 ***Energy performance of lifts, escalators and moving walks - Part 1: Energy measurement and conformance.*** It has been estimated that between 5-15% of a tall-building's total energy consumption can be attributed to the operation of lifts and 58% of the energy consumption of lifts is attributable to stand-by mode. A Working Group of an International Standards Organisation's Technical Committee is developing a standard for the Energy performance of lifts, escalators and moving walkways. This standard outlines proposed procedures to be used when making energy measurements of lifts, escalator and moving walkways.

BS12. ESCALATORS AND TRAVELLING WALKWAYS

Aim	To recognise and encourage the specification of energy-efficient transportation systems.
Credits available	1
Issue summary	1 credit for applying specific efforts to improve the performance of escalators and travelling walkways.
Exclusion	Buildings without escalators or travelling walkways.

Assessment

In order to attain this credit the project team must demonstrate that each escalator and/or horizontal travelling walkway complies with EITHER of the following:

- Is fitted with a load sensing device that synchronises motor output to passenger demand through a variable speed drive.
  OR
- Is fitted with a passenger sensing device for automated operation, so the escalator operates in stand-by mode when there is no passenger demand.

Evidence could be a copy of the specification and manufacturer's technical literature confirming:

- Number and type of escalators specified.
- Escalator control strategy.

Background and Notes

ISO/DIS 25745-1 ***Energy performance of lifts, escalators and moving walks - Part 1: Energy measurement and conformance***. It has been estimated that between 5-15% of a tall-building's total energy consumption can be attributed to the operation of lifts and 58% of the energy consumption of lifts is attributable to stand-by mode. A Working Group of an International Standards Organisation's Technical Committee is developing a standard for the Energy performance of lifts, escalators and moving walkways. This standard outlines proposed procedures to be used when making energy measurements of lifts, escalator and moving walkways.

B3.5. EARTHQUAKE RESISTANCE

BS13. EARTHQUAKE RESISTANCE

Aim	To recognise and encourage the implementation of best practices in respect of Earthquake Resistance.
Credits available	2
Issue summary	a) 1 credit if the design meets or exceeds recognised earthquake resistance standards. Alternatively, damage control design has been used.[1] b) 1 credit if a seismic isolation system or a vibration damping system is installed to prevent sway in time of strong wind or earthquake.[2]
Exclusion	Buildings under 40 stories in low seismic hazard areas.[3]

Assessment

a) Earthquake Resistance design

The project team must demonstrate that the building design is complied with local or international standards/Code of Practices/Regulations in respect of Earthquake Resistance. Evidence could be in form of a report prepared by a suitably qualified person detailing the design criteria that have been adopted and details of all earthquake resistance features.

b) Vibration damping systems/devices

Evidence could be design details and specifications of vibration damping system or seismic isolation system.

Background and Notes

[1] Damage control design is recommended as it is regarded as guaranteeing a high level of earthquake resistance. *The seismic design of a tall-building should always aim to exceed the minimum requirements/standards adopted*. Recommended international standards include:

- ISO's ICS 91.120.25: *Seismic and vibration protection*. (http://www.iso.org).
- BS EN 1998-1:2004 *Eurocode 8. Design of structures for earthquake resistance. General rules, seismic actions and rules for buildings.* (http://www.bsigroup.com/).

[2] For this item, evaluate performance in preventing or reducing sway due to strong wind or earthquake. Specifically, consider improved comfort in strong wind and protection of internal equipment and fixtures in earthquakes. A seismic isolation system is highly appreciated because the protection of internal equipment is almost completely assured. Vibration damping intended to improve comfort during strong winds. Vibration damping elements, such as elastoplastic dampers, can help to improve the earthquake resistance of any frame, but they should be evaluated under a) Earthquake Resistance Design, as damage control design. (Systems that mainly target earthquakes are named 'earthquake damping' and others are named 'vibration damping'). However, when a vibration damping system is used that also prevents sway in warm wind, it can be judged to be an installed seismic damping system.

[3] The seismic risk assessment must be based on local Regulations. As an indication the Global Seismic Hazard Map can be referred to:
http://geology.about.com/library/bl/maps/blworldindex.htm.

B4. DESIGN FEATURES (DF)

B4.1. DESIGN FOR ENERGY EFFICIENT

DF1. ENERGY EFFICIENT BUILDING LAYOUT

Aim	To enhance the building energy efficiency through environmentally considered planning and architectural design.
Credits available	2
Issue summary	Maximum 2 credits for incorporating specific design strategies in respect of energy efficient building layout.
Exclusion	None.

Assessment

Maximum 2 credits for demonstrating compliance with the following strategies:

1	Consideration of built form and building orientation to enhance energy conservation.
2	Consideration of optimum spatial planning to enhance energy conservation.
3	Consideration of building permeability provisions of building features to enhance the use of natural ventilation.
4	Provision of fixed or movable horizontal/vertical external shading devices.
5	Provision of movable external shading devices for major atrium facade windows or skylights.

1 credit if at least three items are achieved.
2 credits if all five items are achieved.

The project team must submit documentation to demonstrate the compliance with the strategy indicators including:

- Clear definition of the objectives of each energy efficient building design, features, evaluated options, applications and verification of the design strategies.
- Annual energy saving estimation.
- Other relevant supporting documentation for improved and innovative ideas.
- Relevant information to demonstrate sufficient effort has been made on the required provisions and considerations, as well as the final design solution that addressed the commitments.

Background and Notes

None.

B4.2. DESIGN FOR FUNCTIONALITY AND USABILITY

DF2. PROVISION OF SPACE

Aim	To encourage the adequate provision of space.
Credits available	1
Issue summary	1 credit for fulfilling the specific design standards in respect of provision of space.
Exclusion	See below.

Assessment

The project team must show evidence in form of design plans, specifications, and other documents confirming the minimum space allowance as follow:

- For Office building: working space[1] per person is at least 9 m^2 (~ 97 ft^2).
- For Hospital, Residential buildings or residential units within a building: private rooms at least 10 m^2/bed (~ 107 ft^2/bed), multi-bed rooms at least 8 m^2/bed (~ 86 ft^2/bed).
- For Hotel buildings: single room at least 22 m^2 (~ 237 ft^2), twin room at least 32 m^2 (~ 344 ft^2).

Background and Notes

This Issue only applies to Office, Hospital, Hotel and Residential buildings/units. It is scoped out otherwise. Different units within a mixed-use project should be assessed separately and accordingly with relevant standards given above.

The primary aspect of interior service ability functionality and ease of use concerns spaciousness and storage capacity. The spaciousness used here as an assessment indicator is not necessarily directly linked to functionality and storage space, but its effects, such as giving more freedom in layout of fixtures and allowing enough space for storage, can easily be imagined. The standard given is regarded as comfortably spacious, with reference to various standards and examples including *CASBEE for New Construction Technical Manual 2008. (http://www.ibec.or.jp)*.

Use the effective measurements (internal dimension) to calculate the area subject to assessment.

[1] **Working space** refers to floor area allocated within the effective floor area of the office for ordinary workers to go about their daily duties. It does not include common spaces such as canteens, medical rooms, conference rooms, meeting rooms, private executive offices, filing rooms, space for refreshment, and similar spaces. Therefore the working space includes meeting spaces (spaces for day-to-day discussions), OA equipment (i.e. fax machines, telecopiers, etc.) spaces, management spaces, circulation spaces etc.

DF3. MAINTENANCE MANAGEMENT

Aim	To encourage the consideration of maintenance management at the design stage.
Credits available	2
Issue summary	a) 1 credit for design which considers maintenance management.[1] b) 1 additional credit for securing maintenance management functions.
Exclusion	Residential buildings or residential units within a mixed-use building.

Assessment

a) Design which considers maintenance management[2]

The project team must show evidence in form of design plans, specifications, and other documents confirming compliance with at least nine of the following requirements:

1	Interior finishes: interior walls use finish methods, materials, paints or coatings that are highly dirt resistant.
2	Interior finishes: floors use finish methods, materials, paints or coatings that are highly dirt resistant.
3	Décor planning: the design and structure of floors enables washing with water.
4	Décor design: design of interior walls and floors avoids creating dust traps and places to leave objects.
5	Décor design: the first and second doors of windbreak lobbies are distanced so that they are not open at the same time, or are otherwise designed to prevent the entry of dust.
6	Décor design: floor materials with very different maintenance management methods are not placed close together.
7	Exterior finishes: exterior walls and glass are designed with highly dirt resistant construction materials, or with finishes such as weather-resistant paint and hydrophilic properties.
8	Façade design: exterior walls are equipped with effective rain flashing, and the flow of water down the walls has been considered, in order to avoid dirtying of the wall surfaces.
9	Façade design: measures have been applied to prevent damage from the droppings of pest birds (pigeons, crows, starlings, etc.).
10	Façade design: metal parts exposed on the exterior are plated or otherwise treated against corrosion.
11	Décor and exterior space design: movement routes, including outdoor spaces and management areas, are designed to eliminate steps as far as possible (steps not exceeding around 5 mm or 0.2 inch).
12	Other: efforts have been made in areas other than the above, with consideration for maintenance management.

b) Securing maintenance management functions[3]

The project team must show evidence in form of design plans, specifications, and other documents confirming compliance with at least nine of the following requirements:

1	Adequate space has been used for cleaning staff rooms, relative to the floor area.
2	Adequate space has been used for cleaning equipment rooms, relative to the floor area.
3	The cleaning equipment rooms have washing areas with drainage channels to safe drainage facilities.
4	Space is planned for washing and drying mops and rags, for the sake of hygiene.
5	Cleaning sinks are installed for each toilet, or for each floor.

6	Cleaning equipment for each type of floor material has been anticipated, and the layout of electrical receptacles (numbers and spacings) for use in cleaning work has been planned accordingly.
7	Design ensures that maintenance management work can be performed safely on exterior glass and walls, air supply and vent holes, light fixtures and other fixtures in high places.
8	Suitable levels of lighting for cleaning purposes can be set.
9	Valves and other devices requiring day-to-day adjustment are installed in positions that allow convenient operation.
10	Inspection access holes for equipment concealed in ceiling voids are at least 600x600 mm (~ 23.6x23.6 inches).
11	Equipment that is not in private areas can be accessed from common areas for maintenance management.
12	Other than the above, points related to securing maintenance management functions have been identified and implemented.

Background and Notes

[1] The term 'maintenance management' as used here encompasses cleaning management duties (cleaning inside and outside the building) and public health management (air environment, water supply, drainage, insect pest eradication, waste disposal, etc.).

[2] **Compliance notes for credit a)**

1	Judging from the design documents, choose at least one from 1. Toilets, 2. Elevator halls, 3. Escalators, 4. Rest and smoking rooms, 5. Waste handling spaces, and count that as an effort if consideration has clearly been given to it consistently throughout the building. • Dirt-prone walls are generally finished in materials that are porous and water-absorbent or water-soluble (for example, cloth wall coverings and water-based paints). However, even if porous and water absorbent materials are used, effort can be judged to have been made if structural measures have been taken to avoid dirt, or if a dirt-preventive coating is applied. Also, avoid using construction materials that are extremely susceptible to deterioration, such as mud walls, plaster and diatom earth, or, if such materials are used, make sure the structure allows easy replacement.
2	Judging from the design documents, choose at least one from 1. Toilets, 2. Rest and smoking rooms, 3. Food handling spaces, 4. Waste handling spaces, and count that as an effort if consideration has clearly been given to it consistently throughout the building. • Dirt-prone floors are generally finished in materials that are porous and water-absorbent or water-soluble, mainly carpet, concrete and natural stone. However, even if these materials are used, effort can be judged to have been made if the materials have a water-repellent treatment or dirt-resistant coating. Also, avoid using materials that are extremely susceptible to deterioration, such as wood and sandstone, or, if such materials are used, make sure the structure allows easy replacement.
3	Judging from the design documents, effort can be judged to have been made if consideration has clearly been given consistently throughout the building. • Water-washable designs and structures are those with joint treatment to prevent gaps in the floor surface in which water can remain. In the case of double floors, the materials must permit the use of water, and wiring etc. must be waterproofed.

4	Judging from the design documents, effort can be judged to have been made if consideration has clearly been given consistently throughout the building. • For design to avoid dust traps and placement of objects, evaluate avoidance of protrusions and indentations wherever possible, the use of curved finishing between walls and floor, wall-mounted or movable structures for toilets and other fixtures, etc.
5	Judging from the design documents, the basis for windbreak lobbies with primary and secondary doors should be to provide a space of at least 1m in which the automatic doors will not detect movement within the lobby. If the space is less than 1m, but the windbreak lobby has manual doors, the placement of windbreak walls etc. can be counted as an effort. This item can be achieved by default if there is no windbreak lobby provided.
6	Judging from the design documents, effort can be judged to have been made if such consideration has clearly been given consistently throughout the building. • The typical example of floor types of very different maintenance management methods is carpet, which requires hours to dry if it gets wet, and wood flooring, which can warp and split when wet. Different flooring materials have their own maintenance management systems, and designs which mix multiple floor types closely together can easily cause trouble at the operation stage.
7	Judging from the design documents, effort can be judged to have been made if consideration has clearly been given consistently throughout the building's facade design.
8	Judging from the design documents, effort can be judged to have been made if consideration has clearly been given consistently throughout the building's facade design.
9	Judging from the design documents, effort can be judged to have been made if consideration has clearly been given consistently throughout the building's facade design. For example, avoid the installation of structural elements above water tanks where bird pests could shelter from rain, rest and make nests.
10	Judging from the design documents, effort can be judged to have been made if consideration has clearly been given consistently throughout the building's facade design. • Metal elements such as external staircases, air conditioning equipment stands and ladders that are only painted are difficult to protect from corrosion in the long term. It is preferable to use stainless steel, or to apply anti-corrosion treatments such as plating.
11	Judging from the design documents, effort can be judged to have been made if consideration has clearly been given consistently throughout the décor design and exterior space design within the area under the management of the building.
12	Unusual efforts not included in items [1]-[11] above should be evaluated as one point/requirement (one point/requirement for ALL efforts).

[3] **Compliance notes for credit b)**

1	Judging from the design documents, judge an effort to have been made if the area is at least 0.2% of the total floor area.
2	Judging from the design documents, judge an effort to have been made if the area is at least 0.2% of the floor area. Cleaning equipment rooms are used to store cleaning chemicals and similar substances, so it is preferable that they should be under negative pressure.
3	Judge from design documents. • Cleaning equipment rooms require a place to wash cleaning equipment after it has been used for cleaning, and a drainage point with a drainage route that is reliably connected to mains drainage or septic tank, for drainage of cleaning fluids after use.

4	Judge from design documents whether space has been provided for washing machines.
5	Judge from design documents. • Performing cleaning work efficiently requires provision of cleaning sinks for every set unit of area, to shorten movement times and distances. Judge whether a cleaning sink has been installed for each toilet (i.e. group of male/female/multi-purpose toilets).
6	Judge from design documents. • Use of extension cables to compensate for lack of electrical receptacles increases hazards such as cables melting from overheating and people tripping over cables. It is also important to provide cleaning receptacles on a separate dedicated circuit, to avoid impeding the activities of other building users. It is assumed here that motorised cleaning equipment powered by AC electricity will be used, for which power cables are generally 8-15 m (~ 26-49 ft) long. Judge an effort to have been made if dedicated cleaning receptacles on a separate circuit are installed at a rate of at least one within each 30 m (~ 98 ft) radius in corridors in common areas.
7	Judge from design documents. • Do not use designs that make work difficult, such as exterior glazing and walls with curves or extreme setbacks from the parapet, and design for safe work by installing a rooftop gondola system. Also judge whether design allows work from the top down with hoist equipment for cleaning and replacing the bulbs etc. in light fixtures in high places.
8	Judge from lighting design documents. • Lighting for cleaning should not use all lights, to save energy, but a minimum level is required to enable safe work, and for checking the results of cleaning, so judge whether a suitable level of lighting has been set for cleaning. A lighting level of at least 75 lux is desirable. The figure is the same for buildings off all types, and is equal to the minimum value in the standard range for corridors in normal use.
9	Judge from design documents. • For efficient maintenance management, valves and other adjustment devices should be positioned where they are easy to operate.
10	Judge from design documents. • Adequate space must be provided for tasks such as replacing filters and adjusting humidifiers in equipment installed in ceiling voids.
11	Judge from design documents. • For efficient maintenance management, a plan is required that allows the work to proceed without impeding the activities of building users.
12	Unusual efforts not included in items [1]-[11] above should be evaluated as one point/requirement (one point/requirement for ALL efforts).

B4.3. DESIGN FOR FLEXIBILITY AND ADAPTABILITY

DF4. SPATIAL FLEXIBILITY

Aim	To encourage the design of building interior elements and building services components that allows modifications to space layout, and to reduce waste during churning, refurbishment and deconstruction.
Credits available	3
Issue summary	a) 1 credit for providing spatial flexibility that can adapt spaces for different uses, and allows for expansion to permit additional spatial requirements to be accommodated. b) 1 credit for flexible design of services that can adapt to changes of layout and use. c) 1 credit for designs providing flexibility through the choice of building structural system that allows for change in future use, and which is coordinated with interior planning modules.
Exclusion	None.

Assessment

Evidence could be in form of a report prepared by a suitably qualified person presenting evidence as to how and the extent to which building adaptability and deconstruction is provided. The report must include drawings and documents including building plans and detail specifications together with elaboration and justification of specific design strategies that provide for the intended outcome.

The project team must demonstrate compliance with the requirements given in *Checklist 5: Adaptability and Deconstruction (Appendix 2: Technical Checklists)* at a minimum. Where it can be demonstrated that applicable good practices in respect of structural and/or spatial flexibility, and/or flexibility in servicing have been adopted whenever feasible and at least 50% for residential development and 70% for other building types of the listed items in the relevant parts of *Checklist 5* could be achieved, the credit(s) shall be awarded accordingly.

Background and Notes

Change of ownership, changing use of premises, changing demography of family units, future growth and expansion etc., require modifications to the layout of tall-buildings. Large amounts of solid waste can be generated during the remodelling, such as demolition of walls and partitions. Designs that allow users flexibility in the building layout and designs that allow for dismantling during deconstruction can significantly reduce consumption of resources and generation of waste.

'Adaptability' refers to the capacity of buildings to accommodate substantial changes. The concept of adaptability can be broken down into a number of simple strategies that are familiar to most designers:

- Flexibility i.e. enabling minor shifts in space planning.
- Convertibility i.e. allowing for changes in use within the building.
- Facilitating additions to the quantity of space in a building.

Designs for adaptability can also increase the longevity of buildings, improve operating performance, and allow more efficient use of space yielding economic benefits. The key design principles include independence of systems within a building, upgradeability of systems and components, and lifetime compatibility of building components. Examples include:

- Foundations that allow for potential vertical expansion of the building.
- Superstructures that rely on a central core for lateral load resistance to allow local modifications to the structure without affecting the building's structural integrity.
- Reducing the use of embedded infrastructure for power, data and HVAC systems.

- The use of building systems that isolate structural and building enclosure systems used for housing building services components.
- The provision of lightweight partitions that can be moved to change layout.
- Design that allows interior fitting-out to use modular and pre-fabricated components.
- Separating long-lived components from short-lived components to reduce the complexity of deconstruction and churning so as to facilitate the collection process for recycling; etc.

Deconstruction is the process of selectively and systematically disassembling buildings that would otherwise be demolished to generate a supply of materials suitable for reuse in the construction or rehabilitation of other structures. Designing for deconstruction facilitates the salvage of recyclable materials during disassembly. The benefits include the reduction of pollution impacts, saving landfill space, and increase in resource and economic efficiency.

This Issue raises a separate concern from Demolition Management aspects, which are covered under Issue PM13.

DF5. SPATIAL MARGIN

Aim	To encourage the flexibility and adaptability of the design by meeting floor-to-floor height allowance and wall length/area recommended ratio.
Credits available	2
Issue summary	a) 1 credit for meeting floor-to-floor height allowance. b) 1 credit for meeting wall length/area recommended ratio.
Exclusion	None.

Assessment

a) The project team must show evidence in form of design plans, drawings, specifications, and other relevant documents confirming that the floor-to-floor height of the standard floors is:[1]
   - $\geq$ 3.7 m (~ 12 ft) for Non-residential buildings.
   - $\geq$ 3.0 m (~ 9.8 ft) for Residential buildings or residential units within a mixed-use building.

b) The project team must show evidence in form of design plans, drawings, specifications, and other relevant documents confirming that the wall length/area ratio[2] is ≤ 0.1.

Wall length/area ratio is calculated by the following equation:

$$\text{Wall length/area ratio} = \frac{\text{Length of perimeter walls (m)} + \text{length of bearing walls (m)}}{\text{Exclusive area (m}^2\text{)}}$$

Background and Notes

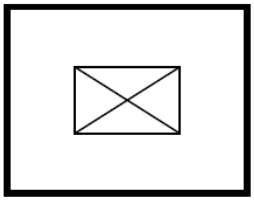
[1] This credit aims to evaluate whether floor-to-floor height would pose an obstacle to changing or reinforcing building types or equipment systems, and whether comfort is achieved. The recommended height allows easy changing of building types and equipment.
   - For Offices, Hospitals, Hotels and Residential buildings, evaluate the floor-to-floor height of the standard floors.
   - For other building types, evaluate the average value of the standard floors.
   - This issue applies to standard or typical floors only, it does not concern with ground floor (with reception, entrance, hall, etc.), basements, technical floors, etc.

[2] By meeting the recommended wall length/area ration, it is ensured that there is a high level of freedom for planning equipment and spaces.

Calculation method

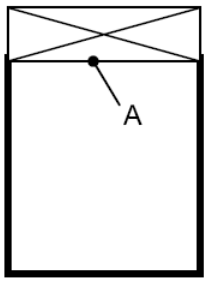
Non-residential buildings: calculate for 1 standard floor.	
1	Equipment spaces/shafts (PS, EPS, EV shafts) should be considered to be 'areas for which room configuration cannot be altered to accommodate future usage,' and excluded from the exclusive area.
2	The walls of equipment spaces/shafts could become constraints on 'areas for which room configuration can be altered to accommodate future usage (exclusive area),' so enter the length of such walls adjoining exclusive areas into the calculation as 'length of load-bearing walls.'
3	The walls around courtyards surrounded by the building should be entered in the calculation as exterior walls.

Example 1 (For a centre core):



- Deduct the centre core portion from the exclusive area.
- If the centre core is surrounded by load-bearing walls, count them as load-bearing walls.
- Count other load-bearing walls, if there are any.
- The length of peripheral walls is the shaded area on the diagram on the left.

Example 2 (For a side core):

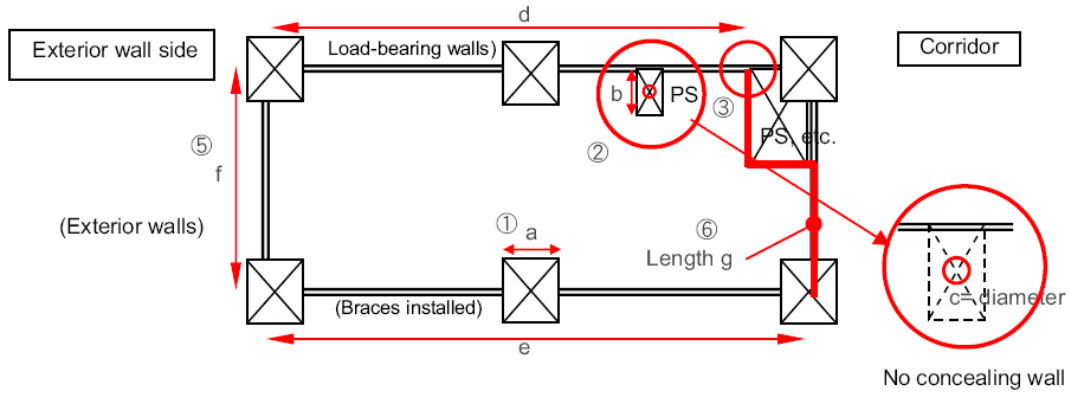


- Deduct the side core portion from the exclusive area.
- If there are load-bearing walls, count those in area A as load-bearing walls.
- Count other load-bearing walls, if there are any.
- The length of peripheral walls is the shaded area on the diagram on the left.

Residential buildings: calculate for the main occupied rooms.

1	Columns with attached walls (regardless of whether they are load-bearing walls) or free standing interior columns should be added to the numerator as the long side x3 (a x 3).
2	For Apartments, include water supply and drainage pipes in exclusive areas. The calculation method for equipment spaces/shafts with attached walls or free-standing interior equipment spaces/shafts is to add the long side x3 (b x 3) for walls to conceal pipes, or the diameter x3 (c x 3) of the fattest pipe if there is no concealing wall, to the numerator.
3	If there is equipment spaces/shafts facing outside, count the point of contact with the equipment spaces/shafts as the end of the load-bearing walls (d).
4	In walls with braces installed, add the distance between centres (e) to the numerator as load-bearing wall. Conversely, do not count party walls that are not load-bearing.
5	Judge the length of exterior walls by the centre-to-centre length (f).
6	If there is an open corridor, add the length of the wall side of the corridor as length of exterior wall. However, if there is equipment spaces/shafts facing the veranda, add the length of contact between the equipment spaces/shafts and the exclusive area, and the lengths of walls of other areas on the veranda side, as shown in (g). If there is a middle corridor do not add the length on the corridor side to the length of exterior wall.

Reference diagram (example of an apartment with an open corridor):



Source: CASBEE for New Construction Technical Manual 2008. (http://www.ibec.or.jp).

DF6. FLOOR LOAD MARGIN

Aim	To encourage the flexibility and adaptability of the design by meeting recommended floor load capacity.
Credits available	1
Issue summary	1 credit for meeting recommended floor load capacity.
Exclusion	None.

Assessment

The project team must show evidence in form of design plans, drawings, specifications, and other relevant documents confirming that the floor load of standard floors is as follow: [1]

- $\geq$ 2900 N/m^2 (~ 60.5 lbf/ft^2) for residential and accommodation units/sections.
- $\geq$ 4500 N/m^2 (~ 94 lbf/ft^2) for entire building and common areas/sections.

Background and Notes

Tall-building projects, with have a long life span, often go through many refurbishments and/or conversions of functions during their life cycle. This Issue aims to promote the flexibility and adaptability of the building design by providing adequate floor load capacity. If the recommended values are met, there is a great potential for conversion to other building types in the future.

The above values were adopted from *CASBEE for New Construction Technical Manual 2008 (http://www.ibec.or.jp)*. These values are calculated for typical areas inside a tall-building and are divided into two categories only for the ease of assessment: residential sections and other sections. Within a tall-building there will be areas which may have higher floor load requirements (such as areas which accommodate heavy machines, etc.). The given values do not apply for such areas.

[1] For Hotels and Apartment buildings, residential and accommodation sections can be defined as the main areas that correspond to occupied rooms of standard floors. Wards in Hospitals can be considered as residential and accommodation sections.

DF7. ADAPTABILITY OF FACILITIES

Aim	To encourage the consideration of building facilities' adaptability at the design stage.
Credits available	1
Issue summary	1 credit for fulfilling the specific design standards in term of building facilities' adaptability.
Exclusion	None.

Assessment

The project team must show evidence in form of design plans, drawings, specifications, and other relevant documents confirming compliance with the following requirements:

1	Ease of air-conditioning duct renewal: exterior air conditioning ducts are used or ceiling space provided so that ducts can be replaced or repaired without damaging either structural elements or surface finishes. Alternatively; ISS,[1] equipment floor installation or other measures are used to allow easy replacement or repair of air conditioning ducts without damaging surface finishes.[2]
2	Ease of water supply and drain pipe renewal: repair and replacement are possible without damaging structural elements or finishes.[3]
3	Ease of electrical wiring renewal: wiring can be replaced or repaired without damaging structural elements or surface finishes.
4	Ease of communications cable renewal: communications cables can be replaced or repaired without damaging structural elements or surface finishes.
5	Ease of equipment renewal: machine hatches or routes to accommodate replacement of major service equipment are provided, and building functions can be maintained through replacement and repair.[4]
6	Provision of backup space: there is planned provision of space for backup equipment.[5]

Background and Notes

[1] An Interstitial Space System (ISS) is an intermediate space located between regular-use floors, commonly used in tall-buildings to allow space for the mechanical systems. By providing ISS, spaces may be easily rearranged throughout the building's life cycles and therefore reduce life cycle cost.

[2] This item can be ignored for buildings with no central air conditioning system.

[3] Examples of water supply and drainage pipe installation methods and specifications are:

- Main riser pipes: spare space or mechanical void.
- Other than main riser pipes: spare space or mechanical void.
- Lateral pipe: inside system ceiling of own floor or ISS or floor piping pit.
- Exterior wall joint: spare sleeve or through panel.

[4] Evaluate for non-generation of solid wastes and new repair requirements, and the ability to maintain building functions during renewal and repair, using backup equipment. The situation in which building functions can be maintained during renewal and repair works is that where other functions do not stop when the routes or machine hatches are used, and there is equipment that can be used for backup during renewal and repair (including arrangements whereby the number of units of equipment can be divided into groups, so that equipment that does not run under low loads can serve as backup).

The term 'major equipment' refers to the following equipment:

- For Non-residential buildings, this refers to major equipment and services necessary for the building to function, specifically power receiver and transformer equipment, generators, boilers, chillers, air conditioners, water tanks, pumps and other equipment.
- For Residential buildings, it refers to the devices necessary for people to live in the building, such as water heaters, room air conditioning, water tank and pumps.

[5] Evaluate the specifications for the parts that support the main functions corresponding to the building's function (main building service systems). If the plan for equipment replacement or repair works secures space to install backup equipment, the building's functions can be maintained while the replacement or repair takes place.

E1. RESOURCES CONSUMPTION (RC)

E1.1. LAND USE

RC1. LAND USE AND REUSE

Aim	To encourage the use of pre-developed land and contaminated land that otherwise would not have been remediated and developed.
Credits available	2
Issue summary	a) 1 credit if at least 75% of the proposed development's[1] footprint is on an area of land which has been *previously developed*[2] for use by industrial, commercial or domestic purposes in the last 50 years. b) 1 credit if the site is deemed to be *significantly contaminated*[3] and remediation[4] strategies are carried out.
Exclusion	None.

Assessment

a) Evidence could be:
- Existing site plan, report or site photographs confirming:
  - Type and duration of previous land use;
  - Area (m^2) of previous land use.
- Proposed site plan showing location and footprint (m^2) of proposed development and temporary works.

b) This has to be confirmed by a contaminated land specialist's site investigation, risk assessment and appraisal identifying:
- The degree of contamination;
- The contamination sources/types;
- The options for remediating sources of pollution that present an acceptable risk to the site.

The project team must confirm that remediation of the site will be carried out in accordance with the remediation strategy and its implementation plan.

Background and Notes

[1] '**Proposed development'** is defined as the area of any building, hard landscaping, car park and access roads that fall within the boundary of the proposed site. Undeveloped areas of the site to be used for temporary works (e.g. temporary offices/parking, material/machinery storage) must be considered as development on undeveloped land and therefore included in the calculations unless they have been defined as 'land of low ecological value' *(see Section E3.3)*.

[2] '**Previously developed land'** is defined as land that is or was occupied by a permanent structure, including the curtilage of the developed land and any associated fixed surface infrastructure.

The definition includes:
- Defence buildings.

The definition excludes:
- Land that is or has been occupied by agricultural or forestry buildings.
- Land that has been developed for minerals extraction or waste disposal by landfill purposes where provision for restoration has been made through development control procedures.

- Land in built-up areas such as parks, recreation grounds and allotments which, although may feature paths, pavilions and other buildings, have not been previously developed.
- Land that was previously developed but where the remains of the permanent structure or fixed surface structure have blended into the landscape in the process of time (to the extent that it can reasonably be considered as part of the natural surroundings).

Where a site has been previously developed (more than 50 years ago) but is now considered undeveloped, the credit may only be awarded on this basis if the site is deemed to be 'contaminated' as defined in b).

[3] **Contaminant:** is defined as any solid, liquid or gaseous material in, or on the ground to be covered by the building, which is classed as a hazard and therefore presents an unacceptable risk to human health and the environment. The definition also includes land significantly infested by non-native invasive plant species (non-indigenous species that adversely affect the habitats; they invade economically, environmentally or ecologically).

Significant contamination: for the purposes of this Issue, significant contamination is contamination compliant with the above and that, without remediation, development of the site is not possible.

[4] **Remediation**: activity undertaken to prevent, minimise, remedy or mitigate the risk caused by contaminated land to human health or the environment. Credit b) can only be awarded where remediation has taken place to enable current development of the site for the assessed building. The credit is not achievable for instances where historical remediation and development of the site has occurred outside the scope of the current development proposals.

Contaminated land that has been decontaminated solely for health and safety reasons (rather than for the specific purpose of re-development) does not comply. Where the only decontamination required is for the removal of asbestos within an existing building fabric, this cannot be classified as contaminated land. However, where asbestos is found to be present in the ground this will be classed as contamination for the purposes of assessing this Issue.

RC2. LAND USE EFFICIENCY

Aim	To encourage the efficient use of land resource.
Credits available	1
Issue summary	1 credit if the land-take of different scheme designs, process designs and layouts of the planned works are calculated; AND these calculations influence the design process and the land use efficiency of the final design.
Exclusion	Projects that entirely use pre-developed land, and where the project team genuinely has no ability to consider land take.

Assessment

Evidence must be provided to demonstrate that specific attention, above normal practice, has been given to the scheme design with the express intention of enhancing land-take efficiency. This should include consideration of sterilisation of mineral resources.

Background and Notes

The first aspect in comparing the impact of tall-buildings with that of low- or medium-rise buildings is land take. Tall-buildings are often built in big cities where the availability of land is extremely low and the price is high. There are great economic advantages for developers in maximising the floor spaces.

Scheme design is a primary influence on how efficient land is used. Careful site layout, optimisation of the scale of buildings and structures, and selection of space-efficient process will all minimise land take. In addition, site selection plays an important role. Selection of sites with existing infrastructure sufficient for the new site use will minimise the need for the constructing of new facilities. Existing local water resources may avoid the need for additional pipeline construction, etc. Using a site with characteristics appropriate for the proposed project in terms of topography, geology, water features, areas of ecological importance, historical monuments, etc. will also contribute to using land to the best effects.

The project team should demonstrate that all relating aspects are considered in order to select the best design in respect of land use efficiency.

RC3. ON-SITE RESOURCES

Aim	To encourage the efficient use and reuse of topsoil, subsoil, minerals and other excavated materials as a result of the development.
Credits available	1
Issue summary	1 credit if the design and construction of the project take into consideration the conservation/use/reuse of topsoil, subsoil, minerals resources and other excavated materials as a result of the development.
Exclusion	None.

Assessment

Evidence could be in form of documented statements in appropriate reports or meeting notes about the optimal use of topsoil, subsoil, minerals resources and other excavated materials as a result of the development.

The project team must demonstrate that at least 80% (by volume) of excavated materials that are suitable for use has been appropriately utilised on-site or within a reasonable distance.[1]

Background and Notes

[1] What represents a 'reasonable distance' must be judged in the context of the project and its location. It might be 15 km (~ 9.3 miles) in a built-up area, but up to 100 km (~ 62 miles) if the site generating the surplus excavated materials is in a remote area). The utilisation off-site includes taking materials to landfill if the materials are genuinely inert and is used for beneficial reuse (it is a beneficial reuse, since landfill sites need inert waste as capping layers and to mix in with other waste).

Lack of use of soils and minerals due to poor quality of these materials can still score this credit, but evidence of this must be presented – 'best use' can be the non-use of soils and minerals, which also minimises the environmental impacts of excavation, transport and/or disposal of the excavated materials.

It may appear strange that it is possible to score for beneficial reuse at the design stage, but it is at that stage of a project when clear decisions can and need to be made about maximising utilisation, especially as it is rarely possible to amend the design at construction stage to take advantage of any surplus excavation arising.

Excavated materials must be separated and stored correctly for appropriate utilisation. For instance topsoil must be stored in stockpiles no higher than 2 m (~ 6.5 ft) to maintain its structure. To avoid compaction of the soil, stockpiles must not be driven on by heavy machinery. Vegetating long-term stockpiles with suitable plants (mustard or annual lupines, etc.) may help prevent dust blow and erosion, silt run-off, and should assist in preventing invasive and/or noxious weeds from invading the soil. Stockpiles should also not be located within 10 m (~ 33 ft) of a watercourse, etc.

More information and guidance on the utilisation of excavated materials can be found in *Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (2009)* - UK Department for Environment Food and Rural Affairs (DEFRA):
http://www.defra.gov.uk/environment/quality/land/soil/built-environ/

E1.2. WATER USE

RC4. ANNUAL WATER CONSUMPTION

Aim	To reduce the consumption of fresh (potable) water through the application of water saving devices that has proven performance and reliability.
Credits available	4
Issue summary	1 to 4 credits for demonstrating that the use of water efficient devices leads to an estimated aggregate annual saving of 10%, 20%, 30% and 40% respectively.
Exclusion	None.

Assessment

The project team must provide evidence in form of calculation of the reduction of water consumption in the project space compared with a similarly occupied space whose water fittings and appliances conform to a baseline performance. The default calculations/assumptions for the project and the baseline building are provided in *Appendix 8: Assumptions and Baselines for Water Consumption*.

The calculation takes into account the number of occupants, male to female ratio, and the number of operational days per annum. This information must be supplied by the project team and may be stated in the design brief or Owner's Project Requirements (OPR). Water use is based either on a 'per operation' basis or as the product of flow rate and operation time.

The same number and type of water devices must be specified for the base line space as are installed in the project space; so does the frequency of use of water devices. The project team must provide the manufacturers' specifications for the performance of installed water devices.

The project team must submit a report that:

- Details all installed devices and their water consumption rate or discharge volume;
- Details devices installed to reduce the potential wastage of water due to unnecessary operation of taps, etc.

The submitted report must contain the following information:

- Number of operational days per annum;
- Number of occupants;
- Male to Female ratio.

There should then be two sets of tables, one for the project space, and one for the base line space. In the table each type of water using device shall be listed and all data used shall be referenced to the source. The calculation shall include water taps for bath, basin, pantry/ kitchen, and also shower heads, and exclude water closet, urinal, water features, appliance and irrigation. There should be separate entries for water use in male and female facilities. Tabular data should be similar to the format provided in *Appendix 8*.

Credits are awarded based on the estimated annual water saving percentage as follow:

Percentage reduction	Credits
10%	1
20%	2
30%	3
40%	4

Background and Notes

This Issue doesn't concern with water for irrigation. The following fixtures, fittings and appliances are also outside the scope of the water use reduction calculation:

- *Commercial Steam Cookers;*
- *Commercial Dishwashers;*
- *Automatic Commercial Ice Makers;*
- *Commercial (family-sized) Clothes Washers;*
- *Residential Clothes Washers;*
- *Standard and Compact Residential Dish Washers;*
- *Pools, spas, fountains, etc.*

Water is one of the most important issues when it comes to sustainability. Reduction in water use can mostly be achieved through the use of water efficient devices and automatic controls.

There is an increasing availability of devices and plumbing fixtures that have demonstrated an ability to save water over the lifetime of the system if installed and maintained properly. Flow rates can be controlled to reduce excessive discharge at taps, faucets and showers without detriment to the quality of water delivery. Substantial evidence shows that the use of water-efficient plumbing fixtures conserves water. A number of studies in the U.S. have measured the impact of installing water-efficient plumbing fixtures through sophisticated sensors, before-and-after comparisons of water bills, or other means. Although the results varied, it is generally concluded that low-flow fixtures are effective in saving water.

High efficiency devices include low flow rate faucets or faucets with aerated flows. However, it must be demonstrated that the actual quantity of water is reduced per standard operation (e.g. in the case of hand washing show that a reduced flow rate does not result in an extended hand washing time resulting in no reduction in water volume used).

The provision of automatic shut-off devices, particular in public use areas, can save significant amounts of water. Examples of automatic shut-off devices are spring-loaded (or push-once) taps, electronic proximity sensors, etc., but excluding timed shut-off devices.

There have been concerns that certain low flow devices such as aerated faucets may increase the risk of Legionella transmission. *Legionella concerns are addressed under Issue IEQ3.*

Water recycling schemes are dealt with under Issue RC7.

RC5. MONITORING AND CONTROL

Aim	To reduce wastage of fresh water and allow for auditing of water use.
Credits available	2
Issue summary	a) 1 credit for installation of a water meter and sub-meter system. b) 1 credit for installation of a leak detection system.
Exclusion	None.

Assessment

a) Water meter and sub-meters

The project team must demonstrate that:

1	A water meter on the mains water supply to the building is installed; this includes instances where water is supplied via a borehole or other private source.
2	The water meter has a pulsed output to enable connection to a Building Management System (BMS) for the monitoring of water consumption.[1]
3	Sub meters are fitted to allow the metering of individual water-consuming building areas, where demand in such areas is expected to be ≥ 10% of the total water demand of the building.[2]
4	Each sub meter has a pulsed output to enable connection to a BMS for the monitoring of water consumption.

Evidence could be the specification and type of water meter(s) AND design plan(s) showing location of the water meter(s) in each assessed building/unit.

b) Major leak detection

The project team must demonstrate that:

1	A leak detection system capable of detecting major leaks on the water supply is installed. The system must cover all mains water supply between and within the building and the site boundary.[3]
2	The leak detection system is: - Audible when activated. - Activated when the flow of water passes through the water meter/data logger at a flow rate above a pre-set minimum[4] for a pre-set period of time. - Able to identify different flow and therefore leakage rates,[5] e.g. continuous, high and/or low level, over set time periods. - Programmable to suit the owner/occupiers' water consumption criteria. - Where applicable, designed to avoid false alarms caused by normal operation of large water-consuming plant such as chillers.

Evidence could the specification confirming scope and performance criteria of leak detection system AND design plan(s) showing location of the installed system.

Background and Notes

[1] **Building (Energy) Management System (BMS):** is a central computer controlling, monitoring and optimising building services and systems such as heating, air-conditioning, lighting, security, water, electricity, etc.

The requirement for a pulsed output has been included to encourage the use of meters capable of transmitting (by wire or wirelessly) a continuous or pulsed signal with water management information such as total water consumed or flow rate to a BMS. This allows demand patterns

on water systems to be monitored and evaluated over time. A significant increase in demand may indicate the presence of a leak or inappropriate or unexpected water consumption.

[2] It is widely accepted that water usage can be decreased by how water is consumed by building users. If there are only small water consuming units used within the building such as singular toilets, small kitchen etc. It is unlikely there will be an opportunity to reduce water consumption by increased water management. And therefore there will be no benefit to installing a sub-meter; in such instances this item can be ignored. Compliance with the criteria can also be demonstrated where the water metering/monitoring equipment is integral to the water consuming plant, as oppose to a sub meter on the water supply to the plant.

[3] **System criteria:** it is anticipated that this credit will usually be achieved by installing a system that detects higher than normal flow rates at meters and/or sub-meters. It does not require a system that would directly detect water leakage along part or the whole length of the water supply system. It is also not a requirement of this Issue that the leak detection system shut off the water supply when the alarm is triggered.

[4] **Pre-set flow rates:** pre-set flow rates and time periods will vary depending on the building type and usage.

[5] **Leakage rates:** it does not specify what the high and low level leakage rates should be; however, the equipment installed must have the flexibility to distinguish between different flow rates to enable it to be programmed to suit the owner/occupier's usage patterns.

RC6. WATER EFFICIENT IRRIGATION

Aim	To reduce the reliance on potable water for irrigation.
Credits available	1
Issue summary	1 credit for adopting an irrigation system that does not require the use of municipal fresh water after a period of establishment is complete. ALTERNATELY, 1 credit for demonstrating highly efficient irrigation technology and/or the use of harvested rainwater and/or recycled grey water to reduce freshwater consumption for irrigation by 50% or more in comparison with conventional irrigation of water intensive planting.
Exclusion	None.

Assessment

The project team must provide a report prepared by a suitably qualified person describing the soft landscaping design, species of plants, etc., and confirm that, after a period of establishment of the plants and vegetation is complete, irrigation will not require the use of municipal potable (fresh) water supply.

ALTERNATIVELY,

The project team must demonstrate highly efficient irrigation technology and/or the use of harvested rainwater and/or recycled grey water to reduce fresh (mains) water consumption for irrigation by 50% or more in comparison with conventional irrigation of water intensive planting.

The water use reduction may be demonstrated by use of metered data compared to any suitable benchmark, or may be demonstrated by calculations provided by a suitably qualified person.

Background and Notes

Providing landscaping in tall-buildings is one of the important issues in order to increase the sustainability, especially the living standard of occupants. Where a building development contains significant landscaping, as defined by the coverage of soft landscaping, greenery and planters there is likely to be a significant consumption of potable water.

Potential strategies to reduce the use of potable water:

- Irrigation by lower quality (harvested or recycled) water can be equally effective.
- Use of water treated and conveyed by a public agency specifically for non-potable uses.
- Perform a soil/climate analysis to determine appropriate plant material and design the landscape with native or adapted plants to reduce or eliminate irrigation requirements. Native plants can survive without additional watering, and require less fertiliser and pesticides, thereby reducing impacts on local waters.
- Where irrigation is required, use high-efficiency equipment and/or climate-based controllers, etc.

RC7. WATER HARVESTING AND RECYCLING

Aim	To encourage harvesting of rainwater and recycling of grey water in order to reduce consumption of fresh water.
Credits available	3
Issue summary	a) 1 credit for harvesting of rainwater which will lead to a reduction of 5% or more in the consumption of fresh water. b) 1 credit for the provision of plumbing and drainage system for separation of grey water from black water. 1 additional credit where recycled grey water will lead to a reduction of 10% or more in the building's annual consumption of fresh water.
Exclusion	None.

Assessment

a) Harvested rainwater

The project team must provide a report detailing the system installed for the purpose of harvesting rainwater, the details of the expectations in respect of savings in the consumption of fresh water, and must demonstrate that the rainwater is of an appropriate quality to the end use. It must be verified that the expected savings in fresh water use is ≥ 5%, either based on baseline building estimates *(see Issue RC4)* or other appropriate estimations.

b) Recycled water

The project team must provide a report detailing:

- The plumbing and drainage system for separation of grey water from black water.
- The system installed for the purpose of recycling grey water.
- Details of the expectations in respect of savings in the consumption of potable water.
- Demonstration that the treated grey water is of a quality appropriate to the end use.

For the additional credit, it must be verified that the expected savings in fresh water use is ≥ 10%, either based on baseline building estimates (*see Issue RC4)* or other appropriate estimations.

Background and Notes

Harvested and/or recycled water must satisfy the water quality requirements for the intended reuse; e.g. cleaning, irrigation, use in heat rejection systems, toilet flushing, etc. Harvested and recycled water that leads to the reduced use of fresh water is also counted in the estimated percentage of reduction in the annual consumption of fresh water (see Issue RC4).

Harvesting and recycling of water not only helps to reduce the demand for potable water supply, but also provides a reliable source in case of supply interruptions. When properly managed it is possible to reuse all wastewater for various purposes. A grey water recycling system is one that collects grey water (i.e. reclaimed condensate, etc.) for treatment and distributes the treated water to the points of use, such as for irrigation, cleaning, or for toilet flushing. Another potential use of the recycled water is for evaporative heat rejection system in air conditioning, which will provide an energy benefit and improves the cost effectiveness of water recycling. Due consideration has to be made for the amounts of water that can be generated, and how this matches with the amounts that can be put to use; else there is little incentive to recycle.

Harvested rain water in tall-buildings is often used for cooling tower or fire safety system. The problem for high-rise buildings is that the potential for collecting rainwater is limited compared to low and medium-rise projects. In some countries water can be harvested from other sources, such as sea water in case of Hong Kong.

RC8. WATER EFFICIENT FACILITIES AND APPLIANCES

Aim	To encourage the wider use of water efficient facilities and appliances.
Credits available	1
Issue summary	1 credit for installing water efficient facilities (pools, spas, fountains, etc.) and appliances that are at least 20% more efficient than otherwise.
Exclusion	Projects where the project team has no control of the installation of such facilities and appliances (e.g. residential buildings where occupants install their own appliances).

Assessment

The project team must provide details of all the water-consuming facilities and appliances installed in the building.

- For water efficient facilities: it must be demonstrated that water savings for pools, spas, fountains and other water features is ≥ 20% than the case when water conservation measures/design innovations are not included.
- For water efficient appliances: it must be demonstrated (by the water use ratings of each type and size of appliance) that water use efficiency is high, typically 20% better than appliances not marketed as water efficient.

Background and Notes

Water use in washing machines, dishwashers in homes, in hotel laundries, etc., can be a substantial part of consumption of fresh water. Likewise there is opportunity for reduce water loss from water features and recreational facilities. TPSI encourages attention to the selection of water efficient equipment and design of water using facilities that include means to save fresh water.

RC9. INNOVATIVE WASTEWATER TECHNOLOGIES

Aim	To reduce wastewater generation and potable water demand, while increasing the local aquifer recharge.
Credits available	1
Issue summary	1 credit for reducing annual potable water use for building sewage conveyance by at least 50%. ALTERNATIVELY, 1 credit for treating at least 50% of wastewater on-site (annually) to tertiary standard (treated water must be infiltrated or used on-site).
Exclusion	None.

Assessment

The project team must demonstrate that the target percentage of reduction in annual sewage volume can be achieved; either based on the default assumptions for the calculation procedure given in *Appendix 8: Assumptions and Baselines for Water Consumption* or other appropriate estimations.

ALTERNATIVELY,

The project team must provide a report prepared by a suitably qualified person detailing the treatment system and estimated percentage of wastewater that will be treated and infiltrated or used on-site. The total amount of wastewater should be calculated either based on the method given in *Appendix 8: Assumptions and Baselines for Water Consumption* or other appropriate estimations.

Background and Notes

The use of potable water for sewage conveyance can be reduced by utilising water-conserving fixtures (e.g., water closets, urinals) and dry fixtures (e.g., composting toilet systems and non-water-using urinals). With the application of modern technology in the design of water closet flushing system, the effectiveness of flushing can be maintained with a reduced discharge. The use of non-potable water (e.g., captured rainwater, recycled grey water, and on-site or municipally treated wastewater) for sewage conveyance is also counted as potable water saving. Options for on-site wastewater treatment include package biological nutrient removal systems, constructed wetlands and high-efficiency filtration systems.

E1.3. ENERGY USE

RC-P1. BASIC ENERGY PERFORMANCE

Aim	To establish the minimum level of energy efficiency for the proposed building and systems to reduce environmental and economic impacts associated with excessive energy use.
Credits available	Required.
Issue summary	Demonstrating a minimum improvement in the building's energy performance compared with the Baseline Building performance rating.
Exclusion	None.

Assessment

This Issue is the prerequisite for all Issues under Section 'E1.3. Energy Use' (Issues RC10 to RC15). It must be fulfilled in order to score under Issues RC10 to RC15.

The project team must demonstrate a minimum improvement in the proposed building performance rating (10% for non-residential buildings and mixed-use buildings, 5% for residential buildings) compared with the Baseline Building performance rating. The Baseline Building performance rating must be calculated according to the building performance rating method in Appendix G of ANSI/ASHRAE/IESNA Standard 90.1-2007[1] using a computer simulation model for the whole building project.

Appendix G of Standard 90.1-2007 requires that the energy analysis done for the building performance rating method include all energy costs associated with the building project. To achieve points using this credit, the proposed design must meet the following criteria:

- Comply with the mandatory provisions (Sections 5.4, 6.4, 7.4, 8.4, 9.4 and 10.4) in Standard 90.1-2007.
- Include all energy costs associated with the building project.
- Compare against a baseline building that complies with Appendix G of Standard 90.1-2007. The default process energy cost is 25% of the total energy cost for the baseline building. If the building's process energy cost is less than 25% of the baseline building energy cost, the project team must include documentation verifying that process energy inputs are appropriate.

For the purpose of this analysis, process energy is considered to include, but is not limited to, office and general miscellaneous equipment, computers, elevators and escalators, kitchen cooking and refrigeration, laundry washing and drying, lighting exempt from the lighting power allowance (e.g., lighting integral to medical equipment) and other (e.g., waterfall pumps).

Regulated (non-process) energy includes lighting (for the interior, parking garage, surface parking, façade, or building grounds, etc. except as noted above), heating, ventilation and air conditioning (HVAC) (for space heating, space cooling, fans, pumps, toilet exhaust, parking garage ventilation, kitchen hood exhaust, etc.), and service water heating for domestic or space heating purposes.

Process loads must be identical for both the baseline building performance rating and the proposed building performance rating. However, project team may follow the exceptional calculation method (ANSI/ASHRAE/IESNA Standard 90.1-2007 G2.5) to document measures that reduce process loads. Documentation of process load energy savings must include a list of the assumptions made for both the base and the proposed design, and theoretical or empirical information supporting these assumptions.

Background and Notes

The reduction of energy leads to the saving of fossil fuels associated, and less generation of carbon dioxide which contributes to global climate change.

Potential Technologies & Strategies

Design the building envelope and systems to meet baseline requirements. Use a computer simulation model to assess the energy performance and identify the most cost-effective energy efficiency measures. Quantify energy performance compared with a baseline building.

If local code has demonstrated quantitative and textual equivalence following, at a minimum, the U.S. Department of Energy (DOE) standard process for commercial energy code determination, then the results of that analysis may be used to correlate local code performance with ANSI/ASHRAE/IESNA Standard 90.1-2007. Details on the DOE process for commercial energy code determination can be found at:
http://www.energycodes.gov/implement/determinations_com.stm.

[1] ANSI/ASHRAE/IESNA Standard 90.1-2007 *Energy Standard for Buildings Except Low-Rise Residential Buildings*. (http://www.ashrae.org)

RC10. ENERGY USE REDUCTION

Aim	To achieve increasing levels of energy performance beyond the basic standard to reduce environmental and economic impacts associated with excessive energy use.
Credits available	18
Issue summary	a) Maximum 15 credits for demonstrating extra improvements in the building's energy performance compared with the Baseline Building performance rating. b) Maximum 3 credits for demonstrating reductions in the maximum electricity demand compared with the Baseline Building.
Exclusion	None.

Assessment

a) Optimise energy performance

The project team must demonstrate a percentage improvement in the proposed building performance rating compared with the Baseline Building performance rating *(see Issue RC-P1)*. The minimum energy cost savings percentage for each credit threshold is as follows:

Residential buildings	Non-residential buildings	Credits
9%	12%	1
13%	16%	2
17%	20%	3
20%	24%	4
23%	27%	5
26%	30%	6
28%	32%	7
30%	34%	8
32%	36%	9
34%	38%	10
36%	40%	11
38%	42%	12
40%	44%	13
42%	46%	14
44%	48%	15

b) Peak electricity demand reduction

The project team must demonstrate a percentage reduction of maximum electricity demand of the assessed building compared with the Baseline Building *(see Issue RC-P1)*. The minimum peak electricity demand reduction percentage for each credit threshold is as follows:

Residential buildings	Non-residential buildings	Credits
8%	15%	1
12%	23%	2
15%	30%	3

Background and Notes

Potential Technologies & Strategies: *see Issue RC-P1*.

RC11. ENERGY USE IN CAR PARKS AND PUBLIC AREAS

Aim	To promote efficient energy use in car parks and public areas.
Credits available	2
Issue summary	a) 1 credit for ventilation systems that will consume less electricity than those meeting the zero-credit requirements (baseline) by 25% or more. b) 1 credit for fulfilling the specific requirements in respect of lighting for car parks and external public areas.
Exclusion	See below.

Assessment

a) Ventilation system in car park

This credit is scoped out for buildings without indoor car park or car park area of less than 10% Construction Floor Area (CFA).

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

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

Besides reduction, it is required to demonstrate that the control systems for regulating the operation of the ventilation systems(s) must be provided to reduce energy use whenever conditions permit. Examples of control systems include variable fan speed control, duty cycling of multiple ventilation fans according to the CO concentration in car parks, etc.

The project team must submit the following information to demonstrate that the installations meet the basic requirements and the requirements for this credit:

- The criteria adopted in the design of the ventilation systems;
- The calculated ventilation rates;
- The design performance and operating patterns of the ventilation equipment;
- The energy use predictions for the zero-credit case and the as designed case for the ventilation system installation;
- Reports of air leakage tests on selected ducting systems;
- The specified performance of any air-conditioning equipment for the building.

The air leakage limit on ductwork should conform to an adequate standard.[1] The test method should be based on DW143,[2] SMACNA[3] or equivalent methods.

b) Lighting for car parks and external public areas

This credit is scoped out for buildings without indoor car park or car park area of less than 10% CFA AND such buildings are designed to operate without external lighting, including external lighting on the building, signs and at entrances.

The project team must demonstrate that:

1	All external light fittings for the building, access ways and pathways have a luminous efficacy ≥ 50 lamp lumens/circuit Watt[4] when the lamp has a colour rendering index (Ra)[5] ≥ 60. OR 60 lamp lumens/circuit Watt when the lamp has a colour rendering index (Ra) < 60.
2	All light fittings to car parking areas, associated roads and floodlighting[6] have a luminous efficacy ≥ 70 lamp lumens/circuit Watt when the lamp has a colour rendering index (Ra) ≥ 60. OR 80 lamp lumens/circuit Watts when the lamp has a colour rendering index (Ra) < 60.
3	All external light fittings for signs and up-lighting have a luminous efficacy ≥ 60 lamp lumens/circuit Watt when the lamp wattage is ≥ 25W. OR 50 lamp lumens/circuit Watt when the lamp wattage is < 25W.
4	External light fittings are controlled through a time switch, or daylight sensor,[7] to prevent operation during daylight hours. Daylight sensor override on a manually switched lighting circuit is acceptable.

Background and Notes

[1] Example of air leakage on ductwork standards: Hong Kong Electrical and Mechanical Services Department: *Code of Practice for Energy Efficiency of Air Conditioning Installations (2007 Edition)*. (http://www.emsd.gov.hk/emsd/e_download/pee/accop_2007.pdf).

[2] Heating and Ventilation Contractors Association, UK. DW143 *A Practical Guide to Ductwork Leakage Testing*. 2000. (www.hvca.org.uk/).

[3] Sheet Metal and Air Conditioning National Contractors Association (SMACNA) *IAQ Guideline for Occupied Buildings under Construction*. (http://www.smacna.org/).

[4] **Luminous efficacy in lamp Lumens/circuit Watt**: the ratio between the luminous flux produced by a lamp (in Lumens) and the total power consumed by both the lamp and its associated control gear (in Watts).

[5] **Colour Rendering:** at nighttime, the sensitivity of the eye is shifted towards the blue region of the visual spectrum. As a result, lamps with poor colour rendering index, such as some sodium lamps that emit light between the yellow and red region of the visual spectrum, require more luminous output to light an object with the same level of brightness than a source with better colour rendering index. Sources with a poor colour rendering index also make the differentiation of cultured objects more difficult for individuals.

Colour rendering index (Ra): a measure, between 0 and 100, of the ability of a lamp to reproduce the colour of objects in comparison to their aspect under a natural or reference source of light. An incandescent source has a Ra of 100 and a low pressure sodium source has a Ra of 0.

[6] **Decorative and floodlighting:** decorative lighting and floodlighting must not be exempt from the assessment criteria although temporary lighting such as theatrical, stage or local display installations, where specified, may be excluded.

[7] **Daylight Sensors:** sensors that detect daylight and switches lighting on at dusk and off at dawn.

RC12. LOW OR ZERO CARBON TECHNOLOGIES

Aim	To reduce carbon emissions and atmospheric pollution by encouraging local and on-site energy generation from renewable sources to supply a significant proportion of the energy demand.
Credits available	4
Issue summary	Maximum 4 credits for supplying the energy demand by low or zero carbon technologies (renewable energy).
Exclusion	None.

Assessment

a) **First credit**

The project team must demonstrate compliance with one of the following options:

OPTION 1:

1	A feasibility study[1] has been carried out by an energy specialist[2] to establish the most appropriate local (on-site or near-site)[3] LZC energy sources for the building/development. This study must cover at a minimum: - Energy generated from LZC energy source per year; - Payback; - Land use; - Local planning criteria; - Noise; - Feasibility of exporting heat/electricity from the system; - Life cycle cost/impact of the potential specification in terms of carbon emissions; - Any available grants; - All appropriate technologies and energy demand of the development; - Reasons for excluding other technologies.
2	At least one local LZC energy technology has been specified for the building/development in line with the recommendations of the above feasibility study.
3	The feasibility study has been carried out at concept design stage.

OPTION 2:

The organisation that occupies the building has in place a contract with an energy supplier to provide electricity for the assessed building/development from a 100% renewable energy source. This supply must be delivered by an *accredited external renewable source*. The contract must be valid for a minimum of three years from the date the assessed building becomes occupied.

b) **Credits 2-4**[4]

The project team must demonstrate that:

1	Credit a) for a feasibility study is already achieved
2	Calculate project energy performance by expressing the energy produced by the LZC energy technology installed as a percentage of the building's annual energy consumption (the calculation must use the method given in Issue RC-P1). Use the table below to determine the number of points achieved.

Percentage renewable energy	Credits
1%	1
1.5%	2
2%	3

Background and Notes

List of recognised LZC technologies

Solar - Solar hot water; - Photovoltaic.	**Combined Heat and Power (CHP) for use with the following fuels:** - Biomass; - Natural gas; - Sewerage gas and other biogases.
Water - Small scale hydro power; - Tidal power; - Wave power.	**Community heating**, including utilising waste heat from processes such as large scale power generation where the majority of heating comes from waste heat.[5]
Biomass - Biomass single room heaters/stoves; - Biomass boilers; - Biomass community heating schemes.	**Heat Pumps** - Ground source heat pumps; - Water source heat pumps; - Geothermal heating systems; - Air source heat pumps. For heat pumps to comply, the heat source (ground or water) must be from a renewable source, for example soil, outside air, ground water, or a river.
Wind - Wind turbines.	**Other** - Fuel cells using hydrogen generated from any of the above 'renewable' sources.
Note: - *The list above is not a definitive list of compliant technologies, but a list of those technologies that may be considered to comply. For specific projects, the low or zero carbon credentials/feasibility of the above technologies may not certain. In such cases the credits must not be achieved.* - *Other systems may be acceptable as part of a LZC strategy under this Issue but are not inherently considered as LZC technologies. Acceptable will be dependent on the nature of the system proposed.* - *The percentage can be made up from more than one of the above technologies.*	

Biofuels: given the current uncertainty over their impact on biodiversity, global food production and greenhouse gas savings, plus the ease of inter-changeability between fossil fuels, TPSI does not recognise *first generation biofuels* manufactured from feedstocks (e.g. biofuels manufactured from sugars, seeds, grain, animal fats etc.). Systems using *second generation biofuels* (e.g. biofuels manufactured from lignocellulose biomass feedstock using advanced technical process) or biofuels manufactured from biodegradable waste materials (e.g. biogas), or locally and sustainably sourced solid biofuels (e.g. woodchip, wood pellets) are considered appropriate.

[1] **Feasible study:** when undertaking a feasibility study at a later stage than *outline* proposals, an additional element will need to be included in the report to highlight the local LZC energy sources which have been discounted due to the constraints placed on the project by the late consideration, and the reason for their omission. If the feasibility study discounts all local LZC as unfeasible due to the late stage in the project that the study was commissioned, then credit a) for the feasibility study must be withheld.

If the feasibility was commissioned at the outline proposals stage or earlier and in the unlikely event the study concludes that the specification of any local LZC technology is unfeasible, credit a) can still be awarded. Subsequent credits for installing LZC technology that meets a percentage of building energy demand will not be achievable.

[2] **Energy Specialist**: an individual who has acquired substantial expertise or a recognised qualification for undertaking assessments, designs and installations of low or zero carbon solutions; and is not professionally connected to a single low or zero carbon technology or manufacturer.

[3] 'Local' does not necessarily mean *on-site* and community schemes (near site) are suitable to achieve this credit.

[4] These credits seek to encourage the installation of on-site and near-site LZC technologies. They are only achievable if credit a) is already attained using OPTION 1. Buildings which use *accredited external renewable sources* (OPTION 2) cannot earn these credits.

[5] **Waste heat**: waste heat from a process that takes place within the assessed building (or on the assessed site), can be considered as 'Low carbon.' This is on the condition that the generation of the heat from the process is integral to the assessed building. Waste heat from an incineration plant can only be considered as a low carbon for the purpose of these credits under the following circumstances:

- All other LZC technologies have been considered and discounted in the feasibility study. **And either:**
- The Local Authority or region in which the incineration plant is located is demonstrably meeting its annual waste reuse/recycling targets and waste management policies.

  Or
- A near-site or on-site facility connected to the building, via a private wire arrangement, which demonstrably removes reusable and recyclable waste material prior to incineration.

RC13. CLOTHES DRYING FACILITIES

Aim	To encourage greater use of natural resources in place of gas or electrical energy for clothes drying purposes.
Credits available	1
Issue summary	1 credit for providing suitable clothes drying facilities that utilise the natural environment for all residential units.
Exclusion	Non-residential and mixed-use buildings.

Assessment

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

Background and Notes

Provisions of clothes drying facilities in many existing residential buildings are inadequate such that people tend not to use them and resort to gas or electric drying machines, increasing energy consumption.

RC14. ENERGY EFFICIENT APPLIANCES

Aim	To encourage the wider use of energy efficient appliances.
Credits available	1
Issue summary	1 credit if at least 70% of total rated power of appliances and equipment are certified energy efficient products.
Exclusion	Buildings where appliances are not provided by the developer.

Assessment

The project team must provide details of all the appliances installed in the building and evidence as to the efficiency ratings of each type and size of the appliances; and quantify the rated power of certified energy products as the percentage of total rated power of appliances and equipment. The eligible appliances and equipment include the products certified by USEPA Energy Star or equivalent labelling schemes.

Where at least 70% of total power of appliances and equipment are certified efficient product, the credit shall be awarded.

Background and Notes

Energy Star is an international standard for energy efficient consumer products. It was first created as a United States government program in 1992, but Australia, Canada, Japan, New Zealand, Taiwan and the European Union have also adopted the program. Devices carrying the Energy Star logo, such as computer products and peripherals, kitchen appliances, buildings and other products, generally use 20–30% less energy than normal appliances. Energy Star is the largest rating scheme for consumer products that is well acknowledged worldwide. Energy Star specifications differ with each item. The highlighted products and specification information available on the Energy Star's website: http://www.energystar.gov

Other equivalent standards for energy efficient appliances include:

- EU Energy Label (Grade A or higher): http://ec.europa.eu/energy
- Hong Kong Electrical and Mechanical Services Department. Voluntary Energy Efficiency Labelling Scheme (Grade 1 or 2): http://www.emsd.gov.hk/emsd/eng/pee/eels_pub.shtml

RC15. METERING AND MONITORING

Aim	To enable building operators to measure, monitor and develop measures to improve the performance of the building's engineering systems, particularly energy-consuming systems.
Credits available	2
Issue summary	a) 1 credit for providing *separate accessible energy sub-meters* for different energy-consuming systems. b) 1 credit for providing accessible sub-meters covering the energy supply to all tenanted, or in the case of single occupancy buildings, relevant function areas or departments within the building/unit.
Exclusion	None.

Assessment

a) Sub-metering of substantial energy uses

The project team must demonstrate that *separate accessible energy sub-meters*,[1] labelled with the end energy consuming use, are provided for the following systems (where present):

- Space Heating;
- Domestic Hot Water;[2]
- Humidification;
- Cooling;
- Fans (major);
- Lighting;
- Small Power (lighting and small power can be on the same sub-meter where supplies are taken at each floor/department);[3]
- Other major energy-consuming items where appropriate.[4]

Evidence could include specification document or technical drawings confirming:

- Energy-consuming systems and their rated outputs;
- Metering arrangements for each system, type and location of meter specified;
- If applicable, scope of BMS[5] and its energy-monitoring capability.

b) Sub-metering of high energy load and tenancy areas

The project team must demonstrate that accessible sub-meters covering the *energy supply* to all tenanted, or in the case of single occupancy buildings, *relevant function areas or departments* within the building/unit are provided. The meters must be labelled with the end energy consuming use.[6]

Evidence could include:

- Marked-up drawings and site plan detailing:
  - Building areas by department/function and/or tenancy;
  - Location of meters.
- Specification document or technical drawings confirming:
  - Metering arrangements for each department/function and/or tenancy area;
  - Type of meter specified.

Background and Notes

Common areas: developments that have several tenant units, particularly large retail developments, office buildings, etc., may also share common facilities and access that is not owned or controlled by any one individual tenant, but used by all. Common areas are typically managed and maintained by the development's owner, i.e. landlord or their managing agent. Examples of common areas include an atrium, external areas e.g. parking, stairwells and main entrance foyers/reception.

Size of plant for which separate metering would be required:

Plant item	Rated input power (kW)
Boiler installation comprising one or more boilers or CHP plant feeding a common distribution circuit.	50
Chiller installations comprising one or more chiller units feeding a common distribution circuit.	20
Electric humidifiers.	10
Motor control centres providing power to fans and pumps.	10
Final electrical distribution boards.	50

[1] **Accessible meters**: the energy meters must be located in an area of the building that allows for easy access to facilitate regular monitoring and readings by the buildings staff and facilities manager. Typically this will be the plant room, main distribution room or control room (where BMS is installed).

[2] **Modular boiler systems:** where the building uses a modular system and the rated input power of the lead boiler is < 50 kW *(see 'Size of plant for which separate metering would be required' above)*, but > 10 kW, sub-metering of the lead boiler is still required.

[3] **Lighting and small power:** due to traditional distribution methods, it can be difficult to cost-effectively separate lighting and small power. It is acceptable, within a single floor, for lighting and small power to be combined for metering purposes, provided that sub-metering is provided for each floor plate.

[4] **Other major energy consuming items:** other major energy-consuming items, depending on the building type, might include, for example, plant used for swimming or hydrotherapy pools, kitchen plant, cold storage plant, laboratory plant, sterile services equipment, transportation systems (e.g. lifts & escalators) drama studios and theatres with large lighting rigs *(see 'Size of plant for which separate metering would be required' above).*

[5] **BMS**: Building (energy) Management System – *see Issue PM10.*

[6] A tall-building is often occupied by different groups of tenants (i.e. different companies, function areas, departments, households, etc.). This credit concerns with the provision of sub-meters for *different groups of tenants* within the building. It defers from credit a), which deals with the provision of sub-meters for *different energy-consuming systems*.

- **Small Units:** for developments consisting of small units a single meter per unit is sufficient to achieve this credit. Individual areas within each unit do not need to be sub-metered. For the purpose of this Issue, a small unit is defined as ≤ 200 m^2 (~ 2150 ft^2). Please note that other Issues may define 'small' using a different size band.
- **Large units:** for developments consisting of larger units (i.e. > 200 m^2), sufficient sub metering to allow for monitoring of the relevant function areas/departments within the unit must be specified, in addition to metering of the unit as a whole.
- **Residential buildings**: a sub-meter for each floor is required.

E2. MATERIAL ASPECTS (MA)

E2.1. SELECTION OF MATERIALS

MA-P1. TIMBER USED FOR TEMPORARY WORKS

Aim	To encourage the well-managed use of timber.
Credits available	Required.
Issue summary	Demonstrate that virgin forest products are not used for temporary works during construction.
Exclusion	None.

Assessment

This Issue is the prerequisite for all Issues under Section 'E2.1. Selection of Materials' (Issues MA1 to MA5). It must be fulfilled in order to score under Issues MA1 to MA5.

The project team must provide a report prepared by a suitably qualified person demonstrating that no virgin forest products were used for temporary works, unless exceptional circumstances required such use. The report should highlight how contract documents and specifications precluded such use in form work, hoardings, walkways, etc., together with evidence such as site photos and records to demonstrate that no *new timber or timber products* were used. *Wood products from well-managed or sustainable sources (certified wood) are acceptable for this credit requirement.*

The project team must assign a person who is responsible for monitoring and reporting on construction activities, and must confirm that the works were conducted in accordance with the specifications and contract documents, and that all details regarding the use of timber contained in the report are correct. Site inspections during construction may be required.

In case certified wood is used, the timber should conform to the requirement of sustainable forestry practice guidelines and accredited by recognised organisations, such as the non-profit Forest Stewardship Council (FSC)[1] or equivalent certification standards. The project team must also demonstrate the compliance with the specification for the recommended sustainable source.

Where it can be demonstrated that all practical steps have been taken to avoid the use of virgin forest products, the credit shall be awarded.

Background and Notes

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

The construction sector is a major consumer of hardwoods from tropical rainforests, with a large proportion used wastefully, and ending up at landfill sites. Timber should originate only from well-managed sources and should be reused whenever possible. Guidelines, templates and implementation measures to help organisations develop purchasing policies and practices that help conserve forest resources are available.[2, 3]

Certified Wood may be defined as wood-based materials originally sourced from forestlands participating in an acceptable system or program that certifies sustainable forest management. Acceptable systems or programs must include adherence to management practices which

conserve biological diversity and maintain productive capacity of forest ecosystems, and be independently audited and monitored. Today there are more than 50 certification programs worldwide. Globally, the two largest umbrella certification programs are the **Forest Stewardship Council (FSC)** and the **Program for the Endorsement of Forest Certification schemes programs (PEFC)**. While the original intent of forest certification was to stop tropical deforestation, it has had the most uptakes in developed nations such as North America. Other equivalent certification standards are:

- American Tree Farm System (ATFS);[4]
- Canadian Standards Association (CSA) Program;[5]
- Sustainable Forestry Initiative (SFI) Program;[6]
- American Forest and Paper Association (AFPA).[7]

For the purposes of TPSI, the FSC program is recommended.

[1] **Forest Stewardship Council (FSC)** is an independent, non-profit organisation established to promote the responsible management of the world's forest. FSC is a certification system that provides internationally recognised standard-setting, trademark assurance and accreditation services to companies, organisations, and communities interested in responsible forestry. (http://www.fsc.org/)

[2] **Certified Forest Products Council**. Project Toolkit. Succeeding with Certified Wood. (http://www.certifiedwood.org/documents/Certified_Wood_Project_Kit_C.PDF)

[3] **World Wildlife Fund**. (http://www.ecowoodasia.org/en/pdf/GFTN%20RPG%20Feb04.pdf)

[4] **American Tree Farm System (ATFS):** http://www.treefarmsystem.org/

[5] **Canadian Standards Association (CSA) Program:** http://www.csa.ca/

[6] **Sustainable Forestry Initiative (SFI) Program:**
http://www.sfiprogram.org/sustainable_forestry_initiative_standard.php

[7] **American Forest and Paper Association (AFPA)**: http://www.afandpa.org/

MA1. MATERIAL SPECIFICATION

Aim	To recognise and encourage the use of construction materials with a low environmental impact over the full life cycle of the building.
Credits available	8
Issue summary	Maximum 8 credits for using materials with low environmental impacts for building elements.
Exclusion	Credit 7 is scoped out for projects without hard landscaping and boundary protection.

Assessment

The *Green Guide rating* for the specifications for the following eight building elements must be determined (Green Guide ratings for the specification(s) of each element can be found at www.thegreenguide.org.uk):

- External Walls;
- Internal Walls;
- Floor Finishes;
- Upper Floor Construction;
- Windows;
- Roof;
- Hard Landscaping and Boundary Protection;
- Insulation.

The assessment does not cover building services system at the calculation.

Maximum 8 credits will be awarded for eight elements based on their Green Guide rating (1 credit for each element). Detail is as follow:

Elements		**Criteria**
1	External Walls	- At least 80% of all external walls (by area) achieve an A or A+ rating. - No percentage of external walls achieves an E rating.
2	Internal Walls	- At least 80% of all internal walls (by area) achieve an A or A+ rating. - No percentage of internal walls achieves an E rating.
3	Floor Finishes	- At least 80% of all floor finishes (by area) achieves an A or A+ rating. - No percentage of floor finishes achieves an E rating.
4	Upper Floor Construction	- At least 80% of all upper floor slabs (by area) achieve an A or A+ rating. - Less the 10% of all upper floor slabs (by area) achieve a D rating or lower. - No percentage of upper floor slabs achieves an E rating.
5	Windows	- At least 80% of all windows (by area) achieve an A or A+ rating.
6	Roof	- At least 60% of all windows (by area) achieve an A or A+ rating. - Less than 10% of all windows (by area) achieve a D or E rating.
7	Hard Landscaping and Boundary Protection[1]	- At least 80% of all external hard landscaping and boundary protection (by area) achieve an A or A+ rating. - No percentage of external hard landscaping and boundary protection achieve an E rating.
8	Insulation	- At least 80% of all insulation used (by volume) achieves an A or A+ rating. - No percentage of insulation achieves a D or E rating.

Evidence could include:

- Specification confirming detailed description of each applicable element and its constituent materials.
- Design drawings or specification detailing location and area (m^2) of each applicable element.
- Output from the Green Guide rating and element number for each specification assessed. Element numbers may change from time to time due to updates in the green guide data.

Background and Notes

Green Guide rating

The Green Guide to Specification is an easy-to-use comprehensive reference website and electronic tool, providing guidance for architects, designers and their clients on the relative environmental impacts for a range of different building elemental specifications. The ratings within the Guide are based on Life Cycle Assessment, using the Environmental Profile Methodology.

Using the Green Guide to Specification

The Green Guide categorises ratings by building type and element. When using the Green Guide online, (www.thegreenguide.org.uk), the main page asks the users to select a building type. To obtain the appropriate ratings for the assessed building elements, select the corresponding building type. The following elements, for the purpose of non-domestic buildings, have common Green Guide ratings irrespective of the building type:

- External walls;
- Landscaping;
- Windows – commercial.

The users can therefore search for ratings for the above elements under any building category.

Whilst exact matches in specifications are not always found, it should be possible to identify a similar specification and use its rating for the purposes of assessment. The Green Guide Online does not cover the potential health and comfort issues associated with flooring materials and indoor air quality, which is covered in different issues throughout TPSI.

[1] **No hard landscaping or boundary protection**: if one of the elements is not present, e.g. boundary protection, then the credit must be assessed on the basis of the specification of the single element e.g. hard landscaping. Where the development has neither element, the credit is scoped out.

- Where less than 20% of the total area of existing hard landscaping and boundary protection elements are subject to minor alterations or maintenance, these elements are awarded an A+ rating for the purposes of this analysis.
- Any part of an external building façade (of either the assessed building or any other neighbouring building) that forms a part of the site boundary should be excluded from the assessment.
- Any existing or specified natural boundary protection (such as hedging or other living barrier) should be awarded with an A+ rating.
- Hard landscaping includes parking areas, but excludes access/approach roads and designated vehicle manoeuvring areas.

MA2. CERTIFIED WOOD

Aim	To encourage the use of timber from well-managed forest.
Credits available	1
Issue summary	1 credit for demonstrating that at least 50% of all timber and composite timber products used in the project are from sustainable source/recycled timber.
Exclusion	None.

Assessment

The project team must provide a report prepared by a suitably qualified person qualifying the amount of forest product used that are from sustainable source/recycled timber, as a percentage of all timber product used. The unit can be mass/volume/money (Pound Sterling, Dollar, etc.) value but must be consistent throughout the assessment of this credit.

The timber should conform to the requirement of sustainable forestry practice guidelines and accredited by recognised organisations, e.g. the non-profit Forest Stewardship Council (FSC) or equivalent certification standards. The project team must also demonstrate the compliance with the specification for the recommended sustainable source.

It must be demonstrated that at least 50% of wood-based materials and products used for building components are certified in accordance with the chosen scheme. These components must include, at a minimum, structural framing and general dimensional framing, flooring, sub-flooring, wood doors and finishes.

Background and Notes

This Issue is a follow-up step from what already achieved in Issue MA-P1. It only concerns with materials that permanently installed in the project. Wood products purchased for temporary use on the project (e.g. formwork, bracing, scaffolding, sidewalk protection, guard rails, etc.) are assessed under Issue MA-P1.

For all related information see Issue MA-P1.

MA3. RAPIDLY RENEWABLE MATERIALS

Aim	To encourage the wider use of rapidly renewable materials in appropriate applications.
Credits available	2
Issue summary	Maximum 2 credits for using rapidly renewable materials.
Exclusion	None.

Assessment

The project team must submit a report prepared by a suitably qualified person quantifying the value of rapidly renewable materials, as percentage of the total value of the materials used in the project. The unit can be mass/volume/money (Pound Sterling, Dollar, etc.) value but must be consistent throughout the assessment of this Issue. If only a fraction of a product or material is rapidly renewable material, then only that percentage can contribute to the rapidly renewable content value. The report should include supporting documentation from the suppliers listing the rapidly renewable materials and quantities contained in the products used. Include only materials permanently installed in the project.

For the purposes of this Issue, reference must be made to the list given in *Table 7: Rapidly Renewable Materials (Appendix 5: Tables)*. The assessment must include only materials permanently installed in the project. Mechanical, electrical and plumbing components and specialty items such as elevators cannot be included in this calculation.

The minimum percentage rapidly renewable material for each credit threshold is as follow:

Recycled content	Credits
2.5%	1
5%	2

Background and Notes

Most tall-building materials necessitate the consumption of large amounts of natural resources. Rapidly renewable materials are materials that substantially replenish themselves faster than traditional extraction demand (i.e., planted and harvested in less than a 10-year cycle) and do not result in significant biodiversity loss, increased erosion, or air quality impacts. Rapidly renewable materials include, but are not limited to, bamboo, linoleum, cork, fast-growing poplar, pine and products such as wheat straw cabinetry. Materials such a bamboo, wool, natural linoleum, etc. require fewer inputs, have reduced environmental impacts, and can provide economic benefits.

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

MA4. RECYCLED CONTENT

Aim	To increase demand for building products that incorporate recycled content materials, thereby reducing impacts resulting from extraction and processing of virgin materials.
Credits available	2
Issue summary	Maximum 2 credits for using material with recycled contents.[1]
Exclusion	None.

Assessment

The project team must submit a report prepared by a suitably qualified person quantifying the value of materials with recycled contents, as percentage of the total value of the materials used in the project. The unit can be mass/volume/money (Pound Sterling, Dollar, etc.) value but must be consistent throughout the assessment of this Issue. If only a fraction of a product or material is recycled, then only that percentage can contribute to the recycled content value. The report should include supporting documentation from the suppliers listing the name of the manufacturer and the recycled contents in the products. Mechanical, electrical and plumbing components and specialty items such as elevators cannot be included in this calculation. Include only materials permanently installed in the project.

The minimum percentage materials recycled for each credit threshold is as follow:

Recycled content	Credits
10%	1
20%	2

Background and Notes

Waste materials and industrial by-products can be used in building construction in an unprocessed form, e.g. as fill material, or processed to a limited degree for use as aggregates in concrete, or used as raw material for manufacturing building products. This reduces the extraction of virgin materials. The basic properties required for technical acceptance are that they can perform their intended functions throughout the design life without being deleterious on the environment or associated constructional features.

Potential Technologies & Strategies

Establish a project goal for recycled content materials and identify material suppliers that can achieve this goal. During construction, ensure that the specified recycled content materials are installed. Consider a range of environmental, economic and performance attributes when selecting products and materials.

[1] **Recycled content** is defined in accordance with ISO 14021 - *Environmental labels and declarations - Self-declared environmental claims (Type II environmental labelling).* (http://www.iso.org).

MA5. REGIONAL MATERIALS

Aim	To increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the use in indigenous resources and reducing the environmental impacts resulting from transportation.
Credits available	2
Issue summary	Maximum 2 credits for using regionally manufactured materials.[1]
Exclusion	None.

Assessment

The project team must submit a report prepared by a suitably qualified person quantifying the value of materials manufactured locally, as percentage of the total value of the materials used. The unit can be mass/volume/money (Pound Sterling, Dollar, etc.) value but must be consistent throughout the assessment of this Issue. If only a fraction of a product or material is extracted, harvested, or recovered and manufactured locally, then only that percentage can contribute to the regional value. The report should include supporting documentation from the suppliers listing the name of the manufacturer and the distance between the project site and the manufacturer.

Mechanical and electrical systems components must not be included in the calculation. Plumbing products, however, may be included at the discretion of the project team. Reused and salvaged material such as furniture may also be included. The location from which they were salvaged may be used as the point of manufacture.

The minimum percentage of regional materials for each credit threshold is as follow:

Regional materials	Credits
10%	1
20%	2

Background and Notes

By using locally manufactured materials, environmental impacts and material costs are reduced, and the local economy is supported. Pollution associated with transportation, including air and noise, has become a serious obstruction to the quality of life, and even the health of citizen. Further, energy consumption by transportation, as well as the demand of petroleum, has dramatically increased. The use of locally manufactured materials reduces the transportation activities and the accompanying pollution associated. It can relieve air pollution generated by trucks, trains, and other vehicles that deplete non-renewable fossil fuels in the long transportation. By purchasing the locally manufactured materials, transportation problems are further reduced.

Due to the reduced transportation costs, the locally manufactured materials are more cost effective. Also, the support of local manufacturers and labour forces contributes to a more stable tax base and a healthier local economy.

[1] **'Regional materials'** is defined as materials manufactured locally within 800 km (~ 497 miles) from the site.

E2.2. EFFICIENT USE OF MATERIALS

MA6. BUILDING REUSE

Aim	To recognise and encourage the reuse of existing building facades and structures, especially in-situ reuse.
Credits available	2
Issue summary	a) 1 credit for reusing existing building facades. b) 1 credit for reusing existing structures.
Exclusion	Credit b) is scoped out for new projects with no existing building onsite or existing building with insufficient structural system to reuse.

Assessment

a) Reuse of Facades

The project team must demonstrate that:

1	At least 50% of the total final building façade (by area) is reused.
2	At least 80% of the reused façade (by mass) comprises in-situ reused material.[1]

Evidence could include:

- Drawings detailing the elevations of the existing and the new-build façades.
- Calculations demonstrating the percentage of façade comprising in-situ material. These calculations should be simply based on the volume of each material and its density, with totals compared for the new and retained parts of the structure.

b) Reuse of Structure [2]

The project team must demonstrate that:

1	At least 80% by volume of an existing primary structure[3] is reused without significant strengthening or alteration works.[4]
2	Where a project is part refurbishment and part new build, the reused structure comprises at least 50% by volume of the final building, i.e. any new-build extension to a building being refurbished should not be larger than the original building to qualify for this credit.

Evidence could include:

- Drawings or design team calculations detailing:
  - The sections of the existing structure to be reused.
  - Any parts of the structure to be demolished and the total new structure.
  - Where appropriate, calculations confirming any strengthening/alteration are not deemed 'significant' in terms of the assessment criteria for the mass of materials used.

Background and Notes

[1] Refurbishment projects are likely to achieve this credit without difficulty. New-build schemes with retained façades provide a means of achieving the credit. In practice, reusing façades will often require extensive renovation and/or reinforcement; hence the TPSI requirement for at least 80% by mass of the reused façade to be in situ reused material. Façades with new external cladding or internal lining therefore can gain this credit provided that this criterion is met. In case there is no previous building onsite or the mass of the existing building is not enough to make up the given figure, this item can be ignored.

Façade: any exposed building face, not just the front elevation. The definition excludes party walls.

Curtain walling & windows: where existing windows are being replaced they may be excluded from the calculation of façade area; however, curtain walling counts as façade.

[2] Refurbishment projects are likely to be the only buildings to achieve this credit. In case of new projects with no existing building onsite or existing building with insufficient structural system to reuse, this credit is scoped out.

[3] **Primary structure**: defined as structural floors, columns, beams, load bearing walls and foundations i.e. where required for structural use by the new building.

[4] **Significant strengthening or alteration**: defined as where the mass of new material is equal to or greater than 50% of the total mass of the reused structure.

MA7. MODULAR AND STANDARDISED DESIGN

Aim	To encourage increased use of modular and standardised components in building design in order to enhance construction process and reduce waste.
Credits available	1
Issue summary	1 credit for the application of modular and standardised design.
Exclusion	None.

Assessment

The project team must submit a report including detailed drawings and specifications that demonstrates and highlights the extent of application of modular design of building systems and components. Where it can be demonstrated that the building development incorporates modular and standardised layouts and components for over 50% of the major elements and modules, the credit shall be awarded.

For the purposes of assessment, the extent of modular and standardised design should make reference to the 'Modular and Standardised Design Elements List' *(see Background and Notes)*.

Background and Notes

Modular and Standardised Design Elements List

Structural elements - Structural beams system; - Concrete slab; - Concrete flooring.	**Architectural/Internal building elements** - Internal partition/wall panels; - Door sets; - Staircases.
Façade elements - External wall; - Bay-window unit; - Cladding unit; - Utility platform.	**Building services elements** - Fire services; - Sanitary fittings; - Luminaires; - Air-Conditioning components.

This Issue concerns with the use of standardised grid systems of design allowing standard size factory built and assembled components to be used. Standardisation of details goes hand in hand with optimisation of material quantity. It also generally has benefits for both quality and environmental cost. It simplifies the design and site operations. Building components produced in standard ranges of sizes can also be interchanged. Materials should be dimensioned carefully to use standard-sized modules to the greatest extent to minimise construction off-cutting waste.

International standards[1] recommend that modular components shall be designed to have size of a multiple or subdivision of the basic module of 100 mm (~3.9 inches). BS 6750[2] provides background on the requirements for modular coordination.

[1] ISO 1006:1983. *Building construction - Modular coordination - Basic module*. AND ISO 2848:1984. *Building Construction – Modular coordination – Principles and rules.* (http://www.iso.org).

[2] BS 6750:1986. *Specification for Modular coordination in building.* (http://www.bsigroup.com/).

MA8. PREFABRICATION

Aim	To encourage prefabrication building elements in order to reduce wastage of materials and quantities of on-site waste.
Credits available	1
Issue summary	1 credit where the manufacture of at least 40% of applicable building elements has been off-site.[1]
Exclusion	None.

Assessment

The applicable building elements (pre-cast concrete) include:

- Facades;
- Staircases;
- Slabs;
- Balcony/utility platform;
- Parapet;
- Partition walls;
- Bridge-decks; and
- Footbridges.

Additional or alternative elements may be included, which the project team believes to demonstrate a significant contribution to the assessment criteria. However, the curtain wall/windows shall be excluded from the assessment.

Evidence can be contract specifications, drawings and other supporting documents quantifying (by weight or volume) building elements fabricated off-site. Where it can be demonstrated that at least 40% of listed building elements are prefabricated off-site, the credit shall be awarded.

Background and Notes

Prefabrication is the manufacture of sections of a building at the factory so they can be easily and rapidly assembled at the building site, improving the constructability of the building. Since the factory fabrication of building elements is produced under controlled conditions, it allows for more efficient disposal of debris and waste. Noise, dust, site traffic and other environmental nuisances can also be reduced. Interior millwork and custom metalwork can be detailed to be shop-finished and installed to the highest degree to limit the need for on-site painting and finishing work.

The construction industry, especially tall-buildings construction, is under continual stringent pressure to raise productivity, reduce costs and improve the quality levels of constructed facilities. All these requirements are the key drivers for change in the industry. With all the advantages, a wider use of prefabrication would help overcome many of the hurdles inherent in traditional in-situ construction, and engender more technically feasible and cost-effective installations. It allows better workmanship and quality control and maximising construction efficiency.

[1] In order to avoid long-distant transportation, the manufacturing factory must be located within 800 km (~ 497 miles) from the site.

MA9. EFFICIENT STRUCTURAL DESIGN

Aim	To encourage the efforts taken to minimise the materials (i.e. steel) used in the building's structure.
Credits available	1
Issue summary	1 credit if the amount of steel used in the building structure is less than 28 psf (Pounds per Square Foot) or 136.7 kg/m^2.
Exclusion	Buildings less than 40 stories.

Assessment

The project team must provide evidence in form of calculations, design details and plans, specifications, and other materials to demonstrate that efforts have been taken to reduce the amount of structural materials through efficient design and other techniques or strategies.

Where it can be proved that the amount of steel used in the building structure is less than 28 psf[1] (Pounds per Square Foot) or 136.7 kg/m^2, the credit shall be awarded.

Background and Notes

Tall-building projects use a great amount of material especially structural steel, which is one of the main factors causing environmental impacts. The evolution of the structural systems for tall-buildings has always been toward enhanced efficiency as well as economy. This Issue aims to promote material savings by designing more efficient structural system with less material. Potential strategies include: utilisation computer-aided software to increase the efficiency of the design; adopting highly-efficient structure types and techniques such as using diagonal members, tubular structure, braced-tube structure, diagrid structure, etc.; using high-strength materials; etc.

[1] The threshold 28 psf is established based on various sources and case studies, including:

- K. S. Moon. (2008). *Material-saving design strategies for tall-building structures*. CTBUH 8th Word Congress.
- Hearts Headquarters, New York (case study).
- John Hancock Centre, Chicago (case study).
- Sears Tower, Chicago (case study).

MA10. DESIGN FOR ROBUSTNESS

Aim	To recognise and encourage adequate protection of exposed parts of the building and landscape, therefore minimising the frequency of use of replacement materials.
Credits available	1
Issue summary	1 credit for applying specific efforts to provide adequate protection of vulnerable parts of the building and landscape.
Exclusion	None.

Assessment

The project team must demonstrate that:

1	Internal and external areas of the building where vehicular, trolley and pedestrian movement occur have been identified.
2	Suitable durability and protection measures or design features have been specified to prevent damage to the vulnerable parts of these building areas from such traffic. This must include, but is not necessarily limited to: - Protection from the effects of high pedestrian traffic in main entrances, public areas and thoroughfares (corridors, lifts, stairs, doors, etc.). - Protection against any internal vehicular/trolley movement within 1 m (~ 3.3 ft) of the internal building fabric in storage, delivery, corridor and kitchen areas. - Protection against, or prevention from, any potential vehicular collision where vehicular parking and manoeuvring occurs within 1 m (~ 3.3 ft) of the external building façade for all car parking areas and within 2 m (~ 6.5 ft) for all delivery areas.

Evidence could be design drawings and specification illustrating vulnerable areas/parts of the building and the durability measures specific.

Background and Notes

Suitable durability and protection measures to vulnerable parts of the building can include:

- Bollards/barriers/raised kerbs to delivery and vehicle drop-off areas.
- Robust external wall construction, up to 2 m (~ 6.5 ft) high.
- Corridor walls specified to Severe Duty (SD) as in BS 5234-2:1992 *Title Identifier Partitions (including matching linings). Specification for performance requirements for strength and robustness including methods of test*. (http://www.bsigroup.com/)
- Protection rails to walls of corridors.
- Kick plates/impact protection (from trolleys etc.) on doors.
- Hard-wearing and easily washable floor finishes in heavily used circulation areas (i.e. main entrance, corridors, public areas etc.).

Vehicle Impact Protection: any vehicle impact protection measures specified must be positioned at an adequate distance from the building to protect the fabric from impact from any vehicle with a measurable overhang of the body from the wheel track, in particular for any goods delivery areas. In vehicle movement areas only, additional protection (beside external robust wall construction) must be provided, i.e. specifying bollards or protection rails.

Public/Common Areas: consideration should be given to materials specification in public/common areas (especially public waiting areas and toilet areas) to provide protection against potential malicious or physical abuse in as far as it is possible.

E3. ENVIRONMENTAL LOADINGS (EL)

E3.1. WASTE

EL1. CONSTRUCTION/DEMOLITION WASTE MANAGEMENT

Aim	To divert construction and demolition debris from disposal in landfills and incineration facilities; redirect recyclable recovered resources back to the manufacturing process and reusable materials to appropriate sites.
Credits available	2
Issue summary	Maximum 2 credits for the implementation of a Construction/Demolition Waste Management Plan that provides for the sorting, recycling and proper disposal of construction and demolition materials.
Exclusion	None.

Assessment

The project team must demonstrate efforts to recycle and/or salvage non-hazardous construction and demolition debris. Evidence could be reports summarising the development and implementation of a Construction/Demolition Waste Management Plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or comingled.

Excavated soil and land-clearing debris do not contribute to these credits. Calculations can be done by weight or volume, but must be consistent throughout. The minimum percentage debris to be recycled or salvaged for each point threshold is as follows:[1]

Recycled or Salvaged	Credits
50%	1
75%	2

Background and Notes

The percentage debris to be recycled or salvaged must be calculated for BOTH Construction and Demolition stage. The credit(s) can only be achieved if the given minimum percentage is met for both stages. In case the demolition process is out of the project team's responsibilities, Demolition Waste Management can be ignored.

Potential Technologies & Strategies

Establish goals for diversion from disposal in landfills and incineration facilities and adopt a construction waste management plan to achieve these goals. Consider recycling cardboard, metal, brick, mineral fibre panel, concrete, plastic, clean wood, glass, gypsum wallboard, carpet and insulation. Construction debris processed into a recycled content commodity that has an open market value, e.g., wood derived fuel (WDF), alternative daily cover material, etc., may be applied to the construction waste calculation. Designate a specific area(s) on the construction site for segregated or comingled collection of recyclable materials, and track recycling efforts throughout the construction process. Identify construction haulers and recyclers to handle the designated materials. Note that diversion may include donation of materials to charitable organisations and salvage of materials on-site.

EL2. RECYCLED AND SECONDARY AGGREGATES

Aim	To recognise and encourage the use of recycled and secondary aggregates in construction, therefore reducing the demand for virgin materials.
Credits available	1
Issue summary	1 credit for utilising recycled and/or secondary aggregates.[1]
Exclusion	None.

Assessment

It must be demonstrated (by a report prepared by a suitably qualified person) that: where the amount of recycled and secondary aggregate specified is over 25% (by weight or volume) of the total high-grade aggregate uses for the building, such aggregates can be EITHER:

- Obtained on site. OR
- Obtained from waste processing site(s) within a 30 km (~ 18.6 miles) radius of the site; the source will be principally from construction, demolition and excavation waste (CD&E) - includes road planning activities. OR
- Secondary aggregates obtained from a non-construction post-consumer or post-industrial by-product source.

Background and Notes

High Grade aggregate uses are considered to be:

Bound	**Unbound**
- Structural frame; - Floor slabs including ground floor slabs; - Bitumen or hydraulically bound base, binder, and surface courses for paved areas and roads.	- Asphalt-based or similar road surfaces; - Granular fill and capping; - Pipe bedding; - Sub bases/building foundations; - Gravel landscaping.
Crushed masonry used as fill material for general landscaping is not considered to be high grade.	

Secondary aggregates: recognised non-construction post-consumer or post-industrial by-products:

- China clay waste; - Slate over-burden; - Pulverised Fuel Ash (PFA); - Ground Granulated Blast Furnace Slag (GGBFS); - Air-cooled blast furnace slag;	- Steel slag; - Furnace bottom ash (FBA); - Incinerator bottom ash; - Foundry sands; - Recycled glass; - Recycled plastic;	- Tires; - Spent oil shale; - Colliery spoil; - Municipal Solid Waste Treatment Residues.

Pre-consumer waste stream: waste material generated during manufacturing processes. Excluded is reutilisation of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it.

Post-consumer waste stream: waste material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose. This includes returns of material from the distribution chain.

[1] **Recycled aggregates** are those derived from reprocessing materials previously used in construction, e.g. crushed concrete or masonry from construction and demolition waste material. Meanwhile, By-products of industrial processes can be processed to produce **secondary aggregates**. Secondary aggregates are sub-divided into manufactured and natural, depending on their source.

EL3. WASTE RECYCLE FACILITIES

Aim	To recognise the provision of dedicated storage facilities for a building's operational-related recyclable waste streams, so that such waste is diverted from landfill or incineration.
Credits available	1
Issue summary	1 credit for providing adequate facilities for the collection, sorting, storage and disposal of waste and recovered materials.
Exclusion	None.

Assessment

The project team must demonstrate that:

1	A dedicated storage space is provided to cater for recyclable materials generated by the building during occupation, compliant with the following: - Clearly labelled for recycling; - Placed within accessible reach of the building;[1] - In a location with good vehicular access to facilitate collections.
2	The size of the space allocated is adequate to store the likely volume of recyclable materials generated by the building's occupants/operation. Whilst a fixed area cannot always be given, the following must be complied with at a minimum: - At least 2 m^2 per 1000 m^2 (~ 21.5 ft^2 per 10764 ft^2) of net floor area for buildings < 5000 m^2 (~ 53820 ft^2); - A minimum of 10 m^2 (~ 108 ft^2) for buildings ≥ 5000 m^2; - An additional 2 m^2 per 1000 m^2 of net floor area where catering is provided (with an additional minimum of 10 m^2 for buildings ≥ 5000 m^2).

Evidence could be marked-up building/site plan and/or copy of the specification confirming:

- The location of the dedicated recyclable storage area;
- Storage area for general waste;
- The area (m^2) of the storage space(s);
- Description of the labelling.

Background and Notes

[1] **Accessible reach of the building:** typically 'accessible reach' is defined as within 20 m (~ 66 ft) of a building entrance. In some circumstances, depending on the size of the building, site restrictions or tenancy arrangements, it may not be possible to meet a 20 m requirement. In such cases it would be the assessor's judgement call to determine if the facility is in an easily accessible location for building occupants and vehicle collection.

Individual recycling bins located at convenient locations throughout the building are necessary to maximise recycling rates. On their own, however, these are not sufficient to obtain this credit.

Internal storage areas: where the facilities are situated internally, vehicular gate heights/widths and manoeuvring and loading space must be sized correctly to ensure ease of access for vehicles collecting recyclable materials.

General waste: the area for recyclable materials storage must be provided in addition to areas and facilities provided for dealing with general waste and other waste management facilities, e.g. compactors and balers.

The following footprint dimensions can act as a guide when determining size and accessibility criteria for the recyclable storage space:

- **Compactor dimensions**: about the size of one car parking bay: 4.8 x 2.4 m (~ 15.7 x 7.9 ft).
- **Skip**: The footprint of an 8 and 12 cubic yard skip measures 3.4 x 1.8 m (~ 11 x 6 ft), therefore allow a minimum of 2 x 4 m = 8 m^2 area (or 6.5 x 13 ft = 86 ft^2) for the storage and access of such containers.
- **Wheeled bins**: 360 litters = 0.86 x 0.62 m / 660L = 1.2 x 0.7 m / 1100L = 1.28m x 0.98m.
- **Roll-on-roll-off containers**: allow a minimum of 6.1 x 2.4 m (~ 20 x 7.9 ft).
- **Vehicle access**: The following are dimensions for lorry types that are typically used to collect waste. Therefore gate height/widths should not be smaller than these measurements:
    - **Dustcart:** medium capacity; length = 7.4 m; height = 4 m; width = 3.1 m (~ 24 x 13 x 10 ft).
    - **Skip lorry:** length = 7 m; height = 3.35 m; width = 3.1 m (~ 23 x 11 x 10 ft).

Consideration must also be given to any other types of vehicle requiring access to this area, e.g. lorries for roll on/off containers.

Reference include:
Metric handbook – Planning and design data. Adler. Architectural Press, 2nd Ed. 1999.

EL4. COMPACTOR / BALER

Aim	To recognise and encourage the provision of facilities which enable efficient and hygienic waste sorting and storage.
Credits available	1
Issue summary	1 credit for providing a compactor/baler[1] for the building.
Exclusion	Buildings which are not qualified for Issue EL3.[2]

Assessment

The project team must demonstrate that:

1	1 credit under Issue EL3 has been achieved.
2	A static waste compactor or baler is installed and situated in a service area or dedicated waste management space.
3	At least one water outlet is provided for each waste sorting and/or storing facility.

Evidence, in addition to what already presented in Issue EL3, could be:

- Marked-up design plan and/or a copy of the specification confirming:
  - Provision of waste compactor/baler;
  - Location and size of space for waste compactor/baler;
  - Water outlet.
- Manufacturer/supplier literature confirming the type of compactor/baler specified.

Background and Notes

Tall-buildings are large projects that produce a great amount of waste during operation. Compacting dry waste can significantly reduce the volume of waste sent to landfill. Furthermore, whether for recycling or landfill, compacting waste at source will reduce the number of trips required for the collection and delivery of the waste and therefore result in reduced fuel consumption and vehicle emissions. Reduced vehicle movements will also provide social and health & wellbeing benefits to the surrounding community and economic benefits to the building occupier.

[1] **Waste compactor or baler**: a machine that is designed to compress waste streams in order to improve storage and transport efficiency.

[2] This Issue is applicable only where the assessed development has a dedicated waste management area/facility. Therefore the requirement to achieve the credit under Issue EL3 for storage of recyclable materials is set in order to encourage the minimisation of the assessed development's waste streams by encouraging a more integrated approach to the concern of waste management, recycling and disposal *(it is scoped out otherwise)*. The provision of adequate recycling and waste management facilities helps to ensure that this objective can be achieved.

Shared Facilities: for office buildings consisting of a number of small units or residential buildings, shared facilities that meet the above criteria for the building as a whole are sufficient to achieve this credit.

Limited space or vehicle access: for developments that have limited space for static installations, the credit can be assessed on the basis of the provision of adequate space for a smaller portable compactor or baler.

EL5. COMPOSTING

Aim	To encourage the provision of facilities that help facilitate the reduction in volume of compostable organic waste going directly to landfill during the building's operation.
Credits available	1
Issue summary	1 credit for providing facilities that help reducing the volume of compostable organic waste during the building's operation.
Exclusion	None.

Assessment

The project team must demonstrate that:

1	Individual dwellings/communal kitchens are provided with home composting facilities with a home composting information leaflet that is provided in each individual dwelling/communal kitchen.[1] *(Only for Residential buildings and Residential units within a mixed-use building).*
2	A vessel is installed on site for composting suitable food waste resulting from the building's daily operation and use.
3	There is adequate space for storing segregated food waste and composted organic material.
4	At least one water outlet is provided for cleaning in and around the facility. OR Where there are space or access limitations on site, the following requirements are met: - There is a dedicated segregated space for storing compostable food waste prior to collection and delivery to an alternative composting facility. - At least one water outlet is provided for cleaning in and around the facility.

Evidence could be marked-up design plan and/or a copy of the specification confirming:

- Specification of composting vessel;
- Location and size of space for vessel and storage of waste/compost;
- Water outlet.

Background and Notes

[1] **Home composting facilities** must consist of a dedicated space for a container within the home or within communal spaces for clusters of individual bedrooms, with an information leaflet provided to each dwelling/communal space. This item can be ignored for Non-residential buildings. **Home Composting Information leaflet** must provide information on:

- How composting works and why it is important.
- The materials that can be composted (e.g. raw vegetable peelings and fruit, shredded paper, teabags etc.).
- Details of the operation and management plan for the communal composting scheme.

Storage Capacity: no criteria are defined for the type of vessel or storage capacity required as this will be determined by the end user and predicted volumes of organic compostable waste. It should be satisfied that, within reason, the installation is adequate for the size of development, bearing in mind the likely quantity of organic waste that will be produced by the development.

E3.2. POLLUTION

EL6. LAND POLLUTION

Aim	To make sure the building, during its life cycle, causes no land pollution.
Credits available	1
Issue summary	1 credit if there are measures, including monitoring of any containment or contaminant, in place to prevent any land pollution during the life of the building.
Exclusion	None.

Assessment

Evidence could show the implementation of recommendations from any remediation strategy, including provision of appropriate monitoring facilities. Evidence could be drawings or photographs showing the installed features.

Background and Notes

This Issue is a follow-up issue from previous contamination of the site, which has been remediated using temporary measures *(see Issue RC1), as well as any possible contamination resulting from the new use of the site* or any other *potentially contaminating use adjacent to the site*. How likely this is, how severe any potential contamination would be, and what kind of preventative measures should have been taken, etc. should be assessed according to the nature of the project.

For example, in the design of new facilities such as fuel tanks, waste storage areas, chemical stores or processes that include chemical use, new infrastructure should be built to current standards to prevent future contamination of ground. Where the assessed site has been cleaned up, but the neighbouring site is potentially contaminated and there is a risk of migration onto the site resulting in recontamination, evidence should be available to demonstrate that measures have been taken to control the risk.

In case after the adoption of remediation measures in Issue RC1, it can be demonstrated that there is *no potential land contamination risk* on-site or near site, therefore no extra effort needed, the credit shall be awarded.

EL7. REFRIGERANT USE AND LEAKAGE

Aim	To reduce the contribution to climate change from refrigerants with a high global warming potential.
Credits available	3
Issue summary	a) 1 credit if there are no refrigerants specified for use in building services OR the refrigerants used have a Global Warming Potential (GWP) of less than 5. b) 1 credit for installing a refrigerant leak detection system. c) 1 additional credit for installing a refrigerant recovery system.
Exclusion	None.

Assessment

a) Refrigerant use[1]

The project team must demonstrate that no refrigerant is used in building services or the refrigerants used have a GWP of less than 5. Evidence could include:

- A copy of the specification clause confirming either:
  - Absence of refrigerant in the development; OR
  - Type(s) of refrigerant to be used.
- Manufacturer's information confirming GWP of each refrigerant.

b) Refrigerant leak detection[2]

The project team must demonstrate that:

1	Systems using refrigerants are contained in a moderately airtight enclosure (or a mechanically ventilated plant room), and a refrigerant leak detection system is installed covering high-risk parts of the plant. OR
2	An automatic permanent refrigerant leak detection system is specified, which is NOT based on the principle of detecting or measuring the concentration of refrigerant in air.

Evidence could be a copy of the specification clause confirming:

- Type of leak detection system(s);
- Scope of the system(s);
- Where relevant, containment strategy for such equipment.

c) Refrigerant recovery system [3]

The project team must demonstrate that:

1	Credit b) has already been achieved.
2	The automatic shutdown and pump down of refrigerant occurs on the detection of high concentrations of refrigerant in the plant room/enclosure. For the majority of cases only systems in mechanically ventilated/moderately airtight plant rooms (or enclosures) comply.
3	Automatic pump-down to either a separate storage tank or into the heat exchanger is acceptable but only where automatic isolation valves are fitted to contain the refrigerant once fully pumped down.
4	The alarm threshold that triggers automatic pump down is set to a maximum of 2000 ppm (0.2%), but lower levels can be set. *This credit cannot be awarded for manual systems.*

Evidence could be a copy of the specification clause confirming:

- Type, scope and operation of automatic refrigerant recovery equipment;
- Details of the plant room enclosure where the refrigeration plant is installed;
- Alarm threshold for triggering automatic pump down.

Background and Notes

[1] This credit can be awarded by default if:

- A **solid refrigerant** is used; OR
- The **total refrigerant charge** used in the building services is less than 5kg.

Where GWP data for the specified refrigerant is not available, the credit cannot be achieved.

Global Warming Potential (GWP) is defined as the potential for global warming that a chemical has relative to one unit of carbon dioxide, the primary greenhouse gas. Assessment should refer to *Table 8: Refrigerant GWP (Appendix 5: Tables).*

Ozone Depleting Potential (ODP): is the ratio of the relative amount of degradation to the ozone layer caused by a particular substance relative to the calculated depletion for the reference gas CFC 11 (ODP = 1.0). The ODP of the refrigerants is not assessed under this Issue and there is no link between GWP and ODP.

Refrigerant: there are three main make-ups of refrigerants:

- Hydrogenated Fluorocarbon Refrigerants (HFCs) are made up of hydrogen, fluorine, and carbon. Because they do not use a chlorine atom (which is used in most refrigerants) they are known to be one of the least damaging to our ozone layer.
- Hydrogenated Chlorofluorocarbon Refrigerants (HCFCs) are made up of hydrogen, chlorine, fluorine, and carbon. These refrigerants contain minimal amounts of chlorine; they are not as detrimental to the environment as some other refrigerants.
- Chlorofluorocarbon Refrigerants (CFCs) contain chlorine, fluorine and carbon. These refrigerants carry high amounts of chlorine so they are known for being the most hazardous to the ozone layer.

[2] This credit can be awarded by default if:

- The building has no refrigerants; OR
- A solid refrigerant is used; OR
- The total refrigerant charge used in the building services is less than 5 kg.

This credit is applied in instances where any type of refrigerant is present, i.e. even if the ozone depleting potential (ODP) of the refrigerant is zero and the Global Warming Potential (GWP) is less than 5.

Moderately airtight enclosure: this can be defined as an enclosure that does not produce a draught or significant fresh air ingress that would dilute any leaked refrigerant gas (dilution may prevent detection).

High-risk parts of refrigeration plant typically include the pipe work and compressor. Evaporator or condenser coils can be omitted from the coverage of the system.

Refrigerant Leak Detection: a permanently installed multi-point sensing system; this may be aspirated or have multiple sensor heads linked to a central alarm unit or BMS. Various sensor types are available including infrared, semi-conductor or electro-chemical. Refer to *Table 9: Refrigerant Leak Detection Systems/Devices (Appendix 5: Tables)* for further guidance.

[3] This credit, along with credit b), can be awarded by default if:

- The building has no refrigerants; OR
- A solid refrigerant is used; OR
- The total refrigerant charge used in the building services is less than 5kg. OR

This credit can also be awarded by default if CO_2 is used as a refrigerant.

Refrigerant Recovery: the process of removing refrigerant from a system and storing it in an airtight container.

Manual refrigerant recovery system: the provision of any manual system, including manual storage cylinders on site, does not comply with the criteria of this credit.

Refrigerant pump down: the specification of automatic refrigerant pump down can further limit potential losses and damage to the environment and have subsequent economic benefits to the building owner. Unwanted refrigerant and refrigerating system oil are classified as either controlled or hazardous waste. It is an offence to discharge them to the environment. There are procedures regarding their transport, storage, transfer of ownership, and ultimate disposal.

Multiple split systems: for installations of small multiple hermetic systems only, where the refrigerant charge in each unit is less than 5 kg but the total refrigerant charge in the building is greater than 5 kg, credits b) and c) can be awarded by default. This is on the basis that the risk of a large refrigerant leak is minimised and individual leaks from each system will be small i.e. < 5 kg.

EL8. NO_X EMISSIONS

Aim	To encourage the supply of heat from heating systems that minimises NO_X emissions, and therefore reduces pollution of the local environment.
Credits available	3
Issue summary	Maximum 3 credits for using a heating system that has a low dry NO_X emission level.
Exclusion	None.

Assessment

Credits are awarded based on the dry NO_X emission levels from the plant installed to meet the building's space heating demand. The emissions should be estimated under normal operating conditions (not standby). The NO_X level for each credit threshold is as follows:

NO_X emissions	Credits
≤ 100 mg/kWh (at 0% excess O_2)	1
≤ 70 mg/kWh (at 0% excess O_2)	2
≤ 40 mg/kWh (at 0% excess O_2)	3

Evidence could include:

- A copy of the specification clause confirming the type of heating system(s) installed.
- For each system specified: details, confirmation and other literature from the manufacturer(s) confirming the dry NO_X emissions rate in mg/kWh.
- If more than one system is providing heat, project team calculations confirming the average NO_X emission rate.

Background and Notes

NO_X emissions: are pollutant gases produced by the combustion of fossil fuels. NO_X reacts with heat and sunlight to produce ozone that can cause serious respiratory problems. It also reacts with water to produce acid rain that has a destructive effect on ecosystems.

Dry NO_X Levels: the NO_X emissions (mg/kWh) resulting from the combustion of a fuel at 0% excess oxygen levels.

NO_X data provided in different units: where data is provided in different units, or at a level of excess oxygen greater than zero; the manufacturer/supplier should be asked to convert this to comply with this Issue. Alternatively, the assessor may correct these using the correction factors provided in *Appendix 9: NO_X Emissions*.

Grid electricity: where some of the building's space heating is fuelled by electricity from the National Grid, however small the incidence is on the overall consumption, the credits will not be achievable as power stations emit NO_X at an average rate of approximately 1200 mg/kWh.

Electricity from a renewable source: where electricity used by the heating system is sourced from a zero emission renewable source such as PVs, wind, etc.; there are no resulting emissions. This source of heating can therefore be counted as having zero NO_X emissions.

Heat pumps: heat pumps powered by grid electricity indirectly produce emission rates higher than those recommended and are therefore typically unable to achieve any credit under this Issue. However, the energy saved by using certain types of heat pumps is covered under Issue RC-P1 and RC10; and the reduced emissions are recognised under Issue RC12.

District heating: district heating systems that incinerate waste usually have NO_X emission rates higher than those recommended and are therefore unable to achieve any credits under this Issue.

Heat recovery: heat recovery can be considered as having zero NO_X emissions.

Combined Heat & Power: refer to *Appendix 9: NO_X Emissions* for guidance on calculating NO_X emission levels from CHP.

Biomass: whilst Biomass systems are recognised as low carbon systems, they can produce a significant amount of NO_X and so may not achieve these credits; however, they can score highly in the Energy Use Section (E1.3). Biomass systems are also recognised as reducing the impact of fossil fuel depletion by employing a renewable combustion fuel source.

More than one heating system: refer to *Appendix 9: NO_X Emissions* for guidance on calculating NO_X emission levels where heat is provided by more than one system.

EL9. WATER POLLUTION

Aim	To minimise the potential pollution to natural watercourses.
Credits available	1
Issue summary	1 credit for applying specific measures to reduce the potential for silt, heavy metals, chemicals or oil pollution to natural watercourses from surface water run-off from buildings and hard surfaces during the building's life cycle.
Exclusion	None.

Assessment

The project team must demonstrate compliance with the following:

1	Specification of Sustainable Drainage Systems (SUDs) or source control systems such as permeable surfaces or infiltration trenches where run-off drains are in areas with a relatively low risk source of watercourse pollution.[1]
2	Specification of oil/petrol separators (or equivalent system) in surface water drainage systems, where there is a high risk of contamination or spillage of substances such as petrol and oil.[2]
3	All water pollution prevention systems have been designed and detailed in accordance with recommended standards or equivalent.[3]
4	A comprehensive and up-to-date drainage plan of the site will be made available for the building occupiers.[4]

Evidence could be:

For 1&2	- Marked-up proposed site plan highlighting low and high risk areas of the site. - Specification or design plan confirming type of pollution control systems specified.
3&4	- Drawings, specifications and other materials confirming: o All water pollution prevention systems designed in accordance with chosen recommended standards or equivalent. o Outlining indicative examples of compliance with the chosen standard. o A copy of the drainage plan will be produced and handed over to the occupier.

Background and Notes

Where it can be demonstrated that there are no external areas that present a pollution risk[1] AND there is no plant supported on the roof, then the credit can be awarded by default. This Issue is not intended to cover the treatment of rainwater run-off except if there is a significant risk of pollution.

[1] **Areas that are a source of pollution:** for the purpose of assessing this Issue an area that presents a risk of watercourse pollution includes vehicle manoeuvring areas, car parks, waste disposal facilities, delivery and storage facilities or plant areas.

Low risk areas: low risk areas can be defined as areas where the risk of contamination or spillage of substances such as petrol and oil is reduced. For the purpose of this Issue, roofs and small car parks may be considered as low risk areas.

[2] **Areas where oil separators are required:** the following site areas (where present) require oil separators in surface water drainage systems:

- Car parks larger than 800 m^2 (~ 8611 ft^2) or with 50 or more parking spaces;
- Smaller car parks discharging to a sensitive environment;
- Areas where goods vehicles are parked or manoeuvred;

- Roads and Vehicle maintenance areas;
- Industrial sites where oil is stored or used;
- Refuelling facilities.

SUDS and oil interception: in some instances, where the risk of contamination is infrequent and potential spills will be small, oil interceptors may not be required if appropriately designed SUDs are specified. *Refer to ([3]) for additional guidance. Refer to Issue EL10 for more information on SUDs.*

Types of Oil Separator:

- *Class 1 Separators*: these are designed to achieve a concentration of less than 5mg/l oil under standard test conditions. They should be used when the separator is required to remove very small oil droplets, such as those arising from car park run-off.
- *Class 2 Separators*: these are designed to achieve a concentration of less than 100mg/l oil under standard test conditions. They are suitable for dealing with discharges where a lower quality requirement applies and/or for trapping large spillages.

Both classes can be produced as 'full retention' or 'by-pass' separators:

- *Full retention separators* treat the flow that can be delivered by the drainage system, which is normally equivalent to the flow generated by a rainfall intensity of 50mm/hr.
- *By-pass separators* fully treat all flows generated by rainfall rates of up to 5mm/hr. Flows above this rate are allowed to bypass the separator. These separators are used when it is an acceptable risk not to provide full treatment for high flows.

Refer to standards given in ([3]) for additional guidance.

[3] Recommended standards/guidelines include:

- Pollution Prevention Guideline (PPG) 3. *Use and design of oil separators in surface water drainage systems*. Environment Agency/SEPA/Environment & Heritage Service, 2006. (www.environment-agency.gov.uk/business/topics/pollution/39083.aspx)
- C697. *The SUDS Manual*. CIRIA. 2007. (www.ciria.org.uk)

[4] **Drainage plan:** a comprehensive and up-to-date drainage plan of the site, which accurately identifies all drains, must be produced and handed over to the new occupier. If there is no in-house expertise to do this, a reputable drainage company should be used.

Roof plant: roof top plant space must be considered where there is a risk from substances such as petrol or oil. Refrigerants are not assessed under this Issue, as the only risk of pollution is to air.

Permeable paving system: where it can be demonstrated that a permeable paving system designed to retain silts and degrade oils has been used, then this will meet the assessment criteria of this Issue for car parks and access roads.

Underground/covered areas: where it can be demonstrated that there will be no drainage or wash down facilities that may lead water from inside the underground or covered area to natural watercourses, then such areas comply with the assessment criteria by default.

Soakaway: a sub-surface structure designed to promote the infiltration of surface water in to the ground. As a general point, soakaways may be shallow and broad – as in a blanket under permeable paving, or deeper structures. Deeper, point source soakaways should be avoided for road and car-park drainage, but shallow structures providing infiltration in an extensive way (infiltration trenches and permeable paving) do not need oil separators. *Refer to ([3]) for additional guidance*.

EL10. FLOOD RISK

Aim	To encourage development in low flood risk areas or to take measures to reduce the impact of flooding on buildings in areas with a medium or high risk of flooding.
Credits available	3
Issue summary	a) Maximum 2 credits if the building is located in a zone with low probability of flooding. b) 1 additional credit for applying attenuation measures to reduce the peak rate of water run-off.
Exclusion	None.

Assessment

a) Flood risk assessment

OPTION 1: **2 credits** if:

1	The assessed development is situated in a flood zone that is defined as having a low annual probability of flooding.
2	A site specific Flood Risk Assessment (FRA)[1] confirms that there is a low risk of flooding from all sources.[2]

OR OPTION 2: **1 credit** if: [3]

1	Where the assessed development is situated in a flood zone that is defined as having a medium or high annual probability of flooding.
2	A site specific Flood Risk Assessment (FRA) confirms to the satisfaction of the local authority and statutory body that the development is appropriately flood resilient and resistant from all sources of flooding.
3	The ground level of the building, and access to it and the site, are designed (or zoned) so they are at least 600 mm (~ 2 ft) above the design flood level[4] of the flood zone in which the assessed development is located.[5,6]

Evidence could be:

For 1	- A copy of a flood map or flood risk assessment confirming flood zone or annual probability of flooding in the site location. - Where appropriate, correspondence from the appropriate statutory body confirming reduced annual probability of flooding due to existing flood defences.
2	- A copy of the Flood Risk Assessment.
3	- Site plans/sections confirming: o The design flood level for the site; o The design ground level(s) for all developed areas of the site; o Safe access and escape routes.

b) **1 additional credit** if:

1	Where attenuation measures are specified to ensure that the peak rate of run-off from the site to the watercourses (natural or municipal) is no greater for the developed site than it was for the predevelopment site. This should comply with the *Interim Code of Practice for Sustainable Drainage systems,*[7] or for at least a 1 year and 100 year return period event with a 6-hour duration.
2	The capacity of the attenuation measures must include an allowance for climate change; this should be made in accordance with current best practice.[8]

Evidence could be site plans and specifications or consultants' report confirming:

- Type and storage volume (l) of the water run-off attenuation measures;
- Total area of hard surfaces (m^2);
- Peak flow rate (l/s) for the design storm event;
- Additional allowance for climate change designed in to the system.

Background and Notes

Flood zones: flood zones are defined in the relevant planning, policy and technical guidance documents for each country. If no local regulation available, the following definitions can be used:

Flood Zone	Definition
Low annual probability of flooding	Less than 1 in 1000 chance of river and sea flooding (< 0.1%)
Medium annual probability of flooding	Between 1 in 100 and 1 in 1000 chance of river flooding (1% – 0.1%) and between a 1 in 200 and 1 in 1000 chance of sea flooding (0.5% - 0.1%).
High annual probability of flooding	*High probability*: 1 in 100 or greater chance of river flooding (> 1%) and a 1 in 200 or greater chance of flooding from the sea (> 0.5%). *The Functional Floodplain*: land where water has to flow or be stored in times of flood.

Flood defences: flood defences do not completely remove the risk of flooding, but they do reduce it. Building in areas where flood defences are present (and appropriately designed to withstand a certain magnitude of flooding) is therefore preferable to those built in medium/high risk areas without defences. However, for the purpose of this Issue, it is still preferable to build in areas of low risk than encourage development of new flood defences in areas with a higher risk of flooding purely for the sake of new development.

Pre-existing flood defences: in an area protected by existing flood defences (designed to withstand a certain magnitude of flooding) the appropriate number of credits can be awarded where the defences reduce the risk to 'low' or 'medium' and the following conditions are met:

- The building is not located in an area where new flood defences have to be, or have been, constructed to minimise the risk of flooding to the site and its locality purely for the purpose of the building and/or its wider master plan.
- The development is located on a previously developed land *(see Issue RC1)* and the appropriate statutory body confirm that, as a result of the existing defences, the risk of a flood event occurring is reduced to low or medium. If firm confirmation is not provided then the credits cannot be achieved.
- The relevant agency confirms that, as a result of such defences, the risk of a flood event occurring is reduced to low or medium risk.

A statutory body's local/regional office may be able to provide more information on existing defences in the area in which the assessed development is located.

Third-party defences: there are many defences, owned by third parties, which due to their location act as a flood defence by default e.g. motorway, railway embankments, walls**,** etc. It can be assumed that embankments will remain in place for the lifetime of the development, unless the assessor or project team has reason to believe otherwise. For walls, assurance must be sought that the wall is likely to remain for the design life of the building.

Run-off: this is usually rainwater, but can also be groundwater or overspill from sewers and other sources. **Run-off rate** is the rate of discharge of water from a surface. **Peak run-off rate** (referred to as Qp [m^3/sec]) is the highest rate of flow from a defined catchment area assuming

that rainfall is uniformly distributed over the drainage area, considering the entire drainage area as a single unit and estimation of flow at the most downstream point only.

Run-off attenuation measures: this covers the range of construction and equipment that can be employed to attenuate run-off from hard surfaces and roofs. Measures include: underground storage, oversized pipes, holding ponds, swales, reed beds, permeable paving, green roofs, local or centralised soakaways etc.

Effectiveness of the water run-off attenuation measures: to ensure effective operation of the water run-off attenuation measures, the facilities must discharge half their volume within 24-48 hours (unless advised otherwise by a local statutory body) of the storm event in readiness for any subsequent storm inflow. Refer to ([9]) and ([10]) for guidance on calculating the peak flow rate and determining the design flooding frequency. This calculation should be provided by the design team to demonstrate that they have sized the attenuation facilities to store the relevant volume of storm water necessary to achieve the credits.

Peak flow rate: the peak rate of discharge of water from hard surfaces. For the purpose of calculating the peak flow rate volume, a 60-minute duration of the design storm event should be used (unless a different duration is required by a statutory body).

Discharge to the sea or estuaries: if all run-off is discharged directly from the site to either the sea, the foreshore, estuaries covered by a shoreline management plan or designated wildlife/SSSI areas (as part of habitat management) then the credits can be awarded without the need to specify additional attenuation measures.

Requirements from an appropriate statutory body: none of these credits can be awarded where the assessed development has proceeded against the recommendation of the statutory body on the basis that the flooding implications are too great. Where the local authority (or other statutory body) requires a greater attenuation than the percentages above, and/or a more onerous design flooding frequency than that recommended in ([9]), then the higher criteria must be met in order to achieve these credits.

Appropriate Consultant: a consultant with qualifications and experience relevant to the calculation of surface water run-off and design SUDS and flood prevention measures. Where complex flooding calculations and prevention measures are required, this must be a specialist hydrological engineer.

Catchment: the area contributing surface water flow to a point on a drainage or watercourse. It can be divided into sub-catchments.

Design flood level: the maximum estimated water level during the design storm event. The design flood level for a site can be determined through either known historical data or modelled for the specific site.

Design flood event: an historic or notional flood event of a given annual flood probability, against which the suitability of a proposed development is assessed and mitigation measures are designed.

Design storm event: historic or notional weather conditions of a given annual probability, against which the suitability of a proposed development is assessed and mitigation measures are designed.

Flood event: a flooding incident characterised by its peak level or flow, or by its level or flow hydrograph.

Flood probability: the estimated probability of a flood of given magnitude occurring or being exceeded in any specified time period. For example, a 100-year flood has a 1% chance of occurring in any given year.

Hard surfaces: these include roofs, car parks, access roads, pavements, delivery/service yards and external hard landscaping. Footpaths less than 1.5 m (~ 5 ft) wide, which have free drainage to soft landscaped areas on both sides, may be excluded.

Infiltration: the passage of water into a permeable surface, such as soil, permeable paving, soakaways and so on.

Natural watercourses: any natural channel that conveys surface water.

Sewerage undertaker: this is a water company with statutory responsibility for sewerage and sewerage disposal and also surface water from roofs and yards of premises.

Shoreline Management Plan: SMPs provide a large-scale assessment of the risks associated with coastal processes and present a policy framework to reduce these risks to people and the developed, historic and natural environment in a sustainable manner.

SUDS - Sustainable Drainage Systems or Sustainable (urban) Drainage Systems: a sequence of management practices and control structures designed to drain surface water in a more sustainable fashion than some conventional techniques. SUDS devices include:

- Holding ponds.
- Swales.
- Reed beds.
- Permeable paving - in areas where local geological and hydrological conditions allow this to function, e.g. block paved surface on permeable sub-base over gravel bed to store the water and allow it to seep into the soil. For less permeable soils, the gravel layer might be deeper and the water taken to a soak-away although this is not an option in some areas.
- Local or centralised soakaways either as full systems or as 'overflow' or 'holding' systems, in areas where local geological and hydrological conditions allow them to function.
- Run-off from roofs collected as a part of a rainwater harvesting system.
- Run-off from roofs directed to a local soak-away or other holding facility such as tanks, ponds, swales, etc.
- Green roofs.

Surface Water Run-off: water flow over the ground surface to a drainage system. This occurs if the ground is impermeable, is saturated or if the rainfall is particularly intense.

[1] **Flood risk** is the combination of the flood probability and the magnitude of the potential consequences of the flood event. A **Flood Risk Assessment (FRA)** is a study to assess the risk of a site flooding, and to assess the impact that any changes or development on the site will have on flood risk on the site and elsewhere. A FRA should be prepared according to good practice guidance as outlined in *Development and Flood Risk: A practice guide companion to PPS 25*, available from www.communities.gov.uk.

[2] **Sources of flooding:** if the development is in zones with low annual probability of flooding, the FRA must demonstrate that there is low risk of flooding from the following sources:

- Fluvial (rivers);
- Tidal;
- Surface water: sheet run-off from adjacent land (urban or rural);
- Groundwater: most common in low-lying areas underlain by permeable rock (aquifers);
- Sewers: combined, foul or surface water sewers.

[3] This credit for locating in a flood zone of 'medium or high annual probability' cannot be achieved where the building is located in the **functional flood plain**. Functional flood plain is defined as 'a zone that comprises land where water has to flow or be stored in times of flood.'

[4] **600 mm threshold**: it is accepted that, for buildings located in a medium flood zone, areas of the car park and site access may be allowed to flood and therefore fall below the 600 mm threshold. In such cases the credit is still achievable provided safe access to the site and the ground floor of the building can be maintained (i.e. they are 600 mm above the design flood level) to ensure the building/site does not become an 'island' in the event of a flood.

Where the development has been permitted and the ground levels of the topography/ infrastructure immediately adjacent to the site fall below the 600 mm threshold, the credit can still be awarded, provided there are no other practical solutions for access to the site above this level and the assessed building, and access to it, meets the assessment criteria. As much of the external site area as possible should be designed at or above the threshold.

[5] *DTI Construction Industry KPI Pack includes Methods of Measurement, Handbook*. KPI Wall Chart. 2005. (http://www.constructingexcellence.org.uk/)

[6] *Secured by Design*. (http://www.securedbydesign.com/professionals/guides.aspx)

[7] *Interim Code of Practice for Sustainable Drainage Systems* (SUDS). CIRIA. 2004. (www.ciria.org.uk)

[8] C624. Development and flood risk, guidance for the construction industry. CIRIA. 2004. (www.ciria.org.uk)

[9] BS EN 752-4: 2008. *Drain and sewer systems outside buildings*. (http://www.bsigroup.com/)

[10] BS EN 12056-3: 2000. *Gravity drainage inside buildings – Part 3: Roof drainage, layout and calculation*. (http://www.bsigroup.com/)

EL11. NOISE POLLUTION

Aim	To reduce the likelihood of noise from the new development affecting nearby noise-sensitive buildings.
Credits available	1
Issue summary	1 credit if the development causes no new source of noise which gives rise to the likelihood of complaints from surrounding noise-sensitive receivers.
Exclusion	None.

Assessment

The project team must demonstrate that:

1	Existing *noise-sensitive areas or buildings*[1] within 800 m (~ 2625 ft) radius of the assessed development are identified. Where there are or will be no noise-sensitive areas or buildings in the locality of the assessed development, the credit can be awarded by default.
2	A noise impact assessment in compliance with BS 4142:1997[2] has been carried out and the following noise levels measured/determined: - Existing background noise levels at the nearest or most exposed noise-sensitive development to the proposed development; or at a location where background conditions can be argued to be similar. - The rating noise level resulting from the proposed noise-source. This can be based upon reference to similar installations or sites, or determined by calculation. The noise impact assessment must be carried out by a suitably qualified acoustic consultant.[3]
3	Where the rating level of the noise source(s) from the site/building is equivalent to or less than the background noise level.
4	Where the rating level of the noise source(s) from the site/building is greater than the background noise level, measures have been installed to attenuate the noise at its source to a level where it will comply with [3].

Evidence could be:

For 1	- Site plan, inspection report, photographs and other materials highlighting: o All existing and proposed noise-sensitive buildings local to, and within, the site boundary. o Proposed sources of noise from the new development (during both construction and operation. o Distance (m) from these buildings to the assessed development.
For 2&3	- A copy of the acoustician's report. The acoustician's qualifications and professional status. OR - A copy of the specification clause requiring a noise assessment in compliance with BS 4142:1997 by a suitably qualified acoustician. OR - A formal letter from the client or design team confirming that they will appoint an acoustician to carry out a noise assessment in compliance with BS 4142:1997.
For 4	- Acoustician's report with recommendations for noise attenuation measures. AND - A marked-up design plan highlighting the specification of the acoustician's attenuation measures. OR - A formal letter from the client or design team confirming that: if relevant, attenuation measures recommended by an appointed suitably qualified acoustician will be installed.

Background and Notes

Scope of the noise impact assessment: the noise impact assessment relates only to building services plant (during construction and operation); additional process-related noise does not have to be considered. Stand-by generating plant should also not be included.

[1] **Noise sensitive area**: landscapes or buildings where the occupiers are likely to be sensitive to noise created by the new plant installed in the assessed building, including:

- Residential areas;
- Hospitals, health centres, care homes, doctor's surgeries, etc.;
- Schools, colleges and other teaching establishments;
- Libraries;
- Places of worship;
- Wildlife areas, historic landscapes, parks and gardens;
- Areas of Outstanding natural beauty or near a Site of Special Scientific Interest (SSSI);
- Any other development that can be considered noise sensitive.

Assessed building is defined as noise sensitive: if the assessed building is itself defined as a noise sensitive building then a noise impact assessment must be carried out regardless of the assessed buildings locality to other noise sensitive areas or buildings.

[2] BS 4142:1997. *Method for rating industrial noise affecting mixed residential and industrial areas*. (http://www.bsigroup.com/).
Where a suitably qualified acoustician confirms that BS 4142:1997 is not an appropriate standard of assessment for the proposed building/site, their assessment of the likelihood of complaint from noise impact can be accepted for the purpose of assessing this Issue.

[3] **A suitably qualified acoustic consultant:** is a person holding a recognised acoustic qualification and membership of an appropriate professional body.

EL12. LIGHT POLLUTION

Aim	To ensure that the development create no unwanted and unnecessary light pollution.
Credits available	1
Issue summary	1 credit for demonstrating that the building's tallness, size, façade glazing, external light installations, etc. cause no light pollution by complying with the specific criteria.
Exclusion	None.

Assessment

The project team must provide evidence that the building's tallness, size, façade glazing, external light installations, etc. comply with the criteria given in the reference publications through submission of detailed measurements, calculations and/or modelling studies carried out by a suitably qualified person.

Compliance is achieved when the designs are within the maximum figure for each parameter (sky glow, light into windows, source intensity, and building luminance), taken from one of the following sources:

- Tables 2.1 to 2.6 in CIE 150;[1]
- Table 1 in CIBSE Factfile 7;[2]
- Table 1 in ILE Guidance Notes.[3]

Background and Notes

Outdoor and public area lighting is necessary for illuminating public connections between premises, buildings and facilities to ensure the security and safety of users. Light pollution[4,5] may be regarded as waste light/reflection from lighting schemes and sunlight that produce glare, obscures the night sky, adversely effects nocturnal ecosystems, and may intrude on neighbouring properties. The brightness of advertising signs is also a concern.[6] The following table is taken from the recommended sources above:

Obtrusive light limitations for exterior lighting installations

Environmental Zone	Sky Glow ULR (Max %)	Light into Windows Ev (Lux) *		Source Intensity I (kcd) **		Building Luminance before curfew ***
		Before curfew	After curfew	Before curfew	After curfew	Average L (cd/m^2)
E1	0	2	1 ****	2.5	0.5 ****	0
E2	2.5	5	1	7.5	0.5	5
E3	5	10	2	10	1	10
E4	15	25	5	25	2.5	25

The definitions of the four zones are:

- *E1: intrinsically dark areas, e.g. national parks, areas of outstanding natural beauty, etc.*
- *E2: low district brightness areas, e.g. rural or small village locations.*
- *E3: medium district brightness areas, e.g. small town centres or urban locations.*
- *E4: high district brightness areas, e.g. town/city centres with high levels of nighttime activity.*

ULR = Upward Light Ratio of the Installation and is the maximum permitted percentage of luminaire flux for the total installation that goes directly into the sky.
Ev = Vertical Illuminance in Lux normal to window glazing.
I = Light Intensity in Kilo-Candelas.
L = Luminance in Candelas per m^2.

Notes:
(*) These values are suggested maximums for any window. So any new lighting will have to produce less than this value if there is any existing light trespass at a specific window.
(**) This is the intensity going beyond the area being lit from any single source in the potentially obtrusive direction. The figures given are for general guidance only and for some large sports lighting applications with limited mounting heights, may be difficult to achieve.
(***) This should be limited to avoid over lighting, and relates to the general district brightness. In this reference building luminance is applicable to buildings directly illuminated as a night-time feature as against the illumination of a building caused by spill light from adjacent floodlights or floodlights fixed to the building but used to light an adjacent area although this should be kept to a minimum.
(****) Acceptable from public road lighting and other safety lighting installations only, zero for all other lighting types.

[1] International Commission on Illumination. *Guide on the limitation of the effects of obtrusive light from outdoor lighting installations*. Technical Report CIE 150: 2003. (www.cie.co.at/)

[2] Chartered Institution of Building Services Engineers. *Environmental Considerations for Exterior Lighting.* Factfile No.7: 2003. (http://www.cibse.org/pdfs/fact72003.pdf)

[3] The Institution of Lighting Engineers. *Guidance notes for the reduction of obtrusive light*. (http://www.britastro.org/dark-skies/pdfs/ile.pdf)

[4] International Dark-sky Association. Information Resource Library. (http://www.darksky.org/resources/library.html)

[5] International Commission on Illumination. *Guidelines for Minimizing Sky Glow*. Technical Report CIE 126: 1997. (www.cie.co.at/)

[6] The Institution of Lighting Engineers. *Brightness of Illuminated Advertisements*. Technical Report No.5: 2001. (http://www.britastro.org/)

EL13. OVERSHADOWING AND VIEWS

Aim	To encourage building development which is sensitive to the needs of neighbours in respect of preserving daylight and views.
Credits available	1
Issue summary	1 credit for designs for which the access to daylight and views of neighbouring sensitive buildings is maintained to the prescribed level.
Exclusion	None.

Assessment

Neighbouring buildings, both existing and planned, must be assessed to determine the value of daylight (and to some extent, sunlight) to sensitive buildings. Assessment must be by appropriate computer and/or physical modelling.

Sensitive building is defined as follow:

- Residential buildings.
- Non-residential buildings:
    - Premises that require daylight to enhance the lighting environment for the occupants to perform tasks, such as office sand schools.
    - Premises that require daylight for energy saving and an improved environment for the transient stage of occupation, such as the circulation area of shopping centres and indoor games halls.
    - Premises that require daylight primarily for view, such as hotels and hospitals.

The project team must submit a report prepared by a suitably qualified person containing a comprehensive analysis (calculations and drawings) that qualifies and quantifies the extent to which the building development will impact on the sensitive neighbouring buildings in respect of access to daylight and views.

Change in the access to daylight may be objectively assessed in terms of the change in Vertical Daylight Factor (VDF) on the façades of sensitive receivers, or change in viewing angle, whichever is deemed most appropriate.

Where the VDF on the façade of the lowest floor of the sensitive receiver most affected is either unchanged or is no less than 12%, or the viewing angle is reduced by less than 5%, the credit shall be awarded.

Background and Notes

Tall-buildings can cause substantial overshadowing of neighbouring developments and amenities, affecting both direct and indirect sunlight and light from the sky. The profile of a building and its layout with respect to neighbouring buildings impacts on beneficial views, such as to the harbour or to mountains and open spaces. Overshadowing and view obstruction are also considered as ‘pollutions.’

The impact of a new building on all existing or planned neighbouring buildings where daylight and sunlight is of value, such as residential buildings, hospitals, schools, etc. should be assessed. Wherever possible the access to these beneficial natural elements should be safeguarded. This Issue reinforces the concept of ‘good neighbour buildings.’

E3.3. ECOLOGY AND MICROCLIMATE

EL14. PROTECTION OF ECOLOGICAL VALUE

Aim	To encourage development on land that already has limited value to wildlife and to protect existing ecological features from substantial damage during site preparation and completion of construction works.
Credits available	1
Issue summary	1 credit for fulfilling specific requirements in order to protect the site's existing ecological value.
Exclusion	None.

Assessment

The project team must demonstrate that:

1	Land within the construction zone[1] is defined as 'land of low ecological value' using either: - *Checklist 6: Land of Low Ecological Value (Appendix 2: Technical Checklists)*; OR - A suitably qualified ecologist who has identified the land as being of 'low ecological value' within an ecological assessment report, based on a site survey.[2]
2	All existing features of ecological value surrounding the construction zone and site boundary area are adequately protected from damage during clearance, site preparation and construction activities as listed below:[3] - Trees of over 100 mm (~ 0.33 ft) trunk diameter, and/or of significant ecological value, are protected by barriers. Barriers must prohibit construction works in the area between itself and the tree trunk. Minimum distance between tree trunk and barriers must be either the distance of branch spread or half tree height, whichever is the greater. - In all cases trees must be protected from direct impact and from severance or asphyxiation of the roots. - Hedges and natural areas requiring protection must either have barriers erected and be protected, or, when remote from site works or storage areas, be protected with a prohibition of construction activity in their vicinity. - Watercourses and wetland areas are to be protected by cut-off ditches and site drainage to prevent run-off to natural watercourses (as this may cause pollution, silting or erosion).
3	In all cases, the contractor is required to construct ecological protection prior to any preliminary site construction or preparation works (e.g. clearing of the site or erection of temporary site facilities).[4]

Evidence could be:

For 1&2	- A completed copy of *Checklist 6*. AND one of the following: - Plans and/or site photographs of the existing site highlighting any ecological features. - A copy of the ecologist's report with date(s) of site survey(s) containing: o Confirmation that the land within the construction zone is of low ecological value; o A description of any ecological features within the site or on the site boundary.
For 2&3	- A copy of the relevant section of the contract specification confirming: o Requirement to protect all identified features of ecological value; o Scope of protection measures required; o Protection measures implemented prior to commencement of site activities.

Background and Notes

No features of ecological value: *where the construction zone is defined as 'land of low ecological value' and where the surrounding site contains no features of ecological value, this credit can be awarded by default.*

[1] **Construction zone** is defined as any land on the site that is being developed (and therefore disturbed) for buildings, hard standing, landscaping, site access, plus a 3 m (~ 9.8 ft) boundary in either direction around these areas. It includes any areas used for temporary site storage and buildings.

[2] **Suitably qualified ecologist:** the definition of a 'suitable qualified ecologist' may differ in each countries. However, an individual achieving the following requirements can be considered to be 'suitably qualified' for the purposes of this Issue:

- Holds a national or international degree/qualification in ecology or a related subject.
- Is a practicing ecologist, with a minimum of three years relevant experience (within the last five years). Such experience must clearly demonstrate a practical understanding of factors affecting ecology in relation to construction and the built environment; including, acting in an advisory capacity to provide recommendations for ecological protection, enhancement and mitigation measures. Examples of relevant experience are: ecological impact assessments, habitat surveys and habitat restoration, etc.
- Is covered by a professional code of conduct and subject to peer review. ('*Peer review'* is defined as the process employed by a professional body to demonstrate that potential or current full members maintain a standard of knowledge and experience required to ensure compliance with a code of conduct and professional ethics).

Use of a suitably qualified ecologist: where a suitably qualified ecologist is employed and has, using their professional judgment, defined the site as land of low ecological value, this assessment/judgment overrides any assessment determined using *Checklist 6*. The suitably qualified ecologist must base their findings on data collected from a site visit conducted at appropriate time(s) of the year, when different plant and animal species are evident. The Ecology Report must be prepared prior to the commencement of initial site preparation works. Where the ecologist has made no on-site visit, the credit cannot be awarded.

[3] **Features of little or no ecological value:** if a suitably qualified ecologist has confirmed that a feature has little or no ecological value, or where a tree is deemed to create a significant danger to the public or occupants by a statutory body or qualified arboriculturalist, then that feature may be exempt from the assessment.

Removal of features of ecological value: if features of ecological value have been removed as part of site clearance then the development cannot achieve this credit, even if they are to be replaced as part of a new landscaping strategy.

[4] **Site clearance prior to purchase of the site:** for sites that have been cleared more than five years ago, the ecological value of the site would be its present ecological value, on the basis that in the intervening five years, ecological features would have started to re-establish themselves and therefore act as an indicator of the site's ecological value. For sites that have been cleared less than five years before assessment, a suitably qualified ecologist should make an estimation of the site's ecological value immediately prior to clearance on the basis of available desktop information (including aerial photography) and the landscape type/area surrounding the site. If it is not possible for the ecologists to make an assessment prior to the site clearance, the credit must be withheld.

EL15. MITIGATION OF ECOLOGICAL IMPACT

Aim	To minimise the impact of the development on existing site ecology.
Credits available	2
Issue summary	Maximum 2 credits for keeping the change in ecological value of the site to a minimum.
Exclusion	None.

Assessment

Credits are awarded based on the change in ecological value of the site as the result of the development:

- 1 credit if the change is ≥ - 9 and < 0 plant species (i.e. minimal change).
- 2 credits if the change is ≥ 0 plant species (i.e. no negative change).

The change in ecological value of the site is calculated using the method provided in *Appendix 10: Calculating the Change in Ecological Value*.

Evidence could include:[1]

- Existing and proposed site plans and, if required, maps and aerial photographs confirming:
  - Landscape and vegetation plot types;
  - Area (m^2) of vegetation plot types;
  - A calculation of the change in ecological value based on the method given in *Appendix 10*.
- In case data used to calculate the change in ecological value is provide by an ecologist,[2] a copy of the ecologist's report must be available confirming the following (prior to and after the development):
  - Landscape and vegetation plot types;
  - Area (m^2) of vegetation plot types;
  - Number of plant species by plots.

Background and Notes

[1] Refer to *Appendix 10: Calculating the Change in Ecological Value* for more information on evidence required.

[2] **Suitable qualified ecologist:** *see Issue EL14*.

EL16. ENHANCEMENT OF ECOLOGICAL VALUE

Aim	To recognise and encourage actions taken to maintain and enhance the ecological value of the site as a result of development.
Credits available	3
Issue summary	a) 1 credit for implementing professional recommendations/measures in order to protect and enhance the site's ecological value. b) 2 credits if these recommendations/measures result in an increase in the site's ecological value.
Exclusion	None.

Assessment

a) First credit

The project team must demonstrate that:

1	A suitably qualified ecologist (SQE)[1] has been appointed to report on enhancing and protecting the ecology of the site. - The SQE provides an Ecology Report with appropriate recommendations for protection and enhancement of the site's ecology. - The report is based on a site visit/survey by the SQE prior to the commencement of initial site preparation works.
2	The ecological recommendations[2] of the Ecology Report for enhancement and protection of site ecology have been, or will be, implemented.

Evidence could include:

- The ecologist's report containing details and scope of the site survey, enhancement recommendations, and other relevant information.
- Proposed site plan highlighting implementation of the SQE's enhancement recommendations.
- Contractual documents and/or project team's confirmation requiring the implementation of the SQE's recommendations.

b) Second and Third credit

The project team must demonstrate that:

1	Credit a) has already been achieved.
2	The recommendations of the Ecology Report for enhancement and protection of site ecology have been implemented, and the SQE confirms that this will result in an increase in ecological value of the site:[3] - *1 credit if the increase is < 6 plant species.* - *2 credits if the increase is ≥ 6 plant species.*
3	The increase in plant species has been calculated by the method given in *Appendix 10*, using actual species numbers.[4]

Evidence includes what outlined in credit a) and the calculation of the change in ecological value based on the method given in *Appendix 10* but using actual species numbers.

Background and Notes

[1] **Suitable qualified ecologist:** *see Issue EL14.*

[2] **Ecological recommendations** are defined as measures adopted to enhance the ecology of the site, which may include:

- The planting of native species or those with a known attraction or benefit to local wildlife.
- The adoption of horticultural good practice (e.g. no, or low, use of residual pesticides)
- The installation of bird, bat and/or insect boxes at appropriate locations on the site.
- Development of a full Biodiversity Management Plan including avoiding clearance/works at key times of the year (e.g. breeding seasons).
- The proper integration, design and maintenance of SUDs (Sustainable Drainage System – *see Issues EL9, EL10*) and Green Roofs, community orchards, etc.

Only native floral species or those with a known attraction or benefit to local wildlife can be considered for the purpose of enhancing the ecological value of the site.

[3] Refer to *Issues EL14, EL15* and *Appendix 10* for relevant definitions and guidance.

[4] Where it is not possible to determine 'actual' number of species per vegetation plot type, either because an on-site ecological survey has not been conducted, or, because construction works have already commenced, the second and third credits cannot be achieved.

EL17. LONG TERM IMPACT ON BIODIVERSITY

Aim	To minimise the long term of the development on the biodiversity of the site and surrounding area.
Credits available	2
Issue summary	Maximum 2 credits for implementing specific efforts to minimise the long term impact on the biodiversity[1] of the site and surrounding area.
Exclusion	None.

Assessment

Credits are awarded for demonstrating compliance with the following criteria:[2]

Mandatory Criteria	
1	A suitably qualified ecologist (SQE)[3] has been appointed prior to commencement of activities on site.
2	The SQE confirms that all relevant local legislation relating to protection and enhancement of ecology has been complied with during the design and construction process.
3	A landscape and habitat management plan, appropriate to the site, is produced covering at least the first five years after project completion. This is to be handed over to the building occupants and includes: - Management of any protected features on site; - Management of any new, existing or enhanced habitats; - A reference to the current or future site level or local Biodiversity Action Plan.[4]
Optional Criteria	
1	The project team appoints a 'Biodiversity Manager' to influence site activities and ensure that detrimental impacts on site biodiversity are minimised in line with the SQE's recommendations.
2	The site workforce is trained on how to protect site ecology during the project. Specific training should be carried out for the entire site workforce to ensure they are aware of how to avoid damaging site ecology. Training should be based on the findings and recommendations for protection of ecological features highlighted within a report prepared by the SQE.
3	Actions taken to protect biodiversity are recorded and their effectiveness is monitored throughout key stages of construction. The requirement commits the contractor to make such records available where publicly requested.
4	A new ecologically valuable habitat, appropriate to the local area, is created. This includes habitat that supports nationally, regionally or locally important biodiversity, and/or which is nationally, regionally or locally important itself.
5	Where flora and/or fauna habitats exist on site, the site works is programmed to minimise disturbance to wildlife. For example, site preparation, ground works, and landscaping have been, or will be, scheduled at an appropriate time of year to minimise disturbance to wildlife. Timing of works may have a significant impact on, for example, breeding birds, flowering plants, seed germination, amphibians etc. Actions such as phased clearance of vegetation may help to mitigate ecological impacts. This additional requirement will be achieved where a clear plan has been produced detailing how activities will be timed to avoid any impact on site biodiversity in line with the recommendations of a SQE.

1 credit if all three Mandatory Criteria and at least two Optional Criteria are achieved
2 credits if all three Mandatory Criteria and at least four Optional Criteria are achieved.

Required evidence includes:

Mandatory Criteria	
For 1	- The SQE report confirming: o That they were appointed prior to commencement of activities on site; o All relevant legislations to be complied with.
For 3	- A copy of the site management plan. OR - A copy of the specification requiring the development of plan and outlining the scope of its content.
Optional Criteria	
For 1	- Documents confirming the appointment of the 'Biodiversity Manager' as well as their role and responsibilities.
For 2	- Training schedule or other documents confirming the provision of relevant training and contents of the training.
For 3	- Documents from the contractor confirming: o Monitoring and reporting criteria for the development; o The records will be publicly available when required.
For 4	- Proposed site plan highlighting the new ecologically valuable habitat. - SQE's confirmation that the habitat supports the relevant biodiversity action plan.
For 5	- The SQE's report or other documents confirming: o Wildlife on site that needs to be accounted for in programming works; o Actions required with respect to programming site works to minimise disturbance. - Relevant section of the main contract confirming: o The program of site works will minimise disturbance to wildlife in accordance with SQE's recommendations.

Background and Notes

[1] **Biodiversity**: is defined as the variety of life on earth. It includes all species, animal, plants, fungi, algae, bacteria and the habitats that they depend upon.

[2] It is likely that either all, or none, of the Optional criteria will apply. Where the Optional criteria and the Mandatory criterion [3] (the management plan) are deemed by the appointed SQE not to be applicable, all 2 credits can be awarded. Mandatory criteria [1] and [2] must always be met. This is likely to be the case in the majority of tall-building projects in central town/city areas that have a high proportion of surrounding and existing development and no existing external landscaped areas within the boundary of the assessed site.

In case one or some Optional Criteria are not applicable, they will be scoped out and the credits will be awarded as follow:

Number of Optional Criteria	Credits	Requirements
1 criterion	1 credit	Meet all Mandatory Criteria and Optional Criterion.
	2 credits	
2 criteria	1 credit	Meet all Mandatory Criteria and all Optional Criteria.
	2 credits	
3 criteria	1 credit	Meet all Mandatory Criteria and two Optional Criteria.
	2 credits	Meet all Mandatory Criteria and all Optional Criteria.
4 criteria	1 credit	Meet all Mandatory Criteria and three Optional Criteria.
	2 credits	Meet all Mandatory Criteria and all Optional Criteria.

Where a site is deemed to have no ecological value, it is still necessary to employ a SQE to achieve this credit. The SQE must confirm that all the Mandatory Criteria have been achieved and provide guidance on how to achieve optional item [4]. Note that in such cases, Mandatory Criterion [1] and Optional Criterion [4] is likely to be applicable in relation to any ecological enhancements (e.g. green roofs, bird boxes, etc.) adopted in order to achieve the Enhancement of Ecological Value Issue (EL16).

[3] **Suitable qualified ecologist:** *see Issue EL14*.

[4] **Biodiversity Action Plan (BAP)**: a plan that sets specific, measurable, achievable, realistic and time bound conservation targets for species and habitats. Steps to produce a BAP can be found at: http://www.businessandbiodiversity.org/

EL18. SURROUNDING MICROCLIMATE

Aim	To ensure that the climate around and adjacent to the building has been adequately considered, and where appropriate, suitable mitigation measures are provided.
Credits available	4
Issue summary	a) 1 credit for conducting an Air Ventilation Assessment (AVA) by wind tunnel or CFD[1] and demonstrating the optimal option is selected in comparing with different options. b) 1 credit for demonstrating that no pedestrian areas will be subject to excessive wind velocities caused by amplification due to the site layout and/or building design c) 1 credit for applying adequate measures over non-roof areas to prevent heat island effect. d) 1 credit for applying adequate measures over roof areas to prevent heat island effect.
Exclusion	None.

Assessment

a) Air ventilation assessment

The project team must present evidence, such as results of wind tunnel or CFD test for different design schemes; to demonstrate that the best building design and site layout have been chosen in order to reduce the impacts on the surrounding wind environment.

b) Wind amplification

Relative wind speeds around buildings should be assessed by placing a suitable scale model of the building and surrounding large structures within 500 m (~ 1640 ft) radius from the development site in a boundary layer wind tunnel. Profiles of relative wind flow can be predicted at pedestrian levels. Measurement may be through multiple point measurement or through erosion techniques. The wind amplification factor, the developed site ground wind speed relative to the open ground site wind speed, can be estimated at pedestrian areas. These include entrances and exits to buildings, car parks, pedestrian routes, play areas, etc. Alternatively, wind flow around the estate can be simulated using computer airflow modelling (CFD), and areas of relative wind speed predicted. Tests should be carried out for the site's average wind speed and prevailing wind directions. Evidence could be a report prepared by a suitably qualified person demonstrating compliance.

It should be demonstrated that, under prevailing wind conditions:

- No pedestrian areas on or immediately adjacent to the site shall have local wind speeds accelerated by factors greater than 2. AND
- No stagnant area has a wind speed of less than 1.5 m/s and not 'flushed' by breezes.

c) Heat island effect[2] – Non-roof areas

The project team must demonstrate compliance with one of the following options:

OPTION 1

Use any combination of the following strategies for 50% (by area) of the site hardscape (including roads, sidewalks, courtyards and parking lots):

- Provide shade from the existing tree canopy or within five years of landscape installation. Landscaping (trees) must be in place at the time of occupancy.
- Provide shade from structures covered by solar panels that produce energy used to offset some non-renewable resource use.
- Provide shade from architectural devices or structures that have a solar reflectance index[3] (SRI) of at least 29.
- Use hardscape materials with an SRI of at least 29.

- Use an open-grid pavement system (at least 50% pervious).

OPTION 2
Place a minimum of 50% of parking spaces under cover.[4] Any roof used to shade or cover parking must have an SRI of at least 29, be a vegetated green roof or be covered by solar panels that produce energy used to offset some non-renewable resource use.

d) Heat island effect – Roof areas
The project team must demonstrate compliance with one of the following options:

OPTION 1
Use roofing materials with a SRI equal to or greater than the values in the table below for a minimum of 75% of the roof surface:

Roof type	Slope	SRI
Low-sloped roof	≤ 2:12	78
Steep-sloped roof	> 2:12	29

Roofing materials having a lower SRI value than those listed below may be used if the weighted rooftop SRI average meets the following criteria:

$$\frac{\text{Area Roof Meeting Minimum SRI}}{\text{Total Roof Area}} \text{ X } \frac{\text{SRI of Installed Roof}}{\text{Required SRI}} \geq 75\%$$

OPTION 2
Install a vegetated roof that covers at least 50% of the roof area.

OPTION 3
Install high-albedo[5] and vegetated roof surfaces that, in combination, meet the following criteria:

$$\frac{\text{Area Roof Meeting Minimum SRI}}{0.75} \text{ X } \frac{\text{Area of Vegetated Roof}}{0.5} \geq \text{Total Roof Area}$$

Roof type	Slope	SRI
Low-sloped roof	≤ 2:12	78
Steep-sloped roof	> 2:12	29

Background and Notes

The microclimate around tall-buildings can suffer as a result of the restricted natural ventilation from winds and breezes, leading to stagnant areas of pollution and elevated temperatures. Conversely, tall-buildings and site layout can deflect high-level wind down towards the ground, leading to discomfort and fatigue for pedestrians, damage to plant life, accumulation of debris, and in more extreme cases, danger from impeded walking and flying objects. Architects, planners and developers must aim to provide safe and comfortable conditions in open-air pedestrian areas; they should, therefore, understand how the wind flows around buildings and how to control it by good design.

Wind flow around a site of a tall-building can be accelerated or decelerated due to the building form, typically two to three times greater than for open ground. Of particular concern are localised areas of accelerated wind around corners and between narrow channels.

The following table indicates that mechanical discomfort sets in at wind speeds of about 5 m/s, with speeds above 8 m/s being very uncomfortable and speeds above 20 m/s being dangerous.

Conversely, some areas may receive low wind flow with free airflow being obstructed by buildings.

Beaufort N°	Wind Speed (m/s)	Effect
0,1	0-1.5	No noticeable wind
2	1.6-3.3	Wind felt on face
3	3.4-5.4	Hair disturbed, clothing flaps
4	5.5-7.9	Raises dust, dry soil and loose paper, hair blown
5	8.0-10.7	Force felt on body, limit of agreeable wind
6	10.8-13.8	Umbrellas use difficult, difficult to walk steadily
7	13.9-17.1	Inconvenience felt when walking
8	17.2-20.7	Generally impedes progress
9	20.8-24.4	People blown over by gusts

In addition to turbulent wind issues, the use of non-reflective external surfaces contributes to localise elevated temperatures created when solar heat gains are absorbed and then radiated back to the surroundings. The effect may be local to pedestrian and recreational areas, and contribute to urban heat islands. As a result, local ambient and effective temperatures can rise by several degrees or more when compared to more open and better ventilated areas. Penalties include local discomfort, detrimental effects on site vegetation and wildlife, etc.

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

[1] **Wind Tunnel and CFD** (Computational Fluid Dynamic) are the methods often used to analysed wind flow around structures. Related information can be found in BRE's Digest 390: 1994 - *Wind around Tall-buildings*. This publish described the process of wind flow around tall-buildings, shows how to decide at an early design stage whether a building is likely to give a satisfactory environment, and suggests measures which can be taken to achieve good conditions.

[2] **'Heat islands'** (or **'Elevated temperatures'**) are defined as thermal gradient differences between developed and undeveloped areas.

[3] The **solar reflectance index (SRI)** is a measure of the constructed surface's ability to reflect solar heat, as shown by a small temperature rise. It is defined so that a standard black surface (reflectance 0.05, emittance 0.90) is 0 and a standard white surface (reflectance 0.80, emittance 0.90) is 100. To calculate the SRI for a given material, obtain the reflectance value and emittance value for the material. SRI is calculated according to ASTM E 1980. Reflectance is measured according to ASTM E 903, ASTM E 1918, or ASTM C 1549. Emittance is measured according to ASTM E 408 or ASTM C 1371 (http://www.astm.org/).

[4] For the purpose of this Issue, under cover parking is defined as parking underground, under deck, under roof or in building's basement.

[5] The **'albedo'** of an object is a measure of how strongly it reflects light from light sources such as the Sun. It is therefore a more specific form of the term Reflectance/Reflectivity. High-albedo roof coatings can lower the absorption of solar energy, reduce surface temperatures and heat transfer into the building, therefore reduce heat island effect and building air-conditioning energy use.

E4. SOCIAL AND ECONOMIC ASPECTS (SE)

E4.1. SOCIAL ASPECTS

SE1. PUBLIC TRANSPORT

Aim	To recognise and encourage development in proximity to good public transport networks, thereby helping to reduce transport-related pollution, traffic congestion and land development impacts from automobile use.
Credits available	3
Issue summary	3 credits if the building is located in proximity to public transport networks/nodes.
Exclusion	None.

Assessment

The project team must demonstrate compliance with one of the following options:

OPTION 1: **Rail Station Proximity**
The building is located within 1000 m (~ 0.62 miles) walking distance[1] of an existing or planned and funded commuter rail, light rail or subway station.

OPTION 2: **Bus Stop Proximity**
The building is located within 650m (~ 0.4 miles) walking distance[1] of one or more stops for two or more public, campus, or private bus lines usable by building occupants.

Background and Notes

Potential Technologies & Strategies
Perform a transportation survey of future building occupants to identify transportation needs *(see Issue SE4)*. Locate the building near mass transit. If the project is not located near existing public transport links, seek for measures to provide public transport. The measures could be the introduction of new dedicated transport service (such as dedicated company bus service for staff); or creation of new links to existing public transport. It could go as far as creating a new bus route or constructing a new tram link for large-scale buildings. Or more simply, measures could be a new footpath/cycle-way to provide better access to an existing bus/tram/train route nearby.

[1] The distance is measured from a main building entrance via a safe pedestrian route. The distance must not be measured in a straight line i.e. 'radius distance.' The service stopping at each node must provide transport from, or onward travel to, either an urban centre, major transport node or a community focal point e.g. hospital, library, school or village centre.

Where a building-dedicated transport service is provided, the building entrance can be substituted for the drop-off/pick-up destination point of this service and therefore public transport proximity is measures from that point.

SE2. PEDESTRIAN AND CYCLIST

Aim	To encourage building users to cycle and walk by providing adequate facilities and safety.
Credits available	3
Issue summary	a) 1 credit for providing adequate cycle storage spaces for building users. b) 1 credit for providing adequate supporting cyclists' facilities for building users. c) 1 credit for providing safe and secure pedestrian and cycle access routes on the development.
Exclusion	None.

Assessment

a) Cyclist storage

The project team must demonstrate that *adequate cycle storage spaces*[1] are provided for building users.[2] 'Adequate cycle storage spaces' is defined as follow:

- 10% of building users if the number of users is < 500;
- 7% of building users if the number of users is in the range of 501-1000;
- 5% of building users if the number of users is > 1000.

Evidence could be site plan, design drawings and specification confirming:

- The location of the cycle storage facilities;
- The number of cycle spaces provided;
- The type, dimensions and layout of cycle racks;
- The materials and construction specified for the facility;
- Building occupancy or, where relevant, net floor area.

b) Supporting cyclists' facilities

The project team must demonstrate that:

- Credit a) has already been achieved. AND
- At least two of the following facilities are provided for the building users:
  - Showers;[3]
  - Changing facilities and lockers for clothes;[4]
  - Drying space for wet clothes.[5]

Evidence includes what outlined in credit a) and design drawings and specification confirming:

- Number of showers;
- Changing room;
- Secure locker locations, dimensions and numbers;
- Drying spaces.

c) Pedestrian and cyclist safety

The project team must demonstrate compliance with the following:

1	Where external site areas form part of the assessed site and these areas contain vehicle access roads, parking and/or pedestrian access to the building, adequate cycle lanes and pedestrian pathways must be provided. If the building does not have any external areas and internal access is directly from the public highway/footpath, then the credit(s) can be awarded on a default basis.
Cycle access criteria	
2	The cycle lanes have been designed and constructed adequately.[6]
3	The cycle lanes and pedestrian paths meet the following minimum width dimensions: - Where pedestrian and cycle routes are shared the minimum total width of the

	combined path is 3 m (~ 9.8 ft). - Where the cycle lane is segregated from both the pedestrian route and carriageway the minimum width of the cycle path is 2 m (~ 6.5 ft) and the minimum width of the pedestrian path is 1.5 m (~ 4.9 ft). - Where the cycle route forms a part of the carriageway, the minimum width of the lane is 1.5 m.
4	Cycle lanes provide direct access to any cycle storage facilities provided on the site, without the need to deviate from the cycle path and, if relevant, connect to offsite cycle paths where these run adjacent to the development's boundary.
Pedestrian access criteria	
5	Onsite footpaths connect to public footpaths off site, providing access to local transport nodes and other offsite amenities (where present).
6	Where provided, drop-off areas are designed off the access road and provide direct access to pedestrian pathways/areas, therefore avoiding the need for the pedestrian to cross vehicle access routes.
7	Where dedicated pedestrian crossing of a vehicle access route is provided, the road is raised to the pavement level (i.e. the pavement is not lowered to road level).
8	For larger developments with a high number of public users/visitors, pedestrian pathways must be signposted to other local amenities off site, including public transport nodes.
Combined cyclists and pedestrian access criteria	
9	Delivery areas are not accessed through parking areas and do not cross or share pedestrian and cyclist routes and other outside amenity areas accessible to building users and general public.
10	Lighting of pedestrian pathways and cycle paths on site is designed adequately.[7]

Required evidence includes:

For 1 & 3-9	Scaled proposed site plan, specification and/or design details highlighting all necessary features and dimensions.
2	Scaled proposed site plan, specification and/or design details confirming cycle routes have been designed in accordance with the adopted standard.
10	Site plan, specification and/or manufacturer's technical details confirming external lighting for specified areas has been designed in accordance with the adopted standard.

Background and Notes

[1] *In city central locations the number of cycle storage spaces can be reduced by 50% if the 3 credits under Public Transport Issue (SE1) have been achieved.*

Adequate cycle storage spaces must meet the flowing requirements:

- The space is covered overhead and protected from the rain.
- The covered area and the cycle racks are set in or fixed to a permanent structure (building or hard-standing) and allow both the wheel and frame to be locked securely. Or racks are located in a locked structure fixed to/part of a permanent structure with CCTV surveillance.
- There is a minimum distance of 1 m (~ 3.3 ft) between cycle racks, where the racks allow for two-sided parking, and 0.8 m (~ 2.6 ft) for one-sided parking.
- There is a minimum distance from any obstruction e.g. wall (located either to the side of the stand or in front of it) of 300 mm (~ 1 ft) for single-sided use and 900 mm (~ 3 ft) for double-sided use.
- Adequate lighting is provided.
- The facilities are in a prominent site location that is viewable from the building.

- The majority of the cycle racks are within 100 m (~ 328 ft) of a building entrance, ideally within 50 m (~ 164 ft).

These types of cycle storage devices are not recognised:

- Hooks and wall attachments;
- Single wheel (butterfly) bike rack holders.

Vertical bike racks that allow direct access (without the need to get alongside the locked bike) and permit one bike per vertical stack can comply with the criteria (provided all other criteria are met). For this type of rack, the distance between each rack can be less than 1 m but not less than 600 mm (~ 2 ft) (the typical width of a bike across the handlebars).

[2] In case of Residential buildings, 'building users' refers to the total number of residents and staff. In case of Non-residential buildings, it is the total number of staffs working in the building. This also includes the estimated number of visitors, customers, etc. who use the facilities within the building. *Refer to Issue RC4 and Appendix 8 for guidance on calculating the estimated number of occupants.*

[3] **Showers:** one shower must be provided for every 10 cycle storage spaces and both male and female users catered for. The showers can be available for others to use in addition to cyclists.

[4] **Changing facilities and lockers** criteria:

- As a guidance, where a shower/changing cubicle is provided there should be a minimum of 1 m^2 (~ 10.8 ft^2) of changing space adjacent to the shower(s) with a bench seat and hooks for hanging clothes. Where there is more than one shower provided there should be a minimum of 1 m^2 of changing space per shower, subject to a minimum changing area of 4 m^2 (~ 43 ft^2). Where there are no showers specified, but there is a changing facility, there is a minimum of 1 m^2 of changing space for every 10 cycle storage spaces, subject to a minimum of 4 m^2 of changing area with a bench seat and hooks for hanging clothes.
- The number of lockers is at least equal to the number of cycle spaces provided.
- Lockers are either in or adjacent to changing rooms. Where the changing space is a cubicle the locker(s) must not be located within the cubicle.
- Each locker is at least 900 mm high by 300 mm wide by 450 mm deep (~ 2.95 x 0.98 x 1.48 ft), or a locker with dimensions that provide an equivalent volume of storage space.
- Both male and female users are catered for.
- Toilet cubicles do not count as changing facilities.

[5] **Drying space** (for wet clothes) must be a specially designed and designated space with adequate heating/ventilation. A plant room is not a compliant drying space.

[6] Recommended guidance: National Cycle Network *Guidelines and Practical Details – issue 2* and Appendix VI *NCN Design and Construction Checklist* (http://www.sustrans.org.uk/).

[7] Recommended standards and guidance: CIBSE *Lighting Guide 6* LG6 (http://www.cibse.org/) and BS 5489-1:2003. *Code of practice for the design of road lighting. Lighting of roads and public amenity areas* (http://www.bsigroup.com/).

SE3. MAXIMUM CAR PARKING CAPACITY

Aim	To encourage the use of alternative means of transport to the building other than the private car, thereby helping to reduce transport related emissions and traffic congestion.
Credits available	1
Issue summary	1 credit if no more than 1 car parking space is provided for every four building users.
Exclusion	None.

Assessment

The project team must demonstrate that car parking capacity is limited to the given ratio (one for every four building users) to encourage alternative means of transport. Evidence could include:

- Site plan or specification confirming number and type of parking spaces provided for the building.
- Relevant documentation from project team or building owners confirming the number of building users.[1]

Background and Notes

[1] In case of Residential buildings, 'building users' is the total number of residents and staff. In case of Non-residential buildings, it is the total number of staffs working in the building. This also includes the estimated number of visitors, customers, etc. who use the facilities within the building. Refer to *Issue RC4* and *Appendix 8* for guidance on calculating the estimated number of occupants. Where the number of building users is variable, provision of parking spaces should be based on the maximum number of building users likely to be using the building at any time.

Disabled, mother & baby & motorbike spaces: parking spaces for these building users can be excluded from the assessment of this Issue provided these spaces are dedicated for this use and they are sized accordingly with the appropriate signage/markings.

Car share spaces: car share spaces can be excluded from the calculation provided these spaces are dedicated for this use with the appropriate signage and the future building occupier confirms they have an enforceable car share policy. Where there is no policy these spaces must be included within the calculation. If the building being assessed forms part of a wider site development and parking is not designated to specific buildings, then this credit must be assessed on the provision of parking spaces for the whole development, accounting for all existing and new users and parking spaces.

Parking shared with other buildings: where the numbers of users for the whole site cannot be confirmed, then the parking spaces can be attributed to the assessed development on the basis of the ratio of assessed building floor area to total building floor area of the whole site. E.g. if the assessed building is 20% of the total building area for the site then attribute 20% of the parking spaces to the building for the purpose of the assessment.

SE4. TRAVEL PLAN

Aim	To recognise the consideration given to accommodating a range of travel options for building users, encourage the reduction of user reliance on forms of travel that have high environmental impact.
Credits available	1
Issue summary	1 credit if a Travel Plan is available to building users that allows and encourages them to choose from a range of travel options instead of using private vehicles.
Exclusion	None.

Assessment

The project team must demonstrate compliance with the following:

1	A Travel Plan[1] has been developed as part of the feasibility and design stages that considers all types of travel relevant to the building type and users.
2	The Travel Plan is structured to meet the needs of the site and takes into consideration the findings of a site-specific transport survey that covers the following (at a minimum): - Where relevant, existing travel patterns and opinions of existing building or site users towards cycling and walking so that constraints and opportunities can be identified. - Travel patterns and transport impact of future building users. - Current local environment for walkers and cyclists (accounting for visitors who may be accompanied by young children). - Disabled access (accounting for varying levels of disability and visual impairment). - Public transport links serving the site. - Current facilities for cyclists.
3	The Travel Plan includes a package of measures that have been used to direct the design of the development in order to meet the travel plan objectives and minimise car-based travel patterns. This is demonstrated via specific examples such as: - Providing parking priority spaces for car sharers. - Providing dedicated and convenient cycle storage and changing facilities. - Supporting facilities for pedestrian and public transport waiting areas. - Negotiating improved bus services, i.e. altering bus routes or offering discounts. - Restricting and/or charging for car parking. - Criteria for lobby areas where information about public transport is made available. - Pedestrian and cycle friendly via the provision of cycle lanes, safe crossing points, direct routes, appropriate tactile surfaces, well lit and signposted to other amenities, public transport nodes and adjoining offsite pedestrian and cycle routes.

Evidence could include:

- The completed Travel Plan;
- Site-specific transport survey/assessment;
- Marked-up site plan demonstrating design measures implemented.

Background and Notes

[1] **Travel Plan:** a Travel Plan is a strategy for managing all travel and transport within an organisation, principally to increase choice and reduce reliance on the car by seeking to improve access to a site or development by sustainable modes of transport. A Travel Plan contains both physical and behavioural measures to increase travel choices and reduce reliance on private vehicles.

SE5. NEIGHBOURHOOD AMENITIES

Aim	To encourage and reward a building that is located in proximity to local amenities, thereby reducing the need for extended travel or multiple trips as well as promoting social and economic sustainability.
Credits available	1
Issue summary	1 credit if the building is located in proximity to adequate local amenities.
Exclusion	None.

Assessment

The project team must demonstrate that the building is located within 500 m (~ 0.3 miles) walking distance[1] of at least 10 basic amenities/services. Recognised amenities/services include the following:

Bank	Supermarket	Day care centre
Cash machine	Convenience grocery	Senior care facility
Beauty salon	Food outlet	Medical or dental office
Laundry	Library	Pharmacy
Fire station	Park	Community centre
Post office	Restaurant	School
Cleaners	Theatre	Hardware
Fitness centre	Museum	Place of worship

For mixed-use buildings, no more than five services/amenities within the project boundary may be counted as required basic services, provided it is open to the public. No more than two of the 10 services required may be anticipated (i.e. at least eight must be existing and operational). In addition, the anticipated services must demonstrate that they will be operational in the locations indicated within one year of occupation of the applicant project.

Required evidence includes:

- Scaled site plan or map highlighting:
  - Location of assessed building;
  - Location and type of services/amenities;
  - The route to the services/amenities.
- Where the services/amenities do not currently exist, but are due to be developed, documents from the client/developer are required; which must confirm:
  - The location and type of services/amenities to be provided;
  - The timescale for development of the services/amenities.

Background and Notes

[1] The distance must be measured via safe pedestrian routes e.g. pavements and safe crossing points or, where provided, dedicated pedestrian crossing points. The distance must not be measured in a straight line i.e. 'radius distance.'

SE6. LOCAL CHARACTER

Aim	To encourage tall-building developments to carry an increased obligation to return positive benefits to the immediate and wider environment.
Credits available	1
Issue summary	1 credit for the design that takes into consideration the surroundings and blends in with, or enhances, the local character.
Exclusion	None.

Assessment

Evidence could be in form of a report or other evidences of research into and understanding of local character all; and how this research affects the design of the final scheme. The project team must demonstrate how the final design seeks to fit into, or enhance, the local character in term of the following aspects (at a minimum):

- Landform;
- Form and silhouette;
- Scale and massing;
- Materials and architectural detailing;
- Landscape/townscape patterns;
- The impact and interface at street level;
- Relation to other tall-buildings in the vicinity;
- Designing for clusters;
- Legibility;
- Local historic context.

Background and Notes

Tall-buildings have visual prominence in, and significant impact on the wider landscape of the surrounding, and often take on the role of major landmarks. It is essential that the design and appearance of tall-buildings are of exceptional quality. Ideally, any tall-building project should respond to its surroundings and blend in with, or enhance, the local character. This does not imply that it has to look vernacular. A high-rise structure can be contemporary, yet still reflect local relationships, design elements, colour and material combinations, etc.

Landform: take into consideration the topographical character of the site such as levels, gradients, profiles, soil stabilisation, retention, etc.

Form and silhouette of a tall-building is critical and includes consideration of visual impact, and relationships with both the local context and other tall-buildings. Tall-buildings should be elegant and slender in form and should not appear as slab like structures. The treatment of the top of the building is particularly significant given its visibility on the skyline. Attention also needs to be given to the treatment of antennae, aerials, roof plant, etc.

Scale and massing: the scale and massing needs to be considered in terms of impact at street level in addition to appearance from more distant views. Bulky tall-buildings with a strong horizontal massing should be avoided, with the emphasis being on creating vertically slender buildings with a clear base, middle and top.

Materials and architectural detailing: given the visual prominence of tall-buildings it is essential that not only the architecture but the detailing in terms of materials and finish are of exemplar quality. Materials need to be of the highest quality and robust enough given the limited opportunities for maintenance access. Climate responsive design may provide the opportunity for the use of innovative materials but the robustness and appropriateness of such

materials will need to be clearly demonstrated. Attention also needs to be given to lift over runs and external cleaning hoists as an integral part of the design of the development.

Landscape/townscape patterns: detailing of walls (for example, regional styles in dry stone walls), landscape features (facings, fences, posts, hard surfaces, etc.), lighting, architectural styles, etc. can respond to area-specific factors.

The impact and interface at street level: the quality of the building at street level is critical. At this level the development needs to enliven spaces through a mix of uses and well overlooked entrances and achieve a high quality public realm treatment around the building and as a setting for the building. The provision of high quality internal circulation space at ground floor will provide a better quality interface with the street for users of the building. Consideration must be given to the impact of the proposal on the street infrastructure and provision made to offset any identified impact. Opportunities to enhance streetscape should be identified.

The building must be fully accessible to all users both into and around the development and employ the principles of inclusive design ensuring a single, equal access treatment for all users. Proposals should be linked with surrounding developments and existing footpaths effectively and avoiding creating under-used routes through vulnerable areas. Support for the development to assist in achieving safe attractive and convenient routes to public transport hubs will be sought.

Relation to other tall-buildings in the vicinity: close and especially adjacent tall-buildings may have great influences on each other in terms of architecture, geology, microclimate, safety, living quality, etc. All potential mutual effects must be studied carefully.

Designing for Clusters: the development of a building within an existing cluster of tall-buildings or the creation of a new cluster has specific design considerations. These include identification of the relationship of the new building to an existing dominant building in the cluster and to other surrounding buildings, or the consideration as to whether there is a need for the proposal to form a new dominant building to the group. These relationships need to be demonstrated through a skyline analysis and as the development is likely to be visible from 360º it must be assessed in this context. It is important to create a visual gap between high buildings so that they do not appear to merge as one large slab.

Legibility: the building must have a positive effect on the skyline and where appropriate, aid the legibility of the townscape, for example by providing a terminating landmark to a vista (without compromising other criteria) and through detailing at the pedestrian level. The building should help pedestrians find their way around the local area. The use of innovative lighting solutions can also enhance the legibility of buildings at night adding value to the city's skyline. Well-designed tall-buildings have the benefit of providing a positive identity for the occupiers of the building.

Local historic context: the proposal must respond to the historic context, including the need to ensure that the proposal will preserve and/or enhance historic buildings, sites, landscapes and skylines. Tall-building proposals must address their effect on the setting of, and views to and from historic buildings, sites and landscapes.

SE7. HISTORIC ENVIRONMENT

Aim	To encourage the development that is not located on sites of historic environment assets/cultural heritages.
Credits available	1
Issue summary	1 credit if the building is not located on site of historic environment assets.
Exclusion	None.

Assessment

Evidence must be a *baseline historic environment study/survey* that is carried out at the project planning stage. The baseline study/survey must be prepared or authorised by a suitably qualified historic environment professional.[1] It must consider the full range of registered and non-registered historic environment assets including:

- Historic built heritage;
- Historic landscape/townscape;
- Below ground archaeological remains;
- Non-registered or non-designated assets;
- Reference to existing characterisation studies and/or regional research agendas.

If it can be demonstrated that none of the assets above is present on site, then the credit shall be awarded.

Background and Notes

The landscape today – rural and urban – is the product of thousands of years of human activity and can be referred to in physical terms as the 'historic environment.' The historic environment comprises those buildings, structures and other features surviving in the current landscape or townscape as evidence for how mankind has shaped and managed our environment (the historic landscape character) over past centuries and millennia. Included in the term historic environment is the wealth of now-buried and often-invisible evidence that has been created and then buried below the existing ground levels – this is referred to as the 'archaeological heritage.'

Historic environment assets are protected by national and international legislation. Each country has different policies and regulations on this matter. A great deal of the historic environment may not be specifically protected by legislation but may be afforded protection through the planning consents regime. It is difficult and to some extends is also unnecessary to give specific standards or regulations to identify these assets. The project team must base on local policies and regulations to prove that the site has no valuable historic environmental assets.

[1] **Suitably qualified historic environment professional** may be indicated by being a member of a national or international heritage body such as UNESCO.

E4.2. ECONOMIC ASPECTS

SE8. LIFE CYCLE COST AND PAYBACK TIME

Aim	To encourage the reduction of Life Cycle Cost and payback time.
Credits available	2
Issue summary	a) 1 credit for demonstrating that efforts have been taken to minimise the Life Cycle Cost of the building. b) 1 credit for demonstrating that the expected payback time of the building is within 15 years.
Exclusion	None.

Assessment

a) **Minimising Life Cycle Cost** [1]
The project team must demonstrate that efforts have been taken to select and develop the most economical design scheme for the building. Evidence could be Life Cycle Cost Assessment (LCCA)[2] of different design schemes and design measures taken to achieve the lowest possible lifetime cost. The following cost must be calculated at a minimum for each design scheme:
- Predicted Life Cycle Cost over a 25-year period at a minimum;
- Construction cost;
- Operating and maintenance cost, including resource consumption cost.

b) Evidence could be calculations and analyses confirming the payback time of the project is less than 15 year. The calculations and analyses must use Discounted Payback (DPB) rather than Simple Payback (SPB).[3]

Background and Notes

This Issue raises a similar concern as the Whole Life Cycle Approach in Issue PM4 but concentrate in costing. Refer to Issue PM4 for related information.

[1] **Life Cycle Cost** can be defined as the sum of present values of investment costs, capital costs, installation costs, energy costs, operating costs, maintenance costs, and disposal costs over the life-time of the project, product, or measure.

[2] **Life Cycle Cost Analysis (LCCA)** is an economic method of project evaluation in which all costs arising from owning, operating, maintaining, and disposing of a project are considered important to the decision. LCCA is particularly suited to the evaluation of design alternatives that satisfy a required performance level, but that may have differing investment, operating, maintenance, or repair costs; and possibly different life spans. This lifetime cost analysis requirement can be the source of some confusion because of varying definitions and interpretations and the math needed to complete the calculations. The cost of a tall-building is also affected by many factors such as locations, currency, project character, etc. It is therefore unrealistic to provide any fixed baseline or standard price for tall-buildings. *The Life Cycle Cost Analysis must be carried out at design stage by a suitably qualified cost consultant.*

[3] The payback period of a project is expressed as the number of years just sufficient for initial investment costs to be offset by cumulative annual savings. DPB is the preferred method of computing the payback period for a project because it requires that cash flows occurring each year be discounted to present value to adjust for the effect of inflation and the opportunity cost of money. The SPB does not use discounted cash flows and therefore ignores the time value of money, making it a less accurate measure than the DPB.

SE9. AFFORDABILITY OF RENTAL/COST LEVELS

Aim	To assess whether rents or costs of residential units in the building will be affordable for the target market.
Credits available	1
Issue summary	1 credit if the design team takes into account the total occupancy cost (rental cost or total carrying charges and upkeep of a purchased unit) and the average household income in the urban region.
Exclusion	Non-residential buildings or non-residential units within a building.

Assessment

The project team must provide evidence in form of a report or analyses with special review of household incomes in the neighbourhood. The report or analyses must show the total occupancy cost (rental cost or total carrying charges and upkeep of a purchased unit) as a percentage of model household income in the local urban region.

Where the analysis of design documentation indicates that the gross housing cost, including rent or financing cost plus basic utilities, as a percentage of gross income will be less than 25%, the credit shall be awarded.

Background and Notes

From a broad social perspective, the affordability of residential occupancies relative to average incomes is a major concern. The project team should demonstrate that they have actively considered this matter at the design stage and these considerations have had important influences to the final design of the building.

This Issue only applies to residential buildings or residential units of a building (in cases of mixed-use developments). It is scoped out otherwise.

SE10. SUPPORT OF LOCAL ECONOMY

Aim	To encourage the purchase of a significant level of construction goods and services within the economic region.
Credits available	1
Issue summary	1 credit if the amount of construction expenditure benefitting the economy of the urban region is ≥ 30% of total construction cost.
Exclusion	None.

Assessment

The project team must provide evidence in form of a report or analyses with special review of expenditure program and sample analysis of construction billing to verify costs. The report or analyses must show the prediction of the percentage of construction expenditures for goods and services going to firms with permanent offices in the urban region.

Where it can be demonstrated that the amount of construction expenditure benefiting the economy of the urban region, as a percentage of total construction costs, is predicted to be ≥ 30%, the credit shall be awarded.

Background and Notes

This Issue raises a similar yet separate concern than the use of local material under Issue MA5. It encourages the consideration of local supports to the construction of the building in a broader manner.

SE11. MIXED-USE DEVELOPMENT

Aim	To encourage the considerations of opportunities for mixed-use development.
Credits available	1
Issue summary	1 credit for the adoption of a mixed-use strategy based on a holistic investigation of local conditions and opportunities.
Exclusion	None.

Assessment

The project team must provide evidence in form of a report detailing and analysing local area's social and economic conditions, and the opportunities for a mixed-use strategy to be applied to the building. This report must be carried out at a very early stage of the project. If a mixed-use strategy is adopted, the report must clearly describe and detail the facilities provided within the development, as well as the mechanism of the strategy (i.e. how is it expected to work).

If as a result of the investigation, a mixed-use strategy is not applicable or not suitable for the building due to different reasons (e.g. the availability of surrounding amenities and services, the character of potential users, economic aspects, etc.) the credit can still be achieved. In such cases the report must demonstrate the reasons and premise leading to the inapplicability of mixed-use strategies.

Background and Notes

Mixed-use development is a very effective strategy for a project to achieve sustainability, especially for tall-building projects with their special characteristic. Mixed-use development in tall-buildings nowadays is a prominent trend. Mixed-use development strategy offers many social and economic and environmental benefits such as:

- Provide various amenities and services within the project, therefore reduce transportation reliance and impacts.
- Provide more jobs and opportunities to increase income.
- Increases housing options for diverse household types.
- Increase the diversity of building users, creates a local sense of the building.
- Populates and activates the building during both day and evening hours.

INNOVATIONS

IN1. INNOVATIVE STRATEGIES AND TECHNOLOGIES

Aim	To encourage the adoption of practices, new technologies, techniques and strategies which are not currently recognised by existing TPSI Issues.
Credits available	5
Issue summary	Maximum 5 credits for adopting procurement strategies, design features, management processes and/or technological development that innovate in the field of sustainability, beyond the scope of current TPSI Issues.
Exclusion	None.

Assessment

The project team must demonstrate the achievement of significant, measurable environmental performance using a strategy not addressed in TPSI. A strategy or technology is recognised only of the associated benefits are of significant importance in achieving the building's sustainability. The benefits may be considered in relation to sustainable living, energy use, materials use, improved comfort, reduced pollution, etc. 1 credit is awarded for each innovation achieved. No more than 5 credits maybe earned.

The project team must produce a report identifying the following:

- The intent of the proposed innovation credit;
- The proposed requirement for compliance;
- The proposed submittals to demonstrate compliance;
- The design approach (strategies) used to meet the requirements. In case technologies are used, they must be clearly described and the results must be recorded as evidence to the adequacy of the technologies adopted.

Background and Notes

None.

IN2. EXEMPLARY PERFORMANCE

Aim	To encourage the achievement of exceptional performance over and above the stated performance criteria under TPSI Issues.
Credits available	11
Issue summary	Maximum 11 credits for exceeding the stated performance criteria under various TPSI Issues.
Exclusion	None.

Assessment

Exemplary performance is demonstrated by meeting Exemplary Performance Criteria for existing TPSI Issues. Refer to the table below for a list of TPSI Issues with defined exemplary performance criteria.

Issue ID and name	Exemplary Performance Criteria	Innovation credits available
IEQ16. Natural Lighting and Glare Control	At least 80% of floor area in all normally occupied spaces is adequately lit with an average daylight factor (DF) of ≥ 3% (instead of 2% as stated in Issue IEQ16)	1
RC4. Annual Water Consumption	Estimated annual water saving percentage is ≥ 60%	1
RC10. Energy Use Reduction	- Energy cost saving: ≥ 50% for Residential buildings, ≥ 55% for Non-residential buildings. - Peak electricity demand reduction: ≥ 18% for Residential buildings, ≥ 23% for Non-residential buildings.	1 1
RC12. Low or Zero Carbon Technologies	All 4 available credits are achieved AND the energy produced by the LZC energy technology installed as a percentage of the building's annual energy consumption is ≥ 4%.	1
MA1. Materials Specification	At least 85% (by area or volume accordingly) of EVERY element among 8 major building elements achieves an A or A+ rating. No percentage of any element achieves and D rating or below.	1
MA3. Rapidly Renewable Materials	The value of rapidly renewable materials as percentage of the total value of the materials used in the project is ≥ 10%.	1
MA4. Recycled Content	The value of materials with recycled content as percentage of the total value of the materials used in the project is ≥ 35%.	1
MA5. Regional Materials	The value of materials manufactured locally as percentage of the total value of the materials used in the project is ≥ 35%.	1
EL1. Construction/ Demolition Waste Management	The minimum percentage debris to be recycled or salvaged is 85%.	1
EL8. NO_X Emission	The NO_X emission level is ≤ 20 mg/kWh (at 0% excess O_2).	1

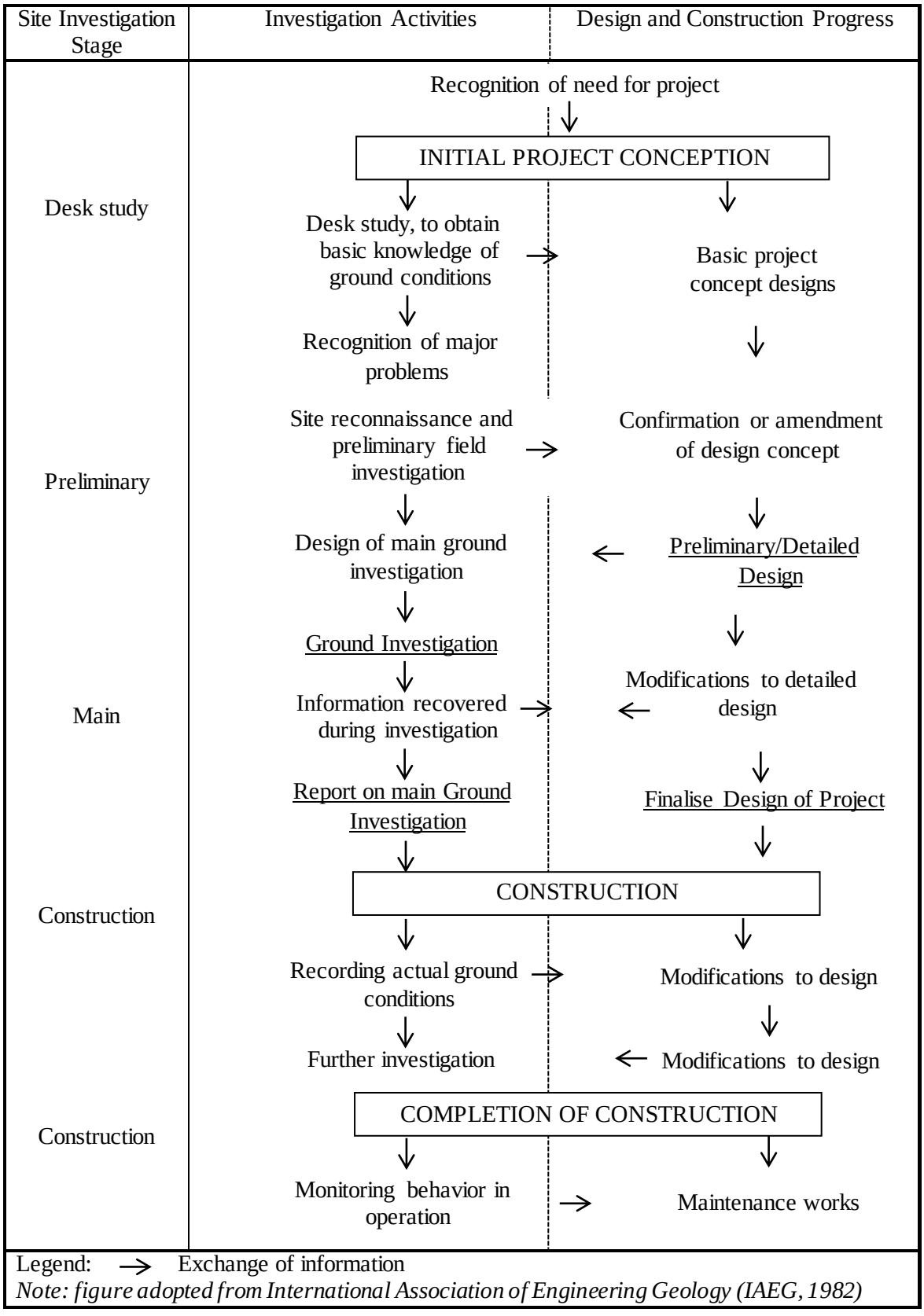
BACKGROUND AND NOTES

None.

APPENDICES

APPENDIX 1: SITE INVESTIGATION

THE INVESTIGATION SEQUENCE OF EVENTS



Note: figure adopted from International Association of Engineering Geology (IAEG, 1982)

STAGES OF SITE INVESTIGATION

1. Planning

The client's brief and the design engineer's design thoughts are coordinated. Knowledge of the design proposals should include layout, alignments, function and probable loadings. Once these points have been established by discussion with the design engineer, the geotechnical or site investigation contractor can proceed to gather preliminary information.

2. Desk Study

The desk study involves the collection of available documentary materials relevant to the site, the immediate environment and the proposed structure in any of the following forms:

- Previous ground investigation;
- Topographical maps;
- Aerial photos;
- Geological maps and memoirs;
- Historical maps;
- Rainfall records;
- Geographic Information System.

Site Reconnaissance

This is to confirm, amplify and supplement the information collected earlier by:

- Having a visual investigation on the site: topography, construction materials and labour, groundwater conditions, site access, surrounding structures, etc.
- Collecting information from local sources: local authorities, local statutory boards and government bodies, local archives, local inhabitants, local contractors, local clubs and societies, schools, colleges and universities.

Ground Investigation

Ground investigation is to determine:

- The suitability of the site for high-rise structure development;
- An adequate and economic foundation design;
- The difficulties which may arise during construction;
- Changes and cause of changes in subsoil conditions.

There must be geotechnical engineers specialising in soil sampling and testing engaged to establish the parameters that will be used in the design of the building foundation. Investigative methods range from non-intrusive (non-destructive) geophysics to intrusive borehole installations. The methods are broadly divided into *Field Tests* and *Laboratory Tests*.

Field Tests, including the following techniques:

- Subsurface Mapping;
- Trial Pitting;
- Exploratory Boreholes;
- In Situ Testing.

Laboratory Tests: laboratory tests for the collected samples are required to identify and classify the samples in terms of type, age, composition, weathering and moisture content, and to make an evaluation on the soil behaviours. Common types include:

- Soil Classification Tests;
- Soil Permeability Tests;
- Soil Compaction Tests;
- Chemical and Corrosivity on Soils and Groundwater;
- Soil Strength Tests;
- Soil Deformation Tests.

APPENDIX 2: TECHNICAL CHECKLISTS

CHECKLIST 1: CONSTRUCTION SITE IMPACTS MANAGEMENT

This checklist is used to assess the adequacy of the Construction Site Impacts Management Plan, in order to achieve 4 credits under Issue PM7.

1	**Monitor, report and set targets for CO_2 or energy arising from the site activities**		
Compliance requirement		**Tick**	**Evidence/Reference**
Monthly measurements of energy use are recorded and displayed on site.			
Appropriate target levels* of energy consumption are set and displayed (targets could be annual, monthly, or project targets).			
At a minimum, monitoring includes checking the meters and displaying some form of graphical analysis in the site office to show consumption over the project duration and how actual consumption compares to the targets set.			
The design/site management team nominates an individual who are responsible for the monitoring and collection of data.			
** Notes: this does not require targets to be met but is encouraging the process of setting, monitoring and reporting against targets.*			
2	**Monitor, report and set targets for CO_2 or energy arising from transport to and from site**		
Compliance requirement		**Tick**	**Evidence/Reference**
A site monitoring system is in place to monitor and record deliveries.* This system must record: - The number of deliveries; - The mode of transport; - The km/miles travelled for all deliveries.			
The design/site management team nominates an individual responsible for the monitoring and collection of data.			
** Notes:* *- Where the delivery is specifically for the site, a figure of total distance travelled should be used, i.e. a round trip (from the point of origin, to the site and back to the point of origin).* *- Where the delivery to the site is part of a multiple delivery route, the recorded figure for distance travelled should be the distance travelled to the site (from the previous delivery), plus the distance to the next delivery or return.*			
3	**Monitor, report and set targets for water consumption arising from site activities**		
Compliance requirement		**Tick**	**Evidence/Reference**
Monthly measurements of water consumption are recorded and displayed on site.			
Appropriate target* levels of water consumption are set and displayed (targets could be annual, monthly or project targets).			
At a minimum, monitoring includes checking the meters and displaying some form of graphical analysis in the site office to show consumption over the project duration and how actual consumption compares to targets set.			
The design/site management team nominates an individual responsible for the monitoring and collection of data.			
** Notes: this does not require targets to be met but is encouraging the process of setting, monitoring and reporting against targets.*			

4	**Implement best practice policies in respect of air (dust) pollution arising from the site**		
Compliance requirement		**Tick**	**Evidence/Reference**
The site adopts best practice procedures in relation to minimising air/dust pollution. This should include: - 'Dust sheets;' - Regular proposals to damp down the site in dry weather; - Covers to skips; etc.			
This information will be/was disseminated to site operatives.			
Notes: further information can be obtained from local regulations and standards on construction pollution.			
5	**Implement best practice policies in respect of water (ground and surface) pollution occurring on the site, including storm water design issues**		
Compliance requirement		**Tick**	**Evidence/Reference**
The site adopts best practice procedures in relation to minimising water pollution during construction, as outlined in local policies.			
The site adopts a storm water management plan that protects receiving stream channels from excessive erosion. The storm water management plan must include stream channel protection and quantity control strategies.			
The site adopts a storm water management plan that reduces cover, promotes infiltration and captures and treats the storm water runoff from 90% of the average annual rainfall using acceptable Best Management Practices (BMPs).*			
This information will be/was disseminated to site operatives.			
** Notes: potential strategies are:* *- Use alternative surfaces (e.g., vegetated roofs, pervious pavement, grid pavers) and non-structural techniques (e.g., rain gardens, vegetated swales, disconnection of imperviousness, rainwater recycling) to reduce imperviousness and promote infiltration and thereby reduce pollutant loadings.* *- Use sustainable design strategies (e.g., low-impact development, environmentally sensitive design) to create integrated natural and mechanical treatment systems, such as constructed wetlands, vegetated filters and open channels to treat storm water runoff.*			
6	**Main contractor has an environmental materials policy, used for sourcing of construction materials to be utilised on site**		
Compliance requirement		**Tick**	**Evidence/Reference**
The main contractor operates an environmental materials policy, used for sourcing of construction materials to be utilised on site. The policy should cover/promote the following: - Use of local materials (where possible); - Use of responsibly sourced materials; - Re use of materials; - Use of materials with a high recycled content; - Waste minimisation and recycling; - Use of non-toxic materials & refrigerants with a low Global Warming Potential (GWP); - Use of materials with a low embodied impact; - Use of durable materials.			
Post construction: indicative examples are provided to demonstrate the policy in action.			

7	**Main contractor operates an Environmental Management System.**		
Compliance requirement		**Tick**	**Evidence/Reference**
The main contractor operates an Environmental Management System (EMS) covering their main operations.			
Notes: for details of the EMS see credit PM1.			

8	**Implement best practice policies in respect of ground-generated gas risks arising from site activities**		
Compliance requirement		**Tick**	**Evidence/Reference**
In case ground-generated gases are present, there is evidence of risk reduction and management in place and fully implemented.*			
This information will be/was disseminated to site operatives			

**Notes:*

- *This item is automatically gained if there is no gas risk identified as a result of construction activities.*
- *Gas risk reduction and management include protective measures in the ground and/or in building and structures. It can be achieved through creating barriers to prevent migration into buildings or between sites, or to create preferential pathways through which gases can be safely vented.*
- *Verification maybe required through long-term monitoring of potential pathways or accepted compliance points to ensure no further increase in the levels of contamination (e.g. from 'bounce-back' from some remediation processes) and/or confirm reducing pollutant values, which is a particular requirement for monitored natural attenuation.*
- *Externally verified validation of remediation is often not conducted, and there is still little information on the long-term performance of many remediation technologies.*

CHECKLIST 2: CONSTRUCTION IAQ MANAGEMENT

This checklist is used to assess the adequacy of the Construction IAQ Management Plan, in order to achieve credit a) under Issue IEQ6.

1	**Contract conditions for the project specifications should require a written Construction IAQ Management Plan which includes procedures meeting or exceeding the minimum requirements, as follows:**		
Compliance requirement		**Tick**	**Evidence/Reference**
Measures to protect the ventilation system components and air pathways against contamination during construction.			
Cleaning procedures to be employed prior to the building being occupied, in the event that ventilation system components and air pathways are not adequately protected.			
Control measures for HVAC system and component protection.			
Contaminant source control.			
Interruption of moisture/pollutant pathways.			
2	**Events should be scheduled to protect indoor air quality by**		
Compliance requirement		**Tick**	**Evidence/Reference**
Permitting adequate airing-out of new materials.			
Sequencing the installation of finish materials.			
Proper curing of concrete before covering.			
3	**The Plan should specify the location, type, amount, sequence and timing of the various control measures, including emergency procedures, and the labour, materials and time required to implement them. The project construction documents should address the following:**		
Compliance requirement		**Tick**	**Evidence/Reference**
An overview of tasks to be executed.			
A list of reference documents, including specifications, drawing list, and submittal drawings.			
A list of participants in the process and their responsibilities.			
A plan for management, communication and documentation.			
An outline of the scope of the IAQ Management Plan, including submittal review, inspection, and enforcement.			
The expected written work products, including checklists and worksheets.			
A schedule of activities.			
4	**The project construction documents should require the contractor to:**		
Compliance requirement		**Tick**	**Evidence/Reference**
Designate a representative with daily responsibility for IAQ Issues.			
Include procedures related to the IAQ Management Plan on the agenda during regularly scheduled meetings.			
Store building materials in a weather tight, clean area protected from dust, debris and moisture damage.			
Keep the premises free from accumulations of waste materials, rubbish and other debris resulting from the work. Identify the storage, disposal and housekeeping practices to be applied to building supplies and waste materials to protect HVAC systems from contamination.			

Submit a construction schedule to prevent materials from acting as sinks for storage and subsequent release of contaminants emitted from finishes which have the potential for short-term off-gassing. In the schedule, the contractor should include appropriate allowances for drying or curing times before installation of materials that have a fibrous or porous nature that tend to adsorb contaminants.		
Provide adequate outside air continuously during installation of materials and finishes.		
Replace all construction-related filtration media used on permanent HVAC equipment at substantial completion of the work.		
Confirm that all air filters, casing, coils, fans and ducts are clean, before air quality testing.		
Ensure air ducts clean by coordinating duct testing and cleaning procedures with the commissioning requirements.		

CHECKLIST 3: AMENITY FEATURES

This checklist is used to assess the adequacy of building's amenity features, in order to achieve 1 credit under Issue BS2.

Compulsory features		**Tick**
1	**Provisions for air-conditioning installations:** For residential buildings, wall boxes or platforms in reinforced concrete or other suitable material may be constructed as a permanent feature. For commercial and industrial buildings, a centralised air-conditioning system should be provided or suitable internal areas should be set aside for this purpose at the design stage. Allowance should be made for adequate ducting and trunking, recesses, set-backs, open yards or other suitable spaces at or above floor levels where air-conditioning package units (or other plant and accessories) can be accommodated without the need to project over streets. In all cases where buildings will be or are likely to be air-conditioned, careful consideration should be given to the location of the exhaust of the plant and the need to provide a disposal system for the condensation from the plant to prevent causing nuisance to adjoining occupants and the public.	
2	**Security gates:** As long as they do not obstruct the means of escape from a building and have locks openable from the inside without keys, security gates may be installed prior to the issue of an occupation permit or may be indicated on floor plans in suitable positions for future installation. Suitable positions are considered to be: - Entrances to individual units; - Main staircase exits from buildings; and - In a Mixed-use building, between the domestic part and the commercial part. (In this case, the gate would be across an exit route, preferably in a lobby, and should be designed to prevent the entry of non-residents into the domestic part of the building).	
3	**Counters, kiosks, offices, stores, guard rooms, and lavatories for watchmen and management staff:** Such provision enhances standards of control and maintenance of buildings. The provision of this feature should meet the following criteria: - It should not be excessive in size; and - It should be located in a common area or designated as a common area to prevent abuse.	
4	**Building service facilities:** Every facilities that required for the *normal function* the building including: - Basic building services facilities (e.g. water tanks, meter rooms, pump rooms, cable rise duct rooms, lift facilities, telecommunication facilities, etc.). - Particular designs of building services facilities (e.g. chimney shafts, antennas, fire refuge areas, swimming pool filtration plant rooms, pipe-ducts, etc.). - The area of refuse container chambers, hopper rooms, chutes and storage chambers, etc.	
Enhanced features		
1	**Logistic service room:** Small logistic service room in a multi-story building allows the temporary storage of delivered goods under the custody of the management staff while the occupants are out. Such facility not only improves security but also alleviates fire hazard as otherwise the goods would be left unattended in the common lobby or staircase. The provision of this feature should meet the following criteria: - The room is not excessive in size. As a general guide, a room size of 8 m^2 (~ 86 ft^2) may be allowed for a block size of 240 flats. - The room should be located in the common area adjacent to the management office or guard post.	

2	**Mail room:** A mail room(s) is necessary to enhance the serviceability of a large building. The provision of this feature should meet the following criteria: - It is not excessive in size. - It is designed properly following a set of standard for mail facilities. - It is located in a common area or designated as a common area to prevent abuse. - The building is centrally managed. - There is a small public area for tenants to enter and collect their items from the lockable boxes. - There is a small counter for postmen to sort mail into lockable mail boxes. - A stamp vending machine and a posting box are usually provided in the mail room for the convenience of the tenants. - It is preferably provided at ground floor or basement level.	
3	**Projections:** - For individual domestic units, sun-shading and reflecting devices, individual canopies, clothes-drying racks, anti-burglar bars and small window hoods designed to provide protection from the elements and falling objects are encouraged; - Similarly, any projections that improve the energy efficiency of a building, including enhanced wall thicknesses would also be counted; - Wing walls, wind catchers and funnels; - Acoustic fins.	
4	**Horizontal screens:** In open areas frequently used by occupants at ground floors or podium floors; or roof gardens/play areas at podium floor around the perimeter of a domestic tower, horizontal screens may be used to provide protection against inclement weather and falling objects subject to the following conditions: - The horizontal screens will not materially affect the lighting and ventilation of the areas or nearby buildings. - The areas are designated as common area. - The areas do not form part of any commercial premises.	
5	**Prestige entrances:** - Prestige entrances such as large voids in front of cinema and theatre balconies, in banking halls and shopping arcades, entrance lobbies, etc., are encouraged. - Wider common corridors and lift lobbies.	
6	**Recreational facilities:** - The provision of communal sky gardens, communal podium gardens and play areas. - Certain other recreational facilities such as squash courts, gymnasiums, indoor swimming pools, sauna facilities, function rooms (for either active or passive recreational activities), etc. *This does not apply to substantial luxury clubs with restaurants and other facilities obviously meant for an exclusive membership and commercial takings, rather than for the general benefit of residents and occupiers.*	
7	**Satellite Dishes**	
8	**Balconies**	

CHECKLIST 4: SECURITY MEASURES AND FACILITIES

This checklist is used to assess the adequacy of building's security measures and facilities, in order to achieve 1 credit under Issue BS9.

Site perimeter controls	**Pt**	**Surveillance**	**Pt**	**Building Security**	**Pt**	**Site/Building Layout**	**Pt**
Site is fenced, gate(s) attended during active hours, intercom and camera surveillance during silent hours.	2	Lighting of site: overall illumination of the site is between 50 and 200 lux.	2	Entry from adjacent building(s): access is prevented by a separating distance of 6m.	2	Pathways are short, wide and straight	1
	or		or		or		
Restricted areas of the site are fenced with a locked gate.	1	Site is illuminated by street and building exterior lighting.	1	Access from adjacent building is inhibited by barriers.	1	Footpaths are well lit, convex steel mirrors to forestall concealment.	1
Vehicle Access Control: parking is indoor and with attended control station.	2	Monitoring of site: colour monitoring of building entrances and perimeter.	2	Security guards can verify by TV monitor and card reader.	2	Amenity/play areas overlooked from the building.	1
	or		or		or		
Parking for visitors and building users are separated with guard patrol.	1	B&W monitoring of building entrances and perimeter.	1	All people and traffic from parking must pass security control or parking control station.	1	Elevators are monitored by CCTV.	1
Security of stored vehicles: company vehicles in indoor parking or fenced compound with TV monitoring in silent hours.	2	Guard patrol: frequent patrol of building and fence perimeter.	2	Doors and windows at grade: secured with heavy duty hardware, security glazing and deadlocks.	2	Staircases are wide, open and well lit.	1
	or		or		or		
Company vehicles in separate well lit area.	1	Single guard patrol during silent hours.	1	Secured with high grade hardware.	1	Meters are located in common areas	1
Optional (by Client)	2	Planting: clear of building pathways and parking.	2	Alarmed for opening and breakage to central control and perimeter is monitored with TV.	2	Optional (by Client)	2
	or		or		or		or
Optional (by Client)	1	Planting 6m clear of building.	1	Alarmed locally for opening and breakage.	1	Optional (by Client)	1

Total Applicable Points:	Points Achieved:	Percentage Achieved:

CHECKLIST 5: ADAPTABILITY AND DECONSTRUCTION

This checklist must be completed in order to achieve 3 credits under Issue DF4.

Credit 1	**Spatial Adaptability**	
Compliance requirement	**Tick**	**Evidence/Reference**
Use of adaptable floor plans, including large grids that can be subdivided, etc.		
Spaces designed for a loose fit rather than tight fit.		
Inclusion of multifunctional spaces.		
Design that allows interior fitting-out to use modular and pre-fabricated components.		
Spaces designed such that minimum disruption will be caused to occupants due to physical change.		
Easy relocation of partition walls that cause minimum damage to flooring or ceiling systems.		
Partition walls are fully salvageable.		
Separating long-lived components from short-lived components to reduce the complexity of deconstruction and churning so as to facilitate the collection process for recycling.		
Use of interior partitions that are demountable, reusable and recyclable.		
Note: ASTM provides guidance for various types of buildings and uses (http://www.astm.org/): - *ASTM International. Designation E1692-95a Standard Classification for Serviceability of an Office for Change and Churn by Occupants.* - *ASTM International. Designation E1679-95 Standard Practice for Setting the Requirements for the Serviceability of a Building or Building-Related Facility.* - *ASTM International. Designation E1334-95 Standard Practice for Rating the Serviceability of a Building or Building-Related Facility.*		
Credit 2	**Flexible Engineering Services**	
Compliance requirement	**Tick**	**Evidence/Reference**
Design that allows interior fitting-out to use modular and pre-fabricated components.		
Using hybrid HVAC systems, with a balance between centralised components and distributed components.		
Luminaires are easily relocated within ceiling grid or uplighters are used.		
Air diffusers on flexible ducts can be relocated at minimum cost with minimum disruption to occupants.		
Exhaust air ducts for special exhausts are easy to install, and space and capacity are available in ceiling and duct shafts.		
Sprinkler heads are easily relocated within ceiling grid.		
Pre-wired horizontal distribution systems in ceilings or floors, with spare capacity and easy access to accommodate change of workplace layouts.		
Reducing the use of embedded infrastructure for power, data and HVAC systems, etc.		

Credit 3	**Structural Adaptability**	
Compliance requirement *Reference may be made to various publications.* Key points include:*	**Tick**	**Evidence/Reference**
Foundations allow for potential vertical expansion of the building.		
Installation of isolation joints or other features avoid the potential for differential settlements and for progressive collapse due to accidental loading.		
Reliance on a central core for lateral load resistance that allows for local modifications to the structure while maintaining complete structural integrity.		
Wide structural grids.		
Lower floors allow for heavier live load.		
Sufficient height to lower floors to enable a range of uses.		
Building envelope is independent of the structure (i.e., functionally discrete systems, with the interfaces designed for separation).		
Versatile envelope capable of accommodating changes to the interior space plan.		
Means for access to the exterior wall system from inside the building and from outside.		
Structural floor system that accommodates a number of mechanical and electrical service distribution schemes based on different occupancies.		
Provision of more than the minimum spatial areas and floor heights.		

**Note: Assessing the Adaptability of Buildings. International Energy Agency. Annex 31. Energy-Related Environmental Impact of Buildings. November 2001. (http://annex31.wiwi.uni-karlsruhe.de/Annex%2031%20Assessing%20the%20Adaptability%20of%20Buildings.doc).*

CHECKLIST 6: LAND OF LOW ECOLOGICAL VALUE

This checklist is used to determine the ecological value of the site, in order to achieve 1 credit under Issue EL14.

Section 1: Ecological features of the site		
Instruction: *criteria [1.1]-[1.5] can be used to determine the presence of existing ecological features across the total site. If YES is recorded against any question in Section 1 for the construction zone, then it cannot be defined as land of low ecological value and the credit cannot be awarded. If the construction zone records a NO against all the questions in Section 1 then proceed to Section 2.*		
1.1	Does the site contain any trees or hedges above 1 m (~ 3.3 ft) high or with a trunk diameter greater than 100 mm (~ 0.3 ft)?	Yes ☐ No ☐
1.2	Are there any ponds, streams or rivers on, or running through the site?	Yes ☐ No ☐
1.3	Is there any marsh or other wetland present on the site?	Yes ☐ No ☐
1.4	Are there any meadows or species-rich grassland present on the site?	Yes ☐ No ☐
1.5	Is there any heath land such as heather present on site?	Yes ☐ No ☐
Section 2: Type of land to be used for the new building		
Instruction: *in addition to answering NO to all the questions in Section 1, if YES is recorded against one or more of the questions in Section 2 then the construction zone can be defined as land of low ecological value. This credit can then be awarded, as long as all features of ecological value (as defined in Section 1) in the surrounding site and boundary area are adequately protected from damage.*		
2.1	Does the construction zone consist of land that is entirely within the footprint of existing building(s) or building(s) demolished within the past two years?	Yes ☐ No ☐
2.2	Does the construction zone consist of land that is entirely covered by other construction such as hard surfaces, car parking or such constructions that have been demolished within the past two years?	Yes ☐ No ☐
2.3	Does the construction zone consist of land that is contaminated by industrial or other waste to the extent that it would need decontamination to facilitate development?	Yes ☐ No ☐
2.4	Does the construction zone consist of land that is a mixture of either existing building(s), hard surfaces and/or contaminated land?	Yes ☐ No ☐
2.5	Does 80% of the land within the construction zone comply with questions [2.1], [2.2] or [2.3] and the remaining 20% of the footprint of the construction zone extend into land which has been EITHER: - Used for single-crop arable farming for at least five years; OR - Consists of regularly cut lawns and sports fields.	Yes ☐ No ☐

APPENDIX 3: BUILDING USER GUIDE CONTENTS

This appendix indicates the type of information that must be included at a minimum in the Building User Guide in order to achieve 1 credit under Issue PM12.

1. Building Services Information

- General User: information on heating, cooling and ventilation in the building and how these can be adjusted, e.g. thermostat location and use, implications of covering heating outlets with files, bags etc., and use of lifts and security systems.
- FM: as above, plus a non-technical summary of the operation and maintenance of the building systems (including BMS if installed) and an overview of controls.

2. Emergency Information

- General User: include information on the location of fire exits, muster points, alarm systems and fire-fighting systems.
- FM: as above, plus details of location and nature of emergency and firefighting systems, nearest emergency services, location of first aid equipment.

3. Energy & Environmental Strategy

This should give owners and occupants information on energy-efficient features and strategies relating to the building, and also provide an overview of the reasons for their use, e.g. economic and environmental savings. Information could include:

- General User: information on the operation of innovative features such as automatic blinds, lighting systems etc., and guidance on the impacts of strategies covering window opening and the use of blinds, lighting and heating controls.
- FM: as above, plus information on airtightness and solar gain (e.g. the impact of leaving windows/doors open in an air conditioned office, or use of blinds in winter with respect to solar gain); energy targets and benchmarks for the building type, information on monitoring such as the metering and sub-metering strategy, and how to read, record and present meter readings.

4. Transport Facilities

- General User: details of car-parking and cycling provision; local public transport information, maps and timetables; information on alternative methods of transport to the workplace, e.g. car sharing schemes; local 'green' transport facilities.
- FM: as above, plus information on conditions of access, maintenance and appropriate use of car parking and cycling facilities, e.g. number of spaces provided.

5. Water Use

- General User: details of water saving features and their use and benefits, e.g. aerating taps, low flush toilets, leak detection, metering etc.
- FM: as above, plus details of main components (including controls) and operation. Recommendations for system maintenance and its importance, e.g. risk of legionella.

6. Materials & Waste Policy

- General User: information on the location of recyclable materials storage areas and how to use them appropriately.
- FM: as above, plus information on recycling, including recyclable building/office/fit out components, waste storage and disposal criteria; examples of Waste Management Strategies and any cleaning/maintenance criteria for particular materials and finishes.

7. Re-fit/Re-arrangement Considerations

- General User: an explanation of the impact of re-positioning of furniture, i.e. may cover grilles/outlets, implications of layout change, e.g. installation of screens, higher density occupation etc.
- FM: as above, plus environmental recommendations for consideration in any refit. Relevant issues covered in TPSI should be highlighted, e.g. the use of natural ventilation, use of sustainable materials, reuse of other materials etc., the potential impact of increasing occupancy and any provision made in the original design to accommodate future changes.

8. Reporting Provision

- General User: contact details of FM/manager, maintenance team, and/or help desk facility; and details of any building user group if relevant.
- FM: as above, plus contact details of suppliers/installers of equipment and services and their areas of responsibility for reporting any subsequent problems.

9. Training

Details of the proposed content and suggested suppliers of any training and/or demonstrations in the use of the building's services, features and facilities that will be needed. This could include:

- General User: training in the use of any innovative/energy saving features.
- FM: as above, plus training in emergency procedures and setting up, adjusting, and fine tuning, the systems in the building.

10. Tall-building-specialised systems/devices

FM only: details of main components (including controls) and operation of tall-building-specialised systems and devices, such as Earthquake and damping systems. Recommendations for system maintenance and risk management.

11. General

Where further technical detail may be required by the FM Team or manager there should be references to the appropriate sections in the O&M manual.

12. Building Log Book

The provision of a 'Building Log-Book' to the owner and/or occupier of the building is mandatory. This Log-Book should contains the necessary details about the everyday operation of the development in a form that is easy for the intended users to understand.

APPENDIX 4: DEMOLITION MANAGEMENT ISSUES

This appendix indicates the aspects that must be considered in a Demolition Management Plan in order to achieve 1 credit under Issue PM13.

1. Sequence of Demolition

There is a strict sequence of events before any demolition can take place. Prior to commencement of any dismantling work taking place, the demolition contractor/company should demonstrate they have adhered to a similar process as follow in order to gain demolition planning permission (different countries and areas often have its own standards, but a typical order would be similar):

- Provision of Information: information must be provided about the construction of the structure to be demolished. Details of its previous use and the appropriate demolition methods to be used, including disposal of hazardous substances.
- Survey of Demolition: a thorough survey of the site to identify any structural problems, as well as risks associated with hazardous or flammable substances.
- Preferred and Safe Method of Work: appropriate method of disposal showing the outline dismantling process.
- Preparation and Planning: issues such as asbestos abatement, rodent baiting, dealing with hazardous substances, disconnecting utilities, and making safe any electric, gas or other services have to be shown in the planning stage.
- Protection of the Public: any health hazards will need to be assessed and temporary services arranged, and people inconvenienced will have to be informed.

2. Demolition Process

The building needs to be 'soft-striped' first (remove all appliances, windows, doors, and other finishing materials). These will account for a large percentage of the marketable components. After the non-structural deconstruction, structural is the next step. It is best to start at the roof and work down to the foundation.

Building components that are dismantled will need to be stored in a secure, dry location. This will protect them from water damage and theft. Once separated from the structure, materials can also be cleaned and/or refinished to increase value. Building an inventory list of the materials at hand will help determine where each item will be sent.

The demolition of main structures necessitates specialist techniques. A wrecking ball on a crane can be used, but is rarely practiced because the swinging ball is rather uncontrollable. The proximity of other buildings is a determining factor that prevents the use of explosives to implode a tall structure. So 'High Reach' demolition excavators are used where other methods are not appropriate to demolish the top part of a tall-building. Once it is down to a manageable height demolition can continue in the usual way. The various methods of demolishing tall-buildings are by implosion using explosives, controlled collapse and piecemeal. To control the dust produced in demolition, water hoses and spray equipment are sometimes used and then it is called a wet demolition. Environmental and social aspects of the project have to be carefully evaluated to select the most suitable demolition method or process.

3. Explosions use

The use of explosives in demolition is very specialist work and getting it wrong would be disastrous. If, for instance, there is atmospheric pressure from low cloud above the implosion site, the shockwave may spread outwards instead of upwards causing the wave of energy and sound to break windows. If an implosion is not prepared correctly the danger may be damage to surrounding buildings where flying debris may cause injury to spectators. Because of the risks of working with explosives they will only be used when other methods are too costly or impractical.

4. Deconstruction and Recycling

The new approach to demolishing buildings is known as deconstruction – a green approach. Deconstruction is the selective dismantlement of building components, specifically for reuse, recycling, and waste management. The work may be a painstaking task of dismantling by hand, e.g. beam by beam, but by going carefully expensive materials are preserved for reuse. The value of deconstruction is that 90% or more of waste is saved from going into landfill sites and reclaimed materials can be reused and recycled for future buildings.

Modern techniques and machinery allows demolition companies to efficiently segregate waste types on or off-site. Construction materials are recycled and reused whenever possible in the new structure making significant savings in project costs as well as being good for the environment.

Concrete can now be rapidly broken up with a new machine called a guillotine. Through the use of mobile crushing plant machinery the demolished building bricks and stone can be recycled into granular materials to use on new buildings. Copper pipes, lead, roof tiles or slates, floor tiles, wiring and doors, and wood panelling are valuable artefacts that are saved for recycling and reuse.

5. Deconstruction's economic viability

Deconstruction's economic viability varies from project to project. The amount of time and cost of labour are the main drawbacks. Harvesting materials from the main structure can take weeks, whereas demolition may be completed in roughly a day. However, some of the costs, if not all, can be recovered. Reusing the materials in a new on-site structure, selling reclaimed materials, donating materials for income tax write-offs, and avoiding landfill 'tipping fees' are all ways in which the cost of deconstruction can be made comparable to demolition.

While all non-structural components of a tall-building should always be deconstructed, economic viabilities should be considered to decide whether to demolish or to deconstruct structural components.

6. Designing for Deconstruction (DfD)

- Architects and engineers should keep the whole life cycle of the building in mind and select construction materials based on their capacity to be reused or recycled after the building has served its purpose.
- An upstream approach to deconstruction should be implemented into buildings during their design process. Often, simple construction methods combined with high-grade, durable materials work best for DfD structures. (Separating layers of a building's infrastructure and making them visible, making components within systems separable, using mechanical fasteners such as bolts to connect parts, allowing physical access to the fasteners, using standardised materials and assemble them in a consistent manner, etc.
- Some conventional construction methods and materials are difficult or impossible to deconstruct and should be avoided when designing for deconstruction. The use of nails and adhesives significantly slows down the deconstruction process and has a tendency to ruin otherwise reusable materials. Avoid hazardous materials altogether as they detrimental to the natural environment and are non-reusable. Avoid the use of mixed material grades that makes the process of identifying pieces for resale difficult.
- An alternative worth considering is modular building.
- *Some other aspects of Design for Deconstruction issue are also assessed in details in Issue DF4.*

7. Health and Safety

It is essential that personnel working in the industry are thoroughly trained. All demolition works must follow local or international regulations and standards in term of Health and Safety.

APPENDIX 5: TABLES

TABLE 1: IAQ OBJECTIVES

Parameter	Unit	8-hour average[1]	
		Excellent Class	Good Class
Room Temperature	°C	20 to < 25.5	< 25.5
Relative Humidity	%	40 to < 70	< 70
Air movement	m/s	< 0.2	< 0.3
Carbon Dioxide (CO_2)	ppmv	< 800	< 1,000
Carbon Monoxide (CO)	µg/m^3	< 2,000	< 10,000
	ppmv	< 1.7	< 8.7
Respirable Suspended Particulates (PM_{10})	µg/m^3	< 20 f	< 180
Nitrogen Dioxide (NO_2)	µg/m^3	< 40	< 150
	ppbv	< 21	< 80
Ozone (O_3)	µg/m^3	< 50	< 120
	ppbv	< 25	< 61
Formaldehyde (HCHO)	µg/m^3	< 30	< 100
	ppbv	< 24	< 81
Total Volatile Organic Compounds (TVOC)	µg/m^3	< 200	< 600
	ppbv	< 87	< 261
Radon (Rn)	Bq/m^3	< 150	< 200
Airborne Bacteria[2]	cfu/m^3	< 500	< 1,000

Notes:

[1] *In some cases, it may not be practicable to take 8-hour continuous measurement. In these circumstances, surrogate measurement (i.e. an intermittent measurement strategy based on the average of half-an-hour measurements conducted at four time-slots) is also accepted.*

[2] *The bacterial count does not necessarily imply health risk but serve as an indicator for further investigation.*

TABLE 2: INCREASED VENTILATION ASSESSMENT

Spaces Identification [1]	Space Type [2]	Occupant Density People/ft^2	Ventilation Rate/Person L/s	Rate/ft^2 L/s	Zone Air Distribution Effectiveness [3]	System Ventilation Efficiency [4]	Class of Air [5]

[1] *List number or name of each ventilation zone, such as office number or name, retail space name, classroom number, etc.*

[2] *List occupancy category of the space from ASHRAE 62.1: 2007 Table 6-1 (Minimum ventilation rates in breathing zone) such as office space, retail sales, classroom, etc.*

[3] *ASHRAE 62.1: 2007 Table 6-2 (Zone Air Distribution Effectiveness).*

[4] *ASHRAE 62.1: 2007 Table 6-3 (System Ventilation Efficiency) or Appendix A.*

[5] *ASHRAE 62.1: 2007 Tables 5-2 (Airstreams) or 6-1; include justification for classification if not in these tables.*

TABLE 3: ACOUSTIC PERFORMANCE CRITERIA

This table is used as the default criteria for assessing acoustic performance of the building in order to achieve 1 credit under Issue IEQ22.

Premises type	Performance criteria
Office type premises	The reverberation time of A-weighted sound pressure level, in modular (private) offices and conference rooms, shall be 0.6 s or below. The noise assessment criterion shall be NC40.
Classrooms and similar premises	The reverberation time of A-weighted sound pressure level in teaching rooms, other than specialist teaching rooms such as laboratories and workshops, shall be 0.6 s or below. The noise assessment criterion shall be NC 35.
Residential premises, hotel and apartments	The reverberation time of A-weighted sound pressure level, in bedrooms and living rooms, shall be between 0.4 and 0.6 s. The noise assessment criterion shall be NC 30.
Indoor games halls & indoor swimming pools, etc.	The reverberation time of A-weighted sound pressure level, in indoor game halls, indoor swimming pools or other recreational premises, shall be 2.0 s or below. The noise assessment criterion shall be NC 45.

TABLE 4: NOISE ISOLATION PERFORMANCE CRITERIA

This table is used as the default criteria for assessing noise isolation performance of the building in order to achieve 1 credit under Issue IEQ23.

Premises type	Performance criteria
Office type premises	- Between two offices Dw = 38 dB minimum. - Where privacy is important: Dw = 48 dB. - Noise Isolation Class (NIC) of at least 40 for cellular offices.
Classrooms and similar premises	Sound Transmission Class of walls between classrooms to be equal to or greater than STC37 for classrooms on the same floor and equal or greater than STC50, Impact Insulation Class IIC46 between floors.
Residential premises, hotel and apartments	- Partitions separating a WC from a noise sensitive room: $D_{nT,w}$ of at least 38 dB. - In hotels, partitions and floors between rooms and between rooms and corridors: $D_{nT,w}$ of at least 50 dB.
Residential premises only	- Bedroom to living room: STC46 (same residential unit). - Bedroom to bedroom: STC52, IIC52 (between residential units); STC44 (same unit). - Living room to living room: STC52, IIC52 (between residential units).

TABLE 5: BACKGROUND NOISE PERFORMANCE CRITERIA

This table is used as the default criteria for assessing background noise performance of the building in order to achieve 1 credit under Issue IEQ24.

Premises type	Performance criteria
Office type premises	- Modular (private) offices and small conference rooms: 40 dB $L_{Aeq,T}$ = 8 hr or 45 dB $L_{Aeq,T}$ = 5 mins. - Large landscaped offices: 45 dB $L_{Aeq,T}$ = 8hr or 50 dB $L_{Aeq,T}$ = 5min.
Classrooms and similar premises	Background noise shall be below 45 dB LAmax in schools in urban areas, otherwise at or below 40 dB LAmax, effective between the hours of 08:00 to 16:00.
Residential premises, hotel and apartments	- In bedrooms under window closed conditions at or below 30 dB $L_{Aeq,T}$ = 8 hr, or 35 dB $L_{Aeq,T}$ = 5 mins, and < 45 dB between 23:00 to 07:00. - In habitable rooms (other than kitchens) under closed window conditions < 55 dB $L_{Aeq,T}$ = 16 hrs between 07:00 to 23:00.
Indoor games halls & indoor swimming pools, etc.	Background noise level shall be less than 50 dB $L_{Aeq,T}$ = 5 mins.

Notes:
Tables 5 and 6 of BS 8233:1999 - Sound insulation and noise reduction for buildings. Code of Practice. (http://www.bsigroup.com/) - give criterion for various activities in buildings.

TABLE 6: DURABILITY (YEARS) OF BUILDING ELEMENTS

This table is used to determine the service life of building components in order to achieve 2 credits under Issue BS7.

Classification		By Construction type	Service life	Specifications etc.	Notes
Structural skeleton		Steel reinforced concrete	65	Slump 18	Planned years to renewal
Building Exterior	Roof	Asphalt Waterproofing	30	Counterweight concrete (thickness 80)	
			30	Counterweight concrete	
		Waterproof sheet	15	Exposed, silver coating	Ronloop or equivalent, T=20
		Title	30		Service life is 10 year - 10% repair for the waterproof course, mortar bed and titles.
			30		Service life is 10 year - 10% repair for the waterproof course, mortar bed and titles.
		Aluminum coping	40		
			40		
	Outer walls	Stones	65	Granite	Polished finish
			60	Granite	Polished finish
		Titling	40	Embedded porcelain title	
			60	Embedded porcelain title	40 years for floating method construction
		Synthetic resin spraying	15	Mortar setting bed	Emulsion finish
			30	Mortar setting bed	Acrylic lysine
		Epoxy-type sprayed title	15	Concrete setting bed	
	Curtain wall	Aluminum	40		Panel mounting
		PC sheet	65	Embedded mosaic titles	
			60	Small embedded titles	
	Exterior ceilings (eaves)	Aluminum Moulding	30		
			40		
		Stainless steel Moulding	40		
			40		
		Boarding	20	Flexible board	EP finish
			25	Flexible board	EP finish
	Exterior fittings	Steel fittings	30		OP coating
			35		Ready-mixed synthetic resin paint
		Aluminum fixtures	40		
		Stainless steel entry/exit doors	40	4,400 x 2,500	Automatic stainless steel doubled-opening doors
			60	4,334 x 2,800	Stainless steel entrance unit
		Synthetic resin on steel (painting)	5		
			3		
	Exterior Misc.	Roof railings (steel)	30		Painted every 5 years
			25		Painted every 3 years
		Roof railings (Stainless steel)	65	H = 1,100	
			60	H = 1,100	
		Roof railing (Aluminum)	40	H = 1,100	
			40	H = 1,100	
Building Interior	Floors	Granite	65	Polished finish	
			60	Polished finish	
		Marble	65		
			60		

		Terrazo block	65		
			60		
		Titling	65	Ceramic title	
			50	Ceramic title	
		Mortar finish	30	Mortar board	
			30	Mortar board	
		PVC titling	20	Mortar setting bed	Semi-hardened
			30	Mortar setting bed	Semi-hardened
		Vinyl flooring sheet	20	Mortar board	Polyvinyl chloride sheet (LONLEUM) or equivalent
			30	Mortar board	
		Carpet	20	Mortar setting bed	
			30	Mortar setting bed	Title carpet
	Inner walls	Granite	65	Polished finish	
			60	Polished finish	
		Marble	65		
			60		
		Terrazo block	65		
			60		
		Titling	65	Porcelain title	
			50	Porcelain title	
		Mortar finish	65	EP coating	Repainted every 10 years
			30	EP coating	Repainted every 5 years
		Multi-layer painted finish	20	Mortar setting bed	Service life, including undercoat (repainted every 10 years (60%))
			30	Mortar setting bed	Service life, including undercoat (repainted every 10 years (90%))
		Vinyl wall paper	20	Plywood underlay	Service life of underlays (repainted every 10 years)
			30	Plywood underlay	Service life of underlays (repainted every 10 years)
		Vinyl wall paper	20	GL construction method, PB T=12	Service life of underlays (repainted every 10 years)
			20	GL construction method, PB T=12	Service life of underlays (repainted every 10 years)
		Walnut veneering	20	T=9, with furring strips	
			20	T=9, with furring strips	
		Melamine-faced board	30	T=9, with furring strips	
			30	T=9, with furring strips	
	Ceilings	Aluminum Moulding	30	Light steel underlay	
			60	Light steel underlay	
		Boards	30	Faced plasterboard	
			30	Faced plasterboard	
		Vinyl wallpaper	30	PB underlay, T=9	Service life of underlays (replaced every 10 years)
			30	PB underlay, T=10	Service life of underlays (replaced every 10 years)
		Synthetic resin spraying	20	Concrete underlay	
			60	Concrete underlay	
	Interior fixtures	Aluminum fixtures	40		
			50		
		Steel fixtures	30	Op Coating	
			40	Op Coating	

		Wooden fixtures	30		Rush door
			30		Rush door
	Misc. other	Toilet screens	65	Terrazo block panel	
			30	Terrazo block panel	However, related finished have a large influence
		Toilet screens	30	Faced sheet steel panel	
			40	Faced sheet steel panel	
		Suspended shelves	20	Faced sheet steel panel	
		Sinks	(30)		From documents calculating refurbishment costs.
			20		
		FRP bathtubs	15		
		Stainless steel bathtubs	25		
Electrical Equipment	High-pressure devices	High-voltage power input equipment	25	Interior cubides	
			30	Interior cubides	
		High-voltage power input equipment	25	Exterior cubides	
			20	Exterior cubides	
		Distribution board	25		
			30		
		Transformer	30		
			30		Interior
		Condenser	25		
	Home electrical appliances equipment	Private generators (Diesel-engined)	30		25 years for the engine
			30	For emergency use	
	DC power supply devices	Storage batteries (lead)	7	Seated lead (HS)	
			7	Seated lead (HS)	
		Storage batteries (alkaline)	25	Seated, AHH	
			15	Pocket alkaline	
	Boards	Power control boards	25		
			30		
		Lighting distribution board	25		
			30		
		Terminal board	30		
			60		
	Lighting fixtures	Fluorescent light fixtures	20		
			30		
		Incandescent light fixtures	20		
			30		
		Guide lamps	20		
			30		
	Light electrical appliances	Telephone switchboard	15	Electric pushbutton telephone	
			30		
		Amplifier	20	Rack type	
			25	Rack type	Boarding amplifier
		Speaker	20	Embedded in ceiling	
			25	Embedded in ceiling	
		Intercom	20	Based and satellite system	
			20	Based and satellite system	
		Electric docks	20	Based and satellite system	
			15	Based and satellite system	
		TV antennae	10		20 years for masts
			15	With mast	
		TV amplifiers	20		
			15		
		Mergers and splitters	20		
			20		

	Automatic fire detection	Sensors	20	Differential type	
			20	Differential type	
		Receivers	20	50L	
			20	P-1 grade, 50L	
	Wiring appliances	Switches	(30)	Tumbler switch	From documents calculating refurbishment costs for governmental buildings.
			20	With P	
		Sockets	(30)		From documents calculating refurbishment costs for governmental buildings.
			20	With P	
	Wiring and plumbing	Electrical wiring	30		
			40	With P	
		Pipes	65	Thin steel cable duct	
			60	Thin steel cable duct	
		Cable racks	65	Steel	
			60	Steel	
Mechanical Equipment	Heating and cooling sources equipment	Steel plate boilers	15		
			15		
		Cast iron boilers	30	Steam	
			25	Steam	
		Smoke tube boilers	20		
		Turbo chillers	20		
			20		
		Reciprocating chillers	15		
			15		
		Absorption chillers	20	Steam	
			20	Steam	
		Hot air heating Pump chillers	15		
			15		
		Cooling tower	13	FRP counterflow	
			15	FRP	
	Air conditioning equipment	Compressed air handling unit	20		
			15		
		Packaged air conditioning system (water-cooled type)	20		
			15		
		Packaged air conditioning system (hot air heat pump)	15		
			15		
	Heating and cooling	Fan coil unit	20		
			15	Exposed, floor mounted	
		Fan convector	20		
			15	Exposed, floor mounted	
	Total enthalpy heat exchanger	Total enthalpy heat exchanger	20	Rotating	
			15	Rotating	
		Heat exchanger unit	20	Embedded in ceiling	
			15	Embedded in ceiling	
	Air supply and venting equipment	Blower	20	Centrifugal	
			20	Forward curved fan	
		Smoke extractor	25		
			25	Forward curved fan	
	Pumps	Lifting pump	20		
			15	Multi-level	
		Hot and cold water pump	20		
			15		
		Hot water supply and recirculating pump	20		20 years for the motor
			15	Line pump	
		Cooling water pump	20		
			15	Volute	

		Misc. waste water pump	15		
			10	Submerged	
		Fire extinguishing pump	20	Unit-type	
			27	Unit-type	
	Water tanks	Water intake tanks, elevated water tanks (made of steel plate)	20	Panel-type	
		Water intake tanks, elevated water tanks (made of FRP)		Panel-type	
				Panel-type	
		Water intake tanks, elevated water tanks (stainless steel)	30	Panel-type	
			20	Panel-type	
	Tanks	Oil tanks (underground)	30		
			25		
		Hot water tank (made of stainless steel)	20		
			15		
		Hot water tank (made of stainless steel)	25		
			15		
	Pipes	Carbon steel pipes (white) (water supply)	12		
		Carbon steel pipes (white) (drainage & ventilation)	30		
			20		
		Carbon steel pipes (white) (Firefighting)	30		
			25		
		Carbon steel pipes (white) (Coolant water)	20		
			20		
		Carbon steel pipes (black) (Steam)	20		
			20		
		PVC-lined steel pipes (water supply)	25		
			30		
		Copper pipes (hot water)	30	M	
			15	M	
		Copper pipes (coolant)	30	L	
			30	L	
		Stainless steel pipes (Cold and hot water supply)	30		
			30		
		Vinyl pipes (water supply)	20	HIVP	
			30	HIVP	
		Vinyl pipes (water drainage)	30	VP	
			25	VP	
		Cast iron pipes (drainage)	40		
			30		
		Fume pipes (water drainage)	28		
			40		
			30		
	Air ducts	Air conditioning ducts	30		
			30		
		Pan-type air vent	30		
			20		
		Universal-type air vents	30		
			20	VHS	
	Water boilers	Gas water heaters	10		
			10		
		Electrical water heaters	10		
			10		
	Fire extingui-shers	Indoor fire hydrants	30		
			20		
		Siamese connection	30		
			20		
		Halogen fire extinguisher spray head	20		
			25		
			25	Standard type	

		Halogen fire extinguisher trigger system	20		
			25		
	Hygienic equipment	Toilet bowl	30	Standard type	
			25	Standard type	
		Urinals	30		
			30		
		Wash basins	30		
			25		
		Vanity wash basins	15		
		Faucets	15		
			20		
	Amc Control equipment	Sensors	15	Electronic, temperature	
			10	Electronic, temperature	
		Regulators	15	Electronic, temperature	
			10	Electronic, temperature	
		Controllers	12	Electronic	
			10	Electronic	
		Control panels	10		
		Central monitoring board	10		
Elevators	Elevators	Elevators	30	General	

Source: CASBEE for New Construction Technical Manual 2008. (http://www.ibec.or.jp)
AND
Values of BELCA and Japan Government Building Department contained in the service life table of 'Building's LC Assessment database, 4th Revised Edition (the first edition published March 1st 2008),' Building and Equipment Life Cycle Association. (http://www.belca.or.jp/)
AND
Various International Standards such as ISO or BS.

TABLE 7: RAPIDLY RENEWABLE MATERIALS

This table lists the rapidly renewable materials for each building component. It is used to demonstrate compliance in order to achieve 2 credits under Issue MA3.

Components	**Materials**
Flooring	Bamboo Natural Linoleum Cork Other rapidly renewable materials
Panels/Partitions	Sunflower Seed Bamboo Wheat-board Other rapidly renewable materials
Cabinetry/Fittings	Wheat-board Strawboard Soy bean composite Bamboo Other rapidly renewable materials
Insulation	Cotton Straw bale Soy-based foam Other rapidly renewable materials
Other applications	

Note: no material specified shall present a fire hazard when installed.

TABLE 8: REFRIGERANT GWP

This table includes available substances that are capable of acting as refrigerants. Many are not currently used as such and some have been phased out and withdrawn from the market. It is used when assessing credit a) under Issue EL7.

Refrigerant type	GWP	Refrigerant type	GWP
R11 (CFC-11) *	4000	R32 (HCFC-32) *	580
R12 (CFC-12) *	8500	R407C (HFC-407)	1600
R113 (CFC-113) *	5000	R152a (HFC-152a)	140
R114 (CFC-114) *	9300	R404A (HFC blend)	3800
R115 (CFC-115)*	9300	R410A (HFC blend)	1900
R125 (HFC-125)	3200	R413A (HFC blend)	1770
Halon-1211	N/A	R417A (HFC blend)	1950
Halon-1301	5600	R500 (CFC/HFC) *	6300
Halon-2402	N/A	R502 (HCFC/CFC) *	5600
Ammonia	0	R507 (HFC azeotrope)	3800
R22 (HCFC-22) *	1700	R290 (HC290 propane)	3
R123 (HCFC-123) *	93	R600 (HC600 butane)	3
R134a (HFC-134a)	1300	R600a (HC600a isobutane)	3
R124 (HCFC-124) *	480	R290/R170 (HC290/HC170)	3
R141b (HCFC-141b) *	630	R1270 (HC1270 propene)	3
R142b (HCFC-142b) *	2000	R143a (HFC-143a)	4400

Source: BREEAM Office 2008 Assessor Manual (http://www.bre.co.uk/).
Notes:

- *N/A indicates that there is insufficient data available to give a GWP value.*
- *Global Warming Potential (GWP) values are based on best available data at the time of writing and are based on a 100-year time horizon. Other published data may be based on different time horizons.*
- *All CFC/HCFC refrigerants (marked *) have an ODP > 0 and as such are illegal for new installations. Existing equipment may continue to use them at present. The use of CFCs and HCFCs as refrigerants has been addressed under the Montreal protocols. Phase out programs have been agreed resulting in these substances no longer being used as refrigerants in all new build and most existing situations. The industry's favoured replacements are currently HFCs that are often potent global warming contributors.*
- *Whilst it is currently still legal to have an existing system that uses refrigerants with ozone depleting potential, it is now illegal to top up with CFCs (either new or recycled refrigerant). It will be illegal to top up with new HCFCs from 2010, and it will be illegal to top up with recycled/recovered HCFCs from 2015.*
- *Hydrocarbons and ammonia-based refrigerants have low or zero GWP and are therefore preferred long-term options. These are now widely available and are valid alternatives to HFCs in all buildings, provided health and safety issues are fully addressed.*

TABLE 9: REFRIGERANT LEAK DETECTION SYSTEMS/DEVICES

This table is used when assessing credit b) under Issue EL7.

Systems/Devices	Guidance
Handheld detectors	Include semi-conductor and corona discharge types. They do not comply with TPSI criteria.
Corona discharge detectors	Not suitable where flammable refrigerants are used, or in potentially explosive atmospheres.
Indicator dyes	Consist of fluorescent or coloured dyes added to the refrigerant to show leakage sites. The use of the dye should be approved by the compressor manufacturer. Some compressor manufacturers do not approve the use of indicator dyes, in which case either an alternative type of equipment should be used, or an alternative type of leak detection specified.
Halide torch detectors	This type of detection is only appropriate for chlorine-based substances such as CFCs and HCFCs, and should not be used in areas where naked flames are prohibited. Compounds that do not contain chlorine, e.g. HFCs, cannot be detected by this method. When awarding this credit in instances where these detectors are in use, the assessor should confirm that the refrigerant is chlorine based.
Electronic leak detectors	These must be designed to detect a certain type of, or multiple types of, refrigerant, i.e. CFC, HFC, HCFC, etc.
Standing hold test	Systems based on monitoring pressure drops within the pipe work are not necessarily compliant with the TPSI criteria. There are natural fluctuations to the pressure of the refrigerant due to changes in volume and temperature of the system, and to the ambient temperature of the surroundings. Low pressure and high pressure switches, which are standard equipment on refrigerant plant, are therefore not sufficient. Other methods exist, such as pressurising the system with a high pressure, dry nitrogen gas for a period of time and then identify whether or not the pressure drops during this time. However, this requires systems to be shut down for a period of time (usually overnight or longer).
Systems NOT based on the principle of detecting or measuring the concentration of refrigerant in air	Such systems (for example based on sensing the presence of refrigerant vapour in liquid carrying pipes) are now commercially available.

Source: BREEAM Office 2008 Assessor Manual (http://www.bre.co.uk/).

APPENDIX 6: SAMPLING PROTOCOL FOR INDOOR AIR QUALITY ASSESSMENT

This appendix serves the assessments taken place under issues IEQ 7 and IEQ 8.

As an alternative to the sampling protocol described in various international standards such as ISO's ICS 13.040: Air Quality or ASHRAE 62.1-2007: Ventilation for Acceptable Indoor Air Quality, the sampling method can be simplified based on the following rationale. This protocol seeks to reduce the number of sampling points and sampling parameters without significantly reducing the representation of IAQ.

Principle 1	**Determining the population of measurement points**

Before sampling is undertaken, the population of IAQ zone has to be defined.

- A sampling zone is defined as a region of indoor space, whether it is confined by partitions providing a physical barrier to other zones, or a part of an open indoor space within which every physical location (preferably the workstations) has the same *quality of ventilating air*, the same *distribution of the ventilating air* and the same *emission characteristics of all significant pollutants*.
- Within a zone, the pollutant concentrations of a set of pollutants are expected to be unchanged within any location in the zone, within the accuracy of the measuring instruments used.
- Air sampling zones must be defined by a suitably experienced person during an initial walkthrough survey of all spaces.
- The total number of zones forms the population of the representative air quality zones.

Principle 2	**Determining the number of sampling points**

If the zones within a building are viewed as the total population, once this is defined, the number of sampling points can be computed using classic statistical sampling theory. Determination of the number of sampling points is done using two procedures:

- The first procedure involves in grouping of similar zones into 'categories.' When zones have the same three factors as defined in Principle 1, they will be grouped together to form a 'category.' In a given category, zones are expected to have similar pollutant profiles. For example, zones within a building where the activities are the same, such as typical offices with sedentary workers and non-smoking, served with typical air conditioning systems, and with the same pollutant inventories within the zones, can be grouped together to form a category.
- The second procedure follows the definition of all the categories. The classic statistical sampling comes into effect the number of sampling points can be reduced to provide a more economical and viable monitoring schedule. Typically, the number of sampling points (N) in a category can be computed by equation (1).

$$N = \frac{t^2 S^2}{d^2} \quad (1)$$

t = number of standard deviations that account for the confidence level.
S = standard deviation for the variable to be estimated.
d = the margin of error (e.g. 10% of the mean value).

Principle 3	**Reducing the number of sampling parameters in each sampling point**

Either if the pollutant comes from outdoor sources and its concentration at the intake point is below the prescribed criteria at all times, or if the pollutant is known to have a constant emission rate and its profile relative to the ventilation rate is known and is under control at all times, this pollutant can be discounted in IAQ sampling program.

Principle 4	**Reducing the sampling time for each parameter in each sampling point**

The reduction of sampling time is based on the assumption that when a building enters into its routine operation that including the activities of the occupancy and the operation of ventilation system, the function of the zone or the pollutant inventory are ever changing, it is reasonable to assume that the pollution profiles of the target pollutants would remain similar with small changes of magnitude. When the pollutant profile is known, a snapshot of measurement at any time can be used to determine the

equivalent 8-hour exposure, and to check if any abnormal built up of the pollutant has occurred. This is particularly useful when availability of instrumentation is a problem.

Principle 5	**Choice of alternative instrumentation**

If the simpler measuring instrument using in the sampling is different from the requirement mentioned in international standards (ISO or ASHRAE) for any reason, the calibration of this measuring instrument against the standard should be undertaken in order to prove that the measuring instrument is suitable for the sampling. Therefore, the cost of sampling can be reduced.

APPENDIX 7: 'CONTROL OF AIR POLLUTION IN CAR PARK' GUIDE

This appendix provides guidance on the control of air pollution in car parks in order to achieve 1 credit under Issue IEQ9. It includes:

- *Air quality guidelines required for the protection of public health; AND*
- *Factors that should be considered in the design and operation of car parks in order to achieve the required air quality.*

Air Quality Guidelines

Carbon monoxide and nitrogen dioxide are the most relevant air pollutants inside car parks. As a generalisation, petrol engine vehicles (mainly cars) are the source of most but not all carbon monoxide in car parks and diesel engine vehicles are the sources of most but not all nitrogen dioxide. Carbon monoxide blocks the absorption of oxygen by the blood and this can lead to dizziness, unconsciousness, or death depending on the concentration. Nitrogen dioxide affects the lungs and can cause breathing difficulties, prompts asthma attacks and cause long term damage to the lungs. To provide adequate protection of the public health, the air quality inside car parks should be kept within the following concentration limits:

Air Pollutants	**Averaging time**	**Maximum Concentration $\mu g/m^3$**	**Parts per million (ppm)**
Carbon monoxide (CO)	5 minutes	115,000	100
Nitrogen dioxide (NO_2)	5 minutes	1,800	1

All limits are expressed as at reference conditions of 298 K and 101.325 kPa.

Design Considerations

Car park ventilation systems should be designed to ensure that the car park air quality guidelines, set out above, are met under all circumstances. For most cases, the NO_2 concentration in a car park is within the guideline limit as long as the CO guideline is satisfied. For car parks used by a high proportion of goods and other diesel-fuelled vehicles, NO_2 concentration becomes a more important consideration.

To meet the stated air quality guideline, good ventilation is of paramount importance. The ventilation provided must be able to provide sufficient dilution of the CO and NO_2 emitted from vehicles during peak hours as well as under the worst foreseeable operating conditions, such as queuing of vehicles within the car park. Other factors to be considered are:

- The supply and exhaust opening for the ventilation system should be distributed to ensure:
  - Even dilution and removal of air pollutants from all parts of the car park; AND
  - No possibility of any obstruction to the airflow due to debris and the like.

  Particular attention should be paid to ensure the fresh air intakes and exhaust outlets will be free from blockage, short-circuiting, and interaction with other systems and down wash due to winds.
- Sufficient standby units should be provided to meet the air quality guidelines during maintenance periods or in the event of the breakdown of the normal units.
- Separate fresh air supply should be provided to areas that are occupied regularly such as lift lobbies, pay booths and car cleaning services bay. For the main car park area, care should be taken to ensure that fresh air is under positive pressure and is supplied without contamination of the vitiated air of the car park or the ventilation exhaust.
- Exhaust air should be discharged to the atmosphere in such a manner and at such a location as not to cause a nuisance to occupants in the building or of neighbouring buildings, or to the public.

The layout of the car park should help minimise the emissions from vehicles. A few possible measures are illustrated below:

- Ramps and bends that may give rise to unnecessary congestion should be minimised.
- Exit routes should, whenever possible, be at a location with little road traffic.

- Additional entrance and/or exit for vehicles should be provided, wherever practicable, if:
    - The anticipated vehicle movement rate is high;
    - The car park has in total more than 500 parking spaces; OR
    - Queuing inside car park is anticipated.

Monitoring and Control

To ensure the air quality guidelines can always be met, the levels of CO in a car park should be monitored continuously and the measurement results linked up automatically through a tamper-proof device with the control of the ventilation system. A sample monitoring and control scheme is as follow:

<table>
<tr><th colspan="3">A Sample Monitoring and Control Scheme</th></tr>
<tr><td>1</td><td colspan="2">The monitoring system should be operated continuously with the performance specifications compatible to those mentioned in the Method IP-3 (Determination of Carbon Monoxide or Carbon Dioxide in Indoor Air) of the United States Environmental Protection Agency's Compendium of Methods for the Determination of Air Pollutants in Indoor Air (EPA/600/4-90/010) and should measure the concentration with an accuracy of 10% in the range between 11,500 μg/m^3 and 138,000 μg/m^3. If the car park does not open 24 hours/day, the system should be automatically activated at such time that it can accurately analysed and properly react to the first sample analysed immediately after the car park is open to receive entering cars.</td></tr>
<tr><td>2</td><td colspan="2">The monitoring system should include devices to detect and signal fault conditions, including erroneous response, non-response to CO concentration, or loss of power to the system. During any of these faulty conditions, the system should automatically active an alarm at a suitable location and set the ventilation system(s) for the corresponding zone/level to operate at full capacity until the faulty condition is rectified.</td></tr>
<tr><td>3</td><td colspan="2">When the monitoring system detects a change in CO concentration to fall within different set concentration ranges listed below, and such condition has been sustained at the same sampling point for four minutes continuously, the system should immediately vary the ventilation rate to exceed the value calculated in accordance with the following criteria:
<table>
<tr><th colspan="2">CO Concentration Range (μg/m^3)</th><th>Mode of Operation</th></tr>
<tr><td>a</td><td>> 90,000</td><td>Operate at full ventilation rate</td></tr>
<tr><td>b</td><td>Between 55,000 and 90,000</td><td>Operate at a rate not less than determined by the following equation:
VR = MR+ [(X-500,000) / 335,000] x (FR – MR)
VR = ventilation rate
MR = minimum ventilation rate as defined in c)
FR = design airflow rate
X = the highest CO concentration sustained for four minutes in the zone/level under consideration</td></tr>
<tr><td>c</td><td>< 55,000</td><td>Operate at the minimum ventilation rate of 25% of the FR for each zone/level (required only when that zone/level is open).</td></tr>
</table></td></tr>
<tr><td>4</td><td colspan="2">The sampling points for each zone/level should, whenever practicable, be evenly distributed spatially so that no part of the car park is more than 25 meters horizontally from a sampling point for CO monitoring. In addition, at least one sampling point should be provided at each of the entrance(s) and exit(s) of car park.</td></tr>
</table>

5	The sampling points for CO monitoring should, whenever practicable, be: - Between 3 feet and 6 feet above floor surface at positions that will allow samples to be fully representative of the local atmosphere. - At least 0.5 feet clear of walls, columns and other vertical or near vertical surfaces, and not in a position significantly influenced by either supply air or car exhaust emissions. - Closer to exhaust inlets than supply air outlets, and wherever possible, situated such that the distance from exhaust openings is 3/10 of the distance between supply air and exhaust openings.
6	All CO analysers should be checked for zero and span with standard gases of known CO concentration and calibrated and certified by a competent environmental laboratory in accordance with the manufactures' recommendations.
7	The car park management should ensure free flow of vehicles inside car park at all times. Procedures should be established to ensure no vehicle will be allowed to enter the car park once it is full or when the air quality guidelines have been exceeded. A display should be provided at the entrance of the car park to inform the users whether the air quality inside is acceptable.
8	Effective control of air pollution requires proper supervision on the maintenance and operation of the ventilation systems and the CO monitoring system. Good preventive maintenance should be employed.
9	Staff should be properly trained on their duties relating to control of air pollution.
10	The car park management should keep log of monitoring results.

APPENDIX 8: ASSUMPTIONS AND BASELINES FOR WATER CONSUMPTION

This appendix details the default assumptions for the calculation of the reduction in water use of the project building when compared with an equivalent base line space, in order to achieve 4 credits under Issue RC4.

Number of working or operational days	- The number of operational days per annum (Nop) should be obtained from the design brief or Owner's Project Requirement (OPR) document. - The number of non-operational days is equal to 365-Nop. *The same values of operational and non-operational days will be used for both the project space and the base line space.*
Occupancy considerations	- The number of occupants should be taken from the design brief, or Owner's Project Requirement (OPR) document. If this data is not obtainable then, in the absence of any other data, the occupant space allowance should be taken as 9 m^2 / person (~ 97 ft^2). - The male:female ratio should be determined from the design brief or OPR. If the data is not available then the default assumptions are as follows: o In offices, the male to female occupancy ratio is 1:1; o In public places, the male to female occupancy ratio is 1:1.25. *The same occupancy load shall apply to the project space and the baseline space.*
WC water use	- The base line building will have a single flush WC (i.e. no low flush option) with a flushing volume of 7.5 litters per flush. The water closet, cistern and flushing fitting shall be of compatible types. - For non-residential: o Males use the WC once per day. If a dual flush system is installed in the project space, it is assumed that the WC will be flushed using the high flush volume. o Females use the WC 5 times per day. If a dual flush system is installed in the project space, it is assumed that the average flush volume is equal to the average of 1 full flush and 4 low volume flushes. - For residential: residents use the WC five times per day. If a dual flush system is installed in the project space, same assumption for use of WC by females can be applied.
Water use in urinals	- For the purposes of calculation, the baseline building would have urinals fitted with 4.5 litters flush and manual controls. The urinal would be flushed after every use. Male employees each use the urinal on average for four times per day. - The water use in the project building would be based on the same number of male employees each using the urinals four times per day. The calculation should consider the actual flushing strategy employed. - An estimate of the potential water savings is not able to be determined as it would be influenced by the number of male employees and the time interval of flushing.

Hand washing in rest rooms	- Number of hand wash operations per occupant per day = 5. - Hand washing time = 10 seconds. - For the base line building, the tap flow rate is 8.3 litters/min (4 bar). *Note that to obtain significant savings, the project space would need to install automatic controls such as proximity sensors to reduce the tap operation time to less than the default assumption of 10 seconds per hand washing operation.*
Water use in pantries/ kitchens	- For non-residential: o Number of pantry tap operations per occupant per day = 1. o Baseline faucet flow rate = 8.3 litres/min (4 bar). o Duration of use = 15 seconds. o Utensil washing operation carried out by hand = 6 litters of water per operation. - For residential: o Number of use per resident per day = 4. o Baseline faucet flow rate = 8.3 litres/min (4 bar). o Duration of use = 60 seconds.
Showers	- Number of use of shower per occupant per day = 0.1 (for non-residential). - Number of use of shower per resident per day = 1 (for residential). - The baseline shower flow rate = 9.5 litters/min (4 bar). - Shower duration = 5 minutes (300 seconds).
Other appliances/ equipment	Justification for capacities of appliance/equipment used in the benchmark building shall be provided by making reference to regulations, standards, guides and other publication published by various authorities

Source: these assumptions and baselines are based on the methods in:

- *USGBC, LEED 2009 for Core & Shell development project checklist. (http://www.usgbc.org/)*
- *Hong Kong BEAM Plus for New Buildings. Version 1.1-2010. (http://www.hk-beam.org.hk)*

TABULAR DATA FORMAT:
Water consumption of flow devices (faucets, showers, etc.):

Device/ equipment	Rated Flow rate	Duration of each operation	Daily Number of Uses	Daily Water Use

Water consumption of utensil washing operation by hand:

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

The calculations can be summarised as follow:

	Project space	Baseline space
Estimated total daily consumption (litters)		
Estimated total annual consumption (litters)		
Estimated annual savings (litters) and percentage:		

APPENDIX 9: NO_X EMISSIONS

This appendix provides guidance on calculation, conversion and correction related to NO_X emissions in order to achieve 3 credits under Issue EL8.

Calculating NO_X Emission Levels from Combined Heat & Power (CHP) Systems

Where CHP systems are present or specified, only the heat-related emissions are considered for the assessment. The NO_X emissions are allocated to heat and electricity in line with the respective power outputs. This is done using a NO_X emission rate for the electrical output equivalent to the current rate for grid electricity, and allocating the remaining NO_X to the heat output. Only the heat related component is then compared with the credit scale. The following formula should be used to determine this:

$$X = (A - B) / C$$

Where:

X = NO emissions per unit of heat supplied (mg/kWh heat).

A = NO_X emissions per unit of electricity generated (mg/kWh^{elec}) i.e. the NO_X emitted by the CHP system per unit of electricity generated. This figure should be obtained from the installer/supplier of the system.

B = NO_X emissions per unit of electricity supplied from the grid (mg/kWh^{elec}) this should be assumed to be 1200mg/kWh^{elec}.

C = Heat to Electricity Ratio of the CHP scheme.

The above methodology determines the net NO_X emissions from CHP-generated electricity compared with central generation of electricity and allocates this amount to the heat production. Where X is calculated to be negative, it should be assumed to be zero.

Where heat is provided by more than one system, an average NO_X emission rate should be used based on the ratio of power outputs from each source, i.e. multiply the emissions of each boiler by the percentage of heat demand it supplies and total these values. This is likely to be the case where a CHP system has been sized on the base power demand rather than the heat demand and therefore a secondary heating system is required. The following formula can be used:

$$\text{Average } NO_X \text{ Emission Rate} = [N_1 \times (H_1/H_T)] + [N_2 \times (H_2/H_T)] \ldots\ldots + [N_n \times (H_n/H_T)]$$

Where:

N_1 = NO_X emissions rate for source 1.

N_2 = NO_X emissions rate for source 2.

N_n = NO_X emissions rate for source n.

H_T = Total heat output from all sources.

H_1 = Heat output from source 1.

H_2 = Heat output from source 2.

H_n = Heat output from source n.

Conversion Factors

Manufacturers should be asked to supply dry NO_X emissions data in mg/kWh. Where this is not possible, the assessor may use the following conversion factors to convert figures in ppm, mg/MJ, mg/m^3 or wet NO_X. It should be noted that these conversion factors assume worst-case efficiencies and are likely to give conservative answers. This could have the effect of lowering the number of credits achieved.

- Figures in mg/m^3 should be multiplied by 0.857 in order to gain emissions in mg/kWh. A conversion may also be necessary for data not calculated at 0% excess oxygen (see below).
- Figures in parts per million (ppm) should be multiplied by 1.76 in order to obtain mg/kWh. A conversion may also be necessary for data not calculated at 0% excess oxygen (see below).
- Figures in mg/MJ should be divided by 3.6 in order to show emissions in mg/kWh (1 kWh = 3.6 MJ). A conversion may also be necessary for data not calculated at 0% excess oxygen (see below).
- Issue EL8's criteria are based on dry NO_X values – almost all manufacturers will quote emissions in dry NO_X. However, if wet NO_X figures are supplied, these should be converted to dry NO_X. This can be done by multiplying the wet NO_X figure by 1.75.

Excess Oxygen Correction

If a NO_X emission rate is quoted by the manufacturer in mg/m^3 or ppm, then it should be established at what % excess oxygen this emission was measured. The greater the amount of excess oxygen in the flue gases at the time of measurement, the more 'diluted' the NO_X. It is therefore important to convert any emission rate back to 0% excess oxygen. The following conversion factors can be used for the most frequently used rates supplied by manufacturers:

% Excess O_2	Conversion (c)
3 %	x 1.17
6%	X 1.40
15%	X 3.54

Conversion factor: $c = 20.9/(20.9 - x)$

Where x = % excess O_2 (NOT excess air) and 20.9 is the percentage of O2 in the air.

Source: BREEAM Office 2008 Assessor Manual (http://www.bre.co.uk/).

APPENDIX 10: CALCULATING THE CHANGE IN ECOLOGICAL VALUE

This appendix provides guidance on calculating the change in ecological value of the site in order to achieve 2 credits under Issue EL15. The change in ecological value of the site is calculated in four steps:

a) Step 1: define the landscape type based on the typology of the sites and the table below:

General Landscape Types	
Pastoral	Mainly grasslands.
Arable	Land dominated by cereals and other arable crops, as well as intensively managed grasslands.
Marginal Upland	Areas which are on the periphery of the uplands, and which are dominated by mixtures of low intensity agriculture, forestry and semi-natural vegetation.
Upland	Land generally above a height suitable for mechanised farming and frequently dominated by semi-natural vegetation.
Building & Derelict Land	Land currently or previously occupied by buildings.
Urban Mosaic	A complex mix of habitats located within cities, towns, or villages, which will include: buildings, hard standing, pockets of disused land and scrub, and areas of managed green spaces, (i.e. gardens, allotments, and parkland). Parklands can be characterised as being accessible to the public and will usually be intensively managed spaces, consisting of a matrix of grassland (grazed or mown) with scattered trees at various densities and areas of dense planting. *This landscape type is to be used only when no other landscape type in the table is more appropriate / predominates.*

b) Step 2: define and calculate the area (m^2) of each vegetation-plot type using the table below and building or hard landscaped area, both before and after development, for the site.

Vegetation Plot Types	
Crops/weeds	Mostly highly disturbed vegetation of arable fields and their boundaries; includes cereal and vegetable crops.
Tall grassland/Herb	Typical vegetation of overgrown lowland field boundaries, ditches and roadside verges.
Fertile Grassland	The bulk of agriculturally improved grasslands, intensive pasture and silage crops; but also includes mown areas of improved grasslands for recreational and amenity purposes, as well as re-sown roadside verges.
Infertile Grassland	A diverse group of semi-improved and semi-natural grasslands; includes acidic to basic, wet to dry grasslands, and tall-herb vegetation mainly present in the lowlands; often found on stream sides and roadside verges.
Lowland Wooded	Wooded vegetation of hedges and broadleaved woods in the lowlands.
Upland Wooded	A varied group of acidic vegetation types usually associated with upland woods, including: semi-natural woodland; conifer plantations; bracken and wooded streamsides.
Moorland Grass/Mosaic	Typically grazed moorland vegetation, including extensive upland acidic and peaty grassland, and species-rich but very localised flushes.
Heath/Bog	Mostly heather moorland, blanket bog and montane heath, but also lowland heath and raised bog.
Wildlife Garden Planting	Garden planting that uses native species and/or those that have a known attraction or benefit to local fauna, based on the advice of a suitably qualified ecologist.

c) Step 3: Define the number of plant species for each vegetation plot type using the table below. If an ecologist has been appointed, actual number of plant species (before and after construction), based on the ecologists site survey should be used instead of this table.

Number of Plant Species by Plot for Different Landscape Types										
Landscape Types / Types of Plot	Arable	Pastoral	Marginal Upland	Upland	Existing Building/ Hard Landscaped Areas	Urban Mosaic	Derelict Land < 1 Year	Derelict Land < 10 Years	Derelict Land < 20 Years	Derelict Land < 30 Years
Crops/weeds	5.4	8.3	-	-	-	-	-	-	-	-
Tall grassland/Herb	12.7	15.0	-	-	-	17.6	0	6.3	15.8	21.1
Fertile Grassland	11.6	12.7	15.3	-	-	11.6	0	4.6	11.5	15.3
Infertile Grassland	17.1	17.6	21.1	-	-	17.6	0	6.3	15.8	21.1
Lowland Wooded	12.9	12.5	-	-	0	13.8	-	-	-	-
Upland Wooded	-	12.7	13.8	20.4	0	13.8	-	-	-	-
Moorland Grass/Mosaic	-	2.0	20.4	21.0	-	-	-	-	-	-
Heath/Bog	-	-	14.3	20.0	-	-	-	-	-	-
Hard Landscaping	0	0	0	0	0	0	0	0	0	0
Buildings	0	0	0	0	0	0	0	0	0	0
Garden Planting (typical)	-	-	-	-	0	0	0	0	0	0
Wildlife Garden Planting *	-	-	-	-	0	0	0	0	0	0

-: Insufficient data to produce national averages, as not all vegetation plot types are found in all landscaped types.

**: Only where the rule concerning wildlife garden planting in Step 2 has been met can actual species values be used.*

***Wildlife garden planting:** 'Garden planting (typical)' and 'wildlife garden planting' will always record a score of zero, unless a suitably qualified ecologist has been appointed: whereby they will make the distinction between 'typical' and 'wildlife' garden planting species and record 'actual' species numbers.*

***Derelict Sites**: The ecological value of derelict sites is time dependent; a linear scale has been used to determine intermediate values between zero ecological value at one year from dereliction/demolition to a value at 30 years based on marginal upland figures. This presents a worst-case figure that can be amended on the advice of a suitably qualified ecologist.*

Source: BREEAM Office 2008 Assessor Manual (http://www.bre.co.uk/).

d) Step 4:

The change in ecological value is calculated by comparing the diversity (number and area) of plant species on the site pre and post construction. The ecological value of the site is expressed as an area-weighted average of plant species for the site's landscape type. This enables users to use this as an indicator of the proposed development's impact on the site's existing ecological value.

A simple example of the calculation is described below:

1. Calculate the ecological value of a previously developed existing site:

   A 4000 m^2 existing site consists of the following types of land:
   - 3000 m^2 hard landscaping = 0 species.
   - 1000 m^2 urban mosaic - infertile grassland = 17.6 species (based on the Table 'Number of Plant Species by Plot for Different Landscape Types' in Step 3).

   The ecological value of the existing site is calculated as follows, for each plot type:

   Number of species on plot type x plot type area as % of total area

   Therefore, for the example site:
   - Hard landscaping: 0 species x (3000 m^2/4000 m^2) = 0 species.
   - Urban mosaic-infertile grassland: 17.6 species x (1000 m^2/4000 m^2) = 13.2 species.

   Ecological value of the existing site = 0 + 13.2 = 13.2 species.

2. Calculate the ecological value of the proposed site:

   The 4000 m^2 post-construction site consists of the following types of land:
   - 3000 m^2 of building = 0 species.
   - 500 m^2 of hard landscaping = 0 species.
   - 500 m^2 has remained as urban mosaic-infertile grassland = 17.6 species.

   The ecological value of the proposed site is as follows:
   - Building: 0 species x (3000 m^2/4000 m^2) = 0 species.
   - Hard landscaping: 0 species x (500 m^2/4000 m^2) = 0 species.
   - Urban mosaic-infertile grassland: 17.6 species x (800 m^2/4000 m^2) = 2.2 species.

   Ecological value of the proposed site = 0 + 0 + 2.2 = 2.2 species.

3. The ecological impact is the difference between the two ecological values:
   Change in ecological value: 2.2 – 13.2 = -11 species.

   Therefore, no credit is achieved.