Fire Research Station

Assessing the fire performance of external cladding systems: a test method

S A Colwell and D J Smit

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1. SCOPE

1.1 This test method enables an assessment of the behaviour of non-loadbearing exterior wall assemblies including external cladding systems, rainscreen overcladding systems, external wall insulation systems and curtain walling when exposed to an external fire.

1.2 The maximum depth of the system to be evaluated by this test method is 200mm.

1.3 The test determines the comparative burning characteristics of exterior wall assemblies by evaluating the following:

(i) Fire spread over the external surface

(ii) Fire spread internally within the system being tested

(iii) Mechanical response such as distortion and collapse

1.4 This test method does not assess:

(i) The fire resistance of the exterior wall assembly.

(ii) The fire performance of the test specimen when subjected to the effects of an interior fire migrating through the external structure of the building.

2. SIGNIFICANCE

2.1 This test method evaluates the performance of exterior wall assemblies under controlled conditions. The fire exposure is considered representative of a fully developed (post flashover) fire in a room typical of a residential occupancy venting through an opening such as a window that exposes the facade to the effects of external flames.

2.2 This test method evaluates the entire exterior wall assembly at full-scale, to fully represent effects such as shrinkage, expansion and mechanical behaviour.

3. DEFINITIONS

Level 1 — A height 2.5 metres above the top of the combustion chamber opening.

Level 2 — A height 5.0 metres above the top of the combustion chamber opening.

Start temperature, Ts — The mean temperature of the thermocouples at level 1 during the five minutes prior to ignition (clause 9.3).

Start time, ts — That time when the temperature recorded by any external thermocouple at level 1 equals or exceeds a 200 °C temperature rise above Ts, and remains above this value for at least 30 seconds.

System — The complete cladding assembly, including any sheeting rails, fixings, cavities and weathering membranes or coatings.

4. TEST FACILITY

4.1 General

4.1.1 The test facility shall be constructed in accordance with Clauses 4.1.2 to 4.1.4. The test facility shall consist of a vertical non-combustible wall with a vertical return wall (wing) at right angles to, and at one side of the main test face. The main test face shall be provided with a combustion chamber as described in 4.1.4. An example of a typical test facility is shown in Figure 1.

4.1.2 The main test face of the facility shall extend at least 6 m over the top of the opening described in 4.1.4 and shall be at least 2.8 m wide. The wing shall be of equal height to the main test face and shall have a minimum width of 1.5 m.

4.1.3 The wing shall be constructed perpendicular to the main test face at a distance of 250 (± 10) mm from the side of the opening to the combustion chamber (Figure 1).

4.1.4 A combustion chamber shall be provided with a clear opening in the plane of the main test face 2.0 (± 0.1) m high and 2.0 (± 0.1) m wide. The combustion chamber shall have a volume not less than 4.25 m3 and shall have internal dimensions of at least 1.9 m (width) x 1.0 m (depth) x 2.25 m (height).

4.2 Materials

4.2.1 The test facility is to be of robust construction capable of enduring the effects of heating without distortion or damage. Concrete blockwork has been found to be suitable.

4.3 Heat Source

4.3.1 The criteria required of the heat source are described in Clause 7.4 conformity with these criteria will generally be determined by conducting a calibration exercise.

5. INSTRUMENTATION

5.1 Total Heat Flux Meter

5.1.1 This is required for calibration only. One total heat flux meter shall be placed 1.0 (± 0.1) m above the opening in the centre line of the combustion chamber and in the plane of the external envelope of the facade as illustrated in Figure 2.

5.2 Thermocouples

5.2.1 All thermocouples shall be 1.5mm (nominal) diameter mineral insulated with insulated measuring junctions.

(i) For calibration purposes only, position three thermocouples 50mm below the top of the combustion chamber opening, 100mm behind the plane of the front face of the calibration boards. One thermocouple on the centre line of the combustion chamber opening, and the outer thermocouples spaced 0.9m from the centre line. These thermocouples shall be located to a tolerance of ± 10 mm.

(ii) At each specified height, temperatures are monitored as follows:

(a) On the main face of the façade, coincident with the centre line of the combustion chamber, 500mm and 1000mm each side of the centre line (five locations).

(b) On the wing, 150mm, 600mm and 1050mm from the main face (three locations).

5.2.2 The thermocouples are positioned as detailed below, to a tolerance of ± 0.1m.

(i) At level 1, thermocouples positioned as described in 5.2.1(ii) with the active end of the thermocouple projecting 10 (±5) mm in front of the face of the system under investigation.

(ii) At level 2, thermocouples positioned as described in 5.2.1(ii) with the active end of the thermocouple projecting 10 (±5) mm in front of the face of the system under investigation.

(iii) At level 2, thermocouples positioned as described in 5.2.1(ii), at the mid-depth of each combustible layer in systems where there is no cavity, except for the outermost layer where this has a thickness less than 10 mm.

(iv) When the system contains cavities, at level 2 thermocouples, positioned as described in 5.2.1(ii) are to be positioned at the mid-width of each cavity.

5.3 A photographic record of the condition of the external appearance of the full height of the test face is to be taken at the start of the logging of the data, then at the time of ignition and at a minimum of 5 minute intervals thereafter.

5.4 The data acquisition system shall record data at intervals not exceeding 10s.

6. INSTALLATION OF SYSTEM

6.1 General

6.1.1 The system shall extend from the top of the combustion chamber opening to a height of not less than 6 m above the combustion chamber opening on the main test face. On the wing, from a level corresponding to the floor of the combustion chamber to a height equal to that on the main test face. The system shall be at least 2.4 m wide on the main face and 1.2 m wide on the wing.

6.1.2 The detail at the corner of the system between the main face and wing shall abut or be representative of practice.

6.1.3 Systems extending below the top of the combustion chamber opening, shall not obstruct the combustion chamber opening.

6.1.4 Exposed edges and the perimeter of the combustion chamber opening shall be protected in a manner representative of the manner in which openings such as windows are protected in the prototype system. If the system does not afford any protection to openings in practice, then the interface between the test specimen and the combustion chamber shall also remain unprotected.

6.1.5 The system shall be representative of the complete exterior wall assembly and shall be constructed using similar practices.

6.1.6 If horizontal joints are typically incorporated in the exterior wall assembly, then the test specimen shall incorporate horizontal joints at similar intervals to those used in practice, with a joint placed not more than 2.5m above the opening.

6.1.7 If vertical joints are typically incorporated in the exterior wall assembly, then the test specimen shall incorporate vertical joints at similar intervals to those used in practice, with a joint placed on the centre line of the test specimen.

6.2 Conditioning

6.2.1 After installation the system shall be protected from adverse weather conditions.

6.2.2 Systems which consist of components that are applied on site (such as renders and coatings) shall be left to stand for a period of time which is sufficient to cure all components for the purposes of the test and in accordance with the manufacturer's instructions for curing.

7. CALIBRATION OF THE TEST FACILITY

7.1 The objective of the calibration exercise is to ensure that the chosen heat source subjects the test specimen to the appropriate level of exposure to total heat flux.

7.2 The calibration specimen shall be a non-combustible board as confirmed through testing to BS 476 Part 4: 1970.

7.3 Calibration instrumentation shall be installed as specified in 5.1.1 and 5.2.1 (i).

7.4 Heat Source

7.4.1 The heat source may be any that imposes the following regime on a non-combustible test specimen (as defined in BS476: Part 4: 1970):

(i) The incident heat flux at the location specified in 5.1.1 shall be within the range of 90 ± 20 kW/m^2 over a continuous 20 minute period[1].

(ii) A steady flame impinging directly on the test specimen over a height of 2.5 m above the opening over a continuous 20 minute period. This shall be determined by the temperatures indicated by at least two of the five external thermocouples on the main face as specified at 5.2.2(i) (level 1) exceeding a 600 °C temperature rise above Ts.

(iii) The temperature shall be essentially uniform across the width of the combustion chamber opening. This shall be determined by the temperature indicated by the three combustion chamber opening thermocouples specified at 5.2.1(i) exceeding a 600 °C temperature rise above Ts.

1 The heat flux measurement usually carries a certain amount of noise. Short term fluctuations in the signal should be ignored.

7.5 The heat source shall be ignited and observations made of the key parameters, to ensure compliance with the conditions specified in 7.4.

7.6 The heat source specified in Annex A may be used without calibration.

8. AMBIENT CONDITIONS

8.1 The ambient temperature during the calibration and test periods shall be 15 (± 15) °C.

8.2 There shall be no fog or precipitation at the test facility during the calibration and test periods.

8.3 The calibration and test procedures shall be conducted under still conditions, defined as those where the ambient air velocity is less than 2 m/s, in any direction, at the time of the start of data logging.

9. TEST PROCEDURE

9.1 An inspection is to be made of the system prior to commencement of the procedure, to ensure that it is in a suitable condition for test.

9.2 Once the ambient conditions specified in Section 8 have been met, the fuel source is to be ignited in an identical manner to that used during the successful calibration exercise. If the crib, described in Annex A is used as the heat source, ignition shall be as described in the Annex.

9.3 The data acquisition from the instrumentation detailed in Section 5 above shall commence at least five minutes before ignition. Not more than two of the locations specified in section 5.2.2 (i) to (iv) may yield unsatisfactory data.

9.4 Visual observations of flaming and mechanical behaviour shall be made during the test. it is recommended that such observations are supplemented by video recording. Photographic records shall be made in accordance with Clause 5.3.

9.5 Collapse of any sections of the system shall be noted.

9.6 The test duration is nominally 30 minutes from ts. However, if the system is still burning, data logging is to continue up to a maximum of 60 minutes.

10 POST TEST EXAMINATION

10.1 Following cooling of the test facility and the specimen, the system is to be dismantled and the damage recorded.

Post test evaluation shall include estimates of:

(i) Flame spread over the surface of the façade.

(ii) Flame spread within the cavity.

(iii) The area of the facade which has burnt away or become detached.

11. ASSESSMENT OF PERFORMANCE

11.1 The performance of the system under investigation shall be evaluated against three criteria

(i) External Fire Spread

(ii) Internal Fire Spread

(iii) Mechanical Response

11.2 External Fire Spread

Failure due to external fire spread is deemed to have occurred if the temperature rise above Ts, of any of the external thermocouples at level 2 exceeds 600 °C, for a period of at least 30 seconds, within 15 minutes of the start time ts.

11.3 Internal Fire Spread

Failure due to internal fire spread is deemed to have occurred if the temperature rise above Ts of any of the internal thermocouples at level 2 exceeds 600 °C, for a period of at least 30 seconds, within 15 minutes of the start time ts.

11.4 Mechanical Response

Full observation shall be made of any collapse (or partial collapse) of the system.

12. TEST REPORT

The test report shall include the following:

(i) The test date

(ii) Details of the test sponsor

(iii) A full description of the test specimen, together with details of materials and components used.

(iv) Details of instrumentation (location of thermocouples).

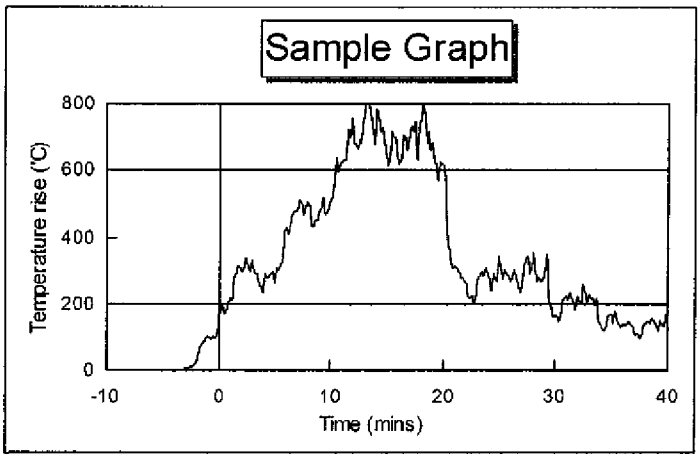
(v) Documentation of ambient conditions.

(vi) Documentation of the temperature profiles recorded during the test. When plotting graphs the origin of the time axis should pass through ts.

(vii) Visual observations made during the test, including mechanical response, supplemented by suitable photographic records.

(viii) Observation of post test damage, supplemented by suitable photographs.

(ix) Statement of whether the test criteria were met.


Sample Graph
Temperature rise (°C)
800
600
400
200
0
-10
0
10
20
30
40
Time (mins)

ANNEX A (informative)

A.1 The following heat source has been found to be satisfactory and may be used without the need for any calibration exercise.

A.2 A timber crib can be constructed of softwood sticks with nominal dimensions of 50 x 50 mm. The softwood is to have a moisture content in the range of 10 to 16% by mass. The crib is to be constructed of alternate layers of long and short sticks. The first layer is to consist of ten 1500 mm long sticks evenly distributed to cover an area of 1000 x 1500 mm. The next layer is to consist of fifteen short sticks (1000 mm) again evenly distributed to cover an area of 1000 x 1500 mm. This is repeated to give a total of 20 layers of sticks giving it a nominal height of 1000 mm. In total 150 short sticks and 100 long sticks are required.

A.3 The crib is to be constructed on a solid platform positioned 400 (± 50) mm above the floor level of the combustion chamber. The crib is to be located centrally in the combustion chamber and displaced 100 (± 10) mm from the back wall of the chamber.

A.4 The crib is to be ignited using 16 strips of low density fibreboard having nominal dimensions of 25 x 12 x 1000 mm. The strips shall be uniformly soaked for a minimum of 5 minutes with 5 litres of white spirit. Not more than 5 minutes before ignition, 14 strips are to be inserted between the timber sticks in the second layer of the crib (ie 50 mm above the platform) allowing approximately 30 mm to project from the front of the crib. The remaining 2 strips are to be placed horizontally across the 14 projected strip ends. Only these 2 horizontal strips are to be ignited.

A.5 The heat source releases a nominal total heat output of 4500 MJ over 30 minutes at a peak rate of 3 (± 0.5) MW.

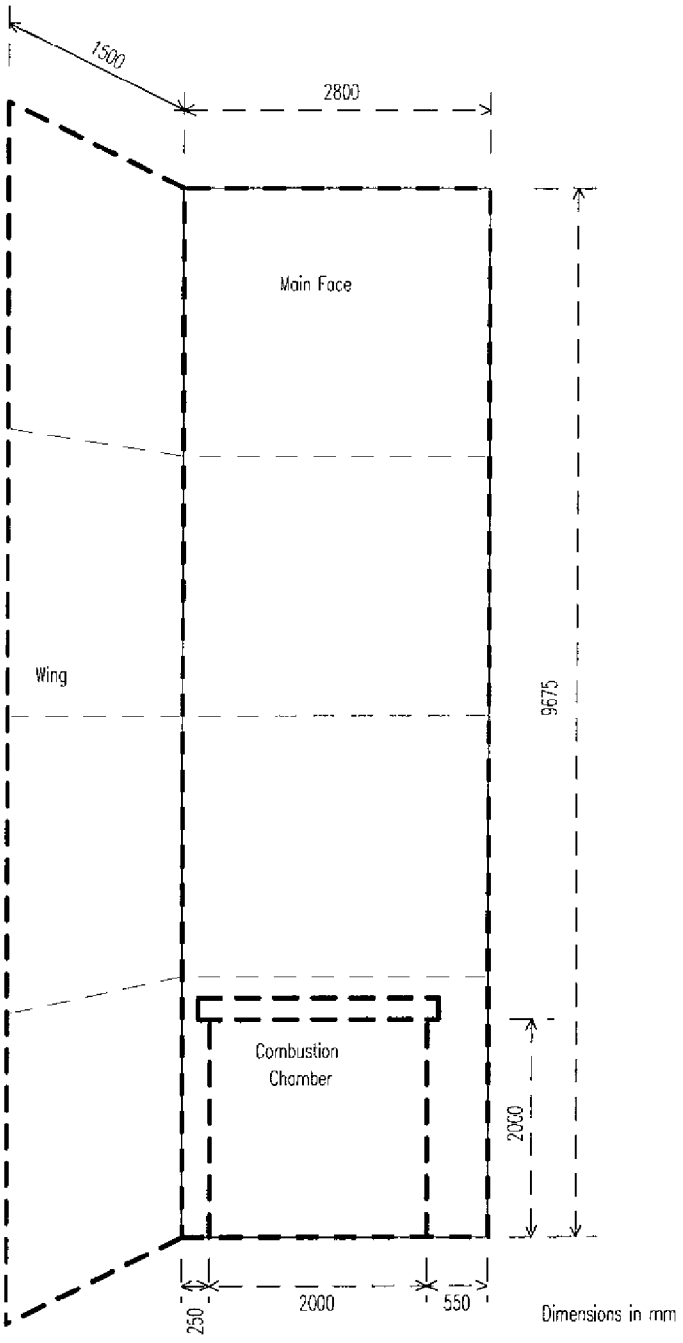


Figure 1 Typical Test Facility

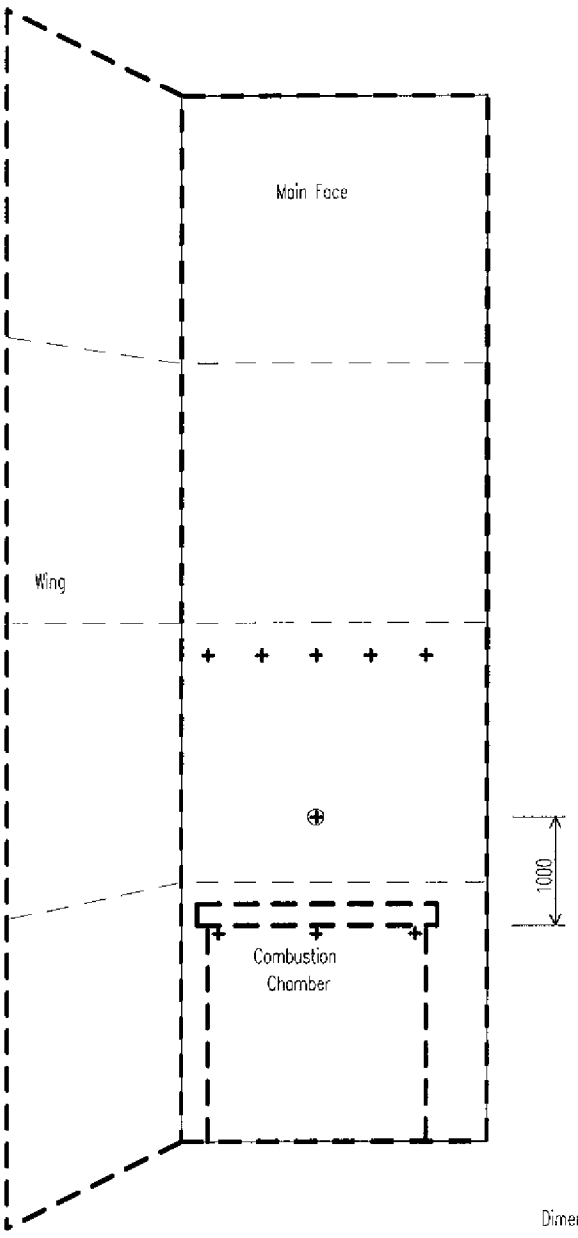


Figure 2 Location of heat flux meter and thermocouples for calibration

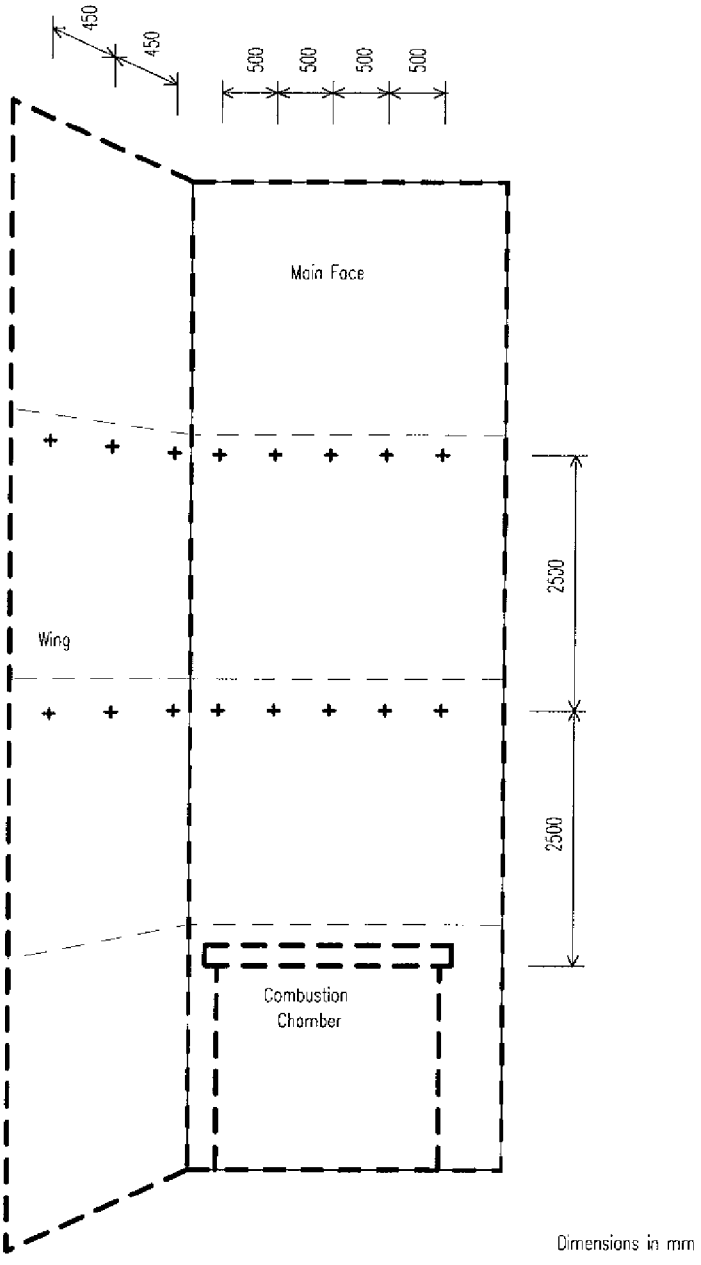


Figure 3 Typical distribution of thermocouple locations