# GUIDE FOR STRUCTURAL STEEL PROTECTION

*Version 1.0* *24 Oct 2010*

Promat

## User Guide

**This guide provides the specifier and contractor guidance in determining the appropriate material to be used for providing fire protection to structural steel members. The following considerations that must be taken into account when the user has to decide between a board, cementitious spray or reactive coating (intumescent paint). This guide also highlights properties critical to the materials performance, including environmental use, method of installation, appropriate certification standards etc.**

**The second stage of this guide provides the user information on the calculation of the section factor (A/V or Hp/A) which is used to determine the thickness of the protective material. Examples for both boxed and profile calculations are provided.**

**The third section details the flow of the application methods. Details on surface preparation, appropriate anti corrosion primers, key coats, protective weather proof coatings etc are all detailed in Stage Three.**

**Because this guide is by no means exhaustive in it's content, the end user should satisfy themselves that the environmental end use conditions are suitable for the product and the relevant approvals and certifications are available. If in doubt, please contact the nearest Promat office for advice.**



**TABLE 1: Summary of Promat Board Products** ***(complies with BS 476: Part 21: 1987, AS 1530: Part 4: 2005 and ASTM E119)***

| BOARD | PROMATECT®-H | PROMATECT®-L | PROMATECT®-250/100 | PROMATECT®-50 | VICUCLAD® |
|---|---|---|---|---|---|
| Maximum FRL & Standard | 120 min (BS& AS)<br>180 min (ASTM) | 240 min (BS & AS) | 150 min (BS & AS) | 240 min (BS & AS) | 240 min (BS & AS) |
| Maximum Section Factor (A/V) | 260 $m^{-1}$ (BS)<br>300 $m^{-1}$ (ASTM) | 260 $m^{-1}$ (BS & AS) | 260 $m^{-1}$ (BS & AS) | 260 $m^{-1}$ (BS & AS) | 265 $m^{-1}$ (BS & AS) |
| Area of Application | - Internal<br>- Semi External | - Internal<br>- Semi External | - Internal | - Internal<br>- Semi External | - Internal |
| Impact Resistance | Yes | Yes | No | Yes | No |
| Fixing Method Used | - Screw<br>- Staples (for thickness > 15mm) | - Screw<br>- Staples | - Screw<br>- Staples (for thickness > 15mm) | - Screw | - Adhesive & Nail<br>- Screw |
| Construction Type | 1,2,3 or 4 Sided Encasement | 1,2,3 or 4 Sided Encasement | 1,2,3 or 4 Sided Encasement | 1,2,3 or 4 Sided Encasement | 1,2,3 or 4 Sided Encasement |
| Type of Fire Curve | ISO / HC Curve | ISO Curve | ISO Curve | ISO Curve | ISO Curve |

**TABLE 2: Summary of Promat Spray and Paint Products** ***(complies with BS 476: Part 21: 1987 and AS 1530: Part 4: 2005)***

| SPRAY | CAFCO® 300 | Cafco MANDOLITE® CP2 | Cafco FENDOLITE® MII | Cafco FENDOLITE® TG | Cafco MANDOLITE® 550 | Cafco SPRAYFILM® WB3 |
|---|---|---|---|---|---|---|
| System Properties | Vermiculite gypsum based | Vermiculite and Portland cement based | Vermiculite and Portland cement based | Vermiculite and Portland cement based | Vermiculite and Portland cement based | Intumescent paint |
| Maximum FRL | 240 min | 240 min | 240 min | 240 min | 240 min | 120 min |
| Maximum Section Factor (A/V) | Up to 400 $m^{-1}$ (AS)<br>Up to 310 $m^{-1}$ (BS) | Up to 310 $m^{-1}$ (BS & AS) | Please consult local Promat office | | | Up to 320 $m^{-1}$ (BS & AS) (depending upon FRL) |
| Area of Application | Internal only | - Internal only<br>- Semi exposed | External | External (Touch-up for Cafco FENDOLITE® MII) | External | - Internal only<br>- Semi exposed (with external appropriate top coat) |
| Surface Preparation Required? | Yes | Yes | Yes | Yes | Yes | Yes |
| Keycoat (Roller, brush or conventional spray application) | CAFCO® SBR bonding latex or Cafco BONDSEAL® | 1. CAFCO® SBR Bonding latex if primer zinc epoxy or zinc epoxy<br>2. CAFCO® PSK 101 Zinc Epoxy primer alkyd or zinc phosphate | CAFCO® PSK 101 | CAFCO® PSK 101 | CAFCO® PSK 101 for primed steelwork | Primer required (See Table 5) |
| Application | Wet spray application - Machine | Wet spray application - Machine | Wet spray application - Machine | Wet hand application - Trowel by hand | Wet spray application - Machine | - Airless spray |
| Galvanized Mesh Required? | Depends Upon FRL and Dimension of Steel Section<br>Please Consult Local Promat Office | | | | | |
| Type of Fire Curve | ISO Curve | ISO Curve | ISO Curve & HC Curve (for Oil & Gas) | ISO Curve & HC Curve (for Oil & Gas) | ISO Curve & HC Curve (for Oil & Gas) | ISO Curve |

**TABLES 1 AND 2 : PLEASE CONSULT PROMAT FOR APPLICATIONS WHERE SECTION FACTOR EXCEEDS 260$m^{-1}$**

## STAGE 1 — PRELIMINARY DESIGN CONSIDERATIONS FOR PRODUCT SELECTION

**BEGIN HERE**

**Protection to Structural Steel Members**
*(Beam or Column)*

### PRODUCT RECOMMENDATION

*All materials (board, spray & reactive coating) are applicable for exposure to **ISO curve**. However, only selected board and spray materials have extended application for exposure to **Hydrocarbon (HC) curve**. Please refer to 'Summary of Product Information' in **Tables 1 & 2**, or consult your local Promat Technical Department for further details.*

ISO / HC

**Board, Spray & Reactive Coating**
*Refer to 'Summary of Product Information' in Tables 1 & 2 for appropriate material.*

**Spray & Reactive Coating**
*Refer to 'Summary of Product Information' in Tables 2 for appropriate material.*

**Board & Reactive Coating**
*Refer to 'Summary of Product Information' in Tables 1 & 2 for appropriate material.*

### PERFORMANCE CONSIDERATIONS

**Fire Resistance Level (FRL)**
*Define FRL required.*

**Type of Fire Exposure**
*Define expected type of fire for building structure, either based on cellulosic (ISO curve) or hydrocarbon (HC curve).*

**Exposure to Weather** (Yes / No)
*Check if location of steel member is directly expose to weather or under cover.*

**Resistant to Impact Loading** (Yes / No)
*Define if impact resistance is required.*

**Constraint on Weight of Protection Material** (Yes / No)
*Define if weight of protection system is a concern.*

**Importance of Aesthetic Appearance** (Yes / No)
*Define if appearance of protection system is concern.*

**Importance of System Cost** (Yes / No)
*Define if overall cost of protection system is of concen.*

### WORKING ENVIRONMENT

**Condition of Steel Members**
*Check if they are new or refurbished steel members.*
New / Refurbished

**Area of Application**
*Check the location of steel members, whether they are located at internal or external of building structure. Is the area easily accessible?*
Internal / External

**Availability of Application Equipment** (Yes / No)
*Check if application equipment is available while deciding type of material used, as this may involve additional cost of investment in machinery etc.*

**Speed of Installation** (Yes / No)
*Check if speed of installation is important. Is there sufficient time period allowed.*

*Surface preparation of steelwork required unless protected using board encasement.*
*See application guide for Spray and Reactive Coating for details, or consult local Promat Technical Department for advice.*

*Carefully select suitable product from Tables 1 & 2 based on environment.*

**Spray & Reactive Coatings are Recommended**
*Refer to 'Summary of Product Information' in Table 2 for appropriate material.*

**Board is Recommended**
*Refer to 'Summary of Product Information' in Table 1 for appropriate material.*

**Board, Spray & Reactive Coating are Recommended**
*Refer to 'Summary of Product Information' in Tables 1 & 2 for appropriate material.*

## STAGE 2 — DETERMINING OF REQUIRED THICKNESS FOR FIRE PROTECTION MATERIAL

**Type of Steel Member and it's Orientation**

*This depends on the function of steel members, whether it is beam or column, and its orientation within the building structure.*

**Performance of Unprotected Steel**

Fire resistance tests have demonstrated that 30 minutes fire resistance can be achieved with fully stressed unprotected steel sections, and these include the following:

- Rolled steel section column filled with aerated concrete blockwork between the flanges – Hp/A up to 69 $m^{-1}$;
- Columns, in simple construction with four sided exposure – Hp/A up to 50 $m^{-1}$;
- Beams, in bending, which directly supporting concrete or composite slabs – Hp/A up to 90 $m^{-1}$.

**NOTE**: Where these specific conditions arise on site, protection may not be necessary subject to agreement with the approving authority.

- When the elements of a lattice beam are to be individually protected, the thickness of protection required for each element should be based on the Hp/A of the individual element.
- Where a lattice beam is to be protected by encasing the entire beam, consult the local Promat Technical Department for advice.

Continuous research is being carried out with castellated section & cellular beams. Current recommendation from the Steel Construction Institute suggests that the Hp/A should be calculated as below.

Section Factor, Hp/A [$m^{-1}$] = 1400 / t

Where t = thickness (mm) of the lower steel web and applies for beams made from all steel rolled sections and from welded steel plate.

If in doubt, consult the local Promat Technical Department for advice.

**Protection Requirement to Dovetail Deck**

*While the supporting beams should be properly protected with appropriate material, voids below decks may be left unfilled for all periods of fire resistance.*

*Voids must be filled on beams that are part of a compartment wall, otherwise the integrity and insulation criteria of the compartment wall will be breached.*

If in doubt, consult your local Promat Technical Department for advice.

**Protection Requirement to Trapezoidal Deck**

*When reference is made to temperature at 550°C, the required thicknesses of protection material to steel beams is outlined below:*

- *No increase in thickness up to 60 minutes FRL;*
- *Increase thickness by minimum 10% up to 90 minutes FRL;*
- *Fill voids above the top flange for over 90 minutes FRL.*

*When reference is made to temperature 620°C, the required thicknesses of protection material to steel beams is summarised as follows:*

- *Increase thickness by minimum 20% up to 60 minutes FRL;*
- *Increase thickness by minimum 30% up to 90 minutes FRL;*
- *Fill voids above the top flange for over 90 minutes FRL.* If in doubt, *consult the local Promat Technical Department* for advice.

**Universal Beam or Column**
*This refers to I-section or H-section*

**Structural and Rolled Tees**

**Angles**
*This includes equal and unequal sections.*

**Channels**

**Steel Hollow Section**
*This includes square, rectangular and circular shaped hollow sections.*

**Lattice**

**Castellated Section & Cellular Beams**

**Composite Floor**
*Two common types of deck - Dovetail and Trapezoidal are fixed to and supported by steel beams.*

**IMPORTANT NOTE:**
The required thickness of protection material is determined by calculating the section factor (Hp/A) of a steel section, which in turn is calculated by the ratio of the heated perimeter surface (Hp) to the cross sectional area (A) of a steel section. Note should be taken that determination of Hp value is different between board encasement method and spray coating method. This is illustrated below for better understanding of the relevant steel section.

### Hp Calculation For Board Encasement (Box)

| Steel section | Box and Solid protection | | | | |
|---|---|---|---|---|---|
| Universal beams, universal columns and joists (plain and castellated) | 4 sides | 3 sides | 3 sides (partially exposed) | 2 sides | 1 side (partially exposed) |
| Hp | 2B + 2D | B + 2D | B + 2d | B + D | B |
| Structural and rolled tees | 4 sides | 3 sides (flange to soffit) | 3 sides (toe of web to soffit) | | |
| Hp | 2B + 2D | B + 2D | B + 2D | | |
| Angles | 4 sides | 3 sides (flange to soffit) | 3 sides (toe of flange to soffit) | | |
| Hp | 2B + 2D | B + 2D | B + 2D | | |
| Channels | 4 sides | 3 sides (web to soffit) | 3 sides (flange to soffit) | | |
| Hp | 2B + 2D | 2B + D | B + 2D | | |
| Hollow sections (square or rectangular) | 4 sides | 3 sides | | | |
| Hp | 2B + 2D | B + 2D | | | |
| Hollow sections (circular) | | | | | |
| Hp | πD | NOTE: The air space created in boxing a section improves the insulation and a value of Hp/A. Therefore, Hp higher than profile protection would be anomalous. Hence, Hp is taken as the circumference of the tube and not 4D. | | | |

**OR**

### Hp Calculation For Cementitious Wet Spray and Reactive Coatings (Profile)

| Steel section | Profile protection | | | | |
|---|---|---|---|---|---|
| Universal beams, universal columns and joists (plain and castellated) | 4 sides | 3 sides | 3 sides (partially exposed) | 2 sides | 1 side (partially exposed) |
| Hp | 2B + 2D + 2(B - t) = 4B + 2D - 2t | B + 2D + 2(B - t) = 3B + 2D - 2t | B + 2d + (B - t) = 2B + 2d-t | B + D + 2(B - t)/2 = 2B + D -t | B |
| Structural and rolled tees | 4 sides | 3 sides (flange to soffit) | 3 sides (toe of web to soffit) | | |
| Hp | 2B + 2D | B + 2D | B + 2D + (B - t) = 2B + 2D - t | | |
| Angles | 4 sides | 3 sides (flange to soffit) | 3 sides (toe of flange to soffit) | | |
| Hp | 2B + 2D | B + 2D | B + 2D + (B - t) = 2B + 2D - t | | |
| Channels | 4 sides | 3 sides (web to soffit) | 3 sides (flange to soffit) | | |
| Hp | 2B + 2D + 2(B - t) = 4B + 2D - 2t | 2B + D + 2(B - t) = 3B + 2D - 2t | B + 2D + 2(B - t) = 3B + 2D - 2t | | |
| Hollow sections (square or rectangular) | 4 sides | 3 sides | | | |
| Hp | 2B + 2D | B + 2D | | | |
| Hollow sections (circular) | | | | | |
| Hp | πD | NOTE: FOR REACTIVE COATINGS, SPECIAL APPROVALS ARE REQUIRED FOR HOLLOW SECTIONS, CASTELLATED SECTIONS AND CELLFORM BEAMS ETC, PLEASE CONSULT PROMAT FOR DETAILS. | | | |

**Worked example:**

Calculate section factor of universal beam 305 mm x 305 mm x 240 kg/m. Assuming 4-sided exposure.

Given: B = 317.9 mm, D = 352.6 mm, t = 23 mm, A = 305.6 $cm^2$

***For board encasement method (board protection),***

Hp = 2B + 2D
= (2 x 317.9) + (2 x 352.9)
= 1341 mm
= 1.341 m

Hence,
Hp/A = 1.341 / 0.03056
= 43.9 $m^{-1}$

***For spray or reactive coating protection (profile protection),***

Hp = 4B + 2D - 2t
= (4 x 317.9) + (2 x 352.6) – (2 x 23)
= 1930.8 mm
= 1.931 m

Hence,
Hp/A = 1.931 / 0.03056
= 63.1 $m^{-1}$

**Determination of Required Thickness for Protection Material**

Once the Hp/A of a steel section is determined, refer to Promat Handbook for recommended thickness of material selected based on the required fire resistance duration.

Contact the nearest Promat office for a copy of The Promat Technical Handbook.

## STAGE 3 — FIRE PROTECTION MATERIAL APPLICATION GUIDE

### Table 3: Protection with Board Encasement

***Work Begins Here***

**Surface Preparation for Steelwork**
*This is not required when using board encasements.*

**Fixing Method Available**
*Board fixing can be applied in three different methods, depending on type of board material.*

**Screw Fixing**
*By mean of screws and metal profiles. Direct fixing board to board possible if material thickness is > 15mm.*
→ **Suitable Products:** *PROMATECT®-H, PROMATECT®-L, PROMATECT®-50, PROMATECT®-250, PROMATECT®-100, VICUCLAD®*

**Staple Fixing**
*By mean of steel wire staple using pneumatic stapler or equivalent. Recommended for material with thickness > 15mm only.*
→ **Suitable Products:** *PROMATECT®-H, PROMATECT®-L, PROMATECT®-50, PROMATECT®-250, PROMATECT®-100*

**Adhesive Fixing**
*By use of Promat VICUBOND® adhesive. Use of nails required for temporary hold while adhesive sets.*
→ **Suitable Products:** *VICUCLAD®*

### Table 4: Protection with Cementitious Wet Spray Coating (for Oil & Gas, Hydrocarbon Exposure, External Use)

***Work Begins Here***

**Location**
*Material to be used at on-shore or off-shore environment.*

**On-Shore**
*Recommended material: Cafco FENDOLITE® MII, Cafco FENDOLITE® TG.*

**Off-Shore**
*Recommended material: Cafco MANDOLITE® 550.*

**SURFACE PREPARATION 1**

**Blast Cleaning**
- *SA 2.0*
- *SA 2.5*
- *SA 3.0*

**Primer**
- *Primer to be applied 2~4 hours after blast cleaning.*
- *Clean salt contamination if any.*

**ZINC** — Thickness: - *75 µm* - *100 µm*
**EPOXY** — Thickness: - *75 µm*
**ZINC EPOXY** — Thickness: - *75 µm*
**Optional** *Apply epoxy Tie Coat*

**SURFACE PREPARATION 2**

**Surface Preparation**
- *Clean the surface from dust, oil and other contamination*
- *Remove any zinc contamination by sweep blast and apply Tie Coat*

**Installation of Pin Studs & Galvanised Mesh before Reinstatement of Primer**

**Key Coat**
*Use CAFCO® PSK101*

**Spray Application**
*Apply selected protection material.*

**FINISHING**

**No Trowelling**

**Trowelling**
*Where surface of protection material is required to be aesthetically pleasing.*

**Optional**
**Water Repellant / Cafco Topcoat® 200**

**Completion of Installation**

### Table 5: Protection with Reactive Coating (Cafco Sprayfilm WB3)

***Work Begins Here***

**Condition of Steelwork**
*Surface condition needs to be ascertained prior to applying protection material. Surface preparation may be required.*

**Refurbished Steelwork**

**Galvanised Steelwork** → **Apply Etching Primer** *- 20 µm DFT* → **Apply Compatible Primer Type** *Alkyd zinc phosphate, zinc silicate, epoxy zinc rich etc are typical types*

**New Build** → **Plain Black**

**SURFACE PREPARATION 1**

**Power Tooling** *(ST3)* → **Alkyd/ Zinc Phosphate**

**Blast Cleaning**
- *SA 2.0*
- *SA 2.5*
- *SA 3.0*

**ZINC** — Thickness: - *75 µm* - *100 µm*
**EPOXY** — Thickness: - *75 µm*
**ZINC EPOXY**

**Zinc Salt Contamination** — No / Yes
Yes → - Sweep blast to remove any zinc contamination - Apply Tie Coat

**SURFACE PREPARATION 2**

**Surface Preparation**
- *Clean the surface from dust, oil and other contamination*
- *Remove any zinc contamination by sweep blast and apply Tie Coat*

**Application of Cafco SPRAYFILM® WB3**
*Coating should be applied according to recommendations. If in doubt, consult the local Promat Technical Department for advice.*

**Application of Top Coat**

**C1 Internal Dry** → **2 Coats of Top Seal (If specified)**
**C2 Internal Potential Damp Environment** → **2 Coats of Top Seal** *2 x 40µm DFT*
**C3 Semi External Weathering** → **Urethane or Acrylic Urethane** *2 x 40µm DFT*

**Completion of Application**

### Table 6: Protection with Cementitious Wet Spray Material - General Construction

***Work Begins Here***

**Application Environment**
*Is steelwork located internally or semi-exposed in building structure?*

**Internal**
*Recommended materials: Cafco® 300, Cafco MANDOLITE® CP2*

**Semi Exposed**
*Recommended material: Cafco MANDOLITE® CP2*

**Fully Exposed**
*Recommended material: Cafco Fendolite® MII*

**CAFCO® 300**

**Check Condition Suitability** → **No Corrosion Risk** → **No Primer Require**; **Corrosion Risk** → **Apply Primer**

**Selection Material**
*Material to be used*

**SURFACE PREPARATION 1**

**Power Tooling** *(ST3)* → **Alkyd/ Zinc Phosphate**

**Blast Cleaning**
- *SA 2.0*
- *SA 2.5*
- *SA 3.0*

**ZINC** — Thickness: - *75 µm* - *100 µm*
**EPOXY** — Thickness: - *75 µm*
**ZINC EPOXY**
**Optional** *Epoxy Tie Coat*

**SURFACE PREPARATION 2**

**Surface Preparation**
- *Clean the surface from dust, oil and other contamination*
- *Remove any zinc contamination by sweep blast and apply Tie Coat*

**Key Coat**
*Use Cafco BONDSEAL® / SBR Bonding Latex*

**Spray Application**
*Apply selected protection material.*

**Optional: Finishing Top Coat**

**Water Repellant** | **Emulsion Paint** | **Acrylic Paint** | **Other Compatible Coating**

**Completion of Installation**

**Cafco MANDOLITE® CP2/ Cafco Fendolite® MII**

**Surface Cleaning**

**SURFACE PREPARATION 1**

**Power Tooling** *(ST3)* → **Alkyd/ Zinc Phosphate**

**Blast Cleaning**
- *SA 2.0*
- *SA 2.5*
- *SA 3.0*

**ZINC** — Thickness: - *75 µm* - *100 µm*
**EPOXY** — Thickness: - *75 µm*
**ZINC EPOXY**
**Optional** *Epoxy Tie Coat*

**SURFACE PREPARATION 2**

**Surface Preparation**
- *Clean the surface from dust, oil and other contamination*
- *Remove any zinc contamination by sweep blast and apply Tie Coat*

**Key Coat**
*Use CAFCO® PSK101*

**Key Coat**
*Use CAFCO® SBR bonding latex/ Cafco Bondseal®*

**Vibration Concern** — No / Yes
Yes → Install galvanised mesh

**Apply Spray Material According to Required Thickness.**
*- When reinforcing mesh is used, minimal thickness of spray must not less than 20 mm. If less, increase to 20 mm thick.*

**Finishing**

**Trowelling** | **No Trowelling**

**Optional**
**Water Repellant / Cafco Topcoat® 200**

**Completion of Installation**

ANTI-CORROSION REQUIREMENT
FIRE PROTECTION REQUIREMENT
COSMETIC SURFACE PERFORMANCE REQUIREMENT



an Etex GROUP company