

ASFP – BCF BEST PRACTICE GUIDE FOR SPECIFYING REACTIVE COATING FIRE PROTECTION FOR STEEL STRUCTURES

1. Introduction

The Association for Specialist Fire Protection and the British Coatings Federation represent manufacturers and installers of fire protection products for structural steel. Their members have written this guide to help ensure that coatings are specified and used in the correct way to ensure that a structure is treated with the required level of fire protection. This guide is aimed at architects, engineers, specifiers, fabricators, contractors, enforcement authorities and anyone else responsible for providing adequate fire protection of a steel framed building.

Two annexes have been incorporated into this document. Annex 1 has been added to provide a useful summary and checklist for the content of this guide, as an aide-memoir. Annex 2 has been added to provide example of bid submittal for designers/specifiers

Further comprehensive information on the role, specification and design of fire protection in buildings can be found in the ASFP 'Yellow Book': Fire protection for structural steel in buildings, 5th Edition obtainable free of charge from <https://is.gd/IZRRLz>

2. Background to specifying 'limiting temperatures'



It is well known that steel significantly loses strength as its temperature rises above 400°C to 550°C, a temperature soon exceeded in many fires. Consequently, there is a need to ensure that the temperature of the structural frame in a steel framed building is kept below certain 'limits' to guarantee its structural performance in the event of a fire. This is traditionally achieved by encasing or spraying the steel sections with a variety of products and materials which insulate it for long enough to allow occupants to escape and to limit damage to the structure itself.

Historically, the default 'limiting temperatures' for the UK required to guarantee such stability were set at 550°C for columns and 620°C for beams on the basis of an analysis of the applied loads and safety factors in buildings. Such guidance was given in the absence of a more engineered approach. The current ASFP Yellow Book gives detailed guidance for the selection of limiting temperatures.

The advent of BS5950: Part 8 and the Eurocodes allow designers to better exploit the properties of structural steel. Individual structural members may be optimised, and the stress level may be higher or lower which will change the limiting temperatures used in conventional design approaches.

Using fire engineering, engineers can balance various factors e.g. the severity of the fire that might be expected to occur, the composite action within the structural frame and the loading factors appropriate to the end-use amongst others. Such an approach can vary the limiting temperature quite significantly from the traditional defaults listed above. In some cases this allows reduction of the fire protection to certain elements in some fire scenarios.

To be able to undertake such calculations and determine appropriate limiting temperatures requires knowledge and skills beyond the ability of many specifying passive fire protection packages. Those specifying fire protection packages need to be confident that the solution they specify has been correctly determined and is up to the job. The ASFP and the BCF recommend that limiting temperatures not determined in this document must be calculated by a suitably qualified engineer e.g. chartered engineers recognised by the Engineering Council. Responsibility for the design will rest with the project design team and the competency of those providing advice. Responsibilities for designers and specifiers are listed below.

3. Responsibilities of designers and specifiers

Under clause 5.3 and 5.4 of the **Regulatory Reform (Fire Safety) Order 2005** (and national equivalents in Scotland and Ireland), those specifying, providing and installing fire protection systems have the same duties and responsibilities as the Responsible Person (Duty Holder in Scotland etc.). This means that if an incorrect solution is proposed and installed, those designing and installing are jointly liable; an installer cannot hide behind what was written on the order/specification.

The **Construction Design and Management (CDM) Regulations 2015** focusses on managing risk, as well as the health and safety of everyone involved with designing, specifying, constructing and using the building right through its life and including its maintenance. In the event of a fire and loss of life, a court will want to know how every fire protection system was selected and installed, as required by the CDM Regulations.

4. Design considerations

It is crucially important for those engineers designing the structure including those providing the fire protection thickness/specification liaise with the fire engineer to ensure that important design considerations are not omitted or misinterpreted. These include:

1. The required period of fire protection, e.g. 30, 60, 120 minutes for each member.
2. The associated limiting temperature for the design. The flow chart overleaf defines a protocol for selecting limiting temperatures.
3. Whether cellular beams are to be considered
4. Whether the design code is based on BS 5950, the Eurocodes or another design standard. Depending on which of these is used will change any default limiting temperatures discussed earlier.

Annex 1 contains a list of questions which should be addressed by the specifier or a competent person on his/her behalf to ensure that any submission will correctly provide details for the fire protection. Some misuses of supporting data are listed below. This list is not exhaustive:

1. Where the design uses test evidence obtained from fire tests on beams (tested with a concrete slab on top which limits fire exposure to only 3 sides) for application on a beam e.g. a roof beam or a column where all sides are exposed
2. Where data from I section test are used for application on hollow sections

3. Where data from one type of section e.g. beams or columns is used to justify use on other types of section e.g. large flat horizontal plates or the underside of metal decking
4. Use of unsuitable limiting temperatures on portal rafters
5. Use of unjustifiably high limiting temperatures to justify a lower thickness of products and thus a cheaper solution.
6. The use of maximum tested dry film thicknesses on steel sections which are not covered by the certification i.e. section factor higher than listed
7. Use of limiting temperatures and design protocol for solid beams for application on cell beams which require a more complex evaluation. For fire protection considerations for cell beams, refer to the ASFP Cell Beam Register available at <https://is.gd/r6orH8>.
8. Extending or extrapolating product performance data beyond the Certificated/listed range
9. Use of Ambient Strength Utilisation below 100% (full strength). This should only be accepted when provided by the project design team as it could lead to unacceptable and unproven lower levels of protection.

It is realised that many of the factors above require specialist knowledge to be able to evaluate and consequently it is recommended that a specialist manufacturer or a suitably qualified engineer (e.g. chartered engineers recognised by the Engineering Council) be consulted.

The ASFP is offering a foundation course in passive fire protection; individuals who undertake the training will have the opportunity to obtain **Level 2** or **Level 3** qualifications in Passive Fire Protection provided by the Institution of Fire Engineers (IFE), a nationally recognised awarding organisation regulated by the qualification regulators Ofqual. The scheme is suitable for all involved in the construction industry from designers and specifiers to contractors and specialist installers. It is also suitable for building owner occupiers and enforcement agencies. Further details can be found here: <https://is.gd/iNOwVN>

5. Reliability of installed fire protection

5.1 Third party certification

To ensure confidence that the correctly specified fire protection will work, it must be manufactured and installed correctly. The ASFP and the BCF recommend that this is ensured by requiring third party certification which uses the services of independent third-party bodies to monitor the manufacture and installation of fire protection products. There are two types of third party certification: **certification of products** and **certification of installers**.



5.2 Certification of products is undertaken by a certification body operating a product certification scheme accredited by UKAS, the government body that monitors certification bodies. Third party certification guarantees the quality of the product as it leaves the factory or as supplied to site by a mixture of:

- Selection of samples for testing by the certification body
- Audits of the manufacturers factory production control systems
- Traceability of product from raw material to final product
- Requirement of manufacturer to operate an ISO 9000 quality management system

5.3 Certification of installers is undertaken by a certification body operating an installer certification scheme accredited by UKAS. This may be a different certification body from that used for the product certification. Third party certification guarantees the quality of the product as installed on site by a mixture of:

- Auditing of installer company's records to check correct materials purchased and delivered to site
- Competency evaluation of installing staff
- Inspection of a selection of jobs during and/or after installation
- Providing completion certificates

5.4 Software verification

A number of software tools are used throughout the industry to design and verify the fire protection required to individual sections including the thicknesses required to achieve the required fire resistance. While software verification is not mandatory, it is recommended that end users should ensure that any such software packages used for structural analysis have been subject to a verification or certification process by an appropriate independent third party.

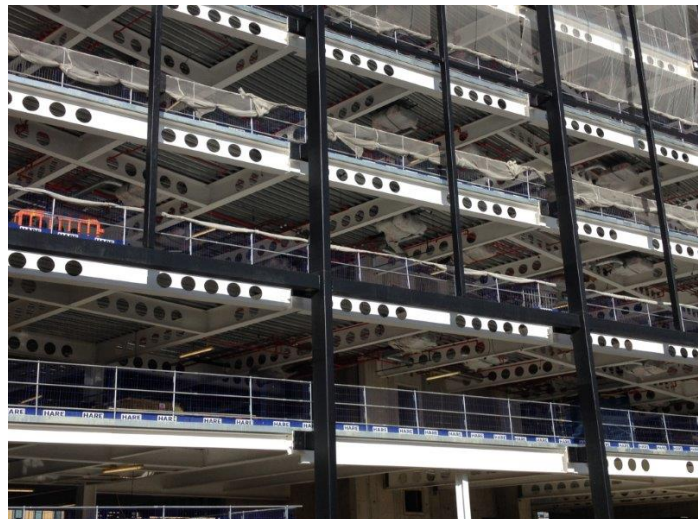
5.5 Third party inspection

For some projects either as an alternative to or in addition to third party certification of installers, clients, architects and other stakeholders specify independent inspection of structural frames during and after application of the fire protection to ensure that it is all installed correctly. Independent inspections can be tailored to the particular needs of the job in question and may be able to provide a more thorough verification of installed fire protection than might be possible with third party certification schemes for contractors.

6. Example specification of fire protection

To ensure an adequate standard of fire protection, structural design drawings and/or associated schedules of the various members must specify:

- The required period of fire protection, e.g. 30, 60, 120 minutes for each structural member
- The structural design code
- The fire test standard
- The associated limiting temperature for the design provided by a specialist manufacturer or a suitably qualified engineer e.g. chartered engineers recognised by the Engineering Council or other suitably competent person
- That the fire protection product be third party certificated and installed by a third-party certificated contractor if on-site application is used
- That both during and after application, the fire protection be inspected by a third-party inspection body
- Sufficient handover information including system specifications and thicknesses to:



- Cover the provisions of Regulation 38 so that a fire risk assessment can be undertaken by a fire risk assessor under the Regulatory Reform (Fire Safety) Order and national equivalents in Scotland, Northern Ireland and Ireland.
- Enable the fire protection system to be maintained and repaired as appropriate throughout the life of the building.

EXAMPLE:

“30 minutes fire protection to a limiting temperature of 500°C to Eurocode EN: 1993: 1-2 to be provided by (type of material) that has been tested to e.g. EN 13381 and third-party certificated to have the requisite performance, and to be installed by a third-party certificated contractor and inspected by a third-party inspection body”

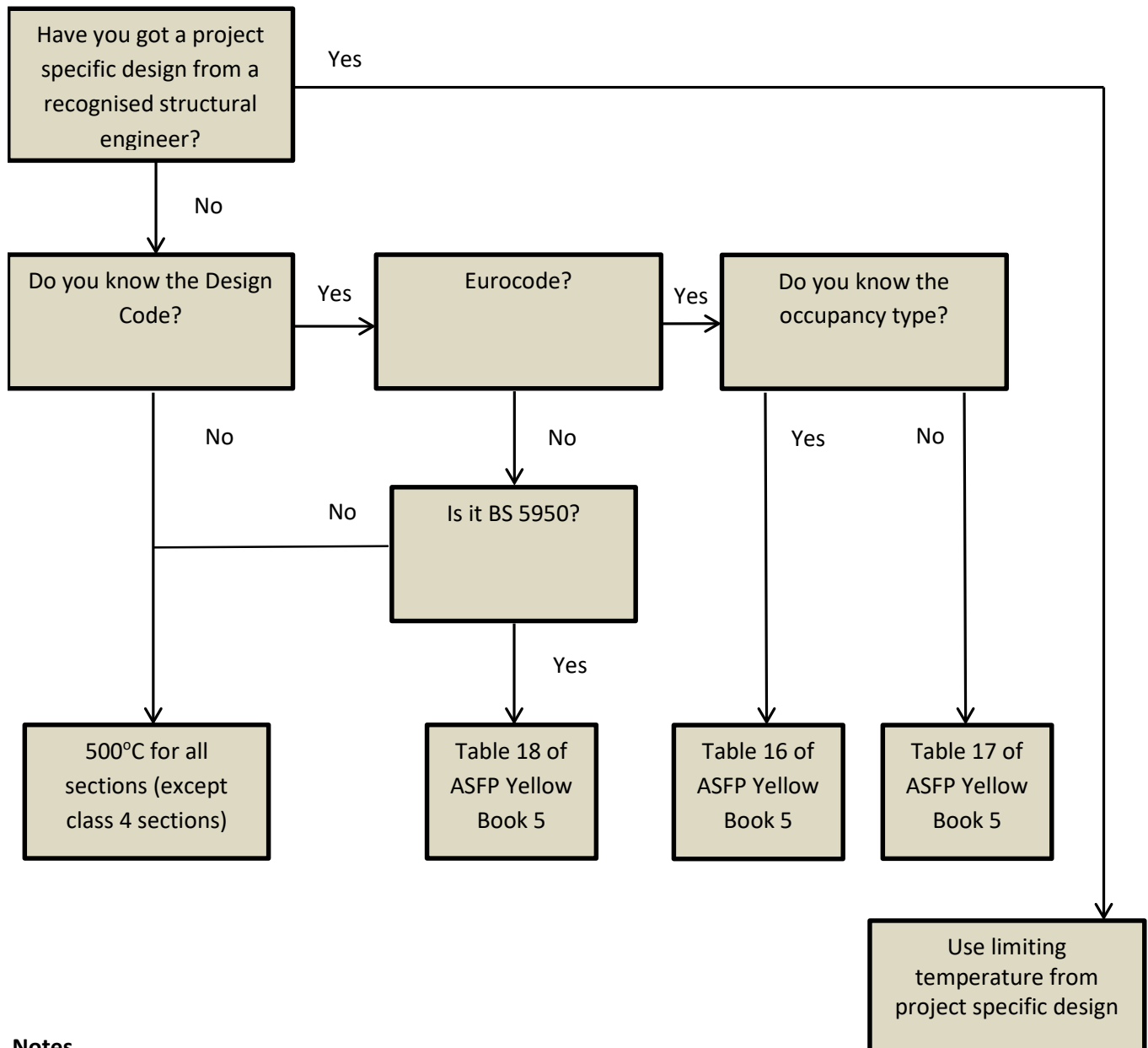
ANNEX 1 – CHECK LIST FOR DESIGNERS/SPECIFIERS

1	What is the required period of fire protection in minutes for each member?	Mins
2	What is the associated limiting temperature for the design? Note 1: the flow chart overleaf defines a protocol for selecting limiting temperatures Note 2: If the limiting temperature provided is in excess of 650°C, then this should be questioned, and a second opinion sought	°C
3	Has the limiting temperature been provided (calculated) by a specialist manufacturer or a suitably qualified engineer e.g. chartered engineers recognised by the Engineering Council or other suitably competent person? If not, then this should be questioned and an authoritative second opinion sought	Yes/No
4	Is the utilisation factor ambient or fire limit state? If you are not sure it should be assumed to be fire limit state. You may need to take advice from a specialist manufacturer or a suitably qualified engineer e.g. chartered engineers recognised by the Engineering Council or other suitably competent person.	Ambient/fire limit state
5	Is the fire protection product third party certificated and does it match or cover the submittal provided by the manufacturer or installer? If not ASFP recommends that only third party certificated products be used which matches or covers the submittal provided by the manufacturer and you should change the specification accordingly. Where a product is used outside its scope of certification then ASFP recommends that it is subject to a separate evaluation by an appropriate third party such as a certification body.	Yes/No
6	Has any software package(s) used to generate the required limiting temperature been accredited or third party certificated? ASFP only recommends the use of accredited or third party certificated software packages for the generation of limiting temperatures.	Yes/No
7	Has adequate consideration been given to the special needs of cell beams? Use of limiting temperatures and design protocol for solid beams for application on cell beams which require a more complex evaluation. For fire protection considerations for cell beams, refer to the ASFP Cell Beam Register available at https://is.gd/r6orH8	Yes/No
8	Does the submittal meet all the conditions in the table below	Yes/No

Some misuses of supporting data are listed below. If you are able, you should check that the submission under consideration meets the following. If you are not sure you should seek specialist guidance e.g. from a specialist manufacturer or a suitably qualified engineer e.g. chartered engineers recognised by the Engineering Council or other suitably competent person.

9	Confusion sometimes exists between loadings for 3-sided beams and 4-sided beams. 3-sided beam loadings are obtained from testing with a concrete slab above the top of the beam and should only be used when a concrete slab is in place. 4-sided beam loadings are certificated and are derived from column loadings. You should check that the submittal only uses 3-sided beam loadings in situations where a concrete slab is above the top flange.	Yes/No
10	Because of the effects of geometry, hollow sections typically require a greater thickness of application than an I section of equivalent massivity. Hollow section loadings of the appropriate shape should be used for the correct application. It is definitely unconservative to use I section loadings for hollow sections. You should ensure that the submittal uses data for an appropriate section shape in each instance and does not mix I section data with hollow section application.	Yes/No
11	I section column data can be used for I section columns, pre-formed channels, tees and angles, provided they are within the scope of the assessment. However, this data should not be used for other types of scenario, such as large flat plates. You should ensure that the certification covers the sections used in practice, or that other ad hoc testing is available.	Yes/No
12	Have suitable limiting temperatures been used in respect of protection to portal frame rafters? When coating portal frame rafters, it is appropriate to use 4-sided beam loadings, as there is no concrete floor slab. It is recognised that is not always possible to paint the top outer face, and if this occurs, advice should be sought to ensure the steel is not under protected. If you are not sure you should take advice from a specialist manufacturer or a suitably qualified engineer e.g. chartered engineers recognised by the Engineering Council or other suitably competent person	Yes/No
13	Product certification will cover certain limits, such as maximum dry film thickness, section factor and time period. These certificated limits are based upon the scope of the testing carried out. It is not possible to safely exceed these limits. You should ensure that these limits are not exceeded. If they are, you should seek advice from a specialist manufacturer or a suitably qualified engineer e.g. chartered engineers recognised by the Engineering Council or other suitably competent person	Yes/No
14	It is conservative to assume that a steel member is designed at 100% of its utilisation. Conversely it is unsafe to use a lower utilisation level without a proven structural model from the project design team, as it could lead to unacceptable and unproven lower levels of protection. You should make sure that any reduction in steel utilisation has been properly evaluated. In these situations, you should take advice from a specialist manufacturer or a suitably qualified engineer e.g. chartered engineers recognised by the Engineering Council or other suitably competent person	Yes/No

FLOW CHART FOR DETERMINING LIMITING TEMPERATURES



Notes

1. Cellular beams are excluded from this flowchart
2. Only Carbon steel is covered here e.g. aluminium must be considered separately
3. For Class 4 sections, the Eurocodes advise a limiting steel temperature of 350°C in the absence of a more detailed calculation

ANNEX 2 – EXAMPLE OF BID SUBMITTAL FOR DESIGNERS/SPECIFIERS

Sample Bid Submittal

Project Name Project XYZ

Submittal by ABC Contractor
Project Reference ABCD1234
Customer Client ABC

Date Created 24/04/2017

Product Standard EN13381/8
Design Code EC3 & EC4

Ref	Section Details								Fire Protection			
	Designation	Category / Occupancy	Cellular	Exp	Data Type	Limiting Temp (°C)	LT Source	A/V	F/R	Product	Cert Ref	DFT (µ)
1	700x150x8x6	B - Office	Yes	3Sides	Beam	PSD	PSD	258	60 min	ABC123	C12345	1000
2	700x200x15x10	D - Shopping	Yes	3Sides	Beam	PSD	PSD	200	90 min	ABC123	C12345	1575
3	406*140*46UKB	B - Office	No	3Sides	Beam	576	T 16	205	120 min	ABC123	C12345	1600
4	254*254*73UKC	B - Office	No	4Sides	Column	563	T 16	160	45 min	ABC123	C12345	330
5	IPE330	B - Office	No	4Sides	Column	563	T 16	200	75 min	ABC123	C12345	1105
6	IPE330	B - Office	No	4Sides	Beam	563	T 16	200	75 min	ABC123	C12345	830
7	HEB160	B - Office	No	4Sides	Column	563	T 16	169	105 min	ABC123	C12345	2400
8	IPE240	B - Office	No	4Sides	Column	563	T 16	236	105 min	ABC123	C12345	n/a
9	137.9*8 CHS	B - Office	No	All Round	Column	547	T 16	133	90 min	ABC123	C12345	4055
10	137.9*8 CHS	B - Office	No	All Round	Column	547	T 16	133	120 min	ABC123	C12345	n/a
11	200*200*8 SHS	Not known	No	4Sides	Column	515	T 17	127	90 min	ABC123	C12345	3300

Notes

Item Reference # 6 has WRONGLY used Beam Data (in lieu of Column Data) - Note the reduction in DFT (over 30%), this is NOT an acceptable nor safe solution, item reference # 5 above is the correct solution

Item Reference # 8 has no DFT Available, due to the high A/V being out of range of the product, the use of a "maximum DFT" or an unsubstantiated high critical temperature should NOT be an accepted alternative

Item Reference # 10 has no DFT Available, due to the high fire resistance requirement being out of range of the product

The use of an assumed "under utilisation" should NOT be an accepted alternative for the above point unless values are provided by the project design engineers

DFT/WFT denoted "n/a" = Not Available

In column "Limiting Temp" PSD denotes "Project Specific Design", this will be provided either by the project design team &/or from specialised accredited design software

Column "LT Source" refers to the Limiting Temperature source. This refers to the relevant Table withing the current version of the ASFP Yellow Book

Item Reference # 11 is shown with an unknown occupancy and as such uses the alternative Table 17 Limiting Temperature