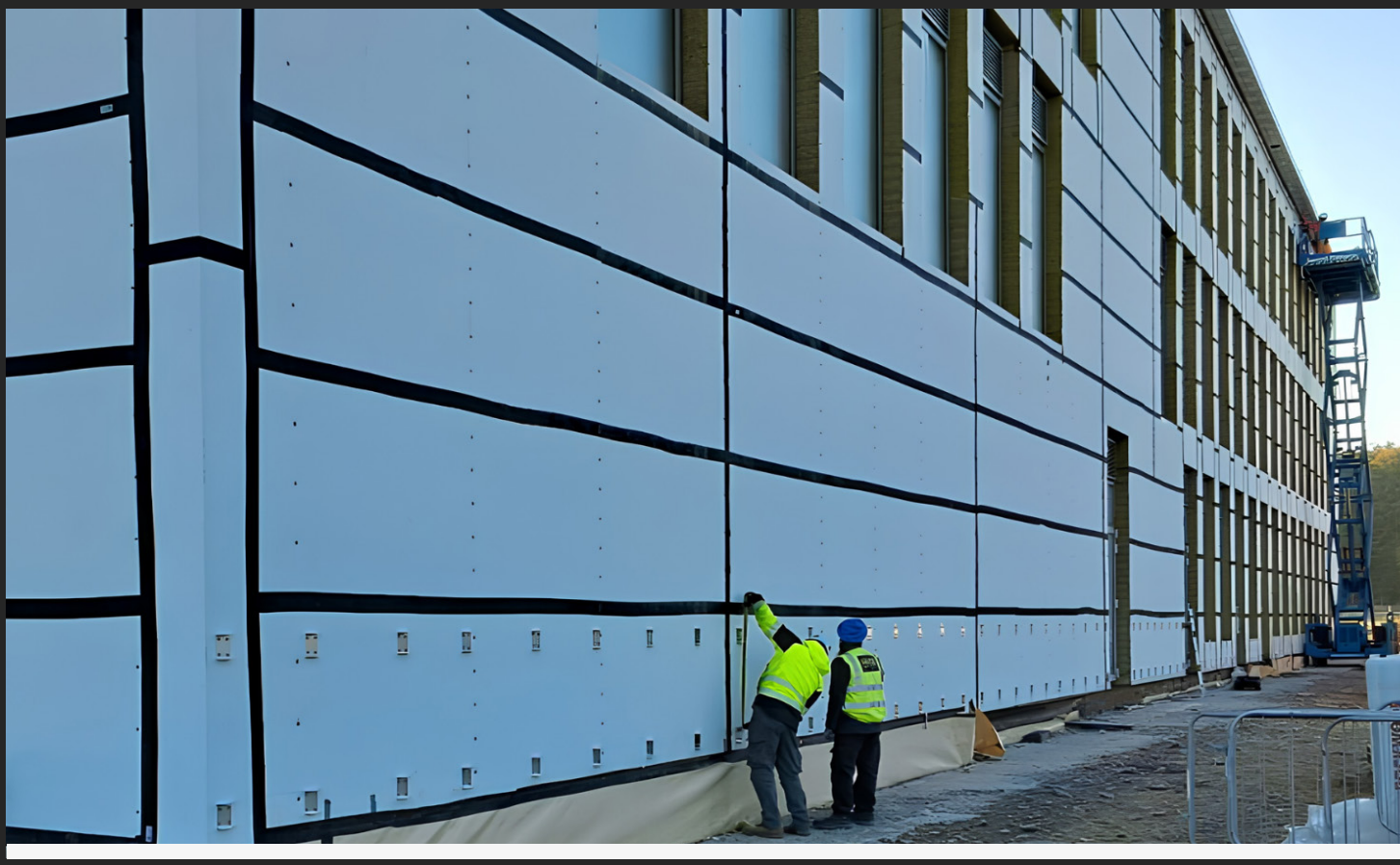
Passivhaus Trust

BE—ST
Built Environment — Smarter Transformation



GOOD PRACTICE GUIDE

Delivering Quality

Construction & Handover for Large & Complex Low Energy Buildings

April 2026

Morrison Construction

Balfour Beatty

Delivering Quality
Construction & Handover for Large & Complex Low Energy Buildings

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April 2026

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Cover image: Nairn Academy, aiming for Passivhaus. Credit: Balfour Beatty

Contents

Introduction – the culture of delivering quality

This paper has been developed by Tier 1 contractors, supported by BE-ST and the Passivhaus Trust, as well as a working group including experienced consultants and certifiers, to share practical approaches for delivering quality on large and/ or complex high-performance projects. It reflects the collective experience of contractors who recognise that delivering quality depends on leadership and culture, not only systems and standards,.

Strong leadership can create a culture for success by setting expectations, driving best practice, and giving teams the confidence to take ownership of solutions. Embedding this culture means creating an environment where people

- care about outcomes,
- take pride in their work,
- feel valued, and
- understand the “why” behind every requirement.

This paper will explain the impact of a **culture of quality** in every area of delivery.

- In **programme management**, it influences how we plan suitable time allowances for consistently delivering a quality product.
- In **procurement,** it shapes how we select and engage our supply chain to create a collaborative environment.
- In **training**, it fosters competence and embeds continuous learning on site.
- In **quality control**, it turns inspection and testing into proactive learning and prevention rather than reactive blame and correction.
- In **commissioning** **and** **handover**, it ensures that we start with the end in mind, and that information is understood, retained, and used to improve performance, both on the current and future projects.

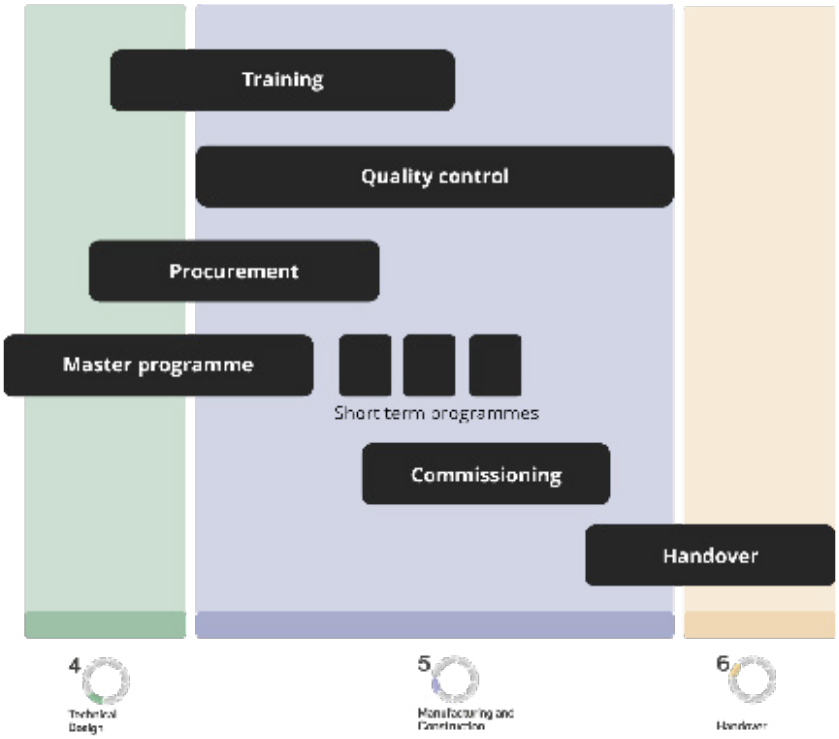

Fig. 1: *The culture of quality across project delivery against RIBA stages*

Across the industry, projects are increasingly shaped by regulatory requirements, environmental assessment frameworks such as BREEAM, client-led net zero targets, and the evolving responsibilities introduced through legislation including the Building Safety Act. At the same time, there is growing recognition of the performance gap between design intent and as-built outcomes.

In some cases, well-intentioned innovative low energy and low carbon projects experience an even greater performance gap than conventional Building Regulations schemes. This is often because they involve more complex systems, novel construction methods, or requirements that push beyond established practice. Ambition alone does not guarantee performance.

Experience in delivering successful large and complex high performance buildings, such as the Passivhaus case studies presented in this guide, has provided a structured response to this challenge. The Passivhaus approach places strong emphasis on clear performance targets, coordinated design development, rigorous testing, and documented verification. Through engaging with this process-driven methodology, Tier 1 contractors have developed practical solutions in quality management, coordination and evidence capture that materially reduce performance risk on complex high performance buildings.

This paper does not advocate for any single performance standard. Rather, it draws on the learning gained from Passivhaus delivery, alongside broader quality management experience, to demonstrate how best practice can be applied across all projects. Applying structured processes, early engagement

and clear accountability more widely offers a proven route to addressing the industry-wide performance gap.

This paper aims to remain clear and succinct by focusing on actions that can be taken and controlled during the construction phase. This includes the procurement phase at the end of RIBA Stage 4 and continues through construction to the handover and in-use phases (RIBA Stages 6 and 7).

The design phase of a project (up to the end of RIBA stage 4) has an even more significant influence on the quality outcomes of a project. Early stage design optimisation is covered in other publications and resources – readers of this paper are particularly directed to "Low energy building optimisation through supply chain collaboration"[1], which highlights and explains the benefit of early contractor involvement.

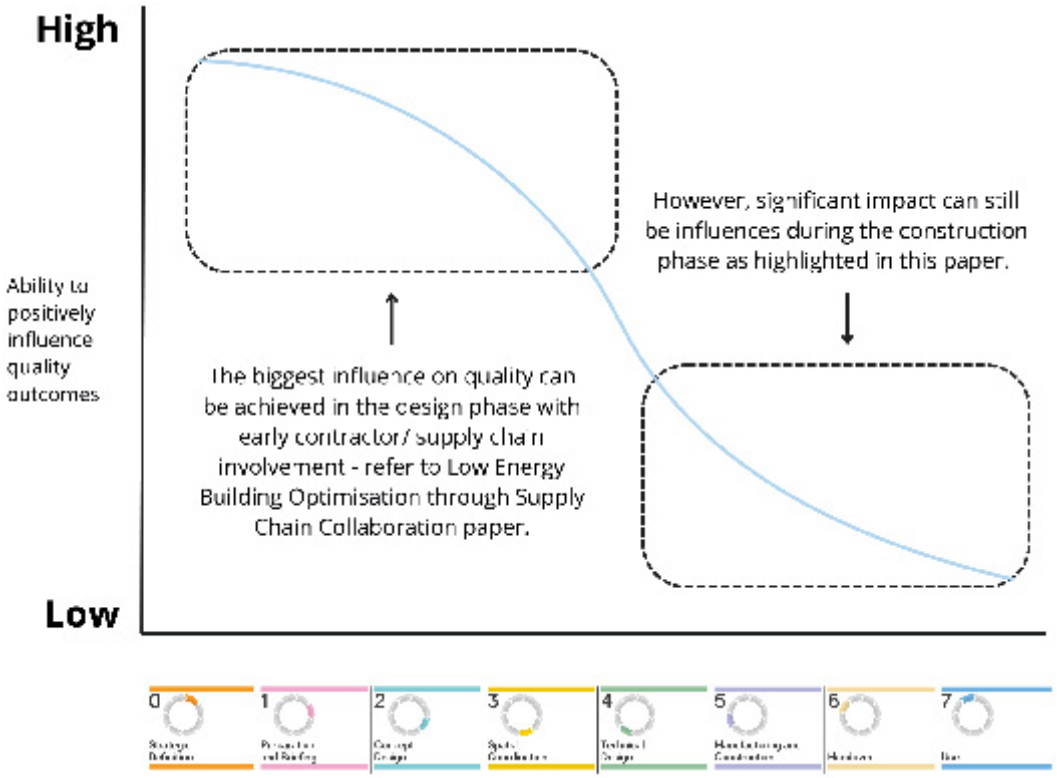

Fig. 2: *The ability to influence quality outcomes across project delivery against RIBA stages*

RIBA Passivhaus Overlay[2]

Low Energy Building Optimisation through Supply Chain Collaboration[1]

1 For more guidance on early stage design optimisation, see Low Energy Building Optimisation through Supply Chain Collaboration (Built Environment - Smarter Transformation, 2025).

2 For more guidance see RIBA Passivhaus Overlay (Passivhaus Trust, 2023).

Programme

Principles

The construction programme is the project's roadmap. It integrates procurement, design, statutory approvals, training, construction activities, testing and commissioning. A construction programme is not merely a scheduling tool. It is a quality control mechanism, and without an up-to-date, dynamically managed programme, it is nearly impossible to consistently deliver quality on site.

"Front loading and completing the design in the preconstruction phase results in many added benefits, including early procurement of sub-contractors and full co-ordination of the digital model. This should, in practice, enable a more efficient build process resulting in less site modification and waste, and ultimately a smoother commissioning and handover process."

Allan Smith, Low Carbon Manager, Morrison Construction

Common issues

Issue	Cause	Effect
Insufficient design time	Inadequate time allocation for subcontractor design work	Delays in procurement and disruption of site activities
Unclear or unprogrammed tasks	Poor engagement and lack of a collaborative approach.	Out of sequence works, increasing risk of remedial work and compromised quality
Compressed inspection periods	Inadequate time allocation for quality to be built in and checks applied.	Sub-standard work missed, covered up or left unresolved, with negative impact on building performance

Practical guidance

This paper does not aim to provide a full guide to construction planning – rather, it focuses on the principles that most influence quality outcomes.

Pre-construction programme

A well-considered pre-construction programme should aim to complete the majority of RIBA Stage 4 activities before site mobilisation, including confirmation that the design is capable of achieving the necessary certification requirements. This sets the foundation for success by reducing uncertainty and embedding quality drivers early. Key considerations include:

Procurement: Break down work packages clearly and align them with the procurement schedule. The procurement schedule contains key information such as:

- design information release dates
- periods for review
- periods for the collation of tender documentation
- tender period
- timescales for the review and final placing of sub-contract orders.

CDP (Contractor's Design Portion) packages: CDP packages will require the relevant subcontractor to complete the design information. The design, certification and procurement of CDP packages can be onerous, and they require full understanding and consideration in the construction programme.

Subcontractor procurement times: Similar to CDP items above, it is critical to have early engagement with the supply chain to understand from them both their procurement lead-in times, and also their expected install durations.

It is worth noting that even where work packages are not classified as CDP they may still entail an element of drawing production that must be planned and resourced.

Statutory and other third party approvals: It is essential to understand the extent of design information required to satisfy staged statutory approvals, and consequently the upfront work involved. Similarly, it is crucial to understand any other third party approvals that are required together with the processes that are required to obtain those approvals - for example, utilities.

> *There should be open and honest discussions with the client to determine whether early procurement of programme-critical CDP packages (for example superstructure) can be brought forward into the pre-construction period to avoid programme and sequencing issues.*
>
> *This will often require upfront expenditure of design fees attributed to the construction works, so discussions on the cost-benefit analysis should take place as early as possible in the process.*

Understanding certification requirements

Certification requirements need to be embedded throughout the programme. Early engagement with the certifying body appropriate to the chosen compliance route of the project will ensure that no requirements are overlooked.

Evidence requirements, including frequency of checking, should be explicitly referenced in subcontractor orders and aligned with the Inspection and Test Plan (ITP) structure [see Section 2: Procurement].

An evidence register should be set up in coordination with the certifier, and a workflow established to keep it up to date (see Section 4: Quality Control).

Enhanced commissioning requirements and evidence needs must be understood and incorporated into the commissioning programme (see Section 5: Commissioning).

Good management of the evidence gathering process will enable the certifier to check and submit information to the certifying body in a timely manner.

Construction Activities

It is critical to the successful planning of construction activities on site that the programme and sequence of activities is built up from first principles. Programme development should include the following elements.

Quality testing and hold points

It is impractical to show every check on the programme, but key test and hold points should be identified clearly and included in both the main construction schedule and subcontractor orders. Break tasks into sufficient detail to show the flow and sequence of works, making it clear where inspection and hold points occur. Schedule early hold points within each relevant work package so quality can be verified before full installation progresses.

Setting designated quality hold points in the programme allows all relevant stakeholders to review and agree on quality before works continue to progress.

Fig. 3: *Quality checking during the construction of Passivhaus project Paisley Grammar School. Image credit: Morrison Construction*

Airtightness testing

An airtightness testing strategy must be developed during the pre-construction period. This will determine opportunities to carry out any formal sectional and interim testing and ensure they are priced accordingly. The airtightness strategy development can be done either in-house, or through specialist companies. Any standard-specific testing requirements should be identified early and factored in[3].

Interim testing can include:

- Components : for example, a glazed window unit that can be boxed out behind and air tested to check the unit and detail interfaces.
- Building room or zone: an area of the building that has been accelerated in the programme. This will likely require temporary internal seals to zone off the area so a plan for how this will be achieved should be part of the programme.
- Whole building: If a whole building test can take place in a sequenced manner, the relevant hold points should be added to the programme (especially after the MEP first fix) to allow for corrective action to be taken in the event of any adverse test before follow-up works take place (see testing and hold points above)

Regardless of the interim testing strategy, it is always good practice to conduct and record a visual inspection of completed rooms / zones before moving on to the next stage of construction.

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3 For detail on Passivhaus airtightness testing requirements, see *Demystifying Airtightness: Good Practice Guide (Passivhaus Trust, 2020).*

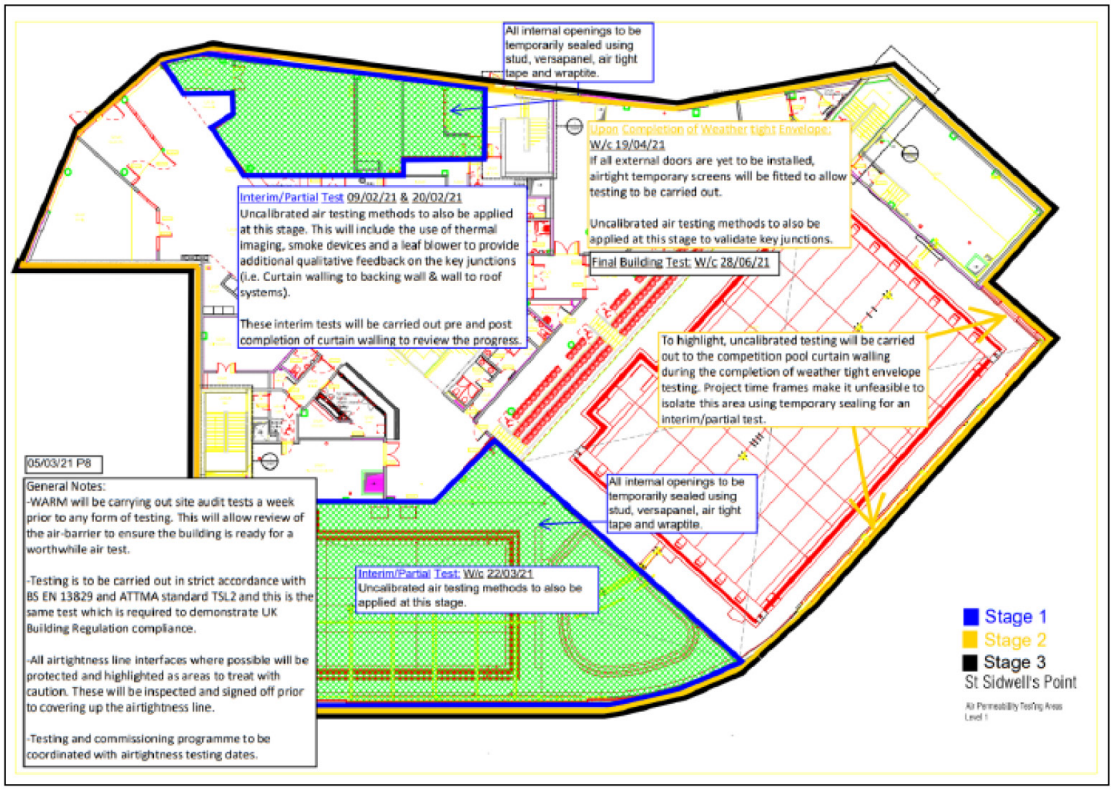


Fig. 4: *Diagram showing the pre-planning of interim air testing. Image credits: Stephen Booth, Kier Construction & Paul Jennings, ALDAS. See digital resources pack to download this diagram*

Commissioning and handover (see Section 5: Commissioning and Section 6: Handover)

Plan for commissioning from day one. For high performance buildings, this phase is especially critical due to precise environmental and system requirements. The commissioning period should never be treated as a buffer for overruns in other project activity. If this period is compressed, there is a risk of certification failure and long-term operational issues. Agree on enhanced commissioning requirements early and integrate them into the programme.

The culture of quality in programming

A programme is more than dates – it is a statement of priorities. A strong project culture determines whether quality critical activities such as airtightness testing, quality hold points and commissioning are protected or squeezed.

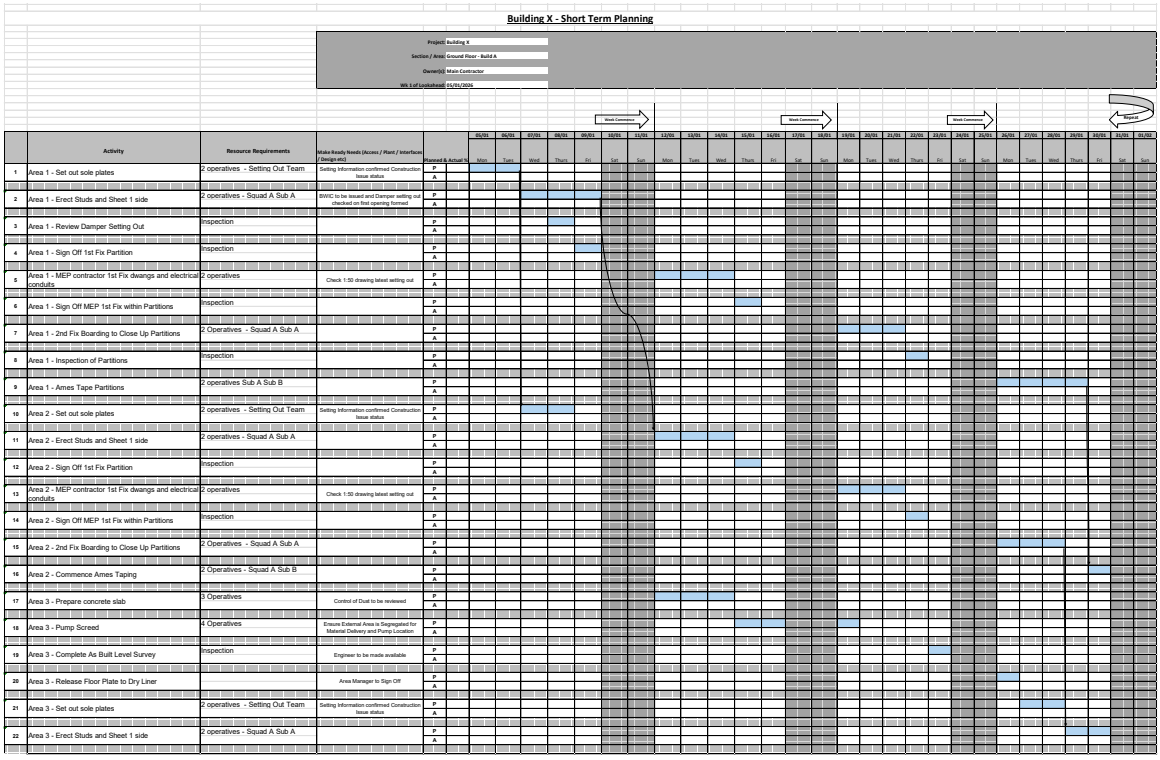
Leadership must reinforce this by treating programme integrity as non-negotiable

Short term planning programmes

Short-term programmes translate strategic intent into actionable site-level coordination. Weekly rolling plans allow teams to adapt to evolving constraints, design changes, and resource fluctuations. These plans should:

- Align with overall milestones
- Break activities into manageable 2–3 day tasks
- Be based on real discussions with subcontractors, not assumptions
- Use visual tools such as phasing diagrams to clarify interfaces
- Encourage timely communication—imperfect but early is better than perfect but late.

Short-term planning is particularly important for projects with complex sequencing or specialist fabrication, where details often become clear only during delivery.



Building X - Short Term Planning

Project: Building X
Section / Area: Ground Floor - Build A
Owner(s): Main Contractor
Wk 1 of Lookahead: 05/01/2026

	Activity	Resource Requirements	Make Ready Needs (Access / Plant / Interfaces / Design etc)	Planned & Actual %
1	Area 1 - Set out sole plates	2 operatives - Setting Out Team	Setting Information confirmed Construction Issue status	P / A
2	Area 1 - Erect Studs and Sheet 1 side	2 operatives - Squad A Sub A	BWIC to be issued and Damper setting out checked on first opening formed	P / A
3	Area 1 - Review Damper Setting Out	Inspection		P / A
4	Area 1 - Sign Off 1st Fix Partition	Inspection		P / A
5	Area 1 - MEP contractor 1st Fix dwangs and electrical conduits	2 operatives	Check 1:50 drawing latest setting out	P / A
6	Area 1 - Sign Off MEP 1st Fix within Partitions	Inspection		P / A
7	Area 1 - 2nd Fix Boarding to Close Up Partitions	2 Operatives - Squad A Sub A		P / A
8	Area 1 - Inspection of Partitions	Inspection		P / A
9	Area 1 - Ames Tape Partitions	2 operatives Sub A Sub B		P / A
10	Area 2 - Set out sole plates	2 operatives - Setting Out Team	Setting Information confirmed Construction Issue status	P / A
11	Area 2 - Erect Studs and Sheet 1 side	2 operatives - Squad A Sub A		P / A
12	Area 2 - Sign Off 1st Fix Partition	Inspection		P / A
13	Area 2 - MEP contractor 1st Fix dwangs and electrical conduits	2 operatives	Check 1:50 drawing latest setting out	P / A
14	Area 2 - Sign Off MEP 1st Fix within Partitions	Inspection		P / A
15	Area 2 - 2nd Fix Boarding to Close Up Partitions	2 Operatives - Squad A Sub A		P / A
16	Area 2 - Commence Ames Taping	2 Operatives - Squad A Sub B		P / A
17	Area 3 - Prepare concrete slab	3 Operatives	Control of Dust to be reviewed	P / A
18	Area 3 - Pump Screed	4 Operatives	Ensure External Area is Segregated for Material Delivery and Pump Location	P / A
19	Area 3 - Complete As Built Level Survey	Inspection	Engineer to be made available	P / A
20	Area 3 - Release Floor Plate to Dry Liner		Area Manager to Sign Off	P / A
21	Area 3 - Set out sole plates	2 operatives - Setting Out Team	Setting Information confirmed Construction Issue status	P / A
22	Area 3 - Erect Studs and Sheet 1 side	2 operatives - Squad A Sub A		P / A

Fig. 5: *Example of short term planning programme. See digital resources pack to download this template as an editable excel file*

Programme summary checklist

Pre-construction

- [ ] Aim to complete majority of RIBA stage 4 activities before site mobilisation
- [ ] Engage with supply chain to confirm lead-in times and install durations
- [ ] Include key quality testing and hold points
- [ ] Develop airtightness strategy and integrate into programme

On-site

- [ ] Create weekly rolling plans for key activities
- [ ] Use visual tools for clarity of understanding
- [ ] Base plans on real discussions with sub-contractors

Procurement

Principles

Procurement is the foundation for delivering quality. It determines not only who delivers the work, but also how information, design responsibility and quality expectations flow through the supply chain. A procurement process that has been well-structured from the outset balances programme, specification, sequencing, and cost in a way that prioritises quality outcomes.

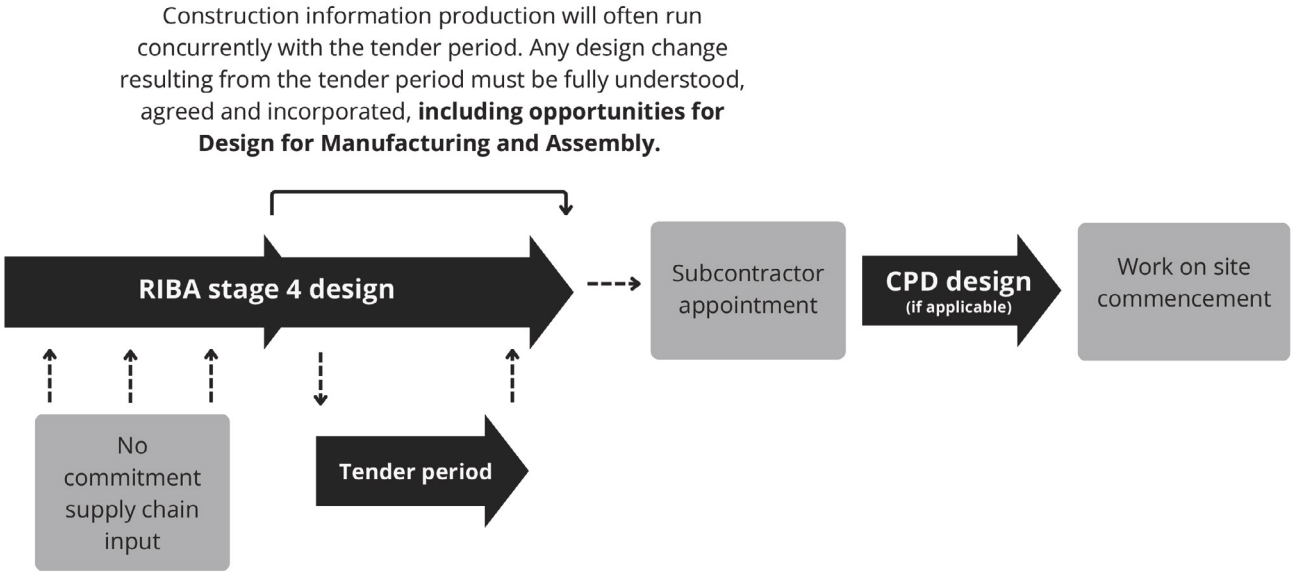


Fig. 6: *Procurement process highlighting supply chain integration and support.*

Common issues

Issue	Cause	Effect
Late sign up of sub-contractors	Lack of early engagement and understanding of procurement and lead-in times	Rushed, out-of-sequence work impacting on aspects such as airtightness and thermal continuity
Lack of clarity on CDP (Contractors' Design Portion) elements	Scope of works not properly defined	Late drawing approval and costly abortive works due to poor coordination of the CDP elements with the other works
Unclear roles and responsibilities	Fragmented procurement	Scope gaps and unaccounted post-contract costs

Practical guidance

Quality of the procurement process

The procurement of subcontracted work packages is often the supply chain's first contact not only with the project, but also with the specific performance criteria of high performance and Passivhaus buildings. It is therefore the perfect time to set the tone for quality expectations of the project.

The procurement process should be transparent, clearly understood and responsive to supplier capacity and capability, particularly where small companies are involved. Suitable assistance can include:

- Tender launches / briefing sessions
- Mid-tender interviews
- Structured feedback

The culture of quality in procurement

A culture of quality in procurement is built by treating tendering as a learning process, not just a selection exercise. Time should be taken to provide clear, specific and actionable feedback to all tenderers, whether successful or not, so they understand where their submission met expectations and where it fell short...

This feedback supports continuous improvement across the supply chain, raising capability and quality outcomes on future projects.

Integrating early subcontractor/ supplier engagement

Early supply chain dialogue, even on a no commitment basis, supports understanding of buildability, sequencing and evidence requirements. Engaging with specialist subcontractors and manufacturers early can help validate and complete design information, establish realistic programme durations, and enable opportunities for Design for Manufacturing and Assembly (DfMA).

Ultimately, early dialogue creates the opportunity to gain expert input from the supply chain, and if it is done in an open and collaborative manner, innovative ideas can be brought to the design team that they may not have previously considered.

> *Subcontractors are often the experts within their particular element. Recognising this opens up the opportunity to benefit from their knowledge and experience.*

Incorporating certification requirements

Early clarification of project-specific quality and evidence requirements (see Section1: Programme) enables their inclusion in subcontractor orders. Requirements should be explicitly referenced and aligned with:

- programming of necessary inspection and hold points for evidence/ quality demonstration (see Section 4: Quality Control);
- workflow for updating the evidence register; and any enhanced commissioning requirements.

Sequencing diagrams

The storyboarding of key interface sequences during pre-construction supports early buildability reviews and clear scope definition.

Sequencing diagrams do not need to be complicated. They can range from full 3D digital models to a marked-up drawing with highlighter pens – whatever works to convey the message.

These diagrams should be developed collaboratively with designers and key subcontractors to:

- Identify the buildability of the detail by highlighting the sequence of the components in the detail. Doing so in the pre-construction period enables early corrective action if issues are identified.
- Identify and assign the correct detail interface components, and ensure that the tender packages for subcontractors include the necessary scopes and requirements.
- Highlight elements in the design that are, or may be, subject to CDP.

It is important to include subcontractors in this process because the procurement strategy may alter the sequence of installation.

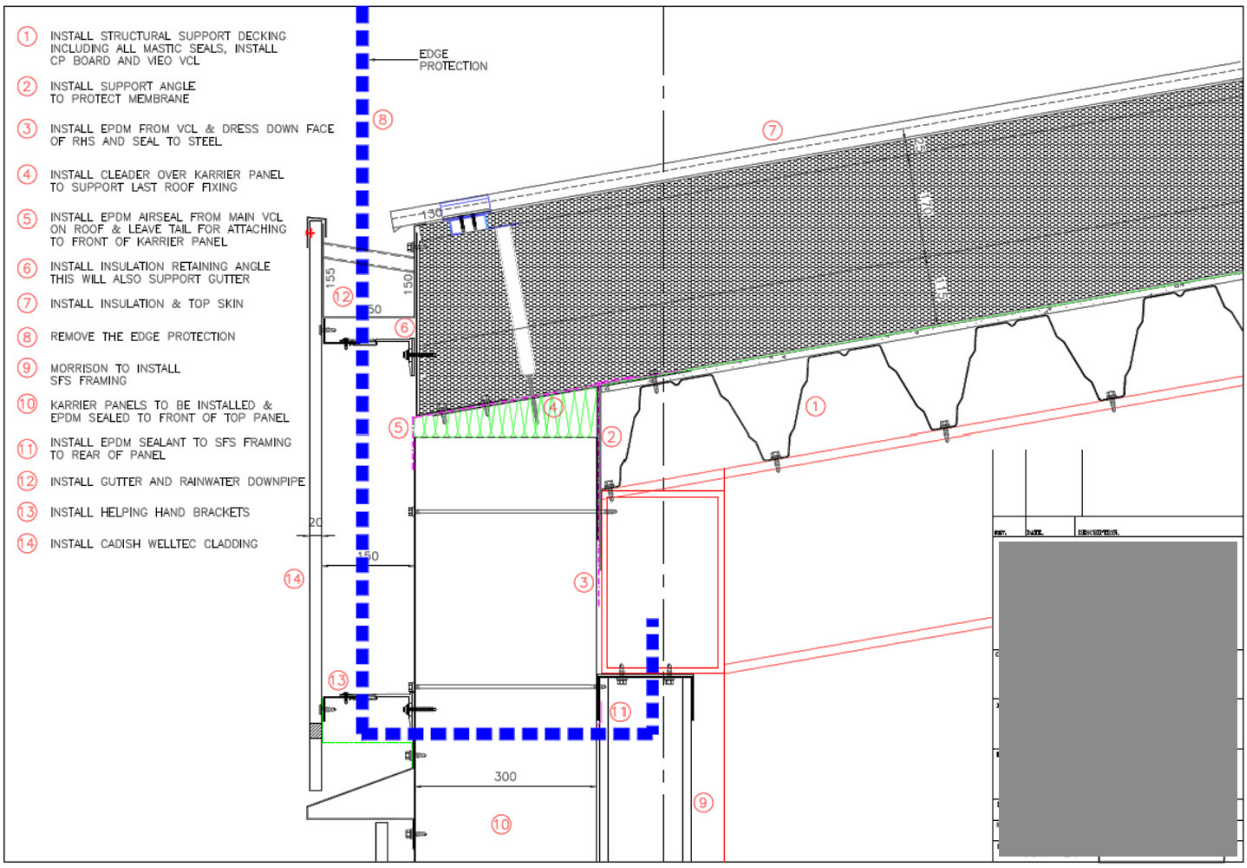


Fig. 7: *Example of sequencing added to detail to explain the build and installation sequence. See digital resources pack to download this diagram*

Simplifying responsibilities

On paper, breaking details into many work packages may at first feel appropriate to help lower costs, but in reality, it can often add complexity and risk, creating more interfaces and potential site issues.

In contrast, using fewer subcontractors simplifies responsibility, improves workforce continuity, and increases the chances of better quality and consistent results, therefore reducing the potential for scope gaps and subsequent risks.

Knowledge continuity

Knowledge continuity between pre-construction and delivery teams is critical to maintaining quality intent. A formal handover meeting to launch the project should involve the client, design team, contractor, and certifier[4] or assessor. This session should confirm key quality drivers, procurement status, outstanding information, and evidence requirements.

4 For more guidance on the role of the Passivhaus Certifier, see *Passivhaus Certifier Scope of Services (Passivhaus Trust, 2023).*

Procurement summary checklist

During pre-construction

- [ ] Hold early engagement sessions with key subcontractors.
- [ ] Develop sequencing diagrams collaboratively (digital or marked-up drawings).
- [ ] Confirm CDP elements and scope clarity.

Tender

- [ ] Hold tender launches for key work packages.
- [ ] Schedule mid-tender interviews to validate understanding.
- [ ] Provide actionable feedback to tenderers

Before contract award

- [ ] Align subcontractor orders with certification evidence requirements.
- [ ] Conduct formal handover meeting with client, design team, and certifier.

Case study – Procurement through collaboration

Context

For Highland Council's new Nairn Academy project, designed to achieve Passivhaus 'Classic' Certification, Architects and Passivhaus Designers Reiach & Hall worked with the Council, Balfour Beatty and the design team to develop a technical solution that utilised a design for manufacture approach utilising large scale composite panels.

Fig. 8: *Nairn Academy render, Reiach and Hall Architects*

Issue to be resolved

A key issue was how to ensure a high level of airtightness and thermal continuity could be achieved with the chosen envelope solution. The use of composite cladding panels is more traditionally used in large 'shed' type structures and had not readily been utilised on Passivhaus projects.

Intervention/ solution

Details were reviewed and developed to 'Construction' level through intense weekly Technical Design Review Workshops involving the design team, Balfour Beatty and key envelope sub-contractors. This included review of the design solutions, installation responsibilities and construction sequencing.

In parallel, the details were iteratively tested for airtightness continuity and thermal bridging by specialist thermal bridge assessors and refined through the workshopping process.

Reiach & Hall then developed a series of '3D Sequencing Diagrams' for the key interfaces to demonstrate the installation responsibilities and sequencing to ensure all parties were aware and bought into the process.

These were further refined throughout the design development phase and finalised prior to the start of construction. The diagrams were then used in package specific 'toolbox talks' on site to ensure operatives were clear on their own responsibilities and how they affected the other relevant trades.

Fig. 9: *3D Sequencing Diagrams, Reiach and Hall Architects*

Outcome and lessons learned

This was a valuable exercise, with the 3D Sequencing Diagrams providing clarity on:

- sub-contractor design responsibilities
- sub-contractor installation responsibilities
- package interface solutions and details
- solutions for key areas of concern
- suggested hold-points for QA review and evidence gathering.

Training

Principles

Training is a continuous, role-specific process that equips everyone from site operatives to senior managers to understand and embrace technical requirements, performance targets, and responsibilities.

Beyond imparting knowledge, effective training:

- fosters a culture of quality,
- assists in developing a sense of pride and ownership,
- creates an engaged and empowered workforce, and
- instils a 'right first time' ethos.

Common issues

Issue	Cause	Effect
Lack of training in designated quality champions and site supervisors	No structured programme for role-specific training	Quality issues overlooked during site operations
Training not addressing project specific requirements	Generic content that ignores buildability of complex details	Inconsistent and sub-standard work across trades
Training ineffective for neurodiverse workers	Lack of understanding of neurodiverse needs and engagement methods	Reduced comprehension and poor application of quality standards; missed opportunity to harness special skills and aptitudes

Practical guidance

Identification of who should be trained and to what level

Training needs should be identified in the pre-construction period to allow the appropriate training solutions to be planned and undertaken.

Training should be identified on a role-specific basis. Formal training for key personnel including supervisors and targeted training for operatives who are involved in detail development will support less formal training for the majority of the site operatives, such as on-site toolbox talks and hands-on learning from mock-ups and first-in-place inspections.

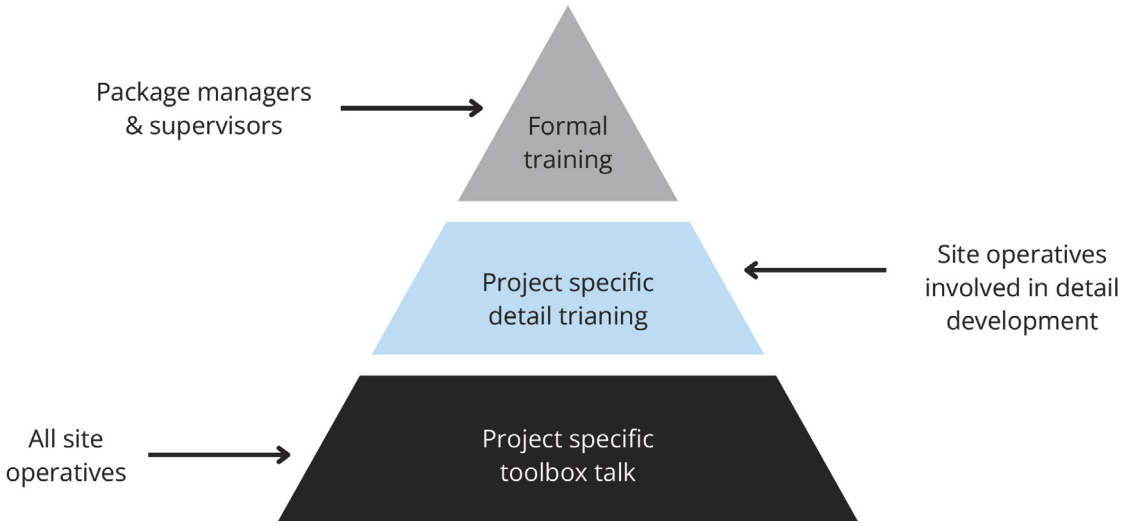


Fig. 10: *Hierarchy of training*

Neurodiverse-inclusive training

Around one in four construction workers identify as neurodivergent, making inclusive training essential for quality delivery. Training should raise awareness of neurodiversity, recognise that differences can include strengths as well as challenges, and provide practical strategies for managers and operatives.

Use clear, structured communication, visual aids, and interactive sessions to support understanding. Break tasks into manageable steps and offer reasonable adjustments such as quiet spaces and predictable schedules.

Toolbox talks should be neurodiverse-friendly, encouraging dialogue and repetition. Embedding these practices fosters engagement, reduces errors, and creates a culture where all team members can thrive.

For further guidance, see National Federation of Builders – Neurodiversity.

Training to develop Inspection and Test plans

Inspection and Test plans (ITPs) are a key tool in delivering a consistent quality culture on site (see Section 4: Quality Control). Site personnel who will be responsible for developing ITPs should be identified and trained to properly undertake and monitor an ITP. Training should equip the relevant personnel to:

- understand ITP structure by viewing best practice examples (see attached case study);
- work with subcontractors to understand the sequencing of the detail installation and the evidence requirements (see Section 2: Procurement); and
- have an awareness of how the ITP fits into the wider project requirements and evidence delivery.

Fig. 11: *Work being progressed, with areas that require attention/ remedial repairs clearly highlighted for action. Image credit: Nairn Academy, Balfour Beatty.*

The culture of quality in training

Respect drives engagement, and engagement drives quality. When tradespeople feel valued, they take ownership, raise issues without fear, and deliver better work.

Training isn't just about skills — it's about creating an environment where people feel respected and motivated. Make training collaborative, inclusive, and tied to purpose. A strong culture of quality turns training into an engine for pride, accountability, and excellence on site.

Mock-ups/ prototypes

Mock-ups and prototypes give workers hands-on experience and set expectations before work commences. They can be developed at any point in the process, but the earlier in the programme they are placed, the more effective they can be. Early stage mock-ups allow all relevant parties to be part of the development and make it possible to establish a best practice approach that can be integrated into the construction drawings.

Examples of mock-ups include:

- Full scale detail mock-up in a controlled environment, enabling airtightness and thermal testing.
- Detail-specific mock-up, allowing operatives to understand detail quality requirements and installation sequence.
- Component level mock-up to test a specific piece of kit.

Fig. 12: *Top left: BE-ST tardis test rig air testing. Top right: Faifley Campus test rig. Bottom: Component mock-up testing the installation and duct connections of an MVHR unit. Image credits: Morrison Construction*

Knowledge gained on projects is hard won, but easily lost unless there are mechanisms and drivers that establish continuity and consistency between projects.

Decisions about technical solutions on projects should factor in lessons learned and best practice from previous projects - which can come from both design teams and supply chains. It's advisable to consider the longer term benefit of developing DfMA (design for manufacture) solutions, and not immediately discount options based purely on upfront cost.

First-in-place inspection/ benchmark tests:

These should form part of the ITP and are instrumental in helping to set the standard early in the project before works progress too far. They provide an opportunity to positively reinforce the quality standards to be achieved on the project in subsequent work.

The decision when and where to set the first-in-place inspections/ benchmarks tests are influenced by:

- How much risk is perceived around the element
- Whether the element is being used as a reference to set a benchmark in quality
- Whether the tests are required by the certifier

Fig. 13: *Process of the evolution of detail mock-up testing to setting first in place inspection hold points.*

Trade-specific toolbox talks

Each trade has specific quality requirements and risks. For envelope and joinery, thermal and airtightness lines are sensitive points; for MEP, sealing penetrations are crucial.

Trade-specific toolbox talks help each trade to:

- understand both the overall performance aim of the project and the importance of how their work interfaces with other trades, to achieve this aim together;
- focus on their specific deliverables, often by including input from manufacturers to explain the correct installation requirements of their product;
- have full clarity on interfaces –that is, who they will be picking up work from, where their work ends, and what condition it needs to be left in.

Trade-specific talks should be interactive and engaging. Encouraging dialogue from operatives will help ensure that they are understood and develop accountability.

Fig. 14: *Passivhaus specific toolbox talk for St Sidwell's Point. Image credit: Stephen Booth, Kier Construction*

Lessons learned

Embed structured 'lessons learned' sessions at project milestones, not just at project completion. This creates a live feedback loop and means that lessons and issues are captured when current, and addressed while teams are still active.

Training summary checklist

Pre-Construction

- [ ] Identify who needs training and at what level.
- [ ] Schedule mock-up sessions for detail development.
- [ ] Train operatives who are responsible for developing ITPs.
- [ ] Embed ‘lessons learned’ sessions at project milestones.

On Site

- [ ] Deliver interactive, trade specific (including manufacturer input) toolbox talks.
- [ ] Conduct first-in-place inspections and benchmark tests.
- [ ] Ensure neurodiverse-friendly training methods (visual aids, interactive sessions).

Case study – Training of workforce and detail development

Context

Faifley Campus is a two-stream primary school, designed by Passivhaus architects Holmes Miller and delivered by Morrison Construction. Located in West Dunbartonshire, the project was procured via the hub West Scotland framework with West Dunbartonshire Council. The funding for the project was partly linked to the operational energy performance of the building in-use, and the client chose both Passivhaus and the 'Net Zero Public Sector Buildings Standard Scotland' as performance standards to meet.

Fig. 15: *Image credit: Faifley Campus, Holmes Miller, Chris Humphreys Photography Ltd.*

Issue to be resolved

At the time of project development, there were limited examples of large-scale steel frame Passivhaus buildings in the education sector. This represented a significant project risk given the perceived complexities of steel interfaces for thermal and airtightness detailing.

Intervention/ solution

In order to gain the required confidence that the chosen solution would achieve the required thermal and airtightness requirements, a significant amount of time was dedicated in the pre-construction period to developing solutions with the design team and supply chain.

The solution that was delivered on site was achieved through an iterative collaborative process developing and refining the envelope details, but more importantly, it allowed the time for the supply chain to input into the details and educate and upskill themselves ahead of site installation.

Fig. 16: *From left to right: 1) Steel rig at BE-ST campus. 2) Panel install at Faifley Campus. 3) Test rig for Faifley Campus. Image credits: Morrison Construction.*

1. Off-site optioneering of detail and component feasibility involving suppliers, design team and sub-contractors
2. Controlled air-testing of developing solution in a purpose built test rig allowed the team to identify weak points in the details and resolve in a controlled environment.
3. On-site mock-up testing various interfaces with site based operatives, including ground slab, external wall, openings and roof construction.
4. Installation on site, resulting in no defects or abortive works

Outcome and lessons learned

The final result was a very robust and simplified solution that comfortably achieved the performance criteria required.

And in parallel with Faifley Campus, another Passivhaus High School project that Morrison Construction were working on was closely engaged in this process and developed the details so they were almost identical to those that were successfully installed at Faifley. The sub-contractor was the same on both projects, and they took their lessons learned where they were more efficient with their time and quality processes, demonstrating a clear line of continuous improvement between projects.

Key lessons learned:

- Involve sub-contractors and suppliers in the pre-construction period, they are the experts in achieving robust buildable solutions.
- Invest time and resources into pre-construction testing. The streamlined process it can lead to during actual construction substantially de-risks the process.
- Strive for consistency across projects through detail refinement, rather than re-inventing the wheel, the supply chain will learn with you and delivering repeatable and familiar details offers commercial and quality benefits.

Fig. 17: *Image credits: Faifley Campus, Holmes Miller, Ruaridh Nicol.*

Quality control

Principles

Quality control is the structured process by which design intent is safeguarded during construction. Unlike quality assurance, which sets systems and standards across business functions and verifies that they have been met, quality control is about the execution of those standards in practice. Ultimately, quality is delivered at the workface and that is where it succeeds or fails. Quality control requires clarity of roles, repeatable processes, and transparent evidence – laying the foundation for the building to achieve its intended performance.

Common issues

Issue	Cause	Effect
Poorly managed change control, both client and contractor driven	Informal or undocumented changes occurring	Materials substituted with non-equivalent performance, reducing building performance
Building material performance compromised	Poor storage and/ or inadequate protection after installation	Damage leading to compromised building performance and costly remedial works
Reporting of quality and inspection records inconsistent	Lack of structured reporting protocols	Issues go unrectified, impacting on certification, building performance and overall client satisfaction
Site operatives not having access to the most up-to-date information	No centralised common data environment	Abortive works and co-ordination issues
Poorly prepared ITPs	Lack of training and inadequate time afforded to preparation of ITPs	Ill-informed quality control measures leading to a lack of control and errors
Disengaged workforce	Unclear lines of communication	Mistakes are made, not reported, and not rectified

Practical guidance

Visible leadership

A culture of quality needs to be guided from the top, with everyone on the site included and feeling empowered by it. Communication from the main contractor to the site team must be clear, consistent and foster an environment where site quality is treated with the same level of care and attention as health and safety.

Leadership must be visible, with directors and senior site managers carrying out regular 'quality walks', to reinforce expectations by presence as much as policy[5].

Management and consequence of change

Changes on projects with high performance contractual requirements can have unintended consequences if all aspects of the change are not fully considered. For example, the performance outputs of an alternative proposed air source heat pump may be the difference between certification success or failure.

All changes must be treated as formal events. The performance impacts of each proposed change should be fully assessed in line with specific project contractual requirements to ensure that in-use building performance and certification requirements are not affected unintentionally.

Capturing evidence for certification

At project outset, ideally prior to contract award, the project team should have dialogue with the relevant certifying body in order to understand the evidence requirements and set up a project-specific evidence register that is clear and prescriptive in its deliverables (see Section 1: Programme).

The site team requires a dedicated, upskilled individual to co-ordinate and manage the evidence workflow. This is a live, organic process and deliverables must be clearly defined and understood from the outset by all involved, including subcontractors.

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5 *Code of Practice for Project Management for the Built Environment, 6th edition (The Chartered Institute of Building, 2022) & Considerate Constructors' Best Practice Hub*

Site Evidence Tracker

Project title: XX
Designer/Contractor: (insert company)

ECD Architects
ENERGY CONSCIOUS DESIGN

Common

Area	No.	Files to upload Example / Template	Site Evidence Item (Link to Sharepoint)	Certifier's notes for QA	(insert company) Review		Certifier Review	
					Status	Comments	Status	Approved
07 Ventilation Installation	07.01		07.01 MVHR-AHU make & model	Create one folder per Unit Ventilation unit series: 4 Adconair 76 03 01 – 76 19 01 systems and 16 Resolair 61 07 01 – 61 15 01 systems, all by Menerga GmbH.				
	07.02		07.02 MVHR manual speed controller	Photo of manual speed controller installed.				
	07.03		07.03 MVHR-AHU filters	F7 for supply air and G4 for extract air. Photo needed as evidence to certify that building meets filter standards.				
	07.04		07.04 MVHR-AHU intake and exhaust duct length	Photo evidence to estimate intake and exhaust duct length from AHU to thermal envelope penetration				
	07.05		07.05 MVHR-AHU intake and exhaust duct insulation material	Insulation thickness 50 mm, thermal conductivity 0.021 W/(mK). Photo evidence of material to be used for duct insulation. Labels showing thermal conductivity and thickness, or a delivery note.				
	07.06		07.06 MVHR-AHU intake and exhaust duct insulation thickness	Insulation thickness 50 mm, thermal conductivity 0.021 W/(mK). Photo evidence of material thickness for each duct. Installed insulation thickness shown with measuring tape.				
	07.07		07.07 MVHR-AHU intake and exhaust duct insulation quality of installation	Ensure the insulation is continuous and well sealed. Photographic evidence of the insulation installation quality for the intake and exhaust ducts. Please include photos of duct supports and fittings.				
	07.08		07.08 Detailing around penetrations through duct insulation	Required only if punctures occur during the ductwork installation and how they were fixed.				
	07.09		07.09 Air transfer paths between rooms	Photo evidence of air transfer paths between rooms (e.g. door undercuts, grilles). Please provide photos showing the door undercut with a measuring tape. When taking the photo, please consider: - The door should be closed. - Finished floor (e.g., carpet, flooring) - Floor joint cover, if present				
	07.10		07.10 Ventilation supply and extract valves	Evidence of clean installation during the construction stage.				
	07.11		07.11 Protection during construction	Photos of the duct delivery, showing how it was stored and protected from dirt and water (e.g., using tapes or foils).				
	07.12		07.12 Confirmation of commissioning of electricity consumption at duty points	Needed as evidence of power consumption under normal operation of the AHU system. Must be signed by on site personnel.				

Fig. 18: *Sample extract from a Passivhaus certifier's checklist, clearly highlighting what is required against each element. See digital resources pack to download this image*

Using a Common Data Environment (CDE)

A CDE is a single, centralised digital platform that stores and manages project information. The CDE underpins quality by centralising drawings, documents and site evidence.

The level of access to the CDE that project teams are granted should be carefully considered, balancing security control with transparency of information for all project stakeholders.

The CDE should be used as the 'single source of truth' for information to ensure that operatives have access to the most up to date information.

Regular reviews of the active issues on the CDE should be carried out by the Project Team to ensure that items are not left unresolved and are dealt with appropriately.

Use of technology

Technology is rapidly advancing, and there are now multiple software platforms that can assist in quality control. The marketplace for such solutions continues to evolve, so a list is not provided here. In assessing software platforms, bear in mind that the most effective will be one that is simple to understand for the entire workforce engaging with it. It is also important that it can connect directly

to the CDE, allowing quality control documentation to be automatically linked to the project information.

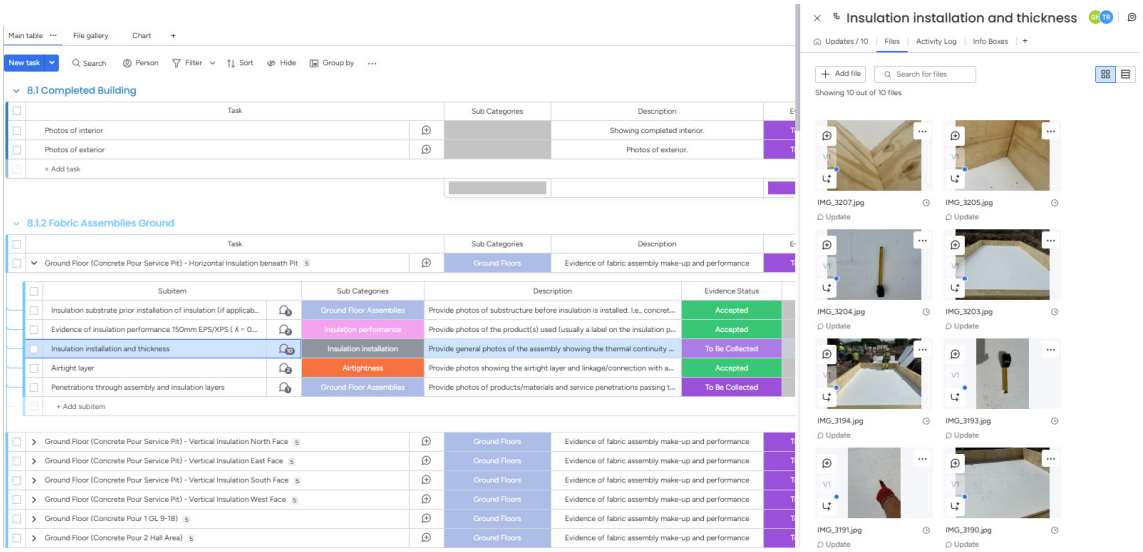


Fig. 19: *Use of software platform to generate work operating system. Image credit: Wilmott Dixon. See digital resources pack to download this image.*

"A project management system widely used across the business has supported evidence gathering on three Passivhaus schemes: Eclipse Leisure Centre, Hounsome Field Primary School, and Glyncoch Primary School.

Developed to streamline Passivhaus quality control, it addresses previous experiences of delays in obtaining detailed feedback on complex junctions and varied superstructure types.

The Common Data Environment (CDE) enables immediate, site-linked photo evidence organised by PHI certification categories, with monthly reviews to close out items and identify upcoming benchmarks.

Build Managers, trained before site start, act as primary evidence collectors and Passivhaus Champions. They submit evidence via the CDE with guidance from the Passivhaus Designer, establishing visibility between visits and efficient feedback loops.

This process continues to evolve, reducing quality risks and helping supply chain partners meet standards promptly upon completion."

Lorna Taverner,Wilmott Dixon

Project- and task-specific Inspection and Test Plans

Inspection and Test Plans (ITPs) are critical for ensuring that the quality of workmanship meets the design intent.

ITPs are the workhorse for implementing quality control on site, yet far too often only lip service is paid to their preparation, with poorly constructed, generic ITPs carried from project to project.

ITPs must be received in a timely manner and adequate time allocated to review. The development of ITPs should be a collaborative process that includes all key parties - contractor, supply chain and manufacturers.

Their value can be understood as follows:

- **Focus on critical details:** Large/ complex high performance buildings depend on fine tolerances at junctions, insulation layers, airtightness membranes, and services penetrations. ITPs highlight these elements, ensuring they receive the attention needed. The ITP should also prioritise 'first in place' inspections to ensure that installation quality is set and agreed by all parties prior to works fully progressing.
- **Clarity of responsibility:** ITPs set out who inspects what, when, and how, creating accountability among subcontractors and site managers for achieving the required standards.
- **Consistency and repeatability:** Standardised inspection procedures reduce reliance on individual judgment, ensuring that quality assurance is consistent across all trades and throughout the project.
- **Documentation and evidence:** ITPs provide a clear audit trail of inspections and test results, which is crucial for certification and for client confidence in the building's performance.

Stage	Ref	Activity / Description	Inspection or Test (use a separate line for each Inspection or Test)				Requirement		Verification (method of checking)	Frequency (of check)	Locations (of checks)	Records (detail the Evidence that will prove the requirement has been met)	Who is responsible (for closing out the requirement)	Monitoring Requirements				
			at source	at delivery	in progress	final	Where from (document & clause)	What is the requirement (acceptance criteria)						S/C	PC	Designer	Client's Rep	Other
Delivery	4.0	Delivery of Materials		I			N/A	All materials comply with those described on the Material Approval Request forms.	All materials to be inspected prior to or immediately after un-loading to ensure: 1) The material described on the Delivery Ticket is that described on the Material Approval Request (MAR). 2) The material being delivered complies with that described on the Delivery Ticket (type and quantity) 3) The material being delivered is not damaged.	Every delivery	At point of delivery / un-loading	Signed Delivery Ticket - with written confirmation that the delivery complies with the MAR.	Sub contractor					
Pre Start	5.0	Steel Frame Handover			I		N/A	Setting-out is in accordance with the drawings / schedules / model - within stated tolerances.	Setting-Out Engineer to check their own work. Independent Setting-Out Engineer or Senior Engineer to provide independent check.	Each Zone	Each Zone	Handover Sheets	Setting-Out Engineer (primary check).	I	I	N/A	R	N/A
	5.1																	
In Progress	6.0	Deck			I		XX	TATA STEEL D32, 0.7mm THICK	Check Drawings / Quality Inspection Sheet	Daily	Each Zone	Photographs / Joint inspection	Sub contractor	I	I	R	R	
	6.1	Deck Fixings			I		XX	FIXED TO STEEL PURLINS USING SX3-S16-6x29 FIXINGS IN EVERY TROUGH, TO EVERY PURLIN.	Check Drawings / Quality Inspection Sheet	Daily	Each Zone	Photographs / Joint inspection	Sub contractor	I	I	R	R	
	6.2	Deck End Laps			I		XX	SIDE LAPS STITCHED WITH SL2-S-S16-5.5x25 @500mm CTRs & TAPED WITH 50mm x 1mm SWRP10 TAPE	Check Drawings / Quality Inspection Sheet	Daily	Each Zone	Photographs / Joint inspection	Sub contractor	I	I	R	R	
	6.3	Deck Side Laps			I		XX	SIDE LAPS STITCHED WITH SL2-S-S16-5.5x25 @500mm CTRs & TAPED WITH 50mm x 1mm SWRP10 TAPE	Check Drawings / Quality Inspection Sheet	Daily	Each Zone	Photographs / Joint inspection	Sub contractor	I	I	R	R	

Fig. 20: *Extract of an example ITP for the installation of an envelope – See digital resources pack to download this template as an editable excel file*

Lines of communication and hierarchy of authority

Hierarchies of authority exist for good reason, and issues can occur on site where they are not observed. For example, if an observation made in good faith is acted upon without the appropriate authority, change control mechanisms may be bypassed and implications not properly assessed, leading to unintended cost and quality consequences.

Clear lines of communication are vital to ensure that instructions and direction come from a single point of authority and to avoid mixed messaging.

Recognition and rewards

Quality should not be seen as merely compliance. Rather, it should be seen as a source of pride and the foundation of a good reputation. It is the route to delivering buildings that both companies and tradespersons can be proud to stand behind.

Initiatives such as monthly 'quality' awards help promote healthy competition across contractors and the supply chain, rewarding best practice and positive behaviours on site. But as well as more formal recognition of a job well done, the power of showing appreciation personally cannot be overstated – even a simple thank you. If authentic, it can demonstrate that leadership genuinely recognises the valued contribution of the workforce and helps instil a feeling of self-worth and pride.

Recognising training and qualifications

The benefit of investment in training and upskilling the workforce is realised when it comes to delivering quality on site (see Section 3: Training). Successful completion of training that is short of an accredited qualification (such as Certified Passivhaus Tradesperson) can be recognised with a certificate or badge, such as the 'Passivhaus Passport' scheme. Such a scheme:

- verifies the standard of training received;
- motivates the workforce by creating a sense of achievement and route to progress; and
- enables access control on site for trained personnel only (see image on the next page).

Fig. 21: *Areas clearly delineated, with signage highlighting only trained personnel shall have access. Image credit: Nairn Academy, Balfour Beatty.*

Workforce feedback

Mistakes only become significant problems when they are not reported and rectified. Establishing a 'no-blame' culture on site creates a solution-oriented environment, where issues can be identified and addressed quickly rather than allowed to escalate.

When time and budget pressures begin to challenge the quality commitment, tradespersons must feel able to raise concerns early. This creates the opportunity to prevent errors, rather than correct them after the fact.

Initiatives which encourage engagement from tradespersons, such as suggestion schemes, can help them see the culture of quality as something they actively participate in, rather than simply comply with. As with subcontractor feedback, the value of input from the experience of those at the workface should not be underestimated.

Site signage and posters

Site signage and posters are an effective way of conveying expectations and culture on site. However, there is a balance to be struck – too much information can result in signage blindness or fatigue, where operatives simply ignore signs because too many are displayed.

Signage should be focused, simple and straightforward to understand. It should be limited to the most important issues on site – including quality as well as health and safety.

Fig. 22: *Culture should be visible as soon as you enter site. Image credit: St Sidwell's Point, Kier Construction*

A culture of quality

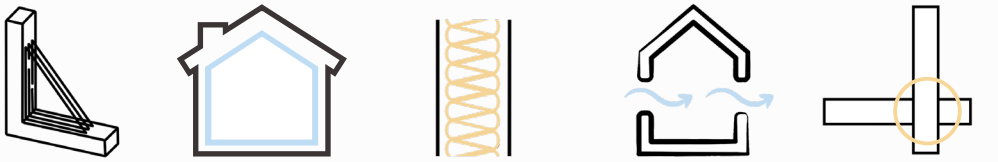
As an industry, we can underestimate the influence of our working environment. It sets the tone for how we perform and what we expect from others.

Quality starts with culture, and culture is shaped by the environment we create. The way we manage our workplaces signals the standards we expect and how we value our people.

Today's workforce has high expectations of working conditions. Investing in better facilities – with attention paid to organisation, maintenance and visual cues – is an investment in quality. It demonstrates care, reinforces expectations, and supports pride in workmanship.

THIS IS A PASSIVHAUS PROJECT

THE 5 PILLARS OF PASSIVHAUS



Windows | Airtightness | Insulation | Ventilation | Thermal bridging

Passivhaus performance relies on 3 core principles: clear criteria, PHPP modelling, and rigorous quality assurance.

PASSIVHAUS IS A METHODOLOGY, NOT AN AESTHETIC

What a Passivhaus project means for you

- Ensure the trade you are following has been QA checked and handed over.
- Use the correct materials and equipment, and follow drawings, specifications, and manufacturer instructions.
- Install in the correct sequence.
- Record and evidence all work in the BIM checklist.
- If mistakes occur, don't cover them up - stop and seek supervisor guidance, following manufacturer advice to make good.
- Avoid complacency: take time to stay familiar with materials and guidance, and if in doubt, stop.
- Fix issues immediately - delays will increase cost and disruption later.

Passivhaus Trust

BE—ST Built Environment – Smarter Transformation

Fig. 23: *Passivhaus site poster. See the media pack for a free print-ready download.*

Quality Control summary checklist

Leadership and culture

- [ ] Schedule regular quality walks by senior managers.
- [ ] Communicate quality expectations clearly and consistently.
- [ ] Recognise and reward the contributions of the team.
- [ ] Facilitate workforce feedback.

Processes

- [ ] Implement a Common Data Environment (CDE) for all project information.
- [ ] Formalise change control procedures to assess building performance impact.
- [ ] Develop project-specific evidence register with certifier.
- [ ] Align evidence requirements with subcontractor orders and ITPs.
- [ ] Establish clear communication hierarchy for site instructions.
- [ ] Introduce recognition and reward initiatives for quality performance.
- [ ] Set up the workplace with clear and focused site signage.

Case study – Quality culture throughlines

Context

St Sidwell's Point was a pioneering project by Kier Construction which successfully achieved Passivhaus certification for a large, complex leisure centre building. The strategies developed were subsequently refined by Kier Construction and applied to the Currie Community High School project, both requiring innovative approaches to meet stringent performance standards.

Fig. 24: *Image credit: Currie Community High School, Kier, BK Photography*

Issue to be Resolved

Delivering Passivhaus on large-scale commercial projects posed two major challenges:

- Cultural and behavioural barriers: Traditional site practices prioritised speed and cost, often compromising workmanship under deadline pressure.
- Technical complexity: Conventional airtightness testing methods for domestic projects were unsuitable for large, multi-zone buildings, creating risk of certification failure.

Intervention / Solution

- **Early Engagement and Collaboration**
  Project teams engaged stakeholders, manufacturers, and suppliers early to align on requirements, identify risks, and establish standard solutions for common workmanship challenges. Continuous improvement was supported

through regular site visits, enabling close monitoring of installation quality and reinforcing best practices.

- **Culture Shift**
  Introduced trade-specific inductions, a 'no-blame' culture, and the Passivhaus Passport scheme to foster accountability and pride in quality. Workforce feedback was actively sought to build ownership. Regular communication simplified methodologies and clarified the implications of individual tasks, ensuring operatives were well-informed and confident in their work.

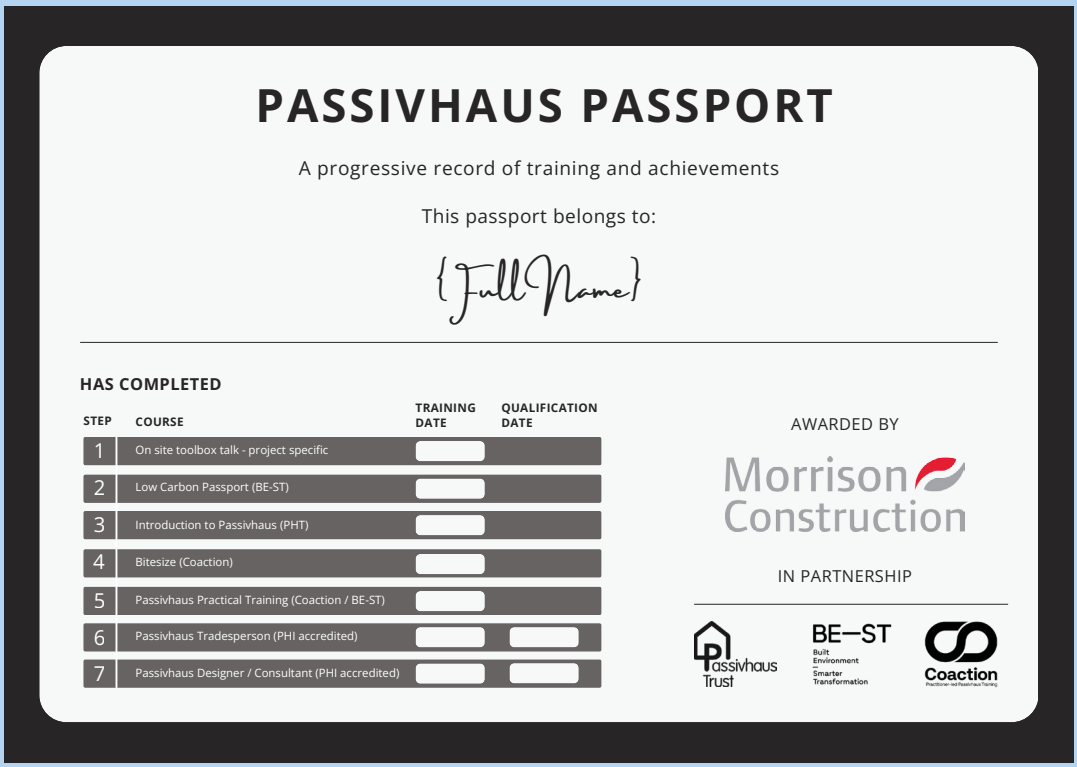


Fig. 25: *Passivhaus training passport . See digital resources pack for a free print-ready downloadable template.*

- **Innovative Testing Strategies**
  Developed flexible airtightness methodologies, including mock-ups, small-scale tests, and interim assessments. Evolved the TTARDIS (Testing, Training & Research rig for Design development, Installation & Sequencing) concept to incorporate all key envelope interfaces—windows, doors, curtain walling, cladding, and roofing.

Fig. 26: *From left to right: 1) The first TTARDIS (Testing, Training and Research rig for Design development, Installation & Sequencing) developed for the St Sidwell's Point project. 2) Example site mock-up, St Sidwell's Point. 3) Evolution of the TTARDIS. Image credits: Stephen Booth, Kier Construction & BE-ST.*

Lessons Learned

- Early and continuous collaboration reduces risks and accelerates problem-solving.
- Cultural transformation is essential—quality must be prioritised over speed and cost.
- Flexible, project-specific testing strategies are critical for large-scale Passivhaus delivery.
- Investing in training, mock-ups, and iterative testing builds confidence and ensures robust performance across complex interfaces.

Commissioning

Principles

The commissioning period is a critical stage for large or complex high performance buildings. It verifies that systems – particularly ventilation, and heating – are operating in line with the design intent and certification requirements.

This phase requires protected time for rigorous testing, fine-tuning, and evidence collection. If compressed or disrupted, the risk to building performance and compliance increases significantly.

Common issues

Issue	Cause	Effect
Commissioning period compressed	Programme delays in the main construction works	Risk of certification failure and long-term operational issues
Enhanced certification requirements not understood at procurement stage	Lack of early engagement and clarification with the certifier	Unplanned and uncosted works late in the project
Clients unavailable to witness testing	Insufficient client resourcing and forward planning	Poor understanding of building controls, leading to in-use performance issues

Practical guidance

Protecting the commissioning period

The commissioning phase must be ring-fenced and safeguarded from disruption during construction. In reality, this can be challenging, but treating the commissioning start date as a non-negotiable milestone on the critical path helps maintain focus. Reinforce its importance with the supply chain and hold

open, honest discussions with the client if delays arise—this proactive approach can lead to practical solutions that protect the time allocated for commissioning.

Practical strategies to protect commissioning:

Integrate commissioning into the main programme early

- Start with the end in mind, create a dedicated commissioning programme that is fully embedded in the main construction schedule.
- Highlight critical path activities (e.g., airtightness completion, MEP installation) and make them clearly visible and understood.

Commissioning tracker and checklists

- Develop a tracker that lists all commissioning tasks, evidence requirements, and sign-off points.
- Review this tracker weekly alongside short-term planning sessions to maintain visibility and accountability.

Early engagement with designers and certifiers

- Engage early with the design team (and certifier where required) to clarify enhanced commissioning requirements and evidence needs.
- Share draft commissioning reports or examples from previous projects to agree on acceptable outputs before testing begins.

Ring-fence time and resources

- Treat the commissioning start date as a hard deadline on the critical path.
- Communicate this clearly to subcontractors and the client, and escalate any slippage early to allow for pragmatic discussions to take place.

Client involvement and training

- Define client roles and responsibilities at the outset, ensuring they allocate resources for witnessing testing, and more importantly to ensure they understand system operation.

Commissioning summary checklist

Early planning

- [ ] Integrate detailed commissioning into main programme.
- [ ] Develop commissioning tracker listing tasks, evidence, and sign-off points.
- [ ] Engage designers and certifiers early to clarify requirements.
- [ ] Ring-fence time and resources for commissioning phase.
- [ ] Define client roles and ensure resources for witnessing tests.

Handover

Principles

Handover is about transferring knowledge, not just the building. For large or complex high performance buildings, this stage is especially important. Building performance depends on end users understanding how the building is intended to operate.

Effective handover equips clients and end users to manage systems and controls effectively. It requires the right people to be involved at the right time, with a clear and structured process.

Common issues

Issue	Cause	Effect
Handover packs lack accurate as-built information	Poor documentation process	End users lack clear understanding of building operation
Insufficient guidance on system controls	End-user training not prioritised	Building does not perform as designed
Absence of follow up assistance	No structured post-completion support	Unresolved defects and systems operating below specification

Practical guidance

End user training

In planning end user training, it should not be assumed that the training process is complete at the point of handover. The majority of end users may not utilise the building until long after it is handed over.

Training should take place in a staggered manner over the course of the initial occupation period of the building. It should continue alongside the fine tuning of the building systems, with the result that all parties gain a deeper understanding of how the building is designed to operate and be maintained.

Types of handover information

The types of handover information should be agreed early in the process, ideally in the pre-construction period, to ensure that the necessary allowances for their production are made.

Handover information should be delivered digitally where possible. Digital O&M (Operation and Maintenance) manuals, 3D models, and evidence records support a more proactive approach to building maintenance and performance than hard copy manuals.

For end users, simple signage can be effective in reinforcing how the building should operate and what they can control. It should be clear about hierarchies of decision-making based on either objective or subjective analysis of the internal environmental conditions.

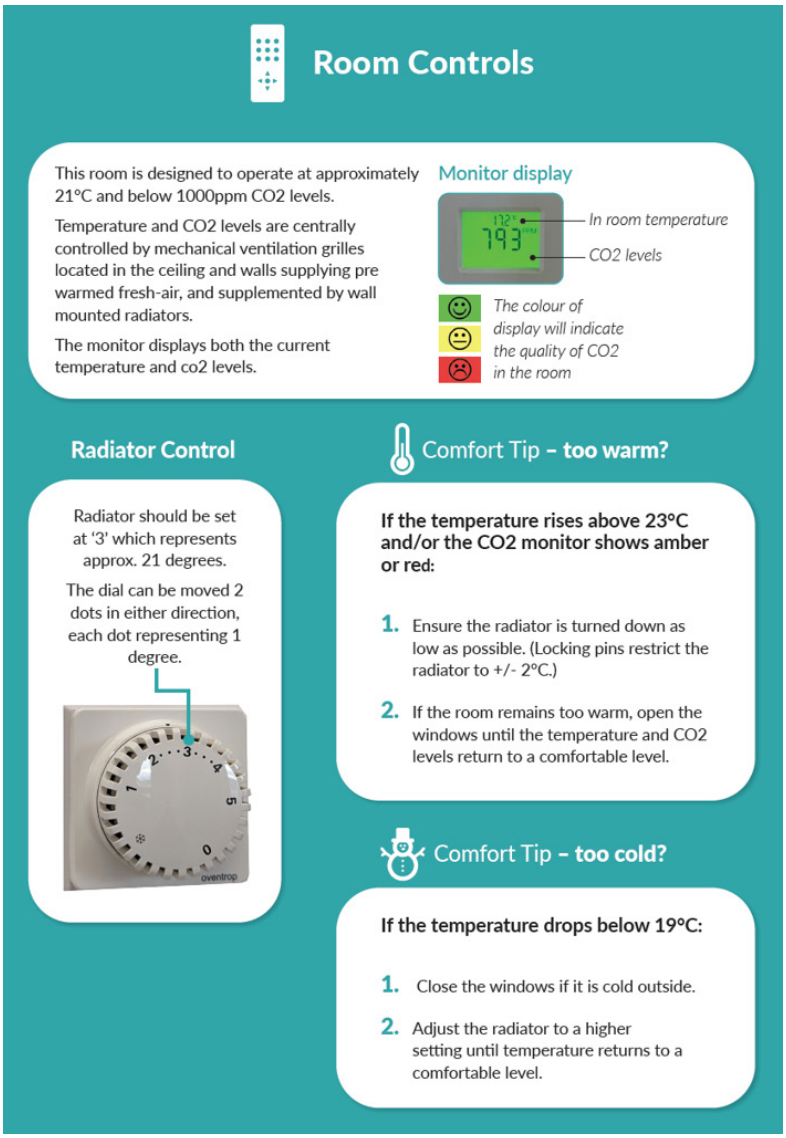


Fig. 27: *In-class signage highlighting to end users how to operate environmental controls. Image credit: Morrison Construction*

Post completion resources

Resourcing for handover should be discussed and planned from the outset. For large/ complex high performance buildings, this will likely involve additional specialist support. Resource requirements should be understood early so that they can be captured in the project planning and budgeting, avoiding issues at the end of the project.

Client-end building champion

It is recommended that the client nominates a lead to manage the handover process from start to finish. This individual should act as the single point of contact, take ownership of the knowledge transfer, and champion best practice in end user engagement with the building performance.

Handover summary checklist

Pre-Construction

- [ ] Plan staggered end-user training sessions during early occupation.
- [ ] Allocate resources for post-completion support.
- [ ] Nominate client building champion for knowledge continuity.

Delivery

- [ ] Install clear signage for building operation.
- [ ] Record training sessions with building operators and end users for future reference.

Case study – Handing over a complex building

Context

Occupied since June 2023, Riverside is Scotland's 1st Passivhaus certified Primary school and was designed by Passivhaus architects Architype and delivered by Robertson Construction. The design of the school included for MVHR ventilation as the primary ventilation strategy and a natural summer purge ventilation strategy via windows with external louvres, allowing secure inward opening by occupants when required.

Fig. 28: *Riverside School, image credit: Architype, David Barbour photography*

Issue to be resolved

When the project was handed over, there was 2 weeks remaining of the school term before summer close. A user guide and workshop day for training and hand over was implemented. The façade of the school is designed with secure louvres over certain window openings, for purge ventilation, particularly at night in warm weather.

There was confusion about the operation of these windows in warmer periods. In the initial weeks the school was reporting higher internal temperatures than expected in the mornings. Teachers were leaving the louvred windows open in the afternoons once school finished (as advised), but the cleaners were coming in a short while later and closing the windows back up, so warmer air was not able to dissipate via the strategy intended.

Intervention/ solution

Another workshop was held to involve all users of the school in the school's operation. User guides, which originally were only put up in common areas, were developed for each space that had louvred windows. This additional signage made communication very clear about the strategy.

Outcome and lessons learned

When a school is handed over there are many information, training and handover procedures that occasionally can be compressed due to the pressure to complete buildings around teaching semesters. There can be fatigue amongst client/users with the volume of information and what they feel they ought to know.

- It is worth investing in developing a relationship with the users for the first year at least to be pre-emptively ahead in identifying issues before they escalate.
- Maintaining a collaborative open relationship with the client and supply chain is critical: the services leads in all parties for Riverside as well as the Architect/Passivhaus designer were in regular open communication when queries or issues arose, often before occupants were aware, also via monitoring of the BMS systems.
- More time taken between handover and the implementation of training sessions
- Repeated training sessions for a period of time post completion, ideally in person, gives users/operators ownership and clarity over the school operation.

The measures taken to resolve the issues were successful. In September 2024, the Perth region, like many parts of Scotland, experienced a heatwave with peak external temperatures reaching at least 28°C. Riverside was reported by the client to be the coolest temperature building within their estate during this time. The, by now, familiar summer purge ventilation strategy, alongside other benefits of resilient high quality Passivhaus buildings, meant that Riverside primary school remained comfortable through this period of external high temperatures.

Glossary

BE-ST	**Built Environment-Smarter Transformation** (Scotland's innovation centre for construction and the built environment)
CDE	A **Common Data Environment** (CDE) is a single, centralised digital platform that stores and manages project information. The CDE underpins quality by centralising drawings, documents and site evidence.
CDP	The **Contractor's Design Portion (CDP)** is an agreement for the contractor to design specific parts of the works. The contractor may in turn sub-contract this design work to specialist sub-contractors.
CIOB	**Chartered Institute of Building**
DfMA	**Design for Manufacture and Assembly**
ITP	**Inspection and Test Plan**
MEP	**Mechanical, Electrical and Plumbing**
RIBA	**Royal Institute of British Architects**
Tier 1 Contractor	A **Tier 1 contractor** is appointed directly by the client to lead delivery on large-scale projects.

Further resources

Publications

- Low Energy Building Optimisation through Supply Chain Collaboration
- Passivhaus Certifier Scope of Services
- RIBA Passivhaus Overlay
- Steel in Passivhaus Construction
- Certifying a Passivhaus: Tips and Costs
- Thermal Bypass Risks
- RIBA Plan of Work
- Code of Practice for Project Management for the Built Environment
- Considerate Constructors' Best Practice Hub

Resources

- Delivering Quality digital resources pack
- Passivhaus Learning Hub
- BE-ST Skills & training
- 2025 Large and Complex Passivhaus Masterclass on-demand

Summary checklists

Programming
Pre-construction
☐ Aim to complete majority of RIBA stage 4 activities before site mobilisation
☐ Engage with supply chain to confirm lead-in times and install durations
☐ Include key quality testing and hold points
☐ Develop airtightness strategy and integrate into programme
On-site
☐ Create weekly rolling plans for key activities
☐ Use visual tools for clarity of understanding
☐ Base plans on real discussions with sub-contractors
Procurement
Pre-construction
☐ Develop sequencing diagrams collaboratively (digital or marked-up drawings).
☐ Confirm CDP elements and scope clarity.
Tender
☐ Confirm CDP elements and scope clarity.
☐ Schedule mid-tender interviews to validate understanding.
☐ Provide actionable feedback to tenderers
Before contract award
☐ Align subcontractor orders with certification evidence requirements.
☐ Conduct formal handover meeting with client, design team, and certifier.
Training
Pre-construction
☐ Identify who needs training and at what level.
☐ Schedule mock-up sessions for detail development.
☐ Train operatives responsible for developing ITPs.
☐ Embed lessons learned sessions at project milestones.
On-site
☐ Deliver interactive, trade specific (including manufacturer input) toolbox talks.
☐ Conduct first-in-place inspections and benchmark tests.
☐ Ensure neurodiverse-friendly training methods (visual aids, interactive sessions).

Quality Control
Leadership and Culture
☐ Schedule regular quality walks by senior managers.
☐ Communicate quality expectations clearly and consistently.
Processes
☐ Implement a Common Data Environment (CDE) for all project information.
☐ Formalise change control procedures to assess building performance impact.
☐ Develop project-specific evidence register with certifier.
☐ Align evidence requirements with subcontractor orders and ITPs.
☐ Establish clear communication hierarchy for site instructions.
☐ Introduce recognition and reward initiatives for quality performance.
Commissioning
Pre-construction
☐ Integrate detailed commissioning into main programme.
☐ Develop commissioning tracker listing tasks, evidence, and sign-off points.
☐ Engage designers and certifiers early to clarify requirements.
☐ Ring-fence time and resources for commissioning phase.
☐ Define client roles and ensure resources for witnessing tests.
Handover
Pre-construction
☐ Plan staggered end-user training sessions during early occupation
☐ Allocate resources for post-completion support.
☐ Nominate client building champion for knowledge continuity.
Delivery
☐ Install clear signage for building operation.
☐ Record training sessions with building operators and end users for future reference.

Passivhaus Trust
The UK Passive House Organisation

BE—ST
Built Environment — Smarter Transformation

Morrison Construction

Balfour Beatty