
PAS2035:2019
Retrofit Design
Guidance

1 Foreword

The following text provides guidance to assist the preparation of Retrofit Designs and corresponding documentation, to help comply with the requirements of PAS2035:2019+A1:2022.

This document has been prepared by ecmk in consultation with Trustmark and other scheme providers including Elmhurst Energy, The Installation Assurance Authority (The IAA) and Quidos Ltd.

This document is broken down into sections covering all areas of the design, with each section including notes on evidence requirements where relevant.

Contents

1 Foreword 2
2 Overview – Property Specific Designs 3
3 Preliminaries 3
3.1 Retrofit Designer Qualifications (Ref PAS2035:2019 Annex A Qualifications) 3
3.2 Relevant Guidance 3
3.3 Assessment information 3
3.4 Retrofit Coordinator Role 3
4 Scope of the Design 3
4.1 Property-Specific Designs 3
4.2 PAS2035 Energy Efficiency Measure (EEM) Compliant Design 4
4.2.1 EEM Specific Design Requirements 4
4.3 EEM Measure-specific Maintenance Requirements 4
4.4 EEM Technical Standards 4
4.5 Intended Outcomes 4
5 U-Values Overridden 5
6 Property Condition 5
7 Planning Conditions 5
8 Product – Installation, Operations and Maintenance Manuals 5
9 Constraints and Exposure Assessment 5
10 Physical Interaction Between Measures 6
11 Ventilation Strategy Ref PAS2035:2019+A1:2022 Annex C and Approved Document F 6
11.1 Property-Specific Ventilation Strategy 6
11.2 IAA Background Ventilation Assessment of Existing Buildings 6
11.3 Ventilation Assessment and Upgrade Evidence Notes 8
12 Moisture Management 8
13 Fire Safety 8
14 Thermal Bridges 8
15 Sequence of Installation 8
16 Pre-installation Building Inspection 8
17 Testing and Commissioning 9
18 Handover 9
19 Revisions 9
20 References 10

2 Overview – Property Specific Designs

Each design and all corresponding documents shall be prepared to be specific to each individual property. As such, all documentation shall include the property address within the header or at the start of the content of each document.

In cases where non-property-specific documentary evidence is included as part of the design, e.g.:

- Thermal bridge prevention design details (from best practice or system designer guidance)
  Note – *only relevant thermal bridge details should be copied from such guidance – not the whole document uploaded e.g. Zero Carbon Hub Thermal Bridging Guide* ;
- Best practice installation guidance e.g. BEIS guidance documents;
- Energy Efficiency Measure (EEM) product specification details.

It is recognized that documents such as the above form an integral part of the design, for them to be property-specific, and these should be saved with the main design document as a single pdf document. This can be quickly and efficiently achieved using online software such as iLovePDF | Online PDF tools for PDF lovers.

All designs shall document the following where relevant:

3 Preliminaries

3.1 Retrofit Designer Qualifications (Ref PAS2035:2019 Annex A Qualifications)

The designer and their relevant experience and qualifications shall be detailed in accordance with the relevant Risk Path and EEM's being installed. Please refer to PAS2035:2019 Annex A for a summary of qualification requirements.

3.2 Relevant Guidance

The design shall confirm the relevant sections within PAS2035 that have been used as guidance and confirm that a "fabric first" approach is being followed where relevant.

E.g. This retrofit design has considered the guidance in Sections 4 & 5 of PAS2035:2019 and has aimed to accomplish the 'fabric first' approach to retrofit. A risk-based and priority-based approach has also been considered. After the most practical insulation and airtightness measures have been installed, building services and Low and zero-carbon technologies (LZC) have been considered.

3.3 Assessment information

Confirmation that the information captured for the property during the PAS Assessment, Preinstallation Building Inspection (PIBI), Pre-Design Survey, and any other technical assessments is sufficient to allow for the preparation of the design.

3.4 Retrofit Coordinator Role

Confirmation that the Improvement Option Evaluation, Medium Term Plan, and any modelling required shall be prepared by the Retrofit Coordinator.

4 Scope of the Design

The scope of design shall confirm that this has been agreed with the Retrofit Coordinator and that the measures proposed have been selected to achieve the Proposed Intended Outcomes, which are in line with the relevant energy grant scheme and its objectives where relevant. This shall include details of the package of EEMs proposed for the dwelling, including materials, products, processes, and relevant standards.

4.1 Property-Specific Designs

As for all design documents, the Scope of Design document and any documentary evidence shall be specific to each individual property.

4.2 PAS2035 Energy Efficiency Measure (EEM) Compliant Design

Details of the PAS2035 compliant design for each EEM shall confirm that the measure shall be installed in line with the guidance set out in:

- Each relevant Measure-specific Annex in PAS2030;
- Specific System Designer's installation guidance and Agrément Certificate specifications;
- Any relevant standards or best practice documents;
- All relevant building regulations.

4.2.1 EEM Specific Design Requirements

Table 1. below, outlines key EEM-specific design requirements to be uploaded with design documentation.

Energy Efficiency Measures / EEM-Specific Design Requirements	CWI	Loft Insulation	UFI	Flat Roof Insulation	EWI	IWI/RIRI	Windows/ Doors	Gas Boiler / FTCH	ESH	Solar Thermal	ASHP	GSHP	Solar PV
Detailed floor plan showing areas/elements where insulation EEM is to be installed	■	■	■	■	■	■	■						
Thermal Bridge Mitigation Design Details	■	■	■	■	■	■	■						
Crossflow ventilation calculations for underfloor void or loft area*		■	■		■	■							
Loft hatch insulation and draught proofing		■				■							
Skeiling insulation and ventilation*		■		■	■	■							
Detailed floor plan showing the location of installed main EEM components e.g. boiler, radiators, Heat pump, cylinders etc.								■		■	■	■	
Detailed floor plan showing location of heat emitters/top up heating*								■	■	■	■	■	
Heat loss/heat generation requirements and efficiency calculations*								■	■	■	■	■	
Noise Assessment Calculations											■		
Roof plan, orientation, performance, and roof structural calculations													■

* - Where relevant

Notes

- *Loft ventilation requirements should be calculated in accordance with BS5250:2021 Table 5: Min. free area of openings for loft-space ventilation;*
- *Crossflow ventilation requirements should be calculated in accordance with Building Regulations Approved Document C, 2010, Section 4.14.*

4.3 EEM Measure-specific Maintenance Requirements

The designer shall outline the maintenance requirements for each EEM, referencing any manufacturer-specific or best-practice guidance specific for the EEM.

4.4 EEM Technical Standards

The retrofit design shall identify the relevant technical standards and or relevant best practices for the EEM(s) under PAS2035:2019+A1:2022 **16.1 Retrofit Framework Standards**, confirming the application of the standards has been incorporated into the design.

4.5 Intended Outcomes

The intended outcomes for the planned energy efficiency measures should be established with the client as performance targets, at the outset of the project. These shall be realistic (taking into consideration available budget and expected EEM performance), measurable, and achievable – taking into account the condition of the property before retrofit. Typically, these shall include fuel cost savings, improved thermal comfort, and reductions in carbon dioxide emissions, or specific outcomes to suit any relevant funding streams.

5 U-Values Overridden

Overridden u-values will only be accepted as permissible, where there is a prior agreement with the scheme provider following receipt of suitable compliant validated evidence.

U-value calculations must be completed in compliance with BR443 Conventions for U-value calculations, the scheme provider reserves the right to audit any calculations should the need arise.

Where agreement is provided, the post-equivalent u-values in the post-EPR must be calculated based on the u-value of the pre-EPR and the thermal resistance of the insulation product installed.

For further reference please see RdSAP Conventions V11.4 3.08.

Evidence Requirements

- Photographic evidence of the property in situ;
- RdSAP Site notes;
- BBA Product Certification* of the insulation being installed;
- Copy of the qualification of the person who has done the U-value calculation(s);
- Scheme U-Value permission form;
- Calculations must match the product's BBA Product Certification*;
- Products within the calculation must be suitable for the building part they are being applied to.
  * Or equivalent e.g. Kiwa.

This guidance supports the TrustMark Energy Performance Report (EPR) Variation Conventions V1.2.

6 Property Condition

The design shall confirm that the condition of the existing building has been considered, including any defects requiring remediation:

- Structural defects;
- Leaks/rainwater ingress;
- Faulty rainwater goods;
- Rising or penetrative damp.

7 Planning Conditions

The design shall identify any constraints imposed by the local planning authority or the Building Control Body, including requirements for: Listed Building Consent, Party Wall Notices, Listing as of Special Architectural or Historic Interest, Conservation Area constraints, Tree Preservation orders, or approval under the Building Regulations.

8 Product – Installation, Operations and Maintenance Manuals

Any relevant sections of the manufacturer's installation guidance should also be included in the design. These shall be attached to the main design document to create a single property-specific design PDF document.

9 Constraints and Exposure Assessment

The design shall identify any constraints imposed by the site, e.g. elevation and exposure (to sun, wind and rain, major roads, and industrial activity), safe access, party walls, rights of light, consideration of adjoining properties, etc.

The selection of EEM specifications shall ensure the suitability of the EEM installation for the exposure conditions at the dwelling location i.e. wind and rain.

The orientation of the dwelling shall be considered for both overheating and the performance of solar thermal and solar PV measures.

10 Physical Interaction Between Measures

Provision for managing the interactions between EEMs installed in the same dwelling shall be included, following The Measures Interaction Matrix provided in PAS2035 Annex D (Figure D.1). Specific consideration being given to yellow and orange interactions.

11 Ventilation Strategy Ref PAS2035:2019+A1:2022 Annex C and Approved Document F

For any project where insulation or air-tightness measures, or replacing windows & doors are being installed, the ventilation system in the property must be assessed and where required upgraded.

For full guidance, please refer to Building Regulations 2010 Ventilation Approved Document F Vol 1 Dwellings (ADF1).

A complete ventilation system should include the following:

- Extract ventilation – to remove stale or moist air from wet rooms;
- Background ventilation – to permit the controlled entry of fresh air into habitable rooms to replace the air being extracted from the wet rooms; via –
- Door undercuts beneath all internal doors which allow air to move throughout the dwelling;
- Purge ventilation available in each room – by means of an opening window or door on an external wall of the dwelling to the outside.

Where any of the above are not available, in correct working order, or to the correct specification to satisfy the requirements of Building Regulations*, the ventilation system shall be considered as inadequate.

Figure 1. overleaf, provides an assessment process developed from ADF1 to help the designer asses the existing ventilation system and prepare an upgrade strategy to ensure compliance with ADF1 and PAS2035. This is available to ecmk members, accessed via Scheme Documents.

11.1 Property-Specific Ventilation Strategy

As for all design documents, the Ventilation strategy and any documentary evidence shall be specific to each individual property.

11.2 IAA Background Ventilation Assessment of Existing Buildings

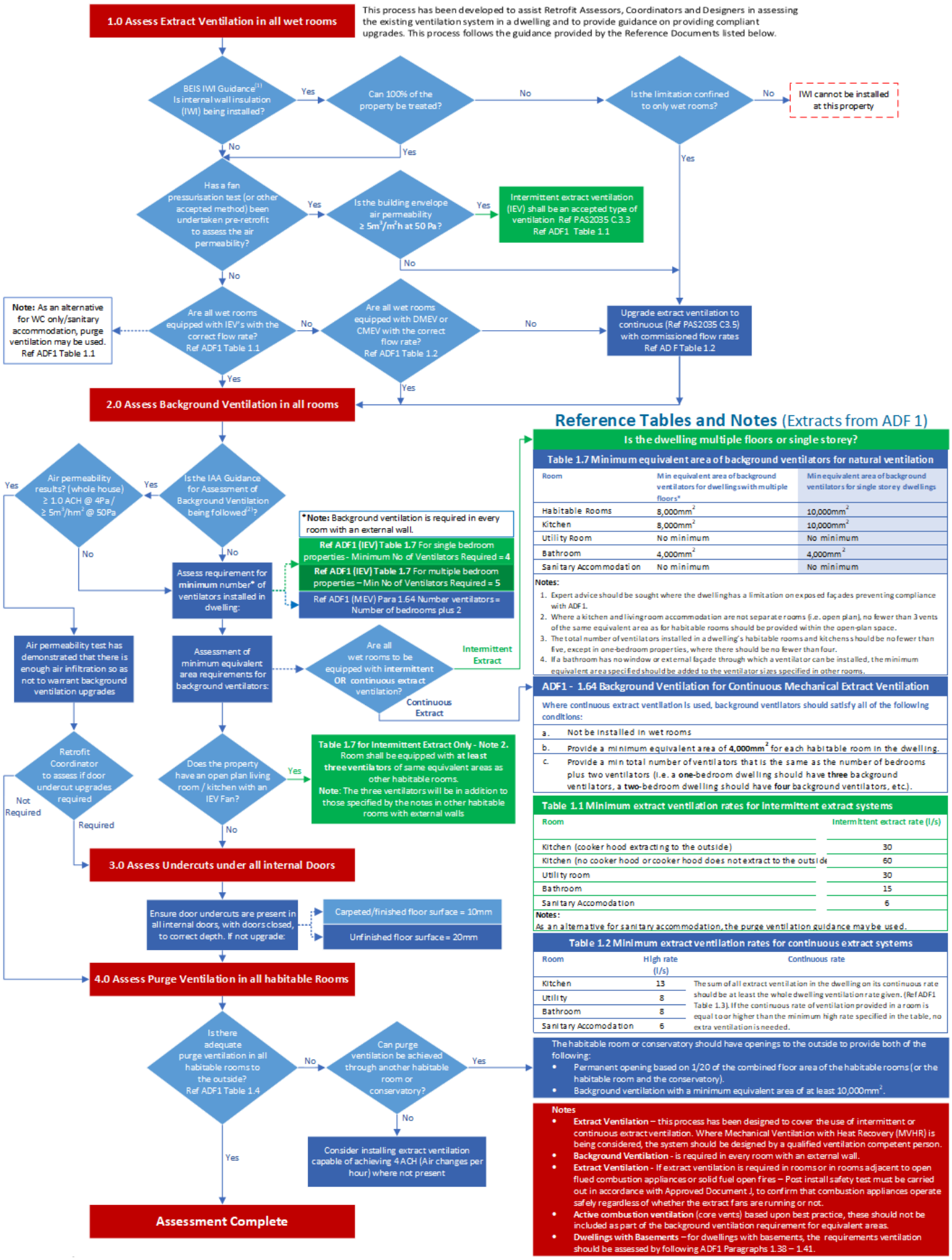
The Installation Assurance Authority (IAA) has developed a TrustMark-approved process for assessing the requirement for background ventilation only. Where this test is being used to determine the requirements for background ventilation for a property, for the test to be compliant:

- Testing must be undertaken by a competent person registered with Elmhurst or ATTMA;
- The process described in the IAA guidance document (link below) must be adhered to;
- For a test to demonstrate that there is sufficient air infiltration so as not to warrant any upgrades of background ventilation:
  - Whole House test demonstrating air permeability of - **≥ 1.0 ACH @4Pa**
  - Room tests in bedrooms where there are no ventilators and/or mould or condensation issues present demonstrating air permeability of - **≥ 1.5 ACH @4Pa**
- Evidence shall be submitted including copies of the test results, fully completed, for both pre- and post-installation testing, and the list of evidence outlined under Section 7. of the guidance, titled “Documentation”;
- The ventilation strategy should also confirm that successful testing has been undertaken, demonstrating there is sufficient air infiltration so as not to warrant background ventilation upgrades.

Background ventilation assessment of existing buildings | IAA - The Installation Assurance Authority

Ventilation & Air Tightness Testing • TrustMark

Ventilation Assessment Process for Fabric Measures Ref PAS2035 & ADF1 2021



Reference Tables and Notes (Extracts from ADF 1)

Is the dwelling multiple floors or single storey?

Table 1.7 Minimum equivalent area of background ventilators for natural ventilation

Room	Min equivalent area of background ventilators for dwellings with multiple floors*	Min equivalent area of background ventilators for single storey dwellings
Habitable Rooms	8,000mm²	10,000mm²
Kitchen	8,000mm²	10,000mm²
Utility Room	No minimum	No minimum
Bathroom	4,000mm²	4,000mm²
Sanitary Accommodation	No minimum	No minimum

Notes:

1. Expert advice should be sought where the dwelling has a limitation on exposed façades preventing compliance with ADF1.
2. Where a kitchen and living room accommodation are not separate rooms (i.e. open plan), no fewer than 3 vents of the same equivalent area as for habitable rooms should be provided within the open-plan space.
3. The total number of ventilators installed in a dwelling's habitable rooms and kitchens should be no fewer than five, except in one-bedroom properties, where there should be no fewer than four.
4. If a bathroom has no window or external façade through which a ventilator can be installed, the minimum equivalent area specified should be added to the ventilator sizes specified in other rooms.

ADF1 - 1.64 Background Ventilation for Continuous Mechanical Extract Ventilation

Where continuous extract ventilation is used, background ventilators should satisfy all of the following conditions:

a. Not be installed in wet rooms

b. Provide a minimum equivalent area of **4,000mm²** for each habitable room in the dwelling.

c. Provide a min total number of ventilators that is the same as the number of bedrooms plus two ventilators (i.e. a **one**-bedroom dwelling should have **three** background ventilators, a **two**-bedroom dwelling should have **four** background ventilators, etc.).

Table 1.1 Minimum extract ventilation rates for intermittent extract systems

Room	Intermittent extract rate (l/s)
Kitchen (cooker hood extracting to the outside)	30
Kitchen (no cooker hood or cooker hood does not extract to the outside	60
Utility room	30
Bathroom	15
Sanitary Accomodation	6

Notes:
As an alternative for sanitary accommodation, the purge ventilation guidance may be used.

Table 1.2 Minimum extract ventilation rates for continuous extract systems

Room	High rate (l/s)	Continuous rate
Kitchen	13	The sum of all extract ventilation in the dwelling on its continuous rate should be at least the whole dwelling ventilation rate given. (Ref ADF1 Table 1.3). If the continuous rate of ventilation provided in a room is equal to or higher than the minimum high rate specified in the table, no extra ventilation is needed.
Utility	8	
Bathroom	8	
Sanitary Accomodation	6	

The habitable room or conservatory should have openings to the outside to provide both of the following:

- Permanent opening based on 1/20 of the combined floor area of the habitable rooms (or the habitable room and the conservatory).
- Background ventilation with a minimum equivalent area of at least 10,000mm².

Notes

- **Extract Ventilation** – this process has been designed to cover the use of intermittent or continuous extract ventilation. Where Mechanical Ventilation with Heat Recovery (MVHR) is being considered, the system should be designed by a qualified ventilation competent person.
- **Background Ventilation** - is required in every room with an external wall.
- **Extract Ventilation** - If extract ventilation is required in rooms or in rooms adjacent to open flued combustion appliances or solid fuel open fires – Post install safety test must be carried out in accordance with Approved Document J, to confirm that combustion appliances operate safely regardless of whether the extract fans are running or not.
- **Active combustion ventilation** (core vents) based upon best practice, these should not be included as part of the background ventilation requirement for equivalent areas.
- **Dwellings with Basements** – for dwellings with basements, the requirements ventilation should be assessed by following ADF1 Paragraphs 1.38 – 1.41.

Figure 1 Ventilation Assessment Flowchart

11.3 Ventilation Assessment and Upgrade Evidence Notes

Preinstallation photographic evidence provided with the Retrofit Assessment should be sufficient to allow the Retrofit Designer and Coordinator to assess the existing ventilation system and prepare an upgrade strategy.

Post-installation evidence should include photographic and documentary evidence to demonstrate that the ventilation system has been upgraded per the ventilation upgrade strategy.

Pre-installation photographic evidence should therefore include the following:

- Existing extract ventilation evidencing:
    - Location of internal extract fans;
    - Location of external exhaust grilles;
    - Any ductwork.
- All existing background ventilators;
- Undercuts on all internal doors, photographs taken at ground level, with the door closed, evidencing the depth of the door undercut with either a measuring wedge or a pen to clearly evidence the depth of the undercut beneath each door;
- Purge ventilation in all habitable rooms.

12 Moisture Management

The retrofit design shall include appropriate provisions for the management of moisture within the construction. The insulation materials selected shall be appropriate to the construction type of the dwelling, specifying vapour-permeable materials and vapour-balanced construction as appropriate, such that moisture does not become trapped within any construction leading to risk of interstitial condensation and consequent dampness and deterioration. Moisture risk shall be evaluated on a whole-dwelling basis.

13 Fire Safety

The designer shall ensure that the fire safety of the building is not compromised by the installation of EEMs in accordance with The Building Regulations Approved Document B Fire, and if necessary, include an updated fire safety strategy following the guidance in BS 7974.

14 Thermal Bridges

Construction details shall be configured to maintain the continuity of the three-dimensional insulated envelope and the integrity of any airtightness barrier, in order to eliminate thermal by-pass (i.e. the uncontrolled penetration of cold air to the warm side of any insulation layer), minimize thermal bridging and maintain an appropriate or specified standard of airtightness.

Where construction details published as part of industry best practice guidance, or details from the system designer are used, these must be relevant to the installation and be property specific.

If other details are used, it shall be shown by calculating the thermal bridge in accordance with BRE IP1/06, assessing the effects of thermal bridging at junctions and around openings, that the temperature factor (f_{Rsi}) of each detail is greater than 0.75.

15 Sequence of Installation

The retrofit design shall also specify the sequence of installation of the EEMs, especially where incorrect sequencing might adversely affect the resilience of the EEMs, the integrity of the building, its historic significance, or its energy performance. This should generally follow the “fabric first” approach.

16 Pre-installation Building Inspection

The Retrofit Installer shall undertake a pre-installation inspection of the designated location based on the installation method statement prepared under PAS203 Clause **6.1**, using a vocationally competent person as defined in the relevant measure-specific Annex of this PAS.

The inspection shall be undertaken at a level of detail sufficient to confirm that the specified EEM can be safely and effectively installed at the designated location paying particular attention to:

- the measures installed;
- the functionality and/or safety of installed services (gas, electricity, water, telecommunications, etc.);
- the use of specified installation methods;
- potential moisture build-up as a result of the installation;
- the fire safety of the dwelling;
- any required ventilation upgrade including where necessary the procurement and installation of any required ventilation upgrade from a ventilation specialist;
- avoidance of thermal bridging;
- testing;
- commissioning and handover.

The inspection shall include all, but not be limited to the measure-specific pre-installation inspection requirements from the relevant measure-specific Annexes of PAS2030.

As part of the pre-installation Inspection the Retrofit Installer shall confirm to the Retrofit Coordinator that the repair works identified by pre-installation assessment or the design have been undertaken.

17 Testing and Commissioning

The design shall outline all testing and commissioning requirements of any heating and electrical installations.

18 Handover

Retrofit Design to consider the requirements for the Retrofit Installer client handover documents, including safe operation and maintenance, information packs, and homeowner advice etc. as specified within each relevant Annex of PAS2030.

19 Revisions

There will be occasions where due to unforeseen circumstances during installation, aspects of the design may require revising. If this should occur, any relevant design documents must be revised in line with any such changes. Omission of this may result in a non-compliant lodgement.

20 References

- PAS 2035:2023 Retrofitting dwellings for improved energy efficiency – Specification and guidance
- BRE Group IP 1/06 Assessing the effects of thermal bridging at junctions and around openings, March 2006.
- External-wall-insulation-specification-for-weathering-and-thermal-bridge-control-Guide.-June-19 External-wall-insulation-specification-for-weathering-and-thermal-bridge....pdf (inca-ltd.org.uk)
- Specification for the installation of external wall insulation ensuring the safety and operation of fuel-burning appliances V1.0 March 2017 Document 1 FINAL.pdf (dropbox.com)
- BEIS Guide to Best Practice Retrofit Internal Wall Insulation, September 2021 https://assets.publishing.service.gov.uk/media/iwi-guidance.pdf
- BEIS Guide to Best Practice Retrofit Floor Insulation – Suspended Timber Floors https://assets.publishing.service.gov.uk/media/suspended-timber-floors-underfloor-insulation-best-practice.pdf
- The Building Regulations 2010 Fire Safety Approved Document B, Volume 1: Dwellings. https://assets.publishing.service.gov.uk/Approved_Document_B_fire_safety_vol_1_-_Dwellings.pdf
- The Building Regulations 2010 Site Preparation of Resistance to Contaminants and Moisture, Approved Document C https://www.gov.uk/government/publications/site-preparation-and-resistance-to-contaminates-and-moisture-approved-document-c
- The Building Regulations 2010 Ventilation Approved Document F Volume 1: Dwellings
- https://assets.publishing.service.gov.uk/media/ADF1.pdf
- The Building Regulations 2010 Conservation of fuel and power, Approved Document L, Volume 1: Dwellings, 2021 Edn. https://www.gov.uk/government/publications/conservation-of-fuel-and-power-approved-document-l
- The Building Regulations 2010 Overheating Approved Document O https://assets.publishing.service.gov.uk/media/ADO.pdf
- ETAG 014 Edition January 2002, Revised 2008, 2011, Guideline for European Technical Approval of Plastic Anchors for Fixing of External Thermal Insulation Composite Systems with Rendering. https://www.eota.eu/sites/default/files/uploads/ETAGs/etag-014-en.pdf
- BS5250:2021 Management of moisture in buildings —Code of practice
- CITB General Requirements and Guidance for the Installation of Cold Roof Loft Insulation, Ver 2 CITB 2013
- NHBC 7.2.15 Ventilation, vapour control and insulation
- BS 493:1995 Specification for airbricks and gratings for wall ventilation (+A1:2010)
- Zero Carbon Hub Thermal Bridging Guide. https://www.labc.co.uk/sites/default/zch/thermalbridgingguide-screen.pdf
- BRE 262 Thermal insulation: avoiding risks A good practice guide supporting building regulations requirements 2002 edition https://www.brebookshop.com/details.jsp
- BR443 Conventions for U-value calculations, 2019.