



Partner for progress

Sir Winston Churchill laan 273
NL-2288 EA Rijswijk
Postbus 70
NL- 2280 AB Rijswijk
Tel.: +31-(0)70-414 44 00
Fax: +31-(0)70-414 44 20
E-mail: certif@kiwa.nl



Member of



www.eota.eu

European Technical Assessment

ETA 13/0837
of 19/02/2015

Technical Assessment Body issuing the ETA:.	Kiwa Nederland B.V
Trade name of the construction product	FLAMRO ST-I
Product family to which the construction product belongs	Reactive Coatings For Fire Protection of Steel Elements
Manufacturer	FLAMRO Brandschutz-Systeme GmbH Am Sportplatz 2, D-56291 Leiningen - Germany Tel. +49 6746 9410-0 Fax +49 6746 9410-10 http://www.flamro.de/ info@flamro.de
Manufacturing plant(s)	D-56291 Leiningen - Germany
This European Technical Assessment contains	19 pages including 1 annex which form an integral part of this assessment.
This European Technical Assessment is issued in accordance with regulation (EU) No 305/2011, on the basis of	ETAG 018-2, edition 2011, used as European Assessment Document (EAD)
This ETA replaces	ETA 13/0837, version 1, issued on 30/06/2013

1. Technical description of the product

FLAMRO ST-I is a spray or brush applied reactive coating formulated for the fire protection of structural steel elements installed in the following environmental conditions: Internal use — ETAG 018-2, Type Z.

2. Specification of the intended use(s) in accordance with the applicable European Assessment Document (hereinafter EAD)

The intended use of FLAMRO ST-I is to fire protect various sizes of structural steel 'H' or 'I' section beams and columns for up to a fire resistance classification of R240 and for design temperatures in the range of 350°C to 650°C. The provisions made in this ETA are based on an assumed intended working life of the applied coating for the intended use of 10 years, provided that it is subject to appropriate use and maintenance. The indications given on the intended working life cannot be interpreted as a guarantee given by the producer, but are to be used as a means for selecting the appropriate product in relation to the expected economically reasonable working life of the works.

Manufacturing, transport and storage

FLAMRO ST-I is manufactured in accordance with the provisions of the ETA using the manufacturing process as identified during the inspection of the factory by Kiwa Nederland B.V. as Technical Approved Body and laid down in the technical documentation.

It is assumed that the manufacture of FLAMRO ST-I fulfils the criteria for stable industrial production. The samples taken in connection with the evaluation of properties shall be representative of the whole production.

Application

The ETA is issued under the assumption that the application of FLAMRO ST-I shall be in accordance with the manufacturer's technical literature.

Maintenance and 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.

3. Performance of the product and references to the methods used for its assessment

The assessment of fitness for use has been made in accordance with ETAG 018-2.

Clause N°	ETA clause N°	Characteristics	Test procedure / Evaluation
5.1		Mechanical resistance and stability	Not relevant
5.2	3	Safety in case of fire	
5.2.1	3	Resistance to fire	
5.2.2	3	Reaction to fire	
5.3		Hygiene, Health and the Environment	
5.3.2	3	- Release of dangerous substances	
5.4	-	Safety in use	Not relevant
5.5	-	Protection against noise	Not relevant
5.6	-	Energy, Economy and Heat Retention	Not relevant
5.7	3	Related aspects of serviceability	
5.7.2.2	3 3	-Primer and top coat compatibility -Type Z2 Durability	
5.7.3 and Annex E	3	- Identification	

Safety in case of fire - Resistance to Fire

The resistance to fire performance according to EN 13501-2 determined in accordance with test principles defined in EN 13381-8: 2010 including Annex A (slow heating curve as defined in EN 1363-2: "IncSlow" according to EN 13501-2). The test data was analysed adopting the numerical regression methods defined in Annex E of EN 13381-8: 2010. Annex A summarises the results of the analysis.

In accordance with ETAG 018-2 (foreword) FLAMRO ST-I may be considered as a reactive coating final assembly (Option 3).

Until the withdrawal of relevant national test and classification standards CE Marking will cover a finite number of variations in coating thickness subjected to a fire resistance assessment. As time progresses the performance declaration for fire resistance covered by CE Marking may change and the ETA holder may incorporate the changes in this ETA by amendment or revision.

In the meantime and taking into account the transitional arrangements for test and classification standards and the corresponding national legislation (see EC Guidance paper 3, the ETA holder shall be permitted to maintain and be able to use - on a national basis — the test data for this characteristic based on relevant national standards next to the performance declaration covered by the CE Marking based on this ETA.

Safety in case of fire - Reaction to Fire

The fire protection coating has a performance determined for a reaction to fire classification in accordance with EN 13501-1 of Class B-s1, d0.

Dangerous substances

According to the manufacturer's declaration, the product specification has been compared with Annex XVII of REACH and the ECHA Candidate List of Substances of Very High Concern to verify that it does not contain such substances above the acceptable limits.

Related Aspects of Serviceability

FLAMRO ST-I has been assessed as being compatible, in accordance with the test procedures defined in ETAG 018-2 Clause 5.7.2.1 with the following primers:

Primers	
Name	Type
FLAMRO ST-I PRIMER 2EZ	Two component epoxy, solvent based

FLAMRO ST-I has been assessed as having passed the requirements for internal use defined in ETAG 018-2 for Type Z2 environmental conditions and can be used with or without top coats.

The top coat is a water based acryl top coating (Acrylon).

FLAMRO ST-I has been identified in accordance with the methods of identification defined in Table 5.3 of ETAG 018-2 including Infrared spectroscopy and thermogravimetry (as defined in Annex E of the ETAG), density and non-volatile content. Each product container is identified with the name FLAMRO ST-I.

4. Assessment and verification of constancy of performance (hereinafter AVCP) system applied, with reference to its legal base

The system of attestation of conformity specified by the European CPR - REGULATION (EU) No 305/2011 for fire protective products is system 1 and is detailed as follows:

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

- (a) Tasks for the manufacturer:
 - factory production control;
 - testing of samples taken the factory in accordance with a prescribed test plan;
- (b) Tasks for the Technical Assessment Body (TAB):
 - initial type-testing of the product;
 - initial inspection of factory and of factory production control;
 - continuous surveillance' assessment and approval of factory production control.

Responsibilities

Tasks for the Manufacturer - Factory production control

The manufacturer of FLAMRO ST-I covered by this European Technical Assessment shall document, operate and maintain an adequate factory production control system to enable the achievement of the required product characteristics, hence conformity of the product to this ETA, and the effective operation of the production control system to be checked.

The manufacturer shall draw up and keep up-to-date documents defining the factory production control that applies. The manufacturer's documentation and procedures shall be appropriate to the product and manufacturing process. The factory production control system shall achieve an appropriate level of confidence in the conformity of the product. 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) a procedure to ensure that both the Technical Assessment Body and the Notified Body are advised before any significant change to the product, its components or manufacturing process, is made.
- f) a procedure to ensure that personnel involved in the production processes and the quality control procedures are qualified and adequately trained to carry out their required tasks.
- g) that all testing and measuring equipment is maintained and up to date calibration records are documented.
- h) maintenance of records to ensure every container of coating material produced is clearly labelled with the batch number, which allows traceability to its production to be identified.

Tasks of the Technical Assessment Body and Notified Body

Initial type testing

The approval tests have been conducted on behalf of the Technical Assessment Body in accordance ETAG 018, Parts 1 or 2, as relevant, and has assessed the results of these tests in accordance with the ETAG, as part of the ETA issuing procedure.

These tests can be used by the Notified Body for Certificate of Conformity purposes.

Assessment of the factory production control system - initial inspection and continuous surveillance

The assessment of the factory production control system is the responsibility of the ETA issuing body. An initial inspection shall be carried out of the production unit specified in this ETA to demonstrate that the factory production control is in conformity with the ETA.

5. Technical details necessary for the implementation of the AVCP system, as provided for in the applicable EAD or applicable ETAG

Other tasks for the manufacturer

The following tables derived from ETAG 018-2 specify properties that should be controlled and minimum frequencies of control. The test method and threshold have been laid down in the factory production control plan.

Reactive Coating

Property	Property Paragraph (ETAG)	Threshold	Minimum frequency of tests
Insulating efficiency	Annex A or alternative ¹	Manufacturer's declaration ²	Every 10 th batch or at least once per month
Incoming material	Declaration of conformity	Manufacturer's declaration	Every delivery
Viscosity	e.g. EN ISO 3219		Every batch
Non- volatile content	EN ISO 3251		Every batch
Density	ISO 2811		Every batch

Issued in Rijswijk on 19.02.2015 by Kiwa Nederland B.V.

P.E. Voshol
Business Unit Manager

¹ agreed with ETA issuing body and manufacturer

² if result of char depth is not sufficient an insulating efficiency test should be carried out

ANNEX A - Product Performance: Fire Resistance

- 1 This Annex relates to the use of FLAMRO ST-I for the fire protection of steel beam and column sections. The precise scope is given in Tables 1 to 12 which show the total dry film thickness of FLAMRO ST-I (excluding primer and top coat) required to provide classifications of R30 to R240 for various design temperatures and section factors.
2. The product is approved on the basis of:
 - i) Approval testing in accordance with the principles of EN 13381-8:2010.
 - ii) A design appraisal against this ETA adopting the numerical regression methods defined in Annex E of EN 13381-8:2010.
3. The data presented in the tables in this annex refers to beams (three-sided fire exposure) and columns (four sided exposure).
4. The data shown is applicable to steel sections blast cleaned to ISO 8501-1 SA2¹/2 or equivalent and primed with the compatible primers listed in this ETA. Based on the test data the total dry film thickness of primer should not exceed the maximum tested.
5. The data applies also to other shaped steel sections that have re-entrant details such as channels, angles and tees.
6. FLAMRO ST-I has been exposed to the slowing heating regime defined in Annex A of EN 13381-8: 2010 and has satisfied the requirements.

Table 1 -Beams 30 minutes

Critical steel temperature °C → Section factor m-1 ↓	350	400	450	500	550	600	650
0	0.473	0.303	0.207	0.207	0.207	0.207	0.207
64.8	0.473	0.303	0.207	0.207	0.207	0.207	0.207
70	0.521	0.339	0.211	0.207	0.207	0.207	0.207
80	0.61	0.406	0.26	0.207	0.207	0.207	0.207
90	0.694	0.47	0.308	0.207	0.207	0.207	0.207
100	0.774	0.531	0.354	0.22	0.207	0.207	0.207
110	0.849	0.59	0.399	0.253	0.207	0.207	0.207
120	0.921	0.646	0.442	0.285	0.207	0.207	0.207
130	0.989	0.7	0.484	0.316	0.207	0.207	0.207
140	1.054	0.753	0.525	0.347	0.207	0.207	0.207
150	1.116	0.803	0.564	0.376	0.225	0.207	0.207
160	1.175	0.851	0.602	0.406	0.246	0.207	0.207
170	1.232	0.898	0.64	0.434	0.266	0.207	0.207
180	1.286	0.943	0.676	0.462	0.286	0.207	0.207
190	1.337	0.987	0.711	0.489	0.306	0.207	0.207
200	1.387	1.029	0.745	0.515	0.325	0.207	0.207
210	1.434	1.069	0.778	0.541	0.344	0.207	0.207
220	1.48	1.108	0.81	0.566	0.363	0.207	0.207
230	1.524	1.146	0.842	0.591	0.381	0.207	0.207
240	1.566	1.183	0.872	0.615	0.399	0.214	0.207
250	1.606	1.219	0.902	0.639	0.416	0.226	0.207
260	1.645	1.253	0.931	0.662	0.434	0.238	0.207
270	1.683	1.287	0.959	0.684	0.451	0.249	0.207
280	1.719	1.319	0.987	0.707	0.467	0.26	0.207
290	1.754	1.351	1.014	0.728	0.484	0.271	0.207
300	1.788	1.381	1.04	0.75	0.5	0.282	0.207
310	1.82	1.411	1.065	0.77	0.515	0.293	0.207
320	1.852	1.44	1.09	0.791	0.531	0.304	0.207
330	1.882	1.468	1.115	0.811	0.546	0.314	0.207
340	1.911	1.495	1.139	0.83	0.561	0.324	0.207
350	1.94	1.522	1.162	0.85	0.576	0.335	0.207
360	1.968	1.548	1.185	0.868	0.591	0.345	0.207
364.1	1.979	1.558	1.194	0.876	0.597	0.349	0.207

Thickness is intumescent only.

Table 2 -Beams 60 minutes

Critical steel temperature °C → Section factor m-l ↓	350	400	450	500	550	600	650
0	1.333	1.011	0.785	0.619	0.491	0.39	0.308
64.8	1.333	1.011	0.785	0.619	0.491	0.39	0.308
70	1.437	1.095	0.854	0.676	0.538	0.429	0.34
80	1.627	1.251	0.983	0.783	0.628	0.504	0.403
90	1.807	1.401	1.108	0.887	0.715	0.577	0.464
100	1.978	1.544	1.228	0.989	0.801	0.649	0.525
110	2.14	1.682	1.345	1.088	0.885	0.72	0.584
120	2.293	1.814	1.458	1.184	0.967	0.79	0.643
130	2.439	1.941	1.568	1.278	1.047	0.859	0.702
140	2.578	2.063	1.674	1.37	1.126	0.926	0.759
150	2.711	2.181	1.777	1.46	1.204	0.993	0.816
160	2.837	2.294	1.877	1.547	1.279	1.058	0.872
170	-	2.404	1.974	1.632	1.354	1.122	0.927
180	-	2.509	2.068	1.716	1.427	1.186	0.982
190	-	2.611	2.16	1.797	1.498	1.248	1.036
200	-	2.709	2.249	1.876	1.568	1.31	1.089
210	-	2.804	2.336	1.954	1.637	1.37	1.142
220	-	2.896	2.42	2.03	1.705	1.43	1.194
230	-	-	2.502	2.104	1.771	1.488	1.245
240	-	-	2.582	2.177	1.836	1.546	1.296
250	-	-	2.659	2.248	1.9	1.603	1.346
260	-	-	2.735	2.317	1.963	1.659	1.395
270	-	-	2.809	2.386	2.025	1.715	1.444
280	-	-	2.881	2.452	2.086	1.769	1.493
290	-	-	-	2.517	2.145	1.823	1.54
300	-	-	-	2.581	2.204	1.876	1.588
310	-	-	-	2.644	2.262	1.928	1.634
320	-	-	-	2.705	2.318	1.979	1.68
330	-	-	-	2.765	2.374	2.03	1.726
340	-	-	-	2.824	2.429	2.08	1.771
350	-	-	-	2.882	2.482	2.129	1.816
360	-	-	-	2.939	2.535	2.178	1.86
364.1	-	-	-	-	2.557	2.198	1.877

Thickness is intumescent only.

Table 3 -Beams 90 minutes

Critical steel temperature °C → Section factor m-l ↓	350	400	450	500	550	600	650
0	2.194	1.719	1.386	1.141	0.953	0.803	0.682
64.8	2.194	1.719	1.386	1.141	0.953	0.803	0.682
70	2.352	1.851	1.497	1.236	1.034	0.874	0.744
80	2.644	2.096	1.706	1.414	1.188	1.008	0.86
90	2.92	2.332	1.908	1.588	1.339	1.139	0.976
100	-	2.557	2.103	1.758	1.487	1.269	1.089
110	-	2.774	2.291	1.923	1.632	1.396	1.201
120	-	-	2.474	2.084	1.773	1.521	1.312
130	-	-	2.652	2.24	1.912	1.644	1.421
140	-	-	2.823	2.393	2.049	1.766	1.529
150	-	-	-	2.543	2.182	1.885	1.636
160	-	-	-	2.688	2.313	2.002	1.741
170	-	-	-	2.831	2.441	2.118	1.845
180	-	-	-	-	2.567	2.231	1.947
190	-	-	-	-	2.69	2.343	2.048
200	-	-	-	-	2.812	2.453	2.148
210	-	-	-	-	2.93	2.562	2.247
220	-	-	-	-	-	2.669	2.345
230	-	-	-	-	-	2.774	2.441
240	-	-	-	-	-	2.878	2.536
250	-	-	-	-	-	-	2.63
260	-	-	-	-	-	-	2.723
270	-	-	-	-	-	-	2.815
280	-	-	-	-	-	-	2.905
290	-	-	-	-	-	-	-
300	-	-	-	-	-	-	-
310	-	-	-	-	-	-	-
320	-	-	-	-	-	-	-
330	-	-	-	-	-	-	-
340	-	-	-	-	-	-	-
350	-	-	-	-	-	-	-
360	-	-	-	-	-	-	-
364.1	-	-	-	-	-	-	-

Thickness is intumescent only.

Table 4 -Beams 120 minutes

Critical steel temperature °C → Section factor m-1 ↓	350	400	450	500	550	600	650
0	-	2.426	1.987	1.663	1.414	1.217	1.057
64.8	-	2.426	1.987	1.663	1.414	1.217	1.057
70	-	2.606	2.141	1.796	1.53	1.319	1.147
80	-	2.942	2.429	2.046	1.749	1.512	1.318
90	-	-	2.707	2.289	1.963	1.702	1.487
100	-	-	-	2.527	2.173	1.888	1.654
110	-	-	-	2.758	2.379	2.072	1.819
120	-	-	-	-	2.58	2.253	1.981
130	-	-	-	-	2.777	2.43	2.141
140	-	-	-	-	-	2.605	2.299
150	-	-	-	-	-	2.777	2.456
160	-	-	-	-	-	2.946	2.61
170	-	-	-	-	-	-	2.762
180	-	-	-	-	-	-	2.913
190	-	-	-	-	-	-	-
200	-	-	-	-	-	-	-
210	-	-	-	-	-	-	-
220	-	-	-	-	-	-	-
230	-	-	-	-	-	-	-
240	-	-	-	-	-	-	-
250	-	-	-	-	-	-	-
260	-	-	-	-	-	-	-
270	-	-	-	-	-	-	-
280	-	-	-	-	-	-	-
290	-	-	-	-	-	-	-
300	-	-	-	-	-	-	-
310	-	-	-	-	-	-	-
320	-	-	-	-	-	-	-
330	-	-	-	-	-	-	-
340	-	-	-	-	-	-	-
350	-	-	-	-	-	-	-
360	-	-	-	-	-	-	-
364.1	-	-	-	-	-	-	-

Thickness is intumescent only.

Table 5 -Beams 180 minutes

Critical steel temperature °C → Section factor m-1 ↓	350	400	450	500	550	600	650
0	-	-	-	2.707	2.337	2.044	1.806
64.8	-	-	-	2.707	2.337	2.044	1.806
70	-	-	-	2.916	2.522	2.208	1.954
80	-	-	-	-	2.87	2.52	2.234
90	-	-	-	-	-	2.826	2.51
100	-	-	-	-	-	-	2.783
110	-	-	-	-	-	-	-
120	-	-	-	-	-	-	-
130	-	-	-	-	-	-	-
140	-	-	-	-	-	-	-
150	-	-	-	-	-	-	-
160	-	-	-	-	-	-	-
170	-	-	-	-	-	-	-
180	-	-	-	-	-	-	-
190	-	-	-	-	-	-	-
200	-	-	-	-	-	-	-
210	-	-	-	-	-	-	-
220	-	-	-	-	-	-	-
230	-	-	-	-	-	-	-
240	-	-	-	-	-	-	-
250	-	-	-	-	-	-	-
260	-	-	-	-	-	-	-
270	-	-	-	-	-	-	-
280	-	-	-	-	-	-	-
290	-	-	-	-	-	-	-
300	-	-	-	-	-	-	-
310	-	-	-	-	-	-	-
320	-	-	-	-	-	-	-
330	-	-	-	-	-	-	-
340	-	-	-	-	-	-	-
350	-	-	-	-	-	-	-
360	-	-	-	-	-	-	-
364.1	-	-	-	-	-	-	-

Thickness is intumescent only.

Table 6 -Beams 240 minutes

Critical steel temperature °C → Section factor m-l ↓	350	400	450	500	550	600	650
0	-	-	-	-	-	2.871	2.556
64.8	-	-	-	-	-	2.871	2.556
70	-	-	-	-	-	-	2.76
80	-	-	-	-	-	-	-
90	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-
110	-	-	-	-	-	-	-
120	-	-	-	-	-	-	-
130	-	-	-	-	-	-	-
140	-	-	-	-	-	-	-
150	-	-	-	-	-	-	-
160	-	-	-	-	-	-	-
170	-	-	-	-	-	-	-
180	-	-	-	-	-	-	-
190	-	-	-	-	-	-	-
200	-	-	-	-	-	-	-
210	-	-	-	-	-	-	-
220	-	-	-	-	-	-	-
230	-	-	-	-	-	-	-
240	-	-	-	-	-	-	-
250	-	-	-	-	-	-	-
260	-	-	-	-	-	-	-
270	-	-	-	-	-	-	-
280	-	-	-	-	-	-	-
290	-	-	-	-	-	-	-
300	-	-	-	-	-	-	-
310	-	-	-	-	-	-	-
320	-	-	-	-	-	-	-
330	-	-	-	-	-	-	-
340	-	-	-	-	-	-	-
350	-	-	-	-	-	-	-
360	-	-	-	-	-	-	-
364.1	-	-	-	-	-	-	-

Thickness is intumescent only.

Table 7 – Columns 30 minutes

Critical steel temperature °C → Section factor m-l ↓	350	400	450	500	550	600	650
0	0.529	0.311	0.207	0.207	0.207	0.207	0.207
64.8	0.529	0.311	0.207	0.207	0.207	0.207	0.207
70	0.591	0.353	0.207	0.207	0.207	0.207	0.207
80	0.706	0.433	0.257	0.207	0.207	0.207	0.207
90	0.817	0.511	0.312	0.207	0.207	0.207	0.207
100	0.925	0.587	0.366	0.21	0.207	0.207	0.207
110	1.029	0.661	0.418	0.247	0.207	0.207	0.207
120	1.129	0.733	0.47	0.283	0.207	0.207	0.207
130	1.226	0.804	0.521	0.319	0.207	0.207	0.207
140	1.32	0.872	0.571	0.354	0.207	0.207	0.207
150	1.411	0.94	0.62	0.389	0.215	0.207	0.207
160	1.499	1.005	0.668	0.424	0.238	0.207	0.207
170	1.584	1.069	0.715	0.457	0.261	0.207	0.207
180	1.667	1.132	0.762	0.491	0.284	0.207	0.207
190	1.747	1.193	0.807	0.524	0.307	0.207	0.207
200	1.825	1.253	0.852	0.556	0.329	0.207	0.207
210	1.901	1.312	0.896	0.588	0.351	0.207	0.207
220	1.974	1.369	0.94	0.62	0.373	0.207	0.207
230	2.046	1.425	0.982	0.651	0.394	0.207	0.207
240	2.115	1.48	1.024	0.682	0.416	0.207	0.207
250	2.183	1.533	1.065	0.712	0.437	0.216	0.207
260	2.249	1.586	1.106	0.742	0.458	0.229	0.207
270	2.313	1.637	1.145	0.772	0.479	0.242	0.207
280	2.375	1.688	1.185	0.801	0.499	0.255	0.207
290	2.436	1.737	1.223	0.83	0.519	0.268	0.207
300	2.495	1.785	1.261	0.858	0.539	0.281	0.207
310	2.552	1.833	1.298	0.886	0.559	0.293	0.207
320	2.609	1.879	1.335	0.914	0.579	0.306	0.207
330	2.663	1.925	1.371	0.941	0.598	0.318	0.207
340	2.717	1.969	1.407	0.968	0.618	0.33	0.207
350	2.769	2.013	1.442	0.995	0.637	0.342	0.207
360	2.82	2.056	1.476	1.021	0.655	0.354	0.207
364.1	2.84	2.074	1.49	1.032	0.663	0.359	0.207

Thickness is intumescent only.

Table 8 – Columns 60 minutes

Critical steel temperature °C → Section factor m-1 ↓	350	400	450	500	550	600	650
0	1.634	1.169	0.873	0.668	0.518	0.404	0.314
64.8	1.634	1.169	0.873	0.668	0.518	0.404	0.314
70	1.773	1.274	0.955	0.733	0.571	0.447	0.349
80	2.033	1.471	1.11	0.858	0.672	0.53	0.417
90	2.283	1.664	1.262	0.98	0.772	0.611	0.484
100	2.526	1.852	1.411	1.101	0.87	0.692	0.551
110	2.76	2.036	1.558	1.22	0.968	0.773	0.617
120	-	2.214	1.702	1.337	1.064	0.852	0.683
130	-	2.389	1.843	1.452	1.159	0.931	0.749
140	-	2.559	1.981	1.566	1.253	1.009	0.814
150	-	2.725	2.117	1.678	1.346	1.087	0.878
160	-	2.888	2.251	1.789	1.438	1.164	0.942
170	-	-	2.382	1.898	1.529	1.24	1.006
180	-	-	2.511	2.005	1.619	1.315	1.069
190	-	-	2.637	2.111	1.708	1.39	1.132
200	-	-	2.762	2.216	1.796	1.464	1.194
210	-	-	2.884	2.319	1.883	1.537	1.256
220	-	-	-	2.421	1.969	1.61	1.317
230	-	-	-	2.521	2.055	1.682	1.378
240	-	-	-	2.62	2.139	1.754	1.439
250	-	-	-	2.717	2.222	1.825	1.499
260	-	-	-	2.814	2.305	1.895	1.559
270	-	-	-	2.909	2.386	1.965	1.618
280	-	-	-	-	2.467	2.034	1.677
290	-	-	-	-	2.547	2.102	1.735
300	-	-	-	-	2.626	2.17	1.793
310	-	-	-	-	2.704	2.238	1.851
320	-	-	-	-	2.781	2.305	1.909
330	-	-	-	-	2.858	2.371	1.965
340	-	-	-	-	2.934	2.437	2.022
350	-	-	-	-	-	2.502	2.078
360	-	-	-	-	-	2.566	2.134
364.1	-	-	-	-	-	2.593	2.157

Thickness is intumescent only.

Table 9 – Columns 90 minutes

Critical steel temperature °C → Section factor m-1 ↓	350	400	450	500	550	600	650
0	2.738	2.027	1.574	1.261	1.032	0.857	0.719
64.8	2.738	2.027	1.574	1.261	1.032	0.857	0.719
70	-	2.194	1.708	1.371	1.124	0.935	0.786
80	-	2.51	1.963	1.581	1.301	1.085	0.914
90	-	2.818	2.212	1.788	1.475	1.233	1.042
100	-	-	2.457	1.992	1.647	1.38	1.168
110	-	-	2.697	2.193	1.817	1.526	1.294
120	-	-	2.933	2.391	1.985	1.67	1.419
130	-	-	-	2.586	2.151	1.813	1.543
140	-	-	-	2.778	2.316	1.955	1.666
150	-	-	-	-	2.478	2.095	1.788
160	-	-	-	-	2.639	2.235	1.909
170	-	-	-	-	2.798	2.373	2.029
180	-	-	-	-	-	2.509	2.149
190	-	-	-	-	-	2.645	2.268
200	-	-	-	-	-	2.779	2.386
210	-	-	-	-	-	2.912	2.503
220	-	-	-	-	-	-	2.619
230	-	-	-	-	-	-	2.734
240	-	-	-	-	-	-	2.849
250	-	-	-	-	-	-	-
260	-	-	-	-	-	-	-
270	-	-	-	-	-	-	-
280	-	-	-	-	-	-	-
290	-	-	-	-	-	-	-
300	-	-	-	-	-	-	-
310	-	-	-	-	-	-	-
320	-	-	-	-	-	-	-
330	-	-	-	-	-	-	-
340	-	-	-	-	-	-	-
350	-	-	-	-	-	-	-
360	-	-	-	-	-	-	-
364.1	-	-	-	-	-	-	-

Thickness is intumescent only.

Table 10 – Columns 120 minutes

Critical steel temperature °C → Section factor m-1 ↓	350	400	450	500	550	600	650
0	-	2.885	2.275	1.854	1.546	1.31	1.124
64.8	-	2.885	2.275	1.854	1.546	1.31	1.124
70	-	-	2.462	2.01	1.678	1.423	1.223
80	-	-	2.816	2.305	1.929	1.64	1.412
90	-	-	-	2.596	2.178	1.855	1.599
100	-	-	-	2.883	2.423	2.068	1.786
110	-	-	-	-	2.666	2.279	1.971
120	-	-	-	-	2.906	2.488	2.154
130	-	-	-	-	-	2.695	2.337
140	-	-	-	-	-	2.901	2.518
150	-	-	-	-	-	-	2.697
160	-	-	-	-	-	-	2.876
170	-	-	-	-	-	-	-
180	-	-	-	-	-	-	-
190	-	-	-	-	-	-	-
200	-	-	-	-	-	-	-
210	-	-	-	-	-	-	-
220	-	-	-	-	-	-	-
230	-	-	-	-	-	-	-
240	-	-	-	-	-	-	-
250	-	-	-	-	-	-	-
260	-	-	-	-	-	-	-
270	-	-	-	-	-	-	-
280	-	-	-	-	-	-	-
290	-	-	-	-	-	-	-
300	-	-	-	-	-	-	-
310	-	-	-	-	-	-	-
320	-	-	-	-	-	-	-
330	-	-	-	-	-	-	-
340	-	-	-	-	-	-	-
350	-	-	-	-	-	-	-
360	-	-	-	-	-	-	-
364.1	-	-	-	-	-	-	-

Thickness is intumescent only.

Table 11 – Columns 180 minutes

Critical steel temperature °C → Section factor m-1 ↓	350	400	450	500	550	600	650
0	-	-	-	-	2.573	2.216	1.934
64.8	-	-	-	-	2.573	2.216	1.934
70	-	-	-	-	2.784	2.4	2.097
80	-	-	-	-	-	2.751	2.407
90	-	-	-	-	-	-	2.715
100	-	-	-	-	-	-	-
110	-	-	-	-	-	-	-
120	-	-	-	-	-	-	-
130	-	-	-	-	-	-	-
140	-	-	-	-	-	-	-
150	-	-	-	-	-	-	-
160	-	-	-	-	-	-	-
170	-	-	-	-	-	-	-
180	-	-	-	-	-	-	-
190	-	-	-	-	-	-	-
200	-	-	-	-	-	-	-
210	-	-	-	-	-	-	-
220	-	-	-	-	-	-	-
230	-	-	-	-	-	-	-
240	-	-	-	-	-	-	-
250	-	-	-	-	-	-	-
260	-	-	-	-	-	-	-
270	-	-	-	-	-	-	-
280	-	-	-	-	-	-	-
290	-	-	-	-	-	-	-
300	-	-	-	-	-	-	-
310	-	-	-	-	-	-	-
320	-	-	-	-	-	-	-
330	-	-	-	-	-	-	-
340	-	-	-	-	-	-	-
350	-	-	-	-	-	-	-
360	-	-	-	-	-	-	-
364.1	-	-	-	-	-	-	-

Thickness is intumescent only.

Table 12 – Columns 240 minutes

Critical steel temperature °C → Section factor m-1 ↓	350	400	450	500	550	600	650
0	-	-	-	-	-	-	2.745
64.8	-	-	-	-	-	-	2.745
70	-	-	-	-	-	-	-
80	-	-	-	-	-	-	-
90	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-
110	-	-	-	-	-	-	-
120	-	-	-	-	-	-	-
130	-	-	-	-	-	-	-
140	-	-	-	-	-	-	-
150	-	-	-	-	-	-	-
160	-	-	-	-	-	-	-
170	-	-	-	-	-	-	-
180	-	-	-	-	-	-	-
190	-	-	-	-	-	-	-
200	-	-	-	-	-	-	-
210	-	-	-	-	-	-	-
220	-	-	-	-	-	-	-
230	-	-	-	-	-	-	-
240	-	-	-	-	-	-	-
250	-	-	-	-	-	-	-
260	-	-	-	-	-	-	-
270	-	-	-	-	-	-	-
280	-	-	-	-	-	-	-
290	-	-	-	-	-	-	-
300	-	-	-	-	-	-	-
310	-	-	-	-	-	-	-
320	-	-	-	-	-	-	-
330	-	-	-	-	-	-	-
340	-	-	-	-	-	-	-
350	-	-	-	-	-	-	-
360	-	-	-	-	-	-	-
364.1	-	-	-	-	-	-	-

Thickness is intumescent only.