

Building Innovation Panel (BIP)

Building and Construction Authority (BCA) • Housing and Development Board (HDB) • JTC Corporation (JTC) • Land Transport Authority (LTA) • Ministry of Manpower (MOM) • Ministry of National Development (MND) • National Environment Agency (NEA) • PUB, The National Water Agency (PUB) • Singapore Civil Defence Force (SCDF) • Urban Redevelopment Authority (URA)

BIP Checklist *for Prefabricated Prefinished Volumetric Construction (PPVC)*

To facilitate BIP evaluation, all applications shall include the drawings, detailing, test reports, certificates, relevant approvals from overseas authorities, and other documentation of the proposed system covering sections (A) to (G) described below.

(A) General

1. Overview of the proposed system
 - 1.1. Construction cost
 - 1.2. Construction time & productivity improvement (*pls request the template from the Secretariat*)
 - 1.3. Characteristics of the proposed system
 - 1.4. Manufacturing process in factory
 - 1.5. Method of assembly on site
 - 1.6. Project track records (both local and international, if any)

(B) Design & Construction (BCA)

Structural Design

1. Construction material – include material type, grade and dimension
2. QA/QC Inspection
 - 2.1. Off-site construction / production (local/overseas)
 - 2.2. On-site construction / installation
 - 2.3. Non destruction examinations
3. Structural design code & specification
4. Compliance with building control act & regulations and other international codes (show approvals from overseas authorities, where relevant)
5. Structural performance
6. Loading criteria – dead, live, earthquake and wind
7. Serviceability criteria - building lateral, deformation and vibration
8. Differential movement
9. Lateral stability
10. Corrosion protection (where relevant)
11. Architectural and structural plans to illustrate the proposed system (min. A3 drawing size)
12. Structural analysis simulation to be carried out for high-rise building (at least for 40-storey building)

Prefabrication, Quality and Maintenance

1. Details of module to module connections
 - 1.1. Method of ensuring alignment /evenness of different floor finishes across the modules, including the interface details of different floor finishes within the unit such as marble, tile and timber floorings
 - 1.2. Method of ensuring continuity of MEP services across the modules
2. Method of preventing damage to finishes and fittings during storage, transportation and installation
3. Façade interfacing, types of façade available, constraints, cladding possibilities

4. Roofing interfacing, opportunities and constraints
5. Internal door interfacing
6. Areas and span of proposed system components
7. Provision of wall openings
8. Staircases material and its connection
9. Addressing water seepage concerns (Sealants with limited lifespan should not be used)
 - 9.1. From façade
 - 9.2. From roof
 - 9.3. Within modules (especially from wet areas)
 - 9.4. Between modules (Both horizontal and vertical)
 - 9.5. Method of water drain-off from the roof of PPVC module (To ensure water will not accumulate on the roof and potentially leak into the module)
10. Ensuring uniformity between on-site and off-site architectural works while joining modules. To show clearly how to address alignment and jointing between modules to ensure level floor finishes at the interface
 - 10.1. Consistency between on-site and off-site floor and wall finishes (example colour tonality)
 - 10.2. Uniformity of wall and ceiling finishing works (example painting)
11. To show method of sealing up gap below partition or internal wall, between modules interface
12. Long-term Performance
 - 12.1. Method of preventing architectural finishes from differential movement (example floor cracks)
 - 12.2. Protection of architectural finishes from deterioration over time
13. Mechanical & electrical works
 - 13.1. Shaft installation
 - 13.2. All MEP services including electrical, air-con refrigerant & drain pipes, plumbing and sanitary pipes to provide details, including method of connection, details, and brand of connector to be used
14. The system shall be completed with architectural finishes for walls, floors and ceilings which are constructed and assembled in factory. The minimum level of off-site works for individual trades must comply with the requirements set out in the COP on Buildability 2017
15. The system shall be completed with wardrobe and cabinets which are constructed and assembled in factory and must comply with the requirements set out in the COP on Buildability 2017
16. Bathrooms inside the PPVC modules (i.e. In-built Bathrooms) shall comply with Prefabricated Bathroom Unit (PBU) performance requirements set out in the COP on Buildability 2017.
17. The critical areas of individual components/trades in the system shall comply with the acceptable international and local standards, for example:
 - 17.1. Durability corrosion protection of structural steel through appropriate coating system or other equivalent method (such as providing additional sacrificial thickness of structural steel) shall be provided to ensure the continued safety of the building for its intended use;
 - 17.2. Internal wall partition strength must comply with SS492;
 - 17.3. Wet areas waterproofing must comply with CP82 and BCA's Good Industry Practices guide;
 - 17.4. Window water-tightness must comply with CONQUAS requirements.
18. The connection details for finishing, fittings, mechanical, electrical and plumbing (MEP) services shall be provided, including the method of replacement in the future.
19. Building maintenance works
 - 19.1. Corrosion
 - 19.2. Façade cleaning
 - 19.3. Water leakage / waterproofing
 - 19.4. Crack line

Inspection

1. Access or specific methodologies to enable inspections of concealed key structural elements (such as in steel PPVC buildings) for the purpose of regular maintenance checks and structural inspection shall be provided in the design of the system.

Household Shelter (HS) and Staircase Storey Shelter (SSS)

1. HS and SSS shall be designed to comply with their latest technical requirements. This shall be stated in the BIP application.
2. The floor slab of the PPVC modules located in the HS/SSS setback distance envelop shall be constructed of normal weight reinforced concrete.
3. Volumetric precast hollow core shall be adopted in HS.
4. Precast staircase flight shall be adopted in SSS or alternatively adopt volumetric precast hollow core staircase storey shelter.
5. The followings shall be included in the BIP application:
 - 5.1 Floor layout plan showing the location of the Household Shelter (HS) and Staircase Storey Shelter (SSS) in relation to overall building layout plan shall be included.
 - 5.2 Sequence of construction of HS/SSS vis-a-vis installation of abutting PPVC modules.
 - 5.3 Proposed connection details between HS/SSS wall and abutting PPVC module and design calculations showing connection capacity is equivalent to that of the RC slab (with 2 layers of nominal reinforcements) connected to HS/SSS wall.

(C) Transportation & Logistics (LTA)

1. Proposed Transportation Plan -
 - 1.1 Indicate route from factory to holding area/construction site and travel schedule
 - 1.2 State vehicle type, overall dimensions (width, rear overhang, length & height) and weight
 - 1.3 Refer to [LTA.PROMPT](#) for oversized vehicle movement (OVM) permit requirements
2. Lifting and Installation Method
 - 2.1 For the installation, to show clearly how to manage potential height restrictions and AMSL control, especially when the project site is under the flight path. To show that the crane used when lifting modules for installation does not extend into restricted air space.
3. Holding Areas - Proposed location to hold the proposed system (location to mark up on location map)
 - 3.1 The holding areas should be within development sites and lifting works should not affect public streets.
4. Road surface protection (where relevant) - Type of protection material and method to be clearly illustrated. For example, protection measures for the road bitumen surface.
5. Road signage relocation (where relevant)
 - 5.1 Type and quantity of affected signages
 - 5.2 New locations to house the affected signages must be clearly illustrated in the map and photographs.
6. To specify method of protecting modules, including protection for all internal fitting-out and finishes during transportation, lifting and installation
7. To specify/show the trailer dimensions and the model to be used for transportation for PPVC modules

(D) Management of Working & Design Risks (MOM)

1. Risk Management

- 1.1 An audit report with supporting documents from a MOM-recognised WSH Auditing Organisation on a document review of your risk assessments and safe work procedures related to PPVC activities in casting and fitting out factories (if located in Singapore) and in your clients' worksites, including but not limited to
 - PPVC module casting and fitting out factory plant layouts (if located in Singapore);

- all dry and wet trades required for PPVC fabrication in casting and fitting out factories (if located in Singapore);
- PPVC module transportation;
- PPVC module storage;
- PPVC module lifting, shifting and installation arrangements;
- access & egress onto & from PPVC module;
- lifting, rigging and guiding / restraint of PPVC module;
- working-at-height and fall prevention / protection of workers during PPVC activities;
- Positioning of workers during adjusting and installation of PPVC module, etc.

Note: Assessment should cover all work activities from when the PPVC module reaches the site by trailer, up till when the module is installed and unrigged.

Note: A bizSAFE audit report is not acceptable as it does not meet the requirements as stated in item 1.1.

1.2 Your audit action plan and all necessary supporting documents/ photographic records to address and close the auditor's findings and recommendations from item 1.1.

1.3 Certification of (minimum) bizSAFE Level 3.

2. **Design for Safety (DfS)**

As a designer/ supplier of PPVC modules, when your PPVC modules are supplied and used in a project as defined Workplace Safety and Health (Design for Safety) Regulations (DfS Regulations), you are responsible to perform the duties of a Designer under the DfS Regulations. The design of your proposed PPVC modules have a significant impact on the safety and health of workers, particularly to those who construct, maintain, repair, and eventually demolish or remove the building / structure. It is therefore important that safety and health are considered at the start of your design process.

Hence, you are required to submit:

2.1 the lifting and installation plan of your PPVC modules at your clients' worksites, highlighting your DfS considerations, and detailing the following:

- lifting equipment to be used (e.g. crane, lifting frame, chains, pulleys, loading platform, wheeled jack, lifting lugs built into the PPVC modules etc);
- relevant Professional Engineer's (PE) design and calculations (e.g. lifting frame, loading platform, lifting lugs etc);
- rigging & load restraint methods;
- plan view of all typical modules showing the locations of all lifting lugs, joints and connections for barricades in the same diagram to confirm that there are no clashes in position and confirmation whether these connections would be built-in or installed on site. (Note: the assessment of work activities would differ depending on the proposal);
- schematic diagram showing the crane's lifting capacity over the project's layout relating to the PPVC modules' position and weight;
- confirmation that safety buffer that would be applied above the SWL of the tower crane is more than 10%;
- the tower crane's tie-back position in the simulated layout and notional details of the element of which the tie-back would be anchored to, and whether the element in question is able to take on the reaction loads from the tower crane including loads during lifting of the module;
- summary table of all the PPVC's dimensions and weights.

- 2.2 A statement by a PE indicating that the lifting frame(s) used to lift the PPVC modules, and the lifting lugs built into the PPVC modules are
 - (i) designed in accordance to an International Standard, and
 - (ii) has attained a minimum Factor of Safety of 3

- 2.3 Method Statement, for purpose of external works, on how plastering and finishes would be carried out (e.g. whether work platforms, safety screens, gondolas etc. would be used and details of the anchorage points for these platforms noting that hacking of the module for installation of anchorage points may not be an option).

- 2.4 A complete step-by-step pictorial SWP illustration of the entire process of the onsite PPVC module lifting, movement and installation.

- 2.5 An owner's manual on future PPVC related building maintenance, defect rectifications and demolition work processes.

(E) Bathroom, Sanitary & Water Services (PUB)

1. Sanitary System

- 1.1 The design of the sanitary work shall comply with the Sewerage and Drainage (Sanitary Work) Regulation and the code of practice for sewerage and sanitary work.
- 1.2 Mock-up Bathroom Drawing and Sectional Plan
- 1.3 Sanitary and Discharges Pipes Detail Plan
- 1.4 Floor-Trap Details. Please provide the options of two floor-trap systems, 1) Shallow Floor Trap 2) P or S-trap including their connection details to vertical stack.
 - 1.4.1 Shallow Floor Trap requirement:
 - 1.4.1.1 State the model no of Snow Brand shallow FT to be used
 - 1.4.1.2 To submit certificate of compliance EN1253-1, with test reports to be enclosed:
 - Anti-Blockage test
 - Water tightness test
 - Flow Rate Test
 - Odour tightness Test
 - Resistance of Water Seal to Pressure
 - Depth of Water Seal
 - Access for Cleaning
 - Self-cleansing capacity
 - Position of side inlet
 - 1.4.2 On top of the requirement specified in EN1253, the following requirement for shallow floor trap are to be complied:

Descriptions	Standard Requirements
Depth of Water Seal	Min 50mm
Passage Clearance	Min 25mm
Outlet Diameter	Min 75mm
Floor Trap (Water Compartment)	Shall be integral type, removable trap is not allowed.
Floor Trap Grating and Anti-Mosquito Valve	Shall incorporate an approved type of floor trap grating and anti-mosquito valve
Service Plug in the Floor Trap (if provided)	To provide permanent instruction label to the service plug.

2. Water Service Installation

- 2.1 The design of the water service installation and the water service work shall comply with the Public Utilities (Water Supply) Regulations as well as the Singapore Standard CP48 - The Code of Practice for Water Services.
- 2.2 Water pipes and fittings to be used shall comply with the standards and requirements stipulated by PUB.

(F) Fire Safety (SCDF)

1. Provision of documental proofs and detail drawings to illustrate compliance of fire code requirements of proposed system in terms of compartmentation, material usage, etc.
2. Mode of fire protection
3. Sectional plans to show the fire protection details and elements
4. Details on the use of plastic materials on or within floors, walls and ceilings, if any
5. Types and integrity of the fire rated board system
6. Fire safety review of the system conducted by fire safety engineer, where relevant
7. Fire test performance reports & certificates of conformity (COCs) for regulated fire safety products for building construction in Singapore
 - 7.1 The proposed building products/materials/systems shall comply with the fire test performance requirements stipulated in Annex B of Appendix 15 Fire Safety Guidelines for Certification of Regulated Fire Safety Products/Materials of the Fire Code.
 - 7.2 Fire test performance reports from test laboratories & certificates of conformity (COCs) for regulated fire safety products from certification bodies accredited by Singapore Accreditation Council (SAC) shall be provided for the proposed products/materials/systems.
 - 7.2.1 If overseas accredited testing laboratory recognised by SAC is engaged to conduct the fire performance tests for the proposed products/materials/systems, the test performance reports shall be certified by accredited certification bodies in Singapore before they can be used for building construction in Singapore.
 - 7.2.2 To avoid unnecessary delay of project completion, QPs shall engage the certification body and registered inspector (RI) earlier to conduct factory inspection at the overseas manufacturing plant for certification and conformity of regulated fire safety products/materials/systems.
8. Mock-up physical sample (1 no.) of proposed system, where relevant. Clear illustration of components of system to illustrate compliance of fire safety integrity and fire performance rating, if applicable.

(G) Environmental (NEA)

1. The system shall comply with the technical requirements and provisions stipulated in the following:
 - 1.1 Code of Practice on Environmental Health
 - 1.2 Singapore Standard SS 593: Code of Practice for Pollution Control
 - 1.3 Environmental Public Health Act, Environmental Protection and Management Act, and their attendant regulations, including the Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.
2. Please specify noise control measure to keep noise within NEA's specified levels, especially for night works