

**Memorandum for the Review Committee on Quality Assurance Issues
Relating to Fresh Water Supply of Public Housing Estates of
the Hong Kong Housing Authority**

**Testing and Commissioning and Final Inspection
for Fresh Water Supply System
in Housing Authority's Public Housing Developments**

PURPOSE

This paper informs Members about the Testing and Commissioning, and Final Inspection at completion stage in the context of fresh water supply system in the Housing Authority (HA)'s public housing developments in post contract stage.

BACKGROUND

2. Paper No. **RC 6/2015** informs Members about the major processes shown in a Flow Chart for Design, Construction and Completion of Fresh Water Supply System in the HA's Public Housing Developments, to facilitate Members' understanding of the existing mechanism as described in Paper No. **RC 3/2015**, and to enable them to make informed decisions. This Paper covers the major processes on the testing and commissioning and final inspection of fresh water supply system at completion stage corresponding to
----- **Step 14 to 18 of the Flow Chart in Annex 1 of Paper No. RC 6/2015.**

**STEP 14 - TESTING AND COMMISSIONING IN POST-CONTRACT
STAGE**

3. Testing and commissioning of the fresh water supply system includes two sections –

- (a) Testing and commissioning for Plumbing Installation - executed by the Register Contractor (RC) and the domestic plumbing subcontractor under Specification Clause PLU1.T020 in **Annex 2**; and

- (b) Testing and commissioning for Water Feed Pump Installation - executed by RC and the Fire Services and Water Pump Nominated Sub-contractor (FSWP NSC) under Specification Clause FWP14.1 in **Annex 1**.

Both the domestic subcontractor and the NSC will appoint individual Licensed Plumbers (LP) to take charge of their respective parts of the works. **Subcontracting of plumbing installation works will not relieve the RC from any of the RC's liabilities or obligations under the contract.** The RC is responsible for the acts, defaults and neglects of the domestic subcontractor or NSC, or their agents, employees or workers.

I. Plumbing Installation

4. Upon completion of the plumbing installation executed by the domestic plumbing subcontractor (DPS) under the supervision of a Licensed Plumber appointed by DPS, pursuant to Specification Clause PLU1.T020.7 in **Annex 2** –

- (a) RC submits detailed procedures and a programme for testing and commissioning for the Contract Manager (CM)'s approval;
- (b) RC and DPS execute pre-test cleaning of the fresh water supply system;
- (c) After CM's approval of (a) above, RC and DPS then execute water pressure test of the system in the presence of Housing Department's Site Inspection Team (SIT). The fresh water supply system and circuits are tested hydraulically to –
 - (i) a minimum pressure of 1.5 times of the system working pressure; or
 - (ii) a minimum of 10 bar, whichever is higher for a period of not less than one hour without leaks appearing.
- (d) Following the water pressure test with satisfactory results, RC and DPS carry out a normal working test during which adjustments and regulation of valves shall be effected and each tap and shower shall be visually checked for satisfactory rate of flow in accordance with

the manufacturers' instructions and to the satisfaction of the CM;
and

- (e) RC submits test reports to the Contract Manager for approval.

II. Water Feed Pump Installation

5. Upon completion of the water feed pump installation executed by FSWP NSC under the supervision of a separate Licensed Plumber appointed by FSWP NSC, pursuant to Specification Clause FWP14.1 in **Annex 1** -

- (a) RC submits detailed procedures and a programme for testing and commissioning for the Contract Manager's approval;
- (b) RC and FSWP NSC execute pre-test cleaning of the fresh water supply system;
- (c) RC and FSWP NSC then execute water pressure test of the system in the presence of Housing Department (HD)'s Site Inspection Team (SIT). The fresh water supply system and circuits are tested hydraulically to –
 - (i) a minimum pressure of 1.5 times of the system working pressure; or
 - (ii) a minimum of 10 bar, whichever is higher for a period of not less than one hour without leaks appearing.
- (d) Following the water pressure test with satisfactory results, RC and FSWP NSC carry out a normal working test during which adjustments and regulation of valves shall be effected in accordance with the manufacturers' instructions and to the satisfaction of the CM; and
- (e) RC submits test reports to the Contract Manager for approval.

6. After CM's approval of RC's reports for testing and commissioning for plumbing installation and water feed pump installation, RC then cleanses and disinfects the fresh water inside service.

STEP 15 – APPLICATION FOR CONNECTION OF WATER SUPPLY

7. As mentioned in Paragraph 5 of Paper No. RC3/2015, HD has adopted parallel administrative practice by nominating the Chief Architect to assume the equivalent roles ^{Note 1} of Authorized Person (AP) to coordinate and supervise the building works and make such inspections as may be necessary. After RC, DPS and FSWP NSC have submitted the above tests reports with satisfactory results and confirmed the plumbing and water feed pump installation in compliance with the Waterworks standards and requirements, the AP applies to WSD for connection of water supply by completing Form no. WWO132 Part II (**Appendix 1 of Paper No. RC 2/2015** refers).

STEP 16 – NOTIFICATION OF COMPLETION AND REQUEST FOR WSD'S INSPECTION AND APPROVAL

8. At the same time, the LPs appointed by the domestic plumbing subcontractor and the FSWP NSC shall notify WSD the completion of respective plumbing installation, and request their inspection and approval of the plumbing installation, by completing Form no. WWO46 Part IV, which is also signed by the AP and the applicant (**Appendix 2 of Paper No. RC 2/2015** refers).

STEP 17 – FINAL INSPECTION AND TESTING OF WATER SAMPLES

9. Upon receipt of the application, notification and request forms in paragraph 7 and 8 above, Water Supplies Department (WSD) arranges site inspection and their Waterworks Chemists to collect water samples for bacteriological and chemical analysis.

10. On top of ensuring compliance with the statutory requirements, the HA has also put in place a number of measures to ensure the safety and quality of water supply –

Note 1 Building works and buildings on land wholly vested to/owned by the HA are exempted from the Building Ordinance (BO). Therefore, the in-house Chief Architects serving as APs in HD do not have the statutory liabilities as stipulated in the BO and are only "equivalent APs". They are effecting the similar tasks without the statutory liabilities under the BO.

- (a) While WSD collects water samples from water collection points for testing and analysis for the purpose of issuing the certificates for water supply connection, HD concurrently requires RC to carry out **additional water sample tests**. These additional tests serve dual purposes –
- (i) they serve as a further test (with more samples) of the water quality standard against the parameters promulgated by WSD via its Circular Letter No. 2/2012 (and later No. 1/2015); and
 - (ii) they serve to meet the assessment criteria for water quality under Building Environmental Assessment Method (BEAM) Plus version 1.2 (a requirement which has been incorporated in the HA's contract specifications since 2012). To meet the BEAM Plus version 1.2 water quality criteria, the requirements specified in WSD's "Quality Water Supply Scheme for Buildings - Fresh Water" should be met. To achieve this, firstly, the water quality standard has to meet the prescribed standards^{Note 2}. Secondly, all water samples should be taken in a manner described in ISO5667, ie. they should be taken at all the farthest points of use in the distribution system from the storage tank for each zone, and should include samples from each water supply tank used in the building. Also, the water tests have to be conducted by a Hong Kong Laboratory Accreditation Scheme (HOKLAS) accredited laboratory or an HA recognised laboratory.
- (b) In order to immediately reduce the risk of recurrence of the presence of lead in solder on joints and of excessive lead content in fresh water, since August 2015, HD has required RC to test additional water samples on top of WSD's requirement for concurrent water quality test by a Direct Testing Contractor employed by the HA, including one random sample from a selected point of use of each distribution zone and a random point of the lowest zone of each vertical riser.

Note 2 The test parameters required under the Quality Water Supply Scheme for Buildings – Fresh Water are basically the same as those in WSD Circular Letter No. 2/2012 except there is one additional test parameter (iron) while two test parameters are omitted (free residual chlorine and heterotrophic plate count).

STEP 18 – CERTIFICATE REGARDING WATER SUPPLY CONNECTION

11. Upon obtaining satisfactory testing results, WSD issues the certificate in prescribed Form no. WWO1005 for permanent connection of water supply connection to the new development.

COMPLETION OF BUILDING WORKS

12. At the completion stage of the building contract works, it takes three steps in the context of fresh water supply system, following the issue of Certificate regarding water supply connection by WSD, before CM certifies Substantial Completion of the Building Works –

- (a) RC, together with FSWP NSC, takes measurement of the pump room noise levels at the nearest noise sensitive receivers, such as flat units located immediately above pump rooms. Both air and structural borne noise emanated from pump rooms are measured in the presence of the SIT. RC has to make adjustment and regulation of equipment if excessive noise is identified. A measurement report endorsed by an independent acoustic consultant employed by the FSWP NSC demonstrating compliance with the specifications shall then be submitted to RC who onward submits to the CM for record;
- (b) SIT conducts flat to flat inspection, including the plumbing installation, and make recommendation to CM for certifying the Substantial Completion of the building works;
- (c) After rectifying the defects found in the above steps to the satisfaction of the CM, RC reports to the CM substantial completion of the building works. With the recommendation of SIT and other contract team members, CM makes site inspection and certifies Substantial Completion of the Building Works;
- (d) After Chief Architect as CM has certified Substantial Completion of the Building Works, the Chief Architect as AP submits an application for Occupation Permit (OP) from the Independent Checking Unit (ICU); and

- (e) After CM has certified Substantial Completion of the Building Works, the HA conducts **Final assessment** under the **Performance Assessment Scoring System (PASS)** with RC on site to assess the quality of works including their performance in plumbing installation (including type and size, pipe brackets, pipe sleeve etc.) and management of its domestic sub-contractors. PASS scores affect the allocation of future tendering opportunities to RC and the evaluation of their submitted tenders.

OCCUPATION OF COMPLETED PREMISES

13. ICU issues the OP after they have inspected the completed building works and found them in compliance with the statutory requirements and their approved plans.

14. To address **the risk of Legionnaires' disease**, since 2012, HA has also required **RC to carry out an additional disinfection to the water supply system of newly completed estates** shortly before occupation. After disinfection with chlorinated water with a concentration of 50 mg/L for one hour ^{Note 3}, RC drains away the chlorinated water and flushes the water supply system with fresh water. Then the HA hands over the premises to tenants for occupation.

15. After tenants' intake, a 72-hour recording of fresh water pump operation over Saturday and Sunday is carried out for each building block by RC and FSWP NSC using automatic recorders. Any identified irregularities in the pump control, such as inappropriate settings of level float switches of water storage tanks, shall be rectified by RC and FSWP NSC to the satisfaction of the CM.

INFORMATION

16. This paper is for Members' information.

Note 3 in accordance with WSD's Circular Letter No. 2/2012

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FWP14.1 INITIAL TESTING AND COMMISSIONING

FWP14.1.010.7 PRE-TEST CLEANING

Before installations are subjected to inspection, testing and subsequent handover, the entire installation shall be thoroughly cleaned internally and externally. All water installations shall be flushed out with clean water. During the flushing operation provision shall be made to exclude filters, pumps, meters and any other item of plant which could be damaged during the cleaning operation.

FWP14.1.020.7 PERFORMANCE TESTS, ADJUSTMENTS AND COMMISSIONING

1. The Sub-contractor shall carry out complete performance tests for all equipment and systems installed by him, make all necessary adjustments, including setting all controls and checking the operation of all protective and safety devices, and commission the installations, in accordance with the manufacturers' instructions, the requirements of the statutory rules and regulations and to the satisfaction of the Contract Manager before the installations will be accepted;
2. Prior to any tests, the Sub-contractor shall submit detailed procedures and a programme for testing and commissioning for Approval;
3. The test shall be witnessed by an authorised representative of the Contract Manager and a report shall be submitted for record purposes.

FWP14.1.030.7 PERIOD OF NOTICE

Forty-eight (48) hours notice shall be given by the Sub-contractor to the Contract Manager of his intention to carry out installation tests.

FWP14.1.040.7 TEST INSTRUMENTS

1. In addition to **PRE.BS1.630** which specifies the provision of a set of measuring instruments for BSPASS and the Contract Manager's Representatives' use, which will be under the custody of the CMR, the Sub-contractor shall provide all necessary instruments used for measurement and testing of the installation. Except for manual/electric hydraulic pump with pressure gauge given in sub-clause (2)(o) and smoke canister for testing smoke detectors given in sub-clause (2)(p) below, the instruments used shall be calibrated with traceability to internationally or nationally recognized standards;
2. Instruments required for inspection and testing purpose whenever necessary shall include, but are not limited to, the followings:
 - a. Measuring tape;
 - b. Vernier caliper;
 - c. Clamp-on ammeter;
 - d. Multimeter;
 - e. Multi-function electronic meter for measurement of current, voltage;
 - f. Insulation resistance tester;
 - g. Earth loop impedance tester;
 - h. Pressure gauge;
 - i. Fire hydrant flow gauge;
 - j. Sound level meter;
 - k. Dial gauge;

- l. Digital stop watch;
 - m. Male instantaneous coupling to BS 336;
 - n. Manual/electric hydraulic pump with pressure gauge;
 - o. Smoke canister for testing smoke detectors;
 - p. Carpenter (spirit) level.
3. Each piece of instrument shall carry an indelible identification mark, and a label showing the due date for calibration (except otherwise calibration is specified not necessary);
 4. The Sub-contractor shall submit evidence of calibration such as calibration certificates and records of calibration results of the instruments used for the Contract Manager's Approval when required. The Contract Manager may reject any instrument(s) which, in his opinion, is not suitable for the inspection or test and the Sub-contractor shall replace the instruments when required.

FWP14.1.050.7 LABOUR AND MATERIALS

1. The Sub-contractor shall despatch competent and experienced commissioning engineers and technicians to carry out the testing and commissioning of the installations;
2. All labour and materials necessary for carrying out the work shall be provided by the Sub-contractor, except that the Main Contractor will supply electricity and water as required;
3. The Sub-contractor shall supply any necessary diesel or other fuel oil for engine-driven pumps, sufficient test gases required for the discharge tests of the gas extinguishing system installations etc;
4. The Sub-contractor shall also replenish all fire extinguishing media and other materials expended or used during the tests and ensure that the entire installations are in "as new" condition at the conclusion of the tests.

FWP14.1.060.7 WATER SYSTEM TESTS

1. Water systems and circuits shall be tested hydraulically to a minimum pressure of 1000 kPa or 1.5 times the working pressure whichever is higher applied at the highest point of the system and held for a period of not less than 15 minutes for fire services installation (except sprinkler installation) and 24 hours for water feed pump installation without leaks appearing. For sprinkler installation, the hydraulic test for pipework shall be in accordance with the LPC Sprinkler Rules;
2. After flushing out the pipework, a flow test shall be performed on the hydrant/hose reel system in accordance with the Fire Services CoP;
3. A water supply test with the drain and test valves fully opened shall be made on the sprinkler system in accordance with the LPC Sprinkler Rules. An alarm test on the water gong shall also be carried out by opening the test valve to ensure that the alarm shall continuously sound in 30 seconds after the flow in the system is detected;
4. The Sub-contractor shall provide whatever hoses or drainage channels are required to safely remove the test water discharged while carrying out these tests in order to ensure that no damage to the building and property will be caused by the test water;
5. All welded joints shall be hammer tested and remain firm;
6. Following the above, a normal working test shall be carried out, during which time adjustments and regulation of valves shall be effected.

FWP14.1.070.7 ELECTRICAL AND ALARM SYSTEMS TESTS

1. Electrical Wiring systems shall be tested generally as required by the latest edition of the Electrical CoP and the HKHA Electrical Installation Specification. Low-voltage wiring shall be insulation tested to a d.c. voltage of twice the normal working voltage of the system. Any tests that are liable to cause damage to the delicate components such as those incorporating electronic circuits shall be carried out with the components disconnected;
2. For electrical power circuits other than those for fire services, tests shall include but not be limited to the measurement of power ratings, power factor and total harmonic distortion in order to ensure the systems are in compliance with the BEC;
3. Smoke detectors shall be checked for correct sensitivity settings by means of manufacturer's test set and for operation by simulated smoke tests using freon;
4. Rate-of-rise heat detectors shall be tested by gentle application of a heat source such as a hair dryer. Fixed temperature heat detectors must not be tested other than using simulated tests;
5. Battery capacity shall be tested by discharging through the alarm circuits and being charged via the incorporated charger unit. The specific gravity of the electrolyte shall be tested with a clean hydrometer;
6. The input d.c. supply to the alarm supervisory circuitry shall be checked for correct voltage and stability such as to match the signal and alarm triggering devices.

FWP14.1.080.7 GAS EXTINGUISHING SYSTEMS TESTS

1. Gas extinguishing system manifolds shall be tested in accordance with **FWP9.7.090**. Pipework shall be tested to a minimum of 1.5 times the operating pressure of the system;
2. Apart from the performance and electrical tests as indicated above, a discharge test using 10% of the required quantity of the extinguishing agent shall also be performed to ensure continuity of pipework and freedom of discharge through nozzles.

FWP14.1.090.7 FSD INSPECTION AND WITNESS OF TESTS

Additional tests, where not specified in the Specification, shall also be carried out to meet the requirements of the Fire Services CoP to the satisfaction of FSD. The Sub-contractor shall make all necessary applications to FSD and attend upon their representative for the purpose of these tests and inspections.

FWP14.1.100.7 PUMP ROOM NOISE LEVEL TESTS

1. Pump room noise levels shall be measured at the nearest noise sensitive receiver and corrected in accordance with the requirements stipulated in the "Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites", hereinafter referred to as the "Technical Memorandum", issued by the Environmental Protection Department. A measurement report which shall be endorsed by an independent consultant employed by the Sub-contractor shall be submitted to the Contract Manager for Approval;
2. Sound level meters used for the measurements shall comply with the Standard specified in the "Technical Memorandum";
3. Both air and structure borne noises emanated from pump rooms shall be measured to verify their compliance with the requirements stipulated in the "Technical Memorandum" in all circumstances.

FWP14.1.105.7 72-HOUR RECORDING OF FRESH AND FLUSH WATER PUMP OPERATIONS

1. After completion of installation and tenant intake, 72-hour recording of fresh and flush water pump operations over Saturday and Sunday shall be carried out for each building block by the Sub-contractor using automatic recorders to confirm the properness of the pump control settings. The records shall show clearly the time and duration of individual pump operations and be submitted to the Contract Manager for approval;
2. Any control irregularities identified shall be remedied and further recordings shall be carried out until a proper 72-hour pump operation pattern is achieved to the satisfaction of the Contract Manager.

FWP14.1.110.7 TESTING AND COMMISSIONING REPORT

A testing and commissioning report shall be forwarded to the Contract Manager within fourteen days after completion of commissioning the installation. The report shall be verified and endorsed by the Supervising Engineer in accordance with **FWP1.5.020** sub-clause (1).

TESTING

GENERAL

PLU1.T010.7

PRE-TEST CLEANING

Before installations are subjected to inspection, testing and subsequent handover, clean thoroughly the entire installation internally and externally. Flush out all water installations with clean water. During the flushing operation, make provision to exclude filters, pumps, meters and any other item of plant which could be damaged during the cleaning operation.

PLU1.T020.7

PERFORMANCE TESTS, ADJUSTMENTS AND COMMISSIONING

1. Carry out complete performance tests for all equipment and systems installed, make all necessary adjustments including the setting of adjustable type pressure reducing valve and commission the installations in accordance with the manufacturers' instructions and to the satisfaction of the Contract Manager;
2. Prior to any tests, submit detailed procedures and a programme for testing and commissioning for the Contract Manager's approval;
3. Submit test reports to the Contract Manager for approval.

PLU1.T030.7

TEST INSTRUMENTS

1. Supply all instruments required for inspection and testing of the installation;
2. Include, but not limited to, the following instruments required for inspection and testing purpose:
 - a. Measuring tape;
 - b. Hand pump;
 - c. Pressure gauge;
 - d. Water flow gauge.

PLU1.T040.7

TESTING OF CONCEALED AND UNDERGROUND PIPEWORK

Before cover up of the pipework, invite the Contract Manager representative to check the pipework and witness for water pressure test in accordance with PLU1.T050. Result of water pressure test shall be satisfactory before cover up of the pipework. Submit test report for record within a week of the satisfactory test.

PLU1.T050.7

WATER PRESSURE TEST

1. Test water systems and circuits hydraulically to a minimum pressure of 1.5 times the system working pressure or a minimum of 10 bar whichever is the higher for a period of not less than one hour without leaks appearing;
2. Provide whatever hoses or drainage channels that are required to safely discharge the test water while carrying out these tests in order to ensure that no damage to the building and property will be caused by the test water;
3. Following the above, carry out a normal working test during which adjustments and regulation of valves shall be effected and each tap and shower shall be visually check for satisfactory rate of flow.

PLU1.T060.7**FSD INSPECTION AND WITNESS OF TESTS**

Make necessary applications including submission of Form 501 to Fire Services Department and attend upon their representative for the purpose of tests and inspections for the fire services installation carried out by Main Contractor such as street fire hydrant system, up-feed riser pipe to storage/transfer tank.

PLU1.T070.7**WATER QUALITY TEST**

Test on the quality of potable water for human consumption shall be carried out on each potable water system to the satisfaction of the Contract Manager and comply with the following:

1. Carry out the test after completion of the cleaning of the plumbing installation as specified in PLU1.W910 (2) to the satisfaction of the Contract Manager of the respective potable water supply system;
2. Take samples from a selection of the water outlets used to supply potable water for human consumption in accordance with ISO 5667, but shall include samples taken at all the farthest point(s) of use in the distribution system from the storage tank, and at each potable water supply tank for human consumption in the building;
3. Analysis of the samples shall be carried out by a laboratory that complies with PRE.B9.570 according to the water quality requirements specified in the Water Authority's Quality Water Recognition Scheme for Buildings;
4. In case the samples failed to comply with the water quality requirements as referred to in sub-clause (3), carry out investigation on the cause(s) and submit investigation results and details of all necessary rectification works to the Contract Manager for approval before carrying out of the approved rectification works. Arrange re-test(s) to ensure compliance of water quality requirements after completion of the rectification works. Bear all cost and expense in connection with the aforesaid investigation, rectification works and re-test(s) to ensure compliance of the required water quality requirements except if such investigation, rectification works and re-test(s) are the direct consequence of a conclusion from any test result(s) of the sample(s) taken at the user end of the first valve from the site boundary that water from the Water Authority failed to comply with the water quality requirements as referred to in sub-clause (3);
5. Submit the detailed report on the selection of sampling points, sampling techniques, handling of water samples, water quality test results with original or certified true copy (issued or certified by the laboratory that complies with PRE.B9.570) of the test reports showing full compliance with the requirements as referred to in sub-clause (3) and the investigation results and approved rectification works as referred to in sub-clause (4) for the Contract Manager's approval within 2 months from the date of the completion to the satisfaction of the Contract Manager of the cleaning of the plumbing installation as specified in PLU1.W910 (2) of the respective potable water supply system.

TESTING TURBIDITY FOR CONNECTION OF UNDERGROUND WATER MAINS TO EXISTING IN- SERVICE MAINS

PLU1.T110.7**TESTING PRIOR TO CONNECTION OF SUPPLY MAINS**

Test fresh, flush and fire service supply mains prior to connection works as required by PLU1.W1210.

PLU1.T120.7**PROCEDURE**

Test for development of white turbidity to identify salt water mains to satisfaction of the Contract Manager, as follows:

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1. Collect two 10 ml samples in clean McCartney bottles from the supply mains under investigation;
 2. Add two drops of barium chloride solution to one sample;
 3. Shake to mix contents and wait for approximately 3 minutes for turbidity to develop;
 4. Compare with the other sample for increase in white turbidity (which would indicate the presence of salt water);
 5. In doubtful cases, seek record drawings as well as laboratory services for confirmation.