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FIRE PROTECTIVE PRODUCTS

REACTIVE COATINGS FOR FIRE PROTECTION OF STEEL ELEMENTS

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This European Assessment Document (EAD) has been developed taking into account up-to-date technical and scientific knowledge at the time of issue and is published in accordance with the relevant provisions of Regulation (EU) No 305/2011 as a basis for the preparation and issuing of European Technical Assessments (ETA).

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1 SCOPE OF THE EAD

1.1 Description of the construction product

The construction product is a fire protective coating or reactive coating kit. The products normally comprise the primer for the corrosion protection or as bonding agent, the reactive component and the top coat. The reactive component of such a fire protective product may be an intumescent material, an ablative material, or a combination of both. These reactive materials may be applied in one or in several layers. In some instances a reinforcing mesh is used.

This EAD does not cover

- Factory-coated steel elements, where the 'product' is the element itself.
- Products placed on the market in the form of prefabricated, preformed shells which are applied to structural elements on site.

In this EAD, unless the phrase "Product or kit" is used, the term "product" refers either to the reactive coating sold alone or to the kit.

The product is not covered by a harmonised European standard (hEN).

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise their clients on the transport, storage, maintenance, replacement and repair of the product.

It is assumed that the product will be installed according to the manufacturer's instructions.

Relevant manufacturer's stipulations having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA.

1.2 Information on the intended use(s) of the construction product

1.2.1 Intended use(s)

The fire protective coating product/kit is to be used on steel elements.

1.2.2 Product/kit options

Option 1:

The ETA only covers the reactive coating product. This option can only be used for products that can be used directly on the steel substrate without any primer and/or topcoat.

Option 2:

The ETA covers a reactive coating kit, i.e. in all cases the reactive coating product, and depending on the kit one (or more) primers and/or one (or more) topcoats and/or one (or more) reinforcements. All components need to be characterised, subjected to the assessment and all FPC requirements. The reactive coating kit shall comprise at least two components.

Option 3:

The ETA is issued for a “final assembly”. The ETA only covers the reactive coating product, but one (or more) primers and/or one (or more) topcoats and/or one (or more) reinforcements are also described. This description may be specific (e.g. trade name, type) or generic (e.g. family of primers). All components of the “final assembly” are subjected to the assessment, but only the reactive coating product is subjected to the FPC requirements.

1.2.3 Use scenarios related to environmental conditions

The type of environmental conditions for the intended use is based on the general principles that temperature, freeze/thaw, humidity (water vapour), liquid water, rain, UV exposure, pollution¹ (e.g. for industrial regions: high SO₂, H₂S, NO_x; for coastal regions: high chloride levels), biological attack¹ etc. may influence essentially the performance of the product considered.

The product shall be assessed for the following use scenario when applied:

- Type X: Fire protective coating products/kits intended for all climatic conditions (internal, semi-exposed and exposed to weather),
- Type Y: Fire protective coating products/kits intended for internal and semi-exposed conditions. "Semi-exposed" includes temperatures below 0 °C, but no exposure to rain and limited or casual exposure to UV (but the effect of UV exposure is not assessed),
- Type Z₁: Fire protective coating products/kits intended for internal conditions with humidity equal to or higher than 85 % RH, excluding temperatures below 0 °C².
- Type Z₂: Fire protective coating products/kits intended for internal conditions with humidity lower than 85 % RH excluding temperatures below 0 °C.

Note: Products/kits that meet the requirements for type X, meet the requirements for all other types. Products that meet the requirements for type Y, also meet the requirements for types Z₁ and Z₂. Products that meet the requirements for type Z₁, also meet the requirements for type Z₂.

Although the product/kit is intended for internal use only, the construction process may result in a reactive coating system being subjected to exposed conditions for a period before the building envelope is closed. There are two possibilities:

1. Special provisions shall be made to protect temporarily the exposed reactive coatings according to the instructions of the manufacturer which are referenced in the ETA.
2. The reactive coating shall be evaluated as if it were to be used for exposed applications (type X).

1.2.4 Working life/Durability

The assessment methods included or referred to in this EAD have been written based on the manufacturer's request to take into account a working life of the fire protective coating product/kit for the intended use of 10 years when installed in the works (provided that the product/kit is subject to appropriate installation (see 1.1)) These provisions are based upon the current state of the art and the available knowledge and experience.

An estimated working life of 25 years shall only be assumed in the case where the applicant can offer, in addition to the above, for examination by the TAB, sufficient documented proof to demonstrate the use of the reactive coating system for a period of 25 years in the environmental conditions claimed (see clause 1.2.3).

¹ The influence of pollution and/or biological attack on the fire performance may be very complex and specific. If specific test methods and assessment procedures not included in this EAD are required, a separate EAD is needed.

² These conditions apply for internal humidity class 5 in accordance with EN ISO 13788.

When assessing the product, the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works³.

The indications given as to the working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by EOTA when drafting this EAD nor by the TAB issuing an ETA based on this EAD, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

1.3 Specific terms used in this EAD

1.3.1 Reactive coating system

Fire protective reactive coating systems normally comprise the primer, the reactive coating and the top coat. In some instances a reinforcing mesh is used.

Note: It is possible that a single coating may perform one or more of the functions described, which means that the "reactive coating system" comprises only the reactive coating.

1.3.2 Primer

A coating applied directly to a suitably prepared steel or cast iron surface to provide corrosion protection and/or to act as an aid to the adhesion of the reactive coating.

1.3.3 Reactive coating

Coating which is specially formulated to provide a chemical reaction upon heating such that the physical form changes and in so doing provides fire protection by thermal insulating and cooling effects

- Intumescent layers expand by foaming when exposed to heat in the conditions of a fire
- Ablative layers could slightly expand due to the formation of a char when exposed to fire. Energy will be consumed in fire conditions through chemical and/or physical processes creating the charred substance.

1.3.4 Topcoat

Coating applied over the reactive coating as a protection against environmental degradation and/or for decorative purposes.

1.3.5 Reinforcing mesh

Mesh of relatively small aperture size (e.g. metal, fibre glass) applied in close proximity or fixed to the substrate, which allows penetration of the reactive coating, to produce a good key.

³ The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than the working life referred to above.

1.3.6 Batch

The unit or quantity of production in a single complete production operation. The volume which constitutes a batch in converting the raw material into the finished product is called “batch size”.

1.3.7 Required minimum thickness of intumescent layer

The dry film thickness of the intumescent layer given in the ETA is the required minimum thickness of the layer on site. Guidance for measuring the thickness and the allowable range is given in Annex G

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 1 shows how the performance of fire protective coating products/kits is assessed in relation to the essential characteristics.

Table 1 Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance (value, class, description)
Basic Works Requirement 2: Safety in case of fire			
1	Reaction to fire	Clause 2.2.1	Class
2	Resistance to fire	Clause 2.2.2	Class
Basic Works Requirement 3: Hygiene, health and the environment			
3	Content, emission and/or release of dangerous substances	Clause 2.2.3	Description
Basic Works Requirement 4: Safety and accessibility in use			
5	Adhesion	Clause 2.2.4	Description
6	Durability	Clause 2.2.5	Description

2.2 Methods and criteria for assessing the performance of the product in relation to essential characteristics of the product

Characterisation of products to be assessed shall be done in accordance with available specifications, notably with the basic material properties which are relating to intended fire protective performance.

2.2.1 Reaction to fire

The reactive coating system shall be tested, using the test method(s) relevant for the corresponding reaction to fire class, in order to be classified according to EN 13501-1.

Guidance on mounting and fixing arrangements for tests in accordance with the test methods is given in Annex D of this document. If the reactive coating system is intended to be used with or without a top coat then both situations shall be tested.

2.2.2 Resistance to fire

Because a reactive coating system does not possess fire resistance in its own right the classification applies to the protected element, including the reactive coating system, and not to the protection itself. Classification with respect to fire resistance is undertaken in accordance with EN 13501-2 and shall specify the protected elements. Classification can also be undertaken for cast iron on the basis of an assessment approach.

The method of application of water borne paints does not significantly affect the results so any method may be used but spray application is recommended. Solvent borne paints are more sensitive to the method of application and spray application shall be used unless the manufacturer specifies a different method which shall then be used.

If there is a national requirement for a resistance to fire classification using the slow heating curve ("IncSlow" according to EN 13501-2) the smouldering curve according to EN 1363-2 shall be used when the product is subjected to a resistance to fire test. The test method is described in EN 13381-8.

See Annex F for the use of test data according to ENV 13381-4.

2.2.3 Content, emission and/or release of dangerous substances

The performance of the product related to the emissions and/or release and, where appropriate, the content of dangerous substances will be assessed on the basis of the information provided by the manufacturer⁴ after identifying the release scenarios (in accordance with EOTA TR 034) taking into account the intended use of the product and the Member States where the manufacturer intends his product to be made available on the market.

⁴ The manufacturer may be asked to provide to the TAB the REACH related information which he must accompany the DoP with (cf. Article 6(5) of Regulation (EU) No 305/2011).

The manufacturer is **not** obliged:

- to provide the chemical constitution and composition of the product (or of constituents of the product) to the TAB, or
- to provide a written declaration to the TAB stating whether the product (or constituents of the product) contain(s) substances which are classified as dangerous according to Directive 67/548/EEC and Regulation (EC) No 1272/2008 and listed in the "Indicative list on dangerous substances" of the SGDS.

Any information provided by the manufacturer regarding the chemical composition of the products may not be distributed to EOTA or to TABs.

The identified intended release scenarios for this product and intended use with respect to dangerous substances for this product are:

- IA1: Product with direct contact to indoor air.
- IA2: Product with indirect contact to indoor air (e.g. covered products) but possible impact on indoor air.
- S/W2: Product with indirect contact to soil, ground- and surface water.

2.2.3.1 SVOC and VOC

For the intended uses covered by the release scenarios IA1 and IA2, semi-volatile organic compounds (SVOC) and volatile organic compounds (VOC) shall be determined in accordance with EN 16516.

The preparation of the test specimen is performed as follows:

The inert substrate (glass or stainless steel) shall be coated as described in the manufacturer's instructions. Testing is performed using $\frac{3}{4}$ of the maximum wet film thickness according to the manufacturer's instructions. For each layer the quantity applied is verified in terms of wet weight [g/m²] by taking weight differences.

The coating shall be carried out exactly in accordance with the manufacturer's specifications. Environmental conditions and drying time have to be reported. Cross contaminations shall be avoided.

Once the test specimen has been completely coated, it is preconditioned for 3 or 28 days. The preconditioning process takes place in a test chamber under the test chamber conditions or in a storage facility where the relevant test chamber conditions can be created.

Once the preconditioning time has been observed, the test specimen is transferred to the emission test chamber. This point in time is considered to be the starting time of the emission test. A 28-day test period using the area-specific air flow rate $q = 1,5$ m/h takes place.

The test results have to be reported for the relevant parameters (e.g. chamber size, temperature and relative humidity, air exchange rate, loading factor, size of test specimen, preconditioning, production date, arrival date, test period, test result).

The relevant test results after 28 days shall be expressed in [mg/m³] and stated in the ETA.

2.2.4 Adhesion

The reactive coating system (primer, reactive coating layer with/without top coat) shall adhere to the substrates, such that the system will have the required fire protective performance. Adhesion is covered by testing the insulation efficiency (see clause 2.2.5.2.1.1).

For all tests required the test result is a pass/fail criterion. No test results or threshold values (e. g. time to reach 500°C) are specified in the ETA.

2.2.5 Durability

The performance of fire protective reactive coating systems shall not deteriorate during their assumed intended working life so as to affect significantly the performance of the products in relation to fulfilling all the Essential Characteristics related to BWR 2 and 4, especially the protective effects in case of fire. The reactive coating system shall be durable under service conditions, such as:

- Humidity: see clause 2.2.5.1
- Variations of temperature and relative humidity, rain and radiation of the sun: see clause 2.2.5.2
- Chemical attack: see clause 2.2.5.2.1.6

2.2.5.1 Corrosion resistance

The reactive coating system shall not react adversely with the intended substrate(s) and where required the primer and/or the reactive coating shall provide corrosion protection to the substrate.

The tests according to clause 2.2.5.2 will serve to indicate whether the coating has an adverse effect on the primer and/or substrate and whether the reactive coating system provides corrosion protection to the substrate. The durability testing shall be carried out with the same reactive coating system used for the fire resistance tests.

The result "passed" in the tests according to clause 2.2.5.2 shall demonstrate sufficiently that the reactive coating has no adverse effect on the primer (if any) and that the reactive coating system provides corrosion protection to the substrate.

If ETA-applicants claim that their product or kit provides or contributes to the corrosion protection of the steel element it is intended to protect against fire, the product, or the kit component (or components together) shall be tested in accordance with EN ISO 12944-1.

2.2.5.2 Behaviour under different environmental conditions

2.2.5.2.1 Method of assessment

The fire behaviour of the reactive coating system shall not change significantly during the working life, if reactive coating systems are used in the defined use conditions. The ETA-applicant shall claim durability of the reactive coating system according to the use scenarios in clause 1.2.3

The need to conduct each of the following tests is determined by the claimed use scenario related to environmental conditions for the reactive coating product or reactive coating kit (see clause 1.2.2 and table 2).

The test result is deemed "passed" when the mean time to achievement of the critical steel temperature (t_{500}) determined in the durability tests is not less than 85% of the time t_{500} (time to reach a steel temperature of 500°C) of the initial tests. To remove influences due to the variability of the thickness of the reactive coating, the relationship thickness/ t_{500} may be assumed as linear. No single result of exposed specimens shall be less than 80% of the mean time t_{500} of the initial test.

Where the result falls outside these criteria, an additional 4 specimens may be exposed, tested and assessed. All 4 specimens shall fulfil the pass criteria.

These criteria for exposure conditions shall also be used for the evaluation of kits including primers and/or top coats when testing efficiency on panels (if testing on short columns, see Annex A).

2.2.5.2.1.1 Insulating efficiency test

The durability assessment is achieved through indirect testing, i.e. the measurement of insulating efficiency as a 'proxy' characteristic that is related to the fire protective behaviour of the reactive coating system. Durability is demonstrated by comparing "insulating efficiency" of initial test specimen (steel panels according to Annex A) and exposed specimen.

For preparation of test specimen, test procedure and test criteria see Annex A. The product or kit is assessed for a use scenario as claimed by the ETA-Applicant and therefore, the insulating efficiency on minimum 2 initial samples is compared with the insulating efficiency on minimum 2 weathered samples, in accordance with clauses 2.2.5.2.1.2 to 2.2.5.2.1.5. Table 2 specifies the tests and the number of tests depending on the possibilities for the different reactive coating systems.

Table 2: Minimum number of test specimens regarding the assessment approach for primer(s) and top coat(s) and the durability requirement (see clauses 2.3.4 and 2.2.4)

No	Required content of assessment	Tests according to clause	minimum number of specimens
1	Reactive coating systems without a primer or with one primer without top coat for type Z ₂	2.2.5.2.1.1 2.2.5.2.1.2 (without top coat)	2 2
1a	Additional generic or specific primer(s)	2.2.5.2.1.1	+ 2 x n ¹⁾
1b	with top coat: (to test every claimed top coat)	2.2.5.2.1.1	+ 2 x m ²⁾
2	Reactive coating systems without a primer or with one primer only with top coat for type Z ₂	2.2.5.2.1.1 2.2.5.2.1.2	2 2
2a	Additional generic or specific primer(s)	2.2.5.2.1.1	+ 2 x n ¹⁾
2b	Additional top coat(s)	2.2.5.2.1.1	+ 2 x m ²⁾
3	Reactive coating systems without a primer or with one primer without top coat for types Z ₂ and Z ₁	2.2.5.2.1.1 2.2.5.2.1.3 (without top coat)	2 2
3a	Additional generic or specific primer(s)	2.2.5.2.1.1	+ 2 x n ¹⁾
3b	with top coat (to test every claimed top coat)	2.2.5.2.1.1	+ 2 x m ²⁾
4	Reactive coating systems without a primer or with one primer only with top coat for types Z ₂ and Z ₁	2.2.5.2.1.1 2.2.5.2.1.2	2 2
4a	Additional generic or specific primer(s)	2.2.5.2.1.1	+ 2 x n ¹⁾
4b	Additional top coat(s)	2.2.5.2.1.1	+ 2 x m ²⁾
5	Reactive coating systems without a primer or with one primer with top coat for type Y (including types Z ₁ and Z ₂)	2.2.5.2.1.1 2.2.5.2.1.4	2 2
5a	Additional generic or specific primer(s)	2.2.5.2.1.1	+ 2 x n ¹⁾
5b	Additional top coat(s) (to test every top coat with only one colour)	2.2.5.2.1.1 2.2.5.2.1.4	+ 2 x m ²⁾ + 2 x m ²⁾
6	Reactive coating systems without a primer or with one primer with top coat for type X (including types Y, Z ₁ and Z ₂)	2.2.5.2.1.1 2.2.5.2.1.5	2 2
6a	Additional generic or specific primer(s)	2.2.5.2.1.1	+ 2 x n ¹⁾
6b	Additional top coat(s) (to test every top coat with only one colour)	2.2.5.2.1.1 2.2.5.2.1.5	+ 2 x m ²⁾ + 2 x m ²⁾
1)	n = number of claimed generic or specific primers <u>in addition to</u> the one tested in number 1, 2, 3 or 4		
2)	m = number of claimed top coats and one colour (see clause 2.3.4.3)		

2.2.5.2.1.2 Exposure conditions for type Z₂: Reactive coating system intended for internal conditions

The test specimen shall be placed in a vertical position into the test chamber and exposed to the following cycle:

- 4 h at (23 ± 3) °C and (80 ± 5) %RH
- 16 h at (40 ± 3) °C and (50 ± 5) %RH
- 4 h at (5 ± 3) °C and (50 ± 5) %RH

The product or kit shall be exposed to 21 cycles without interruption. After exposure the specimen shall be tested according to Annex A.

The chamber temperature change shall be at a rate of 1,5 K/min ± 0,5 K/min. During the period of temperature change the change of humidity is not controlled, but condensation shall be avoided. The duration of temperature change is included in the duration of the 16 h cycle.

2.2.5.2.1.3 Exposure conditions for type Z₁: Reactive coating system intended for internal conditions with high humidity

The test shall be carried out according to EN ISO 11503. The test cycle shall be repeated 21 times. After exposure the specimens shall be tested according to Annex A.

2.2.5.2.1.4 Exposure conditions for Type Y: Reactive coating system intended for internal and semi-exposed conditions

The test specimens shall be stored in a vertical position into the test chamber and exposed to the test conditions. The special requirements of the test method are described in Annex C. After exposure the specimens shall be tested according to Annex A.

2.2.5.2.1.5 Exposure conditions for Type X: Reactive coating system intended for all conditions

The test specimens shall be stored in a vertical position into the test chamber and exposed to the test conditions. The principles of the test method are according to EN ISO 4892-3 table 4 cycle 3. After this exposure to UV and sprayed water the specimens shall be tested under special conditions as described in Annex B. After exposure the specimens shall be tested according to Annex A.

2.2.5.2.1.6 Resistance to chemicals

Reactive coating systems may or may not be influenced in their function by chemicals. For specific areas of application, where reactive coating systems may be exposed to chemicals, additional assessments may be required.

The extent of testing of resistance to chemicals depends on the ETA-applicant's claims.

To determine chemical resistance, as claimed by the ETA-applicant, after subjecting (at least) two specimens to chemicals in accordance with EN ISO 2812-1, the test specimens shall be tested according to Annex A. The insulation efficiency after exposure to chemicals is compared with the insulation efficiency of the initial test.

2.3 Criteria for the application of the test methods

2.3.1 Sampling and Test Specimens

Where possible, samples of the product for all assessment tests shall be taken at the manufacturing site (storage, production) and shall be representative of the reactive coating or reactive coating kit for which assessment is being sought.

The specimens for assessment tests shall as far as possible be prepared at the same time in order to minimize differences caused by variations in specimen preparation. This is in order to relate the characteristics of the material to the performance achieved.

Where relevant, the specimen substrate shall be a grade of steel (S designation) to the EN 10025-series (excluding S 185) of standards. Engineering grades (E designation) shall not be used. Where galvanized steel is used as substrate, EN ISO 1460 or EN ISO 1461 applies.

The surface of the steel used for the specimens shall reflect the surface conditions claimed by the ETA-Applicant, as specified in the application instructions for the product.

2.3.2 Conditioning of Tests Specimens and Test Conditions

The coating on the test specimens shall be applied and fully cured according to the ETA-applicant's instructions.

Except where special conditioning is specified in a referenced test method the prepared test specimens shall be conditioned at (23 ± 2) °C and (50 ± 5) % relative humidity.

The laboratory conditions at the start of fire testing shall be (20 ± 10) °C according to EN 1363-1.

2.3.3 Dry thickness of the reactive coating system

The dry film thickness of all layers of the reactive coating system shall be determined directly upon the test specimen, once the coating is fully dried. The thickness shall be measured using an instrument employing either the electro-magnetic induction principle or the eddy current principle with a probe contact diameter of at least 2,5 mm according to EN ISO 2808.

The measurements points shall be uniformly distributed over the surface of the test sample with a minimum number of 40 per m². For details of preparing and storing the test specimen, see A1 of Annex A of this EAD.

2.3.4 Assessment Approach for primers and top coats

2.3.4.1 General

Fire protective reactive coating systems normally comprise the primer, the reactive coating and the top coat. Some reactive coatings can be applied directly on the substrate without primer. The insulating efficiency tests for the ETA shall then be carried out without a primer. If, in practice there is a primer already on site the use of a primer can be accepted on the basis of an insulating efficiency test providing it is one of the generic types from table 3 tested in accordance with Annex A.

For a reactive coating kit or reactive coating final assembly, consisting of one reactive layer and one or more primers and/or one or more top coats, both primers and top coats may be referred to specifically (by trade name and type) or generically (generic products or generic families, in case of primers).

Specific or generic products shall be specified in the ETA according to the available technical specifications (e.g. EN or ETA) or, when this is not possible, by reference to proprietary items, physical dimensions and material performance. In case of primers, when they are not specific, reference to the generic families indicated in clause 2.3.4.2 shall be made.

2.3.4.2 Primer Evaluation

There are two options for assessing primers and covering primers in the ETA: generic types or specific primers

The most commonly used generic types of primer and their nominal thickness range are given in Table 3. Only one primer from a primer family is subjected to testing and primer types not covered by the generic

types listed in Table 3 will be the subject of a separate evaluation in accordance with Annex A. If a primer is tested on uncoated steel but is intended to be used on galvanised steel as well, a separate evaluation on galvanised steel shall be made. In this case the maximum thickness shall not be more than 50% of the tested thickness.

Each generic primer group will be evaluated separately for both water borne and solvent borne materials. Solvent free materials will be classed in the same generic group as the solvent borne equivalent.

Table 3

Generic Primer Type	Maximum accepted tested thickness + permitted extension from the tested thickness (%)
Acrylic	50
Short/medium oil alkyd	50
Two component epoxy	50
Zinc rich epoxy (containing about 80% by mass of metallic zinc powder)	50
zinc silicate	50

In all cases the dry thickness of the primer shall not exceed the maximum dry thickness for each product as recommended by the manufacturer.

Where the primer contains zinc metal there may be a requirement to include a further tie coat or pre-treatment, in which case this shall be included in the system to be tested.

When a primer from any generic group is tested the generic assessment will be limited to other primers in the group provided the thickness is within the tolerance given in Table 3. Any thicknesses below that tested shall be acceptable provided the lower thickness is not less than recommended by the manufacturer.

If no primer is used then the surface preparation shall be specified and tested in accordance with Annex A.

Compatibility testing carried out on steel panels or short columns will be acceptable for other ferrous substrates except stainless steel, which shall be evaluated separately in accordance with Annex A.

Primers not covered by the families identified above may be grouped in other families of primers based on the binder (e.g. oil alkyd, epoxy), carrier (organic solvent/water) and pigment (e. g. inhibitive or non-inhibitive) type.

Durability testing with a primer from the generic type of zinc rich epoxy primer does not cover galvanized steel, for instance hot dip galvanised steel. Galvanized steel is treated as another form of “primer” and has to be tested separately.

All tests/assessments according to the clauses 2.2 shall be carried out without a primer or with a primer chosen by the applicant. However, where the reactive coating system is intended to be used with more than one primer, an insulation efficiency test is necessary for the additional primers. Only one primer from a primer family is subjected to testing. The tests are valid for primers with the same carrier (water borne or solvent borne) and for a related similar thickness (a range of validity for tested dry film thickness shall be given).

NOTE: It is assumed that the result “pass” within the insulation efficiency test is a basis for the assessment of a comparable behaviour in all other tests (e. g. fire resistance tests, durability test). For the “pass/fail”-criteria (see clause 2.2.4.2.1).

It is recognized that in the majority of cases the steel elements will arrive on site already primed. In such instances, it is necessary for the reactive coating applicator to ensure that the primer is compatible with the reactive coating.

However, where the primer is found to be a type not covered by the ETA, the applied coating is not covered by the ETA.

2.3.4.3 Top coat Evaluation

All tests according to clause 2.2.4 shall be conducted without a top coat unless the ETA-applicant specifies that the top coat is necessary to provide the required performance under the particular exposure conditions. In this case the reactive coating shall be tested with the specified top coat.

If the reactive coating system is claimed to be equally suitable with and without topcoat for environmental conditions types Z₁ and Z₂ the initial tests (clause 2.2.4.2) shall be performed with panels with and without topcoat to show that the topcoat has no influence on the insulation efficiency (this compatibility assessment might also be carried out by testing short columns see Annex A). For determining the insulation efficiency after exposure, it is sufficient to perform the tests without topcoat. The top coat shall be specified in the ETA. The colour of the topcoat has no influence on the result of the durability assessment for types Z₁ and Z₂. Therefore there is no need to test different colours of the topcoat. The ETA is valid for all top coat colours.

For environmental use scenarios type Y and type X the test results could be influenced by the various top coat types and their colours. No generic approach is possible in relation to the type of top coat and the applicant has to test all top coats. However, in order to cover all colours of a particular top coat, a colour having an index L < 50 on the CIELAB⁵ scale (see ISO 7724) shall be selected for test. The decision to choose the colour of the top coat used in durability assessment is taken by the TAB and the ETA-Applicant. The test results are valid for the tested top coat and all its different colours.

2.3.5 Means of technical characterisation

Regardless of which option is chosen for the reactive coating or reactive coating kit all components supplied by the manufacturer of the reactive coating system (primer, reactive layer, top coat and reinforcement) shall be clearly characterised. The product which is the subject of a European Technical Assessment issued based on this EAD has been characterised for the purposes of the assessment on the basis of the following table 4.

Table 4: Testing for technical characterisation

Properties	Primers (if any)	Reactive coating	Top coat (if any)	Reinforcements (if any)
Technical data	x	x	x	x
Colour (visual assessment)	x	x	x	
Density	x	x	x	
Non-volatile content	x	x	x	
Fingerprint according to Annex E or formulation (optional)		x		
Geometry				x

The results of the technical characterisation shall be kept in the files of the TAB.

⁵ "Commission International de l'Eclairage" (CIE) system of colour space defines lightness/darkness (L) scale in CIELAB units. White is defined as L = 100 and black as L = 0.

3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

3.1 System(s) of assessment and verification of constancy of performance to be applied

For the products covered by this EAD the applicable European legal act is: Decision 1999/454/EC.

The system is: **1**

In addition, with regard to reaction to fire for products covered by this EAD the applicable European legal act is: Decision 1999/454/EC.

The systems are: **1/3/4**

3.2 Tasks of the manufacturer

The cornerstones of the actions to be undertaken by the manufacturer of the product in the procedure of assessment and verification of constancy of performance are laid down in Table 5.

In so far the tasks of the manufacturer as described in table 5 include a test or control method, this may be transmitted or subcontracted to a competent laboratory but shall remain under the responsibility of the manufacturer.

Table 5 Control plan for the manufacturer; cornerstones

No	Subject/type of control (product, raw/constituent material, component - indicating characteristic concerned)	Test or control method (refer to 2.2)	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC)					
Reactive layer and reactive coating kit					
	Content, emission and/or release of dangerous substances (IA1, IA2) See 2.2.3 When starting the production process or when starting a new production line	See clause 2.2.3.5	See clause 2.2.3.5		Every five years
1	Incoming material	Declaration of conformity	Manufacturer's declaration,		Every delivery
2	Char depth (expansion ratio)	e. g. Cylinder test (see TR 024) or similar	Manufacturer's declaration, minimum level 6		Every batch
3	Insulating efficiency or any alternative test designed to ensure consistency of fire performance (to be agreed	e. g. Annex A or similar	Manufacturer's declaration,		Every 10th batch or at least once per month

⁶ If the result of the test char depth is not sufficient, an insulating efficiency test shall be done

	between the TAB, the Notified Body and the Manufacturer)				
4	Non-volatile content or density	e. g. EN ISO 3251	Manufacturer's specification		Every batch
5	Sag resistance		Manufacturer's specification		Every batch
6	Viscosity	e. g. EN ISO 3219	Manufacturer's specification		Every batch
7	Raw material Check the test results of the supplier according to the specification of the manufacturer of raw material	Check the raw material supplier's stated levels against the manufacturer's specification in FPC	Declared levels		Every delivery
8	Curing				Every batch
9	Pigment dispersion (fineness of the grind)				Every batch
Primer					
10	Raw material	Check the raw material supplier's stated levels against the manufacturer's specification in FPC	Stated levels		Every delivery
11	Viscosity	e. g. EN ISO 3219	Manufacturer's specification		Every batch
12	Non-volatile content	e. g. EN ISO 3251			Every batch
Top coat					
13	Raw material	Check the raw material supplier's stated levels against the manufacturer's specification in FPC	Stated levels		Every delivery
14	Pigment content colour				Every batch
15	Viscosity	e. g. EN ISO 3219	Manufacturer's specification		Every batch
16	Non-volatile content	e. g. EN ISO 3251			Every batch
Keying mesh					
17	Geometry	declaration of conformity	Manufacturer's specification		Every delivery

3.3 Tasks of the notified body

The cornerstones of the actions to be undertaken by the notified body of the product in the procedure of assessment and verification of constancy of performance are laid down in Table 6.

Table 6 Control plan for the notified body; cornerstones

No	Subject/type of control (product, raw/constituent material, component - indicating characteristic concerned)	Test or control method (refer to 2.2)	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control (for system 1)					
1	Inspection of the factory and the factory production of the manufacturer as described in the control plan	Control of devices and equipment and the documentation of the FPC	See control plan		When starting the production process or when starting a new production line
Continuous surveillance, assessment and evaluation of factory production control (for system 1)					
1	Continuous surveillance, assessment and evaluation of factory production control as described in the control plan including an annual inspection of the factory				Twice a year

4 REFERENCE DOCUMENTS

As far as no edition date is given in the list of standards thereafter, the standard in its current version at the time of issuing the European Technical Assessment is of relevance.

EN 10025-1	Hot rolled products of structural steels - Part 1: General technical delivery conditions
EN 10025-2	Hot rolled products of structural steels - Part 2: Technical delivery conditions for non-alloy structural steels
EN 10025-3	Hot rolled products of structural steels - Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels
EN 10025-4	Hot rolled products of structural steels - Part 4: Technical delivery conditions for thermo-mechanical rolled weldable fine grain structural steels
EN 10025-5	Hot rolled products of structural steels - Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance
EN 10025-6	Hot rolled products of structural steels - Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition
EN ISO 1460	Metallic coatings - Hot dip galvanized coatings on ferrous materials - Gravimetric determination of the mass per unit area.
EN ISO 1461	Metallic coatings - Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods.
EN 1363-1	Fire Resistance tests - Part 1: General Requirements.
EN 1363-2	Fire Resistance Tests - Part 2: Alternative and additional procedures
ENV 13381-4:2002	Test methods for determining the contribution to the fire resistance of structural members - Part 4: Applied passive protection products to steel members
EN 13381-8	Test methods for determining the contribution to the fire resistance of structural members - Part 8: Applied reactive protection to steel members
EN 13501-1	Fire classification of construction products and building elements - Part 1: Classification using test data from reaction to fire tests
EN 13501-2	Fire classification of construction products and building elements - Part 2: Classification using test data from fire resistance tests
EN 13238	Reaction to fire tests for building products - Conditioning procedures and general rules for selection of substrates
EN 13823	Reaction to fire tests for building products - Building products excluding floorings exposed to the thermal attack by a single burning item
EN ISO 1182	Reaction to fire tests for building products - Non-combustibility tests
EN ISO 1716	Reaction to fire tests for products - Determination of the heat of combustion
EN ISO 2808	Paints and varnishes - Determination of film thickness

EN ISO 2812-1	Paints and varnishes - Determination of resistance to liquids Part 1: Immersion in liquids other than water
EN ISO 3219	Plastics - Polymers/resins in the liquid state or as emulsions or dispersions - Determination of viscosity using a rotational viscometer with defined shear rate
EN ISO 3251	Paints, varnishes and plastics - Determination of non-volatile-matter content
EN ISO 4892-3	Plastics - Methods of exposure to laboratory light sources - Part 3: Fluorescent UV lamps
EN ISO 11925-2	Reaction to fire tests - Part 2: Ignitability of products subjected to direct impingement of flame
EN ISO 11503	Paints and varnishes - Determination of resistance to humidity (intermittent condensation)
EN ISO 12944-1	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 1: General introduction
EN ISO 12944-2	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 2: Classification of environments
EN ISO 12944-3	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 3: Design considerations
EN ISO 12944-4	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 4: Types of surface and surface preparation
EN ISO 12944-5	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 5: Protective paint systems
EN ISO 12944-6	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 6: Laboratory performance test methods
EN ISO 12944-7	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 7: Execution and supervision of paint work
EN ISO 12944-8	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 8: Development of specifications for new work and maintenance
EN ISO 13788	Hygrothermal performance of building components and building elements - Internal surface temperature to avoid critical surface humidity and interstitial condensation – Calculation method
ISO 7724-1	Paints and varnishes - Colorimetry; Part 1: Principles
ISO 7724-2	Paints and varnishes - Colorimetry; Part 2: Colour measurement
EOTA TR 034	EOTA Technical Report TR 034: General checklist for EADs/ETAs – Content and/or release of dangerous substances in construction products
EN 16516:2017	Construction products – Assessment of release of dangerous substances – Determination of emissions into indoor air

ANNEX A REACTIVE COATINGS, REACTIVE COATING KITS – INITIAL TEST (INSULATING EFFICIENCY)

A1 General

The small scale furnace fire test shall be carried out under the condition of the standard time - temperature curve as defined in EN 1363-1.

The specimens to be tested shall be prepared in accordance with the manufacturer's instructions for the fire protective system concerned. Specimens shall then be stored in an atmosphere (23 ± 3 °C and 50 ± 5 %RH) for a period of time as specified by the manufacturer for drying.

After exposure to environment conditions, if any, the specimens shall be stored in an atmosphere (23 ± 3 °C and 50 ± 5 %RH) between the end of the exposure and the fire testing for a minimum of 1 week.

As the Insulating Efficiency Test is an indirect testing for comparison (durability, different primers, different top coats) all tests of one assessment shall be carried out under identical conditions/parameters

A2 Specimens

Testing different/additional primers, different/additional top coats, durability or for FPC the insulating efficiency test may be carried out with steel panels.

Alternatively, short columns can be used for testing compatibility of different/additional primers and for FPC purposes. For different/additional top coats short columns may be used for exposure types Z₁ and Z₂. They shall not be used for durability purposes for exposure types X and Y.

A2.1 Panels

The specimens shall consist of steel panels having a nominal thickness of 5 mm and a minimum size of 300 mm x 200 mm (see Note A.1). For every requirement a minimum of two specimens shall be tested.

The dry thickness of the coating shall be measured and recorded at a minimum of 40 per m² but at least 20 points for panels of 500 mm x 500 mm and at least 10 point for panels of 200 mm x 300 mm uniformly distributed points prior to testing.

For panels, used for durability testing, it will be necessary to apply a protective coating (primer) to the back and edges of these (including all control panels), to prevent rust contamination of the cabinet.

The primer and/or the topcoat used (if any) as part of the reactive coating system shall be applied at the dry film thickness that they would be used in practice.

The reactive coating shall be applied at (1000 ± 100) µm dry film thickness or the maximum thickness if the maximum thickness is lower. For epoxy coatings the dry film thickness shall be 2/3 of the maximum thickness.

Note A.1: For tests according to the clauses 2.2.4.2.1.1, 2.2.4.2.1.2 and 2.2.4.2.1.3 it may be more convenient to use steel panels with a size of 500 mm x 500 mm (equal distribution of measurement points, usual in some countries etc.).

A2.2 I-section short columns

For the evaluation of different primers it is equally acceptable to carry out tests on short steel I-/H-sections of minimum height 500 mm comparing the reference result obtained for the primer used in the type testing with any new primer tested on the same section size at the same thickness of reactive coating as used for type testing.

For each short I-/H-column there shall be a measurement station consisting of three thermocouples located at a distance of 250 mm from the top of the column, one thermocouple on the web and one on each flange. The thermocouples on the flanges shall each be fixed mid-way between the toe of the flange and the web, the thermocouple on the web shall be fixed mid-way between the two flanges. In the case of short columns > 500 mm the thermocouples shall be in accordance with the requirements of clause 9.3.5 of EN 13381-8.

To minimize heat transfer from the ends, the steel column sections shall be protected with insulation board or similar which at elevated temperatures is capable of providing equivalent or greater insulation than that of the fire protection material provided over the height of the column. The linear dimensions of the end protection shall be greater than the total overall dimensions of the fire protected steel section.

A minimum number of 16 measurements shall be taken spread over each measuring station. There shall be four measurement stations (in a distance of 100 mm, 200 mm, 300 mm and 400 mm from the top) or as indicated in Figures 3C for I or H short sections according to EN 13381-8.

The thickness measurement stations shall be between 50 mm to 100 mm away from the temperature measurement stations on the surface of the test column.

A3 Test Procedure

A3.1 Panels

The panels may be tested individually or in one test. The panels shall be placed in the furnace either in a vertical or in a horizontal position such that the side without the reactive coating layer is not exposed to the fire.

The position shall not be mixed because the test results may vary depending on the position in the furnace

The panel shall be mounted in a frame which forms part of one side (wall or ceiling) of the furnace. The side with the coating system shall be faced to the fire side. The non-fire side shall be covered using vermiculite or calcium silicate boards with a minimum thickness of 5 mm with a bulk density of (475 ± 25) kg/m³ or mineral wool (stone wool) with a bulk density of (110 ± 10) kg/m³ (see A1).

For each steel panel, a plate thermometer shall be placed in the middle of the panel, at a distance of 100 mm. The plate thermometer shall be oriented so that side 'A' faces the side walls of the furnace. The insulated parts shall face towards the panel. At the commencement of the test the hot junctions of these thermocouples shall be positioned and maintained throughout the test as specified in EN 1363-1.

Two thermocouples shall be attached to the non-fire side of the smaller steel panels. These thermocouples shall be located close to the centre with a distance of 2 cm. The thermocouples shall be of the K type according to EN 1363-1 but without a copper disc and without insulation pad. The thermocouples shall be fixed to the back of the steel panels by welding (resistance spot welding). If 500 mm x 500 mm steel panels are used there shall be three thermocouples on the back in the free area of the steel panel: one in the centre and two in the centre of a quarter section (so that the three thermocouples build up a line).

The fire test is finished when the mean temperature of the two thermocouples reaches 500°C.

A3.2 Short columns

The short column sections shall be supported vertically within the furnace, either installed to the soffit of the furnace cover slabs or stood, directly or on plinths, on the furnace floor.

In the case where short columns are included in the same furnace as a loaded beam or a loaded column and they are placed on the floor of the furnace, the furnace temperature in the region of each column section shall be measured using one plate thermometer placed, on one side of the column, at a distance of 0,5m from the base of column. These thermometers shall be placed as evenly as possible taking into account the location and number of test specimens.

The plate thermometers shall be oriented so that side 'A' faces the side walls of the furnace. The insulated parts shall face towards the column.

At the commencement of the test the hot junctions of these thermocouples shall be positioned and maintained throughout the test as specified in EN 1363-1.

Where the short columns are included in the same furnace as a loaded beam and they are fixed to the roof of the furnace the temperature shall be measured using the plate thermometers positioned in the region of the loaded beam test specimen, placed at locations at $\frac{1}{5}$, $\frac{2}{5}$, $\frac{3}{5}$ and $\frac{4}{5}$ of the heated length of the loaded beam, there being two plate thermometers at each location, one on each side of the beam.

A4 Test Report

The time to reach a mean temperature of 500 °C shall be recorded (on the non-fire side of the steel panel). For information purposes furthermore, adhesion of the char, char structure and char height shall be described in the test report.

In every case the insulating efficiency of the column under test shall be compared to that of an identical control short column.

A5 Assessment criteria

For insulating efficiency testing on panels, assessment criteria are given in clause 2.2.4.2.1.

For the alternative insulating efficiency testing on short columns, the test result shall not be less than 85% of the control short column. Where the result falls outside this criterion, additional 2 specimens may be tested and assessed. Both specimens shall fulfil the pass criterion ($\geq 85\%$).

ANNEX B EXPOSURE CONDITION TYPE X

The specimens shall consist of steel panels having a nominal thickness of 5 mm and a minimum size of 300 mm x 200 mm. A minimum of two specimens shall be tested. The reactive coating shall be applied at (1000 ± 100) μm dry film thickness or the maximum thickness if the maximum thickness is lower. For epoxy coatings the dry film thickness shall be 2/3 of the maximum thickness.

The primer and/or the topcoat used (if any) as part of the reactive coating system shall be applied at the dry film thickness that they would be used in practice.

The specimens shall be exposed in a climate chamber to the conditions according to EN ISO 4892-3 table 4 cycle 3. The samples shall be exposed to 112 cycles (= 28 days) without interruption.

The specimens shall then be visually assessed and after that exposed for 2 weeks (2 cycles) to the following procedure:

Day	Time			
	6 hours	6 hours	6 hours	6 hours
1. + 2.	20 °C \pm 3°C, 95 % \pm 5% R.H.	70 °C \pm 3°C, 20 % \pm 5% R.H.	20 °C \pm 3°C, 95 % \pm 5% R.H.	70 °C \pm 3°C, 20 % \pm 5% R.H.
3. + 4.	20 °C \pm 3°C, 95 % \pm 5% R.H.	30 °C \pm 3°C, 40 % \pm 5% R.H.	40 °C \pm 3°C, 95 % \pm 5% R.H.	30 °C \pm 3°C, 40 % \pm 5% R.H.
5. + 6 + 7	-20 °C \pm 3°C,	40 °C \pm 3°C, 95 % \pm 5% R.H.	-20 °C \pm 3°C,	40 °C \pm 3°C, 95 % \pm 5% R.H.

The chamber temperature change shall be at a rate of 1,5 K/min \pm 0,5 K/min. During the period of temperature change the change of humidity is not controlled. The duration of temperature change is included in the duration of an exposure phase.

ANNEX C EXPOSURE CONDITION TYPE Y

The specimens shall consist of steel panels having a thickness of 5 mm and a minimum size of 300 mm x 200 mm. A minimum of two specimens shall be tested. The reactive coating shall be applied at (1000 ± 100) μm dry film thickness or the maximum thickness if the maximum thickness is lower. For epoxy coatings the dry film thickness shall be 2/3 of the maximum thickness.

The specimens shall be exposed for 2 weeks (2 cycles) to the following procedure:

Day	Time			
	6 hours	6 hours	6 hours	6 hours
1. + 2.	20 °C \pm 3°C, 95 % \pm 5% R.H.	70 °C \pm 3°C, 20 % \pm 5% R.H.	20 °C \pm 3°C, 95 % \pm 5% R.H.	70°C \pm 3°C, 20 % \pm 5% R.H.
3. + 4.	20 °C \pm 3°C, 95 % \pm 5% R.H.	30 °C \pm 3°C, 40 % \pm 5% R.H.	40°C \pm 3°C, 95 % \pm 5% R.H.	30 °C \pm 3°C, 40 % \pm 5% R.H.
5. + 6 + 7	-20 °C \pm 3°C,	40 °C \pm 3°C, 95 % \pm 5% R.H.	-20 °C \pm 3°C,	40 °C \pm 3°C, 95 % \pm 5% R.H.

The chamber temperature change shall be at a rate of 1,5 K/min \pm 0,5 K/min. During the period of temperature change the change of humidity is not controlled. The duration of temperature change is included in the duration of an exposure phase.

ANNEX D REACTION TO FIRE TEST

1. Testing according to EN 13823: Reaction to fire tests for building products – Building products excluding floorings exposed to thermal attack by a single burning item

Dimensions of the test rig

Both wings for the SBI tests shall be set up freestanding with a distance of 80 mm in front of the backing board. During the manufacture for the SBI test each sample wing is to be manufactured individually. Assembly of both sample wings shall only be performed on the sample trolley of the SBI testing device. The two wings shall be fixed by a L-steel profile which is screwed to the wings.

Test specimen

Reactive fire protection systems shall be tested applied on a steel substrate of a thickness of at least 2 mm. The surface of the steel plate shall be prepared in accordance with the manufacturer's instructions and recommendations – it could e.g. be sandblasted, shot-blasted, grit-blasted, high-pressure washed, manually prepared or any other. If there is no instruction or recommendation the surface shall be sandblasted.

For testing according to EN 13823 the reactive coating systems with primer, reactive component and with top coat shall be tested.

The set-up shall be tested with all assessed (see 2.3.4.3) top coats or, if known, with the top coat of which the most unfavourable result is to be expected (e.g. on the basis of formula data, of already existing experience in testing or on the basis of the gross calorific potential determination (PCS)). To get all possible colours of the top coat a black and red topcoat shall be tested. If the system in practice is used without top coat the test according to EN 13823 shall be done without top coat.

The set-up shall be tested with all assessed (see 2.3.4.2) primer families or, if known, with the primer of which the most unfavourable result is to be expected (e.g. on the basis of formula data, of already existing experience in testing or on the basis of the gross calorific potential determination (PCS)). If the system in practice is used without primer the test according to EN 13823 shall be done without primer.

Reactive coating systems shall be tested with the maximum application quantity. Prior to performing the test the samples shall be conditioned in accordance with EN 13238. The dry thickness of the coating shall be measured and recorded at least 20 points for panels of 500 mm x 500 mm and at least 10 point for panels of 200 mm x 300 mm uniformly distributed points prior to testing. For the method see section 2.2.6.3.

The result of the tests executed in the SBI following the stipulations stated above applies to all application quantities smaller than or equal to the application quantity tested including all top coats and primers on steel substrates with a thickness ≥ 2 mm in the practical application

2. Testing according to EN ISO 11925-2 (small burner test)

Reactive fire protection systems shall be tested applied on a steel substrate with a thickness of at least 2 mm.

Prior to performing the test the samples shall be conditioned in accordance with EN 13238.

The reactive fire protection system shall be tested with its largest possible application quantity on two samples each with edge and surface flaming. Four more samples shall be tested with the more critical flaming (edge or surface flaming). For products of Class E, 15 seconds exposure shall be used; for products of Class D or above, 30 seconds exposure shall be used.

The set-up shall be tested with all assessed (see 2.3.4.3) top coats or, if known, with the top coat of which the most unfavourable result is to be expected (e.g. on the basis of formula data, of already existing

experience in testing or on the basis of the gross calorific potential determination (PCS)). To get all possible colours of the top coat a black and red topcoat shall be tested. If the system in practice is used without top coat the test according to EN ISO 11925-2 shall be done without top coat.

The set-up shall be tested with all assessed (see clause 2.3.4.2) primer families or, if known, with the primer of which the most unfavourable result is to be expected (e.g. on the basis of formula data, of already existing experience in testing or on the basis of the gross calorific potential determination (PCS)). If the system in practice is used without primer the test according to EN ISO 11925-2 shall be done without primer.

The result of the tests according to EN ISO 11925-2 applies to all reactive coating systems tested with application quantities smaller than or equal to the application quantity tested including all primers and top coats taken into account for testing on steel substrates with a thickness ≥ 2 mm in the practical application.

3. Testing according to EN ISO 1716 and EN ISO 1182 (if relevant for reactive fire protection systems)

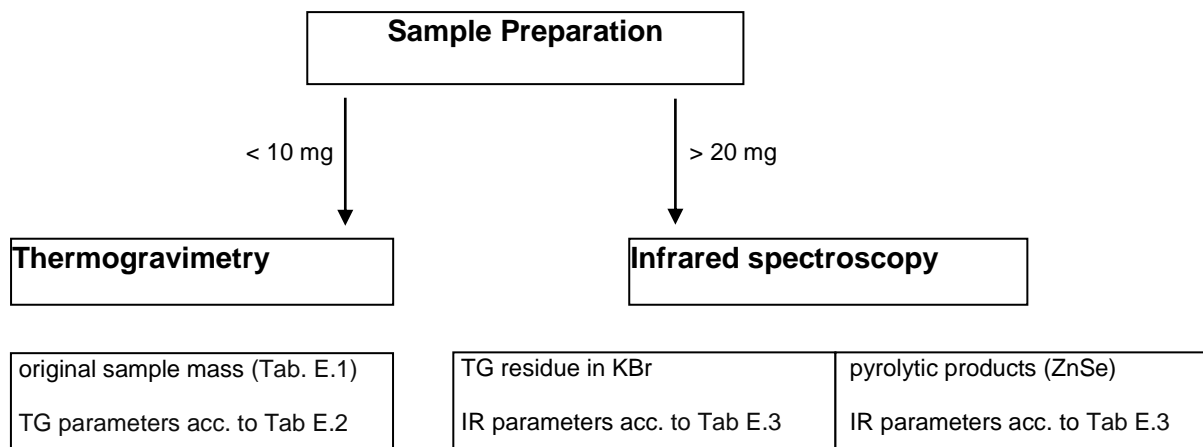
The preparation of the sample and the execution of the test shall be performed in accordance with the stipulations in the standards EN ISO 1716 and EN ISO 1182.

The complete number of specimens with each chemical composition and considering all possible surface coatings is to be tested.

ANNEX E REACTIVE COATINGS - DETERMINATION OF TECHNICAL CHARACTERISATION

In addition to the determination of physical-chemical data the technical characterisation test of fire protective coatings is performed by combining infrared spectrum with thermal analysis of the dried reactive coating.

Scheme of analysis:



SAMPLE PREPARATION

An identical preparation of the samples shall be provided for the thermoanalytical analyses (TG) and infrared-spectroscopy analyses (IR):

- Separation of a representative part quantity (ideally ca. 1g, at least ca. 30 mg) e.g. by means of a scalpel from the fire protective mass
- In the case of a highly heterogeneous sample composition: homogenizing by grinding up in a pot mill or in a mortar – in the case of reaction resin-bound materials, if necessary, by using liquid nitrogen. The required quantity of original sample's mass is then taken from the homogenized mass.
- TG: Original sample's mass without further treatment directly into the sample crucible according to Table E.1: analysis parameter Table E.2.
- IR: Pyrolysis or KBr method according to instructions, analysis parameters Table E.3.

The quantity size of the original samples mass used for the TG may only be chosen such that an increase in volume occurring with some materials during the process of analysis does not lead under any circumstances to sample components escaping from the sample receptacle.

Table E.1: Maximum quantity of original sample 's mass recommended as a function of the size of sample receptacle.

receptacle size / μl	40	70	300	900
max. quantity of original sample's mass/ mg	3	4	10	30

Table E.2: TG parameters for the analysis of fire protective materials

Crucible	standard Alox crucible with perforated lid
Mass of the original sample	see Table E.1
Cleansing gas / Flow	nitrogen / 50 ml/min
Range of temperature	50 – 800 °C
Rate of heating	10 K/min
Graphical representation	both TG and DTG curve

INFRARED SPECTROSCOPY (IR)**Pyrolysis**

1. A typical piece of the sample material (approx. 20 – 50 mg, if necessary, reduced to powder) is placed in the lower part of a dry mini-format test tube (8 mm x 70 mm)
2. The tube is covered at its outer upper end with a 1 cm wide filter paper collar wetted with cold water, which is fixed by means of a test tube clamp.
3. The test tube is held with its bottom into a Bunsen flame, which is preferably carried out underneath the exhaust. The test tube remains in the flame (if necessary, turn in and out) until pyrolysis of the sample. The developing steams condensate at the inner side of the test tube edge in the area of paper collar.
4. The condensate is taken with a clean glass rod and uniformly applied directly on a ZnSe crystal. The spectrum is recorded with the parameters according to Table E.3 as reference against an empty crystal.

KBr method

1. 300 mg KBr powder ("spectroscopy grade") are homogenized with the residue from the TG analysis (maximum 1 mg) e.g. in an agate mortar.
2. The powder is processed in known manner to KBr pressed piece. The inner space of the press total shall be evacuated for 1 to 2 minutes before pressing is done, in order to eliminate air and humidity.
3. The KBr pressed piece is directly analysed at the spectroscope against an identical but empty KBr pressed piece in the reference sample position.

Table E.3: IR parameters for the analysis of fire protective materials

Range of wave number	4000 – 600 cm ⁻¹
Dispersion	< 4 cm ⁻¹

ANNEX F GUIDANCE FOR USE OF TEST DATA (EN 13381)

This Annex F gives guidance for the use of test data carried out according to ENV 13381-4:2002 in an assessment according to EN 13381-8:2013. Test results from ENV 13381-4:2002 can be used within an assessment of performance to EN 13381-8:2013, if there are sufficient data points provided by ENV 13381-4:2002 testing. If not, then additional testing will be required. The ENV 13381-4:2002 results shall be subject to the adoption of the following review process.

- Step 1** The thermal data from the ENV 13381-4:2002 testing shall be re analysed in its entirety.
- Step 2** The data shall then be corrected in accordance with Annex D of EN 13381-8:2013.
- Step 3** Select the desired assessment method and assess the data ensuring that the analysis complies with the Criteria for Acceptability required by EN 13381-8:2013.
- Step 4** Ensure that any extensions of the resulting assessment comply with the requirements of EN 13381-8:2013
- Step 5** If the scope of the ENV 13381-4:2002 tests includes hollow columns then the additional testing of a loaded hollow column and short columns shall be carried out in accordance with the requirements of EN 13381-8:2013 before assessment can be carried out.
- Step 6** If the scope is to be extended further beyond the original ENV 13381-4:2002 testing then any additional tests shall be carried out in accordance with the test specimen requirements of Table 1 of EN 13381-8:2013 and all the data shall be used for assessment. The number of short sections shall comply with the requirements of EN 13381-8:2013.

ANNEX G GUIDANCE FOR THE MEASUREMENT OF THE DRY FILM THICKNESS OF THE INTUMESCENT LAYER AND THE LIMITS ON SITE

The coating thickness acceptance criteria shall be as follows, based on the required thickness stated in the schedule of thickness, being a nominal level:

- 1) The mean dry film thickness applied to each element shall be greater than or equal to the specified nominal level.
- 2) The mean of the measured dry film thickness on any face of any member shall not be less than 80% of the specified nominal level
- 3) Dry film thickness levels less than 80% of the specified nominal level are acceptable, provided that such levels are isolated and that no more than 10% of the readings on a member are less than 80% of the specified nominal level.

Where any single thickness reading is found to be less than 80% of the specified nominal level, a further two, or where possible three, readings shall be taken within 150 mm to 300 mm of the low reading. The initial reading may be considered isolated if all the additional readings are at least 80% of the specified nominal level. If one or more of the additional readings are less than 80% of the specified nominal level, further readings shall be made to determine the extent of the area of under thickness.

- 4) All dry film thicknesses shall be at least 50% of the nominal level