Fire Protection Association®

RISCAuthority

RISC 501:2023 – Fire Safety Assessment Test for External Cladding Systems

RISK INSIGHT, STRATEGY AND CONTROL AUTHORITY
REDUCING INSURABLE RISK THROUGH RESEARCH, ADVICE AND BEST PRACTICE

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Contents

Background

Enhancing cladding system fire safety

The occurrence of large cladding system fires has been increasing since 1990. This is of particular concern as a building's cladding system has the potential to spread fire around a building, bypassing the internal fire compartments.

Combustible cladding systems are approved on high-rise buildings in the UK by the performance-based route to compliance, using the BS8414 test method and BR 135 assessment criteria. However, a number of limitations have been identified with this route in relation to the appropriateness of the fuel source, test construction, construction detailing, assessment criteria, and availability of test results.

Following an extensive research project involving the University of Central Lancashire, external consultants, and insurers, the FPA has developed a new fire safety assessment test through RISCAuthority to address these limitations. An annually funded research scheme administered by the FPA, RISCAuthority comprises a group of UK insurers that actively support a number of working groups to develop best practice guidance for the protection of people, property, business, and the environment.

RISC 501 is designed to evaluate the fire safety performance of non-loadbearing external cladding systems and goes beyond the basic life safety standards, aiming to ensure resilient systems that can effectively prevent vertical spread. The test method is intended to be conducted either alongside BS 8414 so that the results can confer compliance with BR 135 and RISC 501, or as a standalone assessment.

1 Scope

This is a fire test and assessment method used to assess the fire safety performance of the design and materials of non-loadbearing external cladding systems, from a property and life safety perspective.

The test measures the potential of the cladding system to restrict vertical fire spread when the front face is exposed to a fire. The fire load simulates a fully developed fire in a compartment, venting out of a window and attacking the cladding system.

This method is designed to be conducted concurrently alongside BS8414-1 or BS8414-2[1, 2]. Notable differences include:

- different thermocouple locations
- different thermocouple criteria
- additional design requirements affecting floor heights and cavity barrier locations
- additional design requirements affecting detailing around the burn chamber opening and edges of the test rig
- additional service penetration requirements
- additional gas sampling requirements
- additional material characterisation requirements
- additional mechanical performance requirements.

The limits of the cladding system include any components attached to and external to the loadbearing construction.

2 Tolerances

2.1 Measurement of Uncertainty

All measurements must be inside the specified tolerances with a 95% confidence level.

If the tolerance specified is ±100 mm and the accuracy of measurement is ±10 mm then the object must be measured within ±80 mm.

If the tolerance specified is ≥100 mm and the accuracy of measurement ±10 mm then the objected must be measured to be ≥110 mm.

2.2 Value Tolerances

Unless otherwise stated, the following tolerances shall apply:

Table 1 - Value tolerances

Value	Tolerance
Length	±2%
Temperature	±5%
Volume	±5%
Gas concentration	±5%
Time	±5 s/h
Angle	±1°

3 Test Apparatus

3.1 Test Rig

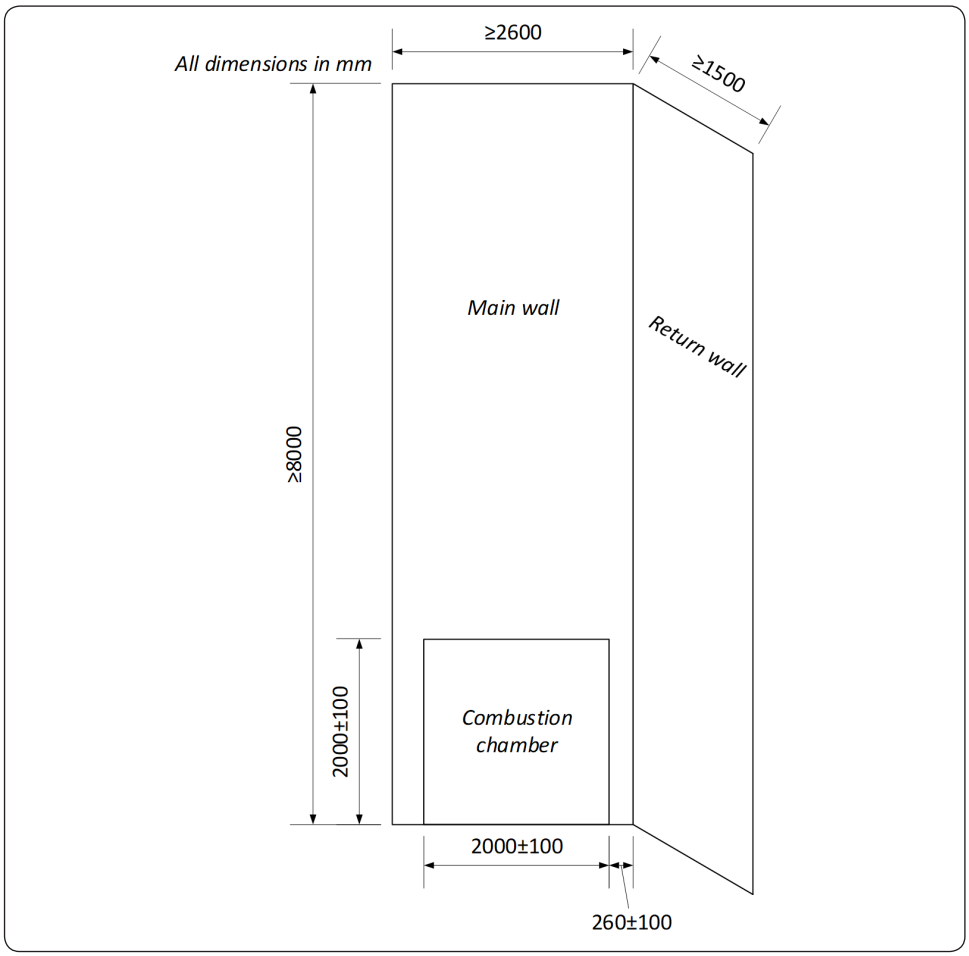
The test rig consists of a structural frame, covered by the test specimen. It is composed of a main wall and a perpendicular return wall. The return wall may be located on either side of the main wall.

It shall be:

- composed of materials representative of the end use application
- capable of supporting the test specimen
- capable of enduring the effects of the test without suffering undue damage or distortion
- constructed with the dimensions in Figure 1 below.

The test rig's protection shall not influence the test outcome.

Figure 1 – Test rig dimensions



3.2 Combustion Chamber

The fuel load is placed at the bottom of the test rig, inside an opening referred to as the combustion chamber. This is representative of a window opening. It shall be constructed as specified in either BS8414-1:2020[1] or BS8414-2:2020[2]. This shall include the lintel across the head of the chamber opening, capable of supporting the structure above it and enduring the effects of the test procedure.

3.3 Heat Source

The heat source shall be as specified in BS8414-1:2020 Annex A[1].

3.4 Data Recording

3.4.1 Thermocouples

Thermocouple data shall be recorded at least every 10 seconds and averaged over a 30 second period.

All thermocouples shall conform to BS EN 60581-1:2013[3], Type K (Chromel/Alumel). The thermocouples shall be mineral insulated and have a 1.5 mm nominal diameter.

Thermocouples shall be positioned 6 m above the combustion chamber opening in accordance with Figure 3 below.

Thermocouples shall be positioned within the test specimen, at the mid-point of each layer and cavity with a depth ≥ 10 mm.

Thermocouples shall be positioned (50±5) mm in front of the external face of the test specimen.

Figure 2 – Side elevation of a compliant thermocouple installation

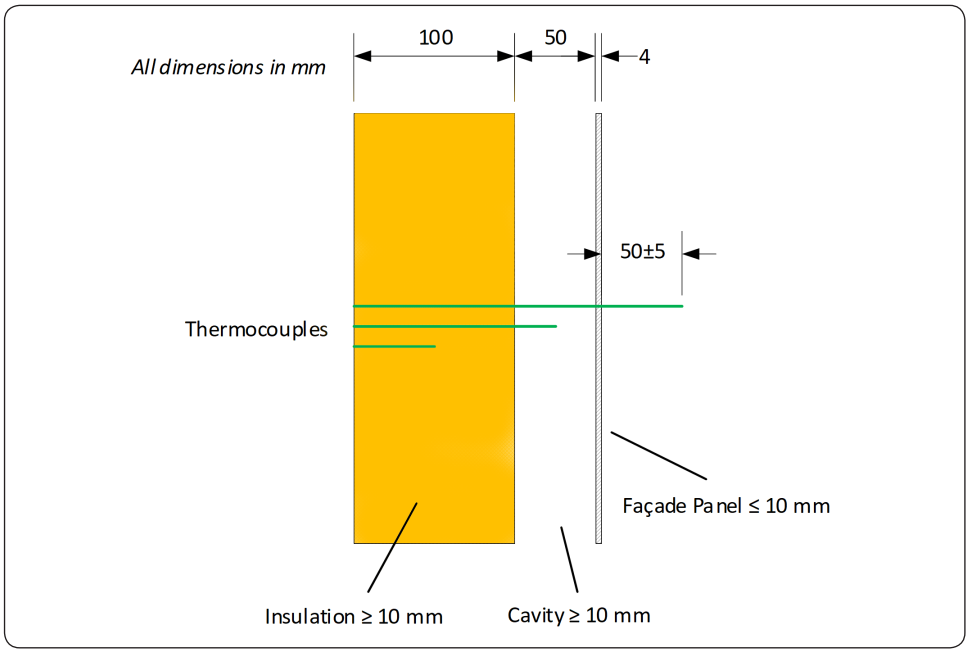
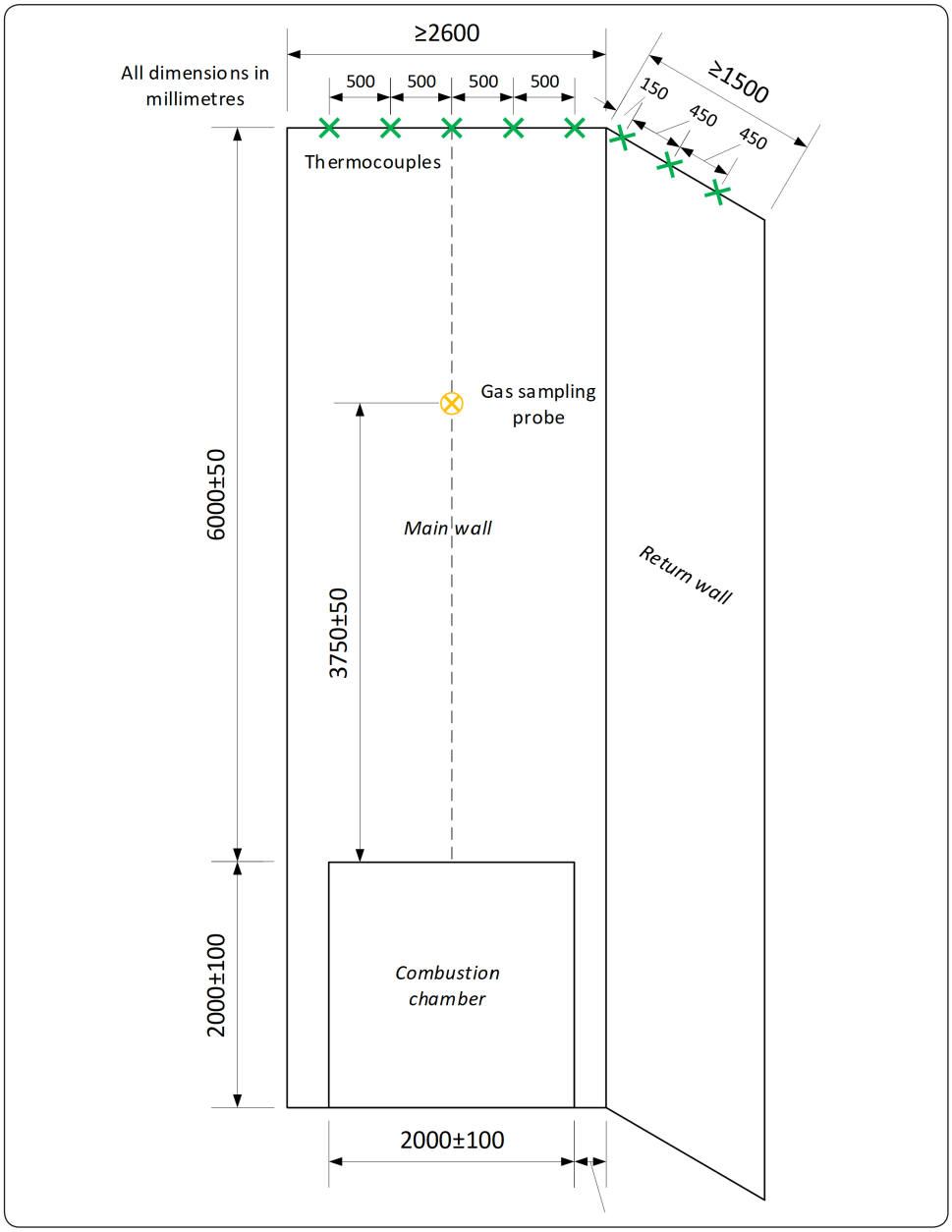


Figure 3 – Front elevation of instrumentation locations relative to the combustion chamber



3.4.2 Gas Sampling

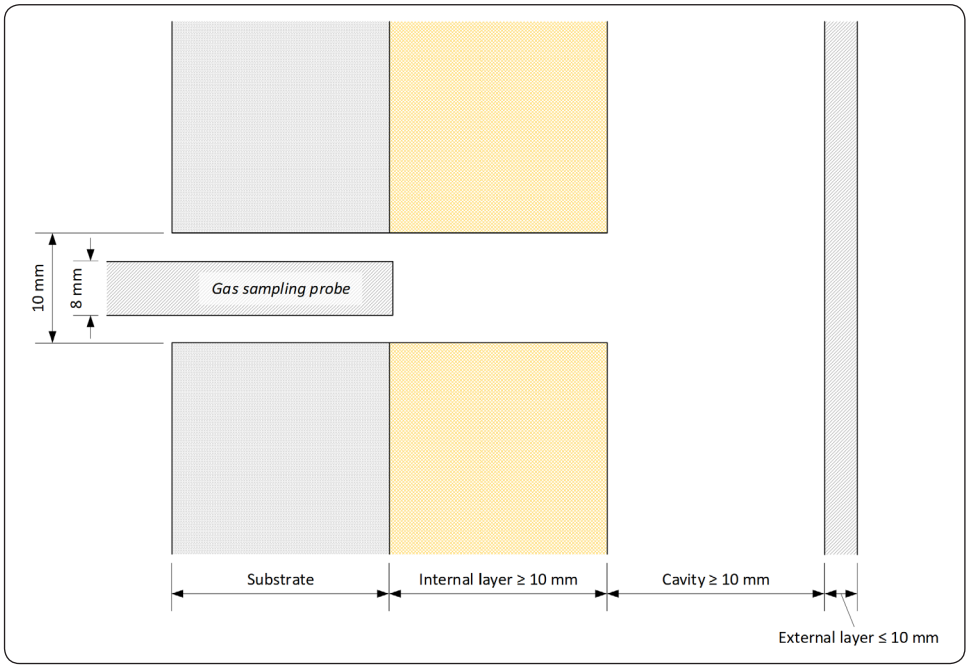
3.4.2.1 Gas Sampling Probe

A gas sampling probe shall be located (3750±100) mm above the combustion chamber as shown in Figure 3 above.

- The tip of the probe shall be positioned in line with the rear of the test sample as shown in Figure 4 below.
- The probe shall be inserted through a hole, in the rear of the test specimen, made through each internal layer. The hole shall not extend through the outer layer.
- The probe shall have an internal diameter ≥ 8 mm.
- The probe shall be sufficiently non-reactive and capable of surviving the duration of the test.

It has been found that 5 mm copper tube with 0.6 mm wall to BS 1057[4] soft is sufficient.

Figure 4 – Side elevation of a compliant gas sampling probe



3.4.2.2 Gas Sampling Measurement

Air shall be extracted from the gas sampling probe at a rate of 1 lpm. It shall be measured for O_2, CO_2 and CO concentration and they shall be recorded at least every 10 seconds.

3.4.3 Video Recording

The full duration of the fire test shall be recorded including ignition. The cameras shall:

- have a nominal frame rate ≥5 frames per second
- be of sufficient quality to enable the extraction of clear still images
- be positioned to cover the full height and width of the front face of the cladding system
- be positioned to identify flame spread at the top of the rig.

3.4.4 Classification Line

A line shall be marked (6000±50) mm above the combustion chamber opening so that it is clearly visible on camera.

It is appropriate for the top of the rig to be used as the test classification line if it is located (6000±50) mm above the combustion chamber opening.

The test may be terminated if flames are identified at this point.

4 Test Specimen

4.1 General Requirements

The external cladding system shall be installed onto the main wall and return wall of the test rig. The components to be tested shall be supplied together with design and installation criteria, operational instructions, drawings and technical data sufficient for the identification of the components.

The level of quality control used for the test installation shall match the standard used for a real installation.

4.2 System Design

The design of the system shall adhere to the same principles used for an actual installation. The virtual building depicted in Appendix A shall be used as the basis for design.

Information concerning system design and installation, critical to meeting the performance requirements, shall be provided to ensure that the system can be replicated as tested.

4.3 System Dimensions

The cladding system shall extend horizontally from the finished internal corner between the main wall and the return wall, covering a minimum distance of 2400 mm on the main wall and 1200 mm on the return wall. The specimen must extend from the base of the test apparatus up to a height of (6000±100) mm above the combustion chamber opening, on both the main and return wall, without blocking the combustion chamber opening.

4.4 Vertical Joints

Where vertical joints are incorporated into the cladding system, including expansion and movement joints, at least one joint shall extend upwards from the centre line of the combustion chamber opening ±100 mm.

4.5 Combustion Chamber Opening

The perimeter around the combustion chamber shall comprise of products, details and components that are intended for use in closing the aperture and related cavities in the final design.

It is appropriate to model the combustion chamber as a window opening for this purpose.

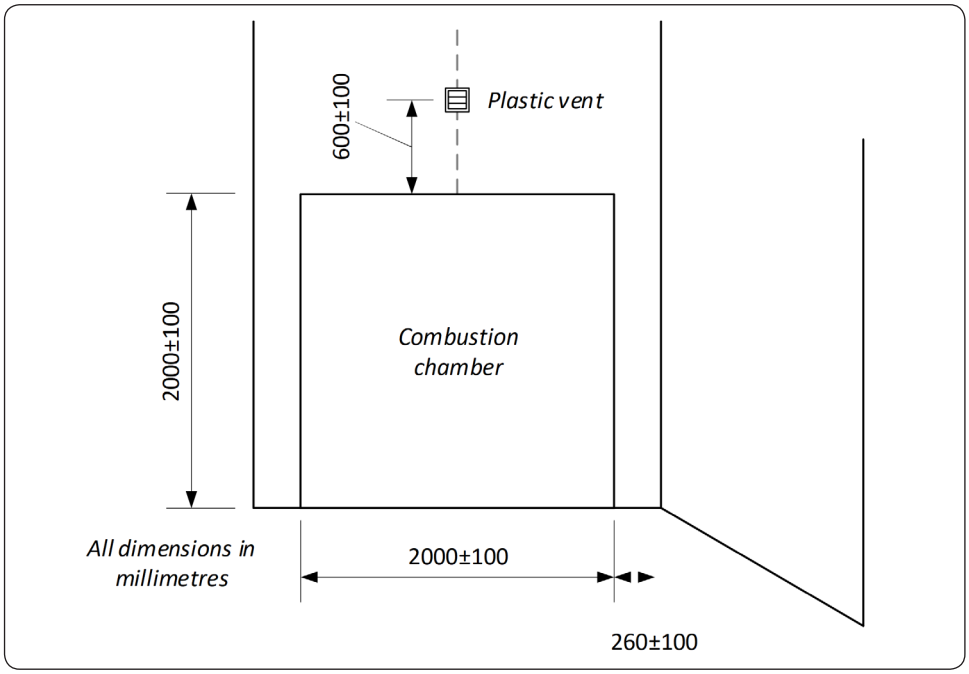
4.6 Edges of Test Rig

No detailing is permitted at the edges of the test rig. The test rig shall be modelled as a continuous flat surface and shall not be sealed around the external edges.

4.7 Service Penetrations

If the system design principles do not include provision for fire stopping around service penetrations, then a 100 mm Ø polyvinyl chloride (PVC) vent shall be included in the test rig. It shall be located (600±100) mm above the combustion chamber opening and shall be centred with respect to the combustion chamber as shown in Figure 5 below. The vent shall consist of PVC ducting which penetrates the entire way through the cladding system and a PVC grille on the front face of the cladding system.

Figure 5 – Front elevation of potential plastic vent location



4.8 Cavity Barriers

If cavity barriers and fire breaks are required for system performance, they shall be installed with the system's design principles applied against the virtual building in Appendix A.

If the design principles require one horizontal cavity barrier per floor, then they shall be installed at locations appropriate for the virtual building, 3150 mm apart.

4.9 Material Characterisation

Samples of each significantly combustible component shall be taken and subjected to material characterisation testing excluding:

- components which meet classification A1 or A2 S1 D0 when tested to BS EN 13501-1[5]
- components which are exempt from regulation 7(2) as noted in Approved Document B[1, 2].

The samples shall be selected at random by the test house.

Samples shall be tested to the procedure in Appendix B.

4.10 Conditioning

After the test specimen has been installed, it shall be conditioned as specified in BS 8414-1:2020[1].

5 Fire Test Procedure

5.1 Environmental Test Conditions

5.1.1 General Conditions

The test specimen shall not be affected by adverse weather conditions.

5.1.2 Wind Speed

The ambient air velocity shall not be greater than 2 m/s.

It shall be measured:

- in line with the test classification line, (8000±100) mm from the ground and (1000±100) mm away from either face of the cladding system
- in three perpendicular axis:
  - facing the main wall
  - horizontal to the main wall
  - vertical to the main wall
- between ignition and 30 minutes prior to ignition
- with the same ventilation conditions used during the test.

5.1.3 Ambient Temperature

The ambient temperature shall be between (5-35)°C.

It shall be measured:

- as an average of all external thermocouples
- as an average between ignition and 5 minutes prior to ignition
- with the same heating and ventilation conditions used during the test.

The facility may be artificially pre heated/cooled prior to the test if it has been proven that the test facility can remain within tolerance,for at least 65 minutes, once the artificial heating/ cooling is removed. This shall be proven during similar or worse ambient weather conditions.

5.2 Data Recording

The recording of thermocouple and toxicity data shall commence 5 minutes prior to ignition and continue until the test is completed or terminated.

5.3 Heat Source

The commencement of the test shall be considered the moment when the heat source is ignited. It shall be ignited using the procedure in BS8414-1:2020 Annex A[1].

The heat source shall be extinguished 30 minutes after ignition as specified in BS8414-1:2020[1].

5.4 Test Observations

Observations during the test, including changes in flaming conditions, mechanical behaviour of the cladding system, and detachment or fire penetrations in any part of the system, shall be recorded.

5.5 Test Duration

The test shall end 60 minutes after ignition.

5.6 Post-test Examination

5.6.1 General Examination

Following the fire test, an examination shall be conducted to record any relevant changes, including combustion, melting,deformation and detachment.

Smoke discolouration does not need to be recorded.

Still images shall be recorded of each layer of construction after the fire test.

5.6.2 Falling Parts

The largest part of each component which has fallen to the floor shall be weighed.

The largest part of each component with an edge ≤ 6mm which has fallen to the floor shall be weighed.

Parts shall be weighed dry.

If a part has been observed to break upon impact, it is acceptable to weigh an equivalent piece.

6 Classification Criteria

6.1 Visual Observation

Flames should not be observed extending beyond the classification line (section 3.4.4) or out the back of the test specimen.

6.2 Temperature Criteria

Thermocouple data shall be continuously sampled and averaged over a rolling 30 second period. The 30 second average shall not exceed the temperature criteria.

Temperature criteria shall be calculated using the following equation based on the ambient temperature (calculated in 5.1.3):

$$TC = 500 + 2AT$$

TC = Temperature Criteria

AT = Ambient Temperature

If it has been exceeded, the time taken to exceed the temperature criteria from ignition shall be recorded.

6.3 Mechanical Performance Criteria

No falling parts should exceed 5 kg.

No sharp falling parts should exceed 1 kg. Sharp is defined as any edges which are ≤ 6 mm.

7 Limits of Application

The results apply to the specific system specification tested. The application of multiple tests may be extended by applying the principles in BS 9414[6], when approved by a suitably qualified and experienced person.

If a service penetration was not installed in accordance with section 4.7, then the results shall not apply to systems which do not require additional protection around service penetrations.

If the system has undergone testing multiple times, it shall meet the classification criteria successfully more times than it fails to meet them.

8 Test Report

A report of the test shall be produced including:

- unique reference and date of report
- name and address of the fire test laboratory
- name and address of the test sponsor
- details of the test rig structural frame
- description of the system tested
- system design principles in accordance with section 4
- all products and components used in the test specimen
- results of the material characterisation tests specified in Appendix B
- drawings of the system in A4 portrait format including:
  - 1:50 scale elevations (or smaller) of each construction layer:
    - including the backing wall, brackets and support systems, insulation and fire barriers, cladding panels, and combustion chamber opening reveal
  - 1:5 scale details (or smaller) of vertical sections:
    - base of main wall
    - lintel
    - floor detailing (at each floor if different)
  - 1:5 scale details (or smaller) of horizontal sections:
    - edge of main wall (and return wall if different)
    - centre of combustion chamber
- the installation process, including still images of each significant layer of construction and still images of the edges of the test specimen
- installation start and end date
- reference to the test method used
- date of the fire test
- identification of the measurement instrumentation locations
- environmental test conditions
- test observations and test duration
- still images of the front face of the cladding system at 5 minute intervals from ignition until the end of the test
- graph of all temperatures and gas concentration measurements
- peak temperature, peak carbon monoxide concentration, peak carbon dioxide concentration, and minimum oxygen concentration
- time taken to exceed the temperature criteria (if exceeded)
- identification and mass of the heaviest falling part
- post-test examination including still images of each layer of the cladding system after the fire test
- a statement of compliance/non-compliance with section 6
- a statement of the limits of application in accordance with section 7
- a statement of all deviations noted.

9 Open Access Results

The test house shall publish publicly the details of the system tested with the results of the test including:

- company name and contact details
- unique report reference and date
- details of the test rig structural frame
- description of the cladding system including insulation and front panel
- whether cavity barriers and/or fire breaks were used
- classification result.

10 References

[1] "BS 8414-1:2020, Fire performance of external cladding systems - Test method for non-loadbearing external cladding systems fixed to, and supported by, a masonry substrate," British Standards Institution, London, 2020.

[2] "BS 8414-2: 2020, Fire performance of external cladding systems - Part 2: Test method for non-loadbearing external cladding systems fixed to, and supported by, a structural steel frame," British Standards Institution, London, 2020.

[3] "BS EN 60584-1:2013, Thermocouples - Part 1: EMF specifications and tolerances," British Standards Institution, London, 2020.

[4] "BS EN 1057:2006+A1:2010, Copper and copper alloys. Seamless, round copper tubes for water and gas in sanitary and heating applications," British Standards Institution, London, 2006.

[5] "BS EN 13501-1:2018, Fire classification of construction products and building elements. Classification using data from reaction to fire tests," British Standards Institution, London, 2018.

[6] "BS 9414:2019, Fire performance of external cladding systems - The application of results from BS 8414-1 and BS 8414-2 tests," British Standards Institution, London, 2019.

Appendix A – Virtual Building

The dimensions of the virtual building shall be considered when designing the system for test.

The virtual building exists for the purpose of defining dependent variables such as the location of cavity barriers. It does not need to be built.

Figure 6 – Front elevation of virtual building floor to floor detail

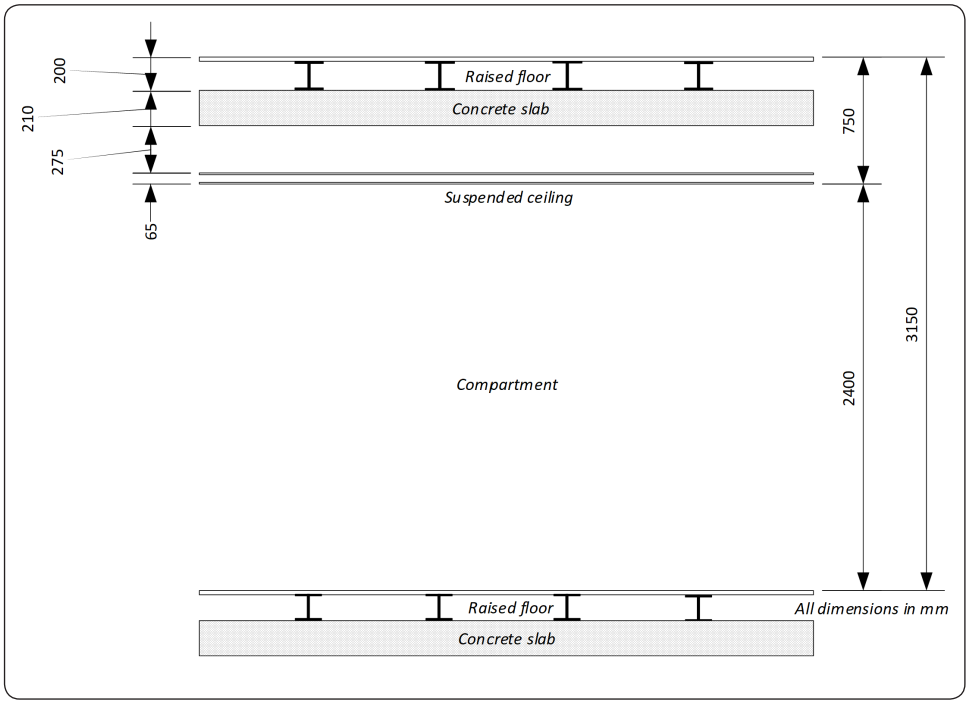
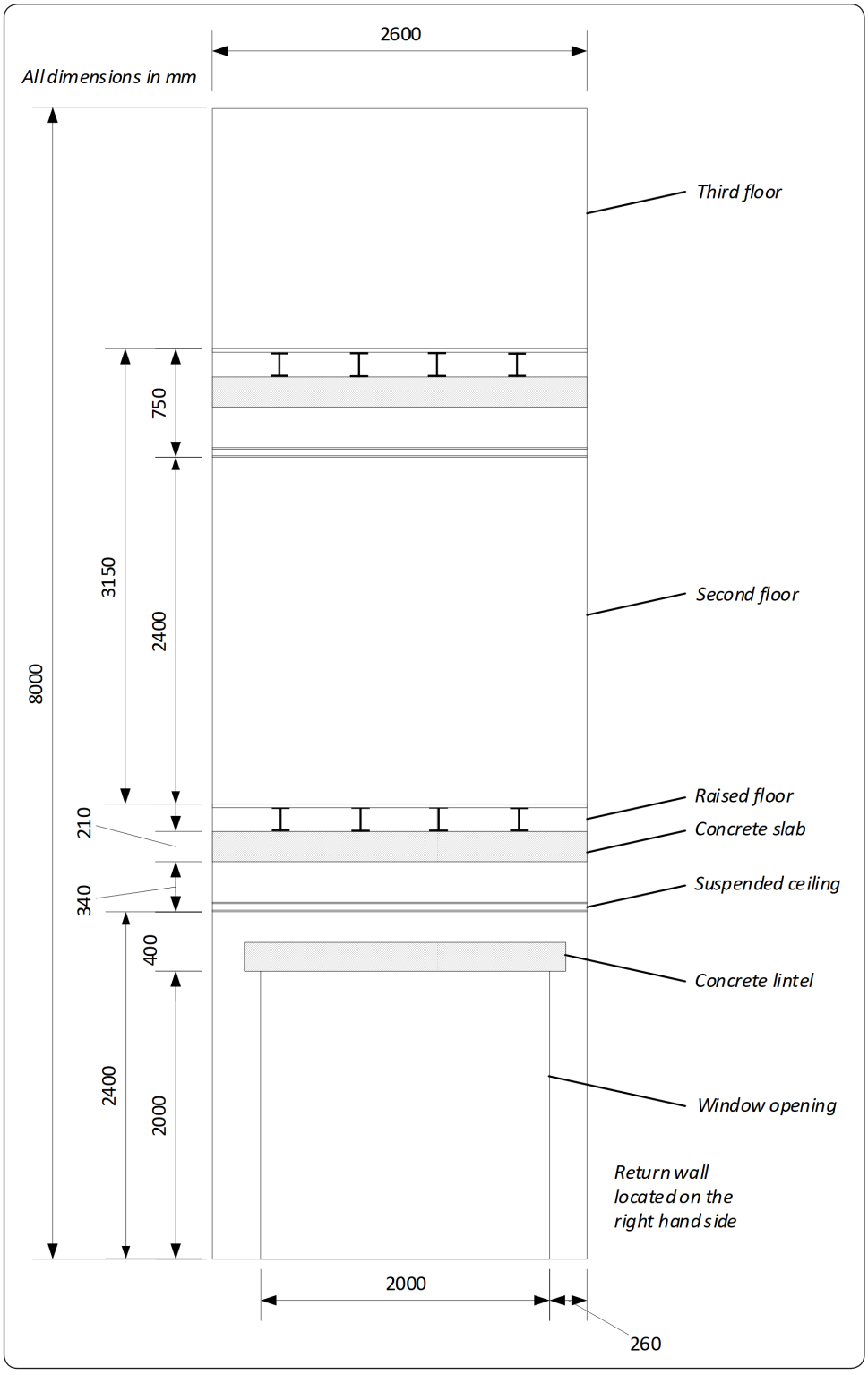


Figure 7 – Front elevation of virtual building



Appendix B – Material Characterisation Test Method

B.1 Sample Preparation

Product samples shall be cut with a method that removes the unclean edges. Samples shall be taken from a clean-cut edge and centrally throughout the thickness ±5 mm.

Samples shall remain dry.

This can be achieved by conditioning at (23 ± 2)°C and a relative humidity of (50 ± 5) % for 2 weeks prior to analysis in accordance with BS EN 13238:2010[7].

B.2 FTIR Procedure

Samples shall be ≥ 0.05 g, compressed into a flat disk with a KBr pellet press at a pressure ≥ 7 tons/cm^2 for at least 2 minutes.

Samples shall be evaluated using Diamond-Attenuated Total Reflectance-Fourier Transform Infra-Red spectrometry (D-ATR-FTIR). At least 32 scans shall be done per sample at a resolution of 4 cm^{-1}. A background scan shall be conducted first and subtracted from the sample.

B.3 MCC Procedure

Samples shall be between 2.000 and 3.000 mg.

Tests shall be conducted in triplicate in accordance with both method A and method B from ASTM D7309-21b – Standard test method for determining flammability characteristics of plastics and other solid materials using microscale combustion calorimetry[8].

The combustor shall be set to 900°C and the samples should be pyrolysed from 150°C to 750°C at a rate of 1.5°C per second.

B.4 References

[7] "BS EN 13238:2010 Reaction to fire tests for building products - Conditioning procedures and general rules for selection of substrates," British Standards Institution, London, 2010.

[8] "ASTM D7309-21b, Standard Test Method for Determining Flammability Characteristics of Plastics and Other Solid Materials Using Microscale Combustion Calorimetry " ASTM International, West Conshohocken, PA, 2021.

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