

TG 17/2019

Offsite Construction for Building Services

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A BSRIA topic guide

ISSN 2516-3809



WHAT IS OFFSITE CONSTRUCTION?

Offsite construction is a general term for making parts of a building away from the construction site before transporting them and installing them in their final location.

There are lots of different terms – offsite manufacture, pre-fabrication, etc. – but they all mean the same thing in this context.

In the building services sector, installing various mechanical and electrical systems on a live construction site can be challenging, with limited space, health and safety considerations, working around other contractors, and often all to a demanding programme. By manufacturing parts of the systems away from the job, in a purpose-built facility, offsite construction has the potential to make things on site much easier.

How does it work?

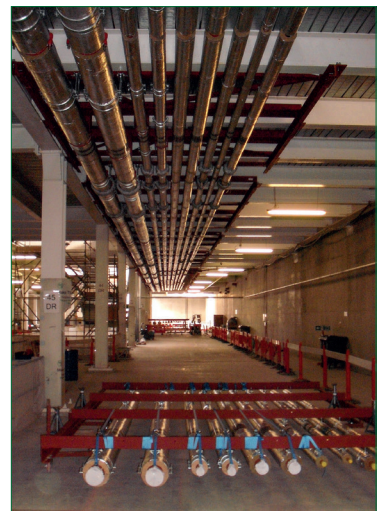
There are many parts of a system which can be assembled in a factory, and then taken to the building site and installed. Also, parts of a number of systems can be arranged together in some form of frame, and simply joined together on site. These are known as modules, and can be a very effective way of providing high quality installations.



Multi-service modules

It's common to make services modules which include a variety of system types – pipework for heating or chilled water systems can be accommodated in the same module as ductwork for air conditioning, and even cable trays to hold electrical wiring.

Once the modules have been made in the factory, they are shipped to site. There, they are craned into position, fixed to the building structure, and then connected up to the next module. By building up all the modules, a complete distribution system is provided.





THE POTENTIAL FOR OFFSITE CONSTRUCTION IN NUMBERS

In the Government's *Construction 2025 – Industrial Strategy: government and industry in partnership strategy*, launched in July 2013, a number of clear and challenging objectives were set out for the construction industry.



- **Lower costs** – **33%** reduction in the initial cost of construction and the whole life cost of built assets
- **Faster delivery** – **50%** reduction in the overall time, from inception to completion, for new build and refurbished assets
- **Lower emissions** – **50%** reduction in greenhouse gas emissions in the built environment
- **Improvement in exports** – **50%** reduction in the trade gap between total exports and total imports for construction products and materials

Within the Construction 2025 strategy, the use of offsite construction techniques has been specifically identified as having a part to play in meeting these ambitious targets. But how far can offsite manufacturing go to help with this? In its 2015 report TR39 *An Offsite Guide For The Building And Engineering Services Sector*, BESA includes an example of the benefits realised from the use of offsite construction on a project in the West Midlands. Offsite construction was used extensively in the delivery of mechanical and electrical building services systems, and also included integration with the building fabric.

Offsite construction methods used on HMP Oakwood, Featherstone, West Midlands including those for services and the Energy Centre (plant rooms) ensured the project was delivered to time and was judged to be substantially quicker to build than a traditional construction project, saving some 76,000 hours of construction activity. This included:

- 12,500 conduit assemblies, including shower heads and drains, incorporated within the precast concrete panels – saving 5000 site hours
- 4416 underfloor heating mats incorporated within the floor panels – saving 1500 site hours
- 240 prefabricated vertical risers with pre-insulated ductwork and pre-installed wiring looms – saving 32,300 site hours
- 30 air handling unit skids including ductwork, pipework, insulation, wiring and controls – saving 4800 site hours
- 40 domestic hot water skids including pipework, insulation, wiring and controls – saving 12,800 site hours

The use of offsite construction also resulted in:

- only three reportable incidents in more than 2.7 million hours worked
- record levels of reduced on-site material wastage.

Case study information courtesy of Buildoffsite.

Full case study can be found at http://ciria.org/buildoffsite/pdf/Case%20studies/casestudy_hmpoakwood.pdf



OFFSITE CONSTRUCTION FOR SERVICES DISTRIBUTION

Engineering services are carried up and down through a building in dedicated services risers. From there, the services are distributed horizontally around the building. In some areas they may be concealed above the ceiling, whereas in others they may well be on show.

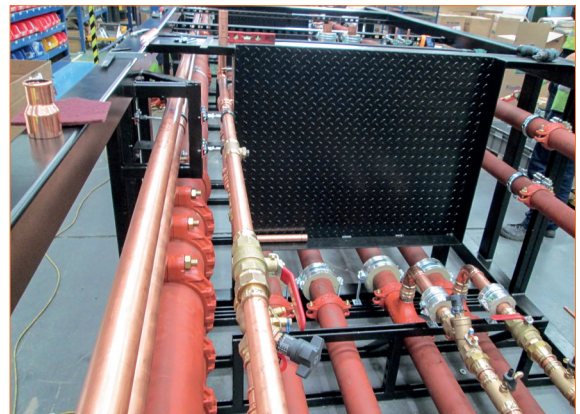
Vertical services risers

Services risers are the arteries of a building – they carry the services from the plant room and get them up or down to all floors of the building. From the risers, the horizontal distribution routes take the services out to all corners of the floors. Sometimes, the risers are split – mechanical and electrical – to help with getting the most effective use out of the space available.



Larger assemblies

As space within services risers is usually limited, it can be tricky to put the services together and install them. By manufacturing the whole riser off site, assembly is much simpler and quicker, saving time on site. Once installed, the connections are made to the horizontal distribution networks. Rather than installing the vertical services at each floor, it is possible to construct a riser running over several floors in the factory and then drop into place on site.



Horizontal distribution

In a modern building, a vast amount of services distribution is required to get all the water, air and electricity to the end user.

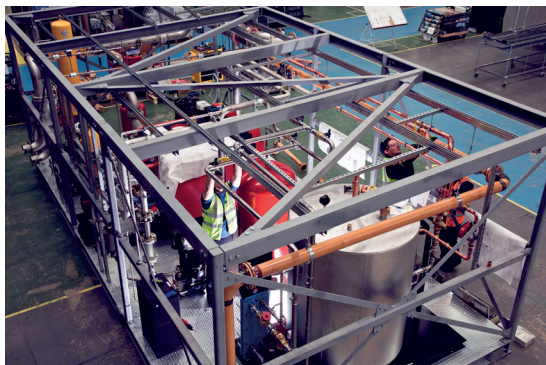
It is common to see heating and chilled water pipework alongside air conditioning ductwork above ceilings, getting the services from the plant room to each fan coil, supply grille or light fitting.





OFFSITE CONSTRUCTION FOR PACKAGED ROOMS

There are a number of areas of concentrated engineering services in modern buildings, often contained within their own area or space. These areas are labour-intensive to construct, and the space can be difficult to work in. This is an opportunity for offsite construction.



How does it work?

Constructing whole rooms away from the building site has been common for a number of years now, with bathroom pods being a feature of construction projects such as hotels.

This approach of constructing whole rooms in an offsite facility works very well for spaces such as plant rooms. This method of offsite construction favours technically complex elements, where the improved quality resulting from working in a controlled factory environment can result in a better outcome.



Flexible construction

This method of construction can be used for a variety of services areas, with different services as well as varying scales. It is becoming increasingly common to produce these spaces in parts or sections, and then combine them on site to provide the complete plant room or service space. Once in place, the incoming services and distribution systems are connected to the various plant and equipment within the plant room. This approach also allows for small units to be provided, which might only accommodate a few items of plant for a single application.



Inside or outside?

Packaged plant rooms, as these types of spaces are known, can be used to provide spaces which will be located within the building, or that may be incorporated as separate areas. Rooms for internal applications can be delivered to site and craned into place. This allows the rest of the site work to go ahead whilst the plant room is being constructed in the factory, which can bring benefits in project programming.

External rooms can be provided later in the construction process than may have been possible with more traditional methods.



IS OFFSITE CONSTRUCTION RIGHT FOR THE PROJECT?

As with any technology or process, the use of offsite construction needs to be considered carefully to get the best from it. Here are some key issues to think about to see if offsite construction is right for the project:

	
Increased productivity Working in a controlled, purpose-made environment can increase productivity, with no distractions from other construction site activities or issues.	Must choose offsite construction early on To get the best from offsite construction, the decision to use it must be made early in the project process to allow for considerations such as increased lead-in times.
Improved health and safety A live construction site has many health and safety risks. By working in a controlled factory environment, operatives are exposed to these risks for a far shorter time.	Reduced flexibility It is more difficult to accommodate changes that occur on site if the assemblies are being made in the factory, particularly if the changes are made at short notice.
Reduced programme Work in the factory can run alongside other work on site, meaning that the overall programme can be reduced. Time spent on site is also reduced as assemblies arrive on site ready to be put in place.	Early design decisions required To enable the factory to plan and get set up for the work, the designs for the various systems need to be finalised earlier in the project process than might be the case traditionally, where more work is done on site.
Reduced waste Working in a purpose-built factory environment can reduce waste by carrying out work in an efficient sequence rather than fitting in with other activities on site.	Limited procurement choices Where offsite construction is being done alongside more traditional site work, this may limit the number of contractors able to do both parts, so less choice.
Improved quality The controlled environment enables quality to be improved – the right conditions can be provided for the task and quality control procedures followed, rather than the general conditions of the construction site.	Transportation can be a problem Transportation of modules from the factory to the site can be challenging – the site may be a long way from the factory, and the modules or packaged rooms may be larger than simply delivering raw materials to site.
Reduced downtime The work in the factory is not affected by other events on the construction site, so downtime due to external factors is reduced.	Lead-in times extended If a change is being considered, then sufficient time needs to be allowed to make the change through the factory process.

Watchpoints

- Consider early on in the project if offsite construction techniques are to be used on the project.
- Make sure that the invitations to tender (ITTs) ask potential contractors for their experience of offsite construction projects and techniques.
- When considering offsite construction, make sure that the designers know – it may affect the design solutions that are put forward.
- Make sure that offsite construction is allowed for in the programme – overall time may be reduced, but certain things may need to happen at a different time. For example the design may need to be finalised or frozen earlier than normal.
- There are different scales of offsite construction, from widespread services distribution to local applications such as packaged plant rooms – see what suits the project.



RELATED RESOURCES

This topic guide gives an introduction to offsite construction for the building services industry. Other sources of information can be found in the text below, together with useful contacts for organisations working in the offsite construction sector.

Technical manuals

BESA, in association with Buildoffsite **TR39 An Offsite Guide for the Building and Engineering Services Sector**
Available from www.thebesa.com and www.buildoffsite.com.

Standards

BS ISO 10007:2017 *Quality management. Guidelines for configuration management*.

BS EN ISO 9001:2015 *Quality management systems. Requirements*

Available from shop.bsigroup.com

Journal articles

Offsite construction is the future – ignore it at your peril – October 2017,
www.architectsjournal.co.uk

Government to favour offsite construction in 2019 – November 2017,
www.constructionnews.co.uk

Off-site manufacture for construction – December 2018,
www.parliament.uk/off-site-manufacture-construction

There are two main barriers to the widespread use of offsite construction – September 2018,
www.building.co.uk

Offsite: Does it deliver on its promise? August 2018,
www.constructionmanagemagazine.com

BSRIA publications

BG 6/2018 *A Design Framework for Building Services, 5th edition*

TN 14/97 *Improving M&E site productivity*

ACT 1/99 *Prefabrication and preassembly*

Available from www.bsria.co.uk. Free downloads for BSRIA members.

Associated organisations

www.buildoffsite.com

Buildoffsite is an industry-wide campaigning organisation that promotes greater uptake of offsite techniques by UK construction.

www.offsitehub.co.uk

The offsite hub is an online information centre promoting the latest news and developments in offsite manufacturing and technology.

www.thebesa.com

BESA is a UK trade association representing the interests of firms working in the area of engineering systems and services in buildings.

www.offsite.lboro.ac.uk

The Loughborough University Offsite Construction website has been created as a resource for people in the construction industry to make better use of offsite manufacturing, standardisation and pre-assembly techniques during the construction process.

Acknowledgements

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