

BPN Response to BS40101 Consultation 2021 – Final Submission 7th September 2021

This document is a draft response from the Building Performance Network (BPN) to the BS40101 Building Performance Evaluation Consultation Draft Document.

As an overview we would draw members attention to the following key changes we are suggesting to the above BPE framework:

- BPN recommends an initial 'In-Use BPE Screening' for the BS40101 which is *disaggregated* from the current BS40101 Post-Construction Review and Monitoring BPE stages. We believe that BPE should be a genuine drill-down process, rather than a one size fits all approach.
- The current 100% requirement for buildings to be sampled within a housing development should be replaced with a 10% sample that is more manageable and that allows a greater depth of initial screening to make the results more diagnostic. We have added in CO₂ measurement in the main bedroom, as well as separate measurement of hot water and space heating, as elements that are essential in relation to verifying indoor air quality by proxy and to enable greater understanding of energy use in the building.
- The findings and recommendations from the initial screening stage should be used to inform a second stage *Investigative* study, where needed, ensuring that only those BPE methods that are needed, are utilised.
- The recommendations from the screening study should be followed through using a new Decision Tree/Triage process incorporated within new guidance associated with the Standard that would identify appropriate BPE investigative pathways to be followed.
- The *Early Occupancy*, *Post-Construction* and *In-use Monitoring* stages should be replaced by a single *Investigative* stage that can run either in parallel with the initial *Screening* stage or after it, depending on the knowledge already available to the client and design team arising from the design and build process, and the intentions arising from this. We believe this simplifies the BPE process and also allows any early occupancy studies to be carried out as optional additional *investigative* elements in addition to the initial screening process.
- We recognise that this response from BPN mainly addresses new build housing, and that an appropriate response for a wide range of retrofit scenarios needs to be developed, both for domestic and non-domestic buildings.
- We also recognise that a more nuanced approach is needed for non-domestic buildings, which is beyond the scope of this response.

Our current proposal for an alternative initial BS40101 In-use screening BPE requirement is:

1. Measure total kWh energy consumption, generation & export from meters including PV and electric vehicles; this should be split into different fuels, where the project is not all-electric. Disaggregate thermal energy uses or thermal demand from the total via separate measurement using heat meters. Disaggregate electrical energy used in heat pumps.
2. Measure CO2 levels in homes in the main bedroom (to be regulated in homes - as per Scottish Building regs since 2015) and other key spaces in non-domestic buildings e.g. sample meeting rooms in offices, sample classrooms in schools.
3. Measure external temperature from a local weather station, internal temperature and humidity levels in key sample spaces - e.g. in homes, minimum of 2 sensors (main bedroom and living room). See sampling notes below.
4. BUS type occupant questionnaire to provide a 'why' to the 'what' of measurements above – *[include a question about whether occupants are opening/ closing windows/doors or using additional heating/cooling devices]* - sent to all occupants of a housing development or building project.
5. Calculations: overall CO2 emissions, actual energy demand vs comparator and, where available, a performance design model from the design stage (normalised for internal, external temperature, and where available other factors such as occupancy, hot water, small power, equipment etc ; and including confidence levels), heating system efficiency (including confidence levels), overheating v comparator, CO2 v comparator, humidity v comparator, using dwelling energy model assumptions and a certified calculation methodology (not covered by BS). I + statement that key comparator = performance objectives for the project
6. Initial review of commissioning activities and comparison of results against comparator
7. Review of airtightness testing results, and comparison against design targets and other comparators, as applicable
8. Review of total annual water consumption, and comparison against applicable comparators (e.g. for homes, Building Regulations limit)

Sampling: In homes, a minimum 10% sample of homes above 10 homes, monitored over a minimum 12 month period – [indicative, not exhaustive, monitoring to verify that the performance is as expected on a statistically significant number of homes]. This sample should reflect higher risk properties and be reflective of production over the full time period. For small developers, where development is less than 10 homes, the requirement would still be 10%, but of 10 homes as built over a period of time. In non-domestic buildings, spaces representing the main use of the building and a representative floor area e.g. 1 classroom in a school, 1 floor plate in a multi-tenanted office building. The sampling rationale and proportion of floor area should be reported along with the results.

There are 24 recommendations/comments from BPN below. We are aware, however, that there may well be a need for more, and to disaggregate domestic BPE approaches from non-domestic BPE approaches within particular sections of the BS40101.

Please note this detailed table mirrors the Word Template provided by the BSi as an alternative to filling in boxes online.

BPN comments on document: BS40101 Public Consultation

No	Comment submitted by	Clause./ Subclause/ Annex	Para/Fig/ Table/Note	Type of comment	Comment (justification for change)	Proposed change	Editorial comments (NAME)	Committee decision
1	BPN FS	4.2.1	Paragraph 8	Tech	The current draft assumes a need to progress directly from the In-use Screening stage mandatory methods to the In-Use Review stage mandatory methods. This is overly onerous for industry, and unlikely to be widely adopted. The BPN recommends that a more relevant approach would be to adopt a 'drill down' approach, where BPE issues are investigated only as identified from the mandatory Screening stage. This effectively disaggregates the Review stage and its methods from the Screening stage.	Replace: with The BPE plan shall clearly identify the minimum BPE Screening to be done at the In-Use stage, with a route map to be devised for any necessary further Review based on the outcomes of the Screening, according to the Decision Trees specified in this Standard at X.X.X		
2	BPN FS	4.2.1	Paragraph 10	Tech	It flows from making the Review BPE methods conditional on the results of the suggested 'Minimum Screening', that this text also needs to be changed to reflect that only the suggested 'minimum in-use screening' needs to be planned for at RIBA Stage 0 via the initial BPE Plan.	Replace:. with The initial BPE plan shall identify the buildings to be studied at the initial in-use screening level including: a) monitoring periods; b) methods to be deployed and on which particular buildings; c) the comparator(s) (primarily the design intent or specification where relevant and any regulatory requirements) against which the performance of the study building(s) shall be assessed; and d) the roles and necessary involvement of key parties.		
3	BPN FS	4.2.1	Paragraph following Note 6, and including Note 7	Tech	Rewording is needed for these paragraphs to align the Review Study with a Decision Tree process developed after the initial In-Use Screening results have identified issues, which the Review Study should address. The	Replace: With For the Review Study BPE the evaluator shall prepare a plan for the study based on the findings		

					Investigative Study level is thus no longer needed.	<p>from the initial In-use Screening BPE study, with reference to any information that is available from the study building(s) at that time. The plan shall set out their investigative strategy, including:</p> <p>a) the hypotheses to be tested in order to establish the root cause of the identified performance discrepancies and/or such specific additional information being sought over and above that covered by the In-Use BPE Screening study (e.g. to study a particular factor more intensively, such as the presence of interstitial condensation);</p> <p>b) the approach they propose to take; and</p> <p>c) the tests they intend to use and any requirements of third-party involvement or information.</p> <p>NOTE 7 Where the likely requirement for A Review BPE study can be anticipated beyond the Initial Screening study , cost and delay may be minimized by allowing for this in the appointment and contractual arrangements made between the client and evaluator, and arrangements/agreements with other key stakeholders whose involvement in such a Review BPE study might be required. It might also be prudent, when agreeing terms for a BPE contract to include a contingency sum to allow for some further BPE to be pursued without recontracting.</p>		
4	BPN FS	4.2.2	Commentary on 4.2.2	Tech	It flows from our suggested changes to 4.4.1 and the replacement of the Investigative Study with a Review Study (based on the identified issues from the new Initial Screening BPE	<p>Replace commentary on 4.2.2</p> <p>With</p>		

					<p>study we propose) that the wording to this clause also has to change to make sense with the new 4.4.1 we proposed. We are basically suggesting just two levels of investigation - Screening and Review, whereby the Review study is effectively an Investigative study that goes as deep as it needs to, depending on the results from the Screening.</p>	<p>Two types of BPE study are as follows:</p> <p>a) In-Use BPE Screening: carried out over a twelve-month period, at any time during the life of the building, provided the building is occupied and/or operational; and</p> <p>b) Review BPE: carried out subsequent to In-Use BPE Screening as necessary.</p> <p>For both types, the screening study may be on an individual building (or separable portion thereof, such as a floor of an office block or a business unit in a retail or innovation centre), or be a sampled buildings/portions within a cohort of similar buildings. In the case of a cohort of buildings the minimum number of buildings that require full studies is set out in section 4.2.2.</p>		
5	BPE FS	4.2.2	Fig 1	Tech	<p>We think that Figure 1 - BPE Schematic needs to be reworked to reflect the framework process and method changes we have proposed. In particular, we believe the Screening process should only be carried out on a sample of houses within a development rather than 100%, for the housing industry to be able to cope with BPE and to capture the minimum sample necessary to establish overall performance of any given development. We also believe that the Post Construction Review study <i>should be optional</i>, and only arise if the findings from the Screening study warrant a further more investigative BPE study as Post Construction Review. The Post Construction Review methods would also be optional, dependent on a Decision Tree approach arising from the findings of the In-Use Screening. The Investigative BPE stage disappears altogether as it is subsumed within the Post Construction Review strategy.</p>	<p>We propose that the Figure 1 BPE Schematic diagram is greatly simplified, removing the Investigative stage and consisting of just two Stages with the following methods:</p> <p>In_use BPE screening:</p> <ol style="list-style-type: none"> 1. Measure total kWh energy consumption, generation & export from meters including PV and electric vehicles; this should be split into different fuels, where the project is not all-electric. Disaggregate thermal energy uses or thermal demand from the total via separate measurement using heat meters. Disaggregate electrical energy used in heat pumps. 2. Measure CO2 levels in homes in main bedroom (to be regulated in homes - as per Scottish Building regs since 2015) and other key spaces e.g. sample meeting rooms in offices, sample classrooms in schools. 		

					<p>We have proposed seven core BPE methods and measurements for the new BPE In-Use Screening, including the installation of a meter to separately and specifically measure the energy used for hot water, so that the occupant, client etc can really understand what energy is being used for what and discriminate between energy used for space heating, hot water and other energy use.</p>	<ol style="list-style-type: none"> 3. Measure external temperature from local weather station, internal temperature and humidity levels in key sample spaces - e.g. in homes, minimum of 2 sensors (main bedroom and living room). See sampling notes below. 4. BUS type occupant questionnaire to provide a 'why' to the 'what' of measurements above sent to all occupants – [include a question about whether occupants are opening/closing windows/doors or using additional heating/cooling devices] 5. Calculations: overall CO2 emissions, actual energy demand vs comparator and, where available, a performance design model from the design stage (normalised for internal, external temperature, and where available other factors such as occupancy, hot water, small power, equipment etc ; and including confidence levels), heating system efficiency (including confidence levels), overheating v comparator, CO2 v comparator, humidity v comparator, using dwelling energy model assumptions and a certified calculation methodology (not covered by BS). I + statement that key comparator = performance objectives for the project 6. Initial review of commissioning activities and comparison of results against comparator 7. Review of airtightness testing results, and comparison against design target and other comparators, as applicable 8. Review of total annual water consumption, and comparison against applicable comparators (e.g. for homes, Building Regulations limit) <p>Sampling: In homes, a minimum 10% sample of homes above 10 homes, monitored over a minimum 12 month period – [indicative, not</p>	
--	--	--	--	--	---	---	--

						<p>exhaustive, monitoring to verify that the performance is as expected on a statistically significant number of homes]. This sample should reflect higher risk properties and be reflective of production over the full time period. For small developments, less than 10 homes, 10% applied over multiple small developments or 10% of 10 homes as built over a period of time. In non-domestic buildings, spaces representing the main use of the building and a representative floor area e.g. 1 classroom in a school, 1 floor plate in a multi-tenanted office building. The sampling rationale and proportion of floor area should be reported along with the results.</p> <p>Post Construction Review: All methods listed in Figure 1 apart from 6.3.2, 6.3.4, which move to the In-use BPE screening under 6.2. Section 6.3 is merged with 5.3 to form a single box which contains all the Post Constructive Review BPE methods that are not already contained in the new In-Use Screening set of methods we propose. This new Post-Construction Review replaces Section 7 Investigative BPE and is based on Decision Tree routes identified from the outcomes of the In-use BPE Screening, which set out which of these methods to use, or other more investigative methods beyond the BS40101.</p> <p>Early Occupation BPE methods in 5.2 are moved to 5.3 as optional methods, used as necessary following In-Use screening findings and any recommendations for further BPE.</p>		
6	BPN FS	4.2.3	Whole section	Tech	The Early-occupation BPE should be combined with the In-Use Screening BPE to form an initial BPE In-use study. The In-Use 12 month screening is the critical evaluation	We would remove section 4.2.3 and focus only on the BPE In-use screening for newly constructed or significant retrofit schemes, with any subsequent methods of investigation as currently set out in		

					needed for the BS40101. Developers and builders can choose to add early occupation screening methods as an optional item on top of the core In-use BPE Screening methods.	Section 5.3 and 6.3 and not already covered in our proposed new In-Use BPE screening 8 step process. The choice of any additional methods would be dependent on a Decision Tree process to be developed by the BS40101, based on the outcomes of the In-Use BPE screening.		
7	BPN FS	4.2.4	Whole section following Note 2 paragraph	Tech	This change flows from the previous changes suggested above, by combining the Post-Construction Review and Monitoring into a single, simplified 'light touch' BPE In-use study which identifies any further BPE required. It also amends the screening sampling for homes to just 10%.	Replace 4.2.4 wording following NOTE 2 paragraph With In-Use BPE comprises: a) A BPE In-use study conducted on 10% of homes or 75% of non-domestic buildings in a cohort, at least nine months following first occupation of buildings that are newly completed, or re-occupation following significant construction works; and b) carried out within the 12-month In-Use Test and Monitoring study period. b) In-use BPE methods as described in Section 4.2.2. c) Identification from the BPE findings of any recommended further BPE investigation to be carried out as set out in Section 4.2.5.		
8	BPN FS	4.2.5	Whole Section	Tech	Having established that a new 'light touch' BPE In-use Screening set of methods should be deployed on a sample of buildings, we propose that such a study should readily identify in its findings any further investigative BPE work required, using a series of Decision Trees which map issues identified against investigative methods to address those issues. We therefore propose amending this section to reflect the need to link outcomes from the In-use BPE study with identified	Replace: With COMMENTARY ON 4.2.5 Investigative BPE can be conducted at any time, either following the identification of issues and raising of questions or concerns as a result of an In-Use BPE study. The BPE In-use study should clearly identify, using a Decision Tree method,		

					<p>investigative BPE routes for addressing any issues identified.</p>	<p>which further BPE methods should be used to investigate the issues identified.</p> <p>NOTE 1 Certain types of building, building uses or retrofit works aimed at improving performance might stimulate additional study elements, e.g. testing for interstitial moisture content following the retrofitting of external or internal insulation. BS 5250 provides particular guidance in respect of moisture in buildings.</p> <p>NOTE 2 Investigative BPE can include tests, monitoring and surveys used in the In-Use BPE study and/or other investigative techniques, as appropriate.</p> <p>Investigative BPE is designed to further the understanding of the building(s)' performance obtained via the In-Use BPE study and shall:</p> <ul style="list-style-type: none"> a) identify the root cause(s) of unexplained performance discrepancies identified in the In-use BPE study; b) inform recommendations for resolution/remediation applicable to the study building(s); c) inform the design, construction and operation of future buildings; and d) provide clients and other stakeholders with information on and a better understanding of the performance of the study building(s) in respect of performance parameters not explicitly covered by the In-Use BPE study and enable these to be considered alongside elemental results of standard In-Use studies, such that the complete, augmented study results can be interpreted in the round by the evaluator. 		
--	--	--	--	--	---	--	--	--

9	BPN FS	4.2.6	Whole Section	Tech	<p>We believe that the sample rates suggested in Table 1 are not appropriate for housing developments as they overly penalise small developers. We suggest a single blanket figure of 10% sample for all housing developments above 10 homes and a single dwelling sample for 1- 10 homes as developed in one year or over a period fo time for small developers. . We believe a separate table needs to be developed for non-domestic buildings, based on the type of building involved.</p>	<p>Replace: 4.2.6 section</p> <p style="text-align: center;">With</p> <p>Where sampling is required, the sampling ratio shall be a minimum of 10% for all housing developments above 10 homes. For site of less than 10 homes per year, and a single dwelling sample for 1- 10 homes as built over a year or a longer period of time (up to 2 years). A separate table of spaces to be evaluated needs to be developed for non-domestic buildings, based on the type of building involved.</p> <p>Determination of the sampling rate and the particular building(s) included in the sample shall be included in the BPE plan. The sampling rate shall be used to determine the minimum number of non-domestic buildings that are required for sampling and/or the minimum number of comparable rooms within any sampled non-domestic building to be monitored for In-Use Test and Monitoring.</p> <p>NOTE 1 The sampling rates presented for housing are the minimum sampling rates for conformity to this British Standard. This does not constitute statistically significant sampling, therefore BPE performance can only be determined for those buildings subject to sampling and results are not conclusive with regards to the performance of all buildings in a cohort. Where a statistically significant sample is required, the sampling rate should be calculated according to statistical science.</p>		
10	BPN FS	5	Whole Section	Tech	<p>We believe this section should be deleted in its entirety with early occupation BPE left to the discretion of clients, builders and developers. The important point for the BS40101 is to drive up performance levels by demonstrating key performance indicators that can be verified</p>	<p>Omit entire section and merge with Investigative BPE - all outlines of methods in this section to be described under <i>optional</i> BPE methods based on Decision Tree process, apart from those described</p>		

					<p>against the original design intentions at the most basic level of SAP for housing and equivalent for non-domestic. This shifts the choice of additional measures needed to drive up performance onto industry, as supported by BPE evaluators. Anything beyond these initial indicators should be optional depending on previous diagnostics or forthcoming diagnostics arising from the proposed new BPE In-use Screening process and subsequent Decision Tree process developed from the findings of the Screening process..</p>	<p>in the new BPE In-use Screening methods proposed here.</p>		
11	BPN FS	6.1	Whole section	Tech	<p>We propose a new In-Use BPE Screening process with 8 steps, and that any subsequent investigation is based logically on the outcomes of that process using a Decision Tree route with any identified methods that are appropriate for that route, set out as part of the Decision Tree route to be adopted. We would omit the Early- Occupation BPE as making this BS standard overly complex. We believe the sampling should obtain additional intelligence by factoring in those buildings of higher risk as a sensitivity factor.</p> <p>This proposed change would necessitate the rewriting of each subsection within Section 6.1 to change each method specified from compulsory (via the Monitoring or Post-Construction Review) to optional depending on the outcomes and recommendations from the new BPE In-use Screening study.</p>	<p>Replace:</p> <p style="text-align: center;">With</p> <p>6.1 General</p> <p>The In-Use BPE Screening process shall be applied to a sample of homes and buildings in a cohort, followed up by a Decision Tree route established from the results of this process, and appropriate methods identified for this route.</p> <p>To account for seasonal variation in external environmental conditions and to a lesser extent, on the way buildings are used, time series performance data or monitoring shall be collected over, as a minimum, 12 months (one year).</p> <p>NOTE 1 Such a period should allow the building to experience all typical weather and time of year conditions, enabling internal environment (e.g. as affected by solar gain) and the performance of energy technology (e.g. heating systems, PV generation, heat pump CoP, solar thermal) to be captured at their least and most effective. It also captures variation in usage which, in some circumstances, e.g. schools and educational establishments, might be significant.</p>		

						<p>NOTE 2 The evaluator should be mindful that the sampled year could be atypical and this should be accounted for in the analysis, e.g. internal temperatures that are close to the top of comfort ranges in a cool year are more likely to exceed those conditions and lead to overheating in a typical or warm year</p> <p>NOTE 3 In instances where wet trades or additional construction moisture has been a feature of construction works, the 12-month period allows time for the building fabric to stabilize and therefore be representative of the building's long-term performance. However, it should be noted that drying within the fabric can, depending on circumstances, exceed 12-months and the evaluator should make note of this where they consider it impacts the raw data captured. Circumstances likely to mean that drying or the achievement of equilibrium moisture states for elements will be prolonged, include:</p> <ul style="list-style-type: none">a) thick walls;b) more porous and permeable substrates;c) more exposed locations;d) north facing or shaded elevations; ande) especially extensive use of wet trades, including processes which include wetting down to improve adherence (needed for some renders). <p>If these factors are a feature of a significant and/or valuable project/building, this could be a trigger for investigative BPE level interstitial moisture measurement from the outset of the BPE process</p> <p>Where completion on a single site/scheme is phased (i.e. handover for individual buildings occurs at various stages), multiple different periods of In-Use BPE shall be permitted for findings and learning to be fed-forward into future</p>		
--	--	--	--	--	--	--	--	--

						<p>phases. Where this occurs, the evaluator shall determine the proportion of sample buildings to be monitored at each phase.</p> <p>NOTE 4 It is recommended that early phases include a higher proportion of sampled buildings to maximize the potential for feedback and optimization. However, there may be reasons for focussing attention on later phases (e.g. due to differences in building geometry that are more representative of the whole development).</p> <p>NOTE 5 It is recommended that the sample buildings contain those deemed to be of higher risk e.g in relation to factors such as overheating.</p>		
12	BPN FS	6.2.1	Whole Section	Tech	<p>We would replace the current In-Use Screening with a more in depth 7 step process carried out on fewer buildings, for reasons explained in above sections.</p>	<p>Replace: 6.2.1 section</p> <p style="text-align: center;">With</p> <p>6.2.1 General</p> <p>BPE In-Use screening shall consist of:</p> <ol style="list-style-type: none"> 1 Measure total kWh energy consumption, generation & export from meters including PV and electric vehicles; this should be split into different fuels, where the project is not all-electric. Disaggregate thermal energy uses or thermal demand from the total via separate measurement using heat meters. Disaggregate electrical energy used in heat pumps. 2. Measure CO2 levels in homes in main bedroom (to be regulated in homes - as per Scottish Building regs since 2015) and other key spaces e.g. sample meeting rooms in offices, sample classrooms in schools. 3. Measure external temperature from local weather station, internal temperature and humidity 		

						<p>levels in key sample spaces - e.g. in homes, minimum of 2 sensors (main bedroom and living room). See sampling notes below.</p> <p>4. BUS type occupant questionnaire to provide a 'why' to the 'what' of measurements above sent to all occupants – [include a question about whether occupants are opening/ closing windows/doors or using additional heating/cooling devices]</p> <p>5. Calculations: overall CO2 emissions, actual energy demand vs comparator and, where available, a performance design model from the design stage (normalised for internal, external temperature, and where available other factors such as occupancy, hot water, small power, equipment etc ; and including confidence levels), heating system efficiency (including confidence levels), overheating v comparator, CO2 v comparator, humidity v comparator, using dwelling energy model assumptions and a certified calculation methodology (not covered by BS). I + statement that key comparator = performance objectives for the project</p> <p>6. Initial review of commissioning activities and comparison of results against comparator</p> <p>7. Review of airtightness testing results, and comparison against design target and other comparators, as applicable</p> <p>8. Review of total annual water consumption, and comparison against applicable comparators (e.g. for homes, Building Regulations limit)</p> <p>Sampling: In homes, a minimum 10% sample of homes above 10 homes, monitored over a minimum 12 month period – [indicative, not exhaustive, monitoring to verify that the performance is as expected on a statistically significant number of homes]. This sample should reflect higher risk properties and be reflective of production over the full time</p>		
--	--	--	--	--	--	--	--	--

					<p>period. For small developers, where development is less than 10 homes, the requirement would be 10% of 10 homes as built over a period of time. In non-domestic buildings, spaces representing the main use of the building and a representative floor area e.g. 1 classroom in a school, 1 floor plate in a multi-tenanted office building. The sampling rationale and proportion of floor area should be reported along with the results.</p> <p>In-use screening shall be implemented on all sampled buildings within a cohort. The screening survey shall be conducted during the 12-month In-Use BPE monitoring period and shall occur no earlier than nine months after occupation/operation of the building(s).</p> <p>There shall be a minimum nine month settling in period before undertaking the occupant survey to ensure that the building has had time to stabilize following occupation or re- occupation, the occupants have experienced a representative range of operating conditions (including winter and summer) and operation and management procedures have been established. The results from the screening process shall not be used to draw conclusions regarding the performance of those screened buildings at any other BPE level. Screening results shall be used by the evaluator to:</p> <ul style="list-style-type: none"> a) recommend additional performance evaluation on individual or all buildings where it is determined necessary by the evaluator (undertaken at the discretion of the client, designers, funders, occupants or other stakeholders); b) identify outliers in a cohort of buildings; and c) compare the screening results for all buildings to assess whether buildings in the sampled 		
--	--	--	--	--	---	--	--

						subset are representative of all buildings in the cohort.		
13	BPN FS	6.2.2	Whole section	Tech	<p>The occupant comfort, satisfaction, wellbeing needs and usability survey should include an element of usability related to whether occupants actually operate doors and windows for ventilation and whether they use additional devices for heating or cooling. These elements have been added to the questionnaire survey in order to understand crucially, if occupants are adding an energy load or if they are adjusting their comfort levels using energy passive means, such as windows and doors.</p>	<p>Replace: 6.2.2. section</p> <p>With</p> <p>6.2.2 Occupant comfort, satisfaction, wellbeing, needs and usability survey</p> <p>An occupant survey shall be issued to at least one adult occupant from each sampled domestic building and to all sampled permanent staff and occupants in non-domestic buildings and to all sampled permanent residents in supported or communal living environments (e.g. care homes, student residences) noting that in some circumstances residents with reduced faculties might be less able to complete a survey, but they might rarely leave the building and it could be even more critical to meet their needs. In buildings where people are typically resident for less than six months, e.g. hospitals, hotels, these shall not be considered permanent residents.</p> <p>NOTE 1 Many other non-domestic buildings have transient occupants/users including, e.g. shops, leisure centres, restaurants, transport hubs, libraries, museums. Transient users of these types of buildings shall be surveyed using the same methods as permanent occupants, noting the type of user in each case to enable collated experiences of each user type to be considered separately, in addition to considering the collective experience of all users. The response rate shall be reported by the evaluator, including any cross section of building users that did or did not respond.</p>		

					<p>For a new-build or retrofit, the occupant survey shall be conducted no earlier than nine months after handover or initial (re)occupancy, thereby encompassing both winter and summer periods. For an existing building being evaluated, as long as the building has been occupied for more than nine months, the survey shall be conducted at any time.</p> <p>NOTE 2 It is advisable that the survey is not conducted during extreme weather conditions (i.e. external temperatures below 5 °C or above 25 °C) as responses might be disproportionately skewed, negatively or positively, by the prevailing conditions.</p> <p>NOTE 3 It is beneficial to evaluate any prior in-use test and monitoring data (i.e. energy consumption, internal environmental quality) and the results of building walkthroughs before reviewing the occupant survey responses to enable greater insight into the building performance to be derived from this process.</p> <p>As a minimum, the survey shall ask for occupant feedback on all of the following performance characteristics (for both domestic and non-domestic buildings), in accordance with Table 2.</p> <p>Occupancy Number of occupants</p> <p>Satisfaction Space</p> <p>Layout Storage Security Appearance</p> <p>Perceived productivity</p> <p>Design</p> <p>Meeting needs Overall</p> <p>Special circumstances (written response) Domestic only: per room, including as a minimum:</p>	
--	--	--	--	--	--	--

						<p>kitchen, living room, bedrooms, and bathroom/toilet.</p> <p>Perceived impact on health and wellbeing in the building.</p> <p>Overall perception of well-being in the building.c)</p> <p>Comfort and indoor air quality Winter comfort – overall</p> <p>Winter thermal comfort – temperature Winter thermal comfort – stability Winter indoor air quality – humidity Winter indoor air quality – air movement Winter indoor air quality – odours</p> <p>Summer comfort – overall</p> <p>Summer thermal comfort – temperature Summer thermal comfort – stability Summer indoor air quality – humidity Summer indoor air quality – air movement Summer indoor air quality – odours</p> <p>Presence of condensation (yes, no, location) Presence of mould (yes, no, location)</p> <p>Sound From inside (i.e. between rooms and adjacent spaces)</p> <p>From services</p> <p>From adjoining buildings From outside</p> <p>Lighting Daylight: glare view out</p>		
--	--	--	--	--	--	---	--	--

						<p>Overall daylight quality Electric light</p> <p>Perceived control over Heating Cooling Ventilation</p> <p>Lighting Noise</p> <p>Utility costs Electricity, including</p> <p>standing charges</p> <p>Occupant use of windows and doors</p> <p>Occupant use of additional cooling devices</p> <p>Occupant use of additional heating devices</p> <p>A) For non-domestic buildings this is determined by the evaluator</p> <p>B) Where work or learning is conducted in the building.</p> <p>C) The Warwick Edinburgh Mental Well-being Scale (SWEMWBS) [10] and Office for National Statistics (ONS) four personal wellbeing questions [11] are both examples of nationally recognised approaches for assessing well-being via survey. The ONS method also includes recent baseline data for subgroups at local, regional and national level.</p> <p>NOTE This list of characteristics is not exhaustive and other performance characteristics may be included i.e. handover and induction process, facilities for laundry, performance of services including internet, satellite tv, mobile phone signal, productivity etc. The evaluator, client, funder, designers (or others) may determine the additional performance characteristics to be surveyed. However, the performance characteristics included here are intended to provide consistent</p>		
--	--	--	--	--	--	---	--	--

						<p>and comparable feedback of occupant comfort and satisfaction between projects or pre- and post-retrofit.</p> <p>Unless otherwise stated, survey questions shall be scored on a Likert scale to enable quantification of performance and comparison (by the evaluator) between buildings and sites.</p> <p>The survey and questions shall be:</p> <ul style="list-style-type: none"> a) developed by or with validation from social scientist(s); b) non-leading; c) non-biased; d) facilitate benchmarking; and e) include space for written responses (open commentary) on each question category <p>NOTE 4 This British Standard does not prescribe any one particular method, nor does it prohibit the generation of new methods. Existing surveying methods can be utilized provided they meet all of a) to e). Additions to those methods might be required. The Building Use Studies (BUS) survey [12] is commonly regarded as the benchmark for surveying in non-domestic and domestic buildings (www.busmethodology.org) and, with some minor additions, meets the criteria of this British Standard. The Centre for the Built Environment (CBE, University of California) occupant survey (https://cbe.berkeley.edu/resources/occupant-survey/) [13] and BSRIA's Building Occupant Wellbeing (BOW) survey [14] are also established methods for non-domestic buildings. The Nabers rating system [15], now available in the UK also refers to the Building Occupants Survey System Australia (BOSSA, The University of Sydney and the University of Technology) as an option for occupant surveying in non-domestic buildings</p>	
--	--	--	--	--	--	--	--

						(www.bossasystem.com). Additionally, existing standards often outline appropriate questions for surveying occupants with respect to specific performance characteristics; BS EN 16798-1 outlines appropriate questions for assessing thermal comfort in occupied buildings; ISO/TS 15666 presents a standardized question for the assessment of noise annoyance; PD ISO/TS 12913-2:2018, Annex C presents questions for collecting data on how people perceive an acoustic environment in context; BS 5250:2011+A1:2016, Annex C includes a list of information required from occupants to help with the assessment of moisture risks.		
14	BPN FS	6.2.3	Whole Section	Tech	<p>We have aligned this section with previous sections which now show our suggested BPE In-Use Screening 7 step process, based on a smaller sample than is currently the case, to facilitate an affordable BPE that is more in depth than the current screening process, and allows an intelligent diagnosis via a Decision Tree based on outcomes of the screening process, to establish what further BPE methods and process might be needed, using optional additional methods. We believe it is important to disaggregate space heating and hot water energy use from overall energy use - hence the requirement to install heat meters where necessary.</p>	<p>Replace: 6.2.3</p> <p>With</p> <p>6.2.3 Start and end meter readings</p> <p>Start and end meter readings shall be taken for <i>sample</i> buildings within a cohort. These readings shall be taken over the same period as the In-Use monitoring.</p> <p>NOTE 1 Where a development is phased and multiple in-use test and monitoring periods are utilized, the study can be broken down into multiple cohorts of buildings constructed in the same phase with each cohort being treated as a separate study. For example, in a phased housing development where terraced homes are completed in phase 1 and multi-storey residential blocks are completed in phase 2, two in-use test and monitoring periods may be applied. In this instance, the screening process could also be conducted in two periods, one for the terraced homes and one for the multi-residential blocks (overlapping with the respective in- use test and monitoring periods).</p>		

						<p>Meter readings of all main utilities (electricity, gas, heat and other heating fuels, e.g. biomass, oil, LPG and water), sub-meters, electrical export, electrical generation (for renewables), and non-building consumption meters (e.g. electric vehicle charging points) shall be taken. The evaluator shall associate each meter to each building and relevant end uses for presenting results. This shall include the use of heat meters to establish the hot water and space heating element of energy use, as necessary.</p> <p>Where metering measurements are collected centrally [i.e. via a BMS or Energy Management System (EMS)], main utility meter readings shall be recorded directly and sub- meters shall be physically checked wherever issues are identified as part of the reconciliation exercise.</p> <p>NOTE 2 The metering strategy should always be considered during the design phase to accommodate and facilitate BPE measurement. This is covered by the Approved Document Part L [16] and/or CIBSE TM39 [17] but might require supplementary metering to meet the objectives of the BPE. The BPE plan developed by the evaluator is a critical element to identify and agree the specific strategy for meter reading in each project.</p>		
15	BPN FS	6.2.4	Whole section	Tech	<p>As with other methods, we believe only a 10% sample of homes should be subject to screening process, not all. We also need to see carbon dioxide levels measured in principle bedrooms as proxy for IAQ - as per Scottish Building Regulations 2015. We suggest that external temperatures could be obtained from local weather stations.</p>	<p>Replace: 6.2.4</p> <p>With</p> <p>6.2.4 Internal and external temperatures, carbon dioxide and relative humidity monitoring</p> <p>Internal and external temperatures (°C), carbon dioxide and relative humidity levels (%) shall be monitored on a sample of buildings subject to the screening process (i.e. the sample of buildings in</p>		

						<p>any cohort in accordance with this British Standard).</p> <p>Monitoring of screened buildings shall be over a 12-month period and shall be conducted in accordance with the temperature and relative humidity requirements in 6.3.4.</p> <p>External environmental condition monitoring shall be conducted in accordance with 6.3.5.</p>		
16	BPN FS	6.3.1	First two paras	Tech	<p>We have amended the first two paragraphs to reflect our recommendation that the In-Use Screening process informs the choice of specific methods shown in the Post-Construction Review and Monitoring processes as part of a second stage Investigative study. The choice of methods to be used should be arrived at through a Decision Tree methodology based strictly on the outcome and recommendations arising from the first stage Screening process, and should not simply be applied wholesale.</p>	<p>Replace: 6.3.1 first two paragraphs</p> <p>With</p> <p>6.3.1 General</p> <p>Specified In-Use test and monitoring, as identified from the outcomes and recommendations from the In-use BPE Screening process, shall be conducted on a number of properties or spaces, (see 4.2.6) and be conducted over a relevant period as determined by the building performance evaluator, commencing at any point from first occupancy or reoccupancy of a building following significant construction works (including from handover where works are completed with residents in-situ). The start and end dates of the monitoring period and the time since occupancy, handover shall be reported by the evaluator.</p> <p>In-Use test and monitoring shall include a range of performance measurement techniques and methods in accordance with this subclause.</p>		

17	BPN FS	6.3.2.5	First and 4th para	Tech	There are amendments here which take account of the new proposed Screening and triage process.	<p>Replace 1st and 4th paragraph of 6.3.2.5 Gas and/or heat consumption</p> <p style="text-align: center;">with</p> <p>Where gas and/or heat is supplied to a building is subject to additional In-Use test and monitoring, total consumption shall be metered from the mains utility meter(s) and secondary meter(s) where installed. This shall be done directly (i.e. via physical meter readings or half-hourly smart meter data) or via secondary monitoring and data logging devices (i.e. optical meter reading or pulse output logging). The measurement shall be in kWh.</p> <p>Good practice for building performance evaluation would include separate metering for space heating, hot water, and cooking consumption (and any other significant gas loads, i.e. a swimming pool); where available, these metered values shall be monitored and reported individually. It is essential that separating metering is supplied for housing to account for hot water and space heating in the In-use BPE Screening study.</p>		
18	BPN FS	6.3.4	First second, and 11th para	Tech	We believe that for the In-Use BPE Screening process, only two sensors are necessary - master bedroom and living room, and that only air temperature is needed not radiant temperature as well for the BPE In-Use Screening process. . The kitchen area is too volatile for a sensor to be meaningful. Other additional monitoring can be advised on through a Decision Tree process based on the outcome and recommendations of the Screening process.	<p>Replace first, second and 11th paragraph of 6.3.4</p> <p style="text-align: center;">With</p> <p>IAQ shall be monitored and analysed throughout the 12-month monitoring period, as characterized by the three metrics:</p> <p>a) air temperature (°C);</p> <p>c) relative humidity (%); and</p> <p>d) carbon dioxide concentration (ppm).</p>		

						<p>The evaluator shall analyse all the measured data (including the other elements of the In-Use BPE Screening Process) to advise on the need for any additional monitoring through further Investigative BPE techniques.</p> <p>For domestic buildings, internal temperature and relative humidity shall be measured in the living room and main bedroom (as a minimum). CO2 concentration shall be measured in the main bedroom (as a minimum).</p>		
19	BPN FS	Section 7	Whole section	Tech	<p>We propose the removal of the compulsory Post-construction and In-Use Monitoring sample stage and to replace these with a second Investigative BPE stage determined by the Screening outcomes and, resulting in a simple two stage BPE process: a) screening b) investigative. This necessitates a number of suggested changes to Section 7</p>	<p>7 Investigative BPE</p> <p>Replace</p> <p>With</p> <p>COMMENTARY ON CLAUSE 7</p> <p>Investigative BPE is covered under this standard as a set of actions to provide detailed and comprehensive understanding of the root cause(s) for deviation of actual performance from the comparator case(s) or to investigate factors arising out of the In-Use BPE Screening Study. elements. It is typically led by an evaluator with a high level of expertise who determines the investigative strategy as a result of the outcomes and recommendations from the In-Use BPE study.</p> <p>Where investigative BPE follows an In-use BPE Screening study,, the evaluator for the investigative BPE need not be the same individual.</p> <p>Where the Investigative BPE is an enhancement of the In-Use BPE Screening study itself,, one evaluator shall take responsibility for the combined</p>		

					<p>project. In all cases, evaluators shall not operate outside of their areas of competence.</p> <p>NOTE 2 This British Standard does not outline the specific situations where investigative BPE is to be conducted as this will depend on the outcomes of the BPE In-use Screening study. The evaluator(s) determines the need for investigative BPE and recommends the appropriate investigative measures, following a BS decision tree process, which are then agreed by the client. This can be done very early in the project if the focus of an enhanced investigative BPE is already known, e.g. at RIBA stage 0. Consideration should be given to the appropriate independence of the evaluator from the team delivering the construction project and from any other stakeholder.</p> <p>Whilst there is merit in a construction delivery team self-evaluating to improve understanding and future projects, any perceived potential or actual conflict of interest should be carefully considered when appointing or directing any type of BPE study.</p> <p>NOTE 3 Investigative BPE may include specific additional tests and invasive inspections; deliberately varying the target performance, e.g. internal environment, ventilation rates, to explore the operating envelope of the building systems; and other investigations to test hypotheses for performance discrepancy.</p> <p>In some cases, an evaluator carrying out an In-Use BPE Screening Study might uncover urgent performance concerns and, based on their experience and with the explicit agreement of the client, could immediately carry out Investigative BPE in respect of these issues; in such cases, the evaluator shall report this Investigative BPE activity setting out their investigative strategy, the tools and techniques deployed and reporting the findings.</p>		
--	--	--	--	--	--	--	--

						<p>NOTE 4 The evaluator, design team, client and other stakeholders may determine remedial action throughout the BPE process, based on the findings presented by the In-use BPE Screening study and/or subsequent Investigative study. The process for remediation is outside the scope of this British Standard. However, this British Standard can be used pre- and post-remediation (as it might be pre- and post-retrofit) to determine the effectiveness of the remediation.</p> <p>Where tests, measurement and monitoring methods are used in an Investigative BPE, the evaluator shall conduct investigations using techniques in accordance with this British Standard and in the BPE toolkit [19], wherever possible, augmenting with additional tests and investigations as required.</p> <p>All tests and measurements and monitoring activities shall follow relevant standards, good practice, or operating procedures, where these are available.</p> <p>The Investigative BPE study shall be reported in accordance with Clause 9.</p>		
20	BPN FS	Section 9	Whole section	Tech	<p>We believe the simplified BS should consist of just two levels 'In-Use BPE Screening Study' followed by an 'Investigative Study' where deemed necessary from the findings of the Screening study. As such the references in section 9 to 'Early Occupation' should be removed and all reporting requirements should refer initially to the BPE In-use Screening process with recommendations for any Investigative studies following a Decision Tree process set out by the BS.</p>	<p>Remove all reference to 'Early Occupation'</p> <p>Table 5 to be amended to address only the newly proposed In-Use BPE Screening study methods. These methods should be carried out 12 months after initial occupation, to allow the building and users to settle down.</p> <p>A separate bespoke report will be required for a subsequent Investigative Study carried out. This can refer to any of the other method reporting listed in Section 9, as necessary.</p>		

21	BPN FS	9.3	Main text (not notes)	Tech	<p>We believe the reporting here is too complex and that a single initial report should be produced for the In-use BPE Screening Study, based on the sampling, with additional Investigative reporting only if necessary.</p>	<p>Replace 9.3 main text (not notes) with</p> <p>9.3 Reporting cohort studies</p> <p>For cohort studies one cohort report shall be produced for the BPE study type (In-Use). Additionally, an individual BPE report shall be prepared where necessary for any subsequent Investigative Studies, or Investigative Studies carried out at the same time as the BPE In-Use Screening study.</p> <p>For cohort reports on sample buildings within a cohort study, the evaluation shall draw on and reference anonymized data for all buildings within the cohort, where available.</p> <p>The report shall include the evaluator's reasoned judgement of the performance of the body of sampled building(s) with reference to the comparator(s) and the extent to which the sampled building(s) are judged to be representative of the cohort (where applicable).</p> <p>Results from a sample of properties in a cohort shall not be used to determine definitively the performance of the whole cohort or the performance of other individual buildings on that or other schemes.</p> <p>The evaluator shall provide their judgement on the likely root cause(s) of any performance deviation and whether they judge these to be single building issues or likely to be systemic across the cohort.</p> <p>The evaluator shall also make recommendations for any further performance evaluation (e.g. Investigative BPE).</p>		
----	--------	-----	-----------------------	------	---	---	--	--

22	BPN FS	9.4	Whole section	Tech	This section would need to be amended to remove reference to 'Early Occupation' as any early findings from the 'In-Use BPE Screening Study' would replace these (e.g. early occupant survey or early monitoring results).	Remove all reference to Early Occupation or Early Occupation BPE.		
23	BPN FS	Annex C	Whole Table C.1	Tech	This table needs to be amended to take account of the new two stage structure proposed (In-Use BPE Screening Study, and Investigative Study) .	Restructure Table C.1 to reflect a new two stage BPE process as outlined above. Omit any reference to Early Occupation Screening, Post-Construction Review and In-Use Test and Monitoring. Add all methods needed for proposed new In-Use BPE Screening Study into this section and the rest into 'Investigative BPE'.		
24	BPN FS	Annex D	Whole pro-forma	Tech	This Early occupation survey is omitted in the new proposed structure, and is replaced by the 'In-Use BPE Screening Study' survey equivalent, which can be carried out early on. This avoids residents having to carry out two surveys on one BPE study which is seen as overkill, particularly if they will already be subject to other required housing satisfaction surveys or building satisfaction surveys.	Replace Early Occupation survey pro-forma with In-Use BPE Screening Study survey pro-forma.		