



BSI Standards Publication

**Building performance evaluation of
occupied and operational buildings
(using data gathered from tests,
measurements, observation and user
experience) — Specification**

Publishing and copyright information

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

© The British Standards Institution 2022

Published by BSI Standards Limited 2022

ISBN 978 0 539 16340 7

ICS 91.040.01

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

Committee reference CB/401

Draft for comment 21/30431027 DC

Amendments/corrigenda issued since publication

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

Contents

	Page
Foreword	iii
0 Introduction	1
0.1 General	1
0.2 Building performance evaluation	1
0.3 Why is a British Standard needed?	2
0.4 What does the British Standard cover?	3
0.5 Who is it for?	3
1 Scope	4
2 Normative references	5
3 Terms and definitions	6
4 Building performance evaluation methodology	10
4.1 Planning BPE projects	10
<i>Figure 1 — Schematic of BPE levels and Investigative BPE</i>	11
<i>Table 1 — Preliminary Evaluation</i>	13
<i>Table 2 — Light BPE</i>	13
<i>Table 3 — Standard BPE</i>	13
<i>Table 4 — Investigative BPE</i>	13
4.2 Conducting BPE projects	15
4.3 Data naming and retention	16
<i>Table 5 — Specific reading point type name</i>	18
<i>Table 6 — Reading metadata</i>	19
4.4 Interpretation and reporting	19
<i>Table 7 — Qualitative and quantitative performance parameters</i>	21
4.5 Evaluator responsibility and claiming conformity	25
5 Specification and execution of BPE elements	27
5.1 General	27
<i>Table 8 — Preliminary evaluation – required elements for different study types</i>	28
<i>Table 9 — Light BPE – required elements for different study types</i>	30
<i>Table 10 — Standard BPE – required elements for different study types</i>	32
5.2 Preliminary Evaluation, Light BPE and Standard BPE	33
5.3 Occupant and user experience	36
<i>Table 11 — Minimum requirements for the in-use occupant survey</i>	37
5.4 Post-construction review	40
5.5 Energy use and generation	47
5.6 Water use	52
5.7 Internal condition monitoring	53
<i>Table 12 — Positioning of internal condition monitoring sensors</i>	54
5.8 External condition monitoring	56
<i>Table 13 — Positioning of external sensors</i>	57
5.9 Investigative BPE	57
Annex A (informative) Investigative BPE toolbox	59
<i>Table A.1 — Investigative BPE – Potential elements for inclusion in a BPE study</i>	59
Annex B (informative) Example information sheet for occupants and participants	72
Annex C (informative) Guidance on conducting building walk-throughs – domestic buildings	74
<i>Table C.1 — Example of a typical placeholder</i>	74
Annex D (informative) Guidance on conducting building walk-throughs – non-domestic buildings	77

Annex E	(informative) Application of BPE in different contexts	83
Annex F	(informative) Early occupation survey pro-forma (Example)	90
Annex G	(informative) Example consent form for occupants/participants	93
	Bibliography	94

Summary of pages

This document comprises a front cover, an inside front cover, pages I to IV, pages 1 to 98, an inside back cover and a back cover.

Foreword

Publishing information

This is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 January 2022. It was prepared by Technical Committee CB/401, *Retrofitting Energy Efficiency Measures*. A list of organizations represented on this committee can be obtained on request to its committee manager.

Relationship with other publications

The British Standard is the first in a series of standards which address building performance. Other standards in development include:

- BS 40102, *Health and well-being and indoor environmental quality in buildings – Health and well-being in buildings*¹⁾
- BS 40104, *Assessment of dwellings for retrofit*¹⁾

Information about this document

This British Standard acknowledges the contribution of the Building Performance Network in developing this British Standard, supported with funding from the UKRI Transforming Construction Challenge.

This publication can be withdrawn, revised, partially superseded or superseded. Information regarding the status of this publication can be found in the Standards Catalogue on the BSI website at bsigroup.com/standards, or by contacting the Customer Services team.

Where websites and webpages have been cited, they are provided for ease of reference and are correct at the time of publication. The location of a webpage or website, or its contents, cannot be guaranteed.

Presentational conventions

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

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

Requirements in this standard are drafted in accordance with *Rules for the structure and drafting of UK standards*, subclause **G.1.1**, which states, “Requirements should be expressed using wording such as: ‘When tested as described in Annex A, the product shall ...’”. This means that only those products that are capable of passing the specified test will be deemed to conform to this standard.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organization” rather than “organisation”).

Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

¹⁾ In preparation

This publication is provided as is, and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

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

0 Introduction

0.1 General

This British Standard is concerned with the evaluation of the performance of buildings at any point during the operational stage of their lives. It provides a tailored and graduated approach enabling the standard to be used across all building types and uses and for a wide range of project or study objectives.

This British Standard uses data gathered from tests and measurements, monitoring, reported experience and observation to evaluate the actual performance of a building or cohort of buildings, and complements other standards, such as BS EN 16798-1 and BS EN ISO 7730, which derive analytical predictions of performance by calculation and analysis of design.

0.2 Building performance evaluation

The term “building performance” can cover all parameters and descriptors that capture how well the building fulfils its purpose. Building performance evaluation is the term used to describe the gathering of quantitative and qualitative data that characterize the performance of a building (or separate premises within a building) and the interpretation of these data to draw conclusions regarding specific performance attributes and the overall performance of the building.

The study of the performance of buildings and the relationship amongst building performance attributes, building and occupant health, occupant wellbeing, flows of electrical energy, fuel, water, CO₂ and other emissions across the building system boundary has been attracting interest since, at least, the 1970s, with the *PROBE* [1] studies of the 1990s being the first to report results of professional study on multiple buildings.

Interest in determining the performance of buildings has grown steadily, stimulated by increasing understanding of:

- a) the often substantial difference between design predictions and the actual technical and functional performance of buildings (now referred to as the performance gap);
- b) how buildings, and especially the indoor environments they enclose, affect human health, wellbeing, productivity and learning; and
- c) how building fabric and structure can be detrimentally affected by the environmental conditions created in and by a building through its design, construction and installed services.

The demand for knowledge about the actual performance of buildings is critically important in the context of aspirations by UK and devolved authority governments to upgrade the UK's building stock to reduce energy demand and improve indoor environments and to ensure both new and existing buildings contribute to meeting the UK's zero carbon emission commitments.

Understandably, the growing appreciation of the significance of building performance has been mirrored by a developing area of professional practice in building performance evaluation, originating in academic and industrial research, and now forming a body of experienced individuals and companies providing professional services in building performance evaluation (BPE) using a growing toolbox of techniques and equipment.

Over the last decade BPE has become a focus area for both The Chartered Institution of Building Services Engineers (CIBSE) and The Royal Institute of British Architects (RIBA), features in the UK Government's Transforming Construction Challenge and increasingly underpins initiatives such as the *Soft Landings Framework* [2] and the *Assured Performance Process* [3] to deliver better performing new buildings and upgrades of existing buildings. The requirement to evaluate the outcome

performance of retrofit improvements is included in PAS 2035 (for domestic scale buildings) and PAS 2038 (for larger non-domestic buildings).

Advances in sensing, monitoring and measurement technology have increased the ease and affordability with which performance measurements can be made and key parameter values monitored, providing better data on which to base building performance evaluation. The roll out of smart meters and the incorporation of energy metering into renewable energy generation equipment and heat pumps increasingly provides time-stamped and time series energy data. Building monitoring systems and devices such as smart thermostats (that are being installed in some new social housing) and CO₂ monitors (since 2020 a regulatory requirement in new-build Scottish housing) herald an era where aspects of monitoring and sensing are automatically embedded within buildings.

The means and rationale for undertaking building performance evaluation are now firmly established. BPE can support a wide range of stakeholders seeking to understand, verify and improve the performance of individual buildings and the wider building stock.

0.3 Why is a British Standard needed?

Whilst the number of BPE projects/studies on individual buildings and groups of buildings continues to grow, there is no consistency in how these projects are carried out and reported and in how the raw data and evaluation results are recorded and stored.

This lack of consistency means that BPE findings are often incompatible, even for an individual performance parameter, making it difficult to revisit findings or re-evaluate a building after time has passed or if a different evaluator carries out a repeat or follow-up study. This limits the benefit of aggregation or meta-analysis and often unhelpfully focuses any review and challenge of BPE findings on the methods and approaches deployed, rather than on the results obtained.

The purpose of this British Standard is, therefore, to:

- a) enable consistency in the evaluation of the performance of buildings and the reporting and recording of evaluation findings and conclusions;
- b) provide a basis for verification of specified performance in new and upgraded buildings in respect of key performance parameters and attributes (e.g. for “pay as you save” finance, performance contracting, performance-linked finance, and potentially for future regulatory compliance);
- c) provide a basis for determining whether the performance specification of a new or upgraded building is achieved in use; and
- d) provide a basis for the identification of improvement options or corrective actions (ranging from setting adjustments to extensive fabric upgrade) and the development of improvement strategies, process improvements, plans and specifications (e.g. in pursuit of transition to net zero carbon).

NOTE The Preliminary Evaluation level included in this British Standard is not likely to satisfy the purposes outlined in b) to d) although it should enable insight based on occupant opinion. Preliminary Evaluation studies carried out in accordance with this British Standard follow the same framework of planning, execution, treatment of data and reporting. Preliminary Evaluation is therefore considered a first step towards more comprehensive BPE.

0.4 What does the British Standard cover?

This British Standard covers:

- a) the planning of BPE studies, including
 - 1) timing: for new buildings or those subject to major refurbishment or retrofit, planning should be carried out at the strategic stage of a construction or refurbishment project (e.g. see [BS 8536](#); RIBA Stage 0 or Stage 1, or *Soft Landings Framework* plan [2]); and
 - 2) content: based on the purpose of the evaluation and the use and complexity of the building(s);
- b) the choice of comparator cases, including but not limited to:
 - 1) performance specification;
 - 2) design predictions;
 - 3) modelled design;
 - 4) regulatory thresholds;
 - 5) previous evaluation of the same building;
 - 6) evaluation of similar building(s); and
 - 7) industry benchmarks and thresholds set by quality standards;
- c) data gathering relevant to the BPE level pursued, through documentation review, test and measurement, monitoring, experiential feedback and observations;
- d) comparison against comparator case parameters and interpretation of individual, interdependent and whole system results;
- e) the derivation and reporting of derived performance parameters;
- f) requirements for data naming and retention; and
- g) report contents and compliance claims.

0.5 Who is it for?

Whilst this British Standard is primarily for use by those carrying out BPE projects, it is also valuable for those considering or commissioning studies or aggregating findings across multiple studies.

A BPE study report provides valuable insight for many different stakeholders, including but not limited to:

- a) specifiers, designers, commissioners/procurers and deliverers of new buildings, and of the modification, upgrade or retrofit of existing buildings;
- b) those assessing the opportunity to improve existing buildings;
- c) those financing construction works (as lender, grant provider/administrator, or self-funder);
- d) owners and leaseholders of buildings and portfolios of buildings, including property fund managers, social housing providers and their investors;
- e) building tenants and occupants;
- f) those wishing (or being required to) disclose (or manage) the CO₂ emissions of buildings for which they are (at least partly) responsible;

NOTE This could include finance providers, corporate or public estate owners and social housing providers.

- g) those concerned with the health and wellbeing of occupants, either through social or contractual responsibility; and

- h) those studying the performance of the building stock to support the derivation of statistics (e.g. on fuel poverty), inform policy, devise programmes, contribute to sector knowledge and to report on any of these.

1 Scope

This British Standard specifies requirements for three levels of building performance evaluation plus an additional supplementary level:

- a) Preliminary Evaluation (PE): the lightest entry level evaluation using readily available data and information plus occupant feedback;
- b) Light BPE: a basic BPE study and the lightest level to take account of internal environmental monitoring;
- c) Standard BPE: a good all-round study based on more granular data enabling greater insight and a good basis for decision making and further performance investigations;
and, additionally:
- d) Investigative BPE: allows for additional investigative elements to be pursued in parallel or following any of the three levels listed above and for all types of study to be structured, conducted and reported consistently.

NOTE 1 Elements from higher levels of study can be added to any of the lowest two levels, PE and Light BPE, as required, to fulfil the purpose of the study.

This British Standard is relevant to all types and uses of buildings, at any point(s) during the “in-use” phase of their lives, including, but not limited to:

- 1) a development of individual homes that has been recently constructed with homes sold to private individuals;
- 2) a cohort of similar dwellings, pre- and post-upgrade to establish a baseline performance and then to verify improvements;
- 3) a portfolio of public buildings to support a business case for investment; and
- 4) a recently completed commercial building where the owner wishes to check that the specified performance has been achieved.

NOTE 2 “As built” performance of a newly constructed or upgraded building, prior to occupation might differ from the “in-use” performance once occupants have moved in. Completion stage (prior to occupation) studies are not covered by this British Standard.

NOTE 3 Evaluation in this British Standard is based on actual quantitative and qualitative data obtained through testing, measurement, monitoring, observations and reported experience.

NOTE 4 Actual data is compared against context-relevant reference cases (comparator cases) thus enabling the evaluator to report on individual and interdependent aspects of the performance of the building and thereby to draw conclusions pertinent to the objectives of the BPE project.

This British Standard specifies requirements for:

- i) the planning of BPE studies, including timing and content;
- ii) the choice of comparator cases;
- iii) data gathering relevant to the BPE project level, through documentation review, test and measurement, monitoring, experiential feedback and observations;
- iv) the derivation and reporting of gathered and derived performance parameter data;

- v) comparison of gathered data and derived performance data with equivalent comparator case data;
- vi) the interpretation of individual, interdependent and whole system results;
- vii) requirements for data naming and retention; and
- viii) reporting and compliance claims.

This British Standard does not include minimum or desirable values for directly obtained performance parameters (e.g. measured temperature) or for performance parameters derived from measured data (e.g. energy use per m²).

NOTE 5 Many sources are available that provide guidance on “what good looks like” and are updated on an irregular basis, including The Association for Environment Conscious Building (AECB) (<https://aecb.net/>) and Passive House (<https://passivehouse-international.org/index.php>) standards on energy intensity and water use; World Health Organisation (<https://www.who.int/>), BS EN 16798-1 [B] and forthcoming BS 40102²⁾ guidance on indoor environmental conditions; relevant building regulations and CIBSE publications on air tightness and ventilation rates (<https://www.cibse.org/>). To provide assistance to the users of this British Standard, many of these sources are signposted where the evaluation of specific aspects of performance is addressed.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this document³⁾. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

[BS 8210](#), *Facilities maintenance management – Code of practice*

BS EN 13187, *Thermal performance of buildings – Qualitative detection of thermal irregularities in building envelopes – Infrared method*

ISO/TS 19488, *Acoustics – Acoustic classification of dwellings*

Other publications

[N1] INTERNATIONAL PROPERTY MEASUREMENT STANDARD. *International Property Measurement Standards: Retail Buildings*. 2019. <https://www.rics.org/globalassets/rics-website/media/upholding-professional-standards/sector-standards/real-estate/ipms-retail-buildings.pdf>

[N2] INTERNATIONAL PROPERTY MEASUREMENT STANDARD. *International Property Measurement Standards: Office Buildings*. 2014. <https://ipmsc.org/standards/office/>

[N3] INTERNATIONAL PROPERTY MEASUREMENT STANDARD. *International Property Measurement Standards: Industrial Buildings*. 2018. <https://ipmsc.org/standards/industrial/>

[N4] INTERNATIONAL PROPERTY MEASUREMENT STANDARD. *International Property Measurement Standards: Residential Buildings*. 2016. <https://ipmsc.org/standards/residential/>

[N5] CHARTERED INSTITUTION OF BUILDING SERVICES ENGINEERS. TM52. *The Limits of Thermal Comfort: Avoiding Overheating in European Buildings*. 2013.

[N6] CHARTERED INSTITUTION OF BUILDING SERVICES ENGINEERS. TM59. *Design Methodology for the Assessment of Overheating Risk in Homes*. 2017.

²⁾ In preparation

³⁾ Documents that are referred to solely in an informative manner are listed in the Bibliography.

[N7] DEPARTMENT FOR COMMUNITIES AND LOCAL GOVERNMENT. The Building Regulations 2010 – Approved Document F: *Ventilation: Approved Document F*. LONDON: THE STATIONERY OFFICE.

[N8] WALES. The Building Regulations 2010 – Approved Document F: F1: *Means of ventilation*. LONDON: THE STATIONERY OFFICE.

[N9] SCOTLAND. *Building standards technical handbook 2020: Domestic and non-domestic*. Section 13. Edinburgh: The Stationery Office.

[N10] NORTHERN IRELAND. *Building Regulations Technical Booklet Part K: Ventilation*. 2012. Belfast: The Stationery Office.

3 Terms and definitions

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

3.1 archetype

type of building such that it can be considered similar to other buildings described as being of the same archetype

3.2 base load

out of hours energy demand used to describe how much energy is used by the building when the building is not being used by its occupants

3.3 building

construction works that have the provision of shelter for its occupants or contents as one of its main purposes and are usually partially or totally enclosed and designed to stand permanently in one place

3.4 building fabric

construction products and materials that are fixed to the building in a permanent manner, so that the dismantling of the product changes the performance of the building and the dismantling or replacement of the product or material constitute construction operations

3.5 building performance evaluation (BPE)

gathering of a building's (or premises') quantitative and qualitative performance parameter data and the interpretation of these data against comparators to draw conclusions regarding specific aspects of performance and the overall performance of the building (or premises)

3.6 cohort of buildings

buildings of the same or very similar design that have been constructed or retrofitted as part of the same phase or programme, using the same construction or manufacturing methods

NOTE Ideally buildings are delivered under equivalent contractual terms, by teams with equivalent skills, hence buildings that could reasonably be expected to exhibit the same performance.

3.7 cold water

water drawn from the mains supply and unheated

NOTE Other sources of unheated water can also be included, although not chilled.

3.8 comparator

including but not limited to design prediction, performance of the building obtained from software model, performance specification, parameters for which thresholds are set by regulation, previous evaluation of the same building, evaluation of similar building(s) and industry benchmarks

3.9 comparator case

reference against which the evaluator compares the performance of the study building or premises and on the basis of which the evaluator evaluates the building's or premises' performance

NOTE This can include essentially identical buildings, such as in standard house types, manufactured buildings, archetypal benchmarks.

3.10 CO₂eq

carbon dioxide emissions and emissions of other greenhouse gases converted into their CO₂ equivalent

3.11 derived performance parameter

performance parameter whose value can be derived by combining a measured or directly captured performance parameter with another and/or with published figures

NOTE For example, kWh/m²; CO₂eq/yr, W/m².

3.12 energy end use

different purposes for which energy supplies to a building are used

NOTE For example space heating and cooling, ventilation (fans), hot water, pumps, lighting, IT, cooking, refrigeration, vertical transport (lifts, escalators).

3.13 evaluator

individual taking overall responsibility for the building performance evaluation project

3.14 external envelope

ground or lowest slab, roof and walls/façade, including openings

3.15 fuel

substance used to generate heat and power and/or to provide power to equipment for a building or premises

3.16 heat transfer coefficient (HTC)

heat flow rate divided by temperature difference between two environments

NOTE 1 HTC represents the steady-state aggregate total fabric and ventilation heat transfer from the entire thermal envelope in watts per kelvin of temperature difference (ΔT) between the internal and external environments and is expressed in watts/kelvin (W/K).

NOTE 2 Ventilation also includes unintended infiltration.

3.17 indoor environmental quality (IEQ)

composite characterization of performance attributes that collectively describe the quality of an internal environment

NOTE There is no definitive list of performance parameters, however these can include temperature, humidity, air quality, acoustic attributes, odours, air movement, lighting, glare, and, in some cases, their time derivative.

3.18 in-use period

any and all time following occupation or reoccupation of a building subsequent to significant construction works

3.19 Likert scale

unidimensional scale used to collect respondents' attitudes and opinions

3.20 monitoring period

period described by its start and end date and time, during which performance data are captured, relating each data point to the time it is captured

NOTE Data captured in such a fashion are referred to as time series data.

3.21 occupant

user spending a significant proportion of time in or about a building or premises

3.22 operability

capability of being put into use as intended

3.23 operational energy demand

energy used by the technical systems within and directly associated with the building, and the energy used by the users during their occupation of the building

3.24 operational water use

water used by the technical systems within and directly associated with the building, and the water used by the users during their occupation of the building, including mains water drawn for uses such as gardening, exterior cleaning, car washing

3.25 party wall

wall between two functionally separate buildings that are attached to each other

NOTE A party wall typically extends from lowest floor to roof.

3.26 performance

ability to fulfill required functions under intended use conditions

NOTE See BS ISO 6707 (all parts).

3.27 performance gap

difference between the actual quantitative or qualitative values of performance metrics and the equivalent designed, predicted or specified values

3.28 power density

instantaneous rate of using energy which can be used to consider the suitability and value for money of plant capacity, the efficiency of installed plant at various loads

NOTE Units are W/m².

3.29 plant

mechanical and electrical equipment comprising technical building systems

3.30 premises

building, collection of buildings, or part of a building that is under separate occupancy from other parts of the building

3.31 refurbishment

modification to an existing building in order to bring it up to a defined condition

3.32 retrofit

adding and/or removing materials and/or systems to/from an existing building with the intention of upgrading the performance of the building

3.33 sample building

building belonging to a cohort of sufficiently similar buildings on which Preliminary Evaluation, Light BPE or Standard BPE is conducted

3.34 significant construction works

works carried out to create or modify a building that impact on the performance of that building

NOTE Works that do not affect the performance of a building are not termed “significant”.

3.35 soundscape

acoustic environment, as perceived or experienced and/or understood by a person or people in context

NOTE See BS ISO 12913-1.

3.36 technical building system

technical equipment for heating, cooling, ventilation, hot water, lighting, IT, energy generation, storage and management or for the combination and interoperability thereof

3.37 time series data

data captured at timed intervals over a period of study and retained alongside the dates and times the data points are captured

3.38 total electricity consumption

summation of mains import electricity and renewable electricity self-consumption

NOTE For example, PV power generated and consumed directly by the building to serve building specific services, excluding electric vehicles.

3.39 upgrade

improving the performance of a building's fabric and/or systems, whether by retrofit, refurbishment or other means

3.40 user

person or organization which a building is intended to serve

NOTE This includes building owner, leaseholder, manager/facilities manager and permanent and transient/temporary occupants and visitors.

3.41 U-value

rate of transfer of heat energy through a m^2 plane of a material or composite element of a building envelope for every degree difference in temperature across the element

NOTE Units are W/m^2K .

3.42 vapour pressure

part of atmospheric pressure which is due to the presence of water vapour

NOTE Expressed in kPa (1 kPa = 10 millibars = 1 000 N/m²).

4 Building performance evaluation methodology

COMMENTARY ON CLAUSE 4

BPE projects can be undertaken to fulfil many different objectives, however this British Standard does not prescribe or restrict the purposes for which BPE projects can be deployed. It does specify how to plan, carry out and report a BPE project consistently and comprehensively and also governs the storage and retention of data obtained and used in the study. To assist the user, the following list illustrates typical situations in which BPE studies are carried out to:

- a) verify that the actual performance of a building or premises is substantially as expected, intended or predicted;*
- b) discover whether there are discrepancies between actual and specified performance and to identify their root cause(s);*
- c) discover whether a particular planned intervention, physical or operational change has resulted in an improvement (or deterioration) in actual performance, including unintended consequential performance impacts that might only be apparent after a period of time (such as mould growth or interstitial condensation);*
- d) identify performance which could indicate underlying problems or failures of fabric, envelope, services or operation;*
- e) help understand the origin of poor occupant-reported performance or difficulty in achieving a satisfactory indoor environment;*
- f) in the case of a cohort of buildings, draw conclusions on the extent to which the performance of buildings subjected to more comprehensive study adequately reflects the likely performance of the cohort;*
- g) inform recommendations for upgrading individual buildings, or cohorts of buildings, and premises;*
- h) inform resolution/remediation applicable to the study building(s);*
- i) inform the design, construction, and operation of future buildings;*
- j) give constructors and manufacturers of buildings and building services information on which to base continuous improvement and the development of new building solutions;*
- k) provide finance providers and owners of buildings with data to support CO₂ emissions disclosures;*
- l) provide owner-occupiers, landlords and tenants with information about the quality and healthiness of indoor environments; and*
- m) contribute to sector benchmark data, e.g. according to building archetype and use.*

4.1 Planning BPE projects

COMMENTARY ON 4.1

As with every project, good planning ensures that the work undertaken to carry out the project is necessary, sufficient and results in the project objectives being met.

In many situations, BPE projects can form part of a much larger process, such as those set out in [BS 8536](#)⁴⁾, a construction project following the RIBA Plan of Works [4], a project following Soft Landings Framework [1] or a retrofit project following PAS 2035 or PAS 2038. Planning for a BPE study as part of such a larger project, should be done at the earliest strategic stage of any larger project (such as a new-build construction or building upgrade). This should include agreeing scope and contractual terms for the BPE project, which should be aligned with the construction project brief.

⁴⁾ In preparation.

In a BPE project, thoughtful, early planning also ensures that the data required to inform the performance evaluation are able to be collected in the most effective and efficient way, e.g. to gather time-stamped data of indoor temperature, suitable sensors might need to be installed and permission might need to be granted by occupants for the project to make use of that data. By understanding and planning for this from the outset, sensors and monitoring equipment can be incorporated or installed at the most appropriate time whilst the building is being constructed or upgraded, or controls with embedded monitoring capability could be specified. Arrangements for occupant engagement can be factored in to ensure occupants understand the reason for collecting temperature data, the protections afforded to their privacy and for early consent to be obtained.

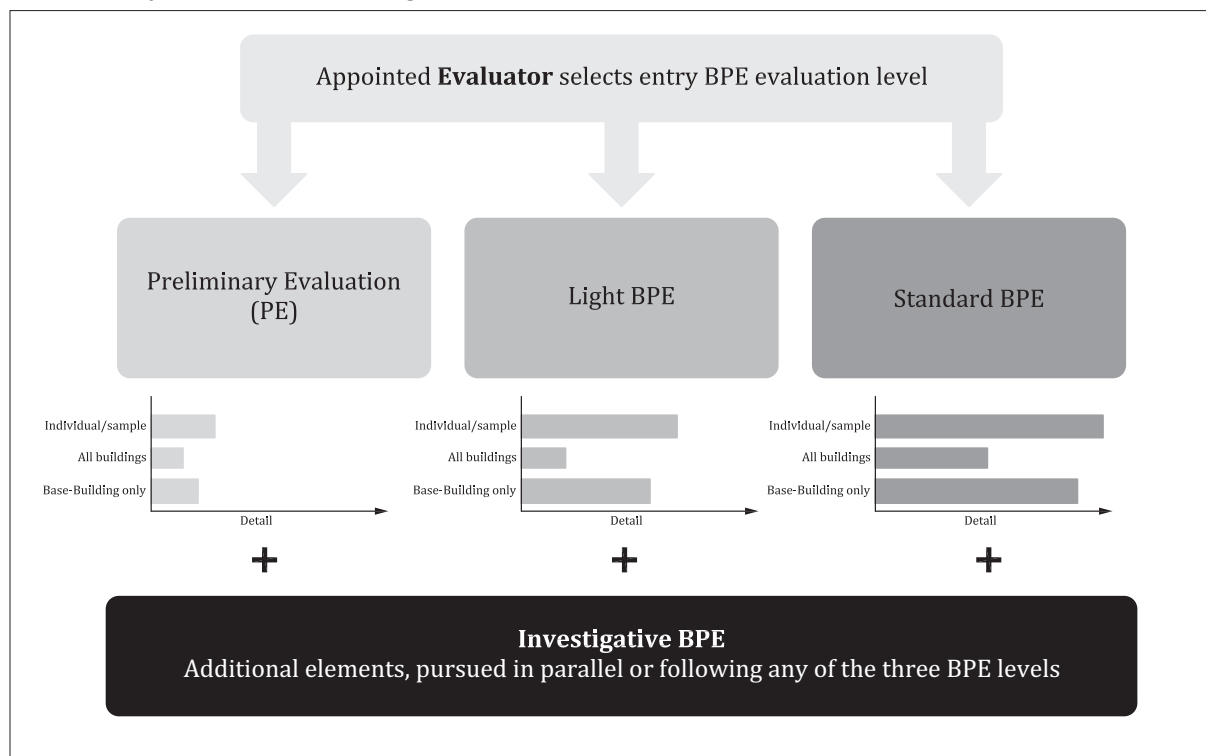
When planning any BPE project it is helpful to consider three areas of influence:

- a) the type and likely availability of data;*
- b) the physical building, including its services and how the building is used; and*
- c) the objectives of the study.*

These aspects govern the scope and depth of the study taking into account what is possible in the particular circumstances and what the study is to be used for.

This British Standard sets out three levels of building performance evaluation; Preliminary Evaluation, Light BPE, Standard BPE, together with Investigative BPE that can augment or follow any of the three levels (see [Figure 1](#)).

Figure 1 — Schematic of BPE levels and Investigative BPE



A Preliminary Evaluation is the lightest entry level evaluation, based largely on occupant feedback together with basic building parameters, evaluator observation and coarse energy use data. Whilst it can provide some insights into the performance of a building, as there is no monitoring of internal conditions, it is not possible to draw fully informed conclusions about the performance of the building. Accepting that it can be difficult to obtain internal environmental data in some circumstances, and until BPE becomes widely accepted as essential to closing the loop between theoretical performance and actual performance, Preliminary Evaluation is included in this British Standard as a first step towards full building performance evaluation.

A Light BPE study requires minimal essential numerical data of coarse granularity. This BPE level is likely to be useful for partial verification of performance, screening a cohort or portfolio of properties to flag significant performance anomalies and guide targeting of deeper or more focussed study, or establishing baseline performance prior to upgrade or improvement.

A Standard BPE study requires more granular data, across a larger number of parameters, to enable the evaluator to provide robust performance verification and gain a more comprehensive insight into the performance of a building, parameter by parameter and also “in the round”, taking into account the cross impact of performance attributes. A Standard BPE study can only be undertaken where suitably granular data and occupant feedback can be obtained (accepting this might be limited to facilities or building managers in the case of the base building evaluation of a multi-tenanted building). It could be undertaken as a follow-on from a Light BPE study or Preliminary Evaluation, e.g. on buildings flagged as raising potential performance concerns. However, wherever practical, it is preferable to plan a Standard BPE study from the outset to facilitate the robust interpretation of data. This could be in situations such as studying the in-use performance of a new house type or the work of a new main contractor, or for a recently completed large and complex building to ensure the performance specification has been met.

Investigative BPE can follow either a Light BPE or Standard BPE study or a Preliminary Evaluation (PE), or investigative elements could be included as additions to augment any of these BPE project levels. Where an Investigative BPE study follows a Standard, Light BPE or a PE, it references the findings of the precursor study. Investigative BPE might involve gathering additional data not covered in the essential elements of the study level, and/or might focus on testing hypotheses regarding performance concerns by, e.g. altering aspects of the building operation and/or carrying out intrusive tests on building fabric. Investigative BPE studies benefit from a common framework for data naming, storage and retention and of project reporting, with the three study levels, thus offering consistency of approach for both providers and customers of BPE services. If, for example, a specialist area of investigation is suggested as a result of a Standard BPE study, an evaluator specialising in that field can be engaged to carry out the investigation with confidence that this can build on previous work and that their findings will also be readily understandable to future evaluators.

The study elements of Preliminary Evaluation, Light and Standard BPE studies therefore comprise the specified essential elements for that study level, together with any optional elements specific to the objectives of the study (including ones in the Investigative BPE toolbox). A high-level overview of essential elements for all Preliminary Evaluation, Light and Standard BPE studies is provided in [Table 1](#) to [Table 3](#). Optional elements for Investigative BPE are provided in [Table 4](#). See [4.7](#) for specific elements of each study category (i.e. building parameters, post-construction review, etc.) that are required by this British Standard.

All levels of BPE project can be carried out on individual buildings, on a cohort of buildings or on a building containing separate dwellings or non-domestic premises. For cohorts of buildings, a minimum 10% sample of buildings is required to be studied at the chosen level in parallel to collecting the specified data (BPE elements) from all buildings within the cohort. For buildings containing multiple premises, an option to study only the common areas and shared services is provided, although inclusion of the individual premises contained within is desirable. This is referred to as a base-building study.

Table 1 — *Preliminary Evaluation*

BPE level and category	All buildings (100% in cohort)	Sample (10%) or individual buildings	Base-building only
Building parameters	X	X	X
Occupant/user experience	X	X	X
Post-construction review	–	X	X
Energy use and generation	–	X	X
Water use	–	–	–
Internal conditioning monitoring	–	–	–
External conditioning monitoring	–	X	X

Table 2 — *Light BPE*

BPE level and category	All buildings (100% in cohort)	Sample (10%) or individual buildings	Base-building only
Building parameters	X	X	X
Occupant/user experience	X	X	X
Post-construction review	–	X	X
Energy use and generation	–	X	X
Water use	–	X	X
Internal conditioning monitoring	–	X	–
External conditioning monitoring	–	X	X

Table 3 — *Standard BPE*

BPE level and category	All buildings (100% in cohort)	Sample (10%) or individual buildings	Base-building only
Building parameters	X	X	X
Occupant/user experience	X	X	X
Post-construction review	–	X	X
Energy use and generation	X	X	X
Water use	X	X	X
Internal conditioning monitoring	–	X	X
External conditioning monitoring	X	X	X

Table 4 — *Investigative BPE*

BPE level and category	Investigative BPE (any building)
Building parameters	optional
Occupant/user experience	optional
Post-construction review	optional
Energy use and generation	optional
Water use	optional
Internal conditioning monitoring	optional
External conditioning monitoring	optional
Building fabric performance	optional

The plan for a BPE project needs to include the basis for comparison of actual performance data with reference performance, selected according to the objectives of the study. Sources of such comparisons are referred to as comparator cases in this British Standard. Depending on the context for the study, this could include design or target performance specification, benchmark performance, previous performance of the same building (e.g. where the study is concerned with an upgraded building or tracking performance over time). BS EN ISO 7730 provides insight into common local discomfort factors and causes of occupant dissatisfaction which might also provide a basis for selecting comparator values for various performance attributes and for interpreting results. The choice of comparator(s) should be included in the project plan and is likely to inform the selection of study elements, e.g. if a performance specification of a new office building includes limits on background noise in an open plan space, this performance specification should be the main comparator chosen for the BPE study and the monitoring of background noise should be included as a key study element.

If the BPE project can be anticipated at an early strategic stage of the plan of works for delivering a new building or carrying out improvement works on a building, clients should take into account all necessary provisions for the study as early as possible in any construction project. By doing so, the timely installation of sensors and monitoring equipment can be included in the construction tender pack and the cooperation by members of the original design, construction and commissioning teams (often very valuable and time saving) can be made a requirement of the contract tender submissions.

Where the likely requirement for Investigative BPE can be anticipated, cost and delay can be minimized by allowing for this in the appointment and contractual arrangements made between the client and evaluator, and arrangements/agreements made with other key stakeholders whose involvement in such Investigative BPE might be required. It might also be prudent, when agreeing terms for a BPE contract to include a contingency sum to allow for Investigative BPE to be pursued without re-contracting.

Cohort Studies – BPE studies are often associated with multiple units or premises. These can be separate houses in a new build development or in a portfolio destined for upgrading, flats in a block, commercial units or offices in a retail development or tenanted office block. In such cases it might be appropriate for a proportion of individual units (a sample set) to be studied in some detail, with minimal information gathered on the remaining properties to enable the evaluator to judge whether conclusions from the sample are likely to be representative of the whole cohort. A minimum 10% (rounded up) of units should be studied to provide a useful basis for drawing such conclusions, however such a sample percentage is suggested as being practically achievable (against a background where very little is currently done to capture the performance of cohorts of buildings for any purpose), rather than statistically significant. For academically robust studies of multiple buildings, sample size should be determined using statistical methods. Where completion on a single site/scheme is phased, multiple BPE studies can be conducted covering successive phases with results feeding forward to inform the delivery of future phases. In such phased developments, early phases should include a higher proportion of sampled buildings to maximize the potential for feedforward and optimization.

Base buildings – In the case of buildings containing multiple separately serviced zones, dwellings and/or premises, the landlord might wish to evaluate the aspects of the building for which they are directly responsible (e.g. heating, lighting, maintenance). At the same time, it might not be feasible to gain data from the individually tenanted or leased areas. To accommodate such circumstances this British Standard provides for the evaluation of the base building, i.e. the building and all its shared services and common areas but excluding separately serviced and tenanted areas.

The evaluator shall prepare a plan for the BPE study, or, where such a plan has been proposed by the client, agree and accept such a plan as their own, having satisfied themselves of the appropriateness of that plan in accordance with this British Standard.

The BPE plan shall clearly set out:

- a) the purpose and objectives of the study;
- b) a description of the building(s) to be studied (e.g. construction, use, age, size), including the selection of sample buildings or premises in the case of cohort studies. Where completion on a single site/scheme is phased (i.e. handover for individual buildings occurs at various stages), multiple study periods shall be permitted for findings and learning, to be fed-forward into future phases. Where this occurs, the evaluator shall determine the proportion of sample buildings to be monitored at each phase;
- c) the level of BPE project to be carried out (see [Table 1](#) to [Table 4](#)), including relationship with any earlier study (e.g. Investigative BPE following Standard BPE project; Standard BPE project carried out post-upgrade following a pre-upgrade Light BPE study);
- d) the full scope of the study comprising:
 - 1) essential elements in accordance with the chosen BPE level, building type; and
 - 2) elements specific to the purpose and objectives of the study and the chosen comparator(s), which could include Investigative BPE elements;

NOTE Preliminary Evaluation elements, Light BPE elements and Standard BPE elements are specified in [Clause 5](#), and a helpful, but not exhaustive, toolbox of Investigative BPE elements is provided in [Annex A](#).

- e) metering and monitoring equipment required in addition to that already installed and accessible (including provision for the specification of this equipment); any calibration (or requirement to check calibration) of existing or third-party measurement or monitoring equipment (or such functions embedded in equipment, e.g. embedded energy metering of heat pumps and PV);
- f) the choice of comparator(s) and rationale for their selection;
- g) timescales and duration of the study allowing for data gathering, analysis and interpretation;
- h) the measured and derived performance data to be reported;
- i) the roles and necessary involvement of key parties, including supplying or providing access to premises, data and information; and
- j) confirmation of conformity to this British Standard claimed for the planned project.

The BPE project plan shall be agreed with the client and constitute acceptance by the client of their responsibilities, as set out in the BPE plan.

4.2 Conducting BPE projects

COMMENTARY ON 4.2

BPE projects can be carried out at any point during the “in-use” period of a building’s life. For a large commercial or multi-tenanted building, “in-use” status is typically considered to be achieved when occupancy levels reach 75% of the designed occupancy. However, this is not set as a requirement of this British Standard to allow flexibility in the applicability of the standard at the discretion of the evaluator. In such cases, the evaluator would take actual occupancy into account through all aspects of the study.

For a new or newly improved building, there is a trade-off between the time required to conduct building performance evaluation and time needed to allow the building and occupants (as an integrated system) to reach a stable operational state. It is also worth noting that the “as built” performance might differ from the “in-use” performance. Insights are therefore different if studying a building immediately following completion, compared with, e.g. a year after occupation.

Whilst monitoring periods for certain parameters are required to be at least twelve months long, there is no upper limit on their duration. Evaluators might therefore find it helpful to begin monitoring as soon as practical to gain maximum data, to note how raw data values change as a building settles down (if the building is new or recently refurbished) and, where relevant, dries out, occupants learn to use their building, and occupancy levels increase (e.g. in the case of a multi-tenanted commercial building with common areas). Any unexpected behaviour of the monitoring kit can also then be investigated prior to the start of the formal monitoring period, improving the quality of data gathered during the formal evaluation period. Equally, monitoring can be continued after the study period (subject to necessary consents) to provide reference data in the case of, e.g. future concerns, plant failures or, in anticipation of successive BPE studies, to track the performance of the building over time. Once sensors and monitoring equipment are installed it is often easier to leave them in place, provided they can be calibrated or calibration checked in situ.

The evaluator shall obtain the necessary data for all study elements included in the study plan (see [4.1](#)), including all essential elements for the selected BPE level.

NOTE See [Clause 5](#) for Preliminary Evaluation, Light BPE, Standard BPE and Investigative BPE elements. A toolbox of suggested elements is provided in [Annex A](#).

The evaluator shall note any concerns or potential issues with the monitoring period selected, e.g. due to any “settling-in”, breakdown or replacement of plant and equipment, periods of no or low occupancy, or any other factor that is likely to affect monitored parameter data, so that this can inform the interpretation of data.

4.3 Data naming and retention

COMMENTARY ON 4.3

A significant impediment to the usefulness of BPE project results is inconsistency in how data is labelled and stored. This inconsistency presents barriers when conducting repeat or follow-up studies on a specific building, e.g. to track performance over time or to evaluate the impact of interventions. It also causes problems when results are being compared against benchmarks and when results need to be brought together to capture performance across portfolios of properties.

A principle adopted in this British Standard is to ensure that raw data are captured, and derived performance data calculated, in ways that are consistent and repeatable, such that these data is not dependent on the nuances or preferential practices of individuals gathering or processing the data. Furthermore, this British Standard specifies that raw and derived data are stored in sufficiently consistent form to enable them to be revisited and reinterpreted, e.g. should a second opinion be sought, and to be used in subsequent studies on the same or similar buildings and in wider studies of anonymized aggregated data.

As BPE projects covered by this British Standard are conducted during the operational phase of a building's life-cycle, for buildings where BIM is used, BPE information and data should conform to [BS EN ISO 19650-3](#). Performance evaluation of an asset is identified in [BS EN ISO 19650-3](#) as an example trigger event for using that standard. File naming compatibility with [BS EN ISO 19650-3](#) is therefore incorporated into the requirements set out in this British Standard. For location of data points, BS EN ISO 4157 (all parts) provide a labelling for locations according to room and floor which is compatible with BIM. Evaluators using this British Standard are referred to the BS EN ISO 19650 series of standards on information management using building information modelling, where relevant.

Data gathered in the course of a BPE project is likely to include personal data and building data that might pose a commercial, security or privacy risk. BPE projects place the evaluator in the role of data controller and/or data processor, as defined under GDPR and thus the responsibilities under these regulations apply when collecting, processing and retaining data provided by individuals, e.g. occupant

survey data. Good practice in BPE studies includes ensuring appropriate consent is obtained at the planning stage to access necessary data, including surveying occupants and building users as well as accessing building data. [Annex B](#) contains informative guidance on providing information to occupants and obtaining their consent for involvement in a BPE study.

Key data pertaining to the physical and technical aspects of a building shall contain, as a minimum, the information listed in [Table 5](#), using the naming conventions included in the table.

Raw data shall be recorded and retained, using the naming and labelling conventions set out in [Table 5](#). Where data cleaning is required and/or interpolated data needs to be added to generate a usable data set, the augmented data files shall also be retained, suitably labelled.

Contextual information, such as location of collection point in the property being studied and the unique identification of the collection device (metadata) relating to a data series shall also be recorded in accordance with [Table 6](#).

NOTE 1 Contextual information is necessary to accommodate situations where measurement and monitoring devices are relocated, either around the same property, or in successive projects. Retaining unique identification of the device enables anomalies to be investigated that might arise from device malfunction or calibration error.

NOTE 2 Wherever possible, it is encouraged that data is stored in a format which is easily accessible, without the requirement for bespoke/expensive software, and follows the BIM ontology for expressing data points in a hierarchical manner based successively on building, floor or level, room and device. See BS EN ISO 4157 (all parts) for requirements for standard identification of levels/floors and rooms.

Where this British Standard specifies that values for derived performance parameters be produced, the basis for these derivations shall be provided, e.g. CO₂ emissions based on energy use for a particular fuel type and emissions factor for a particular year/location.

NOTE 3 Comparator case data can be normalized (typically, adjustment to allow for differences in external or internal environmental conditions or building size) to enable meaningful comparison with data gathered from the study building.

NOTE 4 Following BIM ontology [see BS EN ISO 4157 (all parts)] increasingly makes this straightforward as more buildings and BPE projects adopt standard BIM ontology.

NOTE 5 Data on specific aspects of an evaluation can be gathered by specialists working under the leadership of the evaluator. If data on specific aspects have been obtained separately from the evaluation project in accordance with relevant standards or accepted practice, the evaluator can, at their own discretion, use those data and information.

There is no requirement under this British Standard for data to be shared or lodged with any organization, however, where data is shared by the evaluator, an appropriate degree of anonymization shall be applied to protect personal confidentiality.

NOTE 6 For data concerning, e.g. a dwelling, the full address of the property need not be included; the first part of the post code and first number of the second part provide sufficient location definition.

Table 5 — *Specific reading point type name*

Metric	Sub-category	xxx = <device type>	yyyyyyyyyyyyyyyyyy = <point_type_name>
Temperature	Internal	Temperature sensor (TPS)	zone_air_temperature
	External	Weather station (WST)	air_temperature
Relative humidity	Internal	Humidity sensor (HMS)	zone_air_relative_humidity
	External	WST	air_relative_humidity
Radiant temperature (if applicable)	Internal	TPS	zone_radiant_temperature
Multiple / combined sensor device	Internal	Multi-sensor (MTS)	<i>as above based on relevant logging channel</i>
Interstitial moisture (if used)	Fabric	HMS	wall_relative_humidity
Carbon dioxide	Internal	CO ₂ sensor (CDS)	zone_air_co2_concentration
Precipitation	External	WST	precipitation
Wind speed (if used)	External	WST	wind_speed
Wind direction (if used)	External	WST	wind_direction
Total horizontal solar irradiance (if used)	External	WST	solar_irradiance
Total electricity consumption	Energy	Electricity meter (EM)	total_consumption_electricity
Renewable electricity self-consumption	Energy	EM	renewable_self_consumption
Renewable electricity generation	Energy	EM	renewable_generation_electricity
Electric vehicle consumption (if applicable)	Energy	EM	ev_consumption
Electricity export	Energy	EM	electricity_export
Gas consumption	Energy	Gas meter (GM)	total_consumption_gas
Heat consumption	Energy	Heat meter (HM)	total_consumption_heat
Renewable heat generation	Energy	HM	heat_generation
Water consumption	Water	WM	total_consumption_water

Table 6 — Reading metadata

Category	Required metadata
Property data	• Site/Project; • Address; • Postcode; • UPRN (unique property reference number); • MPAN (Meter Point Administration Number) (for any utility meter)
Location of data point	• Floor/level or unit where relevant, e.g. where a separable floor of a building or unit within a multi- premises building, such as an innovation or business centre is separately studied; • Room/zone (where relevant)
Device	• Manufacturer of device; • Model; • Serial number; • Accuracy of data captured provided by the device (from technical data sheet or calibration record); • Calibration date (most recent); Other device data can be added, if required.

NOTE 6 A structure in accordance with the naming and addition data in [Table 5](#) and [Table 6](#) should be used to collect, collate and store data and linked documents relating to a BPE project, ideally structured so that it can be viewed as either a spreadsheet, XML or IFC rendition.

NOTE 7 It is expected that such BPE information exchange will be most commonly viewed in spreadsheet rendition. XML and IFC renditions can be used to exchange information between software platforms.

4.4 Interpretation and reporting

COMMENTARY ON 4.4

The interpretation of data obtained from following the requirements for a Preliminary Evaluation, Light BPE, Standard BPE or Investigative BPE study requires knowledge and skill appropriate to the level of study being conducted. An important principle in specifying essential study elements for Light BPE and Standard BPE is to ensure that the evaluator can draw on a sufficiently broad range of parameter evidence in reaching conclusions, thus considering the performance of the building “in the round”, in addition to considering performance parameters individually. Even the simplest of buildings are complex systems of interacting and interdependent factors, where interventions targeted at addressing one aspect (e.g. improved thermal insulation), also impact other aspects (e.g. air tightness and hence indoor air quality, moisture and internal acoustics).

This subclause provides requirements for the content of BPE reports to give providers and clients of BPE studies a basis for commissioning and providing BPE studies. A degree of consistency amongst reports enables readers to navigate reports easily when they have been produced by different evaluators and/or for different building studies. A further requirement ensures that links to raw data are preserved should it be necessary to revisit these.

When considering the potential causes of any performance gap between the performance obtained through applying the requirements of this British Standard and the predicted performance, deviations arising from the modelling approach used [e.g. standard assessment procedure (SAP), reduced standard assessment procedure (RdSAP)], materials and components which might differ from those specified, as well as the actual construction and set up of a building and its systems and the way occupants have been using the building should be taken into account.

Finally, without consistency in reporting, the adoption of BPE projects as a reliable means to verify performance could be impeded, hence creating a barrier to their adoption into regulation or performance-based contracts.

For cohort studies, the evaluator is seeking to establish the likely performance of properties included in the cohort but not individually evaluated. Some premises or units (at least 10% of the total and referred to as sample properties) will be subject to evaluation as if they were individual properties and therefore can be reported on individually, if desired. Additionally, a skilled evaluator takes into account the similarities and differences in social, physical and technical aspects, and in evidenced performance, amongst the sample properties and the more limited data gathered on the remainder of the cohort to reach conclusions regarding the likely performance of all properties across the cohort as a whole. Such projects are useful to provide a good indication that properties in the cohort are performing as intended or expected, or to flag potential systemic problems.

The evaluator shall interpret the data on a parameter by parameter basis, taking into account cross impacts of building and systems attributes (including occupant factors) to evaluate the performance of the study building(s) or premises “in the round” and in pursuit of the purpose and objectives of the study.

The BPE report shall include, as a minimum:

- a) project title;
- b) unique building/premises identifier (multiple in the case of cohort studies);
- c) period of study;
- d) evaluator identity;
- e) evaluator contact details and credentials;

NOTE 1 Where the study relies heavily on additional specialists (e.g. scientists specializing in the fabric behaviour related to moisture content) such specialists can also be named in the study. However, responsibility for conformity to this British Standard, including custody of raw data rests with the evaluator.

- f) objectives or purpose of the study and its place in any larger project, such as if included in a project following the *RIBA plan of works* [4], *Soft Landings Framework* [2] or [BS 8536](#). In the case of Investigative BPE, the report shall describe any specific hypothesis being tested;
- g) reference to previous studies on the target building or cohort, where relevant;
- h) reference to, or inclusion of, the BPE project plan and any departures from the plan, including reasons, implications for the data and information gathered and the quality and reliability of the conclusions reached;
- i) the BPE study elements in the project, including, as a minimum, all the elements listed in this British Standard as necessary for the level of study being carried out, e.g. Preliminary Evaluation, Light BPE or Standard BPE, specific to the building type and use;
- j) any additional study elements that the evaluator and client have agreed, specific to the purpose or objectives of the study (including elements from the Investigative BPE toolbox) or to map to parameters available for the chosen comparator(s) and notable omissions and reasons for not including, e.g. if acoustics were not part of the study scope but known to be significant in similar contexts;
- k) qualitative and quantitative performance parameters for all evaluation study elements, including derived parameters, as listed in [Table 7](#);

NOTE 2 For time-series data, only the total or averages (over useful periods) and/or derived parameter values should be included explicitly in the BPE report, with full raw data files held separately and referenced in the report. Other numerical values such as peak can also be reported, as appropriate.

- l) comparator descriptions and comparator parameter values used in the course of the evaluation of the building(s)'s performance, including the design specification, where available, and any regulatory limits;

NOTE 3 These comparators should already have been set out as part of the BPE plan but are explicitly included in the BPE report as they are crucial to understanding the interpretation made by the evaluator.

- m) side by side comparison of gathered and comparator performance parameter data;

NOTE 4 Comparator data can be normalized, if required, to enable like for like comparison with study building data.

- n) interpretation of data and conclusions, referring to noted points, such as building plant failure, low occupancy, during the evaluation period;

Where BPE studies include incomplete or atypical data at some stage during the required minimum 12-month data collection period, this shall be explained clearly in the evaluation report, including the evaluator's assessment of any impact on the confidence in the findings.

- o) further study recommended to enable the originally stated project objectives to be met, or to investigate matters arising from the reported study; and
- p) the type of conformity claimed, which shall be one of the following:
- 1) level of BPE study conducted: Preliminary Evaluation, Light BPE, or Standard BPE and/or any Investigative BPE (where this is included within, or separately following, a PE, Light or Standard Evaluation); and
 - 2) type of study conducted, i.e. individual building or premises, cohort of buildings or premises, and/or a full building or base-building study.

Table 7 — Qualitative and quantitative performance parameters

BPE evaluation element		Minimum reporting requirements
Building Parameters	Building type, location, description and purpose	Building typology as well as its primary and other purposes. Location of the building, either by postcode or longitude and latitude. General description of the building including age, condition, ownership, etc.
	Floor area	Internal floor area (in m ²) in accordance with the relevant IPMS standard: Retail Buildings [N1]; Office Buildings [N2]; Industrial Buildings [N3]; Residential buildings [N4]) and other floor areas (i.e. net floor area, treated floor area, etc.) as used in any comparators.
	Floor plan	Scale drawing of floor plan(s).
	Building occupancy	Number of occupants and occupancy profile (design). Where it can be ascertained (and is required), actual number of occupants and occupancy profile. <i>NOTE Specific requirements exist for domestic and non-domestic buildings.</i>

Table 7 — Qualitative and quantitative performance parameters (continued)

BPE evaluation element		Minimum reporting requirements
	Attachment, orientation and construction (description)	Description of any building attachment including party wall construction (where available) and type of adjacent building. Main façade orientation with respect to north. Construction – description of each element, including materials, thicknesses, and design u-values, where available.
	Building services (description)	Description of building services including: space heating, hot water, cold water, other heating requirements, lighting, ventilation, micro-generation and renewable energy technologies, electric vehicle charging points, cooling and air conditioning, connection to communal or district services, solar shading devices, metering systems and devices, and other buildings services (i.e. storage, lifts, catering equipment).
	Energy Performance Certificate	Copy of EPC provided in the report Annex (where available).
	Display Energy Certificate	Copy of DEC provided in the report Annex (where available).
	Design targets (all where available and relevant)	Design targets, benchmarks or other comparators (e.g. modelled values or Building Regulations minimum values) used in the evaluation – these shall be presented alongside each measured value.
Occupant/user experience	Occupant comfort, satisfaction, wellbeing, needs and usability assessment	Summary of findings, including any issues raised, likely causes, and any proposed Investigative BPE. Quantitative scores for each question (study mean and percentiles) by user type, area of building (if relevant). Narrative summary of freeform feedback. Comparison with survey benchmarks.
	Building / facility manager assessment (where present)	Summary of findings, including any issues raised, likely causes, and any proposed Investigative BPE.
Post Construction Review	Air permeability test (review or conduct)	m³/m²/hr measurement for the whole building(s). Test standard utilized (e.g. CIBSE TM23 [5], ATTMA TSL1 [6] or TSL2 [7]) and test conditions including; temporary sealing or any elements, equipment used, treatment of adjacent properties, and internal and external conditions during the survey. <i>NOTE Where blower door testing is conducted as part of the BPE project on individual dwellings, air permeability at 50Pa is to be reported in pressurization and depressurization.</i>

Table 7 — Qualitative and quantitative performance parameters (continued)

BPE evaluation element		Minimum reporting requirements
	Design construction and maintenance review:	Summary of findings, including any issues raised, likely causes, and any proposed Investigative BPE.
	commissioning and servicing review	Confirmation of services commissioned and those not commissioned. Indication of any potential issues with commissioning records or processes (e.g. elemental commissioning rather than system commissioning).
	Design construction and maintenance review:	Summary of findings, including any issues raised, likely causes, and any proposed Investigative BPE. Conformity with ISO/TS 19488 shall be confirmed for buildings used for domestic purposes.
	acoustics and soundscape review	Testing procedures used, relevant standards used, and review of results. Indication of any acoustics testing (Investigative BPE) that is recommended (also linked to occupant/user experience and building walkthrough findings).
	Design construction and maintenance review:	Summary of findings, including any issues raised, likely causes, and any proposed Investigative BPE.
	handover, induction and user experience review	Report processes used, highlighting any material or methods that might lead to poor occupant experience or building operability.
	Design construction and maintenance review:	Summary of findings, including any issues raised, likely causes, and any proposed Investigative BPE.
	maintenance information and procedures review	Presence of: asset register; maintenance information; maintenance regime in accordance with BS 8210 (see also SFG20 [8], CIBSE Guide M [9], BSRIA Building Maintenance guides [10]), or similar (non-domestic buildings only), planned annual review of systems and processes and building logbook and/or operating and maintenance (O&M) manuals.
	Design construction and maintenance review:	Provide overview in report and include relevant details compiled in appendices.
	design, construction, procurement and delivery details	
	Building walkthrough	Written report and photographic evidence of the building in operation during building walkthrough. <i>NOTE 3 See Annex C and Annex D for guidance on conducting walkthrough surveys.</i>
	Controls review	Controls review on individual control systems. Identification of any recommendations for Investigative BPE.
		Interrogation of a basic management system (BMS) (where present) and its key settings. Out of hours survey for any building with a BMS including assessment of base-load consumption.

Table 7 — Qualitative and quantitative performance parameters (continued)

BPE evaluation element		Minimum reporting requirements
	Thermal imaging survey (winter)	Infrared images (including temperature scale) alongside digital images. Description of detail surveyed and narrative of findings. Marked up site plan showing location of thermal images, highlighting specific areas of concern determined by the evaluator. Conditions 24 h prior to and during survey including (but not limited to); time of survey; internal and external air temperature; wind speed; cloud cover; solar irradiance; and precipitation. Surveys in accordance with BS EN 13187 (see also BG39 [11], BG72 [12], or BRE 176 [13]).
Energy use and generation	Annual meter readings	Energy use intensity, kWh/m²/year (for each energy resource). Total consumption or generation (kWh/yr) and breakdown for each resource and end use where sub-metering or multiple meters are installed. Where internal temperatures are not measured (i.e. for Preliminary Evaluation or screened buildings in a cohort study), correlation of energy consumption for space heating and external temperature i.e. using monthly degree days. Where internal temperatures are measured, further correlation of energy consumption for space heating and average delta temperature: indoor minus outdoor temperature (i.e. kWh/ΔT/year). Derivation of associated carbon emissions, kgCO₂/year, for each building and energy resource. List all conversion factors where used. Confirmation of meter calibration. Raw data to be provided in a suitable format.
	Consumption and generation monitoring	As annual meter readings, including further analysis (where relevant) of; base load(s), peak load(s), power density (W/m²), out of hours consumption, consumption and generation profiles (in relevant time periods i.e. daily, monthly, etc.), correlation between environmental and internal conditions and consumption, correlation between utilities where relevant (i.e. solar generation and mains electricity import), correlation between occupancy and consumption, and identification of potential issues with systems, services, etc. Raw data to be provided in a suitable format. <i>NOTE 4 CIBSE TM22 [14] and DomEARM [15] are recommended tools for producing energy end use analysis for non-domestic and domestic buildings respectively.</i>

Table 7 — Qualitative and quantitative performance parameters (continued)

BPE evaluation element		Minimum reporting requirements
Water use	Annual meter readings	Annual consumption (m ³ /yr) and equivalent normalized consumption (litres/person/day). Other metrics to enable direct comparison with chosen comparators. Raw data to be provided in a suitable format.
	Temperature and relative humidity	Average, maximum, minimum, and interquartile ranges (i.e. 25% and 75% percentiles) of monthly temperature and relative humidity. Calculation of overheating risk in accordance with CIBSE TM52 [N5] and TM59 [N6]. Calculation of humidity risk in accordance with Building Regulations Approved Document F (England and Wales) [N7], [N8], Building Standards Technical Handbook, section 3.15 (Non-domestic or domestic) (Scotland) [N9], Building Regulations Technical Booklet part K (Northern Ireland) [N10]. Confirmation of sensor calibration.
Internal condition monitoring	Carbon dioxide	Average, maximum, minimum, and interquartile ranges (i.e. 25% and 75% percentiles) of monthly carbon dioxide levels. Confirmation of sensor calibration.
	Existing sources (temperature and relative humidity)	Average, maximum, minimum and interquartile ranges (i.e. 25% and 75% percentiles) of monthly external temperature and relative humidity.
External condition monitoring	On-site temperature and relative humidity	Assessment of whether the monitored period is atypical (e.g. unusually cool, hot or wet) and the impact on other variables. Raw data to be provided. Confirmation of source of external data, distance from project site and stated accuracy.
	Investigative BPE	Various
Investigative BPE	Various	Evaluator to list buildings/elements tested, test methods, test conditions, equipment used, results and comparators for each individual Investigative BPE method implemented.

4.5 Evaluator responsibility and claiming conformity

COMMENTARY ON 4.5

In the absence of formal accreditation/qualification for building performance evaluators, the position adopted in this British Standard is that evaluators should be competent in the evaluation of the performance of buildings “in the round”. Evaluators should have the knowledge and analytical skills to interpret test, monitoring and other data gathered for individual performance parameters and to take into account the cross impact and potential for unintended consequences of factors affecting performance. Evaluators should also have the ability to discern when specific data gathering and analysis is beyond the scope of their individual competencies and be able to identify suitable specialists to support the study, whilst retaining overall responsibility for the delivery of the BPE project.

The evaluator should be skilled in planning and directing BPE projects and identifying cross correlations amongst performance parameters, knowledgeable in the probable root causes of anomalies in performance and, especially in the case of Investigative BPE projects, in developing and testing hypotheses.

Evaluators are likely to hold one or more of the following professional registrations:

- a) Chartered Engineer (CEng) – member or fellow of a Professional Engineering institution [e.g. Chartered Institution of Building Services Engineers (CIBSE), The Institution of Civil Engineers (ICE), The Institution of Mechanical Engineers (IMechE), Institution of Engineering and Technology (IET), The Institution of Structural Engineers (IStructE), Institute of Acoustics (IoA), Chartered Association of Building Engineers (CABE)];*
- b) Chartered Member of The Royal Institute of British Architects (RIBA) or architect registered by the Architects Registration Board (ARB);*
- c) Chartered Architectural Technologist (MCiAT);*
- d) Professional Member of the Chartered Institute of Building (MCIOB);*
- e) Chartered Building Surveyor (MRICS or FRICS); and/or*
- f) Incorporated Engineer (IEng) or Eng Tech.*

In PAS 2035 and PAS 2038, a qualified retrofit coordinator is considered to be suitably qualified to conduct the performance evaluation called for in accordance with the relevant PAS. The qualification of retrofit coordinator, on its own, does not indicate that the holder has sufficient knowledge and skills to conduct BPE in accordance with this British Standard. However, it is quite likely that some retrofit coordinators will also have the necessary knowledge, skill and expertise to carry out some or all types of BPE projects.

Clients commissioning building performance evaluation are advised to determine the suitability of the evaluator (supported by their extended team, if appropriate) to lead the specific study by taking into account their professional qualifications, experience in the field of BPE and previous work, and to seek and follow-up references prior to appointment. Clients are also advised to check the potential for actual or perceived conflict of interest on the part of the evaluator, arising, e.g. as a result of prior association with the design or delivery of the study building or association with any key stakeholder body.

The independence of an evaluator from the building design and delivery team or from other stakeholders warrants careful consideration. There is merit in an evaluator being closely associated with the building's design and delivery (for a new build or upgrade) to enable learning from the evaluation study to be fed directly into the design and delivery process for future buildings. Equally, complete independence and impartiality of the evaluator might be essential in other circumstances, such as where complaints have been raised about the performance of a building or delivery of contractual obligations need to be confirmed.

Where members of a building design or delivery team undertake subsequent BPE work on their own construction projects, this should be carried out under a new contract, and that the scope of the study should align with and not extend beyond the original design requirements/criteria/targets as set out in the construction project brief. Evaluators intending to carry out such BPE projects are advised to inform their insurers of the BPE plan ahead of its execution.

4.5.1 General

The building performance evaluator shall take overall responsibility for carrying out BPE studies in accordance with this British Standard.

Consistent with the codes of conduct adopted by most professional institutions, an evaluator shall not seek to operate outside their own competency but can engage specialists in specific evaluation areas