BS EN 16623:2015

BSI Standards Publication

Paints and varnishes — Reactive coatings for fire protection of metallic substrates — Definitions, requirements, characteristics and marking

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National foreword

This British Standard is the UK implementation of EN 16623:2015.

The UK participation in its preparation was entrusted to Technical Committee STI/21, Paint systems and surface preparation for metallic substrates.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Beschichtungsstoffe - Reaktive Beschichtungen für den Brandschutz metallischer Substrate - Begriffe, Einteilung, Eigenschaften und Bezeichnung

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CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (EN 16623:2015) has been prepared by Technical Committee CEN/TC 139 “Paints and vanishes”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 2015, and conflicting national standards shall be withdrawn at the latest by August 2015.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This European Standard applies to reactive coatings intended for the fire protection of steel and other ferrous substrates used as structural elements such as beams and columns, beams supporting composite steel deck floors and concrete filled hollow steel sections. The reactive coating can be applied directly to the substrate or over a priming system. The reactive coating may require a protective top-coat depending on the end service conditions.

Throughout this European Standard, steel and other ferrous substrates are referred to as steel.

Currently, under the requirements of the Construction Products Regulation 2011 (CPR), which superseded the requirements of the Construction Products Directive (CPD), each reactive coating product used to provide fire protection to structural members is required to be subject to a European Technical Assessment (ETA). These are elaborated and issued by a European Technical Assessment Body (TAB) on the basis of guidance given in a European Assessment Document (EAD) produced by the European Organisation for Technical Approvals (EOTA). Previously, under the requirements of the CPD, the relevant equivalent guidance for the issue of ETAs (then termed European Technical Approvals) for reactive coatings was documented in the EOTA Technical Specification ETAG018-2. At the time of ratification of this standard, ETAG018-2 is being edited into an EAD but all existing ETAs issued against ETAG018-2 remain valid until their expiry date. The ETA forms the basis of the voluntary CE marking of the product by the manufacturer based on a 'certificate of conformity' provided by a 'notified certification body' endorsing ongoing compliance of the product with its ETA.

This standard is intended to be supportive to the above mandatory process, reflecting agreed best practice within the industry and for adoption by manufacturers on a voluntary basis. Requirements of this standard do not conflict with requirements of ETAG018-2 or its superseding EAD. They may elaborate on the detail of essential production processes and procedures necessary to provide consistency of reactive products. Approaches are specified to assess the consequences to a products fire protection performance caused by variation or changes in product specification (e.g. changes in raw material) and/or production process (e.g. a process temperature). As such, it provides support to 'notified certification bodies', especially in relation to 'factory production controls' that should be exercised by product manufacturers.

This standard also provides a common basis for non-mandatory product characteristics that a manufacturer may wish to claim for a product, that fall beyond the scope of a product's ETA.

1 Scope

This European Standard relates to reactive coating systems intended to provide fire protection to metallic based structural members, including various grades and types of steel. Reactive coating systems may comprise the reactive coating component alone and/or that component used in conjunction with associated primers, topcoats and, if applicable, reinforcement. It covers the characterization of such systems in end use conditions.

NOTE Fundamental to proving the suitability of any reactive coating system to provide fire protection to any metallic substrate is its fire resistance performance determined in accordance with CEN fire resistance test methods, which are currently EN 13381-6, EN 13381-8 and prEN 13381-9. Consequently, the scope of application and fire performance of any reactive protection system is limited by the scope of available and applicable published CEN fire test methods.

The European Standard sets out the performance criteria, the verification methods used to examine the various aspects of performance, the assessment criteria used to judge the performance for the intended use and the presumed conditions for the design and execution of the reactive coating system in the works.

It deals with the compatibility of the reactive coating component with various primers and topcoats, and a reactive coating system's durability in a number of different service and end use conditions. Specifically, it provides a process for establishing 'generic' primer compatibility and acceptable topcoats for use with a given reactive component layer without prejudicing the reactive coating systems fire performance.

The European Standard also provides guidelines for the manufacture, storage, application, maintenance and repair of the reactive coating system and the final inspection of its installation in end use.

This European Standard does not specify the required performance level or classification [1)] of a given property to be achieved by a product to demonstrate fitness for purpose in a particular application. This European Standard establishes the route for generic primer approval and the use of specific top-coats with which the reactive coating may carry the CE mark.

This European Standard provides guidelines for the manufacture, storage, application, maintenance and repair of the reactive coating system and final inspection of works.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1363-1:2012, *Fire resistance tests — Part 1: General Requirements*

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

EN 13381-6, *Test methods for determining the contribution to the fire resistance of structural members — Part 6: Applied protection to concrete filled hollow steel columns*

EN 13381-8:2013, *Test methods for determining the contribution to the fire resistance of structural members — Part 8: Applied reactive protection to steel members*

prEN 13381-9, *Test methods for determining the contribution to the fire resistance of structural members — Part 9: Contribution of fire resistance to steel beams with web opening*

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

1) The performance levels or classes required for a given application can be found in regulations.

EN 13501-2:2007+A1:2009, *Fire classification of construction products and building elements — Part 2: Classification using data from fire resistance tests, excluding ventilation services*

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 products — Non-combustibility test (ISO 1182)*

EN ISO 1716, *Reaction to fire tests for products — Determination of the gross heat of combustion (calorific value) (ISO 1716)*

EN ISO 4618:2014, *Paints and varnishes — Terms and definitions (ISO 4618:2014)*

EN ISO 11664-4, *Colorimetry — Part 4: CIE 1976 L*a*b* Colour space (ISO 11664-4)*

EN ISO 11925-2, *Reaction to fire tests - Ignitability of products subjected to direct impingement of flame — Part 2: Single-flame source test (ISO 11925-2)*

EN ISO 13788, *Hygrothermal performance of building components and building elements — Internal surface temperature to avoid critical surface humidity and interstitial condensation — Calculation methods (ISO 13788)*

EN ISO 16474-3:2013, *Paints and varnishes — Methods of exposure to laboratory light sources — Part 3: Fluorescent UV lamps (ISO 16474-3:2013)*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 4618:2014 and the following apply.

3.1
reactive coating
reactive materials which are specifically formulated to provide a chemical reaction upon heating such that their physical form changes and in so doing provide fire protection by thermal insulative and cooling effects

3.2
reactive coating system
reactive coating layer together with a specified, blast primer, primer, tie-coat and topcoat if applicable

Note 1 to entry: The reactive coating system can contain reinforcing mesh.

3.3
test specimen
substrate, plus the reactive coating system under test

3.4
reactive coating thickness
mean dry film thickness (DFT) of the reactive coating only

3.5
section factor
ratio of the fire exposed outer perimeter area of the steel structural member itself, per unit length, to its cross sectional volume per unit length

3.6
steel temperature
overall mean temperature of the steel

3.7
blast primer
layer of corrosion protection applied to grit or shot blasted steel as a temporary protection to prevent corrosion prior to application of the main coat of primer

3.8
primer
coating applied directly to a suitably prepared steel surface to provide corrosion protection

3.9
tie-coat
coating applied prior to the reactive coating to improve the bonding

3.10
topcoat
coating(s) applied over the reactive coating as a protection against environmental degradation and/or for decorative purposes

3.11
reinforcing mesh
mesh applied in close proximity or fixed to the substrate

3.12
batch
unit or quantity of reactive coating produced in a single, complete production operation

3.13
durability
ability of the reactive coating system to maintain an adequate level of fire protection after exposure to environmental conditions

3.14
initial type testing
testing carried out in accordance with EN 13381-6 and/or EN 13381-8 to establish fire performance

3.15
controlled stock
product in stock that is traceable to a manufacturing record and factory production control test results

3.16
yield strength
stress level, for a given temperature, at which the stress-strain relationship of steel is truncated to provide a yield plateau as given in EN 1993-1-2

3.17
approved body
body nominated in accordance with Article 18 of the Construction Products Directive by an EU Member State or by an EFTA State (contracting party to the EEA Agreement), to perform specific tasks in the framework of the Attestation of Conformity decision for specific construction products (certification, inspection or testing)

Note 1 to entry: All such bodies are members of the Group of Notified Bodies.

4 Symbols and abbreviations

For the purposes of this document, the following symbols and abbreviations apply:

A/V section factor

DFT dry film thickness

FPC factory production control

QC quality control

RH relative humidity

SBI single burning item

5 Requirements

5.1 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 A. If the reactive coating system is intended to be used with or without a topcoat then both situations shall be tested.

5.2 Resistance to fire

Fire resistance classifications are given in Clause 7 of EN 13501-2:2007+A1:2009.

The resistance to fire tests and the assessment shall be carried out in accordance with EN 13381-8, EN 13381-6 and prEN 13381-9.

5.3 Durability

5.3.1 General

During the life time of the reactive coating system in service it may be subject to a variety of environmental conditions. The ability of the reactive coating system to withstand the adverse effects of water, humidity, UV, temperature, is a measure of its durability. Any deterioration of the reactive coating system shall have an effect on its fire resistance properties. The addition of a topcoat to the fire protection system shall not impair the fire resistance properties of the system. The evaluation of durability is addressed in this European Standard. Evaluation of durability against deterioration effects of chemicals, ozone or any other service environments are not addressed in this European Standard.

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 durability assessment is valid for all topcoat colours.

For environmental use categories type Y, W/Y and type X the test results could be influenced by the various topcoat types and their colours. No generic approach is possible in relation to the type of topcoat and the applicant shall test all topcoats. However, in order to cover all colours of a particular topcoat, a colour having an index $L^* < 50$ on the CIELAB [2)] scale (see EN ISO 11664-4) shall be selected for test. The decision to choose the colour of the topcoat used in durability assessment is taken by the Approved Body and the Applicant. The test results are valid for the tested topcoat and all its different colours.

Durability classifications are given in Table 1.

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

Table 1 — Durability classifications

Type	Exposure Description
X	intended for all conditions (internal, semi-exposed and exposed)
W/Y	Temporary full external for a maximum of 6 months then semi external
Y	intended for internal and semi-exposed conditions. Semi exposed includes temperatures below zero, but no exposure to rain and limited exposure to UV. (UV is not assessed)
W/Z1	Temporary full external for a maximum of 6 months then internal with high humidity
W/Z2	Temporary full external for a maximum of 6 months then internal with controlled environment
Z1	intended for internal conditions (excluding temperatures below zero) with high humidity
Z2	intended for internal conditions (excluding temperatures below zero) with humidity classes other than Z1 These conditions apply for internal humidity class 5 in accordance with EN ISO 13788.

5.3.2 Verification of durability

Durability shall be determined for a given reactive coating system by testing in accordance with Annex C after exposure to the conditions as described in Annex B for the required durability class. Durability is deemed verified when:

a) the average time to achieve a steel temperature of 500 °C is not less than 85 % of the average time achieved from identical unexposed panels or sections;

b) and no single result shall be less than 80 % of the average time to 500 °C of the identical unexposed panels or sections.

The approved body shall ensure that the furnace temperature conditions are identical for all the samples used for comparative testing.

To remove influences due to the variability of the thickness of the reactive coating, the relationship of thickness and time may be assumed as linear and corrected in accordance with the limits given in Annex C.

Where the result falls outside the above criteria, 4 additional specimens and a new control specimen shall be tested and assessed in this case all 4 specimens shall fulfil the above criteria.

In some instances a raw material change may affect durability and re-verification of durability shall be required. For guidance refer to Annex F.

5.3.3 Use of topcoats

A topcoat may comprise of:

a) a single layer of topcoat;

b) multiple layers of the same topcoat;

c) multiple layers of different topcoats.

The rules below shall apply to the topcoat system.

Where a topcoat is used to achieve the required durability classification then it shall be identified by its unique product reference and description. Generic equivalence is not acceptable.

Each topcoat shall be applied in accordance with the manufacturer's recommendation.

For each topcoat the minimum DFT used for durability testing to a particular exposure condition shall be the minimum DFT that can be specified for that exposure condition. The maximum DFT shall not be more than 50 % greater than that tested.

The topcoat may be applied in one or more layers and when referring to the minimum and maximum DFT below this shall be the total DFT of all of the layers.

The reactive coating system with topcoat shall then be subjected to the required environmental testing and the insulating efficiency shall then be determined in accordance with Annex C.

A topcoat is deemed approved if in combination with a reactive coating the system passes the claimed exposure testing.

5.4 Primer Compatibility

5.4.1 General

The reactive coating shall be compatible with a surface preparation, as recommended by the manufacturer, or the primer, such that not only is good adhesion achieved during normal service conditions, but also during fire exposure conditions.

5.4.2 Generic types

The most commonly used generic types of primer are given in Table 2. Only one primer from a primer family in Table 2 is subjected to testing.

Primers types not covered by the generic types listed in Table 2 and galvanized steel shall be the subject of a separate evaluation in accordance with Annex C. Each generic primer group shall be evaluated separately for both water borne and solvent borne primers. Solvent free primers shall be classed in the same generic group as the solvent borne equivalent.

Table 2 — Generic primer types

Generic Primer Type
Acrylic
Short/medium oil alkyd
Two component epoxy
Zinc rich epoxy (containing about 80 % by mass of metallic zinc powder in the dry film)
Zinc silicate

The allowed mean primer thickness range shall be as follows:

a) the minimum mean thickness shall not be less than 50 % of the mean thickness tested;

b) the maximum mean thickness shall not be greater than 50 % more than the mean thickness tested.

In all cases the maximum allowed generic primer DFT, as given in Table 2 shall not exceed the maximum DFT 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.

Where the primer is a system of more than one primer or more than one coat of the same primer then this shall be tested as a separate primer system.

Where a multi-coat priming system is used then the overall mean thickness and the individual mean thickness of each coat shall be limited to 20 % above that tested. This also includes situations where the priming system also includes a topcoat.

Where a temporary blast primer is used with a single coat of primer this is not considered to be a multi-coat system.

When a primer from any generic group is tested the generic approval shall be limited to other primers in the group provided the thickness is within the tolerance given in a) and b) above. The minimum allowed mean thickness shall not be less than the minimum recommended by the primer manufacturer.

Where a primer is not used then the surface preparation shall be specified and tested in accordance with Annex C.

Primer compatibility testing carried out on steel panels shall be acceptable for other ferrous substrates.

5.4.3 Verification of primer compatibility

All primer compatibility test panels shall be compared with the performance of panels primed with the same primer system as used in the initial type testing to EN 13381-8.

The primer thickness of the control panel shall not vary by more than ± 50 % of the thickness tested in initial type testing.

Primer compatibility is determined for a given system by testing in accordance with Annex C. Primer compatibility is deemed verified when the average time to achieve a steel temperature of 500 °C is not less than 85 % of the average time achieved in the control specimen tests. Also no single result shall be less than 80 % of the average time to 500 °C of the control primer test.

To remove influences due to the variability of the thickness of the reactive coating, the relationship of thickness and time may be assumed as linear and corrected in accordance with the limits given in Annex C.

Where the result falls outside the above criteria, four additional specimens may be tested and assessed. In this case all four specimens shall fulfil the above criteria.

The above verification procedure is equally acceptable if carried out on steel sections in accordance with Annex C.

5.5 Emission of dangerous substances

National regulations on dangerous substances can request the template of a document and a declaration on the release of such substances and part of their content in the implementation of the construction products covered by this standard on the market of the country concerned.

Until harmonized European test methods are available, the evidence and the declaration on the release of hazardous materials or their content should be used under consideration of the national regulations which are applicable at the place of use.

NOTE An information database of European and national regulations on dangerous substances is available on the website of the Commission Europe under "Construction" [in English], access via http://ec.europa.eu/enterprise/construction/cpd-ds/.

6 Evaluation of conformity

6.1 General

To ensure product conformity, all parts of Clause 5 shall be carried out. Evaluation of conformity is essential to ensure continued fitness for purpose of the reactive coating.

6.2 Sampling

The manufacture of the batch to be used for Type Testing shall be witnessed by an independent body and the unique batch number shall be recorded by the manufacturer.

A sample shall be taken for identification purposes as required by Annex D.

The containers shall then be sealed and labelled to ensure that future applications for type testing, durability and compatibility testing shall be from the witnessed batch.

6.3 Initial type testing

Reaction to fire testing and fire resistance testing shall be carried out in accordance with 5.1 and 5.2.

Durability testing shall be carried out in accordance with 5.3.

Compatibility testing shall be carried out in accordance with 5.4.

6.4 Characterization of the reactive coating

6.4.1 Analytical characterization

The reactive coating shall be identified to establish its unique formulation characteristics using analytical techniques.

The reactive coating shall undergo identification testing using thermogravimetric analyses (TG) and infrared-spectroscopy analyses (IR) in accordance with Annex D.

The results of identification testing shall be retained by the manufacturer and made available for inspection.

6.4.2 Physical characterization

Physical parameters shall be measured and recorded in order to characterize the physical properties of the reactive coating. These parameters shall include, density, and non-volatile content by mass. The latter shall be determined in accordance with Annex E.

6.5 Factory production control

The manufacturer shall establish, document and maintain an FPC system to ensure that the reactive coating placed on the market conforms to the declared performance characteristics obtained on the basis of initial type testing. The FPC system shall consist of procedures, regular inspections and tests and/or assessments and the use of the results to control raw and other incoming materials and components, equipment, the production process and the product. The FPC system shall comply with at least the requirements of Annex E and control of raw materials shall comply with at least the requirements of Annex F.

An initial inspection of the factory shall be carried out by an approved body and the frequency of surveillance of FPC shall be once a year to ensure continuing conformity. This inspection shall include an assessment of

the FPC and shall be carried out at each production unit to demonstrate that the FPC is in conformity with the requirements of this European Standard.

The manufacturer shall arrange for annual audit testing to be carried out to ensure that product delivered to market is in conformance with the initial type testing.

The annual audit testing shall include fire testing of reactive coating, either sampled from a controlled stock location or from witnessed production. The preparation of the fire test samples shall also be witnessed, although this may be at the manufacturer's premises providing adequate witnessing takes place including sampling of the product.

Audit testing shall comply with at least the requirements of Annex G.

7 Sustainability

Reactive coating systems are designed to protect steel structures from structural collapse in fire and therefore provide preservation of value, both economic and social. The carbon footprint of the applied reactive coating system is minimal compared to that generated by rebuilding a new structure. Also there will be a similar social and economic impact.

Fire protection strategies in multi-storey buildings usually assume that the fire is contained within the compartment of origin. If a fire is contained in this way, the damage is limited, as is smoke emissions and run-off from the fire-fighting activities. This can only be accomplished if proven and reliable passive fire protection systems are installed.

The provisions, test and assessment methods in this standard or referred to, have been written, based upon the assumed intended working life of the product for the intended use of 10 years up to 25 years provided that the product is subject to appropriate use and maintenance.

8 Marking

Reactive coatings conforming to this European Standard shall be clearly marked on the label with the following information:

a) number of this European Standard;

b) manufacturer's or supplier's identification reference;

c) product name;

d) batch number;

e) date of manufacture.

9 Additional voluntary requirements

A manufacturer may decide to include additional voluntary requirements, which are essential to the continued fitness for purpose of the reactive coating system. These additional voluntary requirements include manufacture, storage, application, maintenance, repair and inspection of final works. Guidelines for these additional voluntary requirements are given in Annex I.

Annex A
(normative)

Method for determination of reaction to fire

A.1 Guidance for testing in accordance with EN 13823

A.1.1 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.

A.1.2 Test specimens

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 topcoat shall be tested.

The set-up shall be tested with all assessed topcoats or, if known, with the topcoat 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 heat value determination (gross calorific potential as determined by EN ISO 1716)). To get all possible colours of the topcoat a black and red topcoat shall be tested. If the system in practice is used without topcoat the test according to EN 13823 shall be done without topcoat.

The set-up shall be tested with all assessed 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 heat value determination (gross calorific potential as determined by EN ISO 1716)). 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 dry film thickness. Prior to performing the test the samples shall be conditioned in accordance with EN 13238. The dry coating thickness shall be measured and recorded at a minimum number of 40 per 1 m^2 at uniformly distributed points prior to testing 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 topcoats and primers on steel substrates with a thickness ≥ 2 mm in the practical application.

A.2 Guidance for testing in accordance with 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 13823.

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 s exposure shall be used; for products of Class D or above, 30 s exposure shall be used.

The set-up shall be tested with all assessed topcoats or, if known, with the topcoat 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 heat value determination (gross calorific potential as determined by EN ISO 1716)). To get all possible colours of the topcoat a black and red topcoat shall be tested. If the system in practice is used without topcoat the test according to EN ISO 11925-2 shall be done without topcoat.

The set-up shall be tested with all assessed 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 heat value determination (gross calorific potential as determined by EN ISO 1716)). 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 topcoats taken into account for testing on steel substrates with a thickness ≥ 2 mm in the practical application.

A.3 Guidance for testing in accordance with 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 coatings is to be tested.

Annex B
(normative)

Exposure conditions for determination of durability classification

B.1 General

Each reactive coating system shall be exposed to the conditions in accordance with this Annex and tested in accordance with Annex C to achieve the classification given in Table 1.

The durability assessment is achieved through indirect testing in accordance with Annex C, i.e. the measurement of “insulating efficiency” as a characteristic related to the fire protective behaviour of the reactive coating system.

Durability is demonstrated by comparing the “insulating efficiency” of the initial unexposed specimen with that of the equivalent test specimen exposed to the appropriate exposure conditions given in B.2 to B.6.

The preparation and number of test specimens shall be in accordance with Annex C.

Products that meet the requirements of a particular exposure condition can also meet the requirements of other exposure conditions – details are given in Table B.1.

Table B.1 — Additional approvals based on the actual environmental testing carried out

	Tested in accordance with Type	X	Y	W/Y	W/Z1	W/Z2	Z1	Z2
Approved Type								
X		Yes						
Y		Yes	Yes					
W/Y		Yes		Yes				
W/Z1		Yes		Yes	Yes			
W/Z2		Yes		Yes	Yes	Yes		
Z1		Yes	Yes	Yes	Yes		Yes	
Z2		Yes	Yes	Yes	Yes	Yes	Yes	Yes

B.2 Exposure conditions for Type X: Reactive coating system intended for all conditions internal or external

The test specimens shall be exposed to UV and water according to EN ISO 16474-3:2013, Table 4, Cycle 2. The test specimens shall be positioned vertically in the test chamber and exposed to the test conditions for 28 d (112 continuous cycles). The specimens shall then be exposed under the conditions as described in Table B.2. The test specimens shall be positioned vertically in the test chamber. After exposure the specimens shall be tested according to Annex C.

B.3 Exposure conditions for Type Y: Reactive coating system intended for semi external conditions

The test specimens shall be exposed under conditions as described in Table B.2. After exposure the specimens shall be tested according to Annex C. The test specimens shall be positioned vertically in the test chamber.

B.4 Exposure conditions for Type W: Reactive coating system intended for temporary external exposure prior to final exposure conditions

The test specimens shall be exposed to UV and water according to EN ISO 16474-3:2013, Table 4, Cycle 2. The test specimens shall be positioned vertically in the test chamber and exposed to the test conditions for 5 d (20 continuous cycles). The specimens shall then be exposed to the conditions as described in Tables B.2, B.3 or B.4 depending on the final required exposure conditions. Following exposure the specimens shall be tested according to Annex C. This exposure condition shall be used in conjunction with the final exposure conditions which shall result in classifications W/Y, W/Z1 and W/Z2 respectively.

B.5 Exposure conditions for Type Z1: Reactive coating system intended for internal conditions with high humidity

The test specimens shall be tested under conditions as described in Table B.3. The test specimens shall be positioned vertically in the test chamber. After exposure the specimens shall be tested according to Annex C.

B.6 Exposure conditions for Type Z2: Reactive coating system intended for internal conditions with controlled environment

The test specimens shall be tested under conditions as described in Table B.4. The test specimens shall be positioned vertically in the test chamber. After exposure the specimens shall be tested according to Annex C.

Table B.2 — External and semi-external exposure conditions

Day	Time			
	6 h	**6 h**	**6 h**	**6 h**
1 + 2	(20 ± 3) °C; (95 ± 5) % RH	(70 ± 3) °C; (20 ± 5) % RH	(20 ± 3) °C; (95 ± 5) % RH	(70 ± 3) °C; (20 ± 5) % RH
3 + 4	(20 ± 3) °C; (95 ± 5) % RH	(30 ± 3) °C; (40 ± 5) % RH	(40 ± 3) °C; (95 ± 5) % RH	(30 ± 3) °C; (40 ± 5) % RH
5 + 6 + 7	(−20 ± 3) °C	(40 ± 3) °C; (95 ± 5) % RH	(−20 ± 3) °C	(40 ± 3) °C; (95 ± 5) % RH
8 + 9	(20° ± 3) °C; (95 ± 5) % RH	(70 ± 3) °C; (20 ± 5) % RH	(20 ± 3) °C; (95 ± 5) % RH	(70 ± 3)° C; (20 ± 5) % RH
10 + 11	(20 ± 3) °C; (95 ± 5) % RH	(30 ± 3) °C; (40 ± 5) % RH	(40 ± 3) °C; (95 ± 5) % RH	(30 ± 3) °C; (40 ± 5) % RH
12 + 13 + 14	(−20 ± 3) °C	(40 ± 3) °C; (95 ± 5) % RH	(−20 ± 3) °C	(40 ± 3) °C; (95 ± 5) % RH

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

Table B.3 — Internal conditions with high humidity

Cycles	Time	
	8 h	**16 h**
21	(40 ± 3) °C; (98 ± 2) % RH	(23 ± 3) °C and cabinet off and open to atmosphere

Table B.4 — Internal conditions with controlled environment

Cycles	Time		
	4 h	**16 h**	**4 h**
21	(23 ± 3) °C; (80 ± 5) % RH	(40 ± 3) °C; (50 ± 5) % RH	(5 ± 3) °C; (50 ± 5) % RH

Annex C
(normative)

Insulating Efficiency — Test Procedure

C.1 General

This procedure is used to determine the insulating efficiency of reactive coatings and it is applicable to the requirements of FPC, primer approval, topcoat approval and durability testing. For FPC the results are compared to historical data and eventually there will be sufficient batch test data to construct a pass/fail graph (see C.3). For durability the insulating efficiency of the panel under test shall be compared to that of an identical unexposed control panel. For primer approval the insulating efficiency of the panel with the new primer under test shall be compared to that of an unexposed control panel prepared using a type tested primer. Only the primer as used for type testing shall be used to evaluate all required topcoats for durability.

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. For wall furnace, 2 plate thermocouples shall be positioned at half height of each row of test specimens at 150 mm distance of the specimens. For cubic furnaces, where 2 samples on each side of the furnace are tested, the furnace shall be controlled in accordance with the requirements of EN 13381-8:2013, 9.2.4.1.The test specimens shall be prepared in accordance with the manufacturer's instructions for the fire protective system concerned. Prior to exposure, specimens shall be stored at (23 ± 3) °C and (50 ± 5) % RH for a period of time as specified by the manufacturer for drying.

All specimens following durability testing shall be stored at (23 ± 3) °C and (50 ± 5) % RH between the end of the exposure and the fire testing for a minimum of 1 week.

The coating dry thickness shall be measured and recorded at a minimum number of 40 per square metre provided at least 10 readings are taken. Readings should be taken at uniformly distributed points prior to testing and shall comply with the requirements of EN 13381-8:2013, 6.5.1.2.

C.2 Test specimens

The specimens shall consist of steel panels having a nominal thickness of 5 mm with a minimum panel size of 300 mm × 200 mm and a maximum panel size of 500 mm × 500 mm. For every requirement a minimum of two specimens shall be tested. The insulating efficiency for the two specimens is compared with the insulating efficiency of two unexposed control specimens.

Alternatively, the procedure described in C.3 can be used to test primers on short columns of at least 500 mm in length. The steel sections shall be the same serial size selected from a nominal A/V range of 180 m^{-1} to 200 m^{-1}. For practical reasons steel sections cannot be used for durability determinations.

The primer and the topcoat used 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 (1,0 ± 0,1) mm dry film thickness or the maximum thickness if the maximum thickness is lower. Some materials may have a minimum application thickness greater than 1,0 mm, in which case the minimum application thickness should be applied.

C.3 Test Procedure

In the case of panels they shall be placed in the furnace in a vertical position such that the side without the reactive coating layer is not exposed to the fire. The panel shall be mounted in a frame which forms part of one side 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 50 mm with a bulk density of (475 ± 25) kg/m^3 or mineral wool (stone wool) with a minimum thickness of 20 mm and a bulk density of (110 ± 10) kg/m.

Two thermocouples shall be attached to the non-fire side of the steel panels. These thermocouples shall be located in the central region of the panel on the vertical centreline as shown in Figure C.1. For panel sizes 400 mm × 300 mm and greater than four thermocouples shall be attached to the non-fire side of the steel panels. These thermocouples shall be located in the central region of the panel on the vertical centreline as shown in Figure C.2.

In the case of steel columns three thermocouples shall be attached, one on each flange and one on the web, as shown in Figure C.3. In the case of columns of a length greater than 500 mm, the thermocouples shall be in accordance with the requirements of EN 13381-8:2013, 9.3.5.

For both steel panels and columns the thermocouples shall be of Type K and shall be fixed to the back of the steel panels by spot welding or drilling and peening.

The fire test shall be terminated when the average temperature of the thermocouples on each specimen reaches 500 °C.

In the case of steel columns they shall be constructed in accordance with the requirements of EN 13381-8:2013, 7.4.

To remove influences due to the variability of the thickness of the reactive coating, the relationship of thickness and time may be assumed as linear and corrected in accordance with the limits given in EN 13381-8:2013, Annex D.

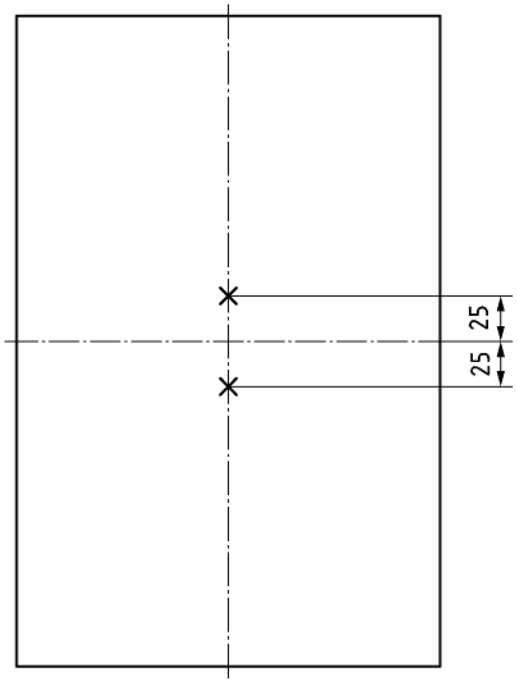
For primer approval, topcoat approval and durability testing the pass/fail criteria is deemed satisfied when the average time to achieve a steel temperature of 500 °C is not less than 85 % of the average time achieved in the initial control tests. Also no single result shall be less than 80 % of the average time to 500 °C of the initial control test.

For FPC the pass/fail criteria shall be based on the first 10 batches tested. A graph shall be constructed based on dry film thickness and time to 500 °C. The pass criteria shall be within 15 % of this graph.

C.4 Test Report

The time for the non-fire side of the steel to reach an average temperature of 500 °C, the thickness measurements and a description of each test specimen shall be described in the test report.

Dimensions in millimetres



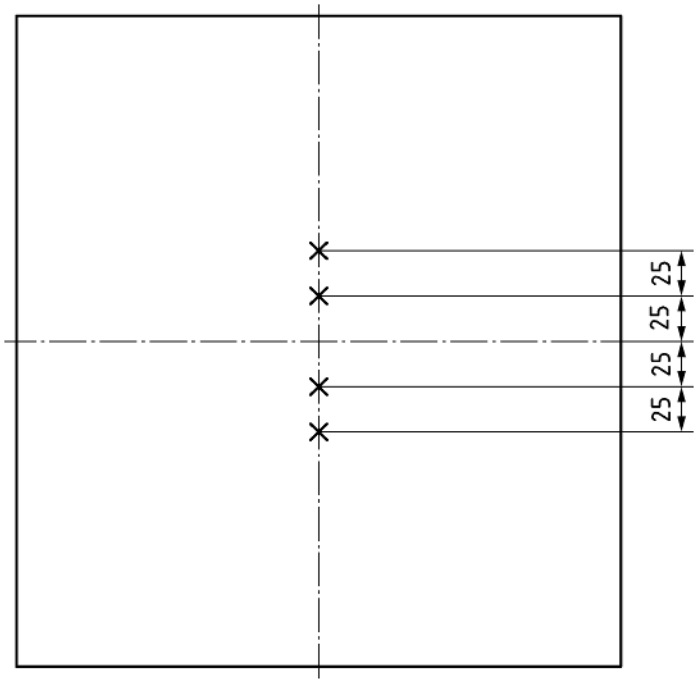
Key

× thermocouple

NOTE Figure C.1 is not to scale.

Figure C.1 — Thermocouple positions: Minimum Size Specimen

Dimensions in millimetres

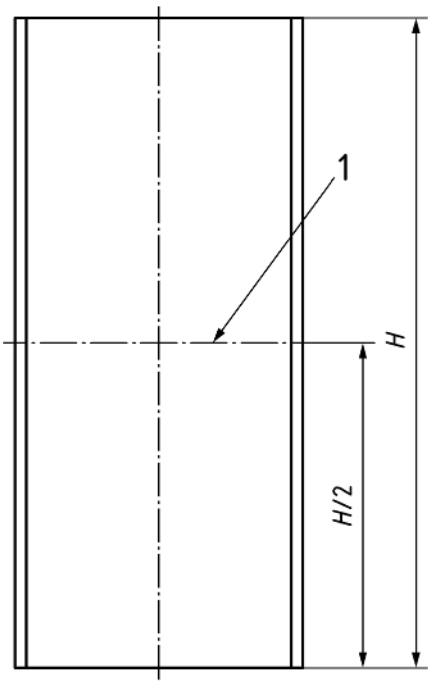


Key

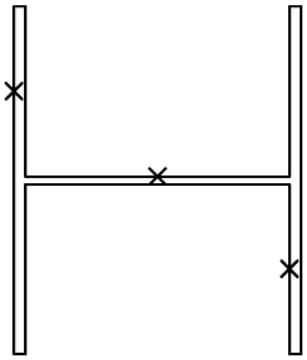
× thermocouple

NOTE Figure C.2 is not to scale.

Figure C.2 — Thermocouple positions: Specimen above minimum size



a) Short column elevation



b) Position 1

Key

1 thermocouple locations applicable to short columns (3 total)

H height

NOTE Figure C.3 is not to scale.

Figure C.3 — Columns — Thermocouple positions

Annex D
(normative)

Determination of identification characteristics

D.1 General

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

D.2 Reporting of Specific Methodology for determination of identification characteristics

All sampling techniques and testing procedures shall be thoroughly documented and retained by the manufacturer.

This is essential to ensure that any future analysis will be carried out and reported and carried out in the same manner.

Annex E
(normative)

Factory production control

E.1 General

The manufacturer's quality control records shall be available for inspection at any time and at all sites where manufacture of the reactive coating takes place.

E.2 Quality control testing

The minimum requirements for quality control testing shall be in accordance with Table E.1.

Table E.1 — Minimum requirements for quality control testing

Test No	Property	Test Method	Minimum frequency
Raw materials			
1	Quality and consistency	Manufacturer's test method or supplier's certificate of conformity	Every batch
Reactive coating			
1	Char expansion [a]	Manufacturer's test method for measurement of char depth See H.2.	Every batch [b] [c]
2	Insulating efficiency	In accordance with Annex C See also H.3.	Every 10th batch, or at least once per month
3	Solids by mass or specific gravity	Manufacturer's test method	Every batch
4	Viscosity	Manufacturer's test method to establish rheology limits	Every batch
5	Curing time (multi component systems only)	Manufacturer's test method to determine speed of curing	Every batch
6	Appearance, degree of pigment dispersion, etc.	Manufacturer's check that the material has been dispersed properly	Every batch

[a] When a reactive coating in its unreacted state is subjected to fire it expands producing a char and the char expansion depth is measured and recorded.

[b] If the result of the test for char depth test shows a deficiency then an insulating efficiency test shall be carried out.

[c] If the insulating efficiency is carried out on every batch then the char expansion test is not necessary.

E.3 Initial factory inspection

The manufacturer shall arrange for assessment of the factory production control system, initial inspection and continued surveillance by an independent body; see 6.5.

Annex F
(normative)

Alternative raw materials, formulation and process changes

F.1 General

Any change of formulation, raw material supply or manufacturing process shall be verified by fire testing in accordance with Table F1.

Table F.1 — Verification of fire performance

Probability of effect on fire protection performance	Fire test level [a]
Certain	5
High	4
Moderate	3
Low	2
Very low	1

[a] Fire test levels are defined in Annex H with Level 5 testing being the most severe where the effect on fire performance is deemed certain. Level 1 fire testing is the least severe where the probability of .affecting fire performance is very low.

F.2 Formulation tolerances

Formulation ingredients will have allowable tolerances applied to them to allow for variations in the physical properties of different sources of the same raw material e.g. specific gravity.

For weight or volume variations of a raw material within a formulation dry film composition shall be within ± 0,2 % of the original weight of that raw material.

In the case of minor additives such as thixotropes, wetting agents, defoamers which are present to control rheological properties the above limit does not apply and may be varied along with the quantity of solvent or water. Any variation in these amounts shall not affect the percentage variation of any other raw material by more than 0,2 %.

F.3 Formulation change

Where the binder resin, acid source, plasticizer, carbon source or blowing agent type is changed, then repeat type testing will be required.

Pentaerythritol and dipentaerythritol (carbon sources) can be used interchangeably provided that Level 5 fire testing and the required durability testing are carried out.

F.4 Raw material approval of an alternative

Tables F.1 and F.2 indicate the level of action required depending on the raw material type and the level of change of grade and supply. The level of action is indicated by Fire Test Levels 1 to 5 which are defined in Annex H. Table F.2 also indicates whether durability may be affected by each raw material change.

Table F.2 — Verification of performances

Component/raw material	Situation/circumstance	Fire test level [a]	Effect on performance [b]
Acid source (e.g. APP)	Change of grade or supplier.	5	Yes
Binder	Change of the supplier of the resin binder used in type testing.	5	Yes
Plasticizer	Change of resin, molecular weight or grade.	5	Yes
	Alternative supplier of same material as used in type testing, same assay and particle size distribution.	3	No
Blowing agent (e.g. melamine)	Change of resin, or grade.	5	Yes
	Alternative supplier of same material as used in type testing, same assay and particle size distribution.	2	No
Reinforcement (e.g. fibre)	Change of material type or fibre length, particle size distribution.	5	Yes
	Alternative supplier of same material as used in type testing, same assay and particle size distribution.	2	No
Carbon source	Change of grade e.g. purity, particle size distribution.	5	Yes
	Alternative supplier of same material as used in type testing, same assay and particle size distribution.	2	No
Liquid carrier/coalescing solvent in a water borne material [c]	Change of carrier/coalescing solvent.	3	Yes
	Alternative supplier of same material as used in type testing, same assay.	1	No
Organic solvent in a solvent borne material	Change of solvent in a solvent borne material.	2	No
	Alternative supplier of same material as used in type testing, same assay.	1	No
Mineral filler or titanium dioxide	Change of type, particle size distribution, purity/grade.	4	Yes
	Alternative supplier of same material as used in type testing, same assay.	2	No
Wetting or dispersion agent and similar additive	Change of type.	3	Yes
	Alternative supplier of same material as used in type testing, same assay.	2	No
Thixotrope	Change of grade or type.	3	Yes
	Alternative supplier of same material as used in type testing, same assay.	2	No

[a] Fire test levels are defined in Annex H.

[b] Where Table F.2 indicates that the alternative raw material may result in a change in the durability, then durability shall be reassessed to the current classification in accordance with Annex B.

[c] This is solvent that stays in the film long enough to bring the resin particles together to form a matrix without fully dissolving them - this is the difference between solvent borne and water borne

For solvent borne reactive coatings where the same raw material is replaced in more than one reactive coating, then the topcoat evaluation shall only be required for one of them.

If the reactive coating system is classified without a topcoat, then this should be replaced with an alternative topcoated system.

In both cases, reassessment should progress against the requirements for the most severe exposure type that the reactive coating systems are classified.

For each topcoat the most severe exposure type shall be tested.

Reassessment can progress with any of the classified primers but the primer shall remain consistent in all reactive coating systems.

Table F.3 — Topcoat exposure types – Example 1

	Exposure types						
	X	**Y**	**W/Y**	**W/Z1**	**W/Z2**	**Z1**	**Z2**
Reactive Coating Systems	Primer Reactive Topcoat 1	Primer Reactive Topcoat 1	Primer Reactive Topcoat 1	Primer Reactive Topcoat 1	Primer Reactive Topcoat 1	Primer Reactive Topcoat 1	Primer Reactive Topcoat 1
		Primer Reactive Topcoat 2	Primer Reactive Topcoat 2	Primer Reactive Topcoat 2	Primer Reactive Topcoat 2	Primer Reactive Topcoat 2	Primer Reactive Topcoat 2
			Primer Reactive Topcoat 3	Primer Reactive Topcoat 3	Primer Reactive Topcoat 3	Primer Reactive Topcoat 3	Primer Reactive Topcoat 3
				Primer Reactive	Primer Reactive	Primer Reactive	Primer Reactive

X type system and W/Z1 system without topcoat to be reassessed as the most severe exposure types with and without topcoat.

Table F.4 — Topcoat exposure types – Example 2

	Exposure types						
	X	**Y**	**W/Y**	**W/Z1**	**W/Z2**	**Z1**	**Z2**
Reactive Coating Systems		Primer Reactive Topcoat 1	Primer Reactive Topcoat 1	Primer Reactive Topcoat 1	Primer Reactive Topcoat 1	Primer Reactive Topcoat 1	Primer Reactive Topcoat 1
		Primer Reactive Topcoat 2	Primer Reactive Topcoat 2	Primer Reactive Topcoat 2	Primer Reactive Topcoat 2	Primer Reactive Topcoat 2	Primer Reactive Topcoat 2
						Primer Reactive	Primer Reactive

One of the Y type systems agreed between manufacturer and approved body and the Z1 system without topcoat to be reassessed as the most severe exposure types with and without topcoat.

Table F.5 — Topcoat exposure types – Example 3

	Exposure types						
	X	**Y**	**W/Y**	**W/Z1**	**W/Z2**	**Z1**	**Z2**
Reactive Coating Systems		Primer Reactive Topcoat 1	Primer Reactive Topcoat 1	Primer Reactive Topcoat 1	Primer Reactive Topcoat 1	Primer Reactive Topcoat 1	Primer Reactive Topcoat 1
		Primer Reactive Topcoat 2	Primer Reactive Topcoat 2	Primer Reactive Topcoat 2	Primer Reactive Topcoat 2	Primer Reactive Topcoat 2	Primer Reactive Topcoat 2

Both Y type systems to be reassessed as the most severe exposure types.

Table F.6 — Topcoat exposure types – Example 4

	Exposure types						
	X	**Y**	**W/Y**	**W/Z1**	**W/Z2**	**Z1**	**Z2**
Reactive Coating Systems		Primer Reactive Topcoat 1	Primer Reactive Topcoat 1	Primer Reactive Topcoat 1	Primer Reactive Topcoat 1	Primer Reactive Topcoat 1	Primer Reactive Topcoat 1
						Primer Reactive Topcoat 2	Primer Reactive Topcoat 2

Both Y and Z1 type systems to be reassessed as the most severe exposure types.

F.5Process and equipment change

If the type of manufacturing equipment, processing time and/or temperature is changed then a Level 3 test shall be carried out.

If the batch size for a solvent borne product is increased or decreased by more than 100 % then a Level 3 test shall be carried out. If the batch size of water borne product is increased or decreased by more than 50 % then a Level 3 test shall be carried out.

If increasing the batch size is carried out as a step-wise increase in more than one stage then it will only be necessary to carry out the Level 3 test on the maximum batch size. Level 3 fire testing is defined in Annex H.

F.6Managing multiple production sites

Where more than one production site is used for manufacture, each site shall apply the appropriate testing procedures. Product from all production sites shall be subject to the FPC requirements of this European Standard.

Annex G
(normative)

Audit testing

G.1 General

The objective of audit testing is to verify the on-going validity of the initial type testing. It shall be conducted on an annual basis for each product. Normally, audit testing represents a repeat of the type testing of the product or at least a simplified version of that testing. It is accepted that it is impractical to test the product over a similar range of temperatures, application thicknesses, section types, and steel section factors as is used for type testing. The product's performance is therefore validated at three positions across its performance range.

Where a manufacture produces more than one product of the same type, with a similar performance level and under a similar detailed quality control programme using the same process and plant, then a further concession is possible that allows the mixing of different products within an agreed audit testing programme over a number of successive years. Irrespective, there shall always be a single point audit test result produced for every product every year and the scope of each product's performance, in terms of temperature, application thickness, section type, and steel section factor shall be covered over a period not exceeding three years.

If QC testing is carried out on sections or panels then audit testing may be conducted using in-house testing, subject to evidence of adequate correlation between the in-house furnace and the type testing furnace which is to the satisfaction of the third party approved body. Preferably, any in-house testing furnace should be the same furnace in which routine quality control testing is carried out to ensure that a consistent history of fire test information is established. Any in-house testing shall be conducted under the responsibility of and shall be witnessed by an independent third party.

To provide a link with the initial type testing performance data it is necessary to ensure that, at the time of that testing, a relationship is established between product performance during the type testing and the product's performance in any furnace to be used for future on-going proxy audit testing. Demonstration of adequacy of the relationship shall involve and be confirmed by the approved body.

G.2 Selection of product and preparation of test specimens

The material to be subjected to audit testing shall be sampled by the approved body or an independent body appointed by the approved body. Ideally it shall be taken direct from production or alternatively from the manufacturer's secure stock from the same batch at one of the production sites.

The preparation of the test specimens and the application of the product shall be witnessed by the approved body or an independent body appointed by the approved body.

G.3 Choice of test specimens

The steel sections chosen and the associated product thicknesses for the audit testing shall match, as close as possible, those used on individual specimens employed within the initial type testing of the product.

A single "I" section column with a mid-range thickness and targeted at the maximum fire resistance performance period for the product (a control specimen) shall be tested every year. Additionally, other test specimens shall be chosen on the basis of the advice offered in Table G.1 below, providing for a review of the product performance over the range of section types, section factors, applications, thicknesses, and fire resistance performance over a three year period.

G.4 Illustrative testing pattern

An example pattern of annual audit testing for a single product is given in Table G.1. Where a manufacturer produces multiple products, the audit testing may include short sections from more than one product, as provided for above and agreed with the approved body. However, in such cases, the total number of audit test specimens shall not be less than six per annum with at least a control specimen for each product being included.

Table G.1 — Example test pattern

Year	Section Factor	Section Shape	Dry Film Thickness
1	Mid-range	I-column	Mid-range
	Higher upper quartile	I-beam	Higher upper quartile
	Mid-range	Worst hollow column shape [a]	Mid-range
2	Mid-range	I-column	Mid-range
	Higher upper quartile	I-column	Higher upper quartile
	Mid-range	I-beam	Mid-range
3	Mid-range	I-column	Mid-range
	Lower quartile	I-beam	Lower quartile
	Higher upper quartile	Worst hollow column shape [a]	Higher upper quartile
[a] As established during the type testing programme to EN 13381–8.			

G.5 Audit test procedure

The audit testing shall be conducted on short steel sections with a minimum length of 900 mm.

Where testing is conducted on a proxy furnace, that furnace shall have a minimum equipment specification as follows:

a) linear internal dimensions of 1 m length by 1 m width by 1 m height;

b) fuel, burner type and lining materials to meet EN 1363-1;

c) be able to test minimum 0,9 m vertically orientated column sections exposed on four sides and/or minimum 0,9 m horizontally orientated beam sections exposed on three sides, generally according to EN 13381-8.

G.6 Audit test results

The results of the testing shall be reported in an audit testing progress file and shall be made available for inspection when required. Any issues requiring action shall be highlighted.

To remove influences due to the differences in thickness of the reactive coating and A/V in the audit testing and the type testing, the relationship of thickness and time may be assumed as linear and audit test performance times corrected in accordance with the limits given in EN 13381-8:2013, Annex D. The corrected time for each specimen to reach 500 °C shall be determined and the differences in these times and the corrected times given from the type testing shall be recorded.

In the case of a “low performance”, the manufacturer shall take appropriate revalidation procedures involving further testing agreed with the approved body.

Pass/fail criteria for low performance is given in H.4 and H.5.

G.7 Non-compliance

In the case of audit testing indicating “low performance” then the frequency of the insulating efficiency test shall be increased to every fourth batch while further investigations are made with the approved body in order to determine:

a) firstly, whether the non-compliance is restricted to the particular batch(es);

b) whether overall product performance has changed;

c) what changes may have been made in the product constituents or its manufacture or to the quality systems that might lead to the inadequacies;

d) if there were problems associated with the adequacy of the audit testing or even the original type testing;

e) whether further testing should be conducted with a view to supporting suspension of production.

Any further testing shall comprise audit testing of freshly sampled product from another batch of the same product(s). As a minimum, the testing shall involve three short column sections and three short beam sections, together spanning the scope of performance of the product, plus a circular hollow column and a rectangular hollow column.

The testing shall be conducted at an EN ISO/IEC 17025 accredited test laboratory under the responsibility of the approved body.

The results from each of these short sections shall be compared with those of the equivalent short sections used in the type testing programme, and each individual audit test result, in terms of time to reach 500 °C, shall be within 85 % of the type test result with an average of all results being at least 90 % of the average type test results.

If this adequate level of performance is achieved, then subject to the implementation of any improvements agreed as necessary between the approved body and the manufacturer, production may be resumed.

Should an inadequate performance be obtained, then the product shall be re-evaluated.

Annex H
(normative)

Levels of fire testing

H.1 General

The fire test levels described below are used for both quality control batch testing and also to re-affirm quality and/or durability following a raw material change.

H.2 Level 1 fire testing

Every production batch shall pass a “char expansion” test as described in E.2.

This test is intended to demonstrate a good and consistent degree of intumescence. A variety of acceptable test methods are already in use by various manufacturers, so no method is prescribed. The method selected, however, should meet the following minimum requirements:

a) The results of the testing shall be recorded as part of the company’s formal Quality Control (QC) system;

b) the inputs (coating thickness/mass over defined area, level of cure, steel thickness, sample geometry, heat source and duration) are adequately defined and have been applied;

c) the char height shall be recorded from a number of batches and shall be basis of establishing the baseline char height for the same thickness of coating tested to Level 2; the pass/fail criteria defined by the manufacturer shall be based on a statistically acceptable number of measurements;

d) the secondary outputs (subjective char qualities such as adhesion, cohesion, structure, etc.) are recorded in a structured and repeatable manner.

In the case of failure to meet the baseline char height and if repeat Level 1 testing fails to meet the baseline char height then Level 2 testing shall be carried out.

H.3 Level 2 fire testing

This test shall be carried out in accordance with Annex C using steel plates on every tenth batch of material. In the case of inadequate performance a batch recall or other suitable investigation and corrective action is required.

The test method shall meet the following requirements:

a) The batches selected are at least one in 10, on average, for routine production;

b) the results of the testing shall be recorded as part of the company’s formal QC system;

c) the furnace shall be calibrated and meet the requirements of EN 1363-1:2012, 4.2;

d) the inputs (coating thickness/mass over defined area, level of cure, steel thickness, sample geometry, heat source and duration) are adequately defined and have been applied;

e) time against steel temperature is measured according to the test principles given in Annex C for steel sections;

f) the secondary outputs (subjective char qualities such as adhesion, cohesion, structure, etc.) have also to be recorded in a structured and repeatable manner.

The manufacturer shall establish upper and lower limits for thickness against time based on Level 2 fire test data; normally a minimum figure of 90 % of the standard time with a moving average of 95 % shall be achieved over 10 batches. In the case of low performance a repeat Level 2 test is carried out. If the repeat test confirms low performance then either Level 3 testing is carried out or the batch is rejected. If it is decided that a Level 3 fire test is carried out then the batch shall not be released unless the results are satisfactory. If Level 3 fire testing fails to meet the pass/fail criteria then the batch shall be rejected.

If the batch is finally rejected then the batch prior to this batch should also be subjected to Level 2 testing and this cycle shall be repeated until a batch that passes the Level 2 fire testing is found. Any batches rejected during this process that have already been dispatched shall be withdrawn from stock or from the customer if they have been released. If the batch has already been applied in the field then an assessment shall be carried out based on the reduced fire performance which may ultimately require application of more product or removal followed by re-application.

H.4 Level 3 fire testing

The manufacturer shall arrange for an annual audit of the production facility and the quality control fire testing. This level of testing is appropriate for this annual audit, but may also be carried out as a non-conformance action following Level 2 failure.

The annual audit shall include a fire testing of material, either sampled from a controlled stock location or from witnessed production. Preparation of the fire test samples shall be witnessed, and this may be at the manufacturer's premises. In the instance where Level 3 testing is carried out as a non-conformance action following a Level 2 failure, the requirement for random sampling and witnessed preparation may not be required.

A key component of the audit testing is that it shall include a pattern of testing that varies from year to year to cover the range of the assessment. This is intended to ensure that any subtle effects, such as variance in char formation at high A/V and DFT are identified.

If QC testing is carried out on sections or panels then audit testing may be conducted using in-house testing, subject to evidence of adequate correlation between the in-house furnace and the type testing furnace which is to the satisfaction of the third party approved body. As with Level 2 testing, the basis for the pass criteria is ideally derived from testing on the batch(es) of material from the original type testing. With existing products the manufacturer shall ensure that the test evidence exists, otherwise he shall carry out testing to create a link between routine QC testing and type testing.

Pass/Fail Criteria for low performance:

a) the average time for the three specimens to reach 500 °C shall not be less than 85 % of the average time for the original specimens from initial type testing to reach 500 °C;

b) the time for any individual specimen to reach 500 °C shall not be less than 80 % of the time for the equivalent original specimen from initial type testing to reach 500 °C.

NOTE The above criteria can be modified with the agreement of the Approval Body depending on the correlation between the furnaces.

The report on the results of the testing shall be made available to the manufacturer and shall highlight any issues requiring action. In the case of a low performance, the manufacturer shall be notified of appropriate corrective action.

H.5 Level 4 independent fire testing

This level of testing shall be carried out at an Independent Approved laboratory and requires either market-sampled material, or witnessed manufacture, and supervised preparation.

Market sampled material cannot be used when testing a raw material change. The test should cover beams, columns and hollow sections, if appropriate. A minimum level of testing to prove the scope of the assessment should be agreed. A test on two 1 m beams and two 1 m columns, one of which may be a hollow section, shall normally be appropriate. In any case the sections shall be the same as some of those from type testing. This allows multiple products to be tested in a single run of a floor furnace.

Pass/Fail Criteria for low performance:

a) the average time for the four specimens to reach 500 °C shall not be less than 85 % of the average time for the original specimens from initial type testing to reach 500 °C;

b) the time for any individual specimen to reach 500 °C shall not be less than 80 % of the time for the equivalent original specimen from initial type testing to reach 500 °C.

H.6 Level 5 independent fire testing

This level of testing shall be carried out at an independent approved laboratory and requires either market-sampled material, or witnessed manufacture, and supervised preparation.

NOTE Market sampled material cannot be used when testing a raw material change.

The main element of this level of testing is a loaded section. The most appropriate specimen shall be a direct repeat of the original maximum DFT loaded beam to prove direct equivalence.

In addition a series of short beams, columns, and hollow sections (as appropriate) to cover the scope of the assessment shall be tested in the same furnace. In any case the sections shall be the same as some of those from Type Testing in accordance with EN 13381-8.

The pass criteria are as follows:

The loaded section shall prove stickability at the original DFT by achieving a load bearing capacity within 10 % of the time period achieved by the original loaded beam from type testing in accordance EN 13381-8 (provided the yield strengths can be shown to be similar). In addition the thermal performance shall be within 10 % of the original loaded beam from type testing in accordance with EN 13381-8.

The pass/fail criteria for the short sections shall be in accordance with H.5. To allow the manufacturer to make best use of this test it is suggested that it should be possible to combine a Level 5 test on one product with a Level 4 on another in the same furnace load.

Annex I
(informative)

Guidance for manufacture, storage, application, inspection and repair

I.1 Manufacture

I.1.1 Manufacturing equipment

The equipment used in the production of reactive coatings may be product dependent. Any change in the manufacturing equipment may have an effect on the products level of resin dispersion and pigment or powder dispersion.

Equipment changes should be verified by quality control testing (FPC) and by appropriate fire testing as described in E.2 and F.4.

I.1.2 Temperature during manufacture

Production procedures should indicate the maximum temperature allowed for a reactive coating during the manufacturing process.

The temperature should be monitored during all production processes that have the potential to exceed the upper temperature limits for a product. This includes re-heating a batch as part of the filling process.

I.1.3 Manufacturing blending time

The sequence in which component parts of a reactive coating are added to the final mix may affect the fire performance of a coating.

The order in which component parts are added and blending times should be specified. The blending time will be determined by the required dispersion level of the pigments and powders and the maximum temperature allowed during manufacture.

I.1.4 Raw material quality and traceability

The traceability and quality of raw materials is essential and should be incorporated as a requirement of any company quality assurance scheme.

The quality and consistency of supply of any raw material should be demonstrated, for example, by in-house testing or by a valid Certificate of Conformity or Certificate of Analysis, which comply with the reactive coatings manufacturer’s required supply specification.

I.2 Storage of raw materials

The recommended storage conditions including acceptable temperature and humidity ranges for all raw materials should be advised by the raw material manufacturer or supplier.

All products should be stored in accordance with these instructions.

I.3 Storage of finished product

During its shipping and storage prior to use, the reactive coating may be exposed to various levels of temperature, extremes and other factors, some of which may be prejudicial to the stability and longevity of the

product and its ability to provide the fire protection performance. While in the can, the effects of temperature are considered as a function of “shelf life”. Guidance is given in manufacturer’s product technical data sheets.

I.4 Application

I.4.1 General

The reactive coating system would normally comprise of primer, reactive coating and topcoat. It is therefore essential that equal attention is given to the application of all the components of the system.

Most construction projects are complex and involve a range of section sizes and configurations, each requiring a different thickness of reactive coating to provide the specified level of protection.

The coating schedule for such a structure may therefore be quite complicated, and one of the main tasks for the site sub-contractor will be ensuring that each steel section receives the correct thickness of fire protection. It is therefore essential that before application commences an application schedule is prepared, which can also be used as the basis for inspection.

Temperature and other environmental conditions may also have considerable influence over the ability of the product to be applied correctly.

I.4.2 Application schedule

In order to assist the sub-contractor to deliver the correct quality of work, and to provide an easy reference for subsequent quality control checks, the following documents should be made available at the commencement of the work:

a) a copy of the plans and drawings of the structure;

b) a list of the reactive coating thicknesses required for each steel section size;

c) a schedule of the measured primer thickness for pre-primed steelwork;

d) where specified the required topcoat thickness for protection of the reactive coating.

The coating sub-contractor may use this information to prepare an application schedule that best suits his work methods, and should retain the documentation for quality assurance purposes, either by his own quality assurance inspector or to assist any third party inspection required by the contract.

I.4.3 Compatibility

In all cases the steel elements for any construction project will arrive on site already primed or with primer and reactive coating. In the case of primed steel only it is necessary for the reactive coating applicator to identify the primer and its condition in consultation with the manufacturer to ensure that it is compatible with the reactive coating. Further preparation in accordance with the manufacturer’s recommendations should be carried out if deemed necessary. If the primer cannot be identified then it may be identified by analytical testing to assign it to a primer group. If the primer group is not approved for use with the reactive coating then it should either be replaced by an approved primer or further compatibility testing should be carried out in accordance with EN 13381-8.

I.4.4 Application requirements and environmental conditions

Prior to application, all surfaces to be coated should be in a clean, dry condition and any areas not requiring fire protection or which may be exposed to overspray should be appropriately protected by masking.

The application of all coatings should be carried out fully in accordance with manufacturers’ technical data sheet requirements and the applicator’s method statement. No application should take place on site when

environmental conditions – air and steel temperatures, relative humidity, dew point – are outside the limits laid down by the coating supplier.

Typically, steel temperatures should be more than 3 °C above the dew point to ensure that no (visible or invisible) moisture or condensation is present on the surface during application.

I.4.5 Application controls

During application certain parameters should be monitored and recorded:

a) Air temperature, substrate temperature, relative humidity and dew point (throughout the application process) – as specified or as manufacturer's data sheet;

b) batch numbers of all products used;

c) dates and times of application and compliance with recommended overcoating times from manufacturer's data sheets;

d) wet film thickness checks.

I.5 Inspection

I.5.1 General

During application and on completion of finished works, inspection of the applied reactive coating system should be carried out to ensure compliance with the required specification. The inspection will confirm whether the applied reactive coating system is fit for purpose to deliver the required end use performance. The inspection will also identify areas of non-conformance which require remedial action.

I.5.2 Inspection criteria

The inspection criteria should include the following but this list may not be exhaustive:

a) Surface Preparation:

   1) surface preparation standard – as specified, usually against EN ISO 8501-1;

   2) surface profile minimum and maximum – as specified (EN ISO 8503-2);

   3) dust or other contamination – visual or EN ISO 8502-3;

b) dry film thickness checks:

   the dry film thickness checks shall include the following:

   1) dry film thicknesses should be checked against the specified film thickness before any topcoat is applied;

c) dry film thickness survey and records:

   1) at primer stage;

   2) after application of reactive basecoat;

   3) on completion of coating.

I.6 Maintenance and repair

Surface damage may be sustained by the coating system, during its service-life. The manufacturer of the reactive coating shall have readily available a procedure for the maintenance and repair of the reactive coating system.

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