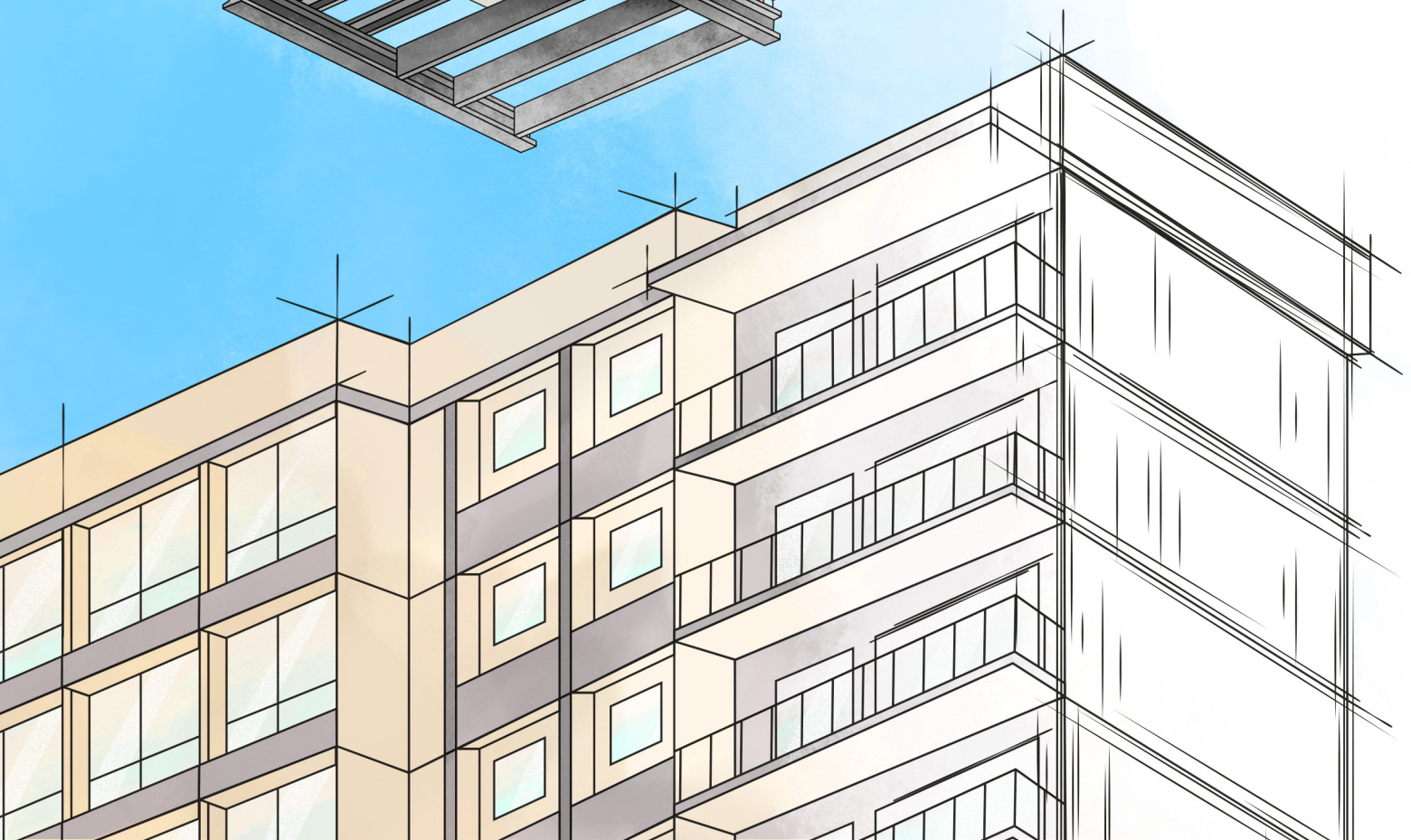


PREFABRICATED MECHANICAL, ELECTRICAL AND PLUMBING SYSTEMS

Information Kit
Version 1 – 2026



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1. INTRODUCTION

This information kit aims to update the industry on regulatory developments to Prefabricated Mechanical, Electrical & Plumbing Systems (Prefab MEP) adoption, share the learning points and good practices from completed and ongoing Prefab MEP projects, and serve as a guide with the useful information on Prefab MEP.

Different sections of this kit may be more applicable to certain stakeholders. The table below summarises the contents and respective target audience.

Content	 Developer	 Consultant	 Builder	 MEP Specialist / Contractor
2. Procurement Matters	✓	✓	✓	✓
3. Prefab MEP Design		✓	✓	✓
4. Production Management			✓	✓
5. Transportation and Installation			✓	✓
6. Useful Resources	✓	✓	✓	✓

2. PROCUREMENT MATTERS



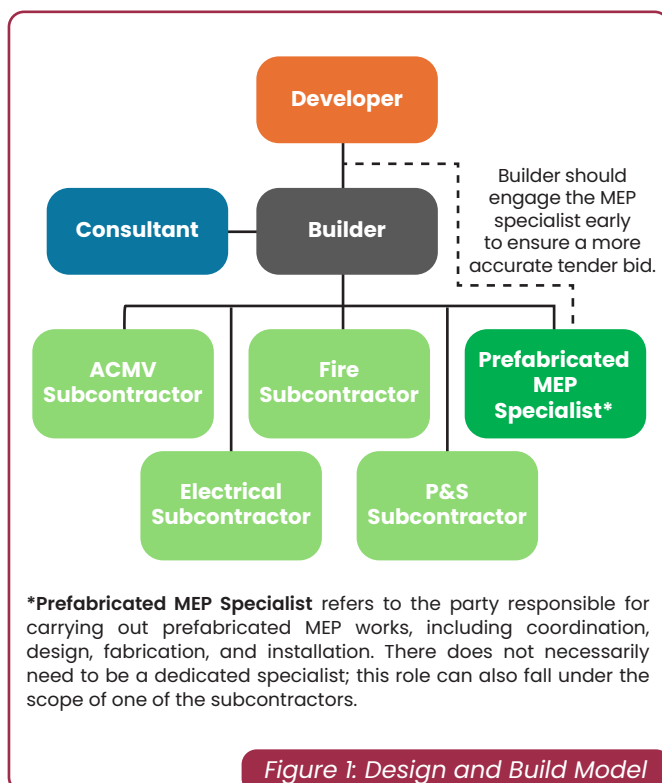
2.1 Early Involvement of Prefab MEP Specialists

The early decision to adopt Prefab MEP modules in a project facilitates greater continuity of design and maximises productivity gains. It is imperative for developers to engage builders, MEP contractors and PMEP specialists at the earliest possible stage. This early collaboration ensures the incorporation of inputs from all parties, leading to a more buildable and coordinated solution.

Below are some typical procurement models adopted for construction projects:

- Design and Build (D&B)
- Design Development and Build (DDB)
- Design Bid Build (DBB)

For more detailed information on the different types of procurement models in Singapore, as well as examples of overseas procurement models, please refer to Chapter 2 of the Prefab MEP Guidebook Version 2.



2.2 Contractual Considerations

Unlike conventional projects where M&E subcontractors work independently, adopting a Prefab MEP system requires greater collaboration and coordination among all relevant parties, as services are integrated within the same modules. Therefore, when calling for tenders for projects utilising Prefab MEP, clients should consider the following points:

Procurement Model Selection

Choose a procurement model that allows for the early involvement of Prefab MEP specialists during the design stage. Their expertise can help anticipate and address potential challenges early, enhancing overall project productivity.

Single-Firm Responsibility

Award the entire scope of design, fabrication and installation of Prefab MEP modules to a single firm to minimise the risk of contractual disputes. For large-scale projects requiring multiple MEP contractors, ensure the following:

- Builders and consultants should clearly delineate each contractor's responsibilities using drawings or other forms of representation to prevent confusion and ensure accountability.
- Designate one contractor to lead and coordinate among the various trades on site and in the factory. It is acceptable for the builder to assume this role.

Adequate Time Allocation

Provide sufficient time for tenderers to evaluate a range of design options for Prefab MEP modules. Assessing different design options across the entire construction value chain upfront is essential to maximise the productivity benefits of adopting Prefab MEP.

Flexible Progress Claims

Review and adjust the schedule and deliverables for progress claim certification. Developers and builders should adopt a flexible payment scheme to accommodate the different work sequences involved in Prefab MEP projects. For instance, progress claims should include completed work (e.g. carried out in the factory before the modules' installation on site).

2.3 Key Elements of Tender Documents

When drafting tender specifications for projects adopting Prefab MEP systems, developers, builders and consultants should consider including the following information and requirements in the tender documents:

Preliminaries

- a. Specify the minimum percentage of the project that must utilise Prefab MEP systems.
- b. Outline requirements for collaboration and coordination with relevant stakeholders to ensure the smooth implementation of the Prefab MEP systems.
- c. Provide a comprehensive project timeline, including milestones and deadlines for Prefab MEP integration.

Detailed Scope of Work

- a. Detail the design requirements for Mechanical and Electrical (M&E) systems within the prefabricated modules. Clearly specify all systems/equipment/accessories to be integrated within the modules.
- b. Clearly mark the precise locations on the floor plans, elevations and schematic drawings where Prefab MEP modules will be installed within the project.
- c. Identify and demarcate works that require interfacing between different contractors to ensure seamless integration.
- d. Define the deliverables and responsibilities of each contractor involved in the project.
- e. Require a Civil Professional Engineer to endorse and submit the structural calculations for Prefab MEP modules to the relevant authorities for approval.
- f. Develop Coordinated Services Drawings incorporating design inputs from all relevant parties to ensure accurate fabrication of the modules.

Technical Specifications

- a. Provide detailed material specifications for all services installations and connection joints.
- b. Include specifications for the entire support system of the modules, from the module frame to associated supports (e.g. anchor bolts and hanger rods).
- c. List the relevant codes and standards that must be adhered to for the design of M&E services and structural support within the modules.

Quality Assurance

- a. Ensure that competent Prefab MEP specialists with proven track records and experience in Prefab MEP adoption are engaged.
- b. Request that the Prefab MEP firm be accredited under the Manufacturer Accreditation Scheme.
- c. Specify acceptable quality standards and criteria for factory acceptance tests.
- d. Outline the requirements (e.g. scope of work, testing frequency, schedule and the parties involved) for testing and commissioning the modules on site and/or off site to ensure compliance with project specifications.
 - i. Specify the roles and responsibilities of stakeholders at different stages, from planning (e.g. materials approval) to site installation (e.g. module connection).

Delivery, Storage and Handling

- a. Require a method statement, lifting plan and risk assessment for the transportation and lifting of modules, considering site accessibility and constraints.
- b. List all necessary equipment for the transport and installation of the modules.
- c. Provide a detailed delivery schedule for the modules.
- d. Specify protection measures for the storage of modules both in the factory and on site to prevent damage.

Documentation

- a. Require Building Information Modelling (BIM) drawings for design planning continuity and installation verification on site.

Payment

- a. Define the payment scheme for the Prefab MEP modules, detailing the payment milestones and conditions.

3. PREFAB MEP DESIGN



3.1 Types of Prefabricated MEP Modules

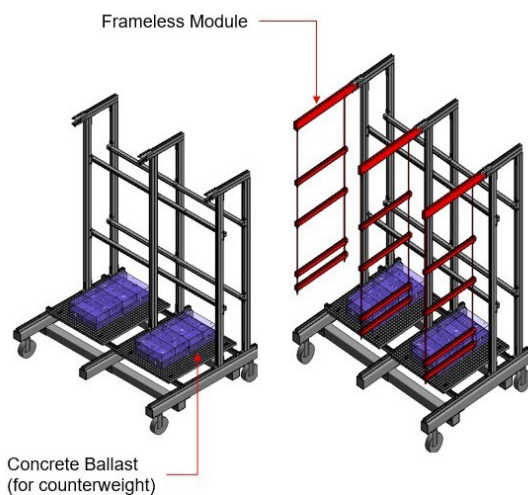
Horizontal Modules – Modules along circulation area

a. Ceiling horizontal module.



(Photograph courtesy of Great Resources Pte Ltd)

b. Frameless horizontal module (ATIF).



(Photograph courtesy of Walraven Pte Ltd)

- c. Goalpost horizontal module.



(Photograph courtesy of Techniques Air-Conditioning & Engineering Pte Ltd)

Vertical Modules – Modules within risers

- a. Wall-mounted vertical module with frame.



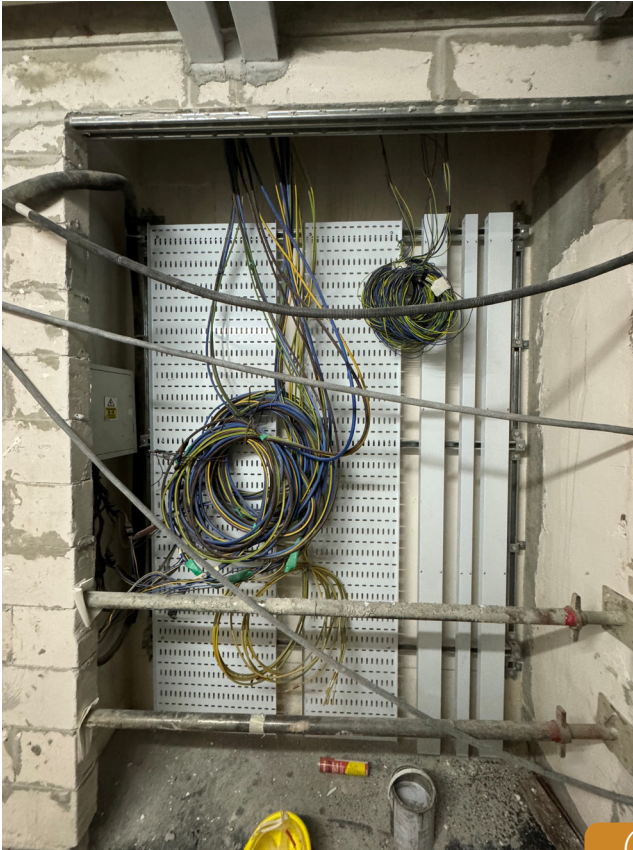
(Photograph courtesy of Kurihara Pte Ltd)

- b. Floor-mounted frameless vertical module.



(Photograph courtesy of Winner Engineering Pte Ltd)

- c. Direct wall-mounted vertical module.



(Photograph courtesy of Tech Onshore MEP Prefabricators)

Plant Modules – Modules for pumps and/or equipment

- a. Plant module preassembled with tank, pumps, pipings, accessories and Pressure Relief Vessel (PRV).



(Photograph courtesy of Active Fire Protection Systems Pte Ltd)

- b. Plant module preassembled with pumps, header pipings, accessories and control panel.



(Photograph courtesy of Techniques Air-Conditioning & Engineering Pte Ltd)

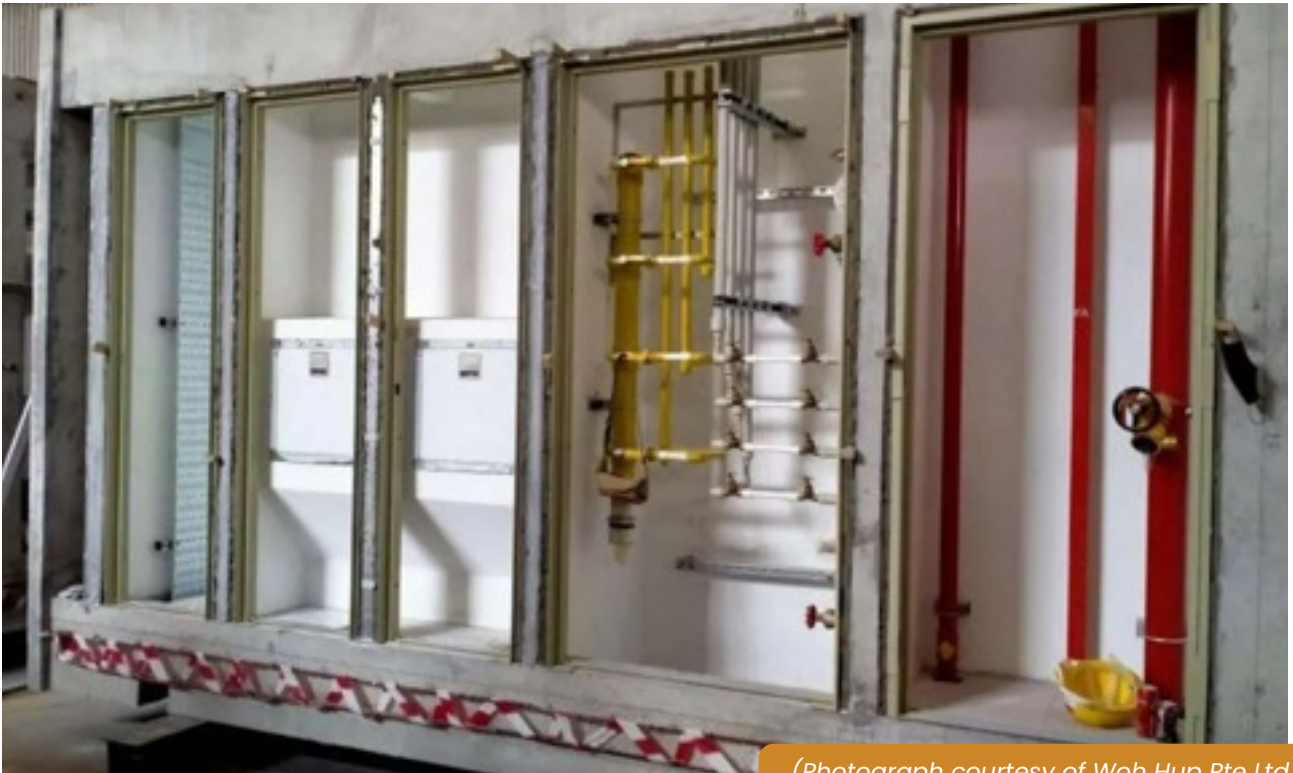
- c. Plant module preassembled with Fan Coil Unit (FCU), control panel, services connection, accessories and drain pan.



(Photograph courtesy of Winner Engineering Pte Ltd)

Fully Integrated Sub-Assemblies

- a. Precast vertical riser integrated with services and architectural finishes.



(Photograph courtesy of Woh Hup Pte Ltd)

- b. Precast vertical riser integrated with services and architectural finishes.



(Photograph courtesy of Soilbuild Construction Group Ltd)

3.2 Modules Design Considerations

Prefab MEP modules fall into three types: horizontal modules, vertical modules and plant modules, depending on the location of the services. The key factors to consider in the design of specific module types are as follows:

Horizontal Modules

- a. Identify the circulation areas where common M&E services are routed, while noting any exclusions as per the Code of Practice on Buildability. Circulation areas include:
 - i. Common corridors, lift lobbies,
 - ii. Main distribution of M&E systems to/from risers or plant rooms.
- b. Organise services within the horizontal modules to account for the potential risk of undesirable leakages.
 - i. No wet trades to be installed directly above electrical services:
 - A. Install electrical services above plumbing and sanitary services, or
 - B. Position electrical services on one side and plumbing and sanitary services on the other side, if corridor width allows.
 - ii. Install potable water piping above non-potable water piping.
- c. Organise the least serviceable system to be at top tier.
- d. Integrate gradient piping, such as sanitary pipes and condensate drain pipes, into the module design.
- e. Adjust the length of the supporting hanger rods to accommodate the required gradient along the modules.
- f. Ensure that the design of horizontal modules is feasible along the offset corridor.
 - i. Incorporate offsets at the connection between modules.
- g. Plan and design the M&E services to tee off into rooms, either within the module or at connections between modules.
- h. Pre-install the fire sprinkler piping in the same horizontal module as other services.
 - i. Maintain the height of horizontal modules within 800mm to eliminate the need for an additional layer of sprinklers.
- i. Due to the tight working space on site, architectural works (e.g. partition walls) can be integrated into the Prefab MEP modules.
- j. Consider using valve chains to enhance accessibility for valve operation.

Vertical Modules

- a. Identify risers that have multiple components, while noting any exclusions as per the Code of Practice on Buildability.
- b. Coordinate with the architect and structural engineer to ensure vertical risers run continuously throughout the entire building height, without horizontal offsets.
- c. Avoid using irregularly shaped shafts, as they may complicate the installation of the vertical modules.
- d. Design connections between modules at working height to facilitate easier installation, eliminating the need for ladders or structural platforms to access and connect the modules.
- e. Allocate adequate space for lifting lugs and brackets to support, transport and install vertical modules within the riser.
- f. Design vertical modules to interconnect seamlessly, eliminating large gaps that require on-site manual installation of extra piping or cable containment.
- g. Consider incorporating shim plates in the design to ensure proper alignment and levelling of the vertical modules.

Plant Modules

- a. Identify all equipment that are suitable for off-site assembly.
 - i. Floor-mounted equipment/pumps set with header piping/wiring.
 - ii. Ceiling-mounted equipment with piping/wiring connections.
- b. Collaborate with the architect to ensure plantroom designs are regular and efficient.
 - i. Avoid unconventional shapes that could complicate installation and maintenance.
- c. Plant modules shall be fully pre-assembled with control panels, and valves/pipework connections mounted on skids with lifting eyes in the factory.
 - i. Two or more modules can be combined on site to complete the installation in a plantroom.
 - ii. Control panels that are part of a larger system, such as those integrated into a Motor Control Centre (MCC) or grouped under a single master control panel, may be excluded from the plant module assembly, as they will be installed separately in a centralised location to enhance accessibility and coordination.

Other Best Practices

In addition to considering the design requirements of individual module types, project stakeholders can also implement the following **best practices** to ensure a more streamlined module design process.

- a. Emphasise on freezing the design upfront
 - i. The endorsement of Coordinated Services Drawings (CSD) by all relevant parties including the client, consultants, builders and Prefab MEP specialist signifies a collective agreement on the proposed design and ensures stakeholders' alignment. Fabrication of modules should only begin once the CSD has been endorsed. This prevents changes that could lead to rework and abortive efforts, which can negatively impact the project schedule and incur unnecessary costs.
- b. Structural support for modules
 - i. The choice of supporting frame can facilitate future expansion and modification of services. Using perforated channels coupled with bolted connections is preferred to allow for greater flexibility in installing additional services and adjusting installations within the supporting frame to accommodate site constraints.
 - ii. Appropriate measures should be implemented to prevent galvanic action across the entire supporting frame, including all connections. Different materials and grades should be considered based on the exposure conditions and the intended service life.
- iii. Module frame and associated supports must be fire-rated to ensure full compliance with the fire code, if fire-rated ducting was incorporated within the modules.
- iv. The structural engineer must account for the loading requirements of Prefab MEP modules based on the placement of supports (e.g. ceiling, floor or wall mounts). The positioning of these supports will also influence the sequencing of all trades' works within the same working space of the Prefab MEP modules installation.
- v. Lifting points should be incorporated into the module design to facilitate handling, transportation and hoisting.
- vi. Structural components supporting the Prefab MEP modules must be designed to accommodate the loading requirements of these modules. The project team should also consider the presence of structural elements (e.g. pre-stress strands) that may influence the placement of supports on the structural components.

c. Transport and delivery of modules

- i. Although longer modules are more efficient, as they reduce the number of connection points and delivery trips, the design of these modules must account for delivery constraints, such as lorry/trailer size and floor-to-floor height, which can complicate the transportation and installation of modules. It is essential to strike a balance between productivity and such delivery limitations.
- ii. Project managers must coordinate the requirements of all disciplines to optimise event sequencing and resource management on site. This involves organising lifting equipment and planning delivery routes for transporting modules to their designated installation locations.

d. Provision of adequate working access

- i. When designing Prefab MEP modules, it is crucial to ensure sufficient working space for connecting modules and performing downstream maintenance and replacement. Early engagement with the facility management team to understand maintenance requirements, equipment accessibility and future modification needs should be integrated into the design of Prefab MEP modules. More information on the principles and good practices can be found under the [Design for Maintainability Guide](#).
- ii. For multi-tier MEP modules, the project team should consider incorporating maintenance platforms within the modules. These platforms enable workers to safely access and maintain services located on the higher tiers, which may otherwise be difficult to reach with a ladder from the floor.

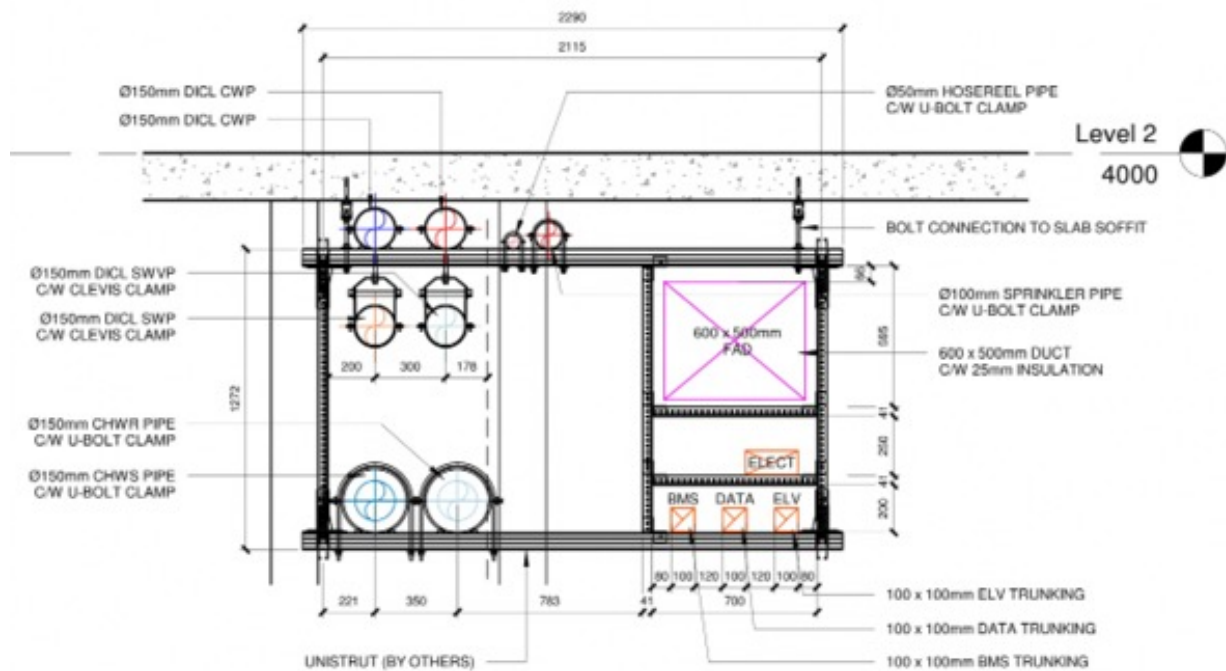


Figure 2: Elevation view of horizontal ceiling module showing the maintenance space. (Photograph courtesy of DLE M&E Pte Ltd)

3.3 Regulatory Requirements

3.3.1 ST Submissions

The design calculation of the Prefab MEP module frame and its supporting elements, including hangers and anchor bolts, must be carried out and endorsed by a Professional Engineer (PE) (Civil/Structural). The static and dynamic loadings contributed by the Prefab MEP modules must be provided to the PE, who will incorporate these loadings into the building's structural design requirements. If there are any questions regarding submission requirements, the QP is encouraged to consult the Building and Construction Authority (BCA), providing all necessary project information for review.

3.3.2 Productivity Requirements under Buildability Framework

BCA has enhanced the Buildability framework to promote the adoption of Design for Manufacturing and Assembly (DfMA) methodologies across all disciplines of work – Structural, Architectural and MEP. It is a joint responsibility between the Qualified Persons for Architectural works, Structural works, PE (Mechanical) and PE (Electrical) to meet the productivity requirements through two options either by:

- Meeting minimum Buildable Design Score (B-Score); or
- Outcome-based options: Meeting high prefabrication levels or achieving minimum productivity improvement over 2010 levels.

B-Score points are allocated based on the implementation of Prefab MEP systems and the manpower savings achievable (refer to **Figure 3**). Higher points are awarded to systems that demonstrate higher manpower savings as an incentive for the adoption of solutions that enhance construction productivity.

For B-Score computation and submission:

- B-Score calculation forms (BS01 and BS03) can be downloaded from this [link](#).
- Within the B-Score form, select the relevant category of building works to display the allocated points.
- Determine the total qualifying area and the total prefabricated area of each MEP system from the building layout plan.
- The Excel sheet will automatically:
 - Compute the coverage (%) of each prefabricated system by dividing the prefabricated area by the total qualifying area.
 - Multiply the coverage of the Prefab MEP system by the corresponding maximum allocated points to derive the B-Score points (refer to Table 5 of the Code of Practice on Buildability).
- The project team is required to submit B-Score form and Buildable Design Implementation Plan (BDIP) with plans showing the location of modules and computation of coverage to substantiate the points claimed.

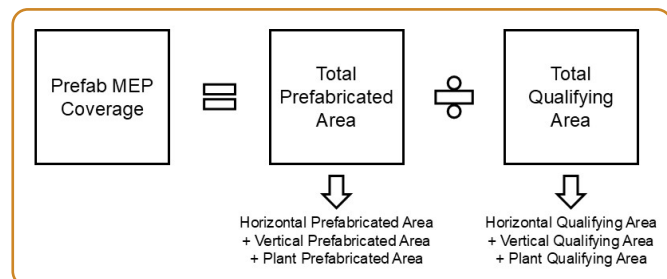
PART V: COMPUTATION OF BUILDABLE DESIGN SCORE						
Project Reference Number		Structural	Architectural	MEP	Innovation	B-Score
0		0.00	0.00	0.00	0.00	0.00
Category (Please Select)		Block No. / Name				
Public Residential (Non-Landed)		0				
Select Category						
Public Residential (Non-Landed)						
Private Residential (Non-Landed)						
Industrial						
Commercial						
Institutional, School & Others						
MRT Station						
		Unit	Wall Length (m)	% of coverage		
		Area	-		To comply with min. 65%	
Description	Max allocated points (a)	Total Qualifying Area (m2)	Prefabricated Area (m2)	% of area (b)	B-Score	
C1 DfMA MEP System (See Note B.10)						
1 Fully integrated system						
1.1 Prefabricated Prefinished Volumetric Construction (PPVC) (See Note B.1)	15.00			0.00%	0.00	
2 Fully integrated sub-assemblies						
2.1 Prefabricated MEP modules integrated with structural or architectural system e.g. working platform / catwalk / façade / ceiling / slab, etc.	12.00			0.00%	0.00	
3 Advanced prefab systems						
3.1 Prefabricated MEP vertical modules	4.00			0.00%	0.00	
3.2 Prefabricated MEP horizontal modules	4.00			0.00%	0.00	
3.3 Prefabricated MEP plant modules	4.00			0.00%	0.00	
Total C1		0.00	0.00	0.00%	0.00	

Note: Figure 3 applies to Public Residential (Non-Landed) projects, and it is for reference only. The allocated points for various Prefab MEP systems vary based on different categories of building works.

Figure 3: Buildability score tabulation for Prefab MEP.

For computation of MEP prefabrication level for outcome-based proposals:

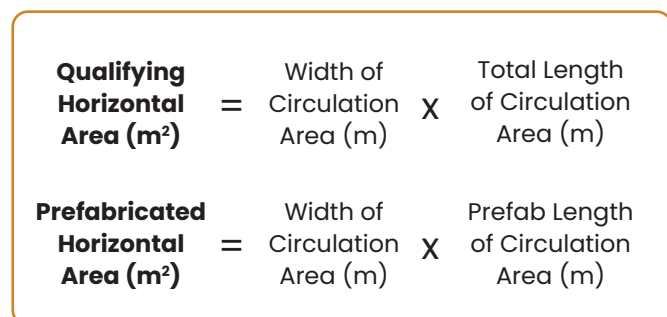
- The project team is required to submit B-Score form and Project Productivity Implementation Plan (PPIP) with plans showing the location of modules and computation of prefabrication levels.
- The tabulation of the coverage (%) is shown in equation below.



Computing Qualifying Area and Prefabricated Area for Horizontal, Vertical and Plant Modules

Horizontal Modules:

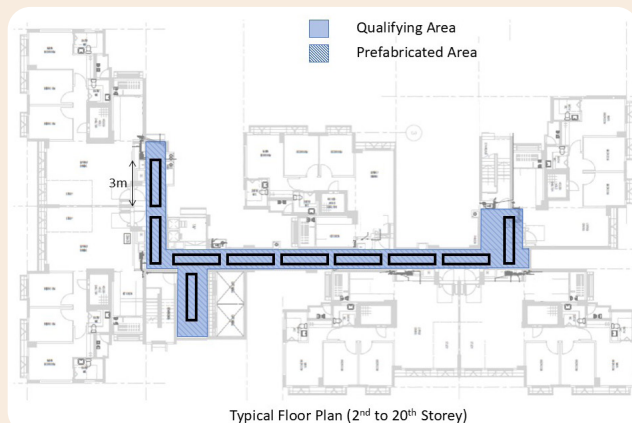
- Steps to compute qualifying and prefabricated areas:
 - Identify typical floors that have a standard layout.
 - Provide the layout plan and include the number of floors.
 - Highlight circulation area where common M&E services will be installed.
 - Display the horizontal modules on the same layout plan and indicate the size and quantity of the horizontal modules along the circulation area.
 - Shade the prefabricated area in a different colour to differentiate between qualifying area and prefabricated area.
 - Calculate the qualifying and prefabricated horizontal areas using formulas below. Details such as the length and width of the circulation area shall be included on the floor plan to verify the computation of areas.



- Below are some common queries faced when calculating the areas:

When calculating the prefabricated area, should the gaps intentionally left between modules for connections/bends be included or excluded?

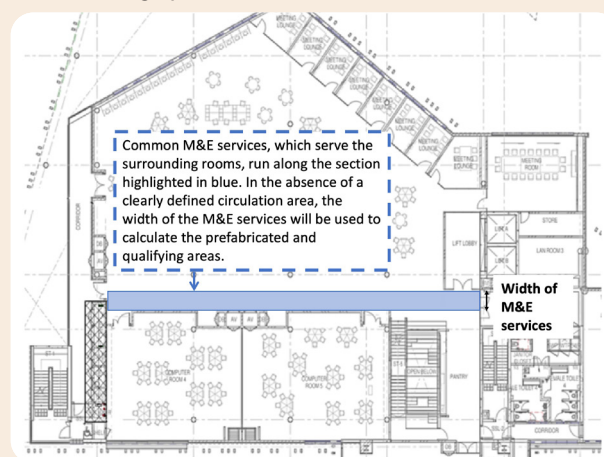
Spaces between modules (i.e. at junctions, bends and module connections) can be included under the prefabricated horizontal area. For the case below, the prefabricated area will be the same as the qualifying area.



If the circulation area is not clearly demarcated (i.e. no walls to define its boundaries), what width should be used?

All circulation areas where common M&E services operate, including but not limited to common corridors and lift lobbies, shall be considered in the computation. If not clearly demarcated, the width of the circulation area will be taken as:

- The width of circulation area on other floors with similar design, if available, or
- The total width of the M&E services based on drawings provided.



What if certain services were not integrated within the horizontal modules and instead, were supported separately on site?

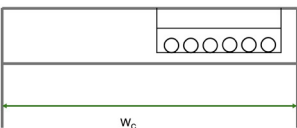
All services shall be incorporated within the horizontal modules to maximise the advantages of Prefab MEP adoption. The integrated approach not only enhances efficiency but also streamlines construction timelines and minimises on-site complexities.

However, if certain services cannot be integrated due to specific technical constraints, please consult BCA. Each case will be reviewed individually to determine the best course of action while maintaining overall project efficiency and compliance with regulatory standards.

When calculating the prefabricated area, should the width of the circulation area or width of the modules be used?

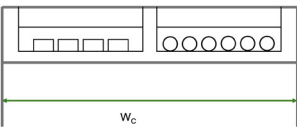
If all services are pre-assembled onto the module, the same width of the circulation area can be applied to simplify the calculations for both the qualifying and prefabricated areas. Therefore, the length becomes the key factor in determining the extent of prefabrication.

Scenario: All services on one module but module width < corridor width.



Qualifying Area = $W_c \times \text{Length}$
 Prefabricated Area = Qualifying Area
 = $W_c \times \text{Length}$

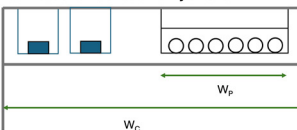
Scenario: All services on modules but modules width < corridor width.



Qualifying Area = $W_c \times \text{Length}$
 Prefabricated Area = Qualifying Area
 = $W_c \times \text{Length}$

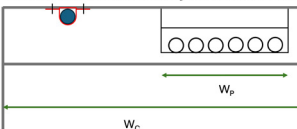
However, if some services are mounted directly to the ceiling rather than within the modules, then the width of the module will be used for calculating the prefabricated area.

Scenario: Besides module installation, some services are installed directly on site.



Services, including supports are installed directly on site
 Qualifying Area = $W_c \times \text{Length}$
 Prefabricated Area ≠ Qualifying Area
 = $W_p \times \text{Length}$

Scenario: Besides module installation, some services are installed directly to the soffit on site.



Directly mounted to soffit on site
 Qualifying Area = $W_c \times \text{Length}$
 Prefabricated Area ≠ Qualifying Area
 = $W_p \times \text{Length}$

Is it necessary to consider the entire length of the circulation area, including the ends where no services are running?

Circulation areas that do not have any services can be excluded from both the qualifying and prefabricated areas.



Is it acceptable to exclude certain locations from the qualifying area where the team decides not to use prefabricated horizontal modules, and compensate for it by using prefabricated modules in other areas not within the qualifying area?

The criteria for the qualifying area are defined in Table 5A of the Code of Practice on Buildability. The project team must input the qualifying and prefabricated areas accordingly. Even if the team chooses not to adopt prefabricated horizontal modules in some sections within the qualifying area, those areas cannot be excluded or compensated.

Nonetheless, the industry is encouraged to go beyond the minimum requirements to improve project productivity. If the project team opts to implement prefabricated horizontal modules in non-qualifying areas, the area of these modules can be included in both the qualifying and prefabricated area calculations, thereby enhancing overall Prefab MEP coverage.

Vertical Modules:

- a. Steps to compute qualifying and prefabricated areas:
 - i. Identify all qualifying vertical risers for M&E services and provide the relevant layout plans.
 - ii. Indicate the type of services within the riser, including the quantity and size of the piping/cable containment.
 - iii. Summarise the vertical risers using elevation view.
 - iv. Highlight the qualifying areas, providing the width and height of the risers.
 - v. Shade risers using vertical modules on the same elevation view in a different colour to differentiate between qualifying area and prefabricated area.
 - vi. Calculate the qualifying and prefabricated vertical areas using formulas below.

$$\text{Qualifying Vertical Area (m}^2\text{)} = \text{Internal Wall-to-Wall Width (m)} \times \text{Height of Riser total (m)}$$

$$\text{Prefabricated Vertical Area (m}^2\text{)} = \text{Internal Wall-to-Wall Width (m)} \times \text{Height of Riser prefab (m)}$$

- b. Below are some common queries faced when calculating the areas:

Is it necessary to include the area of risers at non-typical floors when calculating the qualifying area for vertical risers?

Yes, the entire height of vertical riser shall be accounted for in the computation of the qualifying area. Exclusion for non-typical floors applies to horizontal modules only.

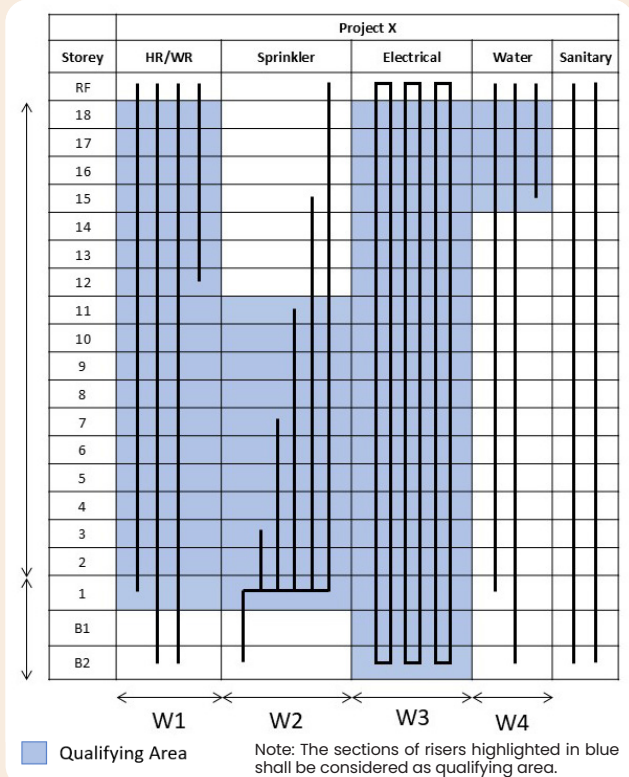
Is it permissible to exclude a portion of the riser from both the qualifying and prefabricated areas due to an offset in the design of vertical riser?

The entire height of the vertical riser (before and after the offset) shall be considered when calculating the qualifying area, regardless of any offsets.

MEP contractors are advised to coordinate closely with the architect early in the design process. This ensures that vertical risers run continuously throughout the entire building height without any horizontal offsets, making the installation of vertical modules easier and more efficient.

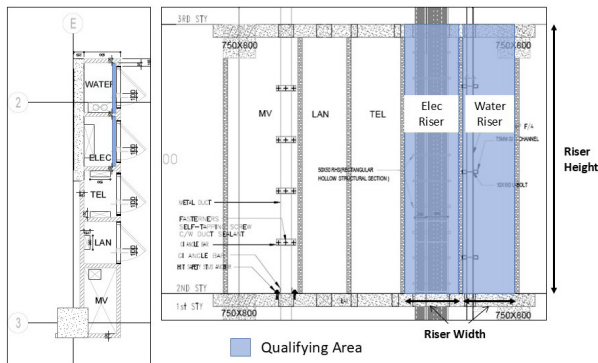
Due to the service design, the number of pipes varies at different sections of the riser (e.g. three pipes in the upper section and two pipes in the lower section due to an additional pipe for pump feed). How should the qualifying area for these risers be tabulated?

Criteria of qualifying area is as defined in Table 5A of Code of Practice on Buildability. From the example below, water risers spanning from storeys 15 to 18 shall be accounted as the qualifying area. However, the project team can explore prefabricating the entire water riser to fully reap the benefits of Prefab MEP.



Should the floor area occupied by the vertical riser, or the front elevation area of the vertical riser be used to calculate the qualifying and prefabricated areas for vertical modules?

The front elevation area of the vertical riser shall be used to calculate the qualifying and prefabricated areas as illustrated in the image below.



If vertical modules cannot be adopted due to an irregularly shaped shaft, can the riser be excluded from the calculation?

Vertical risers that meet the qualifying area criteria must be considered, regardless of the shape of the shaft.

M&E consultants are advised to coordinate closely with the architect early in the design process to avoid using irregularly shaped shafts. Early coordination will make the installation of vertical modules easier and more efficient.

Is it acceptable to exclude certain risers from the qualifying area where the team decides not to use prefabricated vertical modules, and compensate for it by using prefabricated modules in other risers not within the qualifying area?

The criteria for the qualifying area are defined in Table 5A of the Code of Practice on Buildability. The project team must input the qualifying and prefabricated areas accordingly. Even if the team chooses not to adopt prefabricated vertical modules in some sections within the qualifying area, those areas cannot be excluded or compensated.

Nonetheless, the industry is encouraged to go beyond the minimum requirements to improve project productivity. If the project team opts to implement prefabricated vertical modules in non-qualifying areas, the area of these modules can be included in both the qualifying and prefabricated area calculations, thereby enhancing overall Prefab MEP coverage.

When calculating the prefabricated area, should the internal wall-to-wall width of the riser or width of the modules be used?

To simplify calculations, the same internal wall-to-wall width of the riser can be used for tabulating both the qualifying and prefabricated areas. Therefore, the riser height is the primary parameter to determine the extent of prefabrication.

Is it necessary to consider risers that are not housed within a shaft? (E.g. a chilled water riser inside the AHU room.)

Vertical risers that meet the qualifying area criteria must be considered, regardless of whether they are housed within a shaft.

Plant Modules:

- a. Steps to compute qualifying and prefabricated areas:
 - i. Identify all M&E equipment for the project and provide the relevant layout plans.
 - ii. Indicate the designation of the plantroom/skid, including the size of the plantroom/skid.
 - iii. Shade the plant modules on the same layout plan in a different colour to differentiate between qualifying area and prefabricated area.
 - iv. Calculate the qualifying and prefabricated plant areas using formulas below:

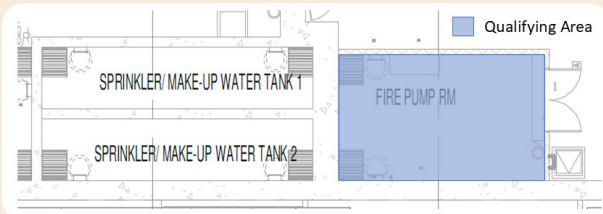
$$\text{Qualifying Plant Area (m}^2\text{)} = \text{Plan Area of the Plantroom/ Skids of M\&E Equipment}_{\text{total}} \text{ (m}^2\text{)}$$

$$\text{Prefabricated Plant Area (m}^2\text{)} = \text{Plan Area of the Plantroom/ Skids of M\&E Equipment}_{\text{prefab}} \text{ (m}^2\text{)}$$

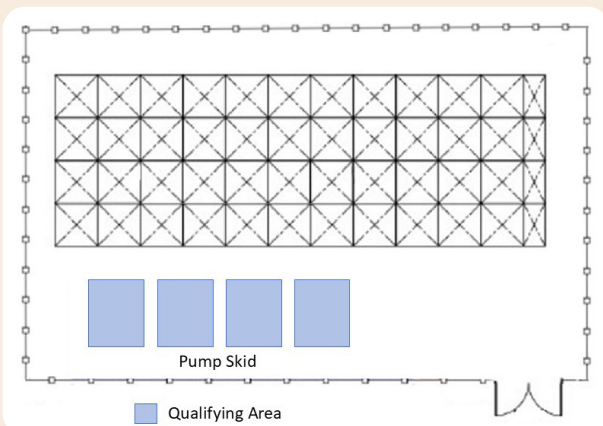
- b. Below are some common queries faced when calculating the areas:

Which area should be used in the calculation: the plantroom area or the pump skid area?

For pumps enclosed in a room, the plantroom area can be used for the tabulation of the qualifying area.



For pumps not enclosed in a plantroom, the pump skid area should be used for the tabulation of the qualifying area.



Does the control panel need to be integrated into the plant module?

Plant modules shall be fully pre-assembled with control panels, and valves/pipework connections mounted on skids in the factory.

Control panels that are part of a larger system, such as those integrated into a Motor Control Centre (MCC) or grouped under a single master control panel, may be excluded from the plant module assembly, as they will be installed separately in a centralised location to enhance accessibility and coordination.

Is it permissible to divide the pumps into multiple modules for easier delivery and lifting?

Multiple modules can be assembled on site to complete the installation in a plantroom. Nonetheless, contractors should strive to combine modules whenever possible to improve installation efficiency by minimising lifting operations. This requires careful planning of logistics in advance.

How can I calculate the prefabricated area when only certain equipment can be prefabricated within the same plantroom due to site constraints?

The prefabricated area is determined based on the proportion of prefabricated equipment to the total equipment in the plantroom. The prefabricated plant area shall be calculated using the following formula:

$$\text{Prefabricated Plant Area} = \frac{\text{Plan Area of Plantroom/ Skid}_{\text{qualifying}} \text{ (m}^2\text{)}}{\text{Total no. of equipment}} \times \frac{\text{No. of prefabricated equipment}}{\text{Total no. of equipment}}$$

Should the water tank inside the plantroom be considered in the calculation of qualifying and prefabricated area?

Water tank area shall be excluded in the calculation of both qualifying and prefabricated areas.

Summary:

- a. Include a summary table tabulating the coverage of individual module type, followed by the total Prefab MEP coverage.

Category	Qualifying Area (m2)	Prefabricated Area (m2)	Coverage (%)
Horizontal Module			
Vertical Module			
Plant Module			
Total			

Others:

- a. If the project team chooses to undertake any prefab works that fall under the exclusion list, the area of prefab works can still be included in both the qualifying and prefabricated areas.
- b. For any further enquiries, please contact BCA using the contact details listed under Section 6(g).

4. PRODUCTION MANAGEMENT



Adopting good management practices is essential for enhancing productivity at the Prefab MEP factory. Key strategies include implementing best practices during the storage and delivery stages, and efficient workflow processes. Utilising advanced technologies and automation can streamline operations, while maintaining rigorous quality control ensures robust standards are consistently met.

4.1 Protection of Modules for Storage and Delivery

Modules must be protected to prevent potential damages during storage and delivery processes. Implementing the following best practices is crucial in ensuring the integrity and functionality of modules:

Protective Packaging

- Use durable, weather-resistant packaging materials to shield modules from environmental factors such as moisture, dust and UV radiation.
- Ensure secure wrapping and padding to prevent scratches, dents and other physical damage during handling and transportation.

Secure Storage

- Store modules in a clean, dry and well-ventilated area to avoid exposure to harmful conditions.
- Elevate modules off the ground using pallets or supports to prevent contact with water and debris.
- Implement appropriate stacking methods to distribute weight evenly and prevent deformation or collapse.

Careful Handling during Transportation

- Utilise proper lifting equipment, such as cranes and forklifts, designed to handle the weight and dimensions of the modules.
- Securely fasten modules during transport to prevent movement and collisions within the delivery vehicle.
- Inspect modules for any signs of damage upon delivery to site and address any issues promptly to maintain their quality.



Figures 4 and 5: Completed modules properly wrapped in factory (top) and modules properly wrapped and secured for delivery to site (bottom). (Courtesy of Tech Onshore MEP Prefabricators)

4.2 Efficient Workflow within Facility

To improve productivity within a facility, an efficient workflow is crucial. Key elements include:

- a. A well-planned facility layout that ensures smooth, unidirectional material flow from entrance to exit, eliminating the need for U-turns.
- b. For labour-intensive or time-consuming stations, consider adopting automation or doubling the number of stations to reduce bottlenecks.
- c. Utilise equipment such as overhead cranes, conveyor belts, forklifts and removable castor wheels beneath modules to facilitate easy manoeuvring and movement of modules.
- d. Ergonomically design workstations at working level, minimising unnecessary movement and ensuring tools are within easy reach. Modules can be supported on a working platform, allowing workers to assemble the services at a comfortable height.
- e. Minimise work at height to further reduce risks and enhance productivity.
- f. Provide ample working space to prevent congestion and accidents.
- g. Maintain a safe working environment with proper ventilation to enhance worker comfort and efficiency.

4.3 Quality Control – Prefab MEP Manufacturer Accreditation Scheme (MAS)

The Prefab MEP Manufacturer Accreditation Scheme (MAS) ensures quality assurance and meticulous control throughout the design, production and installation phases of Prefab MEP modules. Managed by the Specialists Trade Alliance of Singapore (STAS), MAS validates the effectiveness of quality management system and establishes production processes to deliver high quality Prefab MEP systems. This is achieved through a comprehensive set of accreditation criteria that accentuates design proficiency and stringent quality management.

To uphold high standards and excellence in Prefab MEP manufacturing, MAS serves as a crucial benchmark. It is mandatory for suppliers of Prefab MEP modules to obtain MAS accreditation to qualify for participation in Government Land Sales (GLS) and to benefit from the Built

Environment (BE) Transformation Gross Floor Area (GFA) incentive scheme. Furthermore, projects engaging MAS-accredited Prefab MEP specialists stand to gain additional points for Buildability Score, reinforcing the significance and value of MAS accreditation in promoting efficiency and quality across construction projects.

4.3.1. Differential between MAS Tier 1 and Tier 2

4.3.1.1. Introduction of MAS Tier 2 ^{NEW}

To further enhance the productivity of Prefab MEP, STAS collaborated with BCA to upgrade the Prefab MEP MAS to a two-tier framework. This new structure differentiates and rewards Prefab MEP specialists who have made significant strides in automation and digitalisation within their factories. To qualify for MAS Tier 2, in addition to meeting the existing Tier 1 requirements, applicants must fulfil the following two criteria:

Adoption of at least two automated equipment in the production process to:

- a. Encourage Prefab MEP production facilities to automate the fabrication processes and reduce reliance on lower-skilled labour.

Adoption of at least two Integrated Digital Delivery (IDD) use cases under the Digital Fabrication/Construction stages with reference to a live project for the purposes of:

- a. Pushing for greater digitalisation to reap the full benefits of Prefab MEP.
- b. Incorporating IDD in the fabrication and construction stage allows for improved collaboration among the stakeholders and efficiency in design, fabrication, logistic planning, and installation. More information on Integrated Digital Delivery (IDD) is available at this [link](#).

Prefab MEP firms are encouraged to explore the various support schemes available under this [link](#). These schemes co-share the cost of technology adoption and innovations that enhance the facilities productivity.

4.3.1.2. Benefit of Achieving Tier 2 – Off-Site Levy Scheme ^{NEW}

To recognise Prefab MEP facilities that have achieved advanced levels of automation and digitalisation, MAS Tier 2 Accredited Prefab MEP specialists will benefit from reduced levy rates for off-site Work Permit Holders starting from January 1, 2024. More information can be found at this [link](#).

5. TRANSPORTATION AND INSTALLATION



5.1 Oversized Vehicle Movement (OVM)

The transportation route for modules to the site must be meticulously planned, especially for larger plant modules. The modules can be transported using a lorry, trailer or lowbed trailer. It is crucial to obtain an Oversized Vehicle Movement (OVM) permit and/or engage auxiliary police escort from Land Transport Authority (LTA) at least three days prior to transportation.

For the latest requirements on OVM, including permitted travel times, please refer to the website on [Permit for Vehicle Movement](#).

5.2 Plan for Logistics in Advance

A comprehensive method statement, lifting plan and risk assessment for on-site lifting and installation of the modules must be prepared to thoroughly identify and address any potential challenges in the transportation and installation of modules. This requires planning and coordination among all stakeholders, particularly between builders and Prefab MEP specialists, to ensure all aspects of the process are covered. The following elements should be considered and detailed:

Lifting Equipment (to designated floors)

- a. Determine the types of lifting equipment (e.g. cranes, hoists) needed for hoisting the modules to the designated floors.
- b. Assess the availability, load capacity and precise locations where equipment will be stationed.
- c. Ensure the equipment can handle the weight and dimensions of the modules safely and efficiently.
- d. Optimise lifting equipment utilisation through streamlining the use of lifting equipment by properly sequencing its deployment to enhance construction efficiency.
 - i. Account for potential competition for lifting equipment from other structural or architectural components (e.g. Prefabricated Prefinished Volumetric Construction (PPVC) modules and materials) to prevent scheduling conflicts.
 - ii. For risers that are designed near core, be mindful of the system formworks that might obstruct the hoisting of vertical modules into position.

- e. Plan the lifting direction and sequence of modules to their designated floors in advance, ensuring efficient placement to avoid the need for repositioning during installation.
- f. Ensure all components within the modules are secured firmly in place to prevent objects falling from height during lifting.

Lifting Equipment (to designated position for installation)

- a. Determine the types of lifting equipment needed for hoisting the modules to the designated floors based on the following considerations:
 - i. Types of modules
 - ii. Size of modules
 - iii. Weight of modules
 - iv. Floor-to-floor height
 - v. Working space for lifting of modules
- b. Ensure that structural components account for the weight of lifting equipment. The delivery route and manoeuvring space for transporting and positioning lifting equipment for module installation should be planned and considered in advance.

Access Platform (if required)

- a. Identify and set up access platforms for the landing of modules on each floor.
- b. Strategically locate these platforms to facilitate the smooth and safe manoeuvring of modules from the lifting equipment to the designated positions.
 - i. This is particularly crucial for buildings adopting PPVC modules. Detailed planning is necessary to ensure the delivery of modules through pre-identified openings, during the design of PPVC modules, into the common corridors situated between the PPVC modules.
- c. Verify that these platforms can support the weight of the modules.

Logistical Constraints

- a. Evaluate and plan for logistical constraints that could impact the lifting and installation process. This includes:
 - i. Ensuring adequate space on site for the preparation and connection of lifting equipment and modules. This space should be easily accessible and organised to prevent delays.
 - ii. Designating clear entry and exit routes for oversized vehicles transporting the modules. This includes mapping out paths that can accommodate the size and weight of these vehicles without causing disruptions or safety hazards.

Site-Specific Challenges

- a. Pay special attention to unique challenges posed by small or congested sites, particularly in areas like the Central Business District (CBD). These challenges might include limited manoeuvring space, proximity to other structures, and restrictions on vehicle movements.
- b. Develop contingency plans to address these issues, such as scheduling deliveries during off-peak hours or using specialised equipment designed for tight spaces. Consider the need for traffic management and road closures if necessary.

Safety Protocols

- a. Establish comprehensive safety protocols to protect workers and the public during the lifting and installation process. This includes risk assessments for potential hazards, safety training for personnel, and emergency response plans.
- b. Ensure all safety measures comply with relevant regulations and standards by the Ministry of Manpower (MOM).

5.3 Adopting Just-In-Time (JIT) Concept

Adopting the Just-In-Time (JIT) concept, where Prefab MEP modules are delivered according to the construction sequence, can significantly enhance operational efficiency, eliminate congestion in the factory and on site, and reduce the risk of module damage. This is achieved by continually reducing manufacturing lead time and ensuring close coordination between on site and factory teams to maintain a continuous flow of modules from production to installation. This approach not only streamlines the workflow but also optimises resource utilisation and improves overall project outcome.

5.4 Sequencing of Works

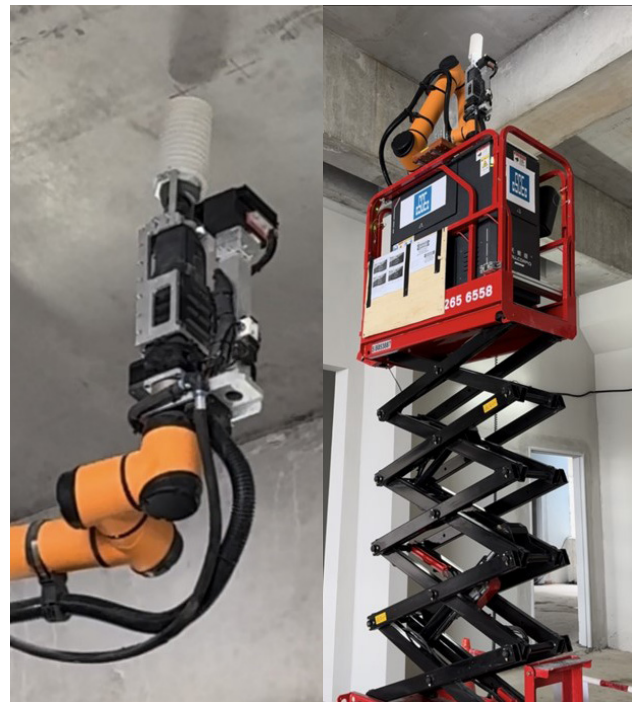
Thorough planning and close collaboration on the sequence of work are essential to prevent rework and significantly enhance overall project efficiency.

- a. Plan and coordinate with architectural and structural trades to ensure a logical sequencing of all tasks that minimises double work during the installation of Prefab MEP modules.
- b. Ensure the installation of horizontal modules is sequenced to allow adequate space for the connection of the last module, which is particularly crucial for designs involving intersections (i.e. begin installing the modules at the cross junction and then expand outwards).

5.5 Leveraging Technologies to Streamline Installation Process

By incorporating advanced technologies and strategic methods, installation tasks can be streamlined, minimising the need for manual labour at height and ensuring greater precision.

- a. Employ drilling robots to replace manual drilling, eliminating the need for workers to perform tasks at height while enhancing precision and efficiency.



Drilling robot.
(Photograph courtesy of Great Resources Pte Ltd)

- b. Utilise laser beam alignment technology to improve the accuracy of module lifting, eliminating the reliance on manual visual checks.
- c. Implement synchronised lifting with either scissor lifts or chain blocks to simultaneously lift multiple horizontal modules.
 - i. Whenever feasible, pre-connect services at ground level prior to lifting modules to minimise the need for workers to connect modules at height.



Synchronised lifter.
(Photograph courtesy of Perfab Engineering Pte Ltd)

6. USEFUL RESOURCES & CONTACTS



[Prefab MEP Guidebook
\(first edition\)](#)



[Specialists Trade
Alliance of
Singapore Website](#)



[Prefab MEP Guidebook
\(second edition\)](#)



[Latest Code of Practice
on Buildability](#)



[List of MAS
Accredited
Companies](#)



BCA Contact

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Department of Design for Manufacturing
and Assembly**

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