

BS 8536-1:2015



BSI Standards Publication

Briefing for design and construction –

Part 1: Code of practice for facilities management (Buildings infrastructure)

bsi.

...making excellence a habit.™

Publishing and copyright information

The BSI copyright notice displayed in this document indicates when the document was last issued.

© The British Standards Institution 2015

Published by BSI Standards Limited 2015

ISBN 978 0 580 88550 1

ICS 03.080.99; 91.040.01

The following BSI references relate to the work on this document:

Committee reference FMW/1

Draft for comment 15/30315620 DC

Publication history

First published as BS 8536, October 2010

First published as BS 8536-1, July 2015

Amendments issued since publication

Date	Text affected
------	---------------

Contents

Foreword *ii*

0	Introduction	1
1	Scope	2
2	Normative references	2
3	Terms, definitions and abbreviations	3
4	Design and construction for operability	8
5	Work stages	24

Annexes

Annex A (informative)	Brief checklist (example)	67
Annex B (informative)	Environmental performance evaluation (example)	69
Annex C (informative)	Social (i.e. functionality and effectiveness) performance evaluation (example)	70
Annex D (informative)	Economic (cost) performance evaluation (example)	71
Annex E (informative)	Responsibility assignment matrices (examples)	73
Annex F (informative)	Risk and opportunity assessment (example)	74
Annex G (informative)	Plain language questions for the owner (examples)	75
Annex H (informative)	Stakeholder identification	77
Annex I (informative)	Stakeholder impact analysis	78
Annex J (informative)	Activity checklist	79

Bibliography 85

List of figures

Figure 1 – Work Stages	12
Figure 2 – Overall approach highlighting the importance of performance reviews and feedback	13
Figure 3 – Asset-project model and feedback	23
Figure I.1 – Stakeholder impact/probability matrix	79

List of tables

Table E.1 – Typical tasks and allocated roles (extract)	73
Table E.2 – Typical design responsibility matrix incorporating information exchanges (extract)	73
Table F.1 – Risks and opportunities	74
Table J.1 – Summary of main activities by focus area and work stage	80

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 88, an inside back cover and a back cover.

Foreword

Publishing information

This Part of BS 8536 is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 July 2015. It was prepared by Technical Committee FMW/1, *Facilities management*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This Part of BS 8536 supersedes BS 8536:2010, which is withdrawn.

Relationship with other publications

BS 8536, *Briefing for design and construction*, will eventually comprise two parts:

- *Part 1: Code of practice for facilities management (Buildings infrastructure); and*
- *Part 2: Code of practice for asset management (Linear and geographical infrastructure).*

Information about this document

The initial drafting of this British Standard was produced in association with BIS as part of their ongoing programme of support for standardization.

Briefing for design and construction focuses on those aspects of design, construction, testing and commissioning, handover and start-up of operations that are concerned with achieving the required operational performance of a new or refurbished asset/facility. These include, but are not limited to, overall concept, context, uses, access, visual form, environmental impact, space, internal environment, durability, adaptability, usability and engineering performance.

This revision introduces the following principal changes:

- broadening of the scope of the standard to take account of operational requirements during design, construction, testing and commissioning, handover, start-up of operations and during defined periods of aftercare;
- the incorporation of the principles of soft landings (3.1.51);
- integration of comprehensive information management with the requirements for post-occupancy evaluation (POE) to strengthen the link between asset/facility owners, operators, operations teams and facility managers, as appropriate, and the design and construction team to assure performance of the design and the operational asset/facility;
- cross-referencing of information requirements associated with “Level 2 BIM” in accordance with PAS 1192-2, PAS 1192-3 and BS 1192-4; and
- updating the retained content to align with current industry best practices in briefing.

The aim is three-fold: to improve the focus of the supply chain on performance in use; to extend supply chain involvement through to operations and defined periods of aftercare; and to involve the operator, operations team or facility manager, as appropriate, from the outset.

Whilst this standard assumes the use of “Level 2 BIM” for projects, the adoption of soft landings (see 3.1.51) is not precluded where “Level 2 BIM” cannot be achieved across the project.

This standard forms part of an existing set of standards connected with facilities management.

This standard broadly aligns with the principles of *The soft landings framework* published by UBT and BSRIA [1] and the principles identified in *Government Soft Landings* [2]. Soft landings (3.1.51) is concerned with the smooth transition from design and construction into operation and use of an asset/facility. It advocates close collaboration during briefing, design, construction and handover between the design and construction team and the operator, operations team or facilities manager, as appropriate, in matters affecting operations and end-users, in order to maintain focus on the required outcomes.

Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

The word “should” is used to express recommendations of this standard. The word “may” is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the Clause. The word “can” is used to express possibility, e.g. a consequence of an action or an event.

Notes and commentaries are provided throughout the text of this standard. Notes give references and additional information that are important but do not form part of the recommendations. Commentaries give background information.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

0 Introduction

This British Standard considers matters relating to projects for the delivery of assets/facilities according to defined operational requirements, including maintenance, and expected performance outcomes. For the purpose of this British Standard, the term “design and construction team” covers the collective efforts of designers, constructors, subcontractors, operators, operations teams, facility managers and other specialists, representing the disciplines and skill-sets engaged in the delivery of a new asset/facility or the refurbishment of one existing. An integrated design and construction team offers benefits in terms of coordinated design and problem solving, as well as consideration of buildability and operational impacts. This British Standard emphasizes the importance of adopting a whole-life view of an asset/facility; not solely its design and construction or refurbishment. In this regard, it is important to recognize that a vast amount of information and data about an asset/facility is generated and exchanged during its lifetime and that a security-minded approach to the handling of such information and data will need to be adopted.

The principle of buildability is widely applied in design. However, the principle of operability has not historically been considered to the same extent. Design decisions have to be based upon accurate and relevant information and data, and their impact on operational needs has to be understood before they are committed to construction work and/or installation. The most effective time to comment on the suitability or effectiveness of design is before it is finalized. Testing assumptions during design is necessary to understand how the asset/facility will perform in operation. Whilst it is too late to comment on the design of the asset/facility once it is operational, systematic measurement, analysis, comparison and feedback can be useful in informing the design of future assets/facilities.

This British Standard is intended to complement and strengthen briefing practices and procedures by:

- a) promoting the early involvement of the operator, operations team or facility manager, as appropriate; and
- b) extending the commitment on the part of the design and construction team to aftercare post-handover of the asset/facility and its correct, safe, secure and efficient operation in line with environmental, social, security and economic performance targets.

The requirements of inclusive design and of managing design in construction have been incorporated to anticipate the implications for managing assets/facilities and their environments effectively and inclusively when they become operational. This British Standard outlines the primary activities, information, questions and deliverables to be addressed by the designers, constructors, subcontractors and other specialists to support their work and so ensure that the asset/facility owner and the operator, operations team and facility manager, as appropriate, are provided with as much certainty as possible in regard to the required operational performance of the asset/facility.

This British Standard broadly aligns with the principles of *The soft landings framework* published by UBT and BSRIA [1] and the principles identified in *Government Soft Landings* [2].

1 Scope

This Part of BS 8536 gives recommendations for briefing for design and construction to ensure that the design takes account of the expected performance of the asset/facility in use over its planned operational life. It is applicable to the provision of documentation supporting this purpose during design, construction, testing and commissioning, handover, start-up of operations and defined periods of aftercare.

This British Standard is not intended to provide detailed guidance on design or construction, but is concerned with information and data that are needed in order that due consideration can be given to operability and performance requirements for the new or refurbished asset/facility. It does not cover decommissioning or other end of life activities.

This British Standard is intended for use by individuals and organizations preparing or contributing to design, construction and operations, in both the public and private sectors, including owners refurbishing an existing asset/facility, organizations procuring a new asset/facility, and the designers, constructors, subcontractors, operators, operations teams, facility managers and other specialists engaged in such activities.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 1192:2007, *Collaborative production of architectural, engineering and construction information – Code of practice*

BS 1192-4, *Collaborative production of information – Part 4: Fulfilling employer's information exchange requirements using COBie – Code of practice*¹⁾

PAS 1192-2, *Specification for information management for the capital/delivery phase of construction projects using building information modelling*²⁾

PAS 1192-3, *Specification for information management for the operational phase of assets using building information modelling*³⁾

PAS 1192-5, *Specification for security-minded building information modelling, digital built environments and smart asset management*

¹⁾ This standard also gives an informative reference to BS 1192-4:2014.

²⁾ This standard also gives an informative reference to PAS 1192-2:2013.

³⁾ This standard also gives an informative reference to PAS 1192-3:2014.

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purpose of this British Standard the following terms and definitions apply.

3.1.1 access

ability of reaching and using a service or facility
[SOURCE: BS ISO 16439:2014, 3.2]

3.1.2 accessibility

ease of reaching and using a service or facility
[SOURCE: BS ISO 11620:2014, 2.2]

3.1.3 activity

task that is needed to produce a deliverable

3.1.4 adaptability

possibility of changing characteristics such as volume, function or space in order to meet new demands or needs

3.1.5 aftercare

defined period post-handover of an asset/facility in which the design and construction team passes on information and knowledge to the operator, operations team or facility manager, responds to queries and problems, and monitors and reviews the asset's/facility's performance.

3.1.6 as-constructed information

expression of the design, its working detail, construction work and/or installations, functions and operation and maintenance needs of an asset/facility in a form suitable for use in managing that asset/facility

3.1.7 asset

item, thing or entity that has potential or actual value to an organization
[SOURCE: BS ISO 55000:2014, 3.2.1]

3.1.8 asset information model (AIM)

data and information that relate to assets to a level required to support an organization's asset management system
[SOURCE: PAS 1192-3:2014, 3.1.4, modified]

3.1.9 asset information requirements (AIR)

data and information requirements of the organization in relation to the asset(s) for which it is responsible
[SOURCE: PAS 1192-3:2014, 3.1.5, modified]

3.1.10 asset management

coordinated activity of an organization to realize value from assets
[SOURCE: BS ISO 55000:2014, 3.3.1]

3.1.11 basis for design

information and data concerning the required function, form, layout, specification and operation of an asset/facility amongst other matters

3.1.12 brief

working document which specifies at any point in time the relevant needs and aims, resources of the client and user, the context of the project and any appropriate design requirements within which all subsequent briefing (when needed) and designing can take place

[SOURCE: BS 7832:1995, ISO 9699:1994, 2.1]

NOTE Annex A offers an example of a "Brief checklist".

3.1.13 briefing

process of identifying and analysing the needs, aims and constraints (the resources and the context) of the client and the relevant parties, and of formulating any resulting problems that the designer is required to solve

[SOURCE: BS 7832:1995, ISO 9699:1994, 2.2]

3.1.14 buildability

degree to which the design of a planned asset/facility assists its construction and utilization

3.1.15 building information modelling (BIM)

process of designing, constructing or operating a building or infrastructure asset using electronic object-oriented information

[SOURCE: PAS 1192-2:2013, 3.7]

3.1.16 carbon emissions

polluting carbon substances released into the atmosphere

3.1.17 carbon metric

measure of the weight of carbon dioxide equivalent (CO₂-eq) emitted per square metre per annum (based on greenhouse gas emissions over a 100-year period), expressed as kgCO₂-eq/m²/annum per building type

3.1.18 commissioning

process by which equipment, a system, a facility or a plant that is installed, is completed or near completion is tested to verify if it functions according to its design specification and intended application

[SOURCE: BS ISO 50004:2014, 3.1.1]

3.1.19 common data environment (CDE)

single source of information for any given project, used to collect, manage and disseminate all relevant approved project documents for multidisciplinary teams in a managed process

[SOURCE: PAS 1192-2:2013, A.30]

3.1.20 deliverable

product or service as an outcome of a process

3.1.21 design review protocol

procedure for ensuring a structured and systematic review of a design at defined points in the project life cycle

3.1.22 digital plan of work (dPoW)

generic schedule of phases, roles, responsibilities, assets and attributes, made available in a computable form

[SOURCE: BS 1192-4:2014, 3.3]

- 3.1.23 employer's information requirements (EIR)**
pre-tender document setting out the information to be delivered, and the standards and processes to be adopted by the supplier as part of the project delivery process
[SOURCE: PAS 1192-2:2013, 3.21]
- 3.1.24 end-user**
person receiving asset/facility-related services
[SOURCE: BS EN 15221-1:2006, 2.4, modified]
- 3.1.25 external envelope**
roof and facade including openings
- 3.1.26 facilities management**
integration of processes within an organization to maintain and develop the agreed services that support and improve the effectiveness of its primary processes and activities
[SOURCE: BS EN 15221-1:2006, 2.5]
- 3.1.27 facility**
tangible asset that supports an organization
[SOURCE: BS EN 15221-1:2006, 2.6]
- 3.1.28 facility handbook**
organized collection of documentation covering the operation of an asset/facility
- 3.1.29 facility-related service**
support provision to the primary processes and activities of an organization, delivered by an internal or external provider
- 3.1.30 flawless start-up**
fault-free commencement of operations
[SOURCE: BS 8587:2012, 3.1.15]
- 3.1.31 handover**
act of passing responsibility for, and control over, an asset/facility to the owner or operator following testing and commissioning
- 3.1.32 impact**
any change that might be adverse or beneficial
[SOURCE: BS ISO 15392:2008, 3.13]
- 3.1.33 inclusive design**
design that seeks to include everyone irrespective of needs, circumstances or identity
- 3.1.34 information exchange**
structured collection of information at one of a number of predefined stages of a project
[SOURCE: PAS 1192-2:2013, 3.25, modified]
- 3.1.35 key performance indicator (KPI)**
measure that provides essential information about the performance of asset/facility-related services delivery
[SOURCE: BS EN 15221-1:2006, 2.13, modified]
- 3.1.36 occupant**
user who spends a significant proportion of their time in or about a facility

- 3.1.37 operability**
capable of being put into use as intended
- 3.1.38 operational strategy**
overall approach to managing the production or use of an asset/facility
- 3.1.39 operations team**
functional group responsible for the day-to-day running and maintenance of an asset/facility
- 3.1.40 operator**
organization responsible for the day-to-day operation of an asset/facility
- 3.1.41 organizational information requirements (OIR)**
data and information required to achieve the organization's objectives
[SOURCE: PAS 1192-3:2014, 3.1.26]
NOTE The management activities leading to OIR are the equivalent of the employer's key decision points in PAS 1192-2.
- 3.1.42 owner**
individual or organization owning or procuring an asset/facility
NOTE This can refer to both existing and prospective owners.
- 3.1.43 performance**
ability to fulfil required functions under intended use conditions or behaviour when in use
[SOURCE: BS ISO 15392:2008, 3.16]
- 3.1.44 plain language question**
request for information that is expressed in simple, easy-to-understand terms
- 3.1.45 post-occupancy evaluation (POE)**
process of evaluating an asset/facility after it has been completed and is in use to understand its actual performance against that required and to capture lessons learned
- 3.1.46 project information model (PIM)**
information model developed during the design and construction phase of a project
[SOURCE: PAS 1192-2:2013, 3.35]
- 3.1.47 project execution strategy**
high-level statement of the intentions and arrangements for a project
- 3.1.48 quality**
degree to which a set of inherent characteristics fulfils requirements
[SOURCE: BS ISO 9000:2005, 3.1.1]
- 3.1.49 scope of work**
design, construction work and/or installation, testing and commissioning, handover and start-up activities necessary to deliver an operational asset/facility
- 3.1.50 service level**
complete description of requirements of a product, process or system, with their characteristics
[SOURCE: BS EN 15221-3:2011, 3.1.11]

- 3.1.51 soft landings**
process for the graduated handover of a new or refurbished asset/facility, where a defined period of aftercare by the design and construction team is an owner's requirement that is planned and developed from the outset of the project
- 3.1.52 stage**
division of a standardized process map for the acquisition of a facility, at some of which the requirements can be delivered
[SOURCE: PAS 1192-2:2013, 3.22]
- 3.1.53 stakeholder**
person, group or organization that has interests in, or can affect, be affected by or perceive itself to be affected by, any aspect of the project
[SOURCE: BS ISO 21500:2012, 2.14]
- 3.1.54 stakeholder impact analysis**
method for evaluating the influence that stakeholders possess in regard to an organization, asset/facility or project
- 3.1.55 statement of needs**
expression of the objectives and needs of an individual or organization and the extent to which they are likely to be satisfied by an asset/facility
- 3.1.56 steady state**
stable operation and use
- 3.1.57 value improving practice**
practice with a demonstrated, statistically-reliable connection between its use and a better outcome

3.2 Abbreviations

AIM	Asset Information Model
AIR	Asset Information Requirements
BIM	Building Information Modelling
BREEAM	Building Research Establishment Environmental Assessment Method
BUS	Building Use Studies
CAFM	Computer-aided Facilities Management
CDE	Common Data Environment
COBie	Construction Operations Building information exchange
DQI	Design Quality Indicator
EIR	Employer's Information Requirements
ERP	Enterprise Resource Planning
HSSE	Health, Safety, Security and Environment
KPI	Key Performance Indicator
LEED	Leadership in Energy and Environmental Design
OIR	Organizational Information Requirements
PIM	Project Information Model
POE	Post-occupancy Evaluation
RASCI	Responsible, Accountable, Support, Consulted and Informed

4 Design and construction for operability

4.1 Key principles and requirements

COMMENTARY ON 4.1

Design and construction for operability takes into consideration the needs of the owner, operator, end-users and other key stakeholders of the new or refurbished asset/facility. An asset/facility is likely to hold its value or benefit for the owner if it is efficient, trouble free and represents best value in terms of operation.

This standard broadly aligns with the principles of The soft landings framework published by UBT and BSRIA [1] and the principles identified in Government Soft Landings [2].

The overarching principles are that the project should take account of the operational requirements and expected performance outcomes for the new or refurbished asset/facility from the outset, through all work stages (see 4.5) and into operation. Design and construction should be guided by these requirements and be followed by defined periods of aftercare to ensure that the owner, operator and/or end-users are able to derive the expected benefits from the asset/facility.

NOTE 1 Projects are set up for success from the outset. Otherwise, they are unlikely to achieve their expected objectives or match the operational performance required by the owner, operator and end-users where these are known. This implies an emphasis at the front end of the project, where the ability to influence changes in design is relatively high and the cost of making those changes is relatively low. It involves developing sufficient strategic definition through which the owner can articulate requirements and address risk and uncertainty then make the decision to commit resources to the project in a controlled manner.

These principles should be supported by the following.

- a) The owner should be capable of articulating the business case for the project, its objectives and the required performance of the asset/facility (see 5.1.1). The owner should seek appropriate professional advice where any aspect cannot be adequately defined.
- b) The owner should be capable of expressing the security needs for the project and the ongoing operation of the asset/facility. The owner should seek appropriate professional advice where any aspect cannot be adequately defined. Where the project relates to a sensitive asset/facility, the owner should appoint a built asset security manager (see PAS 1192-5).
- c) An evidence-based approach to design and construction should be adopted that is driven by outcomes that are explicit and measurable, wherever possible, and which reflect the requirements of the owner, operator, end-users and other key stakeholders in regard to the operational performance of the asset/facility (see 4.2).
- d) Clear targets should be set for the expected outcomes at the start of the project (see 4.3), which should be aligned with the owner's business objectives, as reflected in the business case (see 5.1.1), and be capable of being cascaded through the supply chain. These targets should be reviewed at defined information exchange points within work stages (see PAS 1192-2, PAS 1192-3, BS 1192-4 and 4.9.4) and, finally, during operation of the asset/facility.
- e) The appointment of the design and construction team (see 4.6.6 and PAS 91) should incorporate a commitment to defined periods of aftercare (see 5.1.5).
- f) Post-occupancy evaluation (POE) and other reviews of performance should be undertaken with the involvement of the design and construction team

during a defined period of extended aftercare and these, together with the lessons learned, should be recorded and stored in an asset information model (AIM) so that they are available to the operator, operations team or facility manager, as appropriate, and other parties determined by the owner (see 5.8.2.3.4).

- g) The transition from design through construction and into operation should include the transfer of project information and data for operational purposes from the project information model (PIM) to the asset information model (AIM) (see PAS 1192-2, PAS 1192-3, PAS 1192-5 and 4.9.4).
- h) The adoption of “Level 2 BIM” should be considered to provide a fully populated asset data set to support asset/facilities management through the use of the owner’s defined enterprise system during the operational life of the asset/facility (see BS 1192:2007, PAS 1192-2, PAS 1192-3, BS 1192-4, PAS 1192-5 and 4.9.4).

NOTE 2 PAS 91 provides detailed guidance on the prequalification of appointees.

NOTE 3 The common data environment (CDE) provides a single source of information for the project (see BS 1192:2007, PAS 1192-2, PAS 1192-3 and 4.9.4).

NOTE 4 “Level 2 BIM” represents federated file-based digital information with some automated connectivity (see PAS 1192-2 and PAS 1192-3).

NOTE 5 The owner might utilize an enterprise system [e.g. enterprise resource planning (ERP) system] to support asset/facilities management. In other cases, a computer-aided facilities management (CAFM) system might be used for this purpose. BS 8587 provides guidance on CAFM systems.

4.2 Evidence-based approach

This standard recommends an evidence-based approach to design and construction, where decisions should be based on the best available information from multiple sources, including but not limited to the owner’s business objectives, current operations, the lessons learned from previous projects, design modelling, and simulation and performance evaluations. This approach should be extended to include the provision of evidence to support proposals and recommendations prepared by the design and construction team for the owner’s approval. Information and data for these purposes should be handled, stored and protected in accordance with the owner’s security requirements (see PAS 1192-5).

NOTE 1 BS 7000-4 provides guidance on the management of design, including a general approach to briefing.

NOTE 2 Evidence-based design and construction can be expected to result in improvements to the project’s outcomes and the achievement of more exacting operational requirements with respect to environmental, social, security and economic performance, including demonstration of the owner’s, operator’s and end-users’ satisfaction with the asset/facility in operation.

NOTE 3 Information and data related to the owner’s current and future business objectives and operations might include sensitive commercial/economic details and intellectual property that need to be afforded appropriate and proportionate protection.

4.3 Outcomes

The following performance outcomes should be set at the Strategy work stage and monitored during each subsequent work stage up to Operation and End of life (see 4.5), with post-occupancy evaluation (POE) during a defined period of extended aftercare (see 5.8.2.3) used as the basis for measuring operational performance:

- a) Environmental – the asset/facility should meet performance targets such as those for energy use, CO₂ emissions, water consumption and waste reduction and/or others defined by the owner and operator [see BS EN 15643-2 and Annex B for an approach and typical measures forming a part of POE].
- b) Social (i.e. functionality and effectiveness) – the asset/facility should be designed and constructed to meet the functional and operational requirements of the owner such as the overall concept, context, uses, access, visual form, space, internal environment, durability and adaptability, and in operation should meet the operator's and end-users' requirements, such as utility, usability, safety, maintainability, security, inclusiveness and comfort [see BS EN 15643-3 and Annex C for an approach and typical measures forming a part of POE].
- c) Security – the asset/facility and the creation, use, storage and disposal of asset/facility-related information and data should meet the security requirements of the owner, operator, operations team or facility manager, as appropriate, and end-users (see PAS 1192-5 for the development of an appropriate security-minded approach).
- d) Economic – the asset/facility should meet performance targets for capital cost and operational cost, which should be considered side-by-side to enable whole-life costs to be calculated [see BS EN 15643-4 and Annex D for an approach and typical measures forming a part of POE].

Performance outcomes and targets should be specific to the project and should be verified in each work stage (see 4.5 and Clause 5). As far as possible, a quantitative approach should be taken to measuring performance.

NOTE A number of methods exist for measuring performance. One example is the Design Quality Indicator (DQI) [3], which is a five-stage method for evaluating the design over the project life cycle against three quality principles: functionality, build quality and impact. In the context of POE, the BUS methodology [4] quantifies occupant satisfaction, reveals features of value or concern in the asset/facility and provides feedback. BREEAM In-Use [5] is a scheme to help the owner, operator, operations team or facility manager, as appropriate, reduce the operational costs and improve the environmental performance of existing assets/facilities.

4.4 Processes

The following processes should be measured principally through key performance indicators (KPIs) to determine their effectiveness.

- a) Design and construction – the asset/facility should be designed and delivered to the required operational requirements to allow it to perform as expected for its planned life subject to an appropriate maintenance regime (see 5.3.2.3 and BS 8210).
- b) Commissioning, training and handover – the commissioning and handover of the asset/facility should be supported by training to meet the needs of the operator, end-users and other key stakeholders (see 5.6 and 5.7).
- c) Asset/facilities management – the strategy for managing the asset/facility should be efficient and cost-effective in terms that are quantifiable.

- d) Information and security management – the management of information and security should be efficient and effective in terms that are quantifiable (see PAS 1192-5).

NOTE KPIs measure progress towards achieving objectives or other factors that are critical to success (see BS EN 15221-1). They represent the significant measures that allow the owner to act quickly and decisively upon any deviation in performance.

4.5 Plan of work

The plan of work is a framework to ensure that the deliverables of all contributors are identified and appropriate to the decisions required at each work stage and should be adopted by the owner as the basis for delivering and operating the asset/facility. This plan should be specific to the project, “digitally checkable” and capable of supporting “Level 2 BIM” (see 4.9.4).

NOTE 1 “Level 2 BIM” represents federated file-based digital information with some automated connectivity. A digital plan of work (dPoW) implies the use of “Level 2 BIM”. The BIM Toolkit [6] (<https://toolkit.thenbs.com/>) [viewed 2015-07-29] has been developed to provide step-by-step help to define, manage and validate responsibility for information development and delivery at each work stage.

The work stages should be based on the following and may be adjusted to suit the owner’s specific needs.

- 0 Strategy – defines the owner’s business case for the project, including required outcomes and other core considerations.
- 1 Brief – develops project objectives, including project outcomes and required performance for the asset/facility.
- 2 Concept – prepares the concept design, including outline proposals for the structural design and building services engineering systems.
- 3 Definition – develops the design, including coordinated and updated proposals for structural design and building services engineering systems.
- 4 Design – prepares technical design, including all architectural, structural and building services engineering information, cost and detailed operational data.
- 5 Build and Commission – plans, organizes and coordinates off-site manufacturing with on-site construction, including assembly, testing and commissioning.
- 6 Handover and Close-out – training of the operations team and selected end-users, handover of the asset/facility to the operator and start-up of operations.
- 7 Operation and End of life – steady-state operation, aftercare, post-occupancy evaluation, fine-tuning (POE), benchmarking and feedback.

NOTE 2 A plan of work outlines the work stages and establishes the level of detail and the level of information that need to be delivered by each contributor to the owner during delivery and operation of the asset/facility. Progression depends on satisfying predefined criteria at decision gates (or points) that include requirements relating to environmental, social, security and economic performance. This recommended plan of work reflects a generic approach derived from various sources including, but not limited to, the Construction Industry Council (working with a number of professional institutions), the BIM Task Group (<http://www.bimtaskgroup.org/>) [viewed 2015-07-29] and the Association for Project Management.

An example plan of work is the RIBA Plan of Work 2013 (<http://www.ribaplanofwork.com/>) [viewed 2015-07-29], which is applicable to a wide variety of project types and contexts and which is customizable. Other plans of work have been developed for particular uses and might be appropriate.

Figure 1 outlines the progression from Strategy through to Operation and End of Life, where the decision to proceed from one work stage to the next depends upon the owner signing-off on key decisions. For this reason, the owner should introduce decision gates (or points) in each work stage relating to the progress achieved in alignment with the project's outcomes and the operational targets for environmental, social, security and economic performance. The timing of decision gates, information exchanges (see PAS 1192-2, PAS 1192-3, BS 1192-4, PAS 1192-5 and 4.9.4) and the criteria that should be satisfied should reflect the adopted procurement method.

Figure 1 **Work Stages**

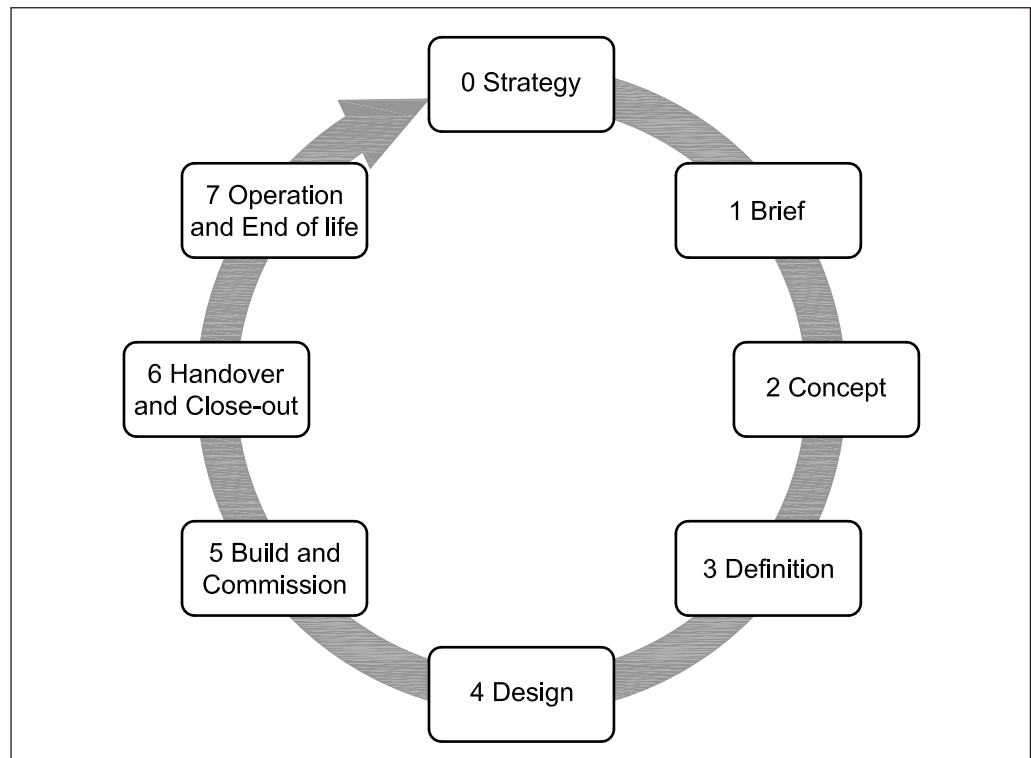
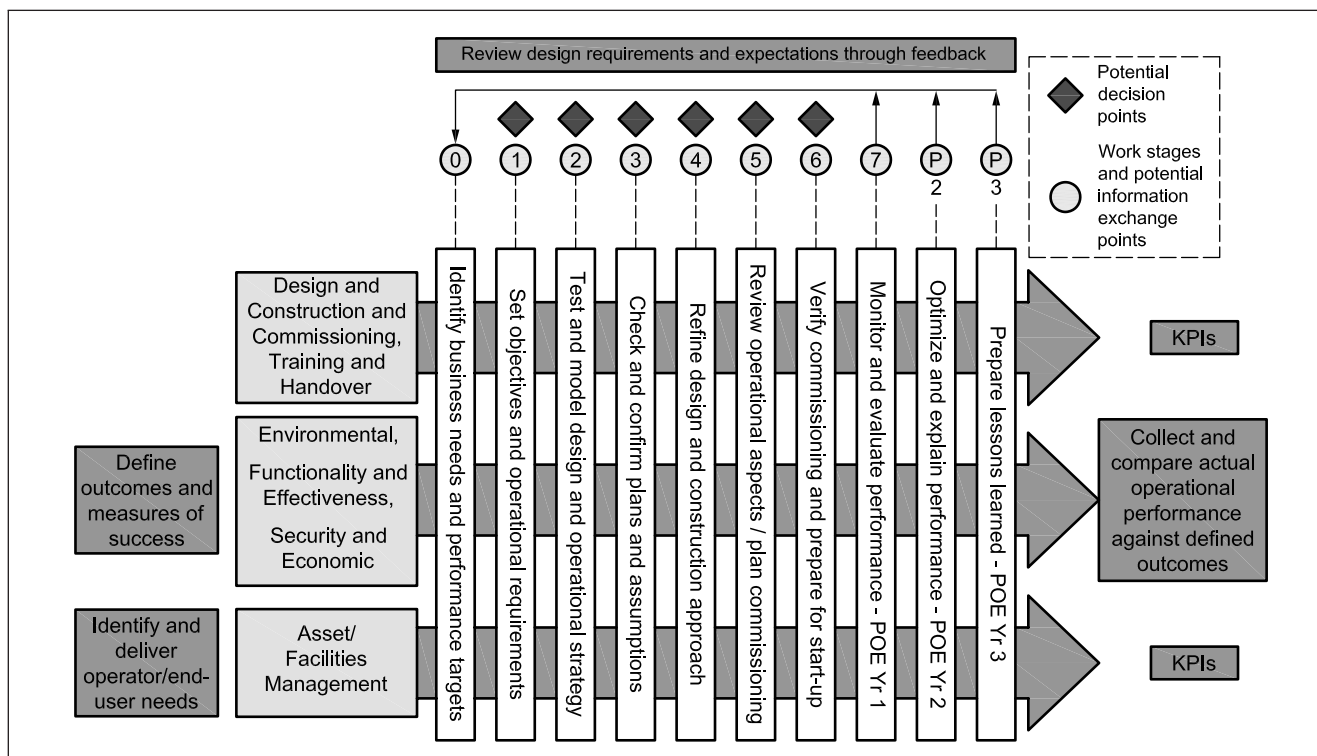


Figure 2 summarizes the overall approach in which design requirements and expectations are reviewed through continual feedback. Progression should be conditional upon satisfying defined criteria relating to operational requirements and the expected environmental, social (i.e. functionality and effectiveness), security and economic performance outcomes for the asset/facility (see 4.3).

Figure 2 Overall approach highlighting the importance of performance reviews and feedback



4.6 Roles and responsibilities

4.6.1 General

The owner should ensure that there is a clear governance structure with defined roles and responsibilities that are resourced by personnel with the appropriate level of competence, skills and experience.

The appointment of the design and construction team and the operator, operations team or facility manager, as appropriate, should be made having regard to the need to establish the clearest possible understanding of the respective parties' duties and obligations from the outset of the project. The incorporation of periods of aftercare within the Operation and End of life work stage will extend the traditional involvement of the design and construction team and so the owner should be explicit about the particular commitments this will entail from all parties affected. The appointment of the operator, operations team or facility manager, as appropriate, should be made before any decision is reached on whether or not to proceed with the project. Where this is impractical, the owner should ensure that expertise on asset/facilities management is available so that operational requirements and the expected performance of the asset/facility form an integral part of the decision making.

NOTE 1 PAS 91 provides detailed guidance on the prequalification of appointees.

There should be, from the outset of the project, an explicit working approach that requires agreement between the various parties on the work activities and their timing, with the associated information requirements and deliverables. The basis upon which decisions will be made should be clearly defined and communicated to all parties from the earliest practicable moment. This task can be greatly assisted if the owner is proactive in ensuring that the roles and responsibilities of the parties are properly defined and communicated.

NOTE 2 Defining and managing the organizational information requirements (OIR), the employer's information requirements (EIR) and the built asset security information requirements (BASIR) are important considerations (see PAS 1192-3, PAS 1192-2 and PAS 1192-5 respectively).

NOTE 3 Agreeing the working approach and the basis of decisions up front is likely to avoid inefficiencies and reduce the potential for conflict between the parties.

Where the asset/facility is sensitive or the owner has decided to implement more than baseline security measures, advice/guidance should be sought from the built asset security manager on all security aspects related to the design, construction and operation of the asset/facility and the protection of asset/facility information and data (see PAS 1192-5).

4.6.2 Owner

COMMENTARY ON 4.6.2

Soft landings [1] and [2] is intended to assist owners and operators in getting the best out of their new or refurbished asset/facility by providing a unified approach for addressing outcomes from an integrated process of briefing, design and delivery of the asset/facility. It aligns with energy performance criteria, building logbooks, building manuals, green leases and social responsibility. The emphasis is upon greater involvement of the design and construction team with the operations team (or with the facility manager) acting on behalf of the owner and/or operator and end-users before, during and after completion of construction, with the aim of improving operational readiness in the expectation of a flawless start-up and sustained operational performance in use. Much of the information required to support soft landings is already collected in the normal course of delivering a project. Where soft landings has been adopted, the owner would be expected to nominate a soft landings champion with responsibility for ensuring that it is developed to suit the project throughout design and construction and into operation of the asset/facility.

The owner should appoint a person whose principal task is to ensure that design and construction is planned and controlled to enable a smooth transition into operation and for the defined periods of aftercare.

NOTE 1 This person might be referred to as the “soft landings champion”, the “owner’s representative” or by some other term at the owner’s discretion. The term “owner’s representative” has been adopted in this standard (see 4.6.3).

The appointed person should be expected to have first-hand working knowledge of the owner’s organization and an understanding of the asset’s/facility’s future. Where an existing asset/facility is to be refurbished, the owner’s representative should have an understanding of its history.

NOTE 2 There is the chance that the owner’s representative might be seen as a project manager. For clarity, a project manager is responsible for delivering the asset/facility to an agreed scope, schedule and cost/budget and, normally, has no involvement or interest once the project has been delivered and the asset/facility is operational. Similarly, a facility manager would likely have little expertise and limited interest in the project’s delivery, other than to ensure that the asset/facility, once delivered, performed as required. There is, therefore, the need for a person who possesses a broader, more integrated understanding of the combined project delivery and asset/facilities management process than either of the aforementioned.

The owner should appoint an integrated design and construction team to ensure there is an emphasis on collaborative working based on shared responsibilities and goals that are aligned with those of the owner and the operator, where the latter is a separate entity (see 4.6.4), and/or the operations team. The owner, or the owner's representative, should determine the composition of the design and construction team. Consideration should be given to the breadth and depth of competences, skills and experience needed in the project through each successive work stage from Strategy through to Operation and End of life, maintaining continuity of purpose in regard to the owner's business objectives throughout (see 5.1.1). The team should be extended by the owner to include personnel from the operations team or, where no such arrangement presently exists, a facility manager should be appointed to ensure that operational requirements and performance outcomes (see 4.3) are taken into account in each work stage.

4.6.3 Owner's representative

The owner's representative should be appointed by the owner for the whole period from the Strategy and into the Operation and End of life work stage to provide continuity of purpose and consistency of approach. The owner's representative should report to the owner and may consult with the representative(s) of end-users or other key stakeholders as determined by the owner.

The role of the owner's representative should be to maintain the focus of all parties on the required project outcomes and operational performance, as well as on an evidence-based approach during all work stages from Strategy through to Operation and End of life. The day-to-day role of the owner's representative should not be delegated to another party.

The role should include regular reference to the schedules or equivalent documentation that identify the work activities of the design and construction team with their associated information requirements and deliverables. The owner's representative should facilitate input from the operator, operations team or facility manager, as appropriate, and end-users to the work of the design and construction team. The owner's representative may communicate directly with the designated manager for the construction work. The owner's representative should liaise with the owner's built asset security manager, where one has been appointed, to ensure that the owner's security requirements are fulfilled.

The owner's representative should ensure that the following are achieved, as a minimum:

- a) establishment of the expected project outcomes and operational performance for the asset/facility and the operational budget (see 4.3);
- b) verification through successive work stages that the expected outcomes and performance will be met (see Clause 5);
- c) plans for commissioning, training and handover of systems and the phasing in of asset/facilities management (see 5.6, 5.7 and 5.8);
- d) post-occupancy evaluation (POE) to establish how the asset/facility is performing as expected (see 5.8.2.3.4), including measurement of actual operational performance against the required performance outcomes and targets from environmental, social, security and economic perspectives (see 4.3) based on information and data taken from reliable sources;

- e) coordination of the preparation of an advisory report during the extended period of aftercare covering the need for any corrective actions, the presentation of benchmarking data and the lessons learned (see 5.2.2.2). The advisory report should be prepared by the operator, operations team or facility manager, as appropriate, with input from the design and construction team where required (see 5.8.5); and
- f) adoption of a security-minded approach by the operator, operations team and facility manager, as appropriate, to the design, implementation and operation of the AIM and the owner's information management system.

4.6.4 Operator, operations team and facility manager

COMMENTARY ON 4.6.4

The owner might be the operator of the asset/facility or another party might fulfil this role. In either case, it is important that the interests of the operator are taken into account from the outset. This interest extends to the needs of the end-users of the asset/facility. In a larger organization, an operations team, facility management team or, perhaps, a facility manager is responsible for the asset/facility on a day-to-day basis, including its maintenance. In a smaller organization, there might not be any equivalent provision. Nonetheless, someone has to provide expertise on operational matters and that might have to fall to a consultant engaged for this purpose. This person is necessary to provide comment and advice on the implications of design and construction proposals from an operational perspective as they are developed from the Strategy through to the Handover and Close-out work stage.

The operator, operations team or facility manager, as appropriate, should be given authority by the owner to contribute information and data concerning the operational strategy and operational requirements, including performance outcomes and targets, operational costs and budgets, and the procurement of facility-related services where appropriate (see BS 8572). The owner might agree that such contributions are channelled through the owner's representative or they might be communicated directly to the design and construction team. In the latter case, the design and construction team should ensure that contributions are duly recorded and made available within the team. A RASCI chart should be used to clarify responsibilities.

NOTE 1 Annex E gives an extract from a RASCI chart.

NOTE 2 PAS 1192-3 contains guidance on the need for the operator, operations team or facility manager, as appropriate, to identify the owner's information requirements, referred to as the employer's information requirements (EIR) in PAS 1192-2 (see 4.9.1).

NOTE 3 PAS 1192-5 contains guidance on the need for a security-minded approach to asset/facilities management and the need for the owner to set out a security strategy and security management plans for the asset/facility.

4.6.5 End-users

COMMENTARY ON 4.6.5

The users of the asset/facility are a key stakeholder group and can include occupants, visitors and external customers among others. They are collectively referred to as "end-users", because they are generally the ultimate beneficiaries of the services provided by the asset/facility in operation.

The owner or the owner's representative should ensure that the interests and needs of the end-users of the asset/facility are taken into account through a process of stakeholder engagement (see 5.1.3). Depending on the number and diversity of end-users, the owner or owner's representative may consider it appropriate to arrange for representation on a group, rather than an individual, basis.

The collection, use and storage of personally-identifiable information and data should be handled in a security-minded manner. The views of end-users should be sought regarding the level of protection required.

NOTE Asset/facilities-related systems might contain a range of information and data about end-users, for example information regarding passes or access tokens and emergency contact details.

4.6.6 Design and construction team

COMMENTARY ON 4.6.6

An integrated, collaborative approach to design and construction is necessary to assure both the buildability of the design and the operational performance of the asset/facility. The term “design and construction team” is used throughout the standard to refer to the combined, collaborative efforts of the many disciplines that can be needed to assist in transforming the owner’s business objectives into an operational asset/facility. An integrated design and construction team reduces the likelihood of “silo working”, reducing the prospect of errors and omissions. Whilst subcontractors and others in the supply chain can be regarded as an integral part of this team, particular requirements in regard to the former warrant additional consideration (see 4.6.7).

The design and construction team should support the role of the owner’s representative in pursuing an operational asset/facility that meets agreed performance outcomes and targets. The design and construction team should nominate a person from within its body to be responsible for coordinating all transition-related activities with the owner’s representative.

The design and construction team should ensure that roles and responsibilities for the project are aligned to defined work activities, with their associated information requirements and deliverables. Responsibility assignment matrices (e.g. RASCI charts) should be prepared for this purpose by the design and construction team and their format should be approved by the owner’s representative. Each RASCI chart should be updated as necessary in each work stage and in readiness for the subsequent work stage (see Clause 5). RASCI charts should be coordinated with an organization chart for the project prepared by the design and construction team to show reporting/communication between all parties within the project delivery organization, with interfaces to external entities and other key stakeholders as appropriate. Design responsibility matrices should complement the use of RASCI charts by providing a focus on assigned design responsibilities, the level of detail and the level of information exchanged (see 4.9.4).

NOTE 1 Annex E gives an example RASCI chart and a design responsibility matrix.

The design and construction team should advise the owner, or the owner’s representative, of the need for any additional competences, skills and experience required in the team as soon as it becomes apparent. Where the building services engineering systems are complex, the owner should consider the appointment of an independent commissioning manager if not already appointed. The commissioning manager should be appointed early in the project’s life. Where there is a known or perceived security threat to the asset/facility, the owner should consider the appointment of a security manager, if not already appointed, at the outset of the project.

NOTE 2 PAS 1192-5 outlines a security triage process which an owner can use to establish the level of security-minded approach required for its asset/facility and associated information and data, and any asset/facility information and data it might hold regarding neighbouring assets/facilities.

4.6.7 Subcontractors, specialist suppliers and manufacturers

COMMENTARY ON 4.6.7

In the course of delivering a new or refurbished asset/facility, much work devolves to subcontractors, specialist suppliers and manufacturers. This standard anticipates such an arrangement. The success of the transition from design through construction and into operation depends on the effective integration of the supply chain covering all of the entities necessary for delivering the operational asset/facility. The management of multiple organizational, technical and contractual interfaces between these entities is part of the task and is a factor in that success. Subcontractors have a pivotal role in the sense of standing between the designers and construction managers and the manufacturers and suppliers of myriad materials, products, components and systems. It is essential that subcontractors are effectively integrated into the approach to be taken, including the work activities, information requirements and deliverables in each work stage.

As far as practicable, subcontractors, suppliers and manufacturers should adopt an approach that supports the key principles (see 4.1) throughout all work stages in which they are involved. Each subcontractor, supplier and manufacturer, where appropriate, should identify its contact person for the purpose of transition and inform the transition coordinator (see 4.6.6) within the design and construction team. The contact person should attend meetings of the design and construction team, when requested, to present proposals concerning the respective parties' work, including details of the operational requirements of systems, equipment, controls and user interfaces, as appropriate.

Subcontractors may be retained to assist the owner and other members of the design and construction team during handover and to monitor performance during start-up and operation of the asset/facility. Subcontractors may be based on site full-time during an initial period of aftercare to assist with end-user queries and to undertake periodic fine-tuning of systems as needed. In this case, the owner, or the owner's representative, should make these requirements clear and ensure that they are embodied in the scope of work and subsequent agreements with these identified subcontractors.

NOTE PAS 91 provides detailed guidance on prequalification for construction tendering.

Subcontractors identified by the owner might be required to provide support for an extended period of aftercare, in which case the roles and responsibilities should follow those required in the Operation and End of life work stage (see 5.8.2.3).

Subcontractors should be required to contribute their specialist information to the common data environment (CDE) (see BS 1192:2007, PAS 1192-2, PAS 1192-3 and PAS 1192-5). Depending on the security requirements of the owner, any subcontractor supplying specialist information relating to sensitive aspects of an asset/facility should follow the owner's security policies, processes and procedures regarding the creation, use, storage and disposal of asset/facility information.

4.7 Collaboration and alignment

COMMENTARY ON 4.7

The purpose of "design and construction for operability" is to align the interests of those who design and construct an asset/facility with those who subsequently operate and use it. Success will be due, in large part, to a collaborative approach between the various parties, but also to monitoring and verifying the alignment of the design and the work of the design and construction team with the project's expected outcomes and the operational performance requirements for the asset/facility.

The owner should ensure that the design and construction team understands the necessity of a collaborative approach to its work and the importance of active engagement with the owner's representative and the operator, operations team or facility manager, as appropriate. The design and construction team should provide evidence of its approach in the form of a schedule of work activities, with their associated information requirements and deliverables, for each work stage (see Clause 5). This should take the form of a responsibility assignment matrix (e.g. a RASCI chart) to cover the work activities with their associated deliverables for each work stage. This should be supplemented by a design responsibility matrix covering assigned design responsibilities, the level of detail and the level of information exchanged (see 4.9.4).

NOTE 1 Annex E gives an example RASCI chart and a design responsibility matrix.

The design and construction team should obtain early input on the operator's, end-users' and other key stakeholders' interests and needs, which should be assisted by the owner's representative who should prepare a plan for stakeholder engagement (see 5.1.3). End-users, or their representative(s), should be allowed to express their views in an environment that is conducive to obtaining an honest and accurate understanding of their needs.

An aim should be to establish clear measures and targets for environmental, social, security and economic outcomes. In the case of social outcomes, these should cover, as a minimum, functionality and effectiveness (e.g. uses, space, internal environment, usability, inclusiveness, durability, adaptability, maintainability and safety) and environmental outcomes should cover energy performance, in particular energy use and CO₂ emissions, water consumption and waste reduction. Security outcomes should focus on the practical steps to be taken to reduce the risk of loss, compromise or disclosure of information and data about sensitive aspects of the design, construction or operation of the asset/facility. Economic outcomes should focus on capital, operational and whole-life costs as early as possible and, thereafter, should focus on ways in which costs might be reduced without suffering a loss of functionality or effectiveness. All performance outcomes and targets should be, as far as practicable, subject to monitoring and verification through all work stages.

NOTE 2 The adoption of value improving practices, if properly controlled, can assist in identifying functions that add cost but no value for the owner and then eliminating them. Value engineering is a common and proven methodology for this purpose. It is important, however, to ensure that value engineering is a genuine attempt to seek value improvement, which implies a relationship between cost and quality, and is not simply a cost-cutting exercise. The adoption of whole-life costing can be similarly regarded as a value improving practice, as can applying lessons learned.

Commissioning, training and handover should be planned jointly by the design and construction team and the operations team, overseen by the owner's representative, to ensure operational readiness, flawless start-up and, subsequently, early optimization of operational performance (see 5.6 and 5.7). End-users, or their representative(s), should be involved in this planning.

The design and construction team should be involved in post-occupancy evaluation (POE) as a process for assessing the performance of the asset/facility over at least the first three years of its operational life to establish actual outcomes and to record and share lessons learned (see 5.8.2.3.4). The POE should extend to measuring the impact of the operator's or operations team's asset/facilities management strategy on the performance of the asset/facility (see 4.4 and 5.7.7).

NOTE 3 The benefits of this approach, including post-occupancy evaluation (POE), are seen in terms of optimized operational performance of the asset/facility within the operational budget as soon as possible and the alignment of operational performance with the required performance outcomes set prior to the start of design and construction. Achievement of the required outcomes could be regarded as an indication of the operator's and end-users' likely satisfaction with the asset/facility and offers some assurance with respect to operational cost.

The owner's representative should ensure that operational input is a continual, but controlled, contribution during design and construction work to ensure that the design of the asset/facility is subject to evaluation from an operational perspective. A design review protocol should be used to support this work together with an information exchange plan (see BS 1192-4). The design and construction team should respond on matters of alignment of the developing design with the expected outcomes, changes to the design that have been necessary and the extent to which performance targets for the operational asset/facility are likely to be met. Confirmation of the associated capital and operational costs should be provided by the design and construction team, with input from the operator, operations team or facility manager, as appropriate, at points defined for each work stage for the purpose of information exchange (see PAS 1192-2, PAS 1192-3, BS 1192-4, PAS 1192-5, 4.9.4 and Clause 5).

4.8 Risks and opportunities

The risks and opportunities that could affect the realization of the value and performance of the asset/facility should be systematically assessed and managed in each work stage. This assessment should be undertaken periodically to identify any condition or event that could impact negatively or positively on the operation of the asset/facility and the actions needed to manage them. The assessment should include identification and analysis of downside risk events and upside opportunities, responses to risk events and the controls to be applied. Account should be taken of the operator's and end-users' interests in the asset/facility when identifying and assessing risk and opportunity. Details of such events and action arising should be recorded in a risk and opportunity register and reflected in the estimates of capital cost and operational cost and the project schedule.

NOTE 1 Downside risks are factors that can have a potentially negative impact on the asset/facility, such as hazards faced in the construction work. Upside risks are factors that can add value to the outcome and are more commonly referred to as "opportunities". The latter might arise from a re-examination of the scope of work against the business and project objectives, e.g. changes to take advantage of more energy-efficient technology.

NOTE 2 PAS 1192-5 includes both a security triage process for assessing the level of security-minded approach required, based on the overall risk, and a risk management process for assessing security risks throughout the asset's/facility's life cycle. These processes support a holistic approach to the production and maintenance of a security risk management strategy. They are not a one-off exercise, but are intended to be repeated at various points through the life cycle and when certain trigger events occur.

A risk and opportunity register should be established and maintained from the outset and is one of the deliverables in the Strategy work stage (see 5.1). It should be used to record any identified downside risks and upside risks (opportunities), an assessment of their potential impact and the likelihood of their occurrence. For downside risks, actions should be explored to reduce or avoid their potential impact. For upside risks, actions should be explored to realize or enhance the improvement. The risk and opportunity register should be kept up to date throughout all work stages so that it reflects the current situation and should be used as part of the process of gathering lessons learned.

NOTE 3 A risk and opportunity register formally records conditions or events, which could threaten or improve outcomes, to be taken into account in risk assessment or risk analysis. The register is not simply a repository, but a tool to help gain a current understanding of conditions or events and the risks and/or opportunities they represent.

NOTE 4 Annex F provides an example of a risk and opportunity assessment.

NOTE 5 The likelihood of cyber attacks occurring and the severity of cyber security threats to the owner's information management systems and the CDE are constantly changing as new vulnerabilities to IT systems and software applications emerge. By maintaining situational awareness of vulnerabilities and potential threats, the owner and operator, operations team or facility manager, as appropriate, can maintain a current understanding of the overall threat environment and the need for any changes to the security-minded approach.

4.9 Information requirements

4.9.1 Employer's information requirements (EIR)

COMMENTARY ON 4.9.1

The employer's information requirements (EIR) set out the information to be delivered, and the standards and processes to be adopted by the design and construction team, including its supply chain, as part of the project delivery process. The information requirements as set out in the EIR are intended to provide enough information to answer the "plain language questions" required at a particular work stage at an appropriate level of detail (see 4.9.3). The EIR would be expected to include the following as a minimum: a) information management; b) commercial management; c) security management (see PAS 1192-5); and d) competence assessment. The EIR would normally exist as a self-standing document, cross-referenced to other documentation used across the work stages. It does not, however, expressly consider the information that the design and construction team or the operator or operations team might need from the owner.

The owner should define its requirements adequately and clearly in terms of the information to be delivered by the design and construction team and its timing, and the standards and processes to be adopted in this regard. The points at which information exchanges are required should be specified in the EIR by reference to the applicable work stage and decision gate (or point) (see 4.5). PAS 1192-2, BS 1192-4 and PAS 1192-5 provide detailed guidance in this regard. The EIR may incorporate a schedule of plain language questions (see 4.9.3).

NOTE 1 PAS 1192-5 provides guidance on the creation of a security management regime and the need to develop security information requirements that inform the development of both the EIR and the asset information requirements (AIR).

NOTE 2 BS 1192-4 provides guidance on a common structure for the exchange of information, i.e. COBie, to ensure that information can be reviewed and validated for compliance, continuity and completeness.

A closely-related document is the brief, which should be used as a basis for developing and, subsequently, for evaluating design and construction proposals (see 5.5.7). The brief should be delivered in a digitally-checkable form supplemented by the EIR.

4.9.2 Asset information requirements (AIR)

The owner should define the asset information requirements (AIR) to be met in order that the organizational information requirements (OIR) can be satisfied, together with the information exchanges by which information and data are transferred to, and from, the asset information model (AIM) (see PAS 1192-3 and PAS 1192-5).

4.9.3 Plain language questions

COMMENTARY ON 4.9.3

The owner requires information from the design and construction team. Similarly, the design and construction team requires information from the owner and the operator, operations team or facility manager, as appropriate, in order to perform its work and to contribute effectively to the outcomes expected by the owner. This communication is best handled through a structured information exchange, where all questions are framed in plain language, with the answers recorded and shared within the design and construction team and with the operator, operations team or facility manager, as appropriate. The efficiency of this process depends to a large extent on the clarity with which questions are put by the owner, or to the owner, how the subsequent answers are interpreted and how the decisions that arise from them are implemented. This often involves confirming understanding then recording details in the owner's information management system, including the relevant parts of the project information model (PIM).

Plain language questions should be drafted for each work stage for the purpose of obtaining information to enable decisions to be taken in a timely and effective manner, including the key question of whether or not to proceed to the next stage. The purposes for which information is required should be stated. The information required to answer questions, and any clarification or confirmation arising, should be delivered at the appropriate information exchange point (see PAS 1192-2, PAS 1192-3 and PAS 1192-5).

NOTE There is a crossover from plain language questions to EIR and vice versa (see 4.9.1). Annex G gives example plain language questions to be asked of the owner by the design and construction team.

4.9.4 Building information modelling (BIM)

The use of building information modelling (BIM) in general and the creation and management of a project-specific building information model in particular should be seen in the wider context of the owner's information management system. The owner should take steps to ensure that there is sufficient information technology in place to support "Level 2 BIM", where this is to be adopted.

The owner, or the owner's representative, should consider the following requirements with respect to BIM:

- a) the common data environment (CDE) to be used – BS 1192:2007, PAS 1192-2, PAS 1192-3 and PAS 1192-5 provide guidance in this regard;
- b) details of information required from the project delivery team to support optimal operational performance of the asset/facility – PAS 1192-3 and PAS 1192-5 provide guidance in this regard;
- c) the format and means for information exchange – COBie may be used for this purpose – BS 1192-4, PAS 1192-2, PAS 1192-3 and PAS 1192-5 provide guidance in this regard;

NOTE 1 COBie provides a common structure for the exchange of information and ensures that information can be reviewed and validated for compliance, continuity and completeness.

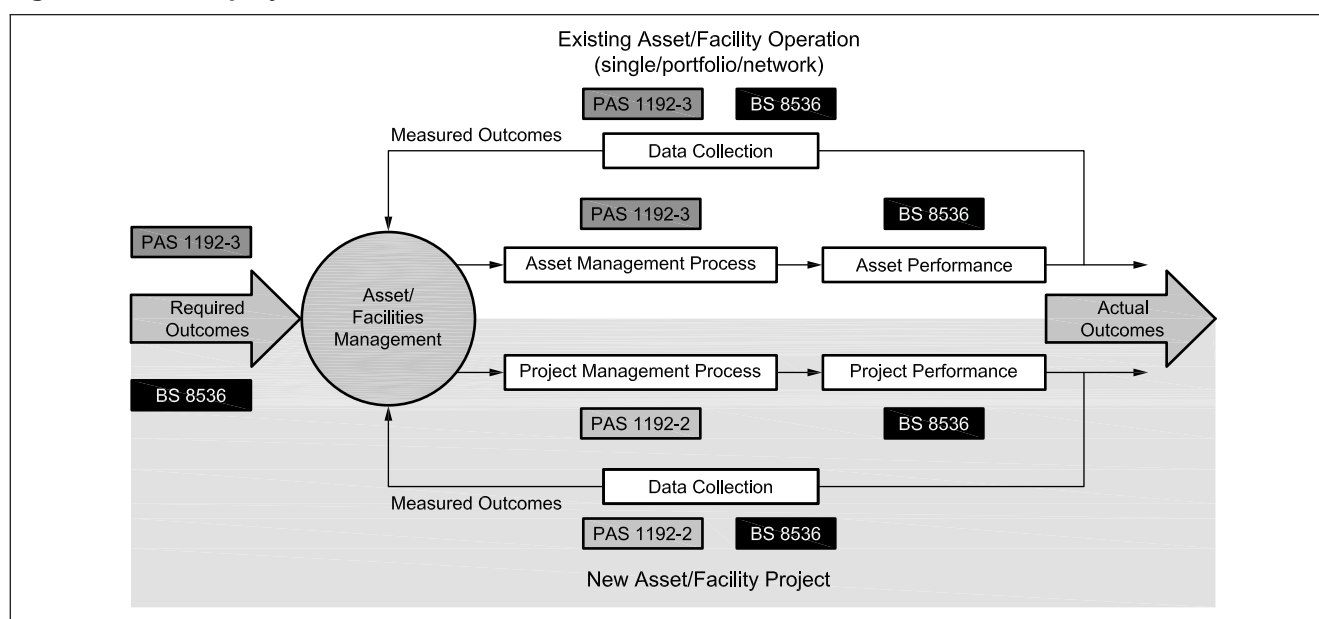
- d) the structure and format of the asset information model (AIM) that will receive the content from the project information model (PIM) – PAS 1192-3 and PAS 1192-5 provide guidance in this regard;

- e) details of how content from the project information model (PIM) is to be transferred into the owner's asset information model (AIM) – PAS 1192-2, PAS 1192-3 and PAS 1192-5 provide guidance in this regard;
- f) requirements, policy, processes and procedures for the security of information and data, including the management of access both physically and digitally – PAS 1192-5 provides guidance in this regard; and
- g) software to be used to meet operational and security requirements such as the owner's defined enterprise system (see PAS 1192-3 and PAS 1192-5), a computer-aided facilities management (CAFM) system or other means – BS 8587 provides guidance in the latter regard.

NOTE 2 PAS 1192-5 specifies the processes which will assist an organization in identifying and implementing appropriate and proportionate measures to reduce the risk of loss or disclosure of information and data.

NOTE 3 Figure 3 illustrates the connection between the project information model (PIM) and the asset information model (AIM) and the need for the measurement of outcomes from projects to support efficient and cost-effective asset/facilities management. The figure emphasizes the important relationship between this British Standard and those standards supporting "Level 2 BIM", namely PAS 1192-2 and PAS 1192-3. PAS 1192-5 contains further information on how security requirements can be integrated into these information models.

Figure 3 Asset-project model and feedback



4.10 Arrangement of work stages

NOTE Clause 5 that follows is structured in accordance with the work stages outlined in the plan of work (see 4.5) as the project progresses from its commencement to the operation of the asset/facility. The same or similar headings are used in each work stage, wherever practicable, to ensure consistent treatment of both guidance and recommendations. In a number of cases, the latter are broadly similar, although might contain important differences.

The users of this standard should ensure that the requirements contained in each work stage (see Clause 5) are properly considered before they are encountered and that the previous stage, where appropriate, has been concluded satisfactorily before making the transition to the next work stage. Users are advised not to omit work stages or parts of them, but to scale down the approach if it is felt that the requirements are inappropriate or in excess of reasonable needs.

5 Work stages

5.1 Strategy

5.1.1 General requirements

COMMENTARY ON 5.1.1

The Strategy work stage is concerned with defining the owner's business case for the new or refurbished asset/facility, the project outcomes, required operational performance and other core considerations. It provides an essential baseline for the owner to assist in clarifying strategic intentions, not least the contribution to the business of the asset/facility. This stage can be thought of as one of strategic definition.

The owner should define the business case and supporting considerations, including initial expectations on the performance of the new or refurbished asset/facility in terms of its contribution to the business. Information and data required for this purpose should be identified (see 5.1.7) together with the work activities associated with them (see 5.1.2). An information management strategy should be agreed between the owner, or the owner's representative on its behalf, the design and construction team, the operator, operations team or facility manager, as appropriate, with the actions needed to gather, record and store information and data to support the primary activities (see 5.1.2) of this work stage and subsequent stages. Information management should be recognized as encompassing the definition and management of the building information model from design, through construction, and into operation of the asset/facility. A security strategy, management plans and information requirements should be developed by the owner, taking appropriate advice as necessary.

5.1.2 Primary activities

The owner should regard the following work activities as a necessary part of the strategic definition of the asset/facility and the project required to deliver it:

- a) identify the business-related activities and processes that are to take place in the new or refurbished asset/facility;
- b) identify the range of potential security issues that are applicable to the owner's business, assets/facilities and personnel;
- c) identify the owner's, operator's, end-users' and other key stakeholders' high-level needs;
- d) develop the required project outcomes and targets for the operational performance and durability of the asset/facility from these identified high-level needs;
- e) determine how the design and construction team could assist in identifying these high-level needs, if appointed at this time;
- f) identify the particular competences, skills and experience that the design and construction team need to bring to the project delivery process;
- g) determine the basis of the engagement of the design and construction team and its relationship with the operator, operations team or facility manager, as appropriate, end-users and other key stakeholders;
- h) identify the particular competences, skills and experience that the operator, operations team or facility manager, as appropriate, could contribute to design and construction;
- i) determine the targets for energy use, CO₂ emissions, water consumption, waste reduction, capital cost, operational cost, functionality and

effectiveness and any other performance targets in consultation with the design and construction team, if appointed at this time;

- j) identify existing policies and standards that are relevant to the design, construction and operation of the asset/facility (e.g. internal design standards, construction standards and asset/facilities management standards);
- k) identify a design standardization policy, where appropriate, drawing on any owner-defined standard design elements, especially those driven by operational needs;
- l) assemble lessons learned from previous projects, including validated case studies and other reliable, documented sources;
- m) establish a risk and opportunity register;
- n) prepare a project management schedule (a Level 1 schedule) to show the relationship between the phases in the project, the main activities, target dates and other key milestones;

NOTE 1 In project planning and scheduling, it is customary to manage schedule information in a hierarchy where each level (of possibly five) has a distinct purpose and is intended for use by a defined stakeholder group. The Level 1 project management schedule provides an overview of the project for use by key stakeholders.

- o) establish an initial view of capital expenditure;
- p) determine the approach to whole-life cost assessment;
- q) establish an initial view of revenue income, where appropriate; and
- r) determine the requirements and arrangements for the delivery of project information and asset information.

The owner should determine which, if any, of the activities in a) to r) the owner's representative should undertake and which of the following activities the operator, operations team or facility manager, as appropriate, should undertake:

- 1) identify the performance benchmarks for this type of asset/facility for use in establishing targets and the processes for subsequently measuring performance;
- 2) identify the approach to be taken to post-occupancy evaluation (POE);
- 3) establish an initial view of operational expenditure, covering operations, maintenance, replacement costs, and costs relating to energy use, water consumption and waste disposal;
- 4) identify any existing facilities management strategy and supporting policy or procedures and, where none exists, prepare such a strategy in outline;
- 5) identify required security arrangements for the asset/facility in operation and during design, construction, testing and commissioning, handover and start-up; and
- 6) identify a holistic approach to address security around the aspects of people and process, as well as physical and technological security.

NOTE 2 BS ISO 55000 provides guidance on the factors to be considered by an organization when managing its assets. BS 8210 provides detailed guidance on facilities maintenance management. PAS 1192-5 specifies the processes which will assist an organization in identifying and implementing appropriate and proportionate measures to reduce the risk of loss or disclosure of information and data.

5.1.3 Stakeholders

5.1.3.1 General

Internal and external stakeholders should be identified and their interest in the new or refurbished asset/facility should be assessed and documented. The extent to which this information can be communicated with third parties should be determined in advance. The owner should be aware of the need to safeguard personally-identifiable information, particularly when responding to requests for information under legislation. A communication plan should be prepared to assist with this task.

NOTE 1 Annex H offers an example of stakeholder identification.

NOTE 2 Attention is drawn to statutory duties relating to data protection and the protection of personally-identifiable information and those arising in connection with planning, transfer of employment and equalities' legislation.

Responsibility for taking account of the interests and needs of end-users of the asset/facility and other key stakeholders should be determined by the owner, or the owner's representative, and made explicit (see 4.6.5).

NOTE 3 Attention is drawn to legislation covering construction, design and management (CDM) and, in particular, the role of the principal designer.

5.1.3.2 Stakeholder impact analysis

A stakeholder impact analysis should be undertaken to determine how, and the extent to which, stakeholder interests and needs might impact on the asset/facility in terms of its design, construction, testing and commissioning, handover and start-up of operations. Where the asset/facility exists, account should be taken of audits and other reviews of the asset/facility, including those pertaining to its immediate surroundings, from the perspective of end-users. Account should be taken of any actions recommended by the owner for the design and construction team that involve specific stakeholder interests, needs and rights in the asset/facility.

NOTE Annex I offers an example of preliminary stakeholder impact analysis.

5.1.3.3 Prioritization of needs

The results of the stakeholder impact analysis used in assessing stakeholder interests and needs in the asset/facility should be made available to the design and construction team if prepared by the owner or the owner's representative. The results should reveal the nature, extent and relative importance or weighting of all expressed needs. Any prioritization should be made explicit. A statement should be prepared that expresses the needs of the owner and operator, where the latter is a separate entity, and end-users. The criteria forming the basis of this expression should be capable of objective assessment for the purpose of subsequent measurement of performance as defined by the owner and/or the operator (see 4.3 and 5.8.2.3.4).

NOTE Multiple stakeholders are likely to have different perspectives on operational requirements and performance outcomes, necessitating close scrutiny of needs and their subsequent prioritization.

5.1.3.4 Updating the analysis

Further stakeholder identification, assessment and impact analysis should take place during subsequent work stages and, prior to Build and Commission, to provide an opportunity to act upon any change in stakeholders, their interests or needs. If a communication plan has been prepared, it should be updated as changes in stakeholders or their interests and needs become known.

5.1.4 Sustainable space provision

The space efficiency of the asset/facility should be calculated, where appropriate, and used to assess the owner's need for space over the planned lifetime of the asset/facility. Allowance for growth and/or reduction in the demand for space and its phasing over the lifetime of the asset/facility, as well as the need for adaptability for uses different to those for which it might have been originally intended, should be incorporated in the assessment of this provision.

Consideration should be given to the extent to which space provision will be affordable into the future, as far as practicable. Account should be taken in this assessment of the space necessary to achieve an inclusive design that anticipates the needs of disabled people and others with equalities-related needs in accordance with design standards such as BS 8300 and BS 9999.

5.1.5 Operational performance and aftercare

COMMENTARY ON 5.1.5

Instead of operational requirements informing and, to a certain extent, driving design and construction decision making, they can sometimes be left until design has commenced or, in the worst cases, until construction is under way. Any definition of project success needs to be broadened to include the achievement of operational performance requirements; after all, these are the ends that the owner/operator is seeking, whilst the project is the means to the ends. Handing over the asset/facility can no longer be seen as, more or less, the final act for the project delivery team. Ensuring that the asset/facility performs as required necessitates defined periods of aftercare that allow for the adjustment and fine-tuning necessary to achieve optimal operational performance.

The initial and extended periods of aftercare should be determined by the owner and incorporated in all agreements involving the design and construction team, including subcontractors, specialist suppliers and manufacturers, and the operator, operations team or facility manager, as appropriate, and should be regarded as an integral part of project delivery and the subsequent operation of the asset/facility.

NOTE 1 Six to eight weeks might be an appropriate period for initial aftercare, with three years as an appropriate period for extended aftercare.

Performance targets should be determined by the owner based on a range that is recognized as achievable, and should be agreed with the design and construction team. Measurement should be based on reliable sources of data, such as project records, meters, control systems and operational records. During the periods of aftercare, data should be collected by the operations team or the facility manager, as appropriate, then analysed to determine the variance, if any, between actual performance and target performance as part of the owner's and, where applicable, the operator's benchmarking (see 5.8.5). Targets should be achievable and not aspirational.

NOTE 2 Measures of the variance between actual and target performance enable the operations team to pinpoint the cause(s), enabling fine-tuning of assets/systems so that operational performance can be optimized as quickly as possible (see 5.8.2.3.4).

Where the owner determines that changes to performance outcomes and/or targets are necessary, details should be communicated to the design and construction team and the operator, operations team or facility manager, as appropriate, then recorded in the relevant part of the project information model (PIM).

NOTE 3 Performance outcomes and targets might have to be reconsidered if, during the prequalification of prospective (supply chain) tenderers, it becomes apparent that the required performance is unlikely to be met.

The period of extended aftercare should include an assessment of the functionality and effectiveness of the asset/facility through a post-occupancy evaluation (POE) (see 5.8.2.3.4). A proven methodology should be selected for this purpose as opposed to an *ad hoc* arrangement that might be devised more for expediency than systematic appraisal.

NOTE 4 The Design Quality Indicator (DQI) [3] is a five-stage method for evaluating the design over the project life cycle against three quality principles: functionality, build quality and impact. In the specific context of POE, an example approach is the BUS methodology [4] which quantifies occupant satisfaction, reveals features of value or concern in the asset/facility and provides feedback. BREEAM In-Use [5] is a scheme to help the owner, operator, operations team or facility manager, as appropriate, reduce the operational costs and improve the environmental performance of existing assets/facilities.

NOTE 5 Longer-term considerations, for example planned maintenance and ongoing facility optimization, can extend for decades necessitating a long-term view of the expected design life and performance of the asset/facility.

5.1.6 Risks and opportunities

The risk and opportunity register should be used to record threats to the achievement of project objectives and performance outcomes and targets and the opportunities for improving those outcomes and the operational performance of the asset/facility. A risk and opportunity identification workshop should be conducted for this purpose.

The owner, or the design and construction team if appointed, should undertake a qualitative assessment of conditions and events recorded in the risk and opportunity register to determine their potential impact and the likelihood of their occurrence. Periodic reassessment of risks should be used to update the risk and opportunity register and associated risk response (see 4.8). The owner should proactively monitor and check the status of risks and opportunities recorded in the risk and opportunity register, the events that give rise to them and the outcomes of any risk responses.

The owner should be aware of the business risks associated with the failure or impaired performance of systems depending on information technology arising from malicious acts, such as damage caused by malware, hackers or disaffected personnel.

The owner, or the design and construction team, should determine the most appropriate response to risks that have been assessed, taking into account the practicability and affordability of any proposed action, including the owner's capability, or, where applicable, the capability of the design and construction team. Account should be taken of the potential that might exist to avoid the risk or realize the risk/opportunity, reduce or increase the extent of exposure for the owner and operator, and the likelihood of its occurrence, together with an indication of the schedule, resource and cost implications of doing so.

5.1.7 Information requirements

The following information should be considered for the purpose of supporting the work activities (see 5.1.2) and contributing to the deliverables (see 5.1.10) in this work stage:

- a) the owner's business case or statement of need for the new or refurbished asset/facility;
- b) strategic fit;
- c) value/project drivers;
- d) major risks, uncertainties and opportunities affecting the owner's business;
- e) lessons learned from previous projects, as appropriate;

- f) the owner's, operator's, end-users' and other key stakeholders' high-level needs;
- g) the owner's security requirements, including the security of information and data;
- h) preliminary indication of the extent to which the asset/facility is likely to satisfy those needs;
- i) performance objectives for the asset/facility and details of any special operational requirements;
- j) availability of performance benchmarks for comparison;
- k) criteria for determining project success, where not covered by performance-related measures;
- l) details of any master plan or strategic statement on development;
- m) characteristics of the site;
- n) initial development options;
- o) limit of available capital expenditure;
- p) sources of funding and owner's cost of borrowing;
- q) anticipated operational expenditure on asset/facilities management, including maintenance;
- r) anticipated revenue income or likely value of the asset/facility at completion, where applicable;
- s) anticipated non-monetary benefits of the asset/facility at completion, where applicable;
- t) time frame and key dates;
- u) details of any technical strategy;
- v) details of any standardization requirements;
- w) facilities management strategy;
- x) information management strategy;
- y) owner's guidelines for the governance of projects; and
- z) health, safety, security and environment (HSSE) requirements.

NOTE HSSE might have its own operational requirements and performance targets; for example, in the case of safety, the operator might be committed to "zero accidents" and in the case of security, it might be "no physical vulnerabilities".

Each of the requirements in a) to z) should be obtained through a plain language question, supported by a prompt and, where appropriate, an example to ensure that the requirements are understood by the person or party receiving the request for information (see 4.9.3).

The owner should consider the types of intellectual property it holds or might develop, and the extent to which it wishes that property to be protected.

5.1.8 Roles and responsibilities

The owner, or the owner's representative, should prepare a responsibility assignment matrix (e.g. a RASCI chart) to cover the work activities (see 5.1.2) and their associated deliverables (see 5.1.10) for this work stage. The RASCI chart should be kept up to date and should be used to inform a similar requirement at the start of the Brief work stage. Details of the information exchange requirements for this work stage should be summarized in a design responsibility matrix (see 4.7).

NOTE Annex E gives an example RASCI chart and a design responsibility matrix.

5.1.9 Information systems and tools

The owner should define the information management strategy for the project (see 5.1.1), including the employer's information requirements (EIR) (see 4.9.1) and subsequent arrangements for the capture and transfer of project information and data for operational purposes from the project information model (PIM) to the asset information model (AIM). The arrangements to support asset/facilities management through the use of the owner's defined enterprise system (see PAS 1192-3), a computer-aided facilities management (CAFM) system or other means should be defined. The operator, operations team or facility manager, as appropriate, should assist with these arrangements where requested by the owner. The owner should confirm the intended arrangements for the asset information model (AIM).

The cyber security requirements for the information systems and tools should form part of the owner's security strategy and security management plans. The requirements should encompass people, process, physical and technical aspects.

5.1.10 Deliverables

The owner's representative should furnish the design and construction team with following information, as a minimum:

- a) strategic definition, including an elaborated business case;
- b) required high-level outcomes with respect to environmental, social, security and economic performance, including targets for energy use, CO₂ emissions, water consumption, waste reduction, functionality, effectiveness, capital cost and operational cost;
- c) performance evaluation measures and post-occupancy (POE) methodology to be introduced in the Operation and End of life work stage;
- d) engagement and communication plan for all identified stakeholders;
- e) risk and opportunity register; and
- f) format for presenting evidence to support subsequent design and construction proposals.

NOTE The emphasis on evidence-based design and construction (see 4.2) means that there has to be agreement up front on the format of evidence for supporting assertions, assumptions and the decisions that stem from them.

5.1.11 Key decisions and next steps

The owner should reach a decision on whether or not there is a business case for the new or refurbished asset/facility and inform the design and construction team, if appointed at this time, and the operator, operations team or facility manager, as appropriate. Where the owner intends to proceed, the owner's representative should be given the opportunity to review and comment on the planned work activities, and their associated information requirements and deliverables, with the design and construction team before commencing the Brief work stage.

NOTE A question that can be considered here is: "Does the owner fully understand what is being started?" The answer will help to bring focus to the consequences of early decisions concerning the strategic definition as well as the broad scope of, and approach to, the project.

5.2 Brief

5.2.1 General requirements

COMMENTARY ON 5.2.1

The Brief work stage is concerned with developing project objectives, including operational requirements and performance outcomes and/or targets for the asset/facility. It is a pivotal point in the life cycle of the asset/facility at which the project objectives, operational requirements and performance outcomes and/or targets are defined, discussed and agreed between the owner, the design and construction team and the operator, operations team or facility manager, as appropriate. These requirements and outcomes are revisited in subsequent work stages to ensure that the teams continue to align themselves with the expected performance against which actual performance of the asset/facility, as well as their own performance, will be measured.

The owner should assemble the design and construction team, the operator, operations team or facility manager, as appropriate, and any other key stakeholder or specialist who the owner considers has a contribution to make to the preparation of the initial brief for the new or refurbished asset/facility. The design and construction team should take responsibility for preparing this initial brief and should ensure that the details of information exchanges between it and other parties are adequately defined (see PAS 1192-2 and PAS 1192-5). An information exchange plan should be used to define and control this work. This task should be undertaken by the design and construction team with the assistance of the operator, operations team or facility manager, as appropriate.

5.2.2 Primary activities

5.2.2.1 Initial brief

The design and construction team should prepare the initial brief for the asset/facility based on the following work activities:

- a) summarize the relevant lessons learned from experience with previous projects and how they relate to the proposed asset/facility;
- b) define the project's organization and governance, supported by an organization chart to show the positions and relationships between the owner's representative and other parties in a way that reflects the anticipated procurement arrangement where known;
- c) identify the current use and capacity of the site and any features likely to impact on the decision to develop or extend, as appropriate;
- d) identify constraints in the provision of public utilities or other forms of infrastructure;
- e) prepare a statement on the general design philosophy and how it will address the project objectives, operational requirements and performance outcomes and/or targets;
- f) determine the environmental performance outcomes for the asset/facility (see 4.3);
- g) prepare a draft strategy for evaluating the performance of functionality and effectiveness, considering features such as comfort, inclusiveness, security, utility, usability, durability, maintainability, adaptability and impact;
- h) define the scope and boundary limits of the project;
- i) prepare a schedule of the named zones and named systems comprising the proposed asset/facility;
- j) identify a method for assessing construction waste that can be used when reviewing design proposals;

- k) define the methodology for whole-life cost assessment – BS 8544 provides guidance in this regard;
- l) update the project management schedule (a Level 1 schedule);
- m) prepare an estimate of capital cost;
- n) estimate the required schedule (i.e. time) contingency and cost contingency;
- o) determine how project information will be transferred from the project information model (PIM) to the asset information model (AIM), asset register and the owner's defined enterprise system (see PAS 1192-3 and PAS 1192-5), a computer-aided facilities management (CAFM) system or other system; and
- p) update the risk and opportunity register.

The owner or the owner's representative should determine which, if any, of the activities in a) to p) and which of the following activities the operator, operations team or facility manager, as appropriate, should undertake:

- 1) prepare a facilities management strategy and policy covering the Operation and End of life work stage;
- 2) prepare a draft plan for measuring operational performance during the Operation and End of life work stage;
- 3) identify the need for any temporary decant of personnel or equipment and outline how this should be managed;
- 4) prepare an estimate of operational cost, including a simple model of energy performance, maintenance and capital replacement costs; and
- 5) prepare an environmental management plan.

NOTE Annex A offers an example of a "Brief checklist".

5.2.2.2 Review of experience

COMMENTARY ON 5.2.2.2

The owner and the new project will benefit from the experience gained on previous projects. Much of this experience will be vested in people, but some might be found in validated case studies and other reliable, documented sources of lessons learned.

The owner's representative should assess the experience of the owner in the context of the project being proposed and highlight any perceived shortcomings in that experience to the owner. Where considered appropriate for the appointment of the design and construction team, the owner's representative should conduct a review of the relevant experience. The owner's representative should allow for the participation of the operator, operations team or facility manager, as appropriate, in review meetings and may also permit the representative(s) of end-users and other key stakeholders to attend.

The design and construction team should study the owner's asset/facility portfolio and/or undertake a review of published studies of similar, existing assets/facilities in order to determine if there are worthwhile lessons to be learned. The design and construction team should gather feedback and lessons learned from previous projects in which its members have been directly involved, to ensure that the design takes into account buildability and operability criteria.

5.2.2.3 Intermediate reviews and verification

COMMENTARY ON 5.2.2.3

There is the possibility that, over time, there might be some drift in the direction that the design is taking which, if not checked, could result in a misalignment between expected and actual outcomes and performance during start-up and operation of the asset/facility. Reviews during design development and at key points in the Build and Commission work stage will reduce the likelihood of this occurrence.

The design and construction team should determine its approach to peer reviews for design, including the timing, frequency of workshops, nature of facilitation, attendees and the method by which outputs can be captured for evidential purposes and later reference. The owner's representative should consider attending design reviews, but should leave the task of facilitation to a member of the design and construction team.

The design and construction team should define a process for peer review and verification during design and at key points during construction. These intermediate checks should be aligned with project decision gates (or points) and should reflect the adopted procurement method.

NOTE A review and verification process termed "pitstopping" has been defined by BSRIA [7].

Peer review and verification should be used to test the ability of the proposed design and construction to meet the required environmental, social, security and economic performance. The design and construction team should determine its approach, including the method to be used, frequency of workshops, nature of facilitation and attendees. The design and construction team should inform the owner's representative of the topics to be peer-reviewed and verified, the personnel required for this purpose and the method by which outputs will be captured and made available in subsequent work stages. The design and construction team should capture and record the outputs from peer review and verification workshops and use the information to inform handover (see 5.7) and aftercare work activities (see 5.8.2.2 and 5.8.2.3).

5.2.2.4 Environmental, social, security and economic performance

The design and construction team should agree a set of performance outcomes with the owner, operator, operations team or facility manager, as appropriate. These outcomes should be the basis upon which the performance of the asset/facility will be measured post-handover.

The outcomes should be continually referenced during peer review and verification and should only be revised following changes in the owner's requirements, changes to the design and any known changes in the intended use (e.g. expected activities, intensity of use or hours of operation of the asset/facility). The design and construction team should assist the owner's representative in the setting of environmental, social, security and economic outcomes and targets. Progress towards meeting targets should be assessed and agreed at decision gates (or points) within the respective, subsequent work stages.

The owner's representative should ensure that an energy monitoring strategy is developed in collaboration between the design and construction team and the operator, operations team or facility manager, as appropriate. The estimated energy consumption of the asset/facility should be measured at intervals during design and construction coinciding with peer review and verification. The design and construction team should ensure that appropriate and sufficient equipment is specified and available to meet the owner's requirements for monitoring the environmental conditions of the asset/facility once handed over. The use of sensing and metering equipment should be investigated.

The design and construction team should ensure that energy and water consumption data are based on metering and that any sub-metering is recorded in accordance with the requirements for the building logbook.

NOTE The principles of CIBSE TM39, Building energy metering [8], and the requirements of CIBSE TM31, Building log book toolkit [9], can assist in supporting data gathering. BS 8587 develops the concept of the building logbook into a facility handbook, which is a broader and deeper collection of information about the asset/facility and its design, construction, operation and maintenance.

5.2.3 Risks and opportunities

The design and construction team should maintain the risk and opportunity register, updating this where necessary to reflect changes in risks that might threaten outcomes and the opportunities that might enhance outcomes.

The design and construction team should proactively monitor and check the status of risks and opportunities recorded in the risk and opportunity register, the events that give rise to them and the outcomes of any risk responses. Where considered appropriate, the owner should ensure that functional experts are available to address specific technical and non-technical risks.

5.2.4 Information requirements

The following information should be considered for the purpose of supporting the work activities (see 5.2.2) and contributing to the deliverables (see 5.2.7) in this work stage:

- a) statement of the project's scope;
- b) schedule of the named zones and named systems comprising the proposed asset/facility;
- c) overall design concept and likely impact on the physical environment;
- d) extent to which building information modelling is to be used and who should manage it;
- e) details of physical constraints or other conditions on or around the site;
- f) details of constraints with respect to public utilities (e.g. water, sewerage and electricity);
- g) technical challenges likely to be encountered in either design or construction;
- h) updated risk and opportunity register;
- i) updated security strategy, where applicable;
- j) approach to obtaining planning and other permissions;
- k) results of stakeholder analysis in terms of stakeholders' interests and probable impact;
- l) extent to which the asset/facility is likely to satisfy the operator's, end-users' and other key stakeholders' needs;
- m) operational requirements or other determinants of capacity for the asset/facility;
- n) details of logistical requirements (e.g. deliveries and maintenance) once in operation;
- o) updated view of capital expenditure, where applicable;
- p) updated anticipated operational expenditure on facilities management, including maintenance;

- q) updated anticipated income or likely value of the asset/facility at completion, where applicable;
- r) updated anticipated non-monetary benefits of the asset/facility at completion, where applicable;
- s) strategy for procuring facility-related services (see BS 8572) during operation of the asset/facility;
- t) building services engineering systems philosophy;
- u) details of specific requirements in facilities management affecting the choice of materials, products or components;
- v) basis of whole-life cost assessment – BS 8544 provides guidance in this regard;
- w) information management plan;
- x) details of specific HSSE requirements; and
- y) extent to which any decanting of personnel and subsequent move-in might be necessary and any phasing, where applicable.

Each of the requirements in a) to y) should be obtained through a plain language question, supported by a prompt and, where appropriate, an example to ensure that the requirements are understood by the person or party receiving the request for information (see 4.9.3).

NOTE Annex A offers an example of a “Brief checklist”.

5.2.5 Roles and responsibilities

The owner, or the owner’s representative, should prepare a responsibility assignment matrix (e.g. a RASCI chart) to cover the work activities (see 5.2.2) and their associated deliverables (see 5.2.7) for this work stage. As far as practicable, this preparation should commence before the conclusion of the Strategy work stage. The RASCI chart should be kept up to date and should be used to inform a similar requirement at the start of the Concept work stage. Details of the information exchange requirements for this work stage should be summarized in a design responsibility matrix (see 4.7).

The owner should appoint an independent commissioning manager, where the complexity of building services engineering systems warrants it, to oversee and be responsible for all commissioning activities. Where a commissioning manager is to be appointed, it should be done during this work stage.

5.2.6 Information systems and tools

The owner should confirm, or revise, the arrangements for the transfer of project information and data for operational purposes from the project information model (PIM) to the asset information model (AIM). The arrangements to support asset/facilities management through the use of the owner’s defined enterprise system (see PAS 1192-3 and PAS 1192-5), a computer-aided facilities management (CAFM) system or other means should be confirmed or revised. The operator, operations team or facility manager, as appropriate, should assist with these arrangements where requested by the owner.

5.2.7 Deliverables

NOTE 1 The primary deliverable at the end of the Brief work stage is the initial brief. The acceptability of the brief by the owner is likely to be contingent upon the probability of meeting the required operational performance.

The design and construction team should provide the owner's representative with the following, as a minimum:

- a) the response to the owner's, operator's, end-users' and other key stakeholders' needs in the form of an initial brief that can be used as a basis for developing and subsequently validating design and construction proposals;
- b) the response to the required project objectives and performance outcomes and/or targets as an integral part of the initial brief that includes details of the method(s) for measuring actual performance against targets;
- c) updated risk and opportunity register; and
- d) a draft environmental management plan.

NOTE 2 Annex A offers an example of a "Brief checklist".

5.2.8 Key decisions and next steps

The owner should reach a decision on whether or not there is a sufficient basis to proceed with the proposed project and inform the design and construction team and the operator, operations team or facility manager, as appropriate. Where the owner intends to proceed, the owner's representative should be given the opportunity to review and comment on the planned work activities, and their associated information requirements and deliverables, before commencing the Concept work stage.

NOTE A question that can be considered here is: "Has enough been done to understand the needs of the owner, operator, end-users and other key stakeholders in regard to the project and its required outcomes?" The answer will help to inform the design and construction team on the approach to be taken to project delivery.

5.3 Concept

5.3.1 General requirements

COMMENTARY ON 5.3.1

The Concept work stage is concerned with preparing the concept design, including outline proposals for the structural design, building services engineering systems and outline specifications, supported by cost information and a project execution strategy. This work stage addresses the feasibility of the proposed approach to the design, where key criteria relate to environmental, social, security and economic performance. It provides an opportunity for agreeing revisions to the initial brief which can then be finalized.

The design and construction team should define the scope of the project and its boundary conditions, its feasibility and the risks and uncertainties, and recommend the option that holds the most promise in terms of its ability to achieve the operational performance requirements. The owner should review the concept design in terms of its architectural treatment, structural form and building services engineering, supported by cost information and a project execution strategy as a minimum, to determine if it aligns with the expected performance requirements for the asset/facility. Any adjustment to the concept design should be confirmed with the owner or, at the owner's direction, with the owner's representative following discussion and agreement between the design and construction team and the operator, operations team or facility manager, as appropriate. Any agreed deviations from the initial brief or performance requirements should be recorded and captured in the relevant part of the project information model (PIM).

NOTE Annex A offers an example of a "Brief checklist".

5.3.2 Primary activities

5.3.2.1 Concept design

The design and construction team should prepare the concept design for the asset/facility based on the following work activities:

- a) identify and assess major risks and uncertainties;
- b) update the risk and opportunity register;
- c) prepare a project execution strategy;
- d) agree the schedule of the named zones and named systems comprising the proposed asset/facility;
- e) prepare high-level simulation models to examine the alignment of the proposed design with the required operational performance outcomes and/or targets;
- f) review design predictions against the required operational performance;
- g) agree the methods and associated measures for evaluating environmental, social, security and economic performance;
- h) devise a plan for recording energy and other environmental performance, user satisfaction, fine-tuning and comparison of actual performance against required performance;
- i) prepare a plan for reporting the results of performance evaluation;
- j) outline commissioning needs, including those for building services engineering systems, and the standards to be applied;
- k) prepare a plan for commissioning, training and handover;
- l) determine the operational resources needed to support commissioning, training and handover;
- m) prepare a plan for satisfying training needs;
- n) update the project management schedule (a Level 1 schedule);
- o) update the estimates of capital cost and operational cost;
- p) assess the whole-life costs of major components and systems – BS 8544 provides guidance in this regard;
- q) determine if the estimated capital and operational costs are within the agreed limits; and
- r) update the required schedule (i.e. time) contingency and cost contingency.

The operator, operations team or facility manager, as appropriate, should undertake the following activities in consultation with the owner's representative and the design and construction team:

- 1) prepare an analysis of the fit between the concept design and operational requirements;
- 2) review and contribute to the estimates of capital costs and operational costs and the assessment of whole-life costs;
- 3) prepare an operational model, operational management plan and operational expenditure budget;
- 4) determine the duration of the initial period of aftercare;
- 5) outline the initial aftercare process including those responsible for delivering it;
- 6) outline the extended period of aftercare, including annual visits and reviews as a basis for optimizing operational performance;
- 7) identify who will be required from the operations team to support the aftercare to be provided by the design and construction team;
- 8) prepare a plan for the removal and replacement of equipment, fabric and debris, where applicable; and
- 9) update any decant proposals with respect to personnel or equipment.

5.3.2.2 Design reviews

The design and construction team should agree the definition of design-related information to be reviewed with the owner's representative, the operator, operations team or facility manager, as appropriate. Design reviews should adopt a structured and systematic approach based on the agreed deliverables for this work stage (see 5.3.7). Where found necessary and agreed with the owner, the design and construction team should update the performance outcomes and/or targets for energy use, CO₂ emissions, water consumption and waste reduction. The design and construction team should prepare an energy model based on reliable estimates of regulated and unregulated load.

NOTE The CIBSE TM54, Evaluating operational energy performance of buildings at design stage [10] can be useful in this regard.

The energy model should be updated and refined during the project as thermal and electrical loads and hours of occupation become clearer. The model should be maintained so that it is able to inform the energy analyses performed during aftercare and at the times post-occupancy evaluations (POE) are conducted.

Where found necessary and agreed with the owner or the owner's representative, the design and construction team should update the required social, security and economic performance outcomes.

The design and construction team should allow for the participation of appropriate subcontractors in design reviews, and record and act on identified access, commissioning and potential maintenance risks, where appropriate. The risk and opportunity register should be updated accordingly (see 5.3.3).

5.3.2.3 Facility maintenance management

NOTE It is important that the proposed arrangements for asset/facility maintenance take account of manufacturers' and other authoritative advice on appropriate maintenance regimes if the expected performance is not to be impaired.

The design and construction team should review and comment on the owner's proposed arrangements for asset/facility maintenance in consultation with the operator, operations team or facility manager, as appropriate, and review them at subsequent project decision gates (or points) up to and including the Handover and Close-out work stage to ensure that they remain appropriate. BS 8210 provides detailed guidance on maintenance management.

5.3.3 Risks and opportunities

The design and construction team should maintain the risk and opportunity register, updating this where necessary to reflect changes in risks that might threaten outcomes and the opportunities that might enhance outcomes. Particular attention should be paid to operation and maintenance implications as design proposals and information become available, in particular preserving or protecting the asset/facility from specific threats and vulnerabilities.

5.3.4 Information requirements

The following information should be considered for the purpose of supporting the work activities (see 5.3.2) and contributing to the deliverables (see 5.3.7) in this work stage:

- a) capacity of existing utility services;
- b) output requirements from the building services engineering systems;
- c) energy performance requirements to be met;
- d) requirements for aligning with environmental assessment methods (for example BREEAM, LEED and Ska⁴⁾), as applicable;
- e) method(s) for measuring energy in use and CO₂ emissions;
- f) Building Regulations [11], [12] and [13] requirements to be met;
- g) arrangements for managing and exploiting building information modelling;
- h) required performance outcomes for use in post-occupancy evaluation (POE);
- i) extent of aftercare required;
- j) commissioning and training plan;
- k) extent of design for manufacture and assembly/disassembly;
- l) data for whole-life cost assessment of major components and systems;
- m) procurement plan;
- n) approach to meeting owner-specific performance requirements;
- o) extent of an inclusive design that anticipates the needs of disabled people and others with equalities-related needs, especially provisions for access, movement and emergency evacuation;
- p) acceptable deviations from the initial brief;
- q) format for presenting outline proposals to the owner;
- r) risks and opportunities to be reflected in a schedule and cost risk assessment;
- s) acceptability of the updated project management schedule (a Level 1 schedule);
- t) updated facilities management strategy and policy; and

⁴⁾ BREEAM: <http://www.breeam.org/>, LEED: <http://www.usgbc.org/leed> Ska: <http://www.rics.org/ska> [viewed 2015-07-29].

- u) updated plan for decanting of personnel and subsequent move-in, where applicable.

Each of the requirements in a) to u) should be obtained through a plain language question, supported by a prompt and, where appropriate, an example to ensure that the requirements are understood by the person or party receiving the request for information (see 4.9.3).

5.3.5 Roles and responsibilities

The owner, or the owner's representative, should prepare a responsibility assignment matrix (e.g. a RASCI chart) to cover the work activities (see 5.3.2) and their associated deliverables (see 5.3.7) for this work stage. The RASCI chart should be kept up to date and should be used to inform a similar requirement at the start of the Definition work stage. A design responsibility matrix should be used for the purpose of assigning design responsibility for aspects of the design, their level of detail and the level of information to be exchanged.

5.3.6 Information systems and tools

The arrangements to support asset/facilities management through the use of the owner's defined enterprise system (see PAS 1192-3 and PAS 1192-5), a computer-aided facilities management (CAFM) system or other means should be confirmed or revised. The operator, operations team or facility manager, as appropriate, should assist with these arrangements where requested by the owner.

5.3.7 Deliverables

NOTE The primary deliverables at the end of the Concept work stage are the final brief and the design concept. Together, they indicate the project's feasibility.

The design and construction team should provide the owner's representative with the following, as a minimum:

- a) a checkable copy of the final brief, including supporting information, data and evidence of any aspect of the concept demonstrated in this work stage, including the relationship of the structural design to the architectural treatment including aesthetics;
- b) an indication of whether or not the required operational performance can be achieved by the design concept, including the preferred building services engineering systems philosophy;
- c) an indication of whether or not any commitments to statutory energy targets are satisfied by the design concept;
- d) an updated risk and opportunity register;
- e) a project execution strategy; and
- f) a record of engagement and checking that has taken place with the operator, operations team or facility manager, as appropriate, and the representative(s) of end-users.

5.3.8 Key decisions and next steps

The owner should reach a decision on whether or not there is a sufficient basis to proceed following what amounts to a feasibility study for the proposed asset/facility. The design and construction team and the operator, operations team or facility manager, as appropriate, should be informed accordingly. Where the owner intends to proceed, the owner's representative should be given the opportunity to review and comment on the planned work activities, and their associated information requirements and deliverables, before commencing the Definition work stage.

NOTE A question that can be considered here is: "Has the design and construction team looked wide enough in terms of considering and assessing the options available?" The answer to this question will either confirm the intended approach to design development or will indicate if the owner has to reconsider the initial brief or, perhaps, the strategic definition and the business case for the new or refurbished asset/facility.

5.4 Definition

5.4.1 General requirements

COMMENTARY ON 5.4.1

The Definition work stage is concerned with developing the design, including coordinating and updating the proposed structural design, building services engineering systems and outline specifications supported by updated capital and operational costs. It provides the opportunity to ensure that the main facets of the design have matured sufficiently to enable detailed, technical design to commence in the subsequent Design work stage.

The design and construction team should ensure that the design takes into account the needs of the operator, operations team or facility manager, as appropriate, and end-users in regard to the required operational performance of the asset/facility and that design assumptions are tested in reviews of the design proposals. The owner's representative should clarify any aspect of uncertainty on the part of the design and construction team in regard to work activities, information exchanges or deliverables.

The owner should require the design and construction team and the operator, operations team or facility manager, as appropriate, to report on any aspect of the developing design that might compromise achievement of the project objectives or the ability to meet the required operational performance outcomes and/or targets for the asset/facility. The operator, operations team or facility manager, as appropriate, should assess the impact of the proposed design upon plans for operation and maintenance, including the delivery of technical and business services, where applicable. An updated estimate of the operational cost for the asset/facility should be provided by the operator, operations team or facility manager, as appropriate, to the owner and the design and construction team.

5.4.2 Primary activities

The design and construction team should prepare the definition of the asset/facility based on the following work activities:

- a) explore the design proposals by means of a walkthrough of a 3D model or other method for explaining the asset/facility to the owner, the operator, operations team or facility manager as appropriate, end-users and other key stakeholders;
- b) undertake model-based design performance simulations that take into account the accuracy of prediction achieved in the past from similar simulations;
- c) determine if the design proposal is capable of meeting the required environmental, social, security and economic performance;
- d) identify any additional operational requirements that are necessary for achieving the required energy performance;
- e) report on the extent to which any operational constraints have been advised to the operator, operations team or facility manager, as appropriate, and the planning authority where applicable;

- f) prepare an update of what will be required for aftercare, including the scope of the engagement required from all involved parties;
- g) prepare aftercare plans as agreed with the operator, operations team or facility manager, as appropriate, and the representative(s) of end-users;
- h) undertake an HSSE risk assessment, identifying any operational hazards, measures to eliminate or reduce the risks and plans to control the risks during operation of the asset/facility;
- i) determine if the design will deliver an asset/facility that is safe to access, maintain and use;
- j) prepare an integrated master schedule (i.e. a Level 2 schedule) to show the interfaces between design, procurement, construction, commissioning, handover, start-up and operations;
- k) update the estimates of capital cost and operational cost;
- l) update the required schedule (i.e. time) contingency and cost contingency;
- m) prepare descriptions for the operation of controls on all building service engineering systems;
- n) identify any controls for use by end-users and the steps to be taken to ensure they can operate them correctly and safely;
- o) prepare a draft version of the building logbook;
- p) identify the commissioning needs for each system and the related standard(s) and methods;
- q) update the plan for commissioning, training and handover; and
- r) update the handover plan, as necessary.

The operator, operations team or facility manager, as appropriate, should undertake the following activities, as a minimum:

- 1) participate in reviews of the design proposals and comment on whether or not the design is capable of meeting the required environmental, social, security and economic performance;
- 2) provide an updated operational model, operational management plan and operational expenditure budget;
- 3) review and comment on the updated estimate of operational cost;
- 4) identify the parties needed to witness demonstrations;
- 5) update the training plan for the operator, operations team or facility manager, as appropriate, and end-users where necessary;
- 6) prepare an updated plan for the removal and replacement of equipment, fabric and debris, where applicable; and
- 7) prepare a schedule of assets, including estimated costs, for management accounting purposes.

5.4.3 Option appraisal

The options available to satisfy functional, technical, operational and end-users' needs and the extent to which these can be practically achieved should be assessed. Options should allow for the measurement of environmental, social, security and economic performance, and comparison with the required outcomes (see 4.3). In particular, the design and construction team should:

- a) indicate when alternative solutions (e.g. designs, materials, products and systems), identified from a combined operational and inclusive perspective,

are available and inform the owner which solution (or combination) optimizes energy use and minimizes CO₂ emissions and whole-life cost;

- b) be explicit when deciding on any matter that could impact on operations, in particular energy use, CO₂ emissions, water consumption, waste disposal and whole-life cost;
- c) obtain information from manufacturers on the operational costs (including maintenance), breakdown frequency, lifetime of system components/parts (including the energy consumed by them) and other information required by the owner; and
- d) obtain current lead times for building services engineering systems and other major components and systems.

All information should be provided to determine whether or not operational parameters are acceptable and to permit the option of visiting manufacturers and/or existing operational assets/facilities to verify details before reaching a decision.

5.4.4 Risks and opportunities

The design and construction team should maintain the risk and opportunity register, updating this where necessary to reflect changes in risks that might threaten outcomes and the opportunities that might enhance outcomes.

5.4.5 Information requirements

The following information should be considered for the purpose of supporting the work activities (see 5.4.2) and contributing to the deliverables (see 5.4.8) in this work stage:

- a) the extent of design development needed to demonstrate detailed proposals for site layout, planning and spatial arrangements, elevations, construction, environmental systems, buildability and operability;
- b) acceptability of the proposed approach to cost planning of construction and maintenance;
- c) acceptability of the cash flow forecast;
- d) the extent to which lessons learned from prior projects have been acted upon;
- e) the extent to which rule-based, auto-generation of objects has been utilized;
- f) the extent of design coordinated at a component and building element level of detail;
- g) the completeness of calculations in regard to any energy-related planning conditions and their implications; and
- h) the design's compliance with standards, specifications and the final brief.

Each of the requirements in a) to h) should be obtained through a plain language question, supported by a prompt and, where appropriate, an example to ensure that the requirements are understood by the person or party receiving the request for information (see 4.9.3).

5.4.6 Roles and responsibilities

The owner, or the owner's representative, should prepare a responsibility assignment matrix (e.g. a RASCI chart) to cover the work activities (see 5.4.2) and their associated deliverables (see 5.4.8) for this work stage. The RASCI chart should be kept up to date and should be used to inform a similar requirement at the start of the Design work stage. A design responsibility matrix should be used for the purpose of assigning design responsibility for aspects of the design, their level of detail and the level of information to be exchanged.

5.4.7 Information systems and tools

The arrangements to support asset/facilities management through the use of the owner's defined enterprise system (see PAS 1192-3 and PAS 1192-5), a computer-aided facilities management (CAFM) system or other means should be confirmed or revised. The operator, operations team or facility manager, as appropriate, should assist with these arrangements where requested by the owner.

5.4.8 Deliverables

The design and construction team should provide the owner's representative with the following, as a minimum:

- a) evidence that lessons learned from previous projects have been acted upon;
- b) evidence of how the design proposals meet the needs of the operator, operations team or facility manager, as appropriate, end-users and other key stakeholders;
- c) detailed proposals with respect to:
 - 1) coordinated design intentions;
 - 2) site layout;
 - 3) planning and spatial arrangements;
 - 4) elevations;
 - 5) construction systems;
 - 6) environmental systems; and
 - 7) buildability and operability;
- d) evidence that the design conforms to standards, specifications and the final brief;
- e) the extent of design coordination at the building element and component level of detail;
- f) details of rule-based, auto-generation of objects, where applicable;
- g) calculations for determining energy use and how energy performance has been considered;
- h) calculations supporting environmental-related planning conditions, where applicable;
- i) evidence that the asset/facility will be safe to operate and use;
- j) evidence that the proposals as developed demonstrate principles in support of operational requirements, including access for disabled people and others with equalities-related needs;
- k) details of the cost plan for construction and the cost plan for maintenance; and
- l) cash flow forecast.

NOTE RICS NRM1, New rules of measurement – order of cost estimating and cost planning for capital building works [14], provides guidance on the quantification of building works for the purpose of preparing cost estimates and cost plans. RICS NRM 3, New rules of measurement – order of cost estimating and cost planning for building maintenance works [15], provides guidance on the quantification of maintenance works for the purpose of preparing order of cost estimates and formal cost plans (pre-construction) and detailed cost plans (post-construction) during the Operation and End of life work stage.

5.4.9 Key decisions and next steps

The owner should be able to reach a decision on whether or not there is a sufficient basis to proceed to detailed design and should inform the design and construction team and the operator, operations team or facility manager, as appropriate. Where the owner intends to proceed, the owner's representative should be given the opportunity to review and comment on the planned work activities, and their associated information requirements and deliverables, before commencing the Design work stage.

NOTE A question that can be considered here is: "Is the design approach capable of being translated into a detailed, technical design supported by specifications?" The answer will help to confirm the intended approach to design or will indicate if the owner has to reconsider the design concept.

5.5 Design

5.5.1 General requirements

COMMENTARY ON 5.5.1

The Design work stage is concerned with preparing the technical design, including architectural, structural and building services engineering information, and detailed cost and operational data. This work stage is likely to involve the supply chain beyond the immediacy of the design and construction team in finalizing the details of the design prior to construction. Specialist suppliers and manufacturers are likely to be involved where components and systems are subject to significant off-site manufacturing. This work stage is one where the incidence of design changes is likely to rise, necessitating an effective change control procedure. In this connection, it is important to recognize the many minor changes that are more in the nature of design development than a change in scope.

The owner should review the technical aspects of the design and, where considered appropriate, should visit manufacturers, other producers, specialist suppliers and subcontractors to confirm the acceptability, or otherwise, of specified materials, products, components and systems. Any adjustment to the design should be confirmed with the owner or, at the owner's discretion, with the owner's representative following discussion and agreement between the design and construction team and the operator, operations team or facility manager, as appropriate. Any agreed deviations from the design or performance requirements should be recorded and captured in the building information model. A procedure for design change control should be implemented by the design and construction team, where the authority for approving those changes classed as significant should rest with the owner or, at the owner's discretion, with the owner's representative. The procedure should include criteria for classifying changes.

5.5.2 Primary activities

5.5.2.1 Technical design

The design and construction team should prepare the technical design for the asset/facility based on the following work activities:

- a) implement a change control procedure;
- b) agree with the owner the form of delivery and method of production for the 3D model and drawings required to operate the asset/facility;
- c) prepare the building information model, drawings, specifications and equipment lists, clearly defining the assets to be operated and maintained;
- d) undertake model-based design performance simulations that take into account the accuracy of prediction achieved in the past from similar simulations;
- e) prepare method statements covering operation and maintenance in consultation with the operator, operations team or facility manager, as appropriate;
- f) prepare aftercare plans and schedules in consultation with the operator, operations team or facility manager, as appropriate, and the representative(s) of end-users;
- g) outline the scope and content of the asset information model (AIM), including operation and maintenance information, and a specification for extracting relevant BIM-related data, where appropriate;
- h) update the building logbook as required;
- i) prepare an updated plan for the removal and replacement of equipment, fabric and debris, where applicable;
- j) update the plan for commissioning, training and handover;
- k) update the training needs' plan;
- l) prepare the HSSE plan for construction and operation;
- m) update the risk assessments and the risk and opportunity register;
- n) update the estimates of capital cost and operational cost;
- o) update the integrated master schedule (i.e. a Level 2 schedule);
- p) prepare a construction and system testing schedule and a commissioning and performance testing schedule (i.e. Level 3 schedules), wherever possible;
- q) update the required schedule (i.e. time) contingency and cost contingency; and
- r) update the handover plan, as necessary.

The operator, operations team or facility manager, as appropriate, should undertake the following activities, as a minimum:

- 1) participate in reviews of the technical design and comment on whether or not the design is capable of meeting the required environmental, social, security and economic performance;
- 2) identify any changed operational requirements that are necessary in order to meet the desired energy performance target(s);
- 3) provide an updated operational model, operational management plan and operational expenditure budget;
- 4) review and comment on the updated estimate of operational cost;
- 5) prepare an asset replacement and removal strategy, where applicable;

- 6) provide a definition of the requirements for the asset register and any specific maintenance plans;
- 7) provide a scope of work and specification for the procurement of maintenance services, as required;
- 8) advise on the need to recruit personnel for the operations team, where applicable;
- 9) advise on the need for procurement of service providers, where applicable; and
- 10) confirm the arrangements for the transfer of asset data to the asset information model (AIM) or asset register, as appropriate.

NOTE BS 8572 contains guidance on the procurement of facility-related services.

5.5.2.2 Design change control

COMMENTARY ON 5.5.2.2

Changes to the scope of work required to deliver the project might be necessary or might be proposed by the owner or a key stakeholder. A change might have implications for the design or other attribute of the scope, such as its cost, schedule or performance in use. It is important to distinguish between a change to the design and design development, where the latter is a matter of increasing levels of detail.

Changes to the design should be avoided unless considered necessary for reasons of safety or inoperability of installations and/or equipment. Changes might be necessary where the results of peer reviews and verification show that the required performance or other outcome or objective cannot be met.

A design change control procedure, incorporating a design change protocol, should be implemented to evaluate proposed changes to the design before they are submitted for approval to the owner and/or operator, so that the full implications for the correct and safe operation of the asset/facility can be verified. This design change protocol should record details of the proposed change, including:

- a) a description of the proposed change;
- b) justification for the change (e.g. if the scope of work is unsafe or inoperable, or if value improvement is sought);
- c) basis of the design (e.g. description and details of the system, component, process or activity to which it relates);
- d) impact on end-users of the asset/facility, including disabled people and others with equalities-related needs;
- e) impact on the whole-life cost of the asset/facility and schedule for construction work and/or installation, and on operations and their cost; and
- f) authority responsible for approving the change.

Approved changes to the design should be reported formally to the owner at intervals, as necessary, reflecting the extent and urgency of the change and the time required for design or redesign.

5.5.2.3 Design documentation

The design and construction team should allow for the review of the 3D model, drawings and specifications and comment by the owner's representative and the operator, operations team or facility manager, as appropriate, in regard to the design meeting environmental, social, security and economic performance outcomes and/or targets. The design and construction team should ensure that any monitoring and metering systems proposed by subcontractors satisfy the owner's performance monitoring requirements.

5.5.2.4 Facilities maintenance management

The design and construction team should review and comment on the owner's and/or operator's arrangements for the procurement of facility-related services (see BS 8572), including those relating to maintenance, to ensure that they are appropriate.

NOTE BS 8210 provides important guidance in regard to facilities maintenance management.

5.5.3 Risks and opportunities

The design and construction team should maintain the risk and opportunity register, updating this where necessary to reflect changes in risks that might threaten outcomes and the opportunities that might enhance outcomes.

The design and construction team should produce an updated HSSE risk assessment, identifying any operational hazards, measures to eliminate or reduce the risks and plans to control the risks in operation. The risk and opportunity register should be updated accordingly. Details of the HSSE risk assessment should be provided to the operator, operations team or facility manager, as appropriate, at the end of the Handover and Close-out work stage.

5.5.4 Information requirements

The following information should be considered for the purpose of supporting the work activities (see 5.5.2) and contributing to the deliverables (see 5.5.7) in this work stage:

- a) the project information and design information needed to enable construction;
- b) the alignment of the design with the needs of the operator, operations team or facility manager, as appropriate, and end-users in terms of the basis of the design, space, access, adaptability and operational cost, as a minimum;
- c) the availability of a procedure or protocol for controlling the distribution of documents, information and data;
- d) any requirement to obtain firm price quotations as a precursor to procuring the building services engineering systems and other long lead items;
- e) updated lead times for building services engineering systems and other major components and systems;
- f) source of specialist maintenance service provision (e.g. lifts/elevators and other specialist building services engineering systems);
- g) the definition and extent of operation and maintenance information; and
- h) method statements for work where existing building services engineering systems and public utilities are to interface with the new or refurbished asset/facility – BS 8210 provides guidance in this regard.

Each of the requirements in a) to h) should be obtained through a plain language question, supported by a prompt and, where appropriate, an example to ensure that the requirements are understood by the person or party receiving the request for information (see 4.9.3).

5.5.5 Roles and responsibilities

The owner, or the owner's representative, should prepare a responsibility assignment matrix (e.g. a RASCI chart) to cover the work activities (see 5.5.2) and their associated deliverables (see 5.5.7) for this work stage. The RASCI chart should be kept up to date and should be used to inform a similar requirement at the start of the Build and Commission work stage. A design responsibility matrix should be used for the purpose of assigning design responsibility for aspects of the design, their level of detail and the level of information to be exchanged.

5.5.6 Information systems and tools

The arrangements to support asset/facilities management through the use of the owner's defined enterprise system (see PAS 1192-3 and PAS 1192-5), a computer-aided facilities management (CAFM) system or other means should be confirmed or revised. The operator, operations team or facility manager, as appropriate, should assist with these arrangements.

The design and construction team should provide a walkthrough of a 3D model or other method to test the perceptions of the operator, operations team or facility manager, as appropriate, and those of end-users in regard to the proposed asset/facility and to assist in optimizing operational procedures and, subsequently, whole-life costs.

5.5.7 Deliverables

The design and construction team should provide the owner's representative with the following, as a minimum:

- a) evidence that the design can be delivered through the proposals for construction and operation;
- b) evidence that the design proposals are likely to meet the targets for environmental, social, security and economic performance;
- c) evidence that the calculations in relation to energy have been verified and that the owner has been advised of any changes that might impact upon the required performance;
- d) evidence that the design and construction proposals satisfy construction, design and management (CDM) legislation and HSSE requirements for construction, operation and maintenance, including 3D models and drawings to show access provisions;
- e) evidence that the design and construction proposals satisfy the requirements for obtaining statutory and other approvals during the Handover and Close-out work stage;
- f) a 3D model and simulations of energy use, CO₂ emissions, acoustical performance, public address and voice alarm performance, fire and smoke modelling and evacuation, vehicle and people movement capacities, where applicable;

NOTE 1 CIBSE TM54, Evaluating operational energy performance of buildings at design stage [10], can be useful in this regard.

- g) details of the metering strategy for energy use, water consumption and waste reduction;

NOTE 2 CIBSE TM39, Building energy metering [8], can be useful in this regard.

- h) evidence that the design and construction proposals meet the needs of the operator, operations team or facility manager, as appropriate, in terms of materials, performance, maintenance methods, cleaning methods and adaptability;

- i) evidence that the design and construction proposals provide sufficient information for the owner to initiate procurement of facility-related services (see BS 8572);
- j) evidence that the automated transfer of BIM data content to the asset information model (AIM), the owner's defined enterprise system (see PAS 1192-3), a computer-aided facilities management (CAFM) system or other means can be achieved where this has been defined as a requirement;
- k) evidence that the updated capital cost and operational costs are within the agreed expenditure limits;
- l) updated budget estimates;
- m) descriptions of controls for all building services engineering systems, including those controls intended to be used by end-users; and
- n) evidence that the specification for operation and maintenance information has been defined in consultation with the operator, operations team or facility manager, as appropriate, and end-users.

5.5.8 Key decisions and next steps

The owner should be able to reach a decision on whether or not there is a sufficient basis to proceed with construction and should inform the design and construction team and the operator, operations team or facility manager, as appropriate. Where the owner intends to proceed, the owner's representative should be given the opportunity to review and comment on the planned work activities, and their associated information requirements and deliverables, before commencing the Build and Commission work stage.

NOTE A question that can be considered here is: "Has the design reached a sufficiently mature state to be moved into construction?" The answer to this question will largely determine the owner's final investment decision and the commitment to construction work.

5.6 Build and Commission

5.6.1 General requirements

COMMENTARY ON 5.6.1

The Build and Commission work stage is concerned with planning, organizing and coordinating off-site manufacturing with on-site construction, including assembly, testing and commissioning with supporting schedules, for example a construction and system testing schedule and a commissioning and performance testing schedule (i.e. Level 3 schedules). This work stage is fundamentally the means by which the required project outcomes are realized. It is inevitable that some adjustments will be needed to the design during construction to resolve operability issues and to avoid quality failures. This stage emphasizes the importance of testing and commissioning as essential to ensuring that there is a smooth transition from construction to the subsequent stages of Handover and Close-out and Operation and End of life.

The owner or the owner's representative should require the design and construction team to provide a detailed schedule covering the construction work and the testing and commissioning of the asset/facility, including building services engineering systems and other systems and installations where functionality and effectiveness need to be demonstrated. Any adjustment to the design during this work stage should be confirmed with the owner or, at the owner's discretion, with the owner's representative following discussion and agreement between the design and construction team and operator, operations team or facility manager, as appropriate. Any agreed deviations from the design or performance requirements should be recorded and captured in the project information model (PIM). The procedure for design change control should continue through this work stage and be used to capture lessons learned for subsequent post-construction review and feedback to all parties.

5.6.2 Primary activities

The design and construction team should prepare for construction and commissioning of the asset/facility based on the following work activities:

- a) review all construction and installation details and highlight any that will impact negatively upon the actual performance relative to the required performance;
- b) highlight any unavoidable changes in design that might give rise to a change in the performance of the asset/facility;
- c) update the building information model as required in light of further design and operational information and data;
- d) update the HSSE risk assessment;
- e) update risk and opportunity register;
- f) update the required schedule (i.e. time) contingency and cost contingency;
- g) prepare forecasts of final capital cost and operational cost;
- h) update the commissioning specification;
- i) update the commissioning and training plan in liaison with the commissioning manager;
- j) identify any skills that end-users and other key stakeholders need to have acquired before attending commissioning demonstrations;
- k) prepare a schedule of pre-commissioning activities;
- l) update the construction and system testing schedule and the commissioning and performance testing schedule (i.e. Level 3 schedules) and integrated master schedule (i.e. Level 2 schedule);
- m) maintain a 14-day look-ahead construction schedule (i.e. Level 4 schedule);
- n) prepare a detailed move-in plan for people and equipment;
- o) update the handover plan to include training requirements for the operator, operations team or facility manager, as appropriate, and end-users; and
- p) collate the architectural, structural, mechanical, electrical and public health information necessary to obtain statutory approvals.

The operator, operations team or facility manager, as appropriate, should undertake the following activities, as a minimum:

- 1) determine whether or not the building services engineering systems and other major components and systems can be maintained safely in compliance with relevant legislation;
- 2) provide an operational risk assessment;

- 3) comment on the construction and system testing schedule and the commissioning and performance testing schedule from the perspective of witnessing demonstrations; and
- 4) contribute to the updating of the handover plan.

5.6.3 Commissioning plan

The design and construction team should develop a plan for managing the commissioning of the asset/facility and the equipment and systems that it comprises in conjunction with the operator, operations team or facility manager, as appropriate. This process can be greatly assisted by a detailed schedule or schedules (see 5.6.2). The design and construction team should ensure that the commissioning is witnessed by appropriate parties, including the owner or owner's representative and the operator, operations team or facility manager, as appropriate, and that the required performance outcomes are achieved to the owner's satisfaction.

5.6.4 Risks and opportunities

The design and construction team should maintain the risk and opportunity register, updating this where necessary to reflect changes in risks that might threaten outcomes and the opportunities that might enhance outcomes.

5.6.5 Information requirements

The following information should be considered for the purpose of supporting the work activities (see 5.6.2) and contributing to the deliverables (see 5.6.8) in this work stage:

- a) arrangements to ensure that the project's construction site will be managed safely and securely;
- b) procedure for involving the owner in decisions on proposed changes to the design during construction, testing and commissioning;
- c) witnesses required for commissioning work; and
- d) format for presenting evidence to support physical deliverables.

Each of the requirements in a) to d) should be obtained through a plain language question, supported by a prompt and, where appropriate, an example to ensure that the requirements are understood by the person or party receiving the request for information (see 4.9.3).

5.6.6 Roles and responsibilities

The owner, or the owner's representative, should prepare a responsibility assignment matrix (e.g. a RASCI chart) to cover the work activities (see 5.6.2) and their associated deliverables (see 5.6.8) for this work stage. The RASCI chart should be kept up to date and should be used to inform a similar requirement at the start of the Handover and Close-out work stage. A design responsibility matrix should be used for the purpose of assigning design responsibility for aspects of the design, their level of detail and the level of information to be exchanged.

5.6.7 Information systems and tools

The arrangements to support asset/facilities management through the use of the owner's defined enterprise system (see PAS 1192-3 and PAS 1192-5), a computer-aided facilities management (CAFM) system or other means should be confirmed or revised. The operator, operations team or facility manager, as appropriate, should assist with these arrangements.

The design and construction team should ensure that a robust project planning and scheduling tool is used to plan and schedule construction, coordinate contractor interfaces and sequence activities for commissioning and training.

5.6.8 Deliverables

The design and construction team should provide the owner's representative and the operator, operations team or facility manager, as appropriate, with the following, as a minimum:

- a) information on design changes, including changes in material and product samples;
- b) information on changes, other than to the design, affecting the expected project objectives and/or operational performance requirements;
- c) evidence that the information required for statutory approvals has been prepared and has been provided to the owner and the operator, operations team or facility manager, as appropriate;
- d) evidence that information exchanges have taken place as planned and to the extent and level of detail required;
- e) evidence that all plant and equipment incorporated into the works can be safely maintained in compliance with current legislation;
- f) evidence that design details prepared by subcontractors, specialist contractors, suppliers and manufacturers have been reviewed to check that the predicted and required performance will be achievable;
- g) evidence that the updated commissioning specification has been produced and agreed with the operator, operations team or facility manager, as appropriate, and end-users; and
- h) evidence that all pre-commissioning activities have been conducted.

5.6.9 Key decisions and next steps

At the end of this work stage, the owner should determine whether or not the construction work and testing and commissioning have advanced sufficiently to meet the project's objectives for delivery of the asset/facility, and should inform the design and construction team and the operator, operations team or facility manager, as appropriate, of its decision. Where the owner determines that the project has met its objectives, the owner's representative should be given the opportunity to review and discuss the planned work activities of the Handover and Close-out work stage, and their associated information requirements and deliverables, in advance of their commencement, with the design and construction team, including those responsible for aftercare.

NOTE A question that can be considered towards the end of this work stage is: "Has the design and construction team executed the construction work according to the defined performance, cost and time objectives?" The answer to this question will largely determine the owner's actions in the remaining work stages.

5.7 Handover and Close-out

5.7.1 General requirements

COMMENTARY ON 5.7.1

The Handover and Close-out work stage is concerned with the training of the operations team, handover of the asset/facility to the operator and the start-up of normal operations. It can be highly advantageous for the owner and/or operator if end-users, or their representative(s), are included in discussions about expectations in regard to the use of the asset/facility. The care with which defects, faults and other shortcomings are identified, logged and investigated will be a major determinant in their being rectified within an acceptable period during the Operation and End of life work stage.

The owner, or the owner's representative on its behalf, should require the operator, operations team or facility manager, as appropriate, to provide a detailed plan for the purpose of training those who have been or who will be given responsibility for the day-to-day operation of the asset/facility and others who would benefit from direct observation of the operational aspects of the asset/facility. The design and construction team should prepare asset/facility user guides and a technical guide. The procedure for design change control should continue through this work stage and be used to identify and log defects and faults and any performance that falls outside the expected or permitted operating range of products and systems. The log should be reviewed by the design and construction team and the operator, operations team or facility manager, as appropriate, with their recommendations fed back to the owner or the owner's representative on its behalf.

5.7.2 Primary activities

5.7.2.1 Preparation for handover

The design and construction team should prepare for handover of the asset/facility based on the following work activities:

- a) summarize the changes that have been incorporated and advise on whether or not their implications have been brought to the attention of the owner and the operator, operations team or facility manager, as appropriate, and the representative(s) of end-users;
- b) verify the commissioning information provided by the suppliers in accordance with the methods identified in the commissioning specification;
- c) prepare a schedule for coordinating on-site activities and the witnessing of balancing, regulating and performance testing by the owner's representative and the operator, operations team or facility manager, as appropriate;
- d) record all equipment and system settings and outputs from commissioning and inform the owner and the operator, operations team or facility manager, as appropriate;
- e) identify where any operational details and performance targets have been adjusted to reflect commissioning results;
- f) finalize the plan for environmental and energy metering;
- g) prepare a plan to identify the responsibilities and scope of energy use reviews;
- h) determine how non-technical users will know how to operate the asset/facility efficiently;
- i) extract data from the building information model to update the building logbook and/or the asset information model (AIM), as appropriate;

- j) review the updated operational information provided by the operator, operations team or facility manager, as appropriate;
- k) prepare the forecast of final capital cost; and
- l) prepare a detailed cost analysis of the final capital cost.

The operator, operations team or facility manager should undertake the following activities, as a minimum:

- 1) provide updated operational information to the design and construction team;
- 2) review and comment on all operation and maintenance information;
- 3) review and comment on all commissioning and handover-related information;
- 4) update the estimate of operational costs;
- 5) contribute to the building logbook and/or asset information model (AIM), as appropriate;
- 6) update the schedule of assets to be maintained, including a responsibility assignment matrix (e.g. a RASCI chart); and
- 7) prepare a cost breakdown of the asset/facility for management accounting purposes.

5.7.2.2 Operational readiness

The design and construction team should prepare an operational readiness plan in advance of the move-in and start-up of normal operations. This should involve milestones for, and regular reports on, the status of the completion of the asset/facility as handover approaches. The plan should include details of commissioning and training activities, preparation of operation and maintenance information, as-constructed information, the facility user guide and the setting up of a helpdesk or other support system for end-users. The training needs of end-users and the arrangements for training sessions should form an integral part of this operational readiness plan.

The design and construction team should organize training for the owner and/or the owner's representative in regard to operation and maintenance before and after handover. Handover training for the operations team should be digitally recorded by the design and construction team for future use. A copy of the recording should be handed over to the owner during the initial period of aftercare (see 5.8.2.2).

The design and construction team should carry out initial end-user training and familiarization prior to handover. All training should be digitally recorded by the design and construction team.

5.7.2.3 Commissioning check

The design and construction team should check that commissioning records include energy data, where available. The design and construction team should review the commissioning records with the owner's representative and the operator, operations team or facility manager, as appropriate, and prepare a schedule for post-handover fine-tuning in line with the requirements for the periods of initial aftercare (see 5.8.2.2) and extended aftercare (see 5.8.2.3). This schedule should be initiated during the Design work stage (see 5.5.2) and be finalized in this work stage.

The design and construction team should ensure that all metering systems are functioning accurately, are adequately labelled by end-use and that their data are reconciled to within 5% of the main meters prior to handover. Meters should be zeroed immediately prior to handover. Any non-functioning or inaccurate meters should be labelled as such and recorded as a defect to be resolved during the initial period of aftercare.

5.7.2.4 Facilities maintenance management

The design and construction team should review and comment on the owner's proposed asset/facility maintenance arrangements to ensure that they remain appropriate for the as-constructed asset/facility.

NOTE BS 8210 provides guidance in this regard.

5.7.2.5 Building management system

The design and construction team should provide a demonstration to the operator, operations team or facility manager, as appropriate, of the building management system (BMS) and associated controls, and demonstrate the methods for adjusting set points and operating schedules. The design and construction team should inform the operator, operations team or facility manager, as appropriate, on the zoning strategies and modes of operation (e.g. seasonal modes).

User control interfaces should be clearly legible and should be tested by the design and construction team and the operator, operations team or facility manager, as appropriate, and a selection of end-users.

5.7.2.6 Move-in

A move-in plan should be coordinated by the design and construction team as part of the operational readiness plan. The team should coordinate with the owner's representative and the operator, operations team or facility manager, as appropriate, to agree the arrangements and to confirm the areas to be used for the fitting-out of the owner's equipment and furniture and to manage the timing of occupation.

5.7.2.7 Aftercare team workplace

The owner should provide a prominent and accessible workplace for the aftercare team from the first day of occupation of the new or refurbished asset/facility for the defined periods of initial and extended aftercare.

5.7.2.8 Facility user guide

The design and construction team should produce a guide for end-users that can help them understand the design intentions and how to use the asset/facility effectively. The information for this purpose should be extracted from the facility handbook where this is available.

NOTE BS 8587 provides detailed guidance in this regard.

The design and construction team should also consider other forms of communication (e.g. webinars, labelling of user controls and explanatory boards) to inform end-users on aspects of the asset/facility that might not be obvious from observation or simple inspection.

5.7.2.9 Facility technical guide

The design and construction team should prepare a technical guide to provide a succinct introduction for the operations team to help smooth the transition into operation. This will complement the operation and maintenance information (see 5.7.2.10), including manufacturers' operating manuals, and should be transferred to the asset information model (AIM).

5.7.2.10 Operation and maintenance information

The design and construction team should submit draft operation and maintenance information for review by the owner and the operator, operations team or facility manager, as appropriate, prior to handover of the asset/facility in accordance with the requirements defined for information exchange in this work stage. The design and construction team should revise the information in light of feedback then seek approval and sign-off prior to handover.

5.7.3 Risks and opportunities

The design and construction team should maintain the risk and opportunity register, updating this where necessary to reflect changes in risks that might threaten outcomes and the opportunities that might enhance outcomes.

5.7.4 Information requirements

The following information should be considered for the purpose of supporting the work activities (see 5.7.2) and contributing to the deliverables (see 5.7.7) in this work stage:

- a) a summary of design changes that have been incorporated;
- b) the required basis for a valuation for insurance purposes;
- c) details of how specific products and elements should perform;
- d) details of the day-to-day operation of the asset/facility;
- e) details of planned maintenance (see BS 8210); and
- f) applicable legislation regarding HSSE.

Each of the requirements in a) to f) should be obtained through a plain language question, supported by a prompt and, where appropriate, an example to ensure that the requirements are understood by the person or party receiving the request for information (see 4.9.3).

5.7.5 Roles and responsibilities

The owner, or the owner's representative, should prepare a responsibility assignment matrix (e.g. a RASCI chart) to cover the work activities (see 5.7.2) and their associated deliverables (see 5.7.7) for this work stage. The RASCI chart should be kept up to date and should be used to inform a similar requirement at the start of the Operation and End of life work stage. A design responsibility matrix should be used for the purpose of assigning design responsibility for aspects of the design, their level of detail and the level of information to be exchanged.

5.7.6 Information systems and tools

All project information and data for operational purposes should be transferred from the project information model (PIM) to the asset information model (AIM) at the end of this work stage in accordance with the information exchange plan. The arrangements to support asset/facilities management through the use of the owner's defined enterprise system (see PAS 1192-3 and PAS 1192-5), a computer-aided facilities management (CAFM) system or other means should be confirmed or revised. The operator, operations team or facility manager, as appropriate, should assist with these arrangements.

NOTE If the operator, operations team or facility manager, as appropriate, does not have possession of information and data for operational purposes at the start of the Operation and End of life work stage then it might be difficult to operate the asset/facility correctly, safely and efficiently.

5.7.7 Deliverables

The design and construction team should provide the owner's representative with the following, as a minimum:

- a) details of the extent to which the asset/facility aligns with the expected project objectives;
- b) evidence of the inherent quality of the design;
- c) evidence that the asset/facility as constructed is capable of meeting the required operational performance;
- d) evidence of the correct and safe operation of the asset/facility in general and the building services engineering systems in particular;
- e) an audit trail of changes made to the design and information about the impact of those changes;
- f) details of any modification to the operational requirements and performance targets established in work stages prior to this work stage to reflect owner-initiated changes;
- g) evidence of an asset/facility operational readiness plan having been implemented;
- h) evidence that the demonstrations of balancing, regulating and performance testing have been conducted successfully;
- i) evidence that the performance of products, components and systems has been reviewed with the operator, operations team or facility manager, as appropriate, and the representative(s) of end-users;
- j) evidence that the commissioning of equipment has been undertaken by the suppliers to the specified method, logic, programme and in accordance with the commissioning specification;
- k) records of the commissioning procedure and tests;
- l) evidence that the owner and operations team have seen the results of all tests;
- m) evidence that the building management system (BMS) has been fully explained to the operations team and has been signed off by it;
- n) evidence that the asset/facilities management team attended the relevant commissioning meetings;
- o) updated operation and maintenance information and facility user guide reflecting the settings at the time of commissioning;
- p) evidence that test results have been transferred to the asset information management (AIM) model;
- q) final predictions of energy use and CO₂ emissions based on simulation models of the as-constructed asset/facility;
- r) updated building logbook; and
- s) as-constructed information with fully populated asset data.

The operator, operations team or facility manager, as appropriate, should provide the design and construction team with the following:

- 1) details of an appropriate workplace, with data communication links, for the aftercare team;
- 2) details of a helpdesk to support end-users;
- 3) evidence of a communication plan to update end-users;

- 4) evidence of a move-in plan for people and equipment;
- 5) evidence that the operations team is aware of the key performance indicators (KPIs) that will be used to assess the performance of asset/facilities management; and
- 6) details of the method for recording and reporting on operational costs.

5.7.8 Key decisions and next steps

At the end of this work stage, the owner should decide whether or not operations should be started up and should inform the design and construction team and the operator, operations team or the facility manager, as appropriate. Where the owner intends to start up operations, the owner's representative should be given the opportunity to review and comment on the planned work activities of the Operation and End of life work stage, and their associated information requirements and deliverables, with the design and construction team, including those responsible for aftercare.

NOTE A question that can be considered here is: "Is the asset/facility likely to measure up to the project objectives and the required operational performance?" The answer to this question will largely determine the owner's actions in the Operation and End of life work stage.

5.8 Operation and End of life

5.8.1 General requirements

COMMENTARY ON 5.8.1

The Operation and End of life work stage is concerned with achieving steady-state operation, involving aftercare, fine-tuning, post-occupancy evaluation of performance, benchmarking and lessons learned. This work stage measures any gap between actual performance and required performance. It provides a vital link in a chain of feedback that provides evidence to the owner on the extent to which the asset/facility satisfies requirements and provides valuable information and data for planning future projects (see Figure 3). This stage considers separately immediate and short-term issues and those arising over the medium term. These are referred to as the periods of initial aftercare and extended aftercare respectively. The initial period of aftercare typically runs from six to eight weeks after Handover and the extended period of aftercare lasts for up to three years and covers asset/facility performance-related activities and actions that are replicated in each year, although at a reducing frequency.

The end-users should be provided with information to help them obtain the maximum benefit from the new or refurbished asset/facility, whilst making them aware of their duties and obligations with respect to HSSE. A facility user guide should be provided for this purpose.

NOTE 1 BS 8587 provides detailed guidance in this regard. The attitude of end-users in regard to health, safety, security and environment (HSSE) can be a significant factor in maintaining environmental, social, security and economic performance at the required levels.

The operator, operations team or facility manager, as appropriate, supported by the design and construction team, should verify the initial as-constructed information and note any deviations from the design. Where "Level 2 BIM" has been adopted, the as-constructed information should be captured in the "work-in-progress section" and processed into the "shared section" of the common data environment (CDE). Once verified by the operator, operations team or facility manager, the data should be allowed to transition through the "verified gate" to the "published section" for use and, thereafter, to the "archive section" as appropriate.

NOTE 2 PAS 1192-2 provides detailed guidance in this regard.

During the transition from Handover and Close-out to operation, significant volumes of asset information and data might be transferred from the PIM into the AIM. There is an increased risk during this transition that sensitive design or commercial details could be inappropriately handled or stored. The owner should ensure that appropriate and proportionate measures are adopted to deal with this risk (see PAS 1192-5).

5.8.2 Primary activities

5.8.2.1 Operations

The design and construction team should prepare for operation of the asset/facility, including the initial and extended periods of aftercare, based on the following work activities:

- a) conduct aftercare review meetings and workshops as planned (see 5.8.2.3.2 and 5.8.2.3.4);
- b) record user comments related to functionality and effectiveness;
- c) maintain records of walkabouts to detect emerging issues;
- d) fine-tune the building services engineering systems;
- e) fine-tune the structural monitoring and control systems, where applicable;
- f) record and feed back details of all fine-tuning;
- g) update the asset information model (AIM);
- h) update the facility handbook, as appropriate; and
- i) update the facility user guide, as appropriate.

NOTE BS 8587 provides detailed guidance on the facility handbook and the facility user guide (see 5.7.2.8).

The operator, operations team or facility manager, as appropriate, should prepare for operation of the asset/facility, including the initial and extended periods of aftercare, based on the following activities:

- 1) record and review early energy usage for comparison with predictions;
- 2) review and record building management system (BMS) monitoring of environmental conditions to detect any emerging problems;
- 3) set up a helpdesk with a physical presence, at least initially; and
- 4) prepare and circulate newsletters or utilize other media for communicating directly with end-users.

5.8.2.2 Initial aftercare

5.8.2.2.1 General

The design and construction team should appoint an aftercare team to represent it on post-handover aftercare duties for the initial period of aftercare to familiarize end-users with the general operation of the asset/facility and to provide training and technical support. The design and construction team, or the aftercare team on its behalf, should monitor the performance of the systems with the active participation of the commissioning manager (see 4.6.6) and the operator, operations team or facility manager, as appropriate. Any deviation from the expected performance should be identified, recorded and shared within the respective teams. Consequent troubleshooting and fine-tuning of the building services engineering systems should be carried out by the design and construction team working with the operator, operations team or facility manager, as appropriate, and reporting to the owner's representative.

5.8.2.2.2 Aftercare team

The aftercare team should include a representative from the design and construction team and the representative(s) of the subcontractor(s) responsible for the building services engineering systems. The aftercare team might, in addition, include the commissioning manager. These named individuals should take specific roles in the initial period of aftercare. A RASCI chart should be prepared by the design and construction team for this purpose, with a copy provided to the operator, operations team or facility manager, as appropriate, and to the owner's representative.

5.8.2.2.3 Support for operations and end-users

The aftercare team should provide technical guidance and support to the operator, operations team or facility manager, as appropriate, for the full period of initial aftercare. The extent of this guidance and support should be determined by the owner's representative during the Definition work stage (see 5.4).

The design and construction team should organize, in consultation with the owner's representative, informal end-user meetings and discussions as soon as possible after the asset/facility has become operational.

5.8.2.2.4 Communications

The design and construction team, or the aftercare team on its behalf, should develop a plan for communicating operational issues to the operator, operations team or facility manager, as appropriate, and end-users. The design and construction team should allow for technical input into the presentations, newsletters and other communications prepared by the operator, operations team or facility manager, as appropriate, for the benefit of end-users concerning the correct and safe operation of the asset/facility to address concerns or questions.

5.8.2.2.5 Walkabouts

The owner's representative should allow the aftercare team to roam informally on a regular basis, talking and liaising with the end-users or the representative(s) of end-users. The design and construction team should ensure that the individuals nominated for this role within the aftercare team have sufficient knowledge of how the building services engineering systems are intended to function.

5.8.2.2.6 Summary of initial aftercare

NOTE Attention is drawn to the example approaches to performance evaluation given in Annex B, Annex C and Annex D.

The design and construction team, or the aftercare team acting on its behalf, should:

- a) record issues that have arisen and discuss them with the owner's representative and the operator, operations team or facility manager, as appropriate, with regard to remedial action;
- b) provide input to early performance evaluation, comparing actual values with required outcomes and targets;
- c) record comments about how specific products and elements perform and prepare reports on their performance;
- d) identify changes made by the owner or operator that might have caused any impaired performance;
- e) maintain records of technical guidance given to the operator, operations team or the facility manager, as appropriate, and end-users; and

- f) report to the owner's representative on how the operator, operations team or the facility manager, as appropriate, is delivering the required performance outcomes.

The operator, operations team or facility manager, as appropriate, should:

- 1) consider any operational costs that might have arisen that were not predicted and maintain records to inform lessons learned;
- 2) record input to any performance evaluation during this period;
- 3) maintain records of walkabouts on the part of the design and construction team or aftercare team on its behalf;
- 4) record informal end-user discussion; and
- 5) maintain records of fine-tuning and any adjustments undertaken.

5.8.2.3 Extended aftercare

5.8.2.3.1 General

The design and construction team should carry out interviews with the operator, operations team or facility manager, as appropriate, and end-users three months after initial occupation, to identify issues or concerns regarding the effectiveness of the asset/facility, including the building services engineering systems, and their control interfaces, and to undertake adjustments as necessary to improve usability and system performance.

The design and construction team should conduct seasonal commissioning and should include for the cost of testing all building services engineering systems under full-load conditions (e.g. heating equipment in mid-winter and cooling/ventilation equipment in mid-summer) and under part-load conditions in spring and summer. Where applicable, testing should also be carried out during periods of high and low occupancy.

5.8.2.3.2 Reviews

The owner's representative should arrange aftercare review meetings during the extended period of aftercare. These should be quarterly for the first year and then annually for two further years. The design and construction team should ensure the attendance of representatives of the aftercare team, with the owner's representative requesting the attendance of the representatives of the operator, operations team or facility manager, as appropriate, and the representative(s) of end-users, so that any emerging issues can be discussed and the appropriate actions agreed.

The design and construction team should provide technical assistance to help the operator, operations team or facility manager, as appropriate, understand and utilize the energy metering system and other monitored systems during the periods of aftercare. The design and construction team should work with the operator, operations team or facility manager, as appropriate, to review the overall systems' and energy performance at a frequency defined by the owner's representative and provide written reports on the findings.

5.8.2.3.3 Fine-tuning of systems

The aftercare team should work with the operator, operations team or facility manager, as appropriate, to carry out fine-tuning of building services engineering systems. The design and construction team should update the building logbook to reflect alterations to systems and equipment, and any changes to standard control settings and operating schedules. Where "Level 2 BIM" has been adopted, these alterations should be captured in the "work-in-progress section" and processed into the "shared section" of the common data environment (CDE). Once verified by the operator, operations team or facility manager, the data should be allowed to transition through the "verified gate" to the "published section" for use and, thereafter, to the "archive section" as appropriate.

NOTE PAS 1192-2 provides detailed guidance in this regard.

5.8.2.3.4 Post-occupancy evaluation (POE)

A formal post-occupancy evaluation (POE) of the building's performance should be conducted at the end of Years 1, 2 and 3. The evaluation should include an end-user satisfaction survey, an energy-use survey and an assessment of the overall performance of the asset/facility against the agreed outcomes and/or targets and applicable benchmarks.

The owner's representative should compare actual performance with the required performance and comment on potential improvements, where appropriate, for the end-of-year review for each year of aftercare. When this annual analysis report has been completed, the operator, operations team or the facility manager, as appropriate, should request the attendance of a senior representative of each of the main disciplines within the design and construction team at a workshop with the owner's representative and the representative(s) of end-users. The annual analysis report should be considered against the owner's business objectives, project objectives and operational requirements and performance outcomes and/or targets as set in the Strategy and Brief work stages. The purpose of the workshop should be to consider recommendations on how the operational performance of the asset/facility can be optimized. The workshop should conclude with agreed actions necessary to achieve alignment with the objectives, outcomes and targets as closely and as quickly as possible.

NOTE The Design Quality Indicator (DQI) [3] is an example of a methodology for measuring three quality principles – functionality, build quality and impact – to provide objective evidence of achievement. The BUS methodology [4] is an example of a survey that quantifies occupant satisfaction, reveals features of value or concern in the asset/facility and provides feedback. BREEAM In-Use [5] is a scheme to help the owner, operator, operations team or facility manager, as appropriate, reduce the operational costs and improve the environmental performance of existing assets/facilities.

5.8.2.3.5 Summary of extended aftercare

NOTE Attention is drawn to the example approaches to performance evaluation given in Annex B, Annex C and Annex D.

At the end of the extended period of aftercare in Year 1, the operator, operations team or the facility manager, as appropriate, should:

- a) compare the post-occupancy (POE) results with expectations;
- b) compare actual performance with the required performance and explain good or bad performance;
- c) determine if any fine-tuning is required to rectify bad performance;
- d) compare actual operational costs with the estimated operational costs and explain good or bad performance;

- e) compare actual water consumption with predicted consumption and explain good or bad performance;
- f) compare actual waste reduction with predicted reduction and explain good or bad performance;
- g) request the attendance of a senior representative of each of the main disciplines within the design and construction team at a workshop with the owner's representative and the representative(s) of end-users; and
- h) report to the owner, through the owner's representative, on the first year of performance and the actions considered necessary to optimize performance of the asset/facility.

At the end of the extended period of aftercare in Years 2 and 3, the operator, operations team or the facility manager, as appropriate, should:

- 1) continue its performance evaluation;
- 2) prepare the annual reports on performance with explanation of improvements, changes and good or bad performance;
- 3) prepare reports on the performance of materials and equipment;
- 4) at the end of each year, feed back the findings of performance evaluation to the design and construction team and the owner's representative;
- 5) retain data on measured performance to inform the benchmarking of required outcomes and performance targets for future projects;
- 6) request the attendance of a senior representative of each of the main disciplines within the design and construction team at a workshop with the owner's representative and the representative(s) of end-users; and
- 7) report to the owner, through the owner's representative, on performance during the year, the actions considered necessary to optimize performance of the asset/facility and the lessons learned.

5.8.3 Risks and opportunities

The design and construction team should maintain the risk and opportunity register, updating this where necessary to reflect changes in risks that might threaten normal operations and the opportunities that might enhance the performance of the asset/facility.

5.8.4 Information requirements

The following information should be considered for the purpose of supporting the work activities (see 5.8.2) and contributing to the deliverables (see 5.8.7) in this work stage:

- a) for the initial period of aftercare:
 - 1) functionality and effectiveness of the architectural provisions;
 - 2) functionality and efficiency of the building engineering services systems;
 - 3) required inputs to the post-occupancy evaluation (POE);
 - 4) actual environmental performance compared to required performance for metered consumption of energy, CO₂ emissions, water consumption and waste reduction; and
 - 5) performance of specific products and elements;
- b) for the extended period of aftercare:
 - 1) functionality and effectiveness of the architectural provisions;
 - 2) functionality and efficiency of the building engineering services systems;

- 3) extent to which stakeholders' needs are satisfied;
- 4) required inputs to the post-occupancy evaluation (POE); and
- 5) results of the analysis of actual performance against required performance.

Each of the requirements in a) and b) should be obtained through a plain language question, supported by a prompt and, where appropriate, an example to ensure that the requirements are understood by the person or party receiving the request for information (see 4.9.3).

5.8.5 Roles and responsibilities

The owner, or the owner's representative, should prepare a responsibility assignment matrix (e.g. a RASCI chart) to cover the work activities (see 5.8.2) and their associated deliverables (see 5.8.7) for this work stage. The RASCI chart should be kept up to date.

The operator, operations team or facility manager, as appropriate, should conduct the measurement, evaluation, benchmarking and advisory reporting related to the environmental, social (i.e. functionality and effectiveness) and security performance at or near the end of Years 1, 2 and 3 after the commencement of operations. Measurement, evaluation, benchmarking and advisory reporting should take place before the end of the defects liability period for the asset/facility to enable remedial work to be carried out as necessary.

The operator, operations team or facility manager, as appropriate, should record data on energy use, water consumption and waste reduction and disposal on a continual basis so that it can be reported at any time. Similarly, data on operational costs should be recorded on a periodic basis and not less frequently than every quarter.

5.8.6 Information systems and tools

The operator, operations team or facility manager, as appropriate, should confirm that all project information and data for operational purposes have been transferred from the project information model (PIM) to the asset information model (AIM). Where this is not the case, the design and construction team should take action to ensure there is no further delay in transferring the required information and data.

5.8.7 Deliverables

The operator, operations team or facility manager, as appropriate, should provide the owner's representative with the following, as a minimum:

- a) evidence of the functionality and effectiveness of the architectural provisions;
- b) details of the functioning of building services engineering systems and controls;
- c) details of the post-occupancy evaluation (POE) at the end of Years 1, 2 and 3 to establish feedback on functionality and effectiveness;
- d) POE results recorded with details of any required corrective action;
- e) evidence of a recognized method of calculation being used to provide an estimate of the expected CO₂ emissions for the year;
- f) an annual review of energy use and a calculation of CO₂ emissions that has been conducted;
- g) records of any fine-tuning or behavioural changes introduced to improve operational performance;

- h) details of any operational changes, where applicable;
- i) evidence that a comparison of actual and predicted operational costs is being maintained;
- j) records of any procedural changes made to improve operational costs whilst still delivering the required service levels;
- k) records of metered consumption of water;
- l) records of measured waste reduction and disposal;
- m) details of actual operational costs;
- n) documented experiences and lessons learned; and
- o) evidence that the findings from the first year of measurement of performance have been coordinated with the sign-off of the first year of the defects liability period.

NOTE Documenting experiences and lessons learned, together with feedback on performance, avoids the situation of valuable know-how disappearing when personnel leave the owner's or operator's organization.

5.8.8 Key decisions and next steps

NOTE 1 This work stage provides the opportunity for the owner, operator, operations team or facility manager, as appropriate, and the design and construction team to consolidate valuable information and data about the performance of the asset/facility.

Adjustments to the operational parameters of the asset/facility and any subsequent changes to the design should be recorded. Where "Level 2 BIM" has been adopted, alterations and changes should be captured in the "work-in-progress section" and processed into the "shared section" of the common data environment (CDE). Once verified by the operator, operations team or facility manager, the data should be allowed to transition through the "verified gate" to the "published section" for use and, thereafter, to the "archive section" as appropriate.

NOTE 2 PAS 1192-2 provides detailed guidance in this regard.

NOTE 3 A question that can be considered here is: "Does the asset/facility measure up to requirements in terms of its environmental, social, security and economic performance?" The answer to this question will determine the owner's next steps in facilities management and any subsequent adjustments or alterations to the asset/facility.

NOTE 4 Annex J offers an activity checklist to assist in briefing for design and construction and, in particular, reviews of progress in all work stages.

Annex A
(informative)**Brief checklist (example)**

A.1 The following extract from a checklist represents typical considerations from a largely design and construction perspective in regard to the work activities involved in briefing (see 5.2.2), the information required to support those activities (see 5.2.4) and the deliverables (see 5.2.7) in the form of an initial brief. These considerations are not comprehensive and might not be appropriate for every situation.

a) Overall design concept:

- 1) vision and image of the organization and the extent to which these are to be reflected in the appearance and design of the asset/facility;
- 2) impact of the design on users as they approach, enter and move about the asset/facility, in particular the internal environment and provisions for assuring the health, safety and security of personnel;
- 3) inclusive design principles applying to the asset/facility, incorporating the needs of disabled people and others with equalities-related needs; and
- 4) extent of design for reduced environmental impact, including choice of principal materials and their eventual reuse, recycling or disposal, and the adoption of passive systems (e.g. natural means of lighting, cooling and ventilation).

b) Operational requirements: internal:

- 1) zoning, internal circulation and transportation (e.g. offices, service cores, lifts escalators, stairways and lobbies);
- 2) demands for space supporting different functions and activities (e.g. production, creative areas, private spaces, meetings and conferences, safety areas, social areas, dining and refreshment areas) and for ancillary services (e.g. waste segregation, recovery, reuse and recycling, and rainwater harvesting);
- 3) organizational structure (e.g. departments and other units), including the anticipated number of personnel and their roles;
- 4) communication between departments and with end-users;
- 5) descriptions of the functions, activities and processes to be supported in the asset/facility, including provisions for the isolation and segregation of space, by zone etc.;
- 6) arrangements for enabling the access, use and emergency evacuation for all users, including disabled people and others with equalities-related needs;
- 7) flexibility/adaptability in the internal design (e.g. re-configurable space and expansion/reduction possibility);
- 8) energy use, water management and waste disposal;
- 9) security, safety, fire and resilience (e.g. measures in the event of a failure in an installation or system, or other incident and arrangements for business continuity);
- 10) carbon footprint, including calculation of carbon metric; and
- 11) support services (e.g. services such as cleaning and waste disposal and supplies such as consumables).

- c) Operational requirements: external:
 - 1) zoning of external areas and associated security (e.g. landscaping, parking, assembly in the event of emergency, fencing, lighting, sign-posting, security and surveillance);
 - 2) entry to and from the asset/facility for occupants, visitors and other end-users, including emergency access and “means of escape” routes; and
 - 3) access to public transport (e.g. modes of transport and their distance from the asset/facility).

A.2 The following checklist represents typical considerations from a largely operational (i.e. facilities management) perspective. These considerations are not comprehensive and might not be appropriate for every situation.

- a) Internal spaces:
 - 1) types of surface (e.g. internal walls, partitions, floors and ceilings);
 - 2) surface areas (m²) by type;
 - 3) planned lifetime of surfaces by type;
 - 4) estimate of initial cost of surfaces by type;
 - 5) provisions for cleaning and routine maintenance by type;
 - 6) restrictions in access; and
 - 7) activities to be performed in connection with the above (e.g. frequency, specialist skills, equipment and consumables) and acceptable service levels.
- b) External envelope:
 - 1) orientation and form;
 - 2) types of surface (e.g. roof covering, external walls, windows and external doors);
 - 3) surface areas (m²) by type;
 - 4) planned lifetime of surfaces by type;
 - 5) estimate of initial cost of surfaces by type;
 - 6) provisions for cleaning and routine maintenance by type;
 - 7) restrictions in access; and
 - 8) activities to be performed in connection with the above (e.g. frequency, specialist skills, equipment and consumables) and acceptable service levels.
- c) External spaces:
 - 1) asset/facility plot size, layout, general operations and access for deliveries and maintenance work;
 - 2) restrictions in access and working height;
 - 3) equipment and permanent fixtures on the plot;
 - 4) types of surface and surface areas (m²);
 - 5) planned lifetime of surfaces;
 - 6) estimate of initial cost of surfaces; and
 - 7) provisions for routine maintenance, including acceptable service levels.

Annex B
(informative)**Environmental performance evaluation (example)****B.1 General**

The following is an example of an approach to be adopted and typical measures to be taken by an owner. It is expected that they would need to be adapted to suit the characteristics and requirements of a specific project.

B.2 Annual energy use

This evaluation might typically include energy measurement, calculation of CO₂ emissions and an advisory report to suggest ways of improving energy performance, and might therefore cover:

- a) assessment of annual energy use with regard to all individual energy sources;
- b) analysis of half-hourly energy demand profiles;
- c) cross-references to the post-occupancy evaluation survey in regard to internal environment, performance and engineering;
- d) investigation of issues arising (especially where there is unusually good, poor or variable performance);
- e) spot checks and recording measurements as necessary;
- f) technical review of building fabric, component and equipment performance;
- g) review of the performance and usability of controls, the building management system (BMS) and metering;
- h) reliability, maintenance and maintainability of energy-using systems and components;
- i) structured reviews with the operator, operations team or facility manager, as appropriate, and the representative(s) of end-users;
- j) review of how the owner's management strategy and leadership, facilities management and user behaviour impact upon energy use;
- k) suggestions for improvement; and
- l) comparison with results from other assets/facilities (from within a portfolio programme or from a wider benchmark database).

B.3 Annual water consumption

This evaluation might typically include measurement of water consumption and an advisory report to suggest ways of reducing water consumption and might therefore cover:

- a) assessment of annual water use;
- b) analysis of water demand profiles;
- c) cross-references to the post-occupancy evaluation survey in regard to the headings of internal environment, engineering and performance;
- d) investigation of issues arising (especially where there is unusually good, poor or variable performance);
- e) spot checks and recording measurements as necessary;
- f) technical review of building fabric, component and equipment performance;
- g) review of the performance and usability of controls, the building management system (BMS) and metering;
- h) reliability, maintenance and maintainability of water systems;

- i) review of water-saving devices or appliances;
- j) structured reviews with the operator, operations team or facility manager, as appropriate, and the representative(s) of end-users;
- k) review of how the owner's management strategy and leadership, facilities management and user behaviour impact upon water use;
- l) suggestions for improvement; and
- m) comparison with results from other asset/facilities (from within a portfolio programme or from a wider benchmark database).

B.4 Annual waste reduction and disposal

This evaluation might typically include measurement of waste and an advisory report to suggest ways of reducing waste and might therefore cover:

- a) assessment of annual solid and fluid waste disposed (to include effluent discharged to drains where relevant);
- b) analysis of waste disposal profiles;
- c) cross-references to the post-occupancy evaluation survey in regard to the headings of internal environment, engineering and performance;
- d) investigation of issues arising (especially where there is unusually good, poor or variable performance);
- e) spot checks and recording measurements as necessary;
- f) structured reviews with the operator, operations team or facility manager, as appropriate, and the representative(s) of end-users;
- g) review of how the owner's management strategy and leadership, facilities management and user behaviour impact upon waste reduction and disposal;
- h) structured reviews with end-users and the operations team;
- i) suggestions for improvement; and
- j) comparison with results from other asset/facilities (from within a portfolio programme or from a wider benchmark database).

Annex C (informative)

Social (i.e. functionality and effectiveness) performance evaluation (example)

The following is an example of an approach to be adopted and typical measures to be taken by an owner. It is expected that they would need to be adapted to suit the characteristics and requirements of a specific project.

NOTE Proprietary surveys of this kind are undertaken commercially and two examples are Design Quality Indicators (DQI) [3] and the BUS methodology [4], and others are available.

A scoring system is used to ascribe a numerical value to a qualitative assessment of aspects of performance, for example:

- a) access – the ease with which occupants, visitors and other end-users of the asset/facility gain access to the asset/facility and move around it, including the use of toilets and other amenities;
- b) space – the size and inter-relationship of rooms or component spaces;
- c) uses – the extent to which the asset/facility caters for the functions it accommodates now and into the future;
- d) performance – the performance of the building service engineering systems,

including those for safety and means of escape, and their ease of maintenance (and whether they are maintainable or not);

- e) engineering – the ease of use and the provision of metering to facilitate management of energy, CO₂ emissions, water consumption and waste reduction;
- f) form and aesthetics of materials – the physical composition, scale and configuration within its boundaries;
- g) construction – the functionality and durability of building materials and the standard of construction;
- h) urban and social integration – the integration and coherence of the asset/facility with the surroundings;
- i) internal environment – what it is like to be in the asset/facility in terms of the quality of air and light and overall comfort;
- j) character and innovation – what end-users think of the asset/facility and what it means to them;
- k) operational performance – what end-users think of the asset/facilities management and how it impacts on the performance of the asset/facility in meeting their needs; and
- l) management – what end-users think of the owner's business strategy and how it impacts upon performance of the asset/facility in meeting end-user needs.

Annex D
(informative)

Economic (cost) performance evaluation (example)

D.1 General

The following is an example of an approach to be adopted and typical measures to be taken by an owner, and might need to be adapted to suit the characteristics and requirements of a specific project.

NOTE The purpose of economic performance measurement is to enable effective post-occupancy evaluation, benchmarking and feedback.

D.2 Capital cost

A number of approaches are possible for measuring and comparing capital cost performance. The following are example benchmarks that could be used.

- a) *Type 1 – Spatial measures*: these metrics are used by owners and their cost consultants to benchmark total construction cost; for example: £/m, £/m² and £/m³. They are related to throughput (quantity) such as square metres of space (accommodation) delivered by a project.
- b) *Type 2 – Functional measures*: these align with functions and business outcomes; for example, £/bed space, £/workspace and £/tonne of production output.
- c) *Type 3 – Ratios*: these are used to benchmark costs that are related to the total capital cost; for example, design fees or project management as a ratio (or percentage) of total construction cost. They can help in understanding efficiency in the project delivery process.

- d) *Type 4 – Elemental measures*: these are similar to Type 1 benchmarks and are applied at the elemental throughput (quantity) level; for example, foundation costs £/m, £/m² or £/m³. They are more meaningful when there is a clear relationship between the element and the spatial measure. £/m² for foundations could be useful, but £/m² for internal doors might not be so useful without understanding something of the density of subdivision.

D.3 Operational cost

A number of methods are available for measuring and comparing operational cost performance. IPD ⁵⁾ provides benchmark costs for occupancy, business support and management, although other organizations might also provide a similar service.

D.3.1 Example cost centres for occupancy

Example cost centres for occupancy include:

- a) internal repair and maintenance;
- b) building services engineering repair and maintenance;
- c) external structure repair;
- d) minor improvements;
- e) internal moves;
- f) reinstatement;
- g) internal plans and decoration;
- h) grounds maintenance;
- i) water and sewerage; and
- j) energy.

D.3.2 Example cost centres for business support

Example cost centres for business support include:

- a) catering;
- b) reception services;
- c) courier and external distribution;
- d) post room and internal distribution;
- e) reprographics;
- f) disaster recovery;
- g) security;
- h) cleaning management; and
- i) waste disposal.

D.3.3 Example cost centres for management

Example cost centres for management include:

- a) helpdesk;
- b) CAFM; and
- c) contract and performance management.

⁵⁾ Investment Property Databank Ltd (<http://www.ipd.com/index.html>) [viewed 2015-07-29].

Annex E Responsibility assignment matrices (examples)

(informative)

An example of a RASCI chart is given in Table E.1 and an example of a design responsibility matrix incorporating information exchanges is given in Table E.2.

Table E.1 Typical tasks and allocated roles (extract) ^{A)}

Task	CEO	COO	CFO	CIO	FM
Prepare information management strategy	Consult	Accountable	Support	Responsible	Support
Manage facility-related contract information	Accountable	Consult	Consult	Support	Responsible
Prepare operational procedures	Inform	Accountable	Inform	Consult	Responsible
Manage asset register	Inform	Accountable	Consult	Consult	Responsible
Undertake post-occupancy evaluations	Consult	Accountable	Inform	Inform	Responsible

^{A)} SOURCE: BS 8587:2012, Annex A, modified.

NOTE CEO = Chief Executive Officer; COO = Chief Operating Officer; CFO = Chief Finance Officer; CIO = Chief Information Officer; FM = Facility Manager

Table E.2 Typical design responsibility matrix incorporating information exchanges (extract)

Aspect of design	Work stage 2: Concept			
	Design team			
Classification	Title	Design responsibility	Level of detail (LOD)	Level of information (LOI)
15-15	Substructure	Groundstone	2	2
15-05-65	Piling	Drivedeal	2	2
15-65-75	In situ concrete frame	Frambold	2	2
15-65-75	Precast concrete frame	Frambold	2	2
15-65-75	Steel frame	Frambold	3	3
20-05-30	Flat roof systems	Rooverton	2	2
20-50-50	Metal sheet roof	Rooverton	2	2
20-55-15	Screeds	Florfinature	2	2
20-55-35	Internal floor tiling	Florfinature	2	2

NOTE 1 The LOD and LOI are expected to be predefined for each work stage and in this example are set as the default value (i.e. level 2), except for one element. The steel frame is a long lead item and requires more detail and information in order to procure it; hence, it is shown as level 3.

NOTE 2 The BIM Toolkit [6] provides a source of default LOD and LOI and a means for producing a digital Plan of Work (dPoW).

Annex F
(informative)**Risk and opportunity assessment (example)**

Table F.1 records the risks and opportunities identified for a new university hall of residence (500 single-study bedrooms off campus). Often, risks present opportunities (and rewards) and, in these cases, they are combined in Table F.1. Opportunities can be handled outside the risk register, but monitored in the Table as shown. Each risk item is held in the risk register, where closer scrutiny and further evaluation of the risk is recorded. Scores can be assigned (high=3, medium=2 and low=1) to each item for both impact and probability. Summation of impact and probability for each item allows the risks to be ranked, enabling attention to be directed towards those having the greatest potential impact and probability of occurrence.

Table F.1 Risks and opportunities

Identified risk/opportunity	Risk (-)		Opportunity (+)	
	Impact	Probability	Impact	Probability
Technical				
Prefabricated bathroom modules			M	H
Access for servicing modules	M	L		
Partial passive cooling and ventilation			H	L
Environmental				
Use of recycled rainwater			H	M
Hot water from solar panels on roof			H	M
Need for third lift ^{A)}	H	H		
Noise pollution from car park	M	L		
Light pollution from car park	M	H		
Need for mobility access parking	M	H		
Need of HGVs to access via housing estate	H	L		
Socio-political				
Public use of sports facilities (tennis courts, etc.)			M	H
Rental of bedrooms during long vacation			M	M
Demand for local (temporary) housing	L	H		
Demand on local shops			M	M
Commercial				
Cost of imported materials exceeding budgets	H	M		
Need for third lift ^{A)}	H	M		
Change in VAT liability	L	L		
Unexpected rise in tender prices	H	M		
Difficulty attracting total FM service provider	M	M		

^{A)} A third lift might be required for access and means of escape for disabled people, including the need to manage evacuation of those unable to be evacuated down staircases (see BS 9999:2008, 18.8).

NOTE H = High, M = Medium, L = Low.

Annex G
(informative)

Plain language questions for the owner (examples)

G.1 General

The following are examples of questions that might be asked of the owner by the design and construction team and are based on plain language questions devised originally by the UK Government Cabinet Office [16] and adapted for the purpose of this standard. These examples are illustrative of the approach and are likely to vary from project to project.

G.2 Strategy

Question 1: How will the owner represent the needs of the operator, end-users and other key stakeholders?

Prompt: Provide an engagement plan including the tasks of the owner's representative.

Question 2: Have the stakeholders' high-level needs been captured in the strategy definition?

Prompt: Provide a list of required outcomes relating to environmental, social, security and economic performance.

Question 3: Are there specific performance requirements for the asset/facility that will help to meet end-users' and other key stakeholders' needs?

Prompt: Identify benchmarks and a process for establishing them and how they relate to required outcomes. Identify the previous knowledge that the owner can bring to the process from previous performance measurement and benchmarking.

Question 4: What are the owner's specific requirements for energy use, CO₂ emissions, water use, waste disposal, functionality, effectiveness, capital cost and operational cost?

Prompt: Provide a list of specific requirements.

Question 5: Have methods of measurement been identified for assessing outcomes and specific performance requirements?

Prompt: Provide a list of performance evaluation measures that are to be applied at the start of the Operation and End of life work stage.

Question 6: Have existing strategies and standards for the wider portfolio been identified, where applicable?

Prompt: Internal design standards, construction standards and asset/facilities management standards.

Question 7: Has a design standardization policy been defined by the owner?

Prompt: The owner's library of standard design elements, where applicable.

Question 8: Has an operational policy been identified by the owner?

Prompt: A description of operational policy.

Question 9: Have lessons learned from previous projects been identified?

Prompt: Feedback from, and case studies of, previous projects.

Question 10: Has an initial view of operational cost been identified?

Prompt: Major operational, maintenance and capital replacement costs, including energy cost target.

Question 11: Has an initial target for capital cost been identified?

Prompt: Owner's cost target or limit, including construction costs, design, project management and cost contingency.

Question 12: Have the production or flow rate capacity requirements of the asset/facility been identified, where appropriate?

Prompt: Statement of capacity related to people, traffic or production, as appropriate.

Question 13: Is there an initial view of revenue income, if appropriate?

Prompt: Schedule of anticipated earnings related to the asset/facility.

Question 14: Have security requirements, including those relating to information and data, been defined?

Prompt: Security policies, processes and procedures.

Question 15: Have requirements for the delivery of asset information been identified?

Prompt: Example asset register for other projects in the owner's portfolio.

G.3 Brief

Question 1: What will be the best way for the owner to consider the design and construction team's proposals at the appropriate decision gates (or points)?

Prompt: Decision gate (or point) review plan.

Question 2: What is the design and construction team's response to the needs of end-users and other key stakeholders' and is it appropriate?

Prompt: Digital brief that can be used for the evaluation of proposals.

Question 2: What is the design and construction team's response to the high-level performance targets?

Prompt: Digital brief providing confirmed targets.

Question 4: Will any temporary decant of personnel, business activities and equipment be required and, if so, how will that be managed?

Prompt: Outline document identifying phased decant requirements.

G.4 Concept

Question: What is the owner's preferred way of dealing with all the questions that can be asked by, or put to, the design and construction team and operations team?

Prompt: Owner's review and commenting plan.

G.5 Handover and Close-out

Question 1: Does the asset as delivered appear to meet the brief (accepting that it is the point of practical completion and, therefore, does not yet demonstrate operational performance)?

Prompt: 3D model, testing and commissioning information, performance simulations, room/other schedules, whole-life carbon assessment and whole-life cost assessment.

Question 2: Has the health and safety information (file) been handed over – does it form part of a broader treatment of HSSE?

Prompt: HSSE information.

Question 3: Have the operations team or facility manager, as appropriate, and end-users been instructed on how to use, operate and maintain the building services engineering systems?

Prompt: Evidence that it has taken place with records of operational checks.

Question 4: Has operation and maintenance information been checked to see that it meets the owner's, operators and end-users' requirements?

Prompt: Confirmation that checking has taken place and that the information is usable by those who may not have seen it before. A facility user guide should also have been prepared for end-users.

Question 5: Is the operations team or facility manager, as appropriate, in place, fully informed and ready to start work?

Prompt: Confirmation to this effect from the owner or operator, as appropriate.

G.6 Operation and End of life

Question 1: After the first year of operation is the asset/facility delivering the required outcomes as identified in the strategic definition?

Prompt: Owner's feedback report.

Question 2: Repeat the above for Years 2 and 3 of the extended period of aftercare.

Prompt: Owner's feedback report.

NOTE The BIM Toolkit [6] provides default Plain Language Questions and a tool to enable authoring of project-specific Plain Language Questions.

Annex H (informative)

Stakeholder identification

New university hall of residence (500 single-study bedrooms) off campus. The numbers in parenthesis in the following list of stakeholders relate to the matrix in Figure I.1.

Internal stakeholders:

- Council (1);
- Finance officer (bursar) (2);
- Property manager (3);
- Facility manager (4);
- Equalities and diversity manager (5);
- Student accommodation manager (6);
- Student services (7);
- Students (students union) representative (8); and
- Health centre (9).

NOTE 1 A project board might be established to take responsibility for the overall success of the project. Members of the board are stakeholders and, as such, have to be identified before the board can begin its work. A project manager can then be appointed by the board to lead the project team.

NOTE 2 The hall is to be managed internally, rather than through an external company.

External stakeholders:

- Bank (10);
- Insurers (11);
- Project consultants (12);
- Consultative groups (13);
- Local authority – planning (14);
- Local authority – highways (15);
- Building control body, e.g. local authority or approved inspector – Building Regulations [11], [12] and [13] (16);
- Neighbours – adjacent to the hall (17);
- Neighbours – in the surrounding area (18);

- Fire authority (19);
- Police authority (20);
- Service providers (21); and
- Utility companies, e.g. energy, water and telecoms (22).

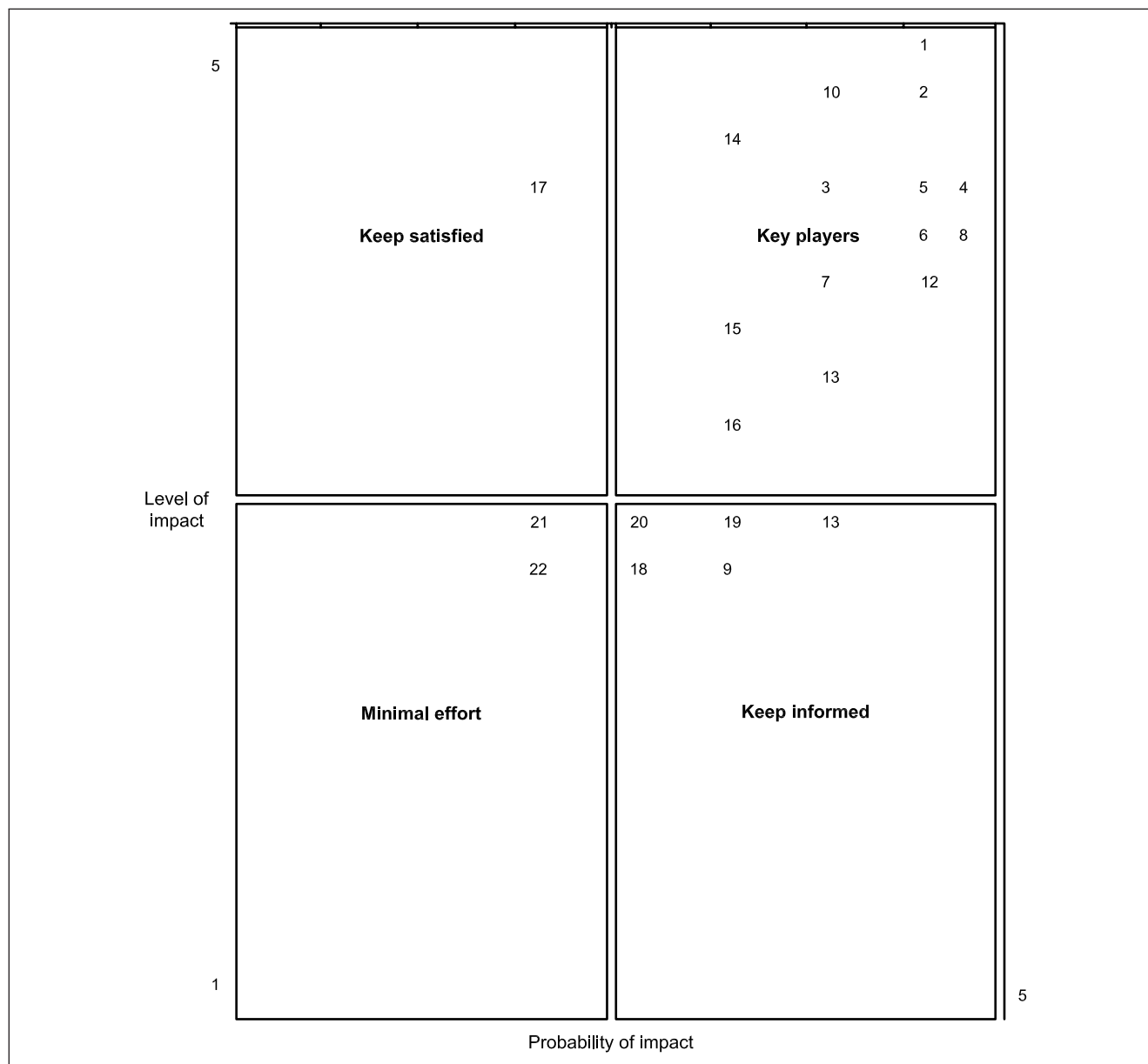
No ranking of importance or other means of differentiating stakeholders (than dividing into internal or external) is implied by these lists. Preliminary assessment of stakeholder impact is covered in Annex I.

**Annex I
(informative)**

Stakeholder impact analysis

Stakeholders' interests in the asset/facility may be assessed in a number of ways, including the use of an impact/probability matrix (see Figure I.1). Individual stakeholders and groups of stakeholders are positioned in the matrix according to the level and probability of impact they have on the design and construction of the asset/facility and its subsequent operations. It is a form of risk assessment. Since stakeholders and their interests could change over time re-assessment is necessary. The overall aim of the matrix is to focus attention on the nature and degree of stakeholder engagement and communication, as indicated by the terms applied to four quadrants, and actions that might then be necessary. The matrix is not intended to provide a complete solution to the assessment of stakeholders.

Figure I.1 Stakeholder impact/probability matrix



Annex J (informative)

Activity checklist

The checklist given in Table J.1 is intended to assist in facilities management briefing for design and construction and, in particular, reviews of progress through design, construction and into operation. It does not purport to provide a complete or comprehensive summary of activities, but suggests an approach.

Table J.1 Summary of main activities by focus area and work stage

Focus area	Work stage							
	0	1	2	3	4	5	6	7
	Strategy	Brief	Concept	Definition	Design	Build and commission	Handover and Close-out	Operation and End of life
Environment Meeting the performance targets for energy use, CO ₂ emissions, water consumption and waste disposal.	Determine the targets for energy use, CO ₂ emissions, water consumption and waste reduction.	Determine the environmental performance outcomes for the asset/facility. Prepare an environmental management plan.	Devise a plan for recording energy and other environmental performance, and the comparison of actual performance against required performance.	Identify any additional operational requirements that are necessary for achieving the required energy performance.	Undertake model-based design performance simulations that take into account the accuracy of the prediction achieved in the past from similar simulations.	Review all installation details and correct any that will impact negatively upon the actual performance relative to the required performance.	Finalize the plan for environmental and energy metering. Prepare a plan to identify the responsibilities and scope of energy metering reviews.	Record and review early energy use for comparison with predictions. Review and record BMS monitoring of environmental conditions to detect any emerging problems.

Table J.1 Summary of main activities by focus area and work stage

Focus area	Work stage							
	0	1	2	3	4	5	6	7
	Strategy	Brief	Concept	Definition	Design	Build and commission	Handover and Close-out	Operation and End of life
Social (i.e. functionality and effectiveness) Meeting the needs of the owner, operator and end-users in regard to concept, space, internal environment, durability, usability, safety, maintainability, inclusiveness and comfort.	Identify the business-related activities and processes that will take place in the new or refurbished asset/facility. Assemble lessons learned from previous projects, including feedback based on documented case studies and other reliable sources. Identify the range of potential security issues that are applicable to the owner's business, assets/facilities and personnel.	Prepare a statement on the general design philosophy and how it will address the project objectives, operational requirements and performance outcomes and/or targets. Prepare a draft strategy for determining the performance evaluation of functionality and effectiveness, considering features such as comfort, inclusiveness, security, utility, usability, durability, maintainability, adaptability, impression and impact.	Prepare high-level simulation models to examine the alignment of the proposed design with the required operational performance outcomes and/or targets. Review design predictions against the required operational performance. Prepare an analysis of the fit between the concept design and operational requirements.	Explore the design proposals by means of a walkthrough of a 3D model or other method for explaining the asset/facility to the owner and other stakeholders. Report on the extent to which any operational constraints have been advised. Determine if the design will deliver an asset/facility that is safe to access, maintain and use.	Undertake model-based design performance simulations. Identify any changed operational requirements that are essential in order to meet the desired energy performance target. Prepare method statements covering operation and maintenance. Prepare aftercare plans.	Review all installation details and correct any that will impact negatively upon the actual performance relative to the required performance. Highlight any unavoidable changes in design that might give rise to a change in the required performance. Collate the architectural, structural, mechanical, electrical and public health information necessary to obtain statutory approvals.	Identify where any operational details and performance targets have been adjusted to reflect commissioning results. Determine how non-technical users will know how to operate the asset/facility efficiently.	Conduct aftercare review meetings and workshops as planned. Record user comments related to functionality and effectiveness. Maintain records of walkabouts to spot emerging issues. Update the facility user guide, as appropriate.
Security Meeting the needs of the owner, operator and end-users from the development of an appropriate security-minded approach.								

Table J.1 Summary of main activities by focus area and work stage

Focus area	Work stage							
	0	1	2	3	4	5	6	7
	Strategy	Brief	Concept	Definition	Design	Build and commission	Handover and Close-out	Operation and End of life
Economic Meeting the targets for capital and operational expenditure and reflecting whole-life cost assessment.	Establish an initial view of capital expenditure and operational expenditure, covering operations, maintenance, capital replacement costs, and costs relating to energy use, water consumption and waste disposal.	Prepare an estimate of capital cost and a methodology for whole-life cost assessment. Prepare an estimate of operational cost, including a simple model of energy performance, maintenance and capital replacement costs.	Update the estimates of capital cost and operational cost and determine if they are within the agreed expenditure limits. Update the assessment of whole-life costs.	Update the estimates of capital cost and operational cost.	Update the estimates of capital cost and operational cost.	Prepare forecasts of final capital cost and operational cost.	Update the forecast of final capital cost. Prepare a detailed cost analysis of the final capital cost. Update the estimate of operational cost.	Consider any operational costs that might have arisen that were not predicted and maintain records to inform lessons learned.

Table J.1 Summary of main activities by focus area and work stage

Focus area	Work stage							
	0	1	2	3	4	5	6	7
	Strategy	Brief	Concept	Definition	Design	Build and commission	Handover and Close-out	Operation and End of life
Commissioning, Training and Handover	Appoint owner's representative to oversee the soft landings process.	Determine how project information will be transferred to the asset information model (AIM), asset register and owner's defined enterprise system or a computer-aided facilities management (CAFM) system.	Outline commissioning needs, including those for building services engineering systems. Prepare a plan for commissioning, training and handover. Determine the operational resources needed to support commissioning, training and handover.	Update the plan for commissioning, training and handover. Identify the commissioning needs for each system and the related standard and methods. Update the handover plan, as necessary.	Update the plan for commissioning, training and handover. Prepare a construction and system testing schedule and a commissioning and performance testing schedule. Confirm the arrangements for the transfer of asset data to the asset information model (AIM).	Update the commissioning specification. Update the commissioning and training plan in liaison with the commissioning manager. Prepare a schedule of pre-commissioning activities. Identify any skills that end-users need to have before attending commissioning demonstrations.	Verify the commissioning information provided by the suppliers. Prepare a schedule for coordinating on site activities and the witnessing of balancing, regulating and performance testing. Record all equipment and system settings and outputs from commissioning. Update the building logbook.	Maintain records of walkabouts to spot emerging issues. Fine-tune the building services engineering systems. Record all and feedback all fine-tuning. Update the facility user guide.
	Ensuring that the project is delivered and the asset/facility is handed over and supported to meet the needs of the operator and end-users.							

Table J.1 Summary of main activities by focus area and work stage

Focus area	Work stage							
	0	1	2	3	4	5	6	7
	Strategy	Brief	Concept	Definition	Design	Build and commission	Handover and Close-out	Operation and End of life
Asset/Facilities Management Providing an efficient and cost-effective strategy, policy and plans for operating the asset/facility.	Identify the performance benchmarks for this type of asset/facility for establishing targets and the processes for subsequently measuring performance. Identify any existing facilities management strategy and supporting policy or procedures and, where none exists, prepare such a strategy in outline. Identify the approach to be taken to post-occupancy evaluation (POE).	Prepare an estimate of operational cost, including a simple model of energy performance, maintenance and capital replacement costs. Prepare a management strategy and policy covering the Operation and End of life work stage. Prepare a draft plan for measuring operational performance during the Operation and End of life work stage.	Prepare an operational model, management plan and operational expenditure budget. Outline the initial aftercare and extended periods of aftercare, including annual visits and reviews as a basis for optimizing operational performance. Prepare a plan for the removal and replacement of equipment, fabric and debris, where applicable.	Participate in reviews of the design proposals and comment on whether or not the design is capable of meeting the required environmental, social, security and economic performance. Provide an updated operational model, operational management plan and operational expenditure budget. Identify the parties needed to witness demonstrations.	Provide a scope of work and specification for the procurement of appropriate maintenance services, where required. Provide details of any specific maintenance plan. Advise on the need to recruit personnel for the operations team, where applicable. Advise on the need for procurement of other service providers, where applicable.	Determine whether or not the building services engineering systems and other major components and systems can be maintained safely in compliance with relevant legislation. Provide an operational risk assessment. Comment of the construction and system testing schedule and the commissioning and performance testing schedule from the perspective of witnessing demonstrations.	Provide updated operational information to the design and construction team. Review and comment on all operation and maintenance information. Review and comment on all commissioning and handover-related information. Prepare or update a schedule of assets to be maintained and a cost breakdown for depreciation purposes.	Compare the post-occupancy (POE) results with expectations. Compare actual performance with the required performance and explain good or bad performance. Compare actual operational costs with estimated operational costs, actual water consumption with predicted consumption and actual waste reduction with predicted reduction then explain good or bad performance.

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 7000-4, *Design management systems – Part 4: Guide to managing design in construction*

BS 7832:1995, ISO 9699:1994, *Performance standards in building – Checklist for briefing – Contents of brief for building design*

BS 8210, *Guide to facilities maintenance management*

BS 8300, *Design of buildings and their approaches to meet the needs of disabled people – Code of practice*

BS 8572, *Procurement of facility-related services – Guide*

BS 8587:2012, *Guide to facility information management*

BS 9999:2008, *Code of practice for fire safety in the design, management and use of buildings*

BS EN 15221-1:2006, *Facility management – Part 1: Terms and definitions*

BS EN 15643-2, *Sustainability of construction works – Assessment of buildings – Part 2: Framework for the assessment of environmental performance*

BS EN 15643-3, *Sustainability of construction works – Assessment of buildings – Part 3: Framework for the assessment of social performance*

BS EN 15643-4, *Sustainability of construction works – Assessment of buildings – Part 4: Framework for the assessment of economic performance*

BS ISO 11620:2014, *Information and documentation – Library performance indicators*

BS ISO 15392:2008, *Sustainability in building construction – General principles*

BS ISO 16439:2014, *Information and documentation – Methods and procedures for assessing the impact of libraries*

BS ISO 21500:2012, *Guidance on project management*

BS ISO 50004:2014, *Energy management systems – Guidance for the implementation, maintenance and improvement of an energy management system*

BS ISO 55000:2014, *Asset management – Overview, principles and terminology*

PAS 91, *Construction prequalification questionnaires*

Other publications

- [1] USABLE BUILDINGS TRUST (UBT) and BUILDING SERVICES RESEARCH AND INFORMATION ASSOCIATION (BSRIA). *The soft landings framework for better briefing, design, handover and building performance in-use*. BG 54/2014. ISBN 9780860227304.
<http://usablebuildings.co.uk/UBTOverflow/SoftLandingsFramework.pdf> [viewed 2015-07-29].
- [2] GREAT BRITAIN. *Government Soft Landings – Executive summary*. London: Cabinet Office. 2013. <http://www.bimtaskgroup.org/reports> [viewed 2015-07-29].
- [3] CONSTRUCTION INDUSTRY COUNCIL (CIC). *Design quality indicator (DQI)*. London: CIC, 2014. <http://dqi.org.uk> [viewed 2015-07-29].

- [4] BUILDING USE STUDIES. *BUS methodology*. Cambridge: The Usable Buildings Trust, 2014. <http://www.busmethodology.org.uk> [viewed 2015-07-29].
- [5] BUILDING RESEARCH ESTABLISHMENT LIMITED. *BREEAM In-Use*. BES 5058. Watford: BRE, 2012.
- [6] BUILDING INFORMATION MODELLING (BIM) TASK GROUP. *BIM Toolkit*. Newcastle: NBS, 2015. <https://toolkit.thenbs.com/> [viewed 2015-07-29].
- [7] BUILDING SERVICES RESEARCH AND INFORMATION ASSOCIATION. *Pitstopping – BSRIA's reality-checking process for Soft Landings*. BG 27/2011. Bracknell: BSRIA, 2011. ISBN 9780860226932.
- [8] CHARTERED INSTITUTION OF BUILDING SERVICES ENGINEERS (CIBSE). *Building energy metering*. TM39. CIBSE, 2009. ISBN: 9781906846114.
- [9] CHARTERED INSTITUTION OF BUILDING SERVICES ENGINEERS (CIBSE). *Building log book toolkit*. TM31. CIBSE, 2006. ISBN: 9781903287712.
- [10] CHARTERED INSTITUTION OF BUILDING SERVICES ENGINEERS (CIBSE). *Evaluating operational energy performance of buildings at design stage*. TM54, CIBSE, 2013. ISBN 9781906846381.
- [11] GREAT BRITAIN. *The Building Regulations 2010*. London: The Stationery Office.
- [12] SCOTLAND. *The Building (Scotland) Regulations 2004, as amended*. Edinburgh: The Stationery Office.
- [13] GREAT BRITAIN. *The Building Regulations (Northern Ireland) 2000, as amended*. London: The Stationery Office.
- [14] ROYAL INSTITUTION OF CHARTERED SURVEYORS (RICS). *NRM1, New rules of measurement – order of cost estimating and cost planning for capital building works*. London: RICS, 2012. ISBN 9781842197684.
- [15] ROYAL INSTITUTION OF CHARTERED SURVEYORS (RICS). *NRM3, New rules of measurement – order of cost estimating and cost planning for building maintenance works*. London: RICS, 2014. ISBN 9781783210244.
- [16] BUILDING INFORMATION MODELLING (BIM) TASK GROUP, *Plain language questions*, Newcastle: NBS, 2012. <http://www.thenbs.com/BIMTaskGroupLabs/questions.html> [viewed 2015-07-29].

Further reading

BS 7000-6, *Design management systems – Part 6: Managing inclusive design*

BS 7543, *Guide to durability of buildings and building elements, products and components*

BS 8544, *Guide for life cycle costing of maintenance during the in use phases of buildings*

BS EN 15221-2, *Facility Management – Part 2: Guidance on how to prepare Facility Management agreements*

BS EN 15221-3, *Facility Management – Part 3: Guidance on quality in Facility Management*

BS EN 15221-4, *Facility Management – Part 4: Taxonomy, Classification and Structures in Facility Management*

BS EN 15221-6, *Facility Management – Part 6: Area and Space Measurement in Facility Management*

BS EN 15221-7, *Facility Management – Part 7: Guidelines for Performance Benchmarking*

BS EN 15265, *Energy performance of buildings – Calculation of energy needs for space heating and cooling using dynamic methods – General criteria and validation procedures*

BS EN 15331, *Criteria for design, management and control of maintenance services for buildings*

BS EN ISO 9001, *Quality management systems – Requirements*

BS EN ISO 14001, *Environmental management systems – Requirements with guidance for use*

BS ISO 15686-1, *Buildings and constructed assets – Service life planning – Part 1: General principles and framework*

BS ISO 15686-2, *Buildings and constructed assets – Service life planning – Part 2: Service life prediction procedures*

BS ISO 15686-5, *Buildings and constructed assets – Service life planning – Part 5: Life cycle costing*

BS ISO 15686-10, *Buildings and constructed assets – Service life planning – Part 10: When to assess functional performance*

BS ISO 19208, *Framework for specifying performance in buildings* ⁶⁾

BS ISO 37500, *Guidance on outsourcing*

BS ISO 55001, *Asset management – Management systems – Requirements*

BS ISO 55002, *Asset management – Management systems – Guidelines for the application of ISO 55001*

GREAT BRITAIN. The Disability Discrimination Act 2005. London: The Stationery Office.

GREAT BRITAIN. The Disability Equality Duty 2005. London: The Stationery Office.

GREAT BRITAIN. The Control of Substances Hazardous to Health Regulations 1988, as amended. London: The Stationery Office.

GREAT BRITAIN. The Control of Substances Hazardous to Health Regulations (Northern Ireland) 2003. London: The Stationery Office.

GREAT BRITAIN. The Energy Performance of Buildings (Certificates and Inspections) (England and Wales) Regulations 2007. London: The Stationery Office.

NORTHERN IRELAND. Energy Performance of Buildings (Certificates and Inspections) Regulations (Northern Ireland) 2008, as amended. London: The Stationery Office.

⁶⁾ In preparation.

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards-based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

All the data, software and documentation set out in all British Standards and other BSI publications are the property of and copyrighted by BSI, or some person or entity that owns copyright in the information used (such as the international standardization bodies) and has formally licensed such information to BSI for commercial publication and use. Except as permitted under the Copyright, Designs and Patents Act 1988 no extract may be reproduced, stored in a retrieval system or transmitted in any form or by any means – electronic, photocopying, recording or otherwise – without prior written permission from BSI. Details and advice can be obtained from the Copyright & Licensing Department.

Useful Contacts:

Customer Services

Tel: +44 845 086 9001

Email (orders): orders@bsigroup.com

Email (enquiries): cservices@bsigroup.com

Subscriptions

Tel: +44 845 086 9001

Email: subscriptions@bsigroup.com

Knowledge Centre

Tel: +44 20 8996 7004

Email: knowledgecentre@bsigroup.com

Copyright & Licensing

Tel: +44 20 8996 7070

Email: copyright@bsigroup.com

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK



...making excellence a habit.™