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Modular buildings and compliance checks

Dr Louise Webb, director at DRLC Ltd, looks at post-completion compliance issues in modular healthcare construction and argues the case for early-stage oversight.

The increasing adoption of modular construction in healthcare – where hospital and clinic buildings are prefabricated off-site – offers clear benefits in speed, cost, and sustainability. However, this shift introduces new challenges in ensuring compliance with healthcare building services regulations.

Traditionally, Authorising Engineers (AEs), Clerk of Works, and NEC4 Project Supervisors conduct compliance checks through site visits and witness testing after construction. In modular builds, this approach may be too late, as critical systems are already designed and assembled in the factory.

In this article, I highlight real-world examples where compliance issues were discovered post-installation, such as inaccessible air handling unit intakes and non-compliant modular bathrooms. These issues, once embedded in the modular design, are difficult or impossible to rectify – especially when replicated across multiple sites.

To address this, I am arguing for a paradigm shift: compliance oversight must begin on the factory floor. AEs should be involved earlier in the process, reviewing and approving systems during fabrication.

As modular construction becomes more prevalent, early-stage compliance checks are essential to safeguard quality and patient safety across healthcare estates.

What is a modular building?

The concept of modular construction has grown significantly in popularity over the past decade, largely because of its reputation for being more sustainable and environmentally responsible when compared with traditional on-site construction methods. Instead of building entirely on location, large sections of a modular building are manufactured in controlled factory environments and then transported to the site for assembly. This shift in approach not only reduces waste and shortens build times but also offers a pathway to lowering the carbon footprint of new developments, something that has become increasingly important across both public and private sectors. Modular building is also known as a Modern Method of Construction or MMC.

AHU fan viewed through porthole.

For the NHS in particular, the need to explore innovative building approaches has become urgent. Much of the health service's estate is ageing and struggling to cope with modern demands, leading to a mounting backlog of maintenance issues. At the same time, hospitals and community services are facing intensifying pressure from rising patient numbers, limited space, and an increasing expectation for quicker access to care. Adding to these challenges is the discovery that many NHS buildings in England were originally constructed using Reinforced Autoclaved Aerated Concrete (RAAC). While RAAC was initially praised for being lightweight and inexpensive, the material has proven to deteriorate after about 30 years in service. This has resulted in significant structural risks in some facilities, forcing urgent decisions about repair, replacement, and in some cases, complete hospital rebuilds.

Early-stage compliance checks are essential to safeguard quality and patient safety

Alongside these structural and logistical pressures, the NHS is also committed to achieving its ambitious climate targets. In October 2020, it published the landmark strategy Delivering a 'Net Zero' National Health Service, setting out a roadmap for becoming the world's first health system to reach net zero carbon emissions. The document highlights the importance of 'optimising the location of care', which includes shifting more services into communities and closer to patients' homes, as well as creating facilities that enable earlier detection and faster diagnosis of illness. By identifying conditions sooner, the NHS can provide treatment that is less invasive, less resource-intensive, and ultimately more effective. To support these goals, a national programme of Community Diagnostic Centres (CDCs) has been launched, and many of these facilities are now

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being delivered using modular building techniques.

Modular building systems bring a number of advantages in this context. Because the majority of the construction work is completed offsite, the level of disruption at busy hospital sites is dramatically reduced. This is particularly valuable in large acute hospitals where services must remain operational throughout building projects. Modular construction also enables more predictable timelines, as fabrication in factories is less subject to weather delays and other on-site variables. Furthermore, when the same design is replicated across multiple sites, time is saved not only in construction but also in the planning stages. Building layouts, as well as detailed Mechanical and Electrical (M&E) specifications, can be standardised and reused, ensuring consistency and efficiency from project to project.

Beyond speed and convenience, modular methods also contribute to the NHS's sustainability agenda. The process typically produces less material waste, requires fewer deliveries to site, and consumes less energy overall, making it a lower-carbon alternative to traditional building approaches. Taken together, these factors explain why modular construction has become such a powerful tool for the NHS in its efforts to modernise facilities, reduce environmental impact, and deliver better healthcare spaces for patients and staff alike.

How are compliance checks carried out currently on traditional builds?

In the NHS currently, there are a number of building services compliance standards known as Health Technical Memorandums (HTMs). There are also standard documents known as Health Building Note (HBNs).

These standards cover all the building services in a clinical building such as ventilation, electricity, water, and medical gases. There is also a HTM for Fire Safety, known colloquially as the Firecode, which is the HTM05 which comprises 14 documents.

Taking the example of healthcare ventilation in new building being constructed using a traditional building process where the building is being constructed on a building site. The ventilation is supplying a new Ultra Clean Ventilation (UCV) theatre. In this case the compliance checks may be carried out by an Authorising Engineer – Ventilation (AE(V). The first process would be to review the design of the new theatre and its associated air handling unit and assess whether the air flows are compliant, which means that air flows from clean to dirty and that there are sufficient air changes for the particular area of the healthcare building. For example isolation rooms have to be supplied with air flows to make them negative pressure and theatres are expected to have 22 air changes. This is all deduced by a close inspection of the drawings.

When the building of the new facility commences the AE(V) will carry out regular spot checks to ensure the ventilation system including the ducting is being installed to a required standard. The ventilation equipment may have been built bespoke to that particular healthcare facility. Then the AE (V) will carry out construction stage checks followed by witnessing commissioning and verification followed by sign off and handover to the Appointed Persons (AP's) and their counterpart Competent Persons (CP's).

The structure of the checks is outlined in the panel above.

How are modular buildings checked for compliance at the moment?

The essence of a modular building process is that the majority of construction takes place within a factory setting, where the building's key components are manufactured and assembled before being transported to the final site. This approach brings efficiency and consistency, but it also creates unique challenges. Once the modules and their integrated systems arrive on site, they are already in a near-complete state, which makes significant modifications extremely difficult, costly, or in some cases practically impossible to carry out.

Because modern methods of construction are based on standardised, repeatable processes, there is often an assumption that if a design has been used successfully before, it will automatically be suitable in future applications. For instance, a modular design previously used for a healthcare facility might be rolled out to another site without undergoing the same level of initial scrutiny. This assumption can weaken the first stage of the typical four-step compliance process – 'Design Review'. Instead of carefully reassessing the design for each new project, stakeholders may believe that the design is already proven, even though specific site conditions or updated standards might demand reconsideration.

The inspection stage risks becoming a formality rather than an effective safeguard

The structure of the checks

Design Stage Review

- An Authorising Engineer – Ventilation (AE(V)) (or the equivalent specialist for other services) reviews the design drawings and specifications.
- They check that the system (e.g. ventilation) meets HTM requirements:
  - •Correct air change rates (e.g. 22 for operating theatres).
  - •Correct airflow direction (clean → dirty).
  - •Specialist cases (e.g. isolation rooms must have negative pressure).

Construction Stage Checks

- During construction, the AE(V) (or relevant Authorising Engineer) conducts regular site inspections.
- These spot checks confirm that the installation of equipment and ducting matches the approved design and complies with standards.
- Many systems are bespoke to the facility, so this process is critical.

Commissioning and Verification

- Once installation is complete, the system undergoes commissioning tests (e.g. air velocity, pressure differentials, filtration performance).
- The AE(V) reviews commissioning results and certifies compliance.

Handover and Ongoing Compliance

- Only when compliance is demonstrated can the facility be signed off.
- For ongoing assurance, Authorised Persons (APs) and Competent Persons (CPs) carry out routine maintenance, monitoring, and re-verification against HTMs.

Summary

- Design review (paper compliance).
- Onsite inspections (build quality).
- Commissioning tests (system performance).
- Handover sign-off and ongoing monitoring.

Scrub sink in theatre suite.

Hospital corridor.

The inspection that occurs once the modules are delivered to site also differs considerably from inspections of traditional builds. In conventional construction, compliance checks can be carried out progressively as the building is assembled step by step, meaning that non-compliances can be identified early and corrected with relatively little disruption. By contrast, modular buildings often arrive in a completed or nearly completed state. At this stage, the opportunity to address compliance issues is much narrower, as retrofitting or altering factory-built components can require major intervention or may simply not be feasible. Consequently, the inspection stage risks becoming a formality rather than an effective safeguard.

The author has encountered these challenges first-hand during an on-site inspection of a modular building constructed for a healthcare estate. In this case, the Air Handling Unit (AHU) installed in the facility did not meet the requirements set out in HTM 05-01, the standard governing specialised ventilation systems in healthcare premises. Although the plant was already operational, it presented a clear compliance failure: the design did not provide adequate access for cleaning and maintaining the fresh air intake. This limitation not only represented a breach of the standard but also posed a long-term risk, as inadequate maintenance access could eventually cause the AHU to malfunction. Despite the clear non-compliance, there was little appetite from the client or contractor to carry out modifications, given the scale of disruption and cost that would have been involved. This case illustrates the real-world difficulty of addressing compliance failures in modular buildings once installation is complete.

What is the problem with this system of compliance checking?

I spoke with Edward Wright, an experienced Authorising Engineer and currently the engineering manager for DRLC Ltd, and asked his opinion of modular buildings. He said:

"The concept of modular buildings is not new; they have been around in the UK in force since the second world war. Prefabrication can be traced back to the Romans, though in the 1940s they were called prefabricated buildings, the concept is the same.

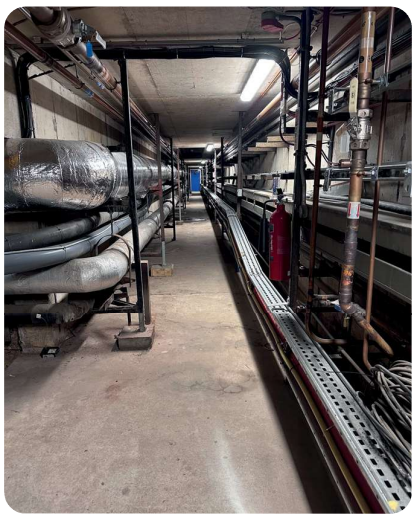
"Historically the 'prefab concept' did not meet what was actually produced, what was in the majority of cases was a cold damp box that were held on to at great cost to health."

I mentioned that the prefabricated houses that sprung up after the end of World War II in the UK had largely disappeared.

"Yes, the boxes have virtually vanished due to legislation and new materials. we still have the element where off-site manufacture does not meet the on-site tolerances/requirements."

I asked Edward what would be needed to ensure modular buildings were of a high standard and he explained:

"Should the process or the manufacture be completely aligned with the actual build and stay within the tolerances of the build this would be a beneficial way forward as this would improve many elements of the construction industry ranging from the speed of build, cost savings from materials and reduction of on-site waste. The list goes on and on."



Plant room corridor in a hospital.

I asked Edward to share his experience of modular buildings:

"From my experience the Modular element either in toilet blocks, prison cells and even modular walls have been challenging where pre-formed holes have not lined up. Then there were the showers where the water runs out of the door, the doorways which were not square. I recall modular pipe runs where one modular frame will not mate with the next and even down to pipes within the modular frame being not being in the correct order with the risk of mixing hot and cold water of not corrected with all the risks of such things like Legionella growing in the tepid water. Yes, this can be resolved, but at what cost not only to the NHS also impacts on the programme and requires additional labour and if the modular parts that are not correct are sent back the programme plan and the final cost."

I asked Edward if he had any confidence in things getting better in the future:

"Sadly, due to the constant saving and value engineering or investor pressure, the process and manufacture either in the building element or mechanical and electrical off-site manufacture rarely fits the on-site requirements. You could argue this is not so critical on a house build, though still expensive to correct not only financially but also on the program. On a multi-storey building, such as a hospital wing, as the structure is built independently of the offsite modular sections if the tolerances have not been met from both parties it could have serious implications for the compliance of the building."

How could the system of compliance checking be improved?

The role of modular buildings within the wider construction industry is well established and not in dispute. Their advantages over traditional methods of construction are numerous and widely recognised. Modular techniques allow for

DRLC staff member Gary next to air handling unit.

DRLC staff member Christian testing air flows for compliance.

DRLC MD David Livingstone checking compliance of plant.

faster delivery times, reduced waste, improved quality control through factory production, and significant reductions in carbon emissions. In addition, because the process is replicable, once a design has been proven it can be rolled out across multiple sites with a high degree of efficiency. This combination of environmental, economic, and practical benefits means that modular buildings are increasingly being viewed as an essential part of the future of construction, particularly in sectors such as healthcare where demand for new facilities is both high and urgent.

However, the author suggests that the adoption of such a new and innovative method of constructing buildings necessitates a parallel rethink of how compliance checks are conducted. Traditional compliance processes were developed with conventional, on-site construction in mind, where inspectors can observe the building as it is progressively assembled and intervene if necessary. Modular construction, by contrast, transfers much of the activity away from the site and into the factory, where key systems and components are completed before delivery. This shift requires a reconsideration of when and how compliance inspections should take place to ensure that the same standards of safety, functionality, and regulatory adherence are being met.

At present, compliance inspections typically begin once the modules arrive at site, when they are already assembled or near completion. This timing creates a significant challenge: by the time issues are identified, it may be too late to resolve them without major disruption or prohibitive cost. The author therefore argues that amendments to the current inspection regime are essential. A crucial improvement would be the addition of a preliminary stage focused specifically on the factory environment. In this approach, inspectors would visit the manufacturing facility while the modular components are being designed, assembled, and fitted out.

Such early-stage inspections would provide an opportunity to confirm that the systems and materials being used are appropriate for the intended context – in this case, a healthcare environment. By verifying compliance at the factory stage, inspectors can ensure that modules are being built to meet the strict standards required, such as those relating to ventilation, fire safety, and infection control. This proactive approach would not only reduce the likelihood of non-compliant buildings being delivered to site, but also provide greater assurance to clients and regulators that modular construction is capable of meeting the highest levels of performance demanded in critical sectors. **IFHE**