ASSESSMENT OF FIRE PERFORMANCE OF FACADES USING LARGE FIRE EXPOSURE

Draft revision 6
Date: 2022 – 11 - 18

Authors:
Johan Anderson, RISE Research institutes of Sweden, Sweden
Lars Boström, RISE Research institutes of Sweden, Sweden
Roman Chiva, Eflectis, France
Fabien Dumont, University of Liege, Belgium
Anja Hofmann-Böllinghaus, BAM
Octavian Lalu, BRE, UK
Niklas O. Lauersen, DBI, Denmark
Robert Olofsson, RISE Fire Research, Norway
Johan Sjöström, RISE Research institutes of Sweden, Sweden
Peter Toth, EMI, Hungary

IMPORTANT NOTE: This document is a draft updated after the performance of most of the initial tests and comments received from steering group until October 27, 2022. The document shall not be spread and used for any other activities. Several details in the assessment method are investigated further, and thus it is likely that major changes will be made on the assessment method.
TABLE OF CONTENT

ASSESSMENT OF FIRE PERFORMANCE OF FACADES USING LARGE FIRE EXPOSURE ............ 1
1 SCOPE.......................................................................................................................... 5
2 NORMATIVE REFERENCES......................................................................................... 7
3 TERMS, DEFINITIONS, SYMBOLS AND DESIGNATIONS ...................................... 8
4 TEST EQUIPMENT ........................................................................................................ 10
   4.1 General .................................................................................................................... 10
   4.2 Main face and wing ............................................................................................ 10
   4.3 Structural frame .................................................................................................... 11
   4.4 Supporting construction ....................................................................................... 11
   4.5 Combustion chamber .......................................................................................... 12
   4.6 Fuel source ........................................................................................................... 13
   4.7 Instrumentation ...................................................................................................... 15
      4.7.1 Thermocouples ............................................................................................... 15
      4.7.2 Data acquisition system ............................................................................... 15
      4.7.3 Visual equipment ........................................................................................... 15
      4.7.4 Mass measurement of falling parts ................................................................. 15
5 ENVIRONMENTAL CONDITIONS ............................................................................. 17
   5.1 Ambient wind speed ............................................................................................ 17
   5.2 Ambient temperature .......................................................................................... 17
   5.3 Ambient moisture ................................................................................................ 17
   5.4 Outdoor testing .................................................................................................... 18
   5.5 Indoor testing ....................................................................................................... 18
6 TEST SPECIMEN ......................................................................................................... 19
   6.1 Size ....................................................................................................................... 19
   6.2 Number of specimens to be tested ..................................................................... 19
   6.3 Design ................................................................................................................... 20
   6.4 Construction ......................................................................................................... 20
   6.5 Verification ........................................................................................................... 20
   6.6 Selection of the test rig ....................................................................................... 21
   6.7 Secondary opening .............................................................................................. 21
      6.7.1 General .......................................................................................................... 21
      6.7.2 Test rig ............................................................................................................ 21
   6.8 Mounting of the test specimen .......................................................................... 21
   6.9 Edges of openings .............................................................................................. 23
   6.10 Junction between façade and floor (optional test procedure and will be revised) . 24
7 CONDITIONING OF TEST SPECIMEN .................................................................. 26
   7.1 General ................................................................................................................. 26
   7.2 Verification of condition ...................................................................................... 26
8 APPLICATION OF INSTRUMENTATION .................................................................. 28
   8.1 Temperature measurements ............................................................................... 28
      8.1.1 General ........................................................................................................... 28
      8.1.2 External thermocouples ............................................................................... 28
8.1.3 Internal thermocouples ................................................................. 29
8.2 Measurements on junction between façade and floor (optional) ............. 30
8.3 Checking of smouldering (optional) .................................................. 32
8.4 Mass of the falling parts ................................................................. 32
9 TEST PROCEDURE ............................................................................. 33
  9.1 General ......................................................................................... 33
  9.2 Test time ....................................................................................... 33
    9.2.1 General .................................................................................. 33
  9.3 Ignition of the fire source ............................................................... 33
  9.4 Observations ................................................................................ 33
  9.5 End of the fire source .................................................................... 34
  9.6 Post-test inspection ....................................................................... 34
  9.7 Termination of test ....................................................................... 34
  9.8 Invalidation of the test .................................................................. 35
    9.8.1 Environmental conditions ....................................................... 35
    9.8.3 Thermocouple failure ............................................................. 35
    9.8.4 Other reasons to invalidate a test .......................................... 35
10 PERFORMANCE CRITERIA .................................................................. 36
  10.1 Fire spread ................................................................................... 36
    10.1.1 Vertical fire spread ................................................................. 36
    10.1.2 Horizontal fire spread ........................................................... 36
    10.1.3 Burning parts ....................................................................... 36
  10.2 Falling parts ................................................................................. 36
    10.2.1 Falling parts – Level 1 .......................................................... 36
    10.2.2 Falling parts – Level 2 .......................................................... 36
  10.3 Façade-to-floor junction (optional) ................................................. 37
    10.3.1 Integrity ............................................................................... 37
    10.3.2 Insulation ............................................................................. 37
  10.4 Smouldering (optional) ................................................................. 37
    10.4.1 Edge damages ..................................................................... 37
    10.4.2 Maximum temperature ......................................................... 37
11 TEST REPORT .................................................................................... 38
12 DIRECT FIELD OF APPLICATION ...................................................... 41
13 CLASSIFICATION ............................................................................. 42
  13.1 Performance classes ................................................................... 42
    13.1.1 LS - Fire spread under large fire exposure .......................... 42
    13.1.2 MS - Fire spread under medium fire exposure .................. 42
    13.1.3 F1 – Falling parts (level 1) .................................................... 42
    13.1.4 F2 – Falling parts (level 2) .................................................... 42
  13.2 Declaration of classification of performance .................................... 42
  13.3 Classification report .................................................................... 43
ANNEX A CALIBRATION OF THE HEAT EXPOSURE (INFORMATIVE) ........... 46
ANNEX B MOUNTING OF TEST SPECIMEN AT OPENINGS (NORMATIVE) ....... 47
ANNEX C FAÇADE-TO-FLOOR JUNCTION (INFORMATIVE) ............................ 53
1 Scope

This assessment method is applicable for any façade system, like for instance external walls, façade cladding systems vertically fixed to and supported by a structural frame or a supporting construction. The façade is a complete external wall construction of any type (massive wall or curtain walling ...etc.) or constitution (masonry, combustible material etc). The method will not address the load-bearing capacity of the tested system, nor inclined façade systems. This method addresses requirements which go beyond the requirements that can be addressed and classified according to EN 13501-1,2, like for instance EN 1364-3 and 4 for fire resistance of curtain walling. The method includes a secondary opening for assessment of detailing of the façade system around openings to simulate the presence of any kind such features at levels above the fire source, but not any window detailing. Vertical and horizontal fire spread on the surface and within façade systems is assessed. The method also evaluates falling parts (mass of falling parts and risk for fire spread downwards through burning material falling down from the façade) of a facade when exposed to fire. This method cannot directly assess the fire re-entry into the compartments above the combustion chamber, because window detailing is not tested. Vertical fire spread is limited to reduce the risk of fire re-entry into the building, see note below.

Note 1: generally, a fire re-entry into the building from one storey (origin of the fire) to the next one above via windows cannot be prevented. Limitation of vertical fire spread concentrates usually on the task to prevent further fire spread.

Note 2: vertical fire spread is assessed in the only upward direction by the present method, not in the downward direction, since the combustion chamber is kept at the base of the test rig. Assessing a downward fire spread would request to raise the combustion chamber at 3 m from the ground for instance.

Examples of typical products and systems covered by this proposal include (but is not limited to):

- Exterior Thermal Insulation Composite Systems (EIFS, ETICS or synthetic stucco)
- Metal composite material cladding systems (MCM)
- High-pressure laminate facade and cladding systems
- Structural Insulation Panel Systems (SIPS) and insulated sandwich panel systems
- Rain screen cladding or ventilated facades
- Weather-resistive barriers (WRB)
- Wooden facades
- External walls
- Curtain walling

This proposal covers the fire performance of the façade system, not its individual insulating components, products or elements.

This proposal defines the procedure using a large fire exposure test, representative of a fully developed (post-flashover) fire in a room, vented through an opening such as a window aperture, that exposes the cladding to the effects of external flames, or from an external fire source.

The method includes an optional measurement for the façade to floor junction and for the smouldering. This are features assessed in some Member States and are therefore also included here. Although, any eventual classification on the façade to floor junction nor for smouldering is not included.

The direct field of application is very limited in the present document, and more information and studies are required to give a wider direct field of application. The extended field of application, i.e. when the results from two or more tests are combined, are out of the scope of this document.

There is no clear definition of a façade system, and it becomes even more unclear on what to include in a test when looking on the regulations in the Member States. In some Member States the
regulation covers the complete exterior wall, while in other Member States it is the outer skin that needs to be assessed. Therefore, the European assessment method needs to cover all, and it will be important to have a good description of the field of application together with the test and classification report.
2 NORMATIVE REFERENCES

ISO 13943 Fire safety - Vocabulary

EN 60584-1 Thermocouples – Part 1: EMF specifications and tolerances

EN 1364-3 Fire resistance tests for non-loadbearing elements – Part 3: Curtain walling – Full configuration (complete assembly)

EN 1364-4 Fire resistance tests for non-loadbearing elements – Part 4: Curtain walling – Part configuration

EN 16733 Reaction to fire tests for building products – Determination of a building product’s propensity to undergo continuous smouldering

EN 1363-1 Fire resistance tests – Part 1: General requirements

EN 13238 Reaction to fire tests for building products – Conditioning procedures and general rules for selection of substrates

EN 13501-1 Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests

EN 13501-2 Fire classification of construction products and building elements – part 2: Classification using data from fire resistance tests, excluding ventilation services
### 3. TERMS, DEFINITIONS, SYMBOLS AND DESIGNATIONS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>cavity systems</td>
<td>Systems with a cavity (i.e. a volume containing air). This includes (but is not limited to) what is generally referred to as ventilated facades.</td>
</tr>
<tr>
<td>charred material</td>
<td>Material that is judged to have been changed by pyrolysis. The assessment should be motivated by some charring characteristic, including (but not limited to) density changes, fissures, porosity etc.</td>
</tr>
<tr>
<td>collapse</td>
<td>Any part of the façade system which becomes detached and/or falls off.</td>
</tr>
<tr>
<td>combustible (layer)</td>
<td>Material whose Euroclass ranges from B to F or whose reaction to fire performance has not been determined. Materials have to be assessed individually, i.e., a composite material may have a Euroclass A due to a good protection of a backing combustible insulation, and in these cases each material must be assessed individually.</td>
</tr>
<tr>
<td>discoloration</td>
<td>Visual change of specimen not caused by burning, charring or melting.</td>
</tr>
<tr>
<td>discrete area</td>
<td>Portion of the total surface of a building element (e.g., façade, floor...) which may be expected to have different thermal insulation than the other areas in presence in this building element, whether visible or invisible (i.e., hidden inside the building element)</td>
</tr>
<tr>
<td>element, component or product</td>
<td>In this context part of the façade system</td>
</tr>
<tr>
<td>Euroclass</td>
<td>Reaction to fire class of a material according to EN 13501-1. For instance: A1, A2; B, C, D, E, F.</td>
</tr>
<tr>
<td>exposed face</td>
<td>Finished external face of the tested façade.</td>
</tr>
<tr>
<td>external cladding system</td>
<td>Complete cladding assembly. Note 1: This includes sheeting rails, fixings, cavities, insulation and membranes, coatings, flashings or joints. Note 2: The limits of the cladding system are taken to be as applied to and forward of the supporting construction</td>
</tr>
<tr>
<td>external wall assembly</td>
<td>Complete system including any sheeting rails, cavities, fire barriers and weathering membranes and/or coatings.</td>
</tr>
<tr>
<td>façade</td>
<td>A complete external wall construction of any type (massive wall or curtain wall ...etc.) or constitution (masonry, combustible material ...etc.). Since there is no general definition available on the term façade or a façade system, it is used in a very general way in this document. Due to different uses of the term in the Member States, and the present assessment method have to be applicable in all Member States the definition has to cover everything from the outer skin of the building envelope to the full external wall. What to test in accordance with this assessment method is than defined by the regulations and requirements in the individual Member States and the field of application.</td>
</tr>
<tr>
<td>façade system</td>
<td>see façade</td>
</tr>
<tr>
<td>falling parts</td>
<td>Material (solid or molten) separating from the specimen, burning - with or without a visible flame - or not burning, during a fire or a fire test.</td>
</tr>
<tr>
<td>finished corner</td>
<td>90° corner formed between both exposed faces of the tested façade, namely the main face and the return wing.</td>
</tr>
<tr>
<td>fire barrier</td>
<td>Separating element which inhibits the passage of flame and/or heat and/or effluents for a period of time under specified conditions</td>
</tr>
<tr>
<td>fire load</td>
<td>Quantity of heat which could be released by the complete combustion of all the combustible materials in a volume, including the facings of all bounding surfaces. Note 1: Fire load is expressed in joules.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
</tr>
<tr>
<td>fire scenario</td>
<td>Detailed description of conditions, including environmental, of one or more stages from before ignition to after completion of combustion in an actual fire at a specific location or in a real-scale simulation</td>
</tr>
<tr>
<td>fire stop</td>
<td>Fire safety measure to limit the fire propagation within the system</td>
</tr>
<tr>
<td>fire spread</td>
<td>Propagation of a fire front on a material surface or within a material defined by the width or height to which any thermocouple exceeds a temperature rise of 500 K continuously over a period of 30 seconds during the 60 minutes test period after the start of the test</td>
</tr>
<tr>
<td>flash-over</td>
<td>Transition to a state of total surface involvement in a ventilated controlled fire within an enclosure</td>
</tr>
<tr>
<td>fully developed fire</td>
<td>State of total involvement of combustible materials in a fire</td>
</tr>
<tr>
<td>hygroscopic material</td>
<td>A material which is able to absorb significant amount of moisture from the ambient air.</td>
</tr>
<tr>
<td>inner corner</td>
<td>90° corner formed between both front sides of the test rig, namely the main face and the return wing</td>
</tr>
<tr>
<td>main face</td>
<td>The large vertical surface of the test rig and test specimen in which the combustion chamber is placed.</td>
</tr>
<tr>
<td>mass loss rate</td>
<td>Mass of material lost per time unit under specified conditions. Note: It is expressed in kilograms per second</td>
</tr>
<tr>
<td>protection to openings</td>
<td>Any feature provided to accommodate the termination of the façade specifically at the boundaries of openings (combustion chamber opening and secondary opening) and that is deemed to offer to this termination any protection against fire spread. Examples of protection to openings are: window frame, sealant, caulking, profile that encapsulates or screens the termination, window sill... covering partially or totally the façade termination.</td>
</tr>
<tr>
<td>smouldering</td>
<td>Combustion of a material without flame and without visible light, including glowing combustion. Note: Smouldering is generally evidenced by an increase in temperature and/or by effluent</td>
</tr>
<tr>
<td>structural frame</td>
<td>A stable frame onto which a full external wall, or a supporting construction, can be mounted.</td>
</tr>
<tr>
<td>supporting construction</td>
<td>A secondary structure mounted on the structural frame onto which a façade test specimen can be mounted. A supporting construction may be necessary when not the full external wall is tested.</td>
</tr>
<tr>
<td>system</td>
<td>see façade</td>
</tr>
<tr>
<td>test rig</td>
<td>The total assembly of the structural frame, the eventual supporting construction, and the combustion chamber.</td>
</tr>
<tr>
<td>window frame</td>
<td>In the test it is possible to have a protection of edges around openings which would be the case in practice through details from windows.</td>
</tr>
<tr>
<td>wing</td>
<td>The smaller vertical part of the test rig and test specimen placed at a 90° angle to the main face.</td>
</tr>
</tbody>
</table>
4 TEST EQUIPMENT

4.1 General

The test equipment consists of the following main components:

- Structural frame
- Supporting construction in some cases
- Combustion chamber and fuel source
- Instrumentation

The test rig consists of a structural frame, eventually covered by a supporting construction, composed of a main face and a return wing, fitted with a combustion chamber. The rig utilizes a vertical structural frame, representative of a structural steel framed building and shall be capable of enduring the effects of the test procedure without itself suffering undue damage or distortion, see 4.3 for details.

Note: In the Figures all along this document, the hatched areas referenced as "test rig" are simplified representations of the main face and the wing of the test rig which – for convenience – have been very schematically reduced to their surrounding rectangular envelope. It should be understood that this schematic representation always include a structural frame and, depending on the kind of façade being evaluated, may or may not include a supporting construction (see 6.6 for detail).

4.2 Main face and wing

The test rig shall include a main face and a wing, see figure 1, where the wing is mounted at 90° to the main face. Figure 1 shows the minimum size of test rigs for medium fire exposure and large fire exposure. The front side of the test rig shall extend horizontally from the inner corner of the test rig, over sufficient widths to accommodate the minimal required dimensions of the tested façade (see 6.1), and this as much for the main face as for the return wing. The needed minimal horizontal dimensions of the test rig will consequently depend on the thickness of the tested façade.

Note 1: It is recommended to design a flexible test rig, with main face and return wing widths sufficient to accommodate any façade thickness, and with a return wing that can be shifted to increase/decrease the main face width, or with a larger combustion chamber to be reduced depending on the façade system thickness.

Note 2: The return wing may be accommodated either on the left or on the right of the main face. In the present document, the figures only show the configuration with the return wing located on the right side of the main face.

The front side of the test rig (both main face and wing) shall extend vertically from the base of the test rig to a height of at least 5500 mm, above the top of the combustion chamber opening.

The main face shall include one secondary opening, see 6.7 for details.
Figure 1. Principle drawing of the test rig. The front side of the test rig is represented here. The widths X (main face) and Y (return wing) are chosen to accommodate the dimensions of the tested facade.

4.3 Structural frame

A structural steel frame may be designed and constructed to withstand the expected loading imposed by the system under test and any subsequent distortions that can occur during the test program. Other structural frames such as timber or concrete can be employed for specific applications.

4.4 Supporting construction

If a part of the full external wall is tested, for instance a cladding system, a supporting construction (representing the wall onto which the tested system is used) is necessary onto which the test specimen can be mounted. See 6.6 for more rules.
The supporting construction shall be erected onto the structural frame. It shall be made of a masonry, e.g. aerated or light weight concrete blocks or slabs, and it shall be mounted in such way that it is airtight.

*Note: It is recommended to fix the supporting construction on the structural frame for safety reasons.*

### 4.5 Combustion chamber

The design and location of the combustion chamber opening in the main face shall be in accordance with the design details specified in table 1. The distance specified in Table 1 are clear distances, i.e. measured once the chamber preparation is ended with the cladded insulation in place.
Table 1. Specification of combustion chambers.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance of combustion chamber opening from finished corner (mm)*</td>
<td>250 ± 100</td>
</tr>
<tr>
<td>Height of combustion chamber opening (mm)</td>
<td>1900 ± 50</td>
</tr>
<tr>
<td>Width of combustion chamber opening (mm)</td>
<td>2000 ± 50</td>
</tr>
<tr>
<td>Internal height of the combustion chamber (mm)</td>
<td>2100 ± 50</td>
</tr>
<tr>
<td>Internal width of the combustion chamber (mm)</td>
<td>2400 ± 50</td>
</tr>
<tr>
<td>Depth of combustion chamber (mm) (inside back wall to front surface)</td>
<td>1300 ± 50</td>
</tr>
</tbody>
</table>

* To fulfil this requirement for any thickness of the tested façade, it is recommended to design a flexible test rig (see note in 4.2).

The combustion chamber walls and roof shall be made of a non-combustible construction and its inner surfaces shall be cladded with insulation (ceramic or equivalent).

However, when assessment of the façade-to-floor junction is performed, the roof of the combustion chamber shall rather comply with the requirements given in Annex C.

Figure 3. Combustion chamber for the large fire exposure.

4.6 Fuel source

The fuel source is a wood crib made of spruce placed in the combustion chamber. The wood shall be stored indoor within a heated building until the weight is constant. The mean density after conditioning shall be 500 ± 100 kg/m³. The mean moisture content of the wood shall be 11 ± 2 % (mass water to mass of dry wood).

The crib is nominally 1500 ± 5 mm × 1000 ± 5 mm in plane and 1100 ± 25 mm high.
It shall be constructed from alternating layers of:
- long lengths 1500 ± 5 mm and
- short lengths 1000 ± 5 mm
of softwood sticks with sawn square section 47 ± 3 mm.

The crib shall be constructed in alternate layers of long and short sticks, with the base layer consisting of 10 long sticks of 1500 mm. The next layer shall consist of 15 short sticks evenly distributed to cover an area of 1500 mm × 1000 mm. The sticks of the layers have 90° angle from layer to layer, the wood to air ratio is about 1:1. This process is repeated until the total height is 1100 ± 25 mm high and the total weight is 350 ± 20 kg.

The crib shall be positioned on a platform made of steel sections, in such a way that the base of the crib is at 300 ± 50 mm above the floor of the combustion chamber. The top side of the platform should be covered by a solid plate. The back side of the crib shall be located at 100 ± 10 mm from the rear wall of the combustion chamber. The distance between the crib and the side walls on both sides shall be the same. See figure 6.

![Figure 4](image)

**Figure 4.** Wood crib for the large fire exposure.

In order to avoid premature collapse of the cribs, the sticks shall be nailed together. It is not necessary to nail all sticks. The minimal nailing shall be done according to the patterns shown in figure 7, alternating the short sticks layer pattern and the long sticks layer pattern from one layer to the next. Additional nails can be placed at the discretion of the laboratory.
4.7 Instrumentation

4.7.1 Thermocouples

The external and internal thermocouples shall have measuring junctions of nickel chromium/nickel aluminium (type K) wire as defined in EN 60584-1 contained within mineral insulation in a heat resisting alloy sheath of nominal diameter 1.5 ± 0.5 mm, the hot junctions being electrically insulated from the sheath.

When testing a façade-to-floors junction, thermocouples with copper disc and insulating pad as described in EN 1363-1 shall be used.

4.7.2 Data acquisition system

Instruments shall be connected to a data acquisition system capable of recording data at intervals not exceeding 10 s.

4.7.3 Visual equipment

Digital cameras shall be used to provide a continuous visual record of the test. A pixel resolution of 1920x1080 or higher shall be used. The camera shall be able to record at a speed of ≥ 10 Hz.

On the exposed face of the tested façade, at least one camera shall be used to cover the full height and width of the exposed faces (both main face and wing). Additional cameras (four cameras in total are generally sufficient) may be needed to ensure good coverage of the whole exposed face.

When also assessing the junction between floor and façade, on the back face of the tested façade, at least one additional camera shall be used at a location allowing capturing the complete width of the façade-to-floor junction.

The recorded pictures may be used to assess the size and test time of falling parts for the purpose of reporting of observations in the test report.

4.7.4 Mass measurement of falling parts

A weighing load cell platform with an accuracy of ± 50 g shall be used to measure the mass of falling parts during the test. A plate that covers the rectangular area which is defined by the main face and the wing as shown in Figure 7 shall be used on top of the weighing cell platform to collect falling parts during the test. A software shall be used that allows the automatic and continuous measurements and recording of the weight. The weight over time shall be documented.
Figure 6. Placement of measurement platform for falling parts.
5 ENVIRONMENTAL CONDITIONS

5.1 Ambient wind speed

The horizontal component of the ambient air speed shall be less than 2 m s\(^{-1}\) before the commencement of the test. This shall be demonstrated by measurements from a bidirectional anemometer measuring the horizontal wind speed and its direction with an accuracy of ±0.1 m/s and ±5°. It shall be located at a distance of 2 m horizontally away from the exposed faces (main face as well as return wing, see Figure 8), and at the same height as the upper edge of the combustion chamber. The ambient air speed shall be measured at intervals of 1 minute during 15 minutes before the commencement of the test, and none of these 15 values shall exceed the speed limit above in order to allow starting the test. For indoor testing, these measurements shall be carried out under the same ventilation conditions as the ones used under the test.

![Figure 7. Position of the anemometer and air speed component of interest.](image)

During the test, wind (direction and velocity) shall be measured by means of a weather station (for outdoor test) or other equivalent system for indoor tests located in the vicinity of the test bench. The 2 m/s\(^{-1}\) limit applies also during the test.

5.2 Ambient temperature

The ambient temperature prior to testing shall be between +5 °C and +35 °C. This shall be demonstrated by a measurement from the ambient thermometer located at a distance of between 1.8 m and 2.2 m horizontally away from the exposed faces (main face as well as return wing), and between 1.8 m and 2.2 m above the ground. This measurement shall be performed not more than 5 min before the commencement of the test. In case of direct sunshine in the thermometer area, the ambient thermometer shall be shadowed from the sun by a suitable screen.

5.3 Ambient moisture

The ambient relative humidity shall be measured prior to the test the day of the test but also the two nights and two days before the test.
5.3 Outdoor testing

The laboratory shall carry out the tests during conditions meeting the requirements on ambient air velocity and temperature above shall be met. It could be necessary to shield the specimen from the effects of high wind. See 10.8 for more rules.

5.4 Indoor testing

The requirements on ambient air velocity and temperature above shall be met. Mechanical or natural ventilation above the test rig (exhaust duct) is allowed, as long as the requirement on ambient air velocity is maintained.
6 Test specimen

6.1 Size

The exposed face of the test specimen shall extend horizontally from the finished corner of the tested façade, at least 3200 mm on the main face and at least 1500 mm on the wing. The system shall, on both the main face and the wing, extend vertically from the lower part of the combustion chamber (or the floor level) to a height of at least 5500 mm above the top of the combustion chamber opening. The test specimen shall not obstruct the combustion chamber opening nor the secondary opening, with the exception of the strictly minimum protrusion constituted by the representative edge detailing. See figure 9.

Figure 8. Test specimen and test rig (minimal dimensions).

6.2 Number of specimens to be tested

At least one specimen shall be tested. In the case where the mounting can be made in different ways (e.g. panels mounted vertically or horizontally), or where different details can be used (e.g. different types of fire stops or cavity barriers), or where other features can be done in different ways, then additional test specimens may be required. It is therefore important to use the direct field of application given in chapter 13 which shows the possible changes and variations based on one test. When more than one test is required the extended field of application (to be developed separately) will show the possible variations and changes.
6.3 Design

The test specimen should be designed to obtain the widest applicability of the test results, by considering the product range of the manufacturer and the direct field of application given in chapter 13.

The test specimen shall include all relevant components assembled and installed in accordance with the manufacturer’s instructions.

The test façade shall include the special detailing around both openings in the façade system as close to end use conditions as possible, i.e. the detailing where features such as opening are to be mounted in practice, see 6.7.

At the boundaries of the tested façade (upper/lower horizontal and left/right vertical extremities), edges detailing and terminations shall be as intended for the end use design and shall be documented.

Ventilated systems should be built with all accessories for the ventilation to function in a real application, such as ducts or channels. The dimensions of cavities and installations should be the same as in a real application.

All detailing shall be installed as in practice, including any fire stop, compressing seal, finishing mastic, insulating material, filling material, cladding, fastening and thermal breaks.

If in practice horizontal joints are incorporated into the outer layer of the façade system (i.e. the first layer on the side of the exposed face), the test specimen shall incorporate such horizontal joints at intervals specified by the manufacturer, with at least one joint placed between the the combustion chamber opening and the secondary opening. If there is no joint in the outer layer, then the outermost layer of the façade system incorporating a joint shall be considered. The horizontal joints shall extend on the full width of the main face and the wing. See figure 9a.

If in practice vertical joints are incorporated into the outer layer of the façade system (i.e. the first layer on the side of the exposed face), the test specimen shall incorporate such vertical joints at intervals specified by the manufacturer, with at least one joint on the main face extending upwards within a tolerance of ±250 mm on the centre line of the combustion chamber opening. If there is no joint in the outer layer, then the outermost layer of the façade system incorporating a joint shall be considered. The vertical joints shall extend on the full height of the main face. See figure 9a.

Any modifications made to accommodate the installation of a test specimen on the test rig shall be such as to have no significant influence on the behaviour of the test specimen and shall be fully described in the test report.

6.4 Construction

The method of construction including the tolerances and the erection shall be representative of the use of the element in practice. The standard of workmanship shall be as normally provided in buildings and shall include the same way of accessing the test specimen.

The sponsor shall be responsible for ensuring that the quality of construction of the test specimen is representative of the product in practice.

The laboratory shall monitor the erection of the test specimen in order to be able to include details of the methodology and workmanship in the test report. The installation of the test specimen shall be compared to the design drawings for reporting by the test laboratory. Photographic records shall be used to support this.

6.5 Verification

The sponsor shall provide a description of all construction details, drawings and schedule of major components and their manufacturer/supplier, as well as an assembly procedure to the test
laboratory, prior to the test. This shall be provided sufficiently in advance of the test to enable the
laboratory to verify the conformity of the test specimen with the information provided. As far as
possible, any area of discrepancy shall be resolved prior to starting the test. In case the
construction details cannot be verified, the laboratory shall oversee the fabrication of the test
specimen. Where appropriate, the critical material properties shall be determined, e.g. density,
moisture content and tolerances.

On occasion, it may not be possible to verify the conformity of all aspects of the construction of the
test specimen prior to the test and adequate evidence may not be available after test. When it is
necessary to rely on information provided by the sponsor, this information shall be clearly identified
in the test report. The laboratory shall nevertheless ensure that it fully appreciates the design of
the test specimen and shall be confident that it is able to accurately record the construction details
in the test report.

6.6 Selection of the test rig

Depending on the type of test specimen being evaluated, the tested façade shall be installed either
directly on the structural frame or it may be necessary to mount it on a supporting construction.

When in practice the façade system doesn’t consist of a full stand-alone external wall but rather of
a covering system to be fixed on an existing wall, then the test specimen shall be mounted onto a
supporting construction, which one substitutes the existing wall in practice for the purpose of the
test. See 4.4 for details.

When in practice the façade system consists of a full stand-alone external wall,
then the test
specimen can be mounted directly on the structural frame. See 4.3 for details.

The fixing on the rig should be as close as possible to the intended practical application and
appropriate for the rig, i.e. if mounting on aerated concrete suitable anchors should be used.

6.7 Secondary opening

6.7.1 General

The objective of the secondary opening is to simulate the presence of any kind of feature – such as
windows - at levels above the fire source opening. The main face of the test specimen and of the
test rig (structural frame/supporting construction) shall incorporate a secondary opening of 1200
mm in width and 1200 mm in height. It shall be located 1500 mm above the top of the
combustion chamber and 1250 mm from the finished corner. See figure 9a.

6.7.2 Test rig

Whether the test specimen is mounted directly on the structural frame or on a supporting
construction, the backside of the opening shall be covered with a board with a thickness of ≥ 20
mm made of calcium silicate or any other material classified A1 according to EN 13501-1, see
figure 10b.

6.8 Mounting of the test specimen

The test specimen shall be installed on both the main wall and the wing as in practice. Among
others, it shall be mounted with access only from areas that are actually accessible in real buildings
and be installed as far as possible by the same method and procedures as in practice. It is not
allowed to mount the specimen on the main face and the wing separately, and afterwards
assemble the main face and the wing, since such mounting would not be possible in any real
building.

If the façade system does not provide any protection to openings in practice (see definition in
chapter 3), then the detailing of the test specimen at openings (combustion chamber opening and
secondary opening) shall also remain unprotected. Otherwise, the test specimen shall include the
representative protections to openings intended to be used in practice.
Figure 9a. Main face with secondary opening including the location of vertical and horizontal joints. Distances in the drawing have to be considered with a tolerance of ±50 mm except the vertical distance between corner and secondary opening which is 1250 ± 100 mm.
6.9 Edges of openings

The perimeter of the secondary opening and of the combustion chamber should be closed as similar to end use as possible. In case end use conditions are not known, a general closing may be used such as thin aluminium or steel plate, that would allow for different details to be fitted at the edge.

This general closing should only be used where it is obvious that the fire behaviour of the simplified detail will be very similar to that used in practice.

A simplified detail cannot be used, for example:

- for heavy sheet coverings used in the window reveal and soffit (e.g. ceramic tiles, stone tiles)

- where the thermal insulation in the window reveal and soffit or the specific design of the junction prevents the fire from spreading to the rest of the façade (e.g. façade insulation system)

For all junction designs, the width of the fire opening in the horizontal direction shall be maintained at 2000 mm. In the vertical direction, detailing may reduce the height of the combustion chamber opening.
Figure 9c. Horizontal section: a: Detail as in practice, b: General closing

Figure 9d. Vertical section: a: Detail as in practice, b: General closing

Note 1: The closing of the façade system is closely linked to the Field of Application and need to be developed separately. A common closing for the separate façade systems to be used in the round robin exercise will be used and evaluated.

6.10 Junction between façade and floor (optional test procedure and will be revised)

The assessment of the junction between floor and façade as potential weak point may be required in some cases. In order to give the possibility to consider this issue, a specific adaptation can be done in the test. Figure 10 shows how the junction between the façade and the floor can be included in the test.

This optional test procedure is exposed in detail in annex D.

Note 1: Façade-to-floor junctions don’t exist in cases of façades mounted on a supporting construction. Therefore, only the façades mounted directly on a structural frame may be concerned by this optional assessment.

Note 2: The junction between façade and floor will only be assessed along the width of the combustion chamber, and not along the whole width of the test specimen. See also 9.3.
Note 3: The junction between façade and floor is not covered by the classification system for facades.

Figure 10. Mounting of façade system and floor at the combustion chamber schematically exemplified. The normal procedure is shown on the left, the adaptation for the evaluation of the façade-to-floor junction is shown on the right.
7 CONDITIONING OF TEST SPECIMEN

7.1 General

After installation of the test specimen to the test rig, it shall be left for a period of time which is sufficient for all components to cure. If the tested façade system includes hygroscopic materials, it shall be conditioned following the requirements of 7.2, otherwise it shall be conditioned in accordance with the test sponsor’s specifications.

The test rig with the mounted test specimen shall be protected from adverse environmental conditions such as water, wind load and ambient temperatures outside the range +5 °C to +35 °C during the mounting, conditioning and test period.

At the time of the test, the strength and the moisture content of the test specimen shall approximate to those expected in normal service.

7.2 Verification of condition

It is up to the sponsor to make sure that the specimen is conditioned to a state that represent what could be expected in its practical use. Thus, materials are not allowed to contain more water than in normal use. It is up to the laboratory to verify these conditions and they must be included in the test report. Verifications are recommended to use oven drying in 105 °C of excess materials during installation. Should moisture contents be deemed unreasonably high then this should be stated in the test report. Further verifications at the time of the test could be necessary. If no excess material is available, the lab needs to plan with the sponsor in advance of how to verify the condition of the specimen.

The same principle applies when testing materials which require time for curing. Their state must be close to what is expected in its practical use. The sponsor is responsible for delivering representative systems and the lab is required to verify that the material meets the representative status described by the sponsor.

When the tested façade system includes hygroscopic materials, in which case the fire performance is affected by the moisture content, the moisture content shall be measured during the conditioning period up to the time of testing by means of a small size mock-up of the facade.

This mock-up shall be prepared during the installation of the facade, using the same materials. This mock-up shall be used to estimate the weight stabilization of the sample and to determine material characteristics (mainly moisture content). It shall be stored together with the façade specimen and in the same ambient conditions.

The mock-up shall have the following dimensions:

- thickness: same thickness than the tested façade system,
- length and height of the front face: at least 200 mm x 200 mm or at least three times the thickness of the tested façade system, whichever is larger.

In order to ensure that the drying is allowed in the same way as for the façade in practice, namely only from the faces exposed to ambient air, all sides of the mock-up shall be covered in plastic except:

- the exposed face in case where the test specimen is mounted onto a supporting construction,
- both exposed and unexposed faces where the test specimen is mounted onto a structural frame.
The whole mock-up shall be weighted daily until the weight change between two measurements, 24 h apart, is less than 0.1 %. In case of materials that need long curing times, the conditioning can be limited to 28 days.

After this conditioning time, the moisture content of each individual hygroscopic material in presence shall be measured on samples taken from the mock-up test specimen. The moisture content of each such sample is determined by weighting the sample before and after drying at 105 °C. For some specific materials, such as gypsum, other drying temperatures may be applied which then shall be clearly stated in the test report.
8 APPLICATION OF INSTRUMENTATION

8.1 Temperature measurements

8.1.1 General

Sheathed thermocouples (external and internal, see below) shall be installed by drilling holes through the test specimen at the locations defined in section 8.1.2 and 8.1.3 to enable the thermocouples to be installed from the rear face of the tested façade. This instrumentation from behind should ensure no interference with the development of the ignition source or with the fire propagation on the tested façade.

Drilling the holes in the tested façade shall be achieved by using equipment suitable for the type of façade system and materials being tested. The diameter of the holes shall be the minimum required to allow the thermocouples to be inserted from the rear to the exposed face of the tested façade, allowing for multiple thermocouples to be located through the full depth of the system, see figure 11.

Care must be taken to ensure that damage or displacement of material in each layer is minimized.

Where the external thermocouples pass through the exposed face of the tested façade, the thermocouples shall be allowed to travel freely and shall not be restrained to the test specimen. If any form of closure around the holes is required on the exposed face of the tested façade, this shall be achieved by use of non-combustible cementitious or packing materials.

One horizontal line (referenced as level 1) and two vertical lines (referenced as columns 1 and 2) are defined for external and internal thermocouples.

---

Figure 11. Principle drawing for the internal and external thermocouples for fire spread assessment

8.1.2 External thermocouples

The position of external thermocouples should be according to Figure 12 within a tolerance of ± 10 mm. Nevertheless, if there are studs, joints, stiffeners, or other components which interfere at the given position, then the external thermocouple can be moved to a location not more than 50 mm from the component. The external thermocouples shall be placed with their hot junction positioned 50 ± 5 mm in front of the exposed face of the test specimen.
8.1.3 Internal thermocouples

In each location, internal thermocouples shall be positioned at the mid-depth of each combustible layer (see definition in chapter 3) or air cavity that are at least 10 mm deep. In this regard, several consecutive layers of the same material shall be considered as one single layer. Notice that to minimize the impact on measurements on the façade system it is allowed to use the same hole for all thermocouples.

In each position, the internal thermocouples shall be positioned around - and at a distance of maximum 50 mm from the external thermocouple or not more than 50 mm from interfering studs, joints, stiffeners, or other components.

![Diagram showing positions of thermocouples on the exposed face of the tested façade.](Image)

Figure 13. Positions of thermocouples on the exposed face of the tested façade.
8.1.4 Method of installation of the thermocouples

An example of installation is presented here:

- marking of the main thermocouples section at the front face (much easier than complicated calculation behind)
- drilling from the front of a 10 mm hole crossing the complete façade thickness and the supporting construction if existing
- creation of a bundle with all internal and external thermocouples of the same section with their measuring junction located at the suitable horizontal distance corresponding to the design of the façade system
- insertion of the bundle in a hollow pipe with external diameter smaller than 10 mm
- introduction of the pipe with thermocouple bundle from the rear of the rig
- adjusting the bundle horizontal position by having the measuring junction of the external thermocouple located at 50 mm distance of the exposed face
- fastening of thermocouples cables at the rear face of rig
- removal of the pipe from the front of the rig
- sealing of the space of hole between the thermocouples and the exposed face of the façade
- sealing of the space of hole between the thermocouples and the unexposed face of the façade or back side of the test rig as the case may be

Another example could consist in:

- installing external thermocouple by means of a grid/mesh made of steel profiles (channels, angles) installed from the top of the rig in front of the exposed face of the façade.
- installing all internal thermocouples by drilling from the rear face

8.3 Measurements on junction between façade and floor (optional)

When assessment of the façade-to-floor junction is performed (see Annex D), copper disc thermocouples and insulating pad, in accordance with EN 1363-1, shall be installed on the visible upper surface of the floor (not inside the floor) as follows:

- in cases of floors which incorporate discrete areas (see definition in chapter 3) with depth ≥ 30 mm alongside the unexposed face of the façade (e.g. linear seal) (see Figure 14):
  a) four thermocouples shall be located at mid-depth of the discrete area,
  b) four thermocouples shall be located on the floor at 15 mm from the discrete area,
- in other cases (see Figure 15):
  c) four thermocouples shall be located on the floor at 25 mm from the unexposed face of the tested façade.

When positioning thermocouples specified in b) and c) near a discontinuity (e.g. a joint between adjacent boards, a joint between one type of construction and another, hotspots...), the centre of the disc shall not be placed closer than 15 mm to the discontinuity.
In all cases, the thermocouples shall be distributed along the width of the junction at equal distances along the internal width of the combustion chamber.

**Figure 14.** Instrumentation at the junction between façade and floor in presence of a discrete area. The view is from above the floor (the roof of the combustion chamber).

**Figure 15.** Instrumentation at the junction between façade and floor in absence of any discrete area. The view is from above the floor (the roof of the combustion chamber).
8.4 Checking of smouldering (optional)

When the smouldering criterion is required, additional thermocouples in accordance with DIN 4102-20 shall be installed within the facade system.

8.5 Mass of the falling parts

A load cell platform shall be located in front of the test bench to collect any falling part coming from both the main face and the wing. See section 4.7.5 and figure 8 for description.

This platform shall have a surface corresponding to the rectangle created by the main face and the wing.

The platform shall be protected from mechanical shocks and thermal aggression.

The weight has to be recorded continuously during the first 60 min of the test. The documentation of the weight over time has to be documented as a weight-time curve in a way that weight of single falling parts can be assessed. Weights of each single part exceeding 1 kg and 5 kg shall be documented. The sum of the weight of all falling parts at the end of the test needs to be documented as well.

In cases where falling parts would eventually fall or bounce of the loadcell platform, their mass should be weighted or estimated separately and added to the recording after the test.
9 TEST PROCEDURE

9.1 General

The test procedure follows the following steps.

- Document the test set-up.
- Confirm that all measurement devices are functioning.
- Determine the environmental conditions (ambient air speed, precipitation and local temperatures).
- Begin data logging and audio-visual recording equipment.
- Ignite the timber crib following the relevant procedure as defined in 10.3.
- Monitor and record the behaviour of the test sample during the full 60 minutes test period.
- Continue to record measurements and observations for the full duration of the test.
- Terminate the test 60 minutes after ignition of the timber crib.
- Record observations of permanent changes to the test specimen once the test is finished.

9.2 Test time

9.2.1 General

The commencement of the test shall be considered the moment when the fire source is ignited (ignition of the strips of soaked fibreboard), see 9.3 for detailed procedure. The elapsed time shall be measured from this point.

The test duration shall be 60 minutes for all fire exposure scenarios.

<table>
<thead>
<tr>
<th>Time (in minute)</th>
<th>Action</th>
<th>Reference Clause</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10</td>
<td>Soak fibreboard ignition strips</td>
<td>9.3</td>
</tr>
<tr>
<td>-5</td>
<td>Insert fibreboard ignition strip into crib</td>
<td>9.3</td>
</tr>
<tr>
<td>0</td>
<td>Ignition of the timber crib</td>
<td>9.3</td>
</tr>
<tr>
<td>60</td>
<td>Termination of test**</td>
<td></td>
</tr>
</tbody>
</table>

* Only for the medium exposure

** Except if the smouldering shall be assessed. If so the test duration is extended according to §9.5.

9.3 Ignition of the fire source

The crib shall be ignited by using 14 strips of low density fibreboard, each strip having nominal length corresponding to the depth of the crib + 30 mm. The width of the strip shall be lower than the space between two consecutive wood sticks, e.g. 25 mm. The strips shall be soaked uniformly in combustible liquid for a minimum of 5 minutes. Not more than 5 minutes before ignition, strips of soaked fibreboard shall be inserted into all spaces between the timber sticks in the second layer of the crib allowing approximately 30 mm to project from the front of the crib. Additional 2 strips shall be laid horizontally and perpendicularly across the projected strip ends.

Ignition of the crib is achieved by igniting only additional perpendicular I strips across their full length.
9.4 Observations

Video records shall be made during the whole duration of tests.

The cameras on the exposed side of the tested façade aims to record the occurrence of any flames, falling parts and other events during the test. It also helps to control the risk of collapse of the test specimen and, more generally, the safety of the test.

When also assessing the junction between floor and façade, the camera at the back face of the tested façade aims to record the occurrence of any sustained flaming. It also helps to control the behaviour of the test rig.

Details and times of significant events shall be recorded during the test such as the change of flaming conditions and any change in the mechanical behaviour of the cladding system shall be recorded, especially the detachment of any part of the cladding system (whether flaming or otherwise) or any fire penetrations through fire stops incorporated within the cladding system.

Areas should be expressed in square meters and lengths in meters or millimetres.

9.5 End of the fire source

The fire in the combustion chamber is not extinguished during the 60 minutes duration of the test.

Only after these 60 minutes, the fire on the test specimen can be extinguished, except if the smouldering shall be assessed. In such case the specimen shall be kept under observation until all thermocouples show a temperature lower than 50°C with a maximum duration of 15 hours after ignition.

9.6 Post-test inspection

Observation of permanent changes of the tested system shall be assessed after the end of the test and have to be documented. Examination of the test specimen shall take place within 24 hours after the test, once the sample has cooled. The examination shall record details of permanent changes, including (but not limited to) spalling, melting, deformation, softening, detachment, charring, discoloration and delamination. The examination shall note size, shape, location and type of permanent changes. Both changes on the surface as well as within any layers or cavities of the system shall be noted. Any collapse or partial collapse of the test specimen shall also be noted.

Areas shall be expressed in square meters and lengths in meters or millimetres.

9.7 Termination of test

The test may be terminated for one or more of the following reasons:

a) flame spread extends beyond the test rig (vertically or horizontally) at any time during the test duration, or if flames pass through the test specimen to the backside of the test rig;

b) there is a risk to the safety of personnel or impending damage to equipment,

c) request of the sponsor,

d) risk of imminent collapse or actual collapse of most of the tested façade,

e) attainment of selected criteria.

When a test has been terminated prior to failure under all of the relevant performance criteria, the reason for termination shall be stated. Regarding the performance criteria which didn't fail prior to termination of the test, the test results shall be given as the time of termination of the test and shall be qualified accordingly.
9.8 Invalidation of the test

The test shall be invalidated when one or more of the following reasons is met during the test (up to its termination at 60 minutes).

9.8.1 Environmental conditions

The validation of test shall be assessed in case of severe changes of environmental conditions during the test. This assessment shall be clearly specified in the test report.

9.8.3 Thermocouple failure

The test shall be invalidated when one or more of the following reasons is met:

- failure of 3 or more thermocouples in the same level and in the same layer on the main wall,
- failure of 2 or more thermocouple in the same level and in the same layer on the wing,
- failure of 4 or more thermocouples in the same column and in the same layer.

9.8.4 Other reasons to invalidate a test

The test shall be invalidated in case of premature collapsing of the crib, i.e. within 15 min after ignition.
10 PERFORMANCE CRITERIA

10.1 Fire spread

This is the time in completed minutes for which the test specimen continues to maintain its ability to limit the propagation of a fire front. The failure of the fire spread performance is deemed to have occurred when one of the criteria below has failed.

10.1.1 Vertical fire spread

The failure of vertical fire spread criterion occurs when any external or internal thermocouple positioned on level 1 exceeds a temperature rise - above its initial temperature - of XXX K. An initial assumption is 500 K. Continuous over a period of 30 seconds during the 60 minutes test period after the start of the test. The time of failure shall be reported as the time at the end of this 30 seconds period; i.e. when the observation is finally made.

10.1.2 Horizontal fire spread

The failure of horizontal fire spread criterion occurs when any external or internal thermocouple positioned on the columns 1 and 2 exceeds a temperature rise - above its initial temperature - of XXX K. Continuous over a period of 30 seconds during the 60 minutes test period after the start of the test. The time of failure shall be reported as the time at the end of this 30 seconds period; i.e. when the observation is finally made.

10.1.3 Burning parts

The burning parts can either be in liquid or solid phase.

The failure of burning parts criterion occurs when a falling part burns for 30 s or longer after hitting the ground.

The time of failure shall be reported as the time at the end of this 30 seconds burning period; i.e. when the observation is finally made.

10.2 Falling parts

Falling parts include all material falling from the test specimen. They are assessed by measuring the mass of the falling parts during the test time with a load cell platform as well as visual observations.

Limits for the mass of falling parts are given below. The time of failure shall be reported as the time at which the falling part touches the ground; i.e. the falling part shall have completely broken off from the façade, without being still hung somewhere.

10.2.1 Falling parts – Level 1

The failure of falling parts (level 1) criterion occurs either when any falling part exceeds 1 kg in mass.

10.2.2 Falling parts – Level 2

The failure of falling parts (level 2) criterion occurs either when any falling part exceeds 5 kg in mass.
10.3 Façade-to-floor junction (optional)

10.3.1 Integrity

This is the time in completed minutes for which the façade-to-floor junction continues to maintain its separating function by preventing the occurrence of flames on the unexposed side of the junction. The failure of the integrity performance is deemed to have occurred when the criterion below has failed.

The failure of the sustained flaming criterion occurs when continuous flaming is observed on the unexposed side of the junction for a period of time greater than 10 s. The time of failure shall be reported as the time at the end of this 10 seconds period; i.e. when the observation is finally made.

10.3.2 Insulation

This is the time in completed minutes for which façade-to-floor junction continues to maintain its separating function by restricting the temperature rise below specified levels. The failure of the insulation performance is deemed to have occurred when the criterion below has failed.

The failure of the maximum temperature rise criterion occurs when any thermocouple positioned at the connection between floor and facade (see figures 14-15) exceeds a temperature rise - above its initial temperature – of 180 K.

10.4 Smouldering (optional)

This is the time in completed minutes for which the test specimen continues to maintain its ability to limit the propagation of a combustion without flame and without visible light. The failure of the smouldering performance is deemed to have occurred when one of the criteria below has failed.

10.4.1 Edge damages

The failure of edge damages criterion occurs when the damage of the test assembly by spread of smouldering processes reach the top of the assembly or reach the lateral edges of the test assembly – both have to be assessed after termination of the test.

10.4.2 Maximum temperature

The failure of maximum temperature criterion occurs when a temperature of higher than 50 °C is measured at any of the thermocouples at the end of the 6 hours period after beginning of the test.
11 TEST REPORT

A test report is to be written describing the execution and the results of the test. The report shall contain the following information and data:

a) Name and address of the test laboratory

b) Date of the test and date of issue of the test report

c) Name and address of the sponsor of the test

d) Applied fire exposure (medium or large) and detailed data describing the wood crib

e) Installation and assembly of the test specimen
   - Description of the supporting construction, if used
   - Mounting (directly on the structural frame or on a supporting construction)
   - The secondary opening

f) Description of the façade system tested including (see chapter 6):
   - Name and type of the products used, dimensions, form
   - Properties of the materials used, nominal and measured values,
   - All elements included in the system such as fixing types, specifications, installation density (i.e. number per m² and layout patterns of fixings, coverage and type of application of adhesive etc.)
   - The position of all components in the system
   - Design of construction details such as lintel, joints, edges, openings, expansion joint details, fire stops, cavity and fire barriers

g) Position of the external and internal thermocouples

h) Environmental conditions (see chapter 5). For indoor tests: changes of ventilation and incoming air during the test. For outdoor tests: changes of wind speed and direction during the test. Assessment of the validation of results in case of changes of weather during the test for outdoor test or change of ventilation for indoor tests.

i) Visual observations and photographs including the time during the test such as:
   - flame spread extends beyond the test rig (vertically or horizontally)
   - visual flame spread on the surface of the test specimen, burning through joints or showing flames at the outer edges of the test specimen
   - occurrence of burning debris of the test specimen including time and duration of burning
   - occurrence, duration and extent of a secondary fire on the floor of the test rig caused by burning debris
   - occurrence time, dimensions and amount of falling parts
   - changes of the test specimen during the tests like deformations, colourations or delamination’s
   - visual description of the smoke development

j) Permanent changes to the test specimen (see chapter 9.6) once the test is finished, both on the surface and inside the test specimen

k) Graphs of temperatures versus time measured by all individual thermocouples
1) The test results stated in terms of the elapsed time, in completed minutes, between the commencement of the test (as defined in chapter 9.2.1) and the time of failure with respect to the relevant performances and criteria (as defined in chapter 11), including:

1) the fire spread performance and its vertical fire spread, horizontal fire spread, and burning parts criteria
2) the falling parts (level 1) performance
3) the falling parts (level 2) performance
4) the façade-to-floor junction (integrity) performance, if assessed
5) the façade-to-floor junction (insulation) performance, if assessed
6) the smouldering performance, if assessed, and its edge damages and maximum temperature criteria

In addition, when the test has been terminated prior to failure under all of the relevant performance criteria:

− the reason for termination shall be reported,
− the performance criteria which didn't fail prior to termination of the test shall be reported as stated in chapter 9.7.

The results shall be presented as follows:

<table>
<thead>
<tr>
<th>Performance</th>
<th>Criterion</th>
<th>Test result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire spread</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vertical fire spread</td>
<td>...... minutes</td>
</tr>
<tr>
<td></td>
<td>Horizontal fire spread</td>
<td>...... minutes</td>
</tr>
<tr>
<td></td>
<td>Burning parts</td>
<td>...... minutes</td>
</tr>
<tr>
<td>Falling parts - Level 1</td>
<td></td>
<td>...... minutes</td>
</tr>
<tr>
<td></td>
<td>Falling parts (level 1)</td>
<td>...... minutes</td>
</tr>
<tr>
<td>Falling parts - Level 2</td>
<td></td>
<td>...... minutes</td>
</tr>
<tr>
<td></td>
<td>Falling parts (level 2)</td>
<td>...... minutes</td>
</tr>
<tr>
<td>Façade-to-floor junction - Integrity</td>
<td></td>
<td>...... minutes / Not assessed</td>
</tr>
<tr>
<td></td>
<td>Sustained flaming</td>
<td>...... minutes / Not assessed</td>
</tr>
<tr>
<td>Façade-to-floor junction - Insulation</td>
<td></td>
<td>...... minutes / Not assessed</td>
</tr>
<tr>
<td></td>
<td>Maximum temperature rise</td>
<td>...... minutes / Not assessed</td>
</tr>
<tr>
<td>Smouldering</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Edge damages</td>
<td>...... minutes / Not assessed</td>
</tr>
<tr>
<td></td>
<td>Maximum temperature</td>
<td>...... minutes / Not assessed</td>
</tr>
</tbody>
</table>

m). The date and the main results of the last calibration performed on the test bench according to Annex A

n) A statement of invalidity of the test in case where the test is invalidated for one or more of the reasons given in chapter 9.8. This statement shall include the reason(s) invalidating the test and the test time from which the test is invalidated.

o) The field of direct application of the results for the specimen being evaluated, either in the form of the full text from chapter 12, or only those clauses which are relevant for the tested specimen. A field of application can only be granted in cases where the tested façade has achieved at least one of the classifications provided in chapter 13. Otherwise, the dedicated section in the report shall mention "Not applicable".
p) The following statements:

“This report details the method of construction, the test conditions and the results obtained when the specific façade system described herein was tested following the procedure outlined in the assessment method xxxxxx (official reference of the assessment method once published). Any significant deviation with respect to size, constructional details, stresses, edges or end conditions other than those allowed under the field of direct application in the relevant section of the method is not covered by this report.

Because of the nature of fire testing and the consequent difficulty in quantifying the uncertainty of measurement of fire performances, it is not possible to provide a stated degree of accuracy of the result.”

q) Signature(s) of the responsible staff(s) of the testing laboratory

As annexes the following shall be added to the test report:

a) Illustrations / drawings of:
   - test assembly
   - constructive design of specific details of the test assembly
   - position of all thermocouples on the test specimen for measuring the temperatures

b) Photo documentation: description of the test course by significant pictures at special time points

The video of the test shall be archived by the test laboratory.
12 DIRECT FIELD OF APPLICATION

Note: It is currently too early to define a set of direct field of applications (DIAP). Later when more information is available the DIAP can be defined in more detail. The following gives examples on what can be considered in the DIAP. The question on when the full external wall or only a part of the wall, or a cladding system is enough, needs to be tested has not yet been decided. Some kind of definition will be needed, especially for the field of application. Such definition could be that the system shall be mounted on a wall with an outer layer of class A and a protection of $K_e 30$, or something similar.

The results of the fire test are directly applicable to similar constructions where one or more of the changes listed below are made and the construction continues to comply with the appropriate design code for its stiffness and stability:

a) decrease in distance of fixing centres;
b) increase in the number of horizontal joints, of the type tested, when tested with joints;
c) increase in the number of vertical joints, of the type tested, when tested with joints;
d) the width of an identical construction may be increased if the dimensions of the tested specimen were at least the minimal size specified in § 6.1 provided joints were tested and provided distance of fixing centres is not increased;
e) the height of the construction may be increased
f) an insulation of Euroclass A2 can be replaced with an insulation of Euroclass A1 if the thickness and density is the same
g) an insulation of Euroclass E can be replaced with an insulation of Euroclass B, C or D if the thickness and density is the same
h) any kind of frame can be fitted around openings (like windows) if the test has been performed without any frame to protect the edge of the façade system at such openings (see Annex B)
i) the width of the construction may be decreased
j) the height of the construction may be decreased
13 Classification

The classification for "limited fire spread" is based on two performances (fire spread and falling parts) on the one hand, and on the two possible fire exposures (medium and large) on the other hand, which combination leads to the definition of the following classes.

13.1 Performance classes

13.1.1 LS - Fire spread under large fire exposure

Fire spread under large fire exposure is the ability of the specimen to limit the propagation of a fire front, according to the fire spread performance (see 11.1), when exposed to a large fire exposure, for the whole 60 minutes duration of the test.

13.1.2 MS - Fire spread under medium fire exposure

Fire spread under medium fire exposure is the ability of the specimen to limit the propagation of a fire front, according to the fire spread performance (see 11.1), when exposed to a medium fire exposure, for the whole 60 minutes duration of the test.

13.1.3 F1 – Falling parts (level 1)

Falling parts (level 1) is the ability of the specimen to prevent falling part, according to the falling parts performance for 1 kg (see 11.2), for the whole 60 minutes duration of the test.

13.1.4 F2 – Falling parts (level 2)

Falling parts (level 2) is the ability of the specimen to prevent falling part, according to the falling parts performance for 5 kg (see 11.2), for the whole 60 minutes duration of the test.

13.2 Declaration of classification of performance

The classification of performance shall be given as a combination of the classes above. It shall always begin with a fire spread class (LS or MS), eventually followed by a falling parts class (F1 or F2). The different possible declarations of classification are listed in Table 2.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS F1</td>
<td>Large fire exposure test fulfilling fire spread and falling parts (F1) during the full test (60 minutes)</td>
</tr>
<tr>
<td>LS F2</td>
<td>Large fire exposure test fulfilling fire spread and falling parts (F2) during the full test (60 minutes)</td>
</tr>
<tr>
<td>LS</td>
<td>Large fire exposure test fulfilling fire spread but not falling parts during the full test (60 minutes)</td>
</tr>
<tr>
<td>MS F1</td>
<td>Medium fire exposure test fulfilling fire spread and falling parts (F1) during the full test (60 minutes)</td>
</tr>
<tr>
<td>MS F2</td>
<td>Medium fire exposure test fulfilling fire spread and falling parts (F2) during the full test (60 minutes)</td>
</tr>
<tr>
<td>MS</td>
<td>Medium fire exposure test fulfilling fire spread but not falling parts during the full test (60 minutes)</td>
</tr>
</tbody>
</table>
Note: Due to the presence of the burning parts criterion (see 11.1.3), no fire spread performance (neither LS, nor MS) can be declared as soon as a falling part burns for 30 s or longer after hitting the ground. As a consequence, in such a case, no classification at all can be declared.

It is assumed that a test result which satisfies the requirements for a given classification will also satisfy the requirements of a less severe classification. The list below gives the allowed classes coverages:

- LS covers MS;
- F1 covers F2.

Any other classes coverage is not permitted.

13.3 Classification report

The classification report shall contain the following information and data:

a) nature of the classification report: fire performance of a façade system;

b) identification number and date of the classification document;

c) identification of the owner of the classification document;

d) identification of the organisation issuing the classification document;

e) details of the type and function of the classified element or product classification, including its commercial name;

f) detailed description of the product/element:

Either reference shall be made to a detailed description of the element(s) or product as available in one of the test reports and/or the extended application report(s) in support of this classification, or a detailed description shall be reproduced in this classification document. The detailed description shall include a full description and identification of all relevant components, the method of assembly etc.

It shall also list all relevant technical specifications applicable to the whole or parts of the classified product or element;

g) test(s) and extended application(s) carried out:

i) All test reports and extended application reports used in support of this classification shall be identified by:

- name of the laboratory carrying out the tests;
- name of the sponsor;
- test and test report identification number.

ii) Identification of the tests carried out in accordance with this European Standard and the relevant field of application.
iii) Detailed test results for each test specimen and each test condition and/or extended application results for all relevant criteria involved in the classification, including the stresses in the suspension devices.

h) Classification and field of application:
   - reference to the relevant classification procedure in this European Standard,
   - classification of the construction element or product;
   - detailed description of the field of application of this classification document.

i) Additional statements:
   - any restrictions on the duration of the validity of this classification report;
   - warning ‘This European Standard does not represent type approval or certification of the product’
Figure 16. Designation and localisation of the main concepts for the large fire exposure test.
ANNEX A  CALIBRATION OF THE HEAT EXPOSURE (INFORMATIVE)

A test bench calibration record is to be maintained and the test bench is to be recalibrated after completion of any repair that could alter the flame distribution, air supply conditions and any other parameters impacting the heat exposure.

The calibration shall be made on an inert façade, like for instance the structural steel frame with the supporting construction. The following measurements shall be performed to characterize the heat exposure:

- Temperatures by means of plate thermometers, according to EN 1363-1, placed on the inert main wall in central axis of the combustion chamber,
- mass loss rate of the crib,
- The measured temperatures shall be within the given tolerance (limit lines) during the first 30 minutes of the calibration test. The ambient temperature, air speed, relative humidity shall be recorded before and along the calibration test.

  Note: Full details on the calibration procedure will be defined after the round robin tests.
ANNEX B  MOUNTING OF TEST SPECIMEN AT OPENINGS (NORMATIVE)

This annex explains how the detailing around openings shall be implemented, namely the combustion chamber opening and the secondary opening.

Different standard configurations are identified below, based on how framed features (like windows or ventilation grid) are mounted in practice. For each standard configuration, when relevant, two testing options are proposed: mounting without any frame or mounting with a frame. When testing without frame, not only the frame should be removed, but also any detailing that implicitly accompanies the frame, i.e. whose presence results from the presence of the frame (e.g. fixings, caulking, sealants, edging profiles...). When testing with a frame, the frame and all its accompanying detailing used to protect the edge of the façade system shall be the same than the one used in practice.

When the practical façade system doesn't correspond to any of the standard configuration below, it shall be tested in the real configuration in which it is intended to be used and shall include the frame used in practice.

When the test setup includes a frame, whether in standard or real configuration, the feature which is normally present in the frame (like glazing or grid) shall not be installed.

Note: The figures below illustrate the configurations for secondary opening, which include a backing board classified A1 according to EN 13501-1 (see 7.2). The figures also apply for combustion chamber opening except that no backing board shall be placed.

Case 1

Building practice

- The feature is mounted within the wall on which the façade system is applied and doesn't flush with the wall on the outside of the building (see figure C.1), AND
- the façade system extends inside the opening, AND
- the frame is used to protect the edge of the façade system.

Test setup

In this case the test specimen is mounted on a supporting construction (see chapter 6.6). The façade system shall extend a minimum of 25 mm into the opening. A frame can be used or not. In the case where no frame is used, there shall be a distance of at least 25 mm from the façade system to the backing board.

<table>
<thead>
<tr>
<th>Without frame</th>
<th>With frame</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Figure C.1 Case 1 without frame" /></td>
<td><img src="image" alt="Figure C.1 Case 1 with frame" /></td>
</tr>
</tbody>
</table>

Figure C.1 Case 1
Case 2

Building practice

- The feature is mounted within the wall on which the façade system is applied and doesn’t flush with the wall on the outside of the building (see figure C.2), AND
- the façade system extends inside the opening, AND
- the frame is not used to protect the edge of the façade system.

Test setup

In this case the test specimen is mounted on a supporting construction (see chapter 6.6). No frame is used. The façade system shall extend a minimum of 25 mm into the opening, and there shall be a distance of at least 25 mm from the façade system to the backing board.

Figure C.2 Case 2
Case 3

Building practice

- The feature is mounted within the wall on which the façade system is applied and doesn’t flush with the wall on the outside of the building (see figure C.3), AND
- the façade system does not extend inside the opening (i.e. flush with the wall), and consequently the frame is not used to protect the edge of the façade system.

Test setup

In this case the test specimen is mounted on a supporting construction (see chapter 6.6). No frame is used.

Figure C.3 Case 3
Case 4

Building practice

• The feature is mounted flush with the wall on the outside of the building (see figure C.4), AND
• the façade system does not extend inside the opening (i.e. flush with the wall), AND
• the frame is used to protect the edge of the façade system.

Test setup

In this case the test specimen is mounted on a supporting construction (see chapter 6.6). A frame can be used or not.

Figure C.4 Case 4
**Case 5**

Building practice
The feature is mounted inside the thickness of the façade system, which presents a protrusion onto which the feature leans (see figure C.5). Consequently the frame is used to protect the edge of the façade system.

Test setup
In this case the test specimen is generally mounted on a structural frame, and sometimes on a supporting construction (see chapter 6.6). A frame can be used or not. In the case where no frame is used, there shall be a distance of at least 25 mm from the façade protrusion to the backing board.

---

**Figure C.5** Case 5
Case 6

Building practice
The feature is mounted inside the thickness of the façade system, which doesn't present any protrusion facing the feature (see figure C.6). Consequently the frame is used to protect the edge of the façade system.

Test setup
In this case the test specimen is generally mounted on a structural frame, and sometimes on a supporting construction (see chapter 6.6).
ANEX C   FAÇADE-TO-FLOOR JUNCTION (INFORMATIVE)

The assessment of the junction between floor and façade as potential weak point may be required in some cases. It concerns the façade systems installed directly connected to floors of a building.

The objective of this optional test procedure is to ensure that the fire cannot spread from one storey to the next superposed storey through the junction. The way to fulfil this objective is to assess the integrity and the insulation of the junction during the façade test.

The following arrangement shall be implemented to assess this junction during the façade test:

- the roof of the combustion chamber shall be replaced by the representative floor intended to be used in practice (aerated concrete, armoured concrete, timber... including any details like ceilings, seals...) and with the same thickness or smaller (see figure 10),

- the tested façade may be extended down the upper edge of the combustion chamber to allow implementing any junction detail as in practice; anyway, this extension shall not exceed 200 mm (see figure 10).

In the neighbouring of the floor, the structural steel frame shall be protected by fire blanket.

Care should be taken in the possible failure of the junction during the test.

Such test configuration allows thus to:

- observe - from behind the test rig - the behaviour of the façade at the junction to check integrity failure,

- add some thermocouples to check any insulation failure.