

**Memorandum for the Building Committee of
the Hong Kong Housing Authority**

**Report on Housing Authority Industry Forum on
Innovative Construction Method for Public Housing Developments
and
Progress Update on the Use of Modular Integrated Construction**

PURPOSE

This paper informs Members of the Hong Kong Housing Authority (HA) industry forum on “Innovative Construction Methods for Public Housing Developments” and the latest progress on the use of Modular Integrated Construction (MiC).

BACKGROUND

2. In March 2020, we informed Members (vide Paper No. **BC 18/2020, QH 1/2020**) that a MiC mock-up would be constructed to examine the buildability of the MiC modules in various aspects prior to its implementation in public housing developments. Following completion of the mock-up in December 2020, we shared the experience of the MiC mock-up and latest status on the use of precast concrete construction (PCC) and MiC in HA with members of the Building Committee (BC) and the Tender Committee (TC) on 28 January 2021.

3. On 14 May 2021, we conducted an industry forum on “Innovative Construction Methods for Public Housing Developments 2021” to collect views and ideas of our industry partners and stakeholders on how to overcome the challenges in association with the use of MiC in public housing developments. We also invited stakeholders to share the experience on the use of Innovation and Technology (I&T) and Construction Robotics that are suitable for enhancing the productivity, construction time, quality and cost. Details of the industry forum and the MiC mock-up are reported in this paper.

INDUSTRY FORUM

4. The industry forum focused on exchanges and collaboration between HA and the industry in respect of the following three main themes –

(a) Theme 1 - Off-site Prefabrication and MiC

To tap the industry's ideas on ways for improvement of logistics for off-site prefabrication and MiC in public housing developments;

(b) Theme 2 - Innovation and Technology

To explore applicable I&T solutions which can enhance construction productivity, quality and cost; and

(c) Theme 3 - Construction Robotics

To identify available robotic technologies in the market and to promulgate its usage in public housing developments with a view to reducing the reliance on on-site labour and boosting productivity.

----- 5. Over 500 attendees (see **Annex A**) from BC, TC, research and development institutes, professional institutions, academia, consultants, contractors, specialists, Government Bureaux and Departments took part in the Forum.

6. Panel sessions were held, in which participants discussed how HA could leverage its strengths to promote the wider use of HA's off-site PCC as well as MiC, and to extend the application to mechanical, electrical and plumbing (MEP) installations; pioneering more advanced construction technologies and construction robotics to help boost the public housing productivity; improving site safety standard and avoiding over-reliance on the ageing and diminishing workforce. Details of the discussions are reported below.

Theme 1 - Off-site prefabrication and MiC

Accumulation of Experience

7. The modular construction demands greater design and engineering input to be completed upfront and involves a fundamental change in the design and construction process. Participants generally agreed that it may take some time for the construction professionals and contractors to be familiar with the

intricacies of the MiC modules fabrication and erection before the real edge can be realised. To this end, participants agreed that HA should be prudent in exploring MiC through pilot projects and join hands with the industry to map out the solutions under different site constraints before wider application of MiC in suitable public housing projects.

Selection of Suitable MiC Sites

8. Aside from those projects which have sufficient transportation network, simple site terrain, and availability of storage area nearby, those sites which are either too small or bound by different site constraints (e.g. hilly terrain, limited storage areas, etc.) are not suitable for MiC. Participants called for a careful selection of sites for reaping the benefits to be brought about by the technology.

Development of Enhanced Modular Flat Design (MFD) for MiC

9. As with all the concrete MiC projects, it will be of paramount importance to devise construction-friendly modules which meet the client's requirements in terms of time, cost and quality. In this regard, HA is now working on the enhancement of the MFD to make it more MiC-friendly and at the same time incorporate the wisdom gained in the past few decades from HA's MFD, not only from the designer's perspective but also meeting many other considerations such as internal floor area, flat mix, barrier free access, tenants' and stakeholders' feedback, etc.

Theme 2 & 3 - I&T and Construction Robotics

10. While HA's PCC and MiC may only be part of the solutions and in view of the current and continued shortage in labour, an ageing workforce and workplace safety issues, the Forum put great emphasis on the emerging I&T solutions and automation through the use of construction robotics for increasing productivity, safety and quality. HA has experimented with robots a few years ago in areas such as tile laying, external and internal wall painting, etc. Participants also shared other state-of-the-art technologies that can be used in public housing construction, including the mobile point cloud technology, Simultaneous Localisation and Mapping (SLAM) for reality capture, AI-driven drone inspection of external facades, etc. HA would continue to partner with various stakeholders for exploring and verifying the I&T solutions which help re-engineer, automate and infuse intelligence across different stages of our public housing developments for building smarter and faster in future.

MiC MOCK-UP

11. A two-storey MiC mock-up covering four types of modular flat design units (**Annex B** refers) was constructed in the Mainland to test out HA's engineering design modules in the areas of installation, buildability, safety, quality assurance, etc. The MiC mock-up was completed in December 2020. The key findings and associated design enhancements have been incorporated in our first MiC pilot project at Tung Chung Area 99 (TC99).

Installation

12. MiC entails totally different thinking of the entire process of building, including architectural and MEP considerations which must be addressed early and consistently throughout the design and construction process. Moreover, an over-riding principle of a wiring installation deployed in a building constructed using MiC with pre-wired and pluggable components is to reduce the amount of post-installation efforts. We have tried out the pre-installation of most of the architectural finishes, fixtures and fittings as well as electrical wiring and accessories (**Annex C** refers) in the MiC mock-up modules under different arrangements to examine the technical feasibility, construction safety as well as the implication to the construction programme during on-site assembly. Through the mock-up, we have tested whether or not the pre-installed MEP under different configurations of pre-installed wiring arrangements will drive or limit the viability of the modular construction. The most suitable wiring connection method ¹Note will be adopted in HA's MiC projects.

Buildability

13. Problematic dimensional and geometric variabilities may abound in MiC owing to modular geometric conflicts during production and between modules and site interfaces. For such a large volumetric element with at least five interfaces with adjoining modules, the on-site assembly of modules in the mock-up resulted in a lot of step-joints. This triggered a significant challenge in dealing with the excessive geometric variability risks in the factory production of modular components and on-site assembly. We note that the accurate specification of allowable tolerances in MiC is indispensable because imprecision may result in less clemency between manufacturing and on-site erection tolerances. To avoid the need for additional touch-up works, we have specified

Note Three wiring connection methods between MiC modules were tried in the mock-up. Among which, the method with cables reserved below the slab at adaptable boxes in each MiC module was found most suitable in terms of subsequent connection works on-site.

allowable tolerances in the specifications, suitable recess at the interfaces for easing after-installation touch-up and adopted semi-precast slab in the MiC modules to allow greater flexibility and tolerance during the installation process.

Safety

14. While it is a common belief that the modular method of construction is safer than traditional construction, it is not without risk. Essentially, the manual handling and operations during modular production and on-site assembly are the recipes for the safety risks, and particular risks associated with the multiple lifting of hoisting heavy modules with weight ranging from 12 to 21 tonnes were identified in the mock-up. In the absence of any bespoke safety risk assessment conducted before, HA will work with the Occupational Safety and Health Council to devise a set of MiC specific safety precaution measures for addressing the manifold risks associated with the operation / lifting of MiC, both at the factory and on-site.

Quality Assurance

15. Nowhere in the construction industry is quality assurance more important than in the MiC. As the majority of work occurs off-site and cannot be rectified once installed, it is imperative for HA to assign competent resident supervision teams for architectural, building services and structural works for assuring the quality of product and its performance. Qualified and experienced resident supervisors at the production factory would be allowed in the pilot project at TC99.

HA's MiC PROJECTS IN THE PIPELINE

16. In addition to the first MiC pilot project at TC99, we have identified the following public housing projects which are suitable for implementation of MiC –

(a) Public Rental Housing (PRH) project at Tak Tin Street

This project comprises one 33-storey block with 462 flats (14 flats per floor). The piling tender will be issued in Q1, 2023 and the building works is targeted for completion in Q1, 2027. This site is located in an area of busy traffic and with very limited storage area. It will enable us to test out ways to address the site installation logistic issues given the site constraints.

(b) *Subsidised Sale Flats (SSF) project at Anderson Road Quarry Site R2-6 & R2-7*

This project comprises three blocks with a total of 1 410 flats: two 28-storey blocks (18 flats per floor) at Site R2-6 and one 17-storey block (26 flats per floor) at Site R2-7. The piling tender will be issued in Q3,2021 and the building works for Site R2-7 is targeted for completion in Q4, 2024 while that for Site R2-6 is in Q2, 2025. Since there are other projects of similar scale in the vicinity using conventional construction method, they will serve as a good benchmark for cost and time comparison with the two projects.

WAY FORWARD

17. HA will spare no effort in driving the industry to get ready for wider application of MiC in public housing developments and collaborating with the industry to resolve challenges identified such as limited suppliers at the upstream, high complexity in structural design for high-rise concrete MiC projects. For sites which are not suitable for MiC, we will continue with the HA's PCC technology. We consider that the two approaches are complementary, and together they contribute to enhance public housing production in terms of time and capacity. We are also actively promoting the use of other technologies such as robotics and the Development Construction Site Monitoring System for site inspection to further enhance productivity.

INFORMATION

18. This paper is issued for Members' information.

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c.c. Members of the Tender Committee

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LIST OF ANNEXES

- Annex A : Details of Hong Kong Housing Authority Industry Forum Innovative Construction Methods for Public Housing Developments 2021
- Annex B : MiC Mock-up for Public Housing Developments
- Annex C : Schedules of Pre-installed Finishes, Fixtures and Fittings in MiC Mock-up

Hong Kong Housing Authority Industry Forum
Innovative Construction Methods for Public Housing Developments 2021

Programme

Date: 14 May 2021 (Friday)
Time: 2:00 p.m. to 5:50 p.m.

Time	Agenda
13:30 – 14:00	Forum Login
14:00 – 14:05	Introduction
14:05 – 14:15	Welcoming Speech [by Stephen K M LEUNG – Deputy Director (Development & Construction), Housing Department]
Session 1 - Off-site Prefabrication and MiC	
14:15 – 15:40	<ul style="list-style-type: none"> ➤ Precast Concrete Construction and MiC for Public Housing Developments [by Rayson W H WONG – Chief Structural Engineer / Development and Construction, Housing Department] ➤ Statutory Requirements for BS Installations for MiC & Opportunity of BS DfMA for Public Housing Developments [by Henry Y S CHANG – Chief Building Services Engineer / 2, Housing Department] ➤ Water Pump and other BS DfMA Applications [by C K CHAN, The Hong Kong Federation of Electrical and Mechanical Contractors Limited (FEMC)] ➤ Panel Discussion
15:40 – 15:55	Break
Session 2 - Innovation and Technology	
15:55 – 16:50	<ul style="list-style-type: none"> ➤ Innovation and Technology (I&T) adopted in Public Housing Developments [by Sherman S L YIP – Chief Architect / Development and Standards, Housing Department] ➤ Digital Project Delivery [by Frankie Y M FUNG, Chief Assistant Secretary (Works) 1, Development Bureau] ➤ Panel Discussion
Session 3 - Construction Robotics	
16:50 – 17:45	<ul style="list-style-type: none"> ➤ New Building Works' Inspection - Unmanned Aircraft System coupled with Artificial Intelligence(AI) and Building Information Model (BIM) [by Jack W ZHANG, Managing Director, Geosys Hong Kong Ltd] ➤ Robotic Construction Technology [by Y H LIU, T Stone Robotic Institute, The Chinese University of Hong Kong] ➤ Panel Discussion
17:45 – 17:50	Closing Remark [by Stephen K M LEUNG – Deputy Director (Development & Construction), Housing Department]
17:50	End of Forum

Group Photograph

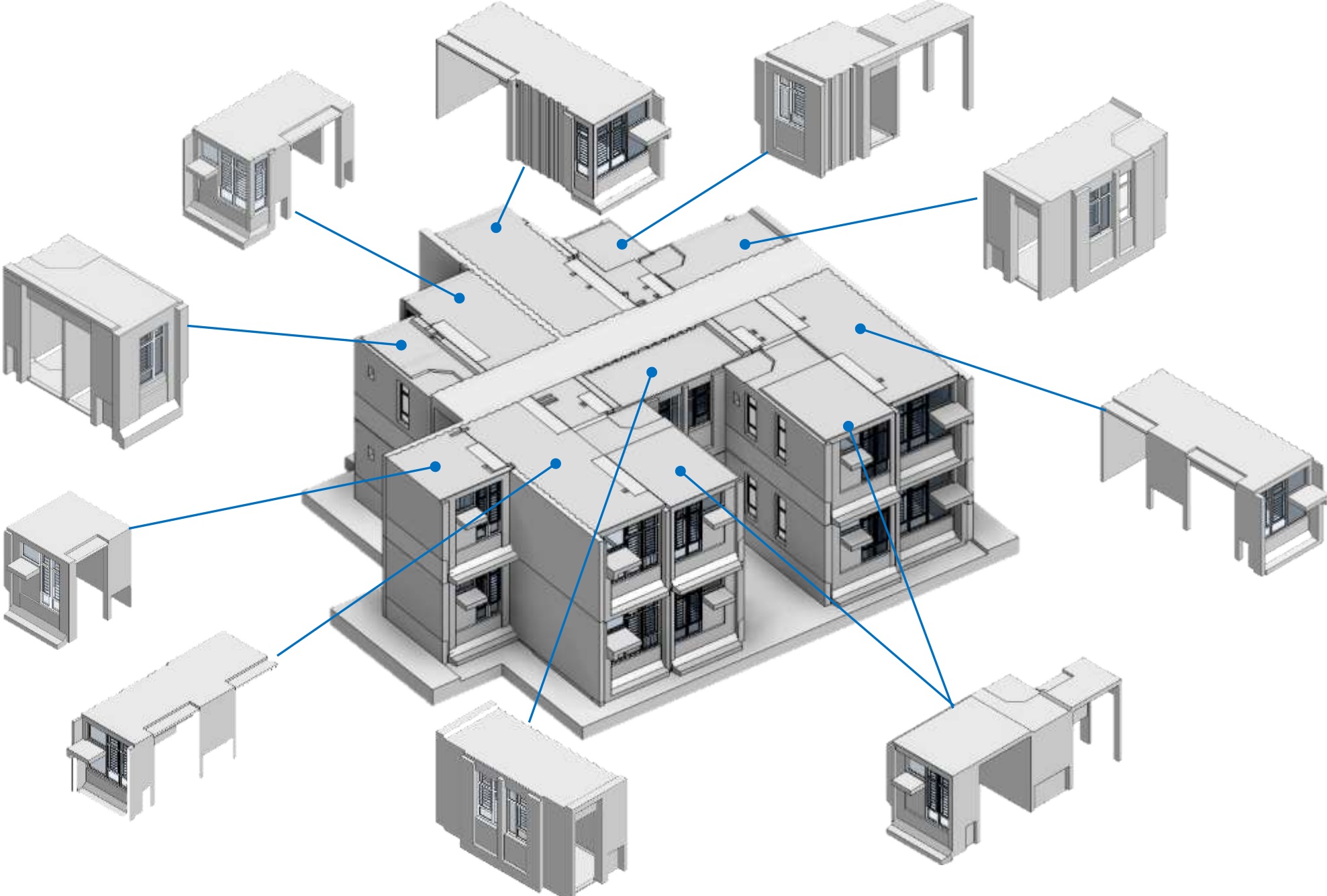


Housing Authority Industry Forum
Innovative Construction Methods for Public Housing Development 2021

List of Participated Stakeholders

1	BC / TC Members	21	The Hong Kong Construction Association, Limited
2	Development Bureau	22	The Hong Kong Federation of Electrical and Mechanical Contractors Limited
3	Architectural Services Department	23	The Lift & Escalator Contractors Association
4	Buildings Department	24	The Chinese University of Hong Kong
5	Civil Engineering and Development Department	25	The Hong Kong University of Science and Technology
6	Electrical & Mechanical Services Department	26	The Hong Kong Polytechnic University
7	Fire Services Department	27	Technological and Higher Education Institute of Hong Kong
8	Transport Department	28	Hong Kong Housing Society
9	Water Supplies Department	29	Geosys Hong Kong Ltd
10	Construction Industry Council	30	Nano and Advanced Materials Institute Limited
11	The Hong Kong Institute of Architects	31	Hong Kong Science & Technology Parks Corporation (HKSTP)
12	The Hong Kong Institution of Engineers	32	T Stone Robotic Institute
13	The Hong Kong Institute of Surveyors	33	The Hong Kong and China Gas Company Limited
14	The Chartered Institute of Building	34	Hong Kong Telecommunications (HKT) Limited
15	The Chartered Institute of Plumbing and Heating Engineering	35	Hong Kong Broadband Network Limited
16	BEAM Society Limited	36	Prefabrication Factories
17	Association of Architectural Practices	37	Material Laboratories
18	Association of Consulting Engineers of Hong Kong	38	Contractors
19	Hong Kong Electrical Contractors' Association Limited	39	Consultants
20	Association of Registered Fire Services Installation Contractors		

MiC Mock-up for Public Housing Developments





Pre-installed Architectural Finishes, Fixtures and Fittings in MiC Mock-up

Items / Location		Finishes/ Fixtures / Fittings	Pre-installed	Installed on-site
External wall		Multi-layer acrylic paint	✓	
Ceiling	Entire flat	Skim coat and internal emulsion paint	✓	
Wall	Living Room / Bedroom	Skim coat and internal emulsion paint	✓	
	Kitchen / Bathroom	Ceramic wall tiles, skim coat and internal emulsion paint	✓	
Floor	Living Room / Bedroom	Power float finish	✓	
	Kitchen / Bathroom	Non-slip homogeneous floor tiles on cement sand screed	✓	
Door curb / shower curb	Flat entrance	Concrete curb finished with non-slip granite edging tiles		✓
	Kitchen / Bathroom		✓	
Door	Flat entrance	Fire-rated flat entrance doorset		✓
		Metal gateset with locking devices		✓
	Kitchen	Fire-rated doorset	✓	
	Bathroom	Folding door / Swing door	✓	
Door ironmongery	Flat entrance door	Door viewer, Lever type door handle with lock and Door closer		✓
	Kitchen	Push plate, Pull handle and Door closer	✓	
	Bathroom	Lockset and handle	✓	
		Lever type door handle and lock	✓	
Aluminium Window	Entire flat	Window frame and sash, glazing, window grilles and A/C window	✓	
Sanitary Wares	Kitchen	Cooking bench and sink with lever type sink mixer	✓	
	Bathroom	- Water closet with seat and cover - Wall-hung wash basin with lever type basin mixer - Sunken shower area with lever type shower-mixer - Flexible hose & shower head - Vertical sliding rod	✓	
Accessories	Living Room / Bedroom	Laundry rack holder	✓	
		Laundry rack		✓
		AC condensation pipes	✓	
	Bathroom	Clothes drying rod, grab bar, shower curtain rail, mirror, mirror backing plate, toilet paper holder, soap holder	✓	
Drainage	Kitchen & Bathroom	All soil / waste / rain water pipes, cross vent pipes and traps at exterior		✓
		All drainage pipes and traps inside flat	✓	
		Floor drains	✓	

Pre-installed Building Services and Plumbing installation Works in MiC Mock-up

Items / Location		Finishes / Fittings	Pre-installed	Installed on-site
Plumbing installation	Kitchen & Bathroom	All external water pipe		✓
		Internal water pipes with isolating valves inside flat	✓	
Electrical Installation	Living Room / Bedroom	Conceal conduit system	✓	
		Wiring	✓	
		Consumer unit - Consumer unit base box - Wire connection	✓	✓
		Accessories: (i) Face plate for – - Socket outlets - Lighting switches and points - TV/FM outlet - Telephone points - Connection units - Equipotential bonding	✓ ✓ ✓ ✓ ✓ ✓	✓
		(ii) Doorphone unit	✓	
		(iii) Door bell c/w push button	✓	
Electrical Installation	Kitchen & Bathroom	Conceal conduits system	✓	
		Wiring	✓	
		Equipotential bonding	✓	
		Face plate for Socket outlets, Lighting switches and points, Connection units, Equipotential bonding	✓	
Gas Supply Installation	Kitchen & Bathroom	Surface gas pipes with supply / connection points		✓
		Flue aperture cover plate	✓	