



## European Technical Approval ETA-11/0430

English translation prepared by DIBt - Original version in German language

Handelsbezeichnung <i>Trade name</i>	pyroplast-ST 100
Zulassungsinhaber <i>Holder of approval</i>	RÜTGERS Organics GmbH Oppauer Straße 43 68305 Mannheim DEUTSCHLAND
Zulassungsgegenstand und Verwendungszweck <i>Generic type and use of construction product</i>	Reaktive Brandschutzbeschichtung auf Stahlbauteilen  <i>Reactive coatings for fire protection of steel elements</i>
Geltungsdauer: <i>Validity:</i>	vom <i>from</i> bis <i>to</i> 16 November 2011  16 November 2016
Herstellwerk <i>Manufacturing plant</i>	RÜTGERS Organics GmbH Oppauer Straße 43 68305 Mannheim DEUTSCHLAND

Diese Zulassung umfasst  
*This Approval contains*

15 Seiten einschließlich 1 Anhang  
*15 pages including 1 annex*

## I LEGAL BASES AND GENERAL CONDITIONS

- 1 This European technical approval is issued by Deutsches Institut für Bautechnik in accordance with:
  - Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products<sup>1</sup>, modified by Council Directive 93/68/EEC<sup>2</sup> and Regulation (EC) N° 1882/2003 of the European Parliament and of the Council<sup>3</sup>;
  - Gesetz über das In-Verkehr-Bringen von und den freien Warenverkehr mit Bauprodukten zur Umsetzung der Richtlinie 89/106/EWG des Rates vom 21. Dezember 1988 zur Angleichung der Rechts- und Verwaltungsvorschriften der Mitgliedstaaten über Bauprodukte und anderer Rechtsakte der Europäischen Gemeinschaften (Bauproduktengesetz - BauPG) vom 28. April 1998<sup>4</sup>, as amended by law of 31 October 2006<sup>5</sup>;
  - Common Procedural Rules for Requesting, Preparing and the Granting of European technical approvals set out in the Annex to Commission Decision 94/23/EC<sup>6</sup>;
  - Guideline for European technical approval of "Fire Protective Products - Part 2: Reactive Coatings for Fire Protection of Steel Elements", ETAG 018-02.
- 2 Deutsches Institut für Bautechnik is authorized to check whether the provisions of this European technical approval are met. Checking may take place in the manufacturing plant. Nevertheless, the responsibility for the conformity of the products to the European technical approval and for their fitness for the intended use remains with the holder of the European technical approval.
- 3 This European technical approval is not to be transferred to manufacturers or agents of manufacturers other than those indicated on page 1, or manufacturing plants other than those indicated on page 1 of this European technical approval.
- 4 This European technical approval may be withdrawn by Deutsches Institut für Bautechnik, in particular pursuant to information by the Commission according to Article 5(1) of Council Directive 89/106/EEC.
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- 6 The European technical approval is issued by the approval body in its official language. This version corresponds fully to the version circulated within EOTA. Translations into other languages have to be designated as such.

<sup>1</sup> Official Journal of the European Communities L 40, 11 February 1989, p. 12  
<sup>2</sup> Official Journal of the European Communities L 220, 30 August 1993, p. 1  
<sup>3</sup> Official Journal of the European Union L 284, 31 October 2003, p. 25  
<sup>4</sup> *Bundesgesetzblatt Teil I* 1998, p. 812  
<sup>5</sup> *Bundesgesetzblatt Teil I* 2006, p. 2407, 2416  
<sup>6</sup> Official Journal of the European Communities L 17, 20 January 1994, p. 34

## II SPECIFIC CONDITIONS OF THE EUROPEAN TECHNICAL APPROVAL

### 1 Definition of the product and intended use

#### 1.1 Definition of the construction product

This European technical approval applies to the reactive coating for fire protection "pyroplast-ST 100". "pyroplast-ST 100" is waterborne (solvent free) and can be applied by spraying or brushing. The reactive coating system for fire protection consists of the primer, the reactive coating and of the topcoat, where appropriate. In the case of fire reactive coatings for fire protection act by temperature stress and thus develop a heat-insulating effect. The reactive component, on which the mode of operation of the reactive coating for fire protection is based, is an intumescent material.

In conformity with ETAG 018-2 the ETA is issued for the product under end use conditions (Option 3).

#### 1.2 Intended use

"pyroplast-ST 100" serves for the use as reactive coating system (sheathing) necessary on beams and columns made of structural steel (marking 'S') in accordance with EN 10025<sup>7</sup>, excluding S185 to achieve a fire resistance duration in accordance with EN 13501-2<sup>8</sup>.

"pyroplast-ST 100" may be applied in accordance with Annex 1 to the following fields.

- Fire resistance: Open sections (H and I): R15, R20, R30, R45, R60, R90, R120
- A/V factor: 68 m<sup>-1</sup> to 318 m<sup>-1</sup>
- Design temperatures: 350 °C to 750 °C

The application of "pyroplast-ST 100" on steel tension members made of structural steel in accordance with EN 100257 is not regulated by this ETA.

#### 1.2.2 Use category

Depending on the use category in accordance with ETAG 018, part 2, section 2.2.2 the following types have been approved.

<sup>7</sup> EN 10025-1 to -6:2004-2005 Hot rolled products of structural steels implemented

<sup>8</sup> EN 13501-2:2007-10 Fire classification of construction products and building elements Part 2: Classification using data from fire resistance tests, excluding ventilation services implemented

Primer	Reactive coating	Topcoat
Acryl-Dispersion (solvent free) e. g. "pyroplast-ST 120 primer" or Alkyd-paint (solvent based) e. g. "pyroplast-ST 210 primer"	"pyroplast-ST 100"	Typ Y (incl. Z <sub>1</sub> ,Z <sub>2</sub> ) without topcoat or alternatively also with "pyroplast-ST 120 top" <sup>9</sup> (waterborn acrylic paint, solvent free) or "pyroplast-ST 210 top" <sup>9</sup> (solvent based)

For the carrying out with "pyroplast-ST 120 primer" the applicability of the reactive coating system has been verified on zinc coated substrates with a thickness of the zinc coating of up to 150 µm according to ETAG 018, part 2, clause 5.7.2.1 for the use category Type Y (incl. Z<sub>1</sub> and Z<sub>2</sub>).

### 1.2.3 Working life

The provisions made in this European technical approval are based on an assumed working life of the reactive coating for fire protection "pyroplast-ST 100" of 10 years; provided that the conditions laid down in sections 4.2, 5.1 and 5.2 for installation, packaging, transport, storage, use, as well as for use, maintenance and repair are met. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

## 2 Characteristics of the product and methods of verification

### 2.1 Mechanical resistance and stability

not relevant

### 2.2 Safety in case of fire

#### 2.2.1 Reaction to fire

In the assembly with primer "pyroplast-ST 210 primer", reactive coating "pyroplast-ST 100" and topcoat "pyroplast-ST 210 top" the reactive coating system corresponds to the reaction-to-fire class B-s1,d0 according to EN 13501-1<sup>10</sup>. All other assemblies correspond to the reaction-to-fire class B-s2,d0 according to EN 13501-1<sup>10</sup>.

#### 2.2.2 Fire resistance

The fire resistance classes were determined according to EN 13501-2<sup>8</sup> corresponding to ENV 13381-4<sup>11</sup> and shall be gathered from Annex 1.

<sup>9</sup> Für alle Farbtöne dieses Deckanstrichs

<sup>10</sup> EN 13501-1:2007-02+A1:2009 Fire classification of construction products and building elements Part 1: Classification using data from reaction to fire tests

<sup>11</sup> ENV 13381-4:2002-07 Test methods for determining the contribution to the fire resistance of structural members – Part 4: Applied protection to steel members

### 2.2.3 Smouldering fire exposure

The verification under exposure to the smouldering fire curve according to ENV 13381-4<sup>11</sup> has been furnished in the context of the approval tests.

## 2.3 Hygiene, Health and the Environment

### 2.3.1 Air and water permeability

not relevant

### 2.3.2 Release of dangerous substances

The formulations for all components of the reactive coating have been deposited at the DIBt. The dangerous substances have been evaluated on basis of the verification of the formulation. The restrictions in respect of production, placing on the market and use of certain dangerous substances, composites and products according to the REACH directive (EC) No. 1907/2006, Annex XVII have been followed. The harmonised European regulations regarding dangerous substances according to the EC database have been complied with. Changes in the formulation may only be effected with approval of the DIBt.

Note: In addition to the specific clauses relating to dangerous substances contained in this European technical approval, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the Construction Products Directive, these requirements need also to be complied with, when and where they apply.

### 2.4 Safety in use (Mechanical resistance and stability)

not relevant

### 2.5 Protection against noise

not relevant

### 2.6 Energy, economy and heat retention

not relevant

### 2.7 Aspects of serviceability, durability and identification

2.7.1 The primers and the topcoats indicated in section 1.2.2 of this ETA are compatible with the reactive coating "pyroplast-ST 100". The verifications were made in accordance with ETAG 018-2, section 5.7.2.2. The approved use categories shall be taken from section 1.2.2 of this ETA.

### 2.8 Identification

The formulation for "pyroplast-ST 100" has been deposited at the DIBt. In addition density and non-volatile content have also been determined.

## 3 Evaluation and attestation of conformity and CE marking

### 3.1 System of attestation of conformity

According to the Decision 1999/454/EG of the European Commission<sup>12</sup> system 1 of the attestation of conformity applies.

<sup>12</sup> Official Journal of the European Communities L 178/52 of 14.07.1999

In addition, according to the Decision 2001/596/EC of the European Commission<sup>13</sup> system 1 of the attestation of conformity is to be used in relation to the reaction-to-fire performance.

This system of attestation of conformity is described in the following:

System 1: Certification of the conformity of the product by an approved certification body on the basis of:

- (a) Tasks for the manufacturer:
  - (1) factory production control;
  - (2) further testing of samples taken at the factory by the manufacturer in accordance with a prescribed test plan;
- (b) Tasks for the approved body:
  - (3) initial type-testing of the product;
  - (4) initial inspection of factory and of factory production control;
  - (5) continuous surveillance, assessment and approval of factory production control.

## 3.2 Responsibilities

### 3.2.1 Tasks for the manufacturer

3.2.1.1 The manufacturer of the reactive coating "pyroplast-ST 100" shall exercise permanent internal control of production. All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures, including records of results performed. This production control system shall ensure that the product is in conformity with this European technical approval.

The manufacturer shall draw up and keep up-to-date documents defining the factory production control that applies. The documentation to be carried out by the manufacturer and the applicable procedures shall be appropriate to the product and manufacturing process. The factory production control shall ensure the conformity of the product to an appropriate level. This involves:

- a) the preparation of documented procedures and instructions relating to factory production control operations
- b) the effective implementation of these procedures and instructions
- c) the recording of these procedures and their results
- d) the use of these results to correct any deviations, repair the effects of such deviations, treat any resulting instances of non-conformity and, if necessary, revise the factory production control to rectify the cause of non-conformity
- e) it shall be ensured that both the Approval Body and the Approved (certification) bodies are advised before the product, its components or the manufacturing process, is changed in a significant way
- f) it shall be ensured that personnel involved in the production processes and the quality control procedures are adequately qualified and trained to carry out the required tasks
- g) the regular maintenance of all testing and measuring equipment and the documentation of up to date calibration records

<sup>13</sup>

Official Journal of the European Communities L 209/33 of 2.8.2001

h) the maintenance of records to ensure every container of coating material produced is clearly labelled with the batch number, which allows traceability to the point of its production.

The manufacturer may only use initial and constituent materials stated in the technical documentation of this European technical approval.

The factory production control shall be in accordance with the "control plan" of this European technical approval. The results of factory production control shall be recorded and evaluated in accordance with the provisions of the "control plan".

Reactive coating

Property	Paragraph, indicating the relevant test method	Threshold (if any) and tolerances	Minimum frequency of tests
Incoming material	Declaration of conformity	Manufacturer's declaration	Every delivery
Char depth	Annex G or similar. <sup>14</sup>	Manufacturer's declaration of minimum value <sup>15</sup>	Every batch
Insulating efficiency	Annex A or alternative. <sup>14</sup>	Manufacturer's declaration	Every 10th batch or at least once per month
Non-volatile content or density	e. g. ISO 3251		Every batch
Sag resistance		Manufacturer's specification	Every batch
Viscosity	e. g. EN ISO 3219		Every batch
Raw material <sup>16</sup>			Every delivery
Curing			Every batch
Pigment dispersion (fineness of the grind)			Every batch

3.2.1.2 Other tasks for the manufacturer

The manufacturer shall, on the basis of a contract, involve a body which is approved for the tasks referred to in section 3.1 in the field of reactive coatings for fire protection of steel elements in order to undertake the actions laid down in section 3.2.2. For this purpose, the control plan referred to in sections 3.2.1.1 and 3.2.2 shall be handed over by the manufacturer to the approved body involved.

3.2.2 Tasks for the approved bodies

The approved body shall perform the

- initial type-testing of the product,
- initial inspection of factory and of factory production control,

<sup>14</sup> The alternative shall be agreed on between the testing laboratory, approval body and the manufacturer.

<sup>15</sup> If the test result for the determination of the char depth is not satisfactory then a test of the insulating effect test should be performed.

<sup>16</sup> Test results of the supplier shall be checked according to the specification of the raw material's manufacturer.



- continuous surveillance, assessment and approval of factory production control, in accordance with the provisions laid down in the control plan.

The approved body shall retain the essential points of its actions referred to above and state the results obtained and conclusions drawn in a written report.

The approved certification body involved by the manufacturer shall issue an EC certificate of conformity of the product stating the conformity with the provisions of this European technical approval.

In cases where the provisions of the European technical approval and its control plan are no longer fulfilled the certification body shall withdraw the certificate of conformity and inform Deutsches Institut für Bautechnik without delay.

### 3.3 CE marking

The CE marking shall be affixed on the packing and on the accompanying commercial document, e.g. the EC declaration of conformity. The letters "CE" shall be followed by the identification number of the approved certification body, where relevant, and be accompanied by the following additional information:

- Identification number of the Approved Body,
- the name and address of the producer (legal entity responsible for the manufacture),
- the last two digits of the year in which the CE marking was affixed,
- the number of the EC certificate of conformity for the product,
- the number of the European technical approval,
- ETAG 018, Part 1 and 2
- Identification of the product (trade name: reactive coating "pyroplast-ST 100")

## 4 Assumptions under which the fitness of the product for the intended use was favourably assessed

### 4.1 Manufacturing

The European technical approval is issued for the product on the basis of agreed data/information, deposited with Deutsches Institut für Bautechnik, which identifies the product that has been assessed and judged. Changes to the product or production process, which could result in this deposited data/information being incorrect, should be notified to Deutsches Institut für Bautechnik before the changes are introduced. Deutsches Institut für Bautechnik will decide whether or not such changes affect the approval and consequently the validity of the CE marking on the basis of the approval and if so whether further assessment or alterations to the approval shall be necessary.

### 4.2 Installation

#### 4.2.1 Application

The manufacturer shall provide an installation guide for his product.

The installation guide shall give information about:

- List of suitable substrates
- Preparation of the surface of the construction (e. g. cleanliness, required preparation grade of the surface, e.g. Sa 2 ½)
- Method of application (e.g. spraying)



Environmental conditions (e.g. the temperature and humidity conditions before, during and after application)

- Necessary application wet film thickness in relation to the dry film thickness
- Required minimum dry film thickness of the reactive coating according to annex 1 of the ETA
- Period of time between the application of each component and the single layers, taking into account the exposure conditions
- Curing time of the system
- Approved topcoats
- Equipment parameters

This ETA is issued on the assumption that the application of "pyroplast-ST 100" occurs in accordance with the manufacturer's instructions.

#### 4.2.2 Primer

Acryl-Disperion or Alkyd-paint as specified by the manufacturer shall be used, see clause 1.2.2 of this ETA.

The primer shall be applied on surface prepared steel. The surface of the steel shall be free of dust, grease and other pollutants. The preparation grade of surface shall be in accordance with the technical data sheets. The primer shall cover the surface of the steel completely. The required dry film thickness according to the manufacturer's declaration shall be respected.

Primer applied on the steel sections at the factory, where relevant, which does not comply with the requirements of the ETA holder shall be removed before.

#### 4.2.3 Reactive coating

The reactive coating shall be compatible with the primer and the topcoat (optional) and shall not exceed the allowable expiration date.

The dry film thickness of the reactive coating "pyroplast-ST 100" (without primer and topcoat) shall have at least the values required in Annex 1.

#### 4.2.4 Topcoat

If a topcoat is used it shall be compatible with the reactive coating. During the tests carried out for the approval procedure the topcoats have been found to be compatible according to section 1.2.2 of this ETA.

The required dry film thickness according to the manufacturer's declaration shall be respected; it is approx. 50 µm.

#### 4.2.5 Structural references

The steel members coated with "pyroplast-ST 100" should not have claddings or other sheathings which could prevent the reactive coating from foaming.

#### 4.2.6 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 minimum thickness in Annex 1:

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

Where any single thickness reading is found to be less than 80 % of the required minimum thickness, 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 required minimum thickness. If one or more of the additional readings are less than 80 % of the required minimum thickness, 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 required minimum thickness

## 5 Indications to the manufacturer

### 5.1 Packaging, transport and storage

In the accompanying document or on the tanks the manufacturer shall give information as to transport and storage.

At least the following shall be indicated: storage temperature, type of storage (container, tank, etc.), required data related to minimum and maximum temperature for transport and storage. In case of combustible components or other potentially dangerous substances the instructions shall contain indications about limitations and/or conditions for handling, transport and storage.

### 5.2 Use, maintenance, repair

The assessment of the fitness for use is based on the assumption that necessary maintenance and repair if required is carried out in accordance with the manufacturer's instructions during the assumed intended working life.

The top coat offers an additional protection and serves the color design; therefore it shall always be kept in a proper state. In case of an execution without topcoat the control shall refer to the reactive coating. If the maintenance work related to the reactive coating or the topcoating is necessary, the manufacturer's instructions shall be respected.

Prof. Gunter Hoppe  
Head of Department

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#### **Annex 1 – Product performance: fire resistance**

1. This Annex relates to the use of "pyroplast-ST 100" for safety in case of fire of open sections (H and I), for steel beams or steel columns. The proper field of application is given in Tables 1 to 7 which show the minimum dry thickness of the layer (without primer and topcoat) required for achieving the classification "R" in case of different design temperatures and profile factors. The tables are applicable to assemblies with or without topcoat.
2. The product has been approved on the basis of:
  - a. The approval test on the basis of ENV 13381-4<sup>11</sup> and ETAG 018, Parts 1 and 2
  - b. The design of the minimum dry film thickness of the layer according to Annex H of ENV 13381-4<sup>11</sup>
3. The data for beams are related to a three-sided fire exposure and for columns to a four-sided fire exposure.
4. The layer thicknesses given are applicable to steel sections with a surface prepared according to section 4.2.2 of this ETA.
5. The thicknesses given for open H- and I-sections also apply to steel sections of other shapes, e.g. U-, L- and T-sections under consideration of the same A/V value.

Annex 1, Table 1: beams and columns, open sections (H and I)

pyroplast-ST 100	Fire Resistance 15 minutes								
	Design Temperature in °C								
	350	400	450	500	550	600	650	700	750
$A_m/V$ (m <sup>-1</sup> )	Minimum thickness required – DFT in mm (without primer and topcoat)								
68	0,252	0,252	0,252	0,252	0,252	0,252	0,252	0,252	0,252
80	0,298	0,252	0,252	0,252	0,252	0,252	0,252	0,252	0,252
100	0,393	0,252	0,252	0,252	0,252	0,252	0,252	0,252	0,252
120	0,477	0,281	0,252	0,252	0,252	0,252	0,252	0,252	0,252
140	0,552	0,347	0,252	0,252	0,252	0,252	0,252	0,252	0,252
160	0,618	0,405	0,252	0,252	0,252	0,252	0,252	0,252	0,252
180	0,678	0,457	0,258	0,252	0,252	0,252	0,252	0,252	0,252
200	0,732	0,504	0,299	0,252	0,252	0,252	0,252	0,252	0,252
220	0,781	0,546	0,336	0,252	0,252	0,252	0,252	0,252	0,252
240	0,826	0,584	0,370	0,252	0,252	0,252	0,252	0,252	0,252
260	0,867	0,619	0,400	0,252	0,252	0,252	0,252	0,252	0,252
280	0,904	0,651	0,428	0,252	0,252	0,252	0,252	0,252	0,252
300	0,939	0,680	0,453	0,252	0,252	0,252	0,252	0,252	0,252
318	0,968	0,705	0,474	0,270	0,252	0,252	0,252	0,252	0,252

Annex 1, Table 2: beams and columns, open sections (H and I)

pyroplast-ST 100	Fire Resistance 20 minutes								
	Design Temperature in °C								
	350	400	450	500	550	600	650	700	750
$A_m/V$ (m-1)	Minimum thickness required – DFT in mm (without primer and topcoat)								
68	0,395	0,252	0,252	0,252	0,252	0,252	0,252	0,252	0,252
80	0,480	0,297	0,252	0,252	0,252	0,252	0,252	0,252	0,252
100	0,606	0,412	0,252	0,252	0,252	0,252	0,252	0,252	0,252
120	0,718	0,512	0,322	0,252	0,252	0,252	0,252	0,252	0,252
140	0,816	0,600	0,402	0,252	0,252	0,252	0,252	0,252	0,252
160	0,905	0,678	0,472	0,284	0,252	0,252	0,252	0,252	0,252
180	0,984	0,748	0,534	0,340	0,252	0,252	0,252	0,252	0,252
200	1,055	0,810	0,590	0,391	0,252	0,252	0,252	0,252	0,252
220	1,120	0,866	0,640	0,435	0,252	0,252	0,252	0,252	0,252
240	1,180	0,917	0,684	0,476	0,288	0,252	0,252	0,252	0,252
260	1,234	0,964	0,725	0,512	0,321	0,252	0,252	0,252	0,252
280	1,284	1,006	0,762	0,545	0,351	0,252	0,252	0,252	0,252
300	1,330	1,045	0,796	0,575	0,378	0,252	0,252	0,252	0,252
318	1,368	1,078	0,824	0,600	0,401	0,252	0,252	0,252	0,252

Annex 1, Table 3: beams and columns, open sections (H and I)

pyroplast-ST 100	Fire Resistance 30 minutes								
	Design Temperature in °C								
	350	400	450	500	550	600	650	700	750
$A_m/V$ (m <sup>-1</sup> )	Minimum thickness required – DFT in mm (without primer and topcoat)								
68	0,718	0,534	0,359	0,252	0,252	0,252	0,252	0,252	0,252
80	0,844	0,651	0,469	0,295	0,252	0,252	0,252	0,252	0,252
100	1,032	0,824	0,629	0,446	0,274	0,252	0,252	0,252	0,252
120	1,198	0,975	0,768	0,575	0,396	0,252	0,252	0,252	0,252
140	1,346	1,107	0,888	0,686	0,500	0,327	0,252	0,252	0,252
160	1,477	1,224	0,994	0,783	0,590	0,411	0,252	0,252	0,252
180	1,595	1,329	1,088	0,869	0,668	0,485	0,316	0,252	0,252
200	1,702	1,422	1,171	0,944	0,738	0,549	0,377	0,252	0,252
220	1,799	1,507	1,246	1,011	0,799	0,607	0,431	0,270	0,252
240	1,887	1,584	1,314	1,072	0,854	0,657	0,478	0,315	0,252
260	1,968	1,653	1,375	1,127	0,904	0,703	0,521	0,355	0,252
280	2,043	1,717	1,431	1,176	0,949	0,744	0,559	0,391	0,252
300	2,111	1,776	1,482	1,221	0,989	0,781	0,594	0,424	0,269
318	2,169	1,825	1,524	1,259	1,023	0,812	0,622	0,450	0,294

Annex 1, Table 4: beams and columns, open sections (H and I)

pyroplast-ST 100	Fire Resistance 45 minutes								
	Design Temperature in °C								
	350	400	450	500	550	600	650	700	750
$A_m/V$ (m <sup>-1</sup> )	Minimum thickness required – DFT in mm (without primer and topcoat)								
68	1,202	1,007	0,821	0,643	0,473	0,310	0,252	0,252	0,252
80	1,390	1,182	0,986	0,799	0,622	0,454	0,293	0,252	0,252
100	1,672	1,442	1,228	1,026	0,837	0,659	0,490	0,332	0,252
120	1,919	1,669	1,436	1,220	1,019	0,830	0,654	0,489	0,334
140	2,139	1,867	1,617	1,387	1,174	0,976	0,793	0,621	0,461
160	2,336	2,043	1,777	1,533	1,309	1,102	0,911	0,734	0,569
180	2,512	2,200	1,918	1,661	1,426	1,211	1,013	0,831	0,662
200	2,672	2,341	2,043	1,774	1,530	1,307	1,103	0,915	0,742
220	2,817	2,468	2,156	1,875	1,622	1,392	1,181	0,989	0,812
240		2,583	2,258	1,966	1,704	1,467	1,251	1,054	0,873
260		2,688	2,350	2,048	1,778	1,535	1,314	1,112	0,928
280		2,784	2,434	2,123	1,845	1,595	1,370	1,165	0,977
300		2,872	2,510	2,191	1,906	1,651	1,420	1,212	1,022
318			2,574	2,247	1,956	1,696	1,462	1,250	1,058

Annex 1, Table 5: beams and columns, open sections (H and I)

pyroplast-ST 100	Fire Resistance 60 minutes								
	Design Temperature in °C								
	350	400	450	500	550	600	650	700	750
$A_m/V$ (m <sup>-1</sup> )	Minimum thickness required – DFT in mm (without primer and topcoat)								
68	1,686	1,480	1,283	1,095	0,915	0,743	0,578	0,419	0,267
80	1,936	1,714	1,503	1,303	1,114	0,933	0,761	0,597	0,441
100	2,311	2,060	1,826	1,606	1,400	1,205	1,021	0,848	0,683
120	2,641	2,362	2,104	1,865	1,641	1,433	1,237	1,054	0,882
140		2,627	2,347	2,088	1,848	1,626	1,420	1,227	1,047
160		2,862	2,559	2,282	2,027	1,793	1,576	1,374	1,187
180			2,747	2,453	2,184	1,937	1,710	1,501	1,307
200			2,915	2,604	2,322	2,064	1,828	1,611	1,411
220				2,739	2,444	2,176	1,932	1,708	1,502
240				2,861	2,554	2,276	2,024	1,793	1,582
260					2,653	2,366	2,106	1,870	1,653
280					2,742	2,447	2,180	1,938	1,717
300					2,823	2,520	2,247	2,000	1,774
318					2,890	2,580	2,302	2,050	1,821

Annex 1, Table 6: beams and columns, open sections (H and I)

pyroplast-ST 100	Fire Resistance 90 minutes								
	Design Temperature in °C								
	350	400	450	500	550	600	650	700	750
$A_m/V$ (m <sup>-1</sup> )	Minimum thickness required – DFT in mm (without primer and topcoat)								
68	2,654	2,425	2,207	1,999	1,799	1,608	1,425	1,250	1,081
80		2,776	2,538	2,311	2,096	1,892	1,697	1,511	1,334
100				2,766	2,525	2,297	2,083	1,880	1,688
120					2,887	2,637	2,403	2,184	1,978
140							2,674	2,439	2,219
160							2,905	2,655	2,423
180								2,842	2,598
200									2,750
220									2,882
240									
260									
280									
300									
318									

Annex 1, Table 7: beams and columns, open sections (H and I)

pyroplast-ST 100	Fire Resistance 120 minutes								
	Design Temperature in °C								
	350	400	450	500	550	600	650	700	750
$A_m/V$ (m <sup>-1</sup> )	Minimum thickness required – DFT in mm (without primer and topcoat)								
68				2,902	2,683	2,474	2,273	2,080	1,895
80						2,851	2,633	2,426	2,227
100								2,913	2,693
120									
140									
160									
180									
200									
220									
240									
260									
280									
300									
318									