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European approach to assess the fire performance of façades

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SUMMARY

Several attempts have been made in the past to develop a European harmonized testing and assessment method for façades before the European commission decided to publish a call for tender on the topic. A project consortium from five countries (Sweden, UK, France, Germany and Hungary) applied to the call for tender and was contracted to develop a European approach to assess the fire performance of façades. 24 sub-contractors and 14 stakeholder entities were part of the project. The objective of the European project was to address a request from the Standing Committee of Construction (SCC) to provide EC Member States regulators with a means to regulate the fire performance of façade systems based on a European approach agreed by SCC. The initial stages of this project were focused on establishing a register of the regulatory requirements in all Member States in relation to the fire performance of façade systems, and to identify those Member States who have regulatory requirements for the fire performance façade systems which go beyond the current EN 13501 (reaction to fire and fire resistance) classification systems and to collate the details of these additional requirements. After having confirmed the regulatory needs a testing and classification methodology based on BS 8414 and DIN 4102-20 was developed to address the identified key performance and classification characteristics. This paper is a short overview of results the two-year development work, which Final Report published by the European Commission in 2018.

KEYWORDS

facade, regulation, testing

1 | INTRODUCTION

As identified by the Invitation To Tender (ITT), the primary objective of this project is to develop a common method to allow the assessment of the fire performance of façade systems. The assessment is a full-scale assessment of façades to catch effects of details such as mounting, fixing, air gaps, lengths, singularities and weak points such as windows. In this context, assessment based only on reaction to fire and/or fire resistance provisions is not necessarily enough.[1,2]

The initial stages of this project were focused on:

- establishing a register of the regulatory requirements in all Member States in relation to the fire performance of façade systems, and
- to identify those Member States who have regulatory requirements for the fire performance façade systems which go beyond the current EN 13501 (reaction to fire and fire resistance) classification systems and to collate the details of these additional requirements.[3]

After having confirmed the regulatory needs the following steps were discussed:

- a testing and classification methodology based on BS 8414—Fire performance of external cladding systems series and DIN 4102-20—Fire behaviour of building materials and building components—Part 20: Complementary verification for the assessment of the fire behaviour of external wall claddings to address the identified key performance and classification characteristics.[4,5]
- a verification and validation proposal, in the form of a round robin programme to support the development of the proposed testing and classification methodologies.
- an Alternative assessment method which was developed on the basis of the comments from stakeholders during the project

Several hundreds of comments were received during the project and were implemented in the development.

The results of the workshops and seminars on the topic which have been held within Europe in the past 10 years, identify that the most difficult and important part of the task is the definition of a classification system which is acceptable by all Member States accounting for their national regulations and meeting the requirements of the Construction Products Regulation (CPR).[6] The classification system should be transparent and should fit within the framework of existing national regulations, and should be as simple as possible, for example, using the minimum number of classes required to enable Member States to effectively maintain their required safety levels. It has also been identified that the assessment method should be applicable to the wide range of façades systems available in the market including glazed façades, green façades and other emerging technologies.

Both the work from the EOTA PT4 façade testing task group and an EGOLF workshop held in October 2015 sought to collect data and experience on the current national regulations and test methodologies used in Europe. Both activities generated outlines for the development of possible classification systems and this experience has been used as part of this project. Key areas missing from the earlier studies included:

- The consideration of a façade kit as a construction product.
- The consideration of a façade as a part of a specific building. In some national regulations this would mean that detailing such as window openings may also need to be considered.
- How to manage direct applications and extended applications including whether the performance of the façade system can be based on the fire characteristics of single components within the façade system.
- Fire scenario identification for each of the Member States that regulate for the fire performance of the façade system based on alternative assessment methods.

Both, the *Proposed* and the *Alternative assessment method* have been developed from the data collected during the project and the findings from the associated workshops and meetings presented in this report. The methodology and associated findings provide the basis on which the tasks outlined in the ITT have been addressed.

These approaches are also designed to enable regulators to review local building regulation requirements to ensure required safety levels can be maintained and allow industry to have a clear understanding the scenarios and classification methods proposed for determining the classification of fire performance for façade systems.

This paper is a short overview of results of the two-year development work, which Final Report was published by the European Commission in 2018.[7]

2 | LIMITATIONS

It has not been possible to include measurements for all characteristics identified as part of the initial regulatory survey. The proposed assessment methods were developed to produce working assessment methodologies that can be presented to the European standards making body (CEN) as baseline documents for potential development into a European method for the assessment of the fire performance of façades.

The baseline test methods were defined in the ITT as the BS 8414 series and DIN 4102-20 protocols. It was therefore decided to investigate the differences between the prescribed methods and the other test methods used in the Member States, and to define whether any changes were required to the predefined methods to fulfil the requirements of the regulations in the Member States. Examples of modifications to the predefined methods included variations to the size of the test assembly, inclusion of a secondary opening, junction detailing between façade and floor and some performance criteria.

It has not been possible to find published comparable information on the key performance characteristics such as heat exposure to the test specimen for all the currently available test methods, so it has not been possible to undertake any comparisons on these key parameters between the proposed methods with other test methods currently used in the Member States as part of this project.

Another important factor that could affect the repeatability and reproducibility of the proposed methodology is the environmental conditions under which testing takes place. Both BS 8414 series and DIN 4102-20 testing in Europe takes place within laboratory buildings fitted with suitable extracts. Many of the alternative test methods currently in use are undertaken outside. For the Proposed assessment method, the tests have to be performed indoors or at least in an environment where the ambient conditions are kept within certain limits during the full extent of a test.

However, the *Proposed assessment method* will lead to a considerable number of tests for one product to be sold throughout in Europe because of the optional character of additional requirements for certain Member States, especially when the product is to be used in Member States who have additional requirements not covered by DIN 4102-20 or BS 8414. That was the reason to propose an *Alternative assessment method* which combines as many options as possible in one test method.

The measurement and classification system presented does not address smoke or toxicity parameters as smoke classification is

partially addressed by EN 13501-1 and the survey findings showed that most Member States do not consider them relevant to the façade fire performance objectives.

3 | REGISTER OF REGULATORY PROVISIONS

At the request of the SCC the project was established to provide a proposed European harmonized approach to the fire performance assessment and classification for façade systems. In order to ensure a clearly defined baseline was available on which to base this proposed approach and to capture all relevant regulatory data and experiences a concise and complete register of the regulatory provisions of all EU/EFTA Member States which have regulations on the obligatory assessment of construction products used to build façades was created.

The survey form circulated to each Member State representative sought to obtain information on the regulatory provisions for that country based on:

- A working definition for the term façade, and
- Details of the regulatory requirements including any alternative test or classification methods.

Definition of façade: The definition of a façade can be wide ranging, varying from the outer skin of a building to the complete exterior wall structure. It is therefore important that a common understanding of the term façade is obtained. In the enquiry the following working definition for façades was suggested:

"A complete external wall construction of any type (massive wall or curtain wall …etc.) or constitution (masonry, combustible material …etc.)."

The respondent was asked whether this definition adequately covered any national definition according to their building regulations. If it did not, they were asked to provide a suitable definition according to their national regulations.

The results show that the term façade is only rarely used in the regulations. More frequently are the terms "external wall", "cladding", or similar used. The proposed definition, with some fine tuning, was acceptable for most countries: of 24 countries 12 countries answered with "yes"—this working definition is in accordance to their national system, four answered that this definition suits their national system—even if it is not implemented yet. Swiss, German and Austrian regulations distinguish between the exterior wall and the cladding for which different requirements exist. The Swedish regulations refer to the exterior wall. The Belgian regulations refer to external wall construction of any type or constitution without any loadbearing function.

All countries have regulations and/or guidance governing the fire performance of façades. These regulations are mainly covered by the existing European system on reaction to fire and fire resistance.

Fourteen countries stated that they have additional requirements that are not covered by the EN 13501-1 reaction to fire and/or EN 13501-2 fire resistance classification system. For some countries it is clearly stated that a specific test method shall be used but for other countries the regulation enables the use of performance based testing at medium or large scale to demonstrate performance against the requirements of the regulations.

A total of 12 different test methods have been identified as being either currently in use, or referenced in the regulations, throughout Europe. The different test methods, and the countries using them, are presented in Table 1.

During the final drafting stages of the project report, information was received from Italy in relation to a recently finalized national fire performance assessment method for façades. Therefore, it has not been fully assessed within the scope of this project.

4 | COMPLEMENTARY VERIFICATIONS

As part of the regulatory survey the group also sort to identify any verification or assessment which are recorded in the register (and thus a part of the regulatory needs of the EU/EFTA Member States).

All participating countries have been asked during the inquiry whether they have additional requirements for the fire performance of façades which are not covered by the already harmonized methods according to EN 13501-1 and 2. 14 of 24 European countries answered that they have additional requirements. The main purposes of these requirements are:

- Limitation of fire spread on the surface and inside the façade system
- Demonstration of fire performance for systems which do not follow or cannot meet the fire performance characteristics for individual components, for example, insulation which does not fulfil required reaction-to-fire class

TABLE 1 Test methods used in Europe and countries using them[8-16]

Test methods	Countries using the test method
PN-B-02867:2013	Poland
BS 8414-1:2015 and BS 8414-2:2015	UK, Republic of Ireland
DIN 4102-20	Switzerland, Germany
ÖNORM B 3800-5	Switzerland, Austria
Prüfbestimmung für Aussenwandbekleidungssysteme	Switzerland/Lichtenstein
Technical regulation A 2.2.1.5	Germany
LEPIR 2	France
MSZ 14800-6:2009	Hungary
SP Fire 105	Sweden, Norway, Denmark
Engineering guidance 16 (unofficial test method)	Finland
ISO 13785-2:2002	Slovakia
ISO 13785-1:2002	Czech Republic

- Requirement regarding fire spread through façades from one room to another (external surface but also through cavity, façade floor-junction)
- Limitation or avoidance of falling parts and/or burning debris/droplets
- Limitation of smouldering fires

These additional requirements are covered by 12 different test methods which are in use in Europe. Four of the test methods are defined as medium heat exposure and all other are defined as large heat exposure tests. Two of the tests take fires from outside of the building into account (external fire) while all other test methods have fire scenarios representing fire inside the building and the impact on the façade of flames emerging from an opening.

The following list summarizes the targets addressed by the façade tests in use:

- Flame spread—vertical and horizontal, surface and within the system
- Fire spread from one room to another (above)
- Junction between façade and floors
- Windows
- Detailing around window openings
- Smouldering
- Falling parts
- Smoke
- Heat
- Fire from inside
- Fire from outside
- Permanent changes to the system (assessed after the test)

Four of the methods are medium scale, and the remaining eight are large scale.

Three similar medium scale tests (DIN 4102-20, ÖNORM B 3800-5 and ISO 13785-1) are based on the fire scenario of a developing fire inside the building and the impact of flames emerging the opening on the lintel and the façade immediately above the opening. The fourth medium scale test (PN-B-02867, used in Poland) addresses the fire from outside the building.

The other eight tests in use are large scale tests, seven are addressing a fully developed fire inside the building with flames emerging the opening, and one test addresses the fire from outside the building.

Six test methods in use have a test rig with a single wall and five have a corner configuration and one has two wings.

Part of this task consists of an evaluation of the possibilities to cover the complimentary requirements which are in use at present and covered by the national tests with either DIN 4102-20 or BS 8414 series test protocols: An inquiry was sent to the Member States who have additional requirements for the fire behaviour of façades to requesting information on the scope of their methods, data of measured temperatures and heat fluxes to the wall of the test rig (without specimen) and an assessment of whether the needs of the Member State can possibly be fulfilled with either the DIN 4102-20 or the BS 8414 series tests.

Switzerland and Lichtenstein have requirements on how tests are to be assessed if they are conducted according to DIN 4102-20 to be used to fulfil Swiss regulatory needs. Austria uses the DIN 4102-20 test rig but has a slightly different fire load and temperature measurement locations. The fire performance criteria also differ from those presented in DIN 4102-20. Both the DIN 4102-20 and the BS 8414 series are with wing configurations. The wing configuration is often referred to as the more severe configuration than a single wall configuration. Five national test methods use a single wall configuration.

The BS 8414 series and DIN 4102-20 test rig configurations have a fire scenario which represents a fire plume exiting an opening in the face of the building and laying back on to the face of the façade system in the area immediately above the opening. As part of the round robin test program it has been suggested that the impact of the fire load being placed directly in contact with the surface of the façade to be considered, representing an external fire load such as a rubbish bin being placed in contact with the external surface.

The size of the fuel sources in the national tests differ significantly, for example, wood cribs in use range from 20 to 650 kg. However, the temperatures reached at different heights and the heat flux to the specimens (and the area where a certain level is reached) are not only dependent on the size of the fuel source but depend as strongly on the fire scenario as location of the fire source, ventilation and geometry of the test. Of significance to address is the needs to fulfil the national requirements are the exposure of the specimen. Therefore, it is important to compare temperature and heat flux levels in the different test methods to assess the severity of the tests and this will be investigated further as part of the round robin testing and will assist regulators in assessing the appropriate levels of performance between current and proposed methodologies.

Information on heat exposures to the test specimen of all methods used has been asked for, but very limited information has been obtained. Since very little information has been obtained on the heat exposure to the specimen, and the available information has been measured differently, it is not possible to compare the different methods.

5 | FALLING PARTS

As identified in the survey Some Member States have requirements for falling parts and burning debris/droplets to be assessed. These requirements appear to reflect two safety goals:

- The protection of escape routes and the rescue services.
- The prevention of secondary fire arising from burning debris/droplets.

The robustness of façade systems with respect to falling off and burning debris/droplets is also required in some countries. The national requirements are defined differently, in some cases directly in

the regulations and in other it is specified in the test methods. The requirements are also specified differently from very specific measurable quantities to quite loosely defined outputs such as "*no large pieces shall fall down*". The requirements used in Europe are summarized in Table 2.

The requirements can be grouped into three main categories, criterion related to weight, area or requirement not expressed with measurements. The falling pieces are difficult to measure during (or after) test due to the time factor and damage of falling pieces. A time independent solution is needed which provides evaluation method of falling pieces before the large pieces reach the ground.

6 | COMPARATIVE ANALYSIS

A detailed comparison of the 10 alternative test methods against the BS 8414 series and DIN 4102-20 methods based on key physical and performance characteristics shows that while there are many similarities between the approaches used, a quantification of the influence of all the differences was not possible as part of this project despite trying to gain additional supporting data from the consortium and sub-contractors who have experience of these test methods and this matter has been identified as requiring further investigation as part of future studies.

TABLE 2 National requirements on falling off and burning debris/droplets

Country	Requirement	Method
Austria	No more than 5 kg or more than 0.4 m^2	ÖNORM B 3800-5
Denmark, Norway, Sweden	There may not be any large pieces falling down from the façade	SP Fire 105
Finland	No pieces of the specimen (parts of wall) in excess of 0.1 m^2 shall fall down	Engineering guidance 16
Germany	Falling parts recorded, burning and non-burning, including origin of a second fire on the floor	DIN 4102-20
UK, Republic of Ireland	Spalling, delamination or flaming debris is recorded and should be considered as part of the overall risk assessment when specifying the system. Burning debris and pool fire.	BS 8414 series
Greece	Falling parts recorded	SBI reaction-to-fire test
Hungary	Heavier falling part than 5 kg	MSZ 14800-6
Poland	Falling flaming parts	PN-B-02867
Switzerland, Lichtenstein	Falling parts recorded including the type and size of the parts and the location of occurrence	DIN 4102-20/ ÖNORM B 3800-5

A simple analysis of the basic geometry of the test rigs show that both the BS 8414 series and DIN 4102-20 test rigs are fundamentally identical with respect to size and geometry and neither use secondary openings above the fire source as part of the test configuration. The primary differences with the alternative test methods can be summarized as:

- The width of the test rigs used is generally larger. The only exception is the Polish PN-B-02867 method.
- Most test rigs are equal or higher, with the exceptions of PN-B-02867 and MSZ 14800-6.
- Only one other method that uses a wing and that wing is considerably larger.
- Four methods have windows or secondary openings included in the test rig, LEPIR 2, MSZ 14800-6, SP Fire 105 and Engineering guidance 16.
- LEPIR 2 and MSZ 14800-6 are using compartments on two levels

Table 3 shows a summary on the regulatory characteristics currently used in the Member States with additional requirements. In light grey both the BS 8414 series and DIN 4102-20 with their characteristics are shown. As can be seen clearly some of the requirements of Member States are not covered by either BS 8414 or DIN 4102-20 nor by a combination of both. Namely, these regulation characteristics are junction between floor and façade, heat (through temperature or flux) and detailing. These characteristics are therefore marked in dark grey.

Heat flux and other temperature measurements are made with the SP Fire 105 method. The heat flux in a window one floor above the combustion chamber is regulated in the Swedish building code for buildings with 16 or more floors. There is also a requirement on the temperature at the eave, 2.5 floors above the combustion chamber.

It is clear that the national tests can be divided into two regimes, medium fire exposure and large fire exposure (often defined as medium size test and large scale test). In the large scale tests wood cribs are generally used and the amount on wood varies from 400 kg up to 650 kg. Also, in the medium scale tests wood cribs are generally used and the amount varies from 20 kg up to 50 kg. In addition to the different amounts of fuel, the specific surface and the porosity of the wood cribs varies which affects the fire.

In the SP Fire 105 method heptane is used as fuel which in the configuration used gives a very rapid temperature increase compared to that of wood cribs. The maximum heat release is of the same magnitude as the other large scale tests, but the duration is shorter. It should also be noted that the smoke density is different depending on the fuel, while gas burners generally gives a cleaner smoke heptane produces a heavy black smoke. The smoke radiates heat to the specimen so depending on the type of smoke the heat exposure to the test specimen may be different.

TABLE 3 Summary of regulatory characteristics[7]

Regulation characteristics	Slovak republic	Hungary	Switzerland	Sweden	Austria	Germany DIN	Germany—technical regulation	Finland	Poland	England & Wales, Scotland, Irelands	France	Denmark-Norway
Flame spread—vertical	x	x	x	x	x	x	x	x	x	x	x	x
Flame spread—horizontal		x	x		x	x	x			x	x	
Flame spread—internal	x		x	x	x	x	x	x	x	x	x	x
Junction between floor and façade		x		x							x	
Smouldering						x						
Falling parts[a]		x	x	x	x	x		x	x	x		x
Smoke[b]				x		x						
Heat (through temperature or flux)		x		x	x							x
Detailing (window openings, fire stop, etc)		x		x							x	x

[a]Falling parts are to be observed in several methods but the regulations on falling parts are very different.
[b]Only to be observed and not assessed.

Another factor that may affect the heat exposure to the test specimen is the geometry and the ventilation conditions of the combustion chamber.

7 | DEVELOPMENT OF A PROPOSED AND AN ALTERNATIVE ASSESSMENT METHOD

Two conflicting goals were identified during the project: on the one hand to use as much of the historical test data as possible and on the other hand to reduce the number of tests. The use of historical data is only possible for countries where either the DIN or the BS tests are already in use. To reach this goal even for these countries the DIN and BS tests have to stay as they are because any change in the standards would conflict with the use of historical data. However, the use of historical data is paid by an increased number of tests because all additional requirements of member states which are not covered by the DIN and BS tests have to be implemented as optional which leads to an increased number of tests to fulfil all requirements in Europe. For the use historical data, the *Proposed assessment method* was developed.

To fulfil the goal of a reduced number of tests the *Alternative assessment method* was developed. For the Alternative assessment method modifications of the test rig and the test procedure were implemented.

In the following the proposals for the fire scenario, size of the test rig, fuel and combustion chamber, secondary opening, junction between façade and floors, test time and classification for both methods is described.

8 | FIRE SCENARIO

Both DIN 4102-20 and BS 8414 series are based on a fire scenario where an initial fire starts in a room and exits through a window opening. The fire is simulating a flash over fire in the compartment. The difference between the DIN 4102-20 and BS 8414 series is that in the DIN 4102-20 a downscaling of the fire load and test rig has been undertaken.

> For both of the methods two fire scenarios are proposed, as prescribed in BS 8414 series and DIN 4102-20, represent a fire exit through a window opening from a room with a fully developed fire. Although fire from outside is a completely different fire scenario it seems possible that the BS 8414 test series can cover external fires up to a certain fire load.

9 | SIZE OF TEST RIG

The size and geometry of test rigs used in the Member States varies to a large degree. It has been judged that a height of the test sample above the lintel of the combustion chamber of 6 m will cover the requirements in the Member States.

> For the Proposed assessment method, the BS 8414 and DIN 4102-20 test rigs are kept as they are. If falling parts/burning debris is to be assessed the complete rig needs to be uplifted, or extended, at least 0.5 m to ensure that the radiation from the combustion chamber not affects the material falling down during the test.

> For the Alternative assessment method, the width and height of the main face and the wing is 3.5 x 7 m and 1.5 x 7 m for the medium fire exposure and 3.5 x 8 m and 1.5 x 8 m for the large fire exposure. Since the height from the floor to the lintel of the combustion chamber is different in the two methods, 1 m for the medium fire exposure and 2 m for the large fire exposure, the heat exposed area will be the same for the two methods. In addition, the complete rig needs to be uplifted, or extended, at least 0.5 m to ensure that the radiation from the combustion chamber not affects the material falling down during the test.

10 | FUEL AND COMBUSTION CHAMBER

Since different amounts of fuel, type of fuel, shape of combustion chamber, and ventilation conditions are used, and very limited data is available on the heat exposure to the test specimen, it is not possible to compare the different test methods. Therefore, it has been chosen to keep the heat source and all specifications around it as it is in BS 8414 series and in DIN 4102-20.

> For both of the assessment methods, the medium and large exposure tests are proposed to use wood cribs and combustion chambers as defined in DIN 4102-20 and BS 8414.

11 | SECONDARY OPENING

In some national test methods are details such as windows or detailing around window openings included and assessed. It is therefore proposed to include a secondary opening in the assessment method to evaluate the detailing of the façade system around openings. In the proposal the secondary opening is moved towards the edge of the main face of the test specimen. This is done in order to be able to evaluate the façade with and without secondary opening during the test. This has not yet been verified and needs to be examined during the next step of the project.

For the Proposed assessment method a secondary opening may be included in the test set-up, to assess the mounting and behaviour of the façade system around openings. The secondary opening is optional in the Proposed assessment method.

For the Alternative assessment method a secondary opening shall be included in the test set-up, to assess the mounting and behaviour of the façade system around openings. This secondary opening is mandatory in the Alternative assessment method.

12 | JUNCTION BETWEEN FAÇADE AND FLOORS

In some national test methods are also details such as the junction between floor and façade included and assessed. It concerns only the façade systems installed directly connected to floors of a building. It is therefore proposed for these specific façade systems to include a junction in the test method in order to evaluate the risk that the fire goes through the junction.

For concerned façade systems, a specific adaptation of the combustion chamber ceiling is done in the test. This measurement and classification is optional for the Proposed assessment method.

For concerned façade systems, a specific adaptation of the combustion chamber ceiling is done in the test. This measurement and classification is optional for the Alternative assessment method.

13 | MEASUREMENT OF FIRE SPREAD

The methods used to evaluate the fire spread in and on the façade system is different in the Member States. The main methods used are visual observations during and after the fire test and temperature measurements at different locations on the test sample. Visual observations shall be avoided as far as possible for measures used for the classification. Measured values give a much better repeatability and reproducibility.

Both BS 8414 and DIN 4102-20 are kept as they are for the Proposed assessment method.

For the Alternative assessment method, a method for determination of flame spread, both vertical and horizontal, is proposed. The method is based on temperature measurements with thermocouples. It is similar as the ones used in BS 8414 and DIN 4102-20, but not exactly the same. The positions of the thermocouples have been altered to some extent. For the assessment of horizontal flame spread has thermocouples been introduced to replace visual observations.

14 | TEST TIME

The time of the fire exposure to the test specimen varies from around 15 minutes up to 45 minutes in the Member States. Furthermore, in some countries is also an additional time used, after the fire source has been extinguished.

The MSZ 14800-6 has a longer duration compared to the proposed methods, as well as the German external fire test method. Two methods have a shorter duration, SP Fire 105 and ISO 13785-2. It would be possible to have both longer and shorter fire exposure times, but that would lead to more classes in the classification system. It has been decided to keep the classification system as simple as possible, based on the comments achieved during the project, and therefore has only the durations given in BS 8414 series and DIN 4102-20 been kept.

The test time is different in the BS 8414 series and the DIN 4102-20 method. Also, the starting time of the test is different.

Test times remain as they are in the BS 8414 series and the DIN 4102-20 method for the Proposed assessment method.

For the Alternative assessment method only one test time is proposed for the large scale and the medium scale test. The heat exposure from the combustion chamber will be 22 for the medium exposure or 30 minutes for the large exposure, after the start time. After this time the fire in the combustion chamber will be extinguished, and an additional 30 or 38 minutes of observations and measurements will be made, that is, a total test time of 60 minutes after the test time has been reached. This needs to be addressed in the coming studies and preferable result in a transparent system where the same procedures and times are used.

As a demonstration in Figure 1, the Alternative assessment method is shown schematically.

15 | CLASSIFICATION

For classification large differences between the *Proposed* and the *Alternative assessment method* exist. The *Proposed assessment method* has been optimized on the use of historical data which has the drawback that the classification system will be more complicated.

The *Alternative assessment method* on the other hand has been optimized to get as few classes as possible, that is, to have a very simple classification system.

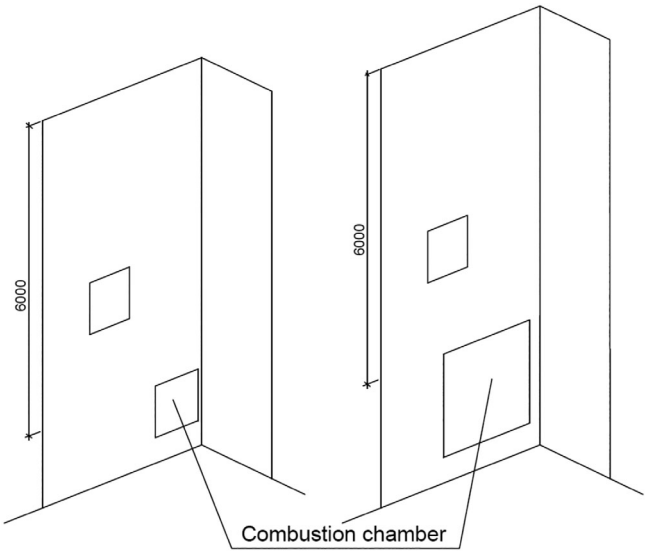

FIGURE 1 Principle drawing of the Alternative assessment method, medium fire exposure represented on the left and large fire exposure on the right

The classification system for the Proposed assessment method contains six different characteristics that may be included in the classification, see Table 4. Only the heat exposure is mandatory, all other characteristics are optional.

The following classes are available for the different fire exposure levels:

LF	J	W	F1	D0
	NPD	NPD	F2	D1
			NPD	NPD

36 different combinations.

MF	S	F1	D0
	NPD	F2	D1
		NPD	NPD

18 different combinations.

For instance, façade systems tested to BS 8414 historically may be classified as LF-NPD-NPD-NPD-NPD, and a façade system tested to DIN 4102-20 may be classified as MF-S-NPD-NPD as long as the test was performed by an accredited laboratory, in an enclosed environment. Note that all NPD's cannot be changed to any other options.

For the Alternative assessment method, a general comment from stakeholders on the classification was followed that a simple system, with as few classes as possible, is desirable. It is judged that is the classification system presented in Table 5.

Some classes in the system will also cover other classes as follows:

TABLE 4 Proposed classification system—proposed assessment method[7]

Feature	Classification	Comment
Heat exposure	LF, MF	LF when a large size fire has been used MF when a medium size fire has been used
Junction	J	Junction between façade and floor
Secondary opening	W	If secondary opening was present and the test successful
Smouldering	S	If smouldering has been considered and the test is successful
Falling parts	F1, F2	If falling parts have been considered and the test has been successful • F1: No part larger than 1 kg and 0.1 m^2 • F2: No part larger than 5 kg and 0.4 m^2
Burning debris	D0, D1	If burning debris have been considered and the test has been successful • D0: No burning debris at all • D1: Limited duration burning debris <20 seconds

TABLE 5 Proposed classification system[7]

Heat exposure	Classification	Comment
Large heat exposure	LS1	Fulfilling requirements on flame spread and falling parts
	LS2	Fulfilling requirements on flame spread, but not falling parts
Medium heat exposure	LS3	Fulfilling requirements on flame spread and falling parts
	LS4	Fulfilling requirements on flame spread, but not falling parts

– A classification in class LS1 also cover classes LS2, LS3 and LS4
– A classification in class LS2 also cover class LS4
– A classification in class LS3 also cover class LS4

16 | DISCUSSION

Throughout the project two assessment methods for fire performance of façades were developed. The *Proposed assessment method* incorporates the nearly unchanged tests BS 8418-1,2 and DIN 4102-20 which allows countries using the test already to go on with relatively minor changes. However, all additional requirements have to be tested as options—leading to a large number of tests. The *Alternative assessment method* incorporates additional requirements of member states leading to a reduced number of tests and a less difficult

classification system. In the following the advantages and disadvantages of both methods are discussed.

The advantages of the *Proposed Assessment method* are

- Historical data can be used for those MS using the BS and DIN methods (in four countries), but there most likely will be stricter limitations on the environmental conditions (tests must be done indoors) the use of historical data can be difficult
- Easy work to make the methods into standards since they already exist

The disadvantages of the *Proposed assessment method* are

- Only a limited number of countries can use historical data
- Difficult to get acceptance by the MS (it did not succeed in the EOTA work)
- More tests will be needed
- The classification system will be complicated—a lot of comments were achieved that this classification system is too complicated
- Increase the work for regulators and industry due to the complexity of the classification system, interpretation of data in relation to the development of potentially new legislation and products
- The large fire exposure test will not cover the medium fire exposure test

The advantages of the *Alternative Assessment method* are

- Minimized the number of tests (one successful test can cover all regulations in Europe)
- Easier to get acceptance by the MS
- The large fire exposure test also covers the medium fire exposure test (limits the test burden for industry), and potentially also the external fire exposure
- Simple classification system
- The test methods will be upgraded with the current knowledge on façade testing

The disadvantages of the *Alternative assessment method* are

- The use of historical data may be limited
- More work is needed to ensure the repeatability and reproducibility of the test methods

In the *Proposed* and the *Alternative assessment method*, two fire scenarios (medium scale heat exposure and large scale heat exposure) were proposed which both represent a fire exiting through a window from a room. The fire exposure in the DIN 4102-20 test is downscaled. BS 8414 test series represents a fully developed fire from a room, and the impact on the façade system. DIN 4102-20 test has a medium scale heat exposure and BS 8418 test series has large heat exposure. Temperatures and heat impact of the medium scale heat exposure close to the lintel appear to be similar to the large heat exposure. The method can be used to assess the lintel as weak point of a façade system.

According the decision of the Commission the *Alternative assessment method* can be the basis of a harmonized system for fire safety of facades in Europe. Advantage of a harmonized test and assessment method in Europe is a reduced number of tests for producers to sell their products in all European countries. At the moment, national regulations are still in place with a variety of different tests and regulations for facades. As different European countries treat exterior walls and façade systems in a completely different way a harmonized assessment method would be the first step to a more unified market in Europe for these systems. The consideration of façade as a construction product or as a part of individual constructions is still open.

17 | NEXT STEPS FOR HARMONIZATION

The next steps of European harmonization are now:

- to perform a second European project which has started in March 2020 with Round Robin tests to assess repeatability and reproducibility of the finally retained Alternative assessment method
- to develop direct field of application based on first result of the Round Robin phase
- to propose extended field of application for façade as a product as well as specific to any building
- to implement the new assessment method into the various Members States regulations, including the documentation needed to justify the fire safety level of facades for specific buildings.

18 | FURTHER STUDIES

Further studies are needed to ensure that the Alternative assessment method method has good enough repeatability and reproducibility. There are several factors that must be studied, such as:

- Effect of environment (especially wind speed and direction).
- Tolerances needed for the fuel (the research community do not agree on the repeatability of wood cribs, especially on the size needed for these types). Factors affecting are timber species, conditioning of the timber, density of the individual timber sticks, dimensions of sticks, amount of timber, and the tolerances needed.
- Mounting of samples and representatives substrates for systems not intended to be mounted on masonery.
- Mounting of thermocouples. There is a disagreement on how to mount the thermocouples in the best way, by drilling through the test specimen, or hanging them from the outside. Both methods have pros and cons. This is also sensitive for measurement of smouldering as new criteria introduced by this work.
- Measurement of heat exposure to the test specimen. It is important that the heat exposure can be reported after a test. There are different options such as measurement of temperature with plate thermometers pointing towards the fire, heat flux gauges measuring the

radiation or mass loss measurement of the fuel source. A suitable method needs to be developed and validated.

– External fire. In some Member States is the external fire scenario used. It may be that the proposed methods would work well also for external fires such wildland fire scenarios or vehicle fires, but this needs to be validated.

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