Structural Steel Surface Conditions for the Application of Spray-Applied Fire-Resistive Materials (SFRM) and Intumescent Coatings or Thin Film Intumescent Fire Resistive Materials (TFIFRM)

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Spray-Applied Fire-Resistive Materials (SFRM) and Mastic Coatings or Thin Film Intumescent Fire Resistive Materials (TFIFRM), are common steel fire protection materials. Underwriters' Laboratories of Canada (ULC) and Underwriters Laboratories Inc. (UL) in the USA both list the fire rated structural steel assemblies or designs in their Fire Resistance Directories.

Within the ULC and UL Fire Resistance Directories the numbering system for SFRM fire protected steel assemblies have a 700-899 suffix number series. The TFIFRM fire protected steel assemblies are denoted by a 600-699 suffix number. Some SFRM and TFIFRM fire protected floor/roof assemblies are also listed in the 900-999 suffix number series that are referred to as "unprotected" since only steel beams require the applied protection while the steel deck is left unprotected. A prefix letter that denotes the types of construction precedes the suffix number series, e.g., A, B, or C refers to concrete and cellular steel deck while X, Y or Z refers to columns.

The use of paints or primers on structural steel to receive SFRM is not recommended. Constraints have been placed upon this application by UL and ULC, and these are provided in the preamble material in the front of the UL and ULC Fire Resistance Directories, where the following two statements are made:

1. "The surfaces on which the material (i.e., SFRM) is to be applied must be free of dirt, oil and loose scale".
2. "Surfaces may be primed with the primers/paints covered under Primers for Structural Steel (CGJM Guide Information)".

In regards to the second statement, ULC harmonized with UL on this issue in March 2008 by providing the following requirements for primers on their website (ULC's revised clarifications become effective on January 1, 2009). The acceptability of primed, painted or encapsulated steel shall be determined by consulting the design criteria cited for the fire-rated assembly. Unless specifically prohibited in the fire-resistance design criteria, SFRM shall be applied to primed, painted or encapsulated wide flange steel shapes, in assemblies published in the UL and ULC Fire Resistance Directories, provided,

a) The beam flange width does not exceed 305 mm (12 in)
b) The column flange width does not exceed 406 mm (16 in)
c) The beam of column web depth does not exceed 406 mm (16 in)
d) The pipe outer diameter or tube width does not exceed 305 mm (12 in)
e) Bond tests conducted in accordance with ASTM E736, *Standard Test Method for Cohesion/Adhesion of Sprayed Fire Resistive Materials Applied to Structural Members*, indicate a minimum average bond strength of 80% and a minimum individual bond strength of 50%, when compared to the bond strength of the SFRM as applied to clean uncoated 3 mm (⅛ in) thick steel plate. The average and minimum bond strength values shall be determined based on a minimum of five bond tests conducted in accordance with ASTM E736.

If condition e) is not met, UL and ULC require that a mechanical bond be obtained by wrapping the structural member with expanded metal lath with a mass at least 0.92 kg/m^2. If any of conditions a), b), c) or d) are not met, UL and ULC require that a mechanical break be provided using strips of metal lath or steel studs and disks – refer to the UL and ULC Directories for details. Most SFRM is configured to adhere to bare steel, galvanized steel and painted steel. There are dimensional limits in many cases, so it is recommended that the SFRM manufacturer be consulted. The manufacturer can make recommendations for galvanized surfaces and usually maintains a list of primers and paints that have been tested in accordance with ASTM E736. More information on steel's substrate condition is overviewed in Technical Manual 12-A, *Standard Practice of the Testing and Inspection of Field Applied Sprayed Fire-Resistive Materials; an Annotated Guide,* published by the Association of the Wall and Ceiling Industries.

An intumescent coating (or TFIFRM) has a pre-fire appearance of paint. In many instances, the coating is actually a system of multiple coats with different properties and functions. For example, these include a compatible primer to provide a strong bond to the steel substrate, the intumescent layer that provides the fire protection, and a topcoat, formulated to provide a durable finished surface. Both UL and ULC Fire Resistance Directories reference Technical Manual 12-B, *Standard Practice of the Testing and Inspection of Field Applied Thin-Film Intumescent Fire Resistive Materials; an Annotated Guide*, published by the Association of the Wall and Ceiling Industries. The Guide states that the surface condition of steel "be free of dirt, oil, grease, release agents, loose scale, paint, primer or any other surface condition that may prevent adequate adhesion". It further states, "The acceptability of primers, paints or other surface conditions shall be determined by consulting the fire resistance rating design criteria and the TFIFRM manufacturer's specifications".

Thus, when acceptable, because building interiors are conditioned for human comfort and are non-corrosive environments, it is usually better not to prime or paint steel, both to save the unnecessary costs and to eliminate the concern for SFRM adhesion. TFIFRM will generally require the use of a compatible primer. In accordance with Clauses 28.8.1 and 6.6.2 in CSA Standard S16-01 (S16S1-05) shop painting of steel would not be required when the building environment is controlled, i.e., no corrosion occurs once the building is enclosed. The corresponding Clauses read as follows:

28.8.1 General Requirements
Steelwork need not be coated unless required by Clause 6.6 or otherwise specified.

6.6.2
Interiors of buildings conditioned for human comfort may be generally assumed to be non-corrosive environments; however, the need for corrosion protection shall be assessed, and protection shall be furnished in those buildings where it is deemed to be necessary.

As mentioned above, when left unpainted, the steel surface should be clean and free of oil, dirt, and loose mill scale. The SFRM and TFIFRM commercial products have proprietary formulations and, therefore, it is imperative to closely follow the manufacturer's recommendations for their application on to the steel substrate. These products are qualified through standard fire testing procedures that require the assembly to be built and protected in accordance with these recommendations. Upon successful completion of a fire test, the configuration of the assembly, as well as the manufacturer's recommendations for the product application procedure, become a part of the listing for the particular design. Compliance with all the manufacturer's instructions for the SFRM or TFIFRM application is thus mandated.

More information on SFRM, TFIFRM and other methods of fire protection are given in Section 2 of CISC's Fire Facts for Steel Buildings (Gewain et al, 2006), available as a free download from the following CISC webpage:

http://www.cisc-icca.ca/publications/technical/design/FireFacts/

REFERENCES

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