Building Performance Evaluation in Non-Domestic Buildings

A guide to effective learning

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I  INTRODUCTION

Despite genuine intentions to develop efficient buildings, the construction industry is still missing the mark. Recent research from academia and industry has shown that buildings do not always perform in the way that was originally intended. This results in inefficiencies in energy performance, and occupant dissatisfaction.

This guide is intended to support the industry by explaining how to use Building Performance Evaluation (BPE) to address these issues. It is a general introduction to BPE, and explains why it is important and how it can be carried out. It is aimed at clients, designers, developers, constructors and facilities managers to improve their understanding about BPE and how they can benefit from it.

BPE is the process of evaluating how a building performs and can be carried out on both new and existing buildings. The scope of BPE will vary depending on the depth of the evaluation undertaken and is influenced by the building or project size, complexity, construction stage, time, access and budget constraints. BPE integrates into the BSRIA Soft Landings process (described later in this guide) to help deliver a building that meets the performances as expected and deliver an effective and efficient building.

This guide discusses some of the tests and methods that can be included when reviewing building performance, to provide information on:

- building fabric
- building services and operating strategies
- energy use
- handover and commissioning processes
- occupant satisfaction
- occupant comfort conditions.

BPE aims to inform those involved in the design, construction, operation and/or management of a building about the current performance. It can help deliver a building that operates as the designers intended or can help improve the performance of an existing building.

This guide focuses on new, existing and refurbished non-domestic buildings. The tools and methods deployed to carry out BPE studies in domestic and non-domestic buildings are similar. However, the scope of a BPE study is affected by the type of building, who the findings and recommendations are relevant to, who can take action on recommendations and how factors such as user expectations and perceptions are used.
The following factors must be considered when structuring a BPE study:

- Management of building services – In non-domestic buildings there is generally a dedicated role, either through a facilities manager or an agency, that is responsible for operating and maintaining the main building services providing space heating, cooling, hot water, lighting and ventilation etc.

- Nature of occupancy – The occupancy patterns within non-domestic buildings are likely to vary in density, duration and schedule over time.

- Comfort and controls – The conditions within these buildings are generally expected to meet the comfort requirements for a number of people, and the controls may be managed by area zones and/or centrally.

- Indoor air quality – Non-domestic buildings may have a high (and varying) occupancy and could accommodate specialist activities for which specific criteria for indoor air quality need to be met.

Specific considerations around BPE in domestic buildings is discussed in BG 64/2015[1].
THE NEED FOR BUILDING PERFORMANCE EVALUATION

The gap between actual and expected performance of buildings being experienced continues to be an issue. A contributing factor is that construction teams are not involved in operation and they get limited feedback from the occupiers. BPE can play a vital role in facilitating this feedback and helping to close this gap.

The terms “POE” and “BPE” are sometimes used together and there is often confusion between what the scope of each is. Post-occupancy evaluation (POE) constitutes the activities of the BPE process once the building is occupied and in use, focusing on the operational performance and the occupants using the building. It is important to know to what extent the building maintains its occupants' satisfaction and perceived comfort. To do this in a systematic and structured way, post-occupancy evaluation (POE) can be employed as a major part of BPE. This would involve collecting feedback (soft data) from the occupants through survey questionnaires, interviews and/or workshops, ideally at least one year after building occupation to cover at least one seasonal cycle.

Figure 1 shows that physical and technical data should also be used to support and validate the soft data. This can include:

- information about the resource consumption (energy, fuel, water) of the overall building and, where possible, a breakdown of where these resources are being consumed.
- information on the indoor environmental quality (IEQ) which can be evaluated by measuring temperatures, humidity, CO₂, and pollutant levels, light and glare levels, noise, and other factors that would impact the comfort and wellbeing of users within a space.

![Figure 1: POE activities and methods](image-url)

- Physical environment (e.g. air quality, temperature, lighting, outside view)
- Use of space (e.g. layout, spaciousness, privacy, storage)
- Indoor facilities (e.g. WCs, showers, kitchens, restaurant, recycling)
- Air quality
- Lighting
- Noise
- Thermal comfort

**IEQ**
- Data loggers
- Sensors
- Were the design assumptions correct?

**Operational performance**
- Energy use
- Maintenance
- Water use
- Waste

**POE**
- Supplier’s data
- Sub-meters
- BMS
- Utility bills
- Walkthrough
- Observation
- Questionnaires
- Interview
- Do the users understand their building's operational set points?

**Occupant satisfaction**
- What is the users’ perception about their building environment?
TEST METHODS

4.1 BUILDING FABRIC: AIRTIGHTNESS TESTING

Airtightness testing (also known as air leakage testing, air pressure testing or air permeability testing) evaluates the rate of air infiltration through the entire building envelope. This is generally expressed in terms of the volume of air that escapes through the building fabric, and gives an understanding of uncontrolled heat losses that would take place. The test involves using a fan (or set of fans) to pressurise (and ideally depressurise) a building, and measuring the air flow rate required to maintain a pressure differential of an average of 50 Pascals.

Airtightness testing to specified standards must be carried out in all new buildings to demonstrate compliance with the Building Regulations. However, the test can be used to carry out a more detailed investigation of the building fabric and also in existing buildings.

Test methods and standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
</table>

For large commercial buildings, a diesel-powered fan may be required to pressurise the building for the test. Access considerations are important in situations such as these.

Testing programme

- The building airtightness test should be carried out by a tester registered with ATTMA (The Air Tightness Testing and Measurement Association) or accredited by UKAS.
- Testing should be carried out in accordance with the relevant standard.
- Pre-test: All mechanical ventilation openings should be sealed. Smoke extracts should not be sealed. All internal doors should be wedged open.
- During test: All exterior doors and windows must be kept closed during the actual pressurisation tests. Tests usually last for about 1 hour.
- Further information on the test regime can be found in the relevant standard.
Occupant surveys provide evidence on critical factors to inform building design and facilities management about the perceived satisfaction of occupants within buildings. These would typically include perceptions of comfort, wellbeing and internal conditions, and effectiveness of controls and facilities management.

Established and managed surveys are commercially available and may require a licence for use. Bespoke surveys can also be developed to address the specific objectives of the study.

Surveys may be paper or web-based, as the context and conditions at the time of response may be recorded for the former, while the latter is generally preferable for a large sample (>200).

### Test methods and standards

<table>
<thead>
<tr>
<th>Building Use Studies (BUS) methodology</th>
<th>Commercially-available occupant survey method developed and managed by the Usable Building Trust and ARUP.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leesman® leesmanindex.com</td>
<td>Confidential, on-line survey for measuring employee effectiveness created and operated by Leesman.</td>
</tr>
</tbody>
</table>

**Testing programme**

The following considerations should be made while devising and carrying out a survey, irrespective of the method used:

- The objectives of the study should be determined along with the targeted respondents and sample size.
- There should be clear understanding of the methodology to be used for analysis of responses.
- All people in authority as well as the building owners or tenants should be informed and their permission sought prior to carrying out the survey.

Typical range of information that can be captured in surveys (overlaid over BUS template)
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