

GUIDELINES
ON
CONSTRUCTION AND COMMISSIONING
OF
S1 – S5 PUBLIC SHELTERS

Issued By:



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BUILDING RESILIENCE GROUP

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CONTENTS	Page No.
1. INTRODUCTION	1
2. REFERENCES	1
3. CONSTRUCTION STAGE	1
3.1 General	1
3.2 Construction Supervision	2
3.3 Regulatory Inspections	3
4. COMMISSIONING STAGE	3
4.1 General	3
4.2 Inspection of Shelter Structural Works.....	4
4.3 Inspection of Shelter Building Works	5
4.4 Commissioning of Shelter Mechanical Systems	7
4.5 Commissioning of Shelter Electrical Systems	8
4.6 Commissioning Tests for Public Shelters	9
5. DOCUMENTATION OF OPERATIONS AND MAINTENANCE MANUALS FOR PUBLIC SHELTERS	12
5.1 General	12
6. DOCUMENTATION OF CONVERSION MANUAL FOR PUBLIC SHELTER	13
6.1 General.....	13
7. CONCLUSION	14

1 INTRODUCTION

1.1 This document serves as a useful guide to the qualified persons (QPs) who are responsible for the construction and commissioning of a public shelter.

1.2 The QPs are required to follow the procedures described herein to obtain the necessary Notices of Approval from Building Resilience Group of Building and Construction Authority (BCA) and the Fire Safety & Shelter Department (FSSD) of the Singapore Civil Defence Force (SCDF).

(Note: FSSD of SCDF will conduct commissioning inspection with respect to the operational and management requirements of the public shelter.)

2 REFERENCES

2.1 In addition to this document, the construction and commissioning of a public shelter shall be in compliance with the following documents where appropriate:

- a) *"Technical Requirements for S1 – S5 Public Shelters"*;
- b) *"Technical Specifications for Works of Public Shelters"*; and
- c) *"Handbook for Commissioning Requirements of S1 – S5 Public Shelters"*

3 CONSTRUCTION STAGE

3.1 General

3.1.1 The QP for structural works is required to inform BCA when construction works for the public shelter is about to commence. He shall submit a copy of the site plan of the public shelter.

3.1.2 For clarifications regarding construction and/or commissioning issues, the QP may request for a consultation meeting with BCA by submitting *e-Form BCA-CD-PLAN01 (Request for Consultation on Civil Defence Shelter Requirements)*.

3.2 Construction Supervision

3.2.1 The construction of a public shelter and the installation of its mechanical and electrical systems shall be closely supervised and inspected by the QPs and their site supervisors, resident engineers and resident technical officers.

3.2.2 The QPs shall ensure that the public shelter is constructed in accordance with the following:

- a) Approved public shelter plans;
- b) Other requirements stipulated in the "*Technical Requirements for S1 – S5 Public Shelters*", "*Technical Specification for Works of Public Shelters*"; and
- c) Detailed manufacturer's specifications for installation of services and equipment such as blast valves, overpressure blast valves, overpressure valves, anchor bolts, sealing devices, etc.

3.2.3 The QPs and their site supervisors, resident engineer and resident technical officer shall note the following salient requirements:

- a) No hacking or drilling of structural members is allowed after the structural members have been cast. The QP is required to liaise closely with other consultants and builders regarding the locations of walls/slabs openings, ducts and pipes penetrations, etc., before carrying out any concreting of public shelter walls and slabs. He shall ensure that all cast-in-place items such as sleeves for blast valves, frames for sealing devices, cast-in bolts, etc., are placed and secured in the correct positions before concreting.

- b) The QP shall take note that all protective steelworks shall be completed and fully assembled before installation on site. The assembled protective steelworks shall be installed and secured in position with temporary guides and bracing before concreting.

3.3 Regulatory Inspections

- 3.3.1 Regulatory inspections are carried out by BCA during the construction stage to inspect the critical structural elements and M&E systems of the public shelter.
- 3.3.2 The QP shall inform BCA prior to concreting of all critical structural elements of the public shelter, including the installation of protective steelworks and CD dedicated equipment so that regulatory inspections could be scheduled if necessary.
- 3.3.3 During the regulatory inspection, BCA will inform the QP of any non-conformances. BCA will follow up with a letter to the QP listing the non-conformance items noted during the regulatory inspection. The QP shall take corrective actions to rectify all non-conformances. Upon completion of rectification works, the QP shall inform BCA so that a re-inspection could be scheduled if required.

4 COMMISSIONING STAGE

4.1 General

4.1.1 After the completion of the public shelter works, QP shall conduct inspections, testing and commissioning to ensure that the public shelter and all its functional systems meet the requirements specified in the "*Technical Requirements for S1 – S5 Public Shelters*".

4.1.2 The QP shall be responsible for the co-ordination and supervision of the inspections, testing and commissioning. He shall ensure that all necessary labour, equipment, instruments and tools are available for the tests.

4.1.3 Commissioning of a public shelter involves the following items:

- a) Inspection of structural and architectural works
viz. air-tightness inspection, anchor bolts pull-out test and visual inspection of completed public shelter;
- b) Commissioning of mechanical and electrical systems
viz. individual functional system tests for M&E systems and combined Electrical and Communications systems test;
- c) Commissioning tests for public shelters
viz. internal overpressure test, overpressure regime and airflow test and integrated systems test.

4.2 Inspection of Structural Works

4.2.1 General

4.2.1.1 Inspection of structural works involves checking the external structural envelope of the public shelter to ensure that the public shelter and its essential

components such as blast doors, CD valves and blast louvres, etc., are properly constructed and installed. This is known as the air-tightness inspection and is carried out after the completion of the structural works for the public shelter and the installation of the protective steelworks and CD valves. The purpose of the inspection is to ensure that the public shelter is ready to conduct the internal overpressure test.

4.2.2 Air-Tightness Inspection

4.2.2.1 The QP is advised to inform BCA prior to the conduct of the air-tightness inspection.

4.2.2.2 The following items are to be checked during the air-tightness inspection:

- a) Protective doors and hatches;
 - Visual inspection
 - Light penetration test
 - Chalk trace examination
- b) CD valves;
- c) Floor traps;
- d) Sumps with gully trap; and
- e) Scupper drains

4.2.2.3 The QP or his representative shall carry out the air-tightness inspection and their observations shall be recorded, maintained and kept on site. A sample record for air-tightness inspection is given in "*Handbook for Commissioning Requirements of S1 – S5 Public Shelters*".

4.2.2.4 All detected faults, defects or imperfections must be rectified and re-inspected to ensure that rectification works has been done satisfactorily.

4.2.2.5 Upon the completion of the air-tightness inspection, the QP may make necessary arrangement to conduct the internal overpressure test. Procedure for the internal overpressure test is given in "*Handbook for Commissioning*

Requirements of S1 – S5 Public Shelters".

4.3 Inspection of Shelter Building Works

4.3.1 General

4.3.1.1 Inspection of shelter building works shall be carried out when all the architectural fixtures, M&E cables, ducting and equipment have been installed. The purpose is to ensure compliance with the "*Technical Requirements for S1 – S5 Public Shelters*".

4.3.1.2 Inspection of shelter building works involves:

- a) Visual inspection of the completed public shelter; and
- b) Anchor bolts pull-out tests.

4.3.2 Visual Inspection of Completed Public Shelter

4.3.2.1 The QP is advised to inform BCA prior to the conduct of visual inspection of the completed public shelter whereby the following items are to be checked:

- a) Building works, including penetration details;
- b) Protective doors and hatches;
- c) Blast louvres, CD valves and sealing devices;
- d) Floor traps, sumps and scupper drains; and
- e) Water tank.

4.3.2.2 The QP or his representative shall carry out the visual inspection and their observations shall be recorded, maintained and kept on site. A sample record for visual inspection of completed public shelter is given in "*Handbook for Commissioning Requirements of S1 – S5 Public Shelters*".

4.3.2.3 All detected faults, defects or imperfections must be rectified and re-inspected to ensure that the rectification works have been done satisfactorily.

4.3.3 Anchor Bolts Pull-Out Test

4.3.3.1 All architectural fixtures such as wash basins, water cisterns, handrails, cat-ladders, toilet partitions, etc., and M&E systems such as pipework, ductwork, control panels and equipment, etc. in a public shelter shall be shock-mounted. The QP shall ensure that only anchor bolts with valid CD certificates are used for the installation and the spacing of the supporting brackets and anchor bolts are in accordance with the approved shock design plans. He shall also ensure that the minimum anchor torque values for the bolts are attained during the installation.

4.3.3.2 In addition to the above checks, the QP shall also arrange for pull-out tests to be conducted on samples of installed anchor bolts. The anchor bolts pull-out test shall be conducted in accordance with the prescribed method (refer to *Section 4.2 Anchor Bolts Pull-out Test* in "*Handbook for Commissioning Requirements of S1 – S5 Public Shelters*").

4.3.3.3 The QP is advised to inform BCA prior to the conduct of anchor bolts pull-out test. Before any anchor bolts pull-out test, the QP shall prepare layout plans of the test bolts showing the following information:

- a) Numbers and locations of anchor bolts;
- b) Test batches (e.g. 1 to 90 – Batch 1, 91 to 120 – Batch 2);
- c) Types of anchor bolts; and
- d) Test loads for the anchor bolts.

4.3.3.4 The QP shall ensure that the results of the anchor bolts pull-out tests are recorded and kept on site together with the layout plans. A sample record for anchor bolts pull-out test is given in "*Handbook for Commissioning Requirements of S1 – S5 Public Shelters*".

4.3.3.5 All detected faults and defects must be rectified and re-inspected to ensure that rectification works have been done satisfactorily.

4.4 Commissioning of Shelter Mechanical Systems

4.4.1 General

4.4.1.1 To ensure that the mechanical systems in a public shelter are functioning in accordance with the design and regulatory requirements, individual functional system tests (IFST) are carried out after the installation of the following shelter mechanical systems:

- a) Air-conditioning and mechanical ventilation system / Environmental Control System;
- b) Water supply system; and
- c) Sanitary and drainage system.

4.4.1.2 The instruments used for the tests shall be tested, calibrated and certified by an accredited laboratory. The QP shall ensure that all testing instruments have valid calibration certificates.

4.4.1.3 The QP is advised to inform BCA prior to the conduct of IFST of each mechanical system. Before the commencement of the IFST, the QP shall ensure that the system is tested and inspected to ensure compliance with peacetime requirements.

4.4.1.4 The QP shall ensure that the results of the IFST for the mechanical systems are recorded and submitted to BCA together with the method statement for the overpressure regime and airflow test. Sample records of IFST for mechanical systems are given in "*Handbook for Commissioning Requirements of S1 – S5 Public Shelters*".

4.4.1.5 In addition to the IFST, the QP shall make arrangements to obtain the necessary approval, acceptance or clearance from the relevant authorities.

4.5 Commissioning of Shelter Electrical Systems

4.5.1 General

4.5.1.1 To ensure that the electrical systems in a public shelter are functioning in accordance with the design and regulatory requirements, individual functional system tests are carried out after the installation of the following electrical systems:

- a) Electrical Distribution system;
- b) Communications and Monitoring systems; and
- c) Generator and Fuel Delivery system.

4.5.1.2 The instruments used for the tests shall be tested, calibrated and certified by an accredited laboratory. The QP shall ensure that the testing instruments have valid calibration certificates.

4.5.1.3 The QP is advised to inform BCA prior to the conduct of IFST of each electrical system. Before the commencement of the IFST for any electrical system, the system shall be tested and inspected to ensure compliance with peacetime requirements.

4.5.1.4 The QP shall ensure that the results of the IFST for the electrical systems are recorded and submitted to BCA together with the method statement for the integrated systems test. Sample records of IFST for electrical systems are given in "*Handbook for Commissioning Requirements of S1 – S5 Public Shelters*".

4.5.1.5 In addition to the IFST, the QP shall make arrangements to obtain the necessary approval, acceptance or clearance from the relevant authorities.

4.5.2 Combined Electrical and Communications Systems Test

4.5.2.1 Upon the completion of IFST for the electrical and communications systems, the QP shall make arrangements to conduct a combined electrical and communications systems test using normal electricity supply or supply from the standby generator set if the latter is available and IFST has been conducted.

4.5.2.2 The QP is advised to inform BCA prior to the conduct of the test so that an inspection to witness the test can be scheduled.

4.5.2.3 The QP shall record the results of the test, which will be submitted to BCA together with the method statement for the integrated systems test. A sample record of the combined Electrical and Communications systems test is given in "*Handbook for Commissioning Requirements of S1 – S5 Public Shelters*".

4.6 Commissioning Tests for Public Shelters

4.6.1 General

4.6.1.1 The 3 commissioning tests to be conducted for public shelters are:

a) Internal overpressure test:

To be conducted after the completion of structural works and air-tightness inspection.

b) Overpressure regime and airflow test:

To be conducted after the completion of the internal overpressure test and IFST for all the mechanical systems.

c) Integrated systems test (IST):

To be conducted after the completion of the overpressure regime and airflow test and IFST for all the electrical systems.

4.6.1.2 The QP shall ensure that all relevant works, commissioning of the required M&E systems and inspections of the completed structural and building works are carried out satisfactorily before making arrangements for the commissioning tests.

4.6.1.3 The requirements for the commissioning tests are given in "*Handbook for Commissioning Requirements of S1 – S5 Public Shelters*".

4.6.2 General Procedure for Commissioning Tests for Public Shelters

(The procedure given in this Section is applicable to the 3 commissioning tests)

4.6.2.1 Prior to any commissioning test, the QP is required to submit a method statement of the test to BCA for approval preferably 4 weeks before the proposed date of the test. The method statement shall be submitted together with *e-Form BCA-CD-PLAN02 (Application for Approval of Civil Defence Shelter Plans)* and the relevant documents as stated in the respective section below.

4.6.2.2 If the application is in order, BCA will issue a *Notice of Approval of Method Statement of Commissioning Test for Public Shelter*. If the application is not in order, a Written Direction (WD) will be issued. The QP shall amend and re-submit within 2 weeks from the date of the Written Direction. All re-submissions shall be accompanied by a covering letter and may be submitted via CORENET e-Submission System using **CR Submission**. For re-submission, the **ES No.** (for e-submission) and **Plan Type No.** shall be the **same** as those of the WD.

- 4.6.2.3 If the QP does not re-submit within the stipulated time frame, a *Notice of Disapproval (NOD)* would be issued and the QP would have to submit a re-application using *e-Form BCA-CD-PLAN02*.
- 4.6.2.4 For all 'New' applications, which includes first-time application, re-application (i.e. application after NOD has been issued by BCA) and amendments to approved method statement; a new Plan Type number shall be used.
- 4.6.2.5 After the NOA for method statement has been issued, the QP can proceed to conduct the commissioning test. The QP shall notify BCA at least one week before the date of the actual commissioning test by submitting *e-Form BCA-CD-NCOM01 (Notification of Commissioning Test for Public Shelter)*.
- 4.6.2.6 For the Integrated Systems Test, the QP shall also forward a copy of *e-Form BCA-CD-NCOM01 (Notification of Commissioning Test for Public Shelter)* to FSSD of SCDF at least one week before the date of the actual commissioning test.
(Note: FSSD will conduct commissioning inspection with respect to the shelter management and operational requirements. A sample record for the shelter management and operational requirement inspection is given in "Handbook for Commissioning Requirements of S1 – S5 Public Shelters".)
- 4.6.2.7 The QP shall supervise the conduct of the commissioning test. Before the commencement of the test, the QP shall brief BCA representatives on the test procedure, set-up, instrumentation and approval criteria, etc.
- 4.6.2.8 After the briefing, the QP can commence the test in accordance with the approved method statement and the detailed procedure as given in the respective sections below.
- 4.6.2.9 BCA representatives will conduct random checks on the test procedure, set-up, instrumentation, etc., to see if they are in accordance with the approved method statement. If there are major deviations from the approved method statement, the QP will be advised to abandon the test. BCA will follow up with a letter to

the QP stating the reasons for abandoning the test. The QP shall take corrective actions and ensure that everything is in order before he schedules another date for the test.

4.6.2.10 Upon completion of the test, the QP shall submit one (1) set of endorsed test report and test records together with *e-Form BCA-CD-PLAN02* to BCA for approval. BCA will issue a *Notice of Approval of Commissioning Test for Public Shelter* if the test report and records are in order. If the test report and records are not in order, a Written Direction would be issued. The QP shall rectify and resubmit within 2 weeks from the date of the Written Direction (WD). All re-submissions shall be accompanied by a covering letter and may be submitted via CORENET e-Submission System using **CR Submission**. For re-submission, the **ES No.** (for e-submission) and **Plan Type No.** shall be the **same** as those of the WD.

4.6.2.11 If the QP does not re-submit within the stipulated time frame, a *Notice of Disapproval (NOD) of Test Report of Commissioning Test for Public Shelter* would be issued and the QP shall be required to submit a re-application using *e-Form BCA-CD-PLAN02 (Application for Approval of Civil Defence Shelter Plans)* and a new Plan Type number.

5 DOCUMENTATION OF OPERATIONS AND MAINTENANCE MANUALS FOR PUBLIC SHELTER

5.1 General

5.1.1 Every public shelter requires a set of "*Operations and Maintenance (O&M) Manuals for Public Shelter*" that are designed to address all the systems and particular features of the public shelter. One set of the manuals shall be kept in a locked cabinet in the plant room for future reference and another set shall be kept by the user/owner of the public shelter.

- 5.1.2 The co-ordinating QP shall be responsible for the documentation of the "O&M Manuals for Public Shelter" which shall be written in a comprehensive and concise manner that can be easily understood by users and operators in future. The requirements for the O&M manuals are given in "*Handbook for Commissioning Requirements of S1 – S5 Public Shelters*".
- 5.1.3 One set of the O&M manuals for Public Shelter shall be submitted to BCA together with the application for approval of method statement for the integrated systems test (IST). Upon approval of the method statement for the IST, the co-ordinating QP shall send 2 sets of O&M manuals to the user/owner of the public shelter and make arrangements as stipulated in Section 5.1.1.

6 DOCUMENTATION OF CONVERSION MANUAL FOR PUBLIC SHELTER

6.1 General

- 6.1.1 For a public shelter to be operationally ready during an emergency, it is important that the public shelter can be smoothly and successfully converted from its peacetime usage to the various CD modes of operation within a reasonable time frame. Hence, it is necessary to have a "*Conversion Manual for Public Shelter*" that gives clear instructions for the public shelter operating personnel to follow when converting the public shelter from its peacetime usage into a public shelter. One set of the manual shall be kept in a locked cabinet in the plant room for future reference and another set shall be kept by the user/owner of the public shelter.
- 6.1.2 The co-ordinating QP shall be responsible for the documentation of the conversion manual that shall be written in a comprehensive and concise manner that can be easily understood by users and operators in future. The requirements for the Conversion Manual are given in the "*Handbook for Commissioning Requirements of S1 – S5 Public Shelters*".

- 6.1.3 One copy of the conversion manual shall be submitted to BCA together with the application for approval of method statement for integrated systems test (IST) for review and clearance. BCA will inform the co-ordinating QP accordingly whether the manual is in order or needs to be improved. The co-ordinating QP shall make the necessary amendments to ensure that the manual is cleared with BCA.
- 6.1.4 Upon clearance of the "*Conversion Manual for Public Shelter*" by BCA, the co-ordinating QP shall send 2 sets of the manuals to the user/owner of the public shelter and make arrangements as stipulated in Section 6.1.1.

7 CONCLUSION

- 7.1 Besides obtaining the *Notice of Approval of Commissioning Test for Public Shelter (Integrated Systems Test)*, clearance on the commissioning with respect to shelter operation and management requirements has to be obtained from the FSSD of SCDF. Please note that the Notice of Approval of Commissioning Test for Public Shelter (Integrated Systems Test) is required for the purpose of obtaining the Certificate of Statutory Completion from the Building Plan Department of BCA.
- 7.2 Under the CD Shelter Act 1997, the owner or occupier of the public shelter shall be required to maintain the public shelter in accordance with the procedures and schedules given in the "*O&M Manual for Public Shelter*". The public shelter will be subjected to periodic operational readiness inspections by FSSD of SCDF and BCA.