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October 16, 2019

Mr. Stephen Wieroniey
American Chemistry Council
Director, Center for the Polyurethanes Industry
700 2nd Street, NE
Washington, DC 20002

RE: Application of Spray Polyurethane Foam (SPF) over Spray-applied Fire-Resistive Materials (SFRM) in Fire-Resistance Rated Construction
JENSEN HUGHES Project Number 1AJP00272.000

Dear Mr. Wieroniey:

JENSEN HUGHES is providing this letter to support the application of spray polyurethane foam (SPF) products over spray-applied fire-resistive materials (SFRM) in various construction configurations. SFRM products are one of the most commonly used product types to enhance the fire resistance properties of structural steel elements and floor or roof/ceiling assemblies. SFRM products typically consist of a dry powder that is mixed with water in a specific ratio (prior to pumping or at the spray nozzle) to achieve a workable consistency, after which it is either spray-applied or troweled onto a substrate. The substrates are typically either primed steel or a lath covered surface to ensure adhesion of the SFRM to the substrate material.

Documented assemblies that use SFRM as a means for fire protection can be found in the UL Online Fire Resistance Directory as indicated in the table below.

Type of Element/Assembly	UL Directory Design Series (i.e. D700 = D701, D702, D703, etc. …)
Concrete and Steel Decking Floor/Ceiling Assemblies	D700, D800, E700, F700, and F800
Concrete with Steel Joists Floor/Ceiling Assemblies	G700
Concrete Floor/Ceiling Assemblies	J700
Beams for Floor/Ceiling Assemblies	N700, N800, O700, O800
Roof/Ceiling Assemblies	P700, P800, R700, R800
Beams for Roof/Ceiling Assemblies	S700, S800
Columns	X700, X800, Y700, Z700, Z800

The aforementioned UL Designs do not include provisions for SPF to be applied over the indicated minimum SFRM thicknesses. The introduction of SPF into these fire resistance-rated systems poses concerns where the application of SPF over SFRM could potentially have adverse effects on the evaluated systems. These concerns include the combustible nature of SPF and the effect that it could have on the fire resistance performance of the system, and the potential effect that the SPF may have on the bond strength of the SFRM to the substrate (whether that be structural steel or steel decking). If the bond strength were negatively impacted by the SPF, then the SFRM may not stay in place throughout a fire exposure and consequently the assembly would not achieve the fire resistance rating it would have were the SFRM still in place.

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Technical Considerations

The application of SPF over a SFRM application will not adversely affect the fire-resistance rating of the assembly due to the increased amount of combustibles introduced to the system. By installing SPF over the exposed face of a rated assembly or a structural member, the SPF becomes the material which would first be exposed to heat and flame of an interior fire. Therefore, in a fire it will ignite and burn. During the process of the SPF burning, the SFRM and deck materials above would not be directly exposed to the fire until the SPF layer had been completely consumed. Effectively, while the SPF will contribute combustibles to the fire, it will act as a shielding layer to the assembly above, or structural member beneath while it burns.

The ASTM E119 test method is conducted in a manner that already simulates a fully developed interior fire with flashover conditions (i.e. full ignition of all combustibles in the interior space). During these tests the furnace is controlled in a manner to follow a specific time-temperature curve, regardless of the contribution or heat sync effect that the test assembly materials may have on the environment of the furnace. Therefore, if this installation scenario were replicated in an ASTM E119 test, the resulting exposure conditions within the test furnace both while the SPF foam was covering the SFRM material and for the remainder of the qualification period thereafter would then be the same ASTM E119 time-temperature conditions to which the rated assembly was originally subjected. Based on the test method described in ASTM E119 used to qualify the fire performance of the SFRM protection, the addition of the combustible SPF would not adversely impact the overall fire performance of the SFRM applied over the steel beams and metal floor deck.

Other concerns with the installation of SPF over SFRM include potential adverse effects to the bond strength of the SFRM to the metal substrate.

If the SPF is installed over the SFRM insulation before the SFRM has fully cured then the SFRM may retain moisture that would have otherwise evaporated and could negatively affect the bond strength of the SFRM to the metal substrate. Therefore, the SFRM material must be allowed to fully cure before the any SPF is installed over the exposed surface.

The bond strength could also potentially be negatively impacted if a material installed over the SFRM introduces additional moisture that would otherwise not be present in the system. However, SPF insulation is formed by mixing two liquid components that react chemically, expand, and harden within a matter of minutes, after which there is no latent moisture present in the SPF. Therefore, the SPF insulation would not have an impact on the SFRM substrate in regards to introducing additional moisture to the system.

The last scenario where the bond strength of the SFRM could be impacted would be due to the weight of additional material applied to the underside of the SFRM. Several UL Designs, including UL D779, D798, D925, and D985 allow for the installation of other materials over SFRM which have a nominal dry density of up to 3.5 lb/ft^3. Closed cell SPF materials typically have a nominal density of 2.0 lb/ft^3. Therefore, when installed at equal thicknesses, the SPF foam will subject the SFRM to less load than other materials which are allowed in these UL Designs. The allowable SPF installation thicknesses over the surface of SFRM depends on the thickness and density of the SFRM material over which it is installed. Higher thicknesses of SFRM insulation are allowed less covering material as the SFRM approaches the maximum thickness (and weight) at which it has been evaluated for fire resistance. Guidance on allowable SPF installation thickness over SFRM is provided in the following “Installation Constraints” section.

Installation Constraints

The introduction of combustible SPF insulation onto the exposed face of a fire resistance rated assembly has certain limitations associated with it.

First, the substantiated conclusions that SPF installed onto a system will not reduce the fire resistance is limited strictly to application over SFRM products. Intumescent paints or coatings may not have SPF installed over them. The reason being that the intumescent paint or coating must react to the heat from the fire to form the insulative char layer. The SPF application may prevent the intumescent from being directly exposed to the elevated temperatures and any residual SPF char may interfere with the char layer formation.

Secondly, the introduction of combustible SPF to the exposed face of a system invokes the surface burning requirements in Chapter 8 and thermal barrier provisions of Chapter 26 requirements of the IBC. These include the requirement for the SPF to have maximum a flame spread index of 75 as determined in accordance with ASTM E84 (IBC Section 2603.3) and the

SPF must be separated from the interior of a building by a thermal barrier (Section 2603.4) unless testing in accordance with IBC Section 2603.9 determines that a thermal barrier is not required.

Lastly, as previously mentioned, the installation of the SPF foam should not subject the SFRM installation beneath it to loads which it has not been evaluated for in a fire resistance test. Therefore, SFRMs installed at their maximum evaluated thicknesses should not have SPF insulation added over them. For any installation thickness of SFRM less than the maximum evaluated thickness, SPF can be added at a thickness determined per the equation below:

$$Allowable\ SPF\ Installation\ Thickness = (t_{SFRMMax} - t_{SFRMcurrent}) \times \left(\frac{\rho_{SFRM}}{\rho_{SPF}}\right)$$

Where $t_{SFRMMax}$ is the maximum evaluated thickness (per the UL Design for the SFRM) of the SFRM material, $t_{SFRMCurrent}$ is the current installation thickness of the SFRM, ρ_{SFRM} is the nominal density of the SFRM, and ρ_{SPF} is the nominal density of the SPF insulation.

As an example, if nominal 2.0 lb/ft^3 SPF were installed over a low density, nominal 15 lb/ft^3 SFRM material, the SFRM material was approved at a max install thickness of 2 inches, and the SFRM were currently installed at 1½ inches, the allowable SPF installation thickness would be determined as follows.

$$Allowable\ SPF\ Installation\ Thickness = (2\ in. - 1.5\ in.) \times \left(\frac{15\frac{lb}{ft^3}}{2\frac{lb}{ft^3}}\right) = 3.75\ in.$$

This will ensure that the total combined weight of the SFRM installation and covering SPF do not exceed the weight of the SFRM alone when installed at its maximum thickness.

Conclusion

Based on the technical justification provided above, it is our engineering opinion that it is acceptable to install SPF insulation over SFRM protected structural members or floor and roof/ceiling assemblies and not adversely impact the fire-resistance rating of the protected structural member or assembly. The limitations stated above must be adhered to in order to ensure the required fire-resistance ratings will remain.

The analysis supports the fire resistance rating of such assemblies will not be compromised by a cover installation of SPF insulation. Installation of foam plastic insulation must comply with Chapter 26 of the IBC to mitigate risks associated with interior applications.

The conclusion on the performance of fire resistance rated assemblies is based on technical reasoning provided within this letter that the application of SPF over SFRM will not adversely affect the bond strength of the SFRM. The qualification testing that established the fire-resistance rating of a given assembly was based on a standard fire exposure conditions within the test furnace and additional combustible materials as part of the tested assembly will not change these standard exposure conditions, resulting in no reduction to the overall assembly fire-resistance rating.

We appreciate the opportunity to assist the American Chemistry Council. If there are any questions, please contact us at 312-604-5540 or 443-313-9891, respectively.

Submitted by,

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