



FireBlock™

Intumescent Flame Retardant FRP

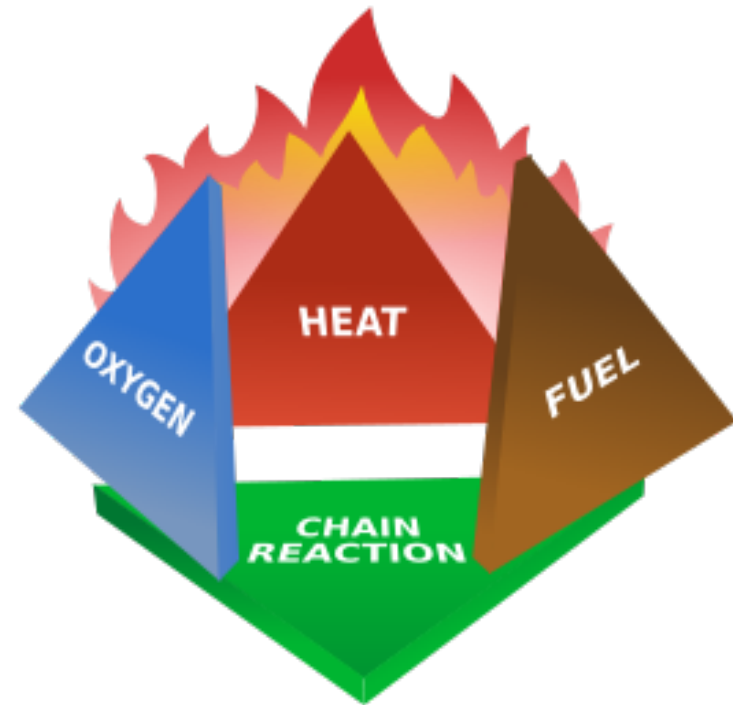
Development of a new, Halogen-free, polyester resin for Rail and Mass Transit Interior Parts.

Railway & Mass Transit Interiors Expo
Boston, MA
October, 2012



Four Mechanisms of Fire Retardation

- **Dilution of Gas Phase-** Inert gas (CO_2) or water (steam) reduces oxygen and combustible gas %
- **Endothermic Degradation-** Fire consumes energy during fire, which in turn helps put fire out (i.e. ATH)
- **Gas Phase Radical Quenching-** Halogen (RBr) reaction is preferred and ties up very reactive H and OH radicals in gas phase, forming HBr.
- **Thermal Shielding-** Creates an insulation barrier that separates the fire flame from the fuel source (blanket or intumescent char materials)



Fire tetrahedron

FR or FR ?

- **A Flame Retardant material is one that is designed to resist burning and withstand heat.**
- **Fire Resistant materials are designed not to burn at all.**
- **FireBlock™ materials are Flame Retardant not Fire Resistant.**

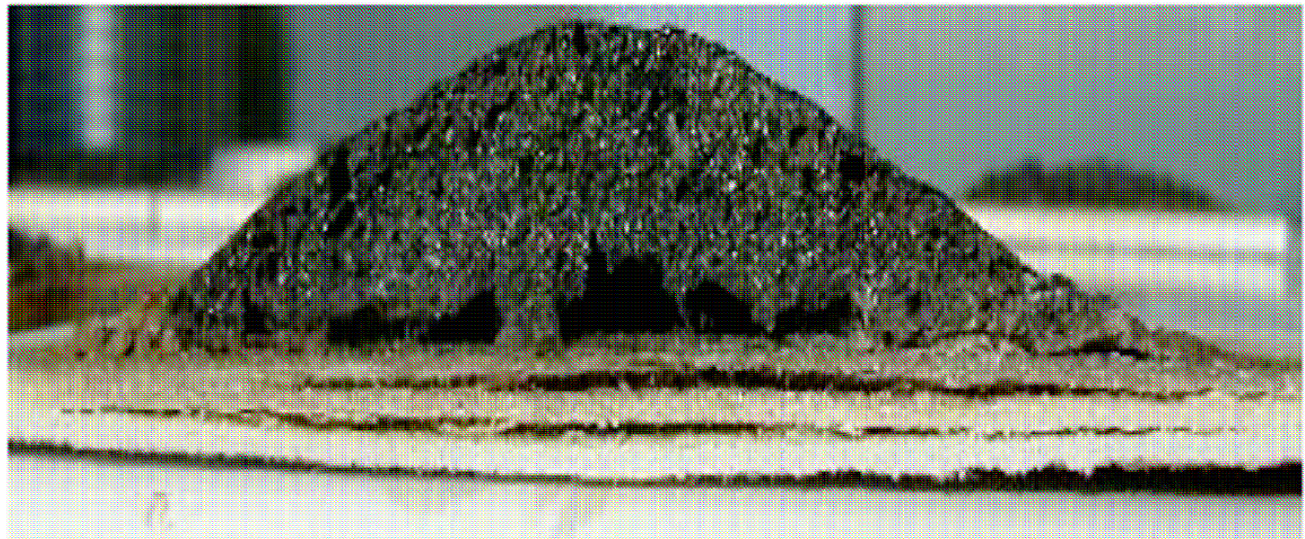
FireBlock™

Traditional fire resistant materials in plastics have used halogenated (bromine/chlorine) based polymers and FR fillers (i.e. Antimony, ATH, etc.) to meet FR specs. Toxicity of the gases and high smoke are of concern when using these.

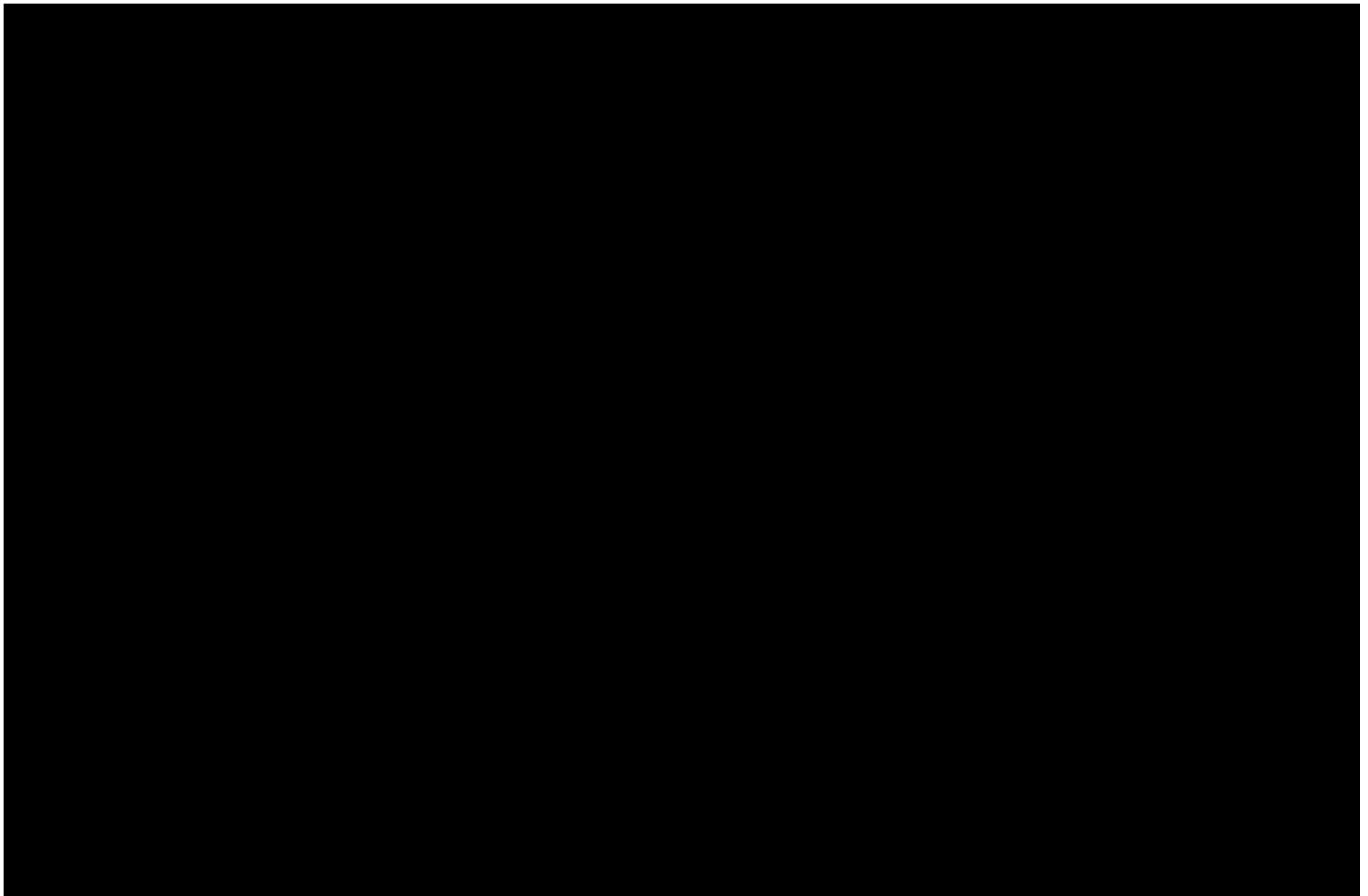




Intumescent materials work by forming a char layer at the interface of the fire source and the composite laminate, thus cutting off the oxygen accelerant from the organic fuel source.



FireBlock™ 30 sec video of fire char formation on gel
coat with blow torch



FIREBLOCKTM
SERIES



Intumescent resins and gel coat

NorsodyneTM H 81269 TF - General Purpose Applications in
Hand Lay UP and Spray Up. Meets EN TS 45545-2 for Railway
Equipment, and E84 for both Flame Spread and Smoke

NorsodyneTM H 81270 TF- Aerospace, Hand Lay up and Spray
up. Meets FAR 25.853. Lightweight at < 1.40 specific gravity

NorsodyneTM P 81091 TF- Pultrusion Applications

NorsodyneTM I 81268 F- RTM and Infusion

Polycor[®] 2330- **FireBlock** Gel Coat (<1.44 specific gravity)

Review of FireBlock™ product properties

- Meets a variety of **flame-retardant** specifications including UL 94 V-0, ASTM E 162-02a, and EN TS 4554-2, FAR 25.853 for transportation applications.
- **Low Smoke** Generation meeting ASTM E 662 and EN/ISO 5659-2 smoke specifications
- **Toxicity** standards meeting Bombardier SMP800C and EN TS 45545-2 annex C

Review of FireBlock™ product properties



CMR component free
(**C**arcinogenic, **M**utagenic or toxic-
free for **R**eproduction)

Halogen and Antimony free

Low filler content and relatively,
Low density

Very high fire protection

Main Market Segments for FR Resins

- **Industrial**
 - **Ductwork, Smoke Stacks**
- **Architectural**
 - **Panels, Building Material, Facades, Theme Parks**
- **Aerospace/Military**
 - **Plane Interiors, Cargo Bins, etc.**
- **Transportation/Mass Transit,**
 - **Buses, Trains, Subways, Ferries**

Main Market Segments for FR Resins

- **Industrial**
 - **Ductwork, Smoke stacks,**
 - **Usually requires corrosion resistance**
 - **Utility boxes with FR specs**

Common test to pass is ASTM E84 or UL 94V-0

Main Market Segments for FR Resins

- **Architectural**
 - **Panels (interior and exterior)**
 - **Building Materials**
 - **Facades**
 - **Theme Parks (i.e. Disney)**

Common test to pass is ASTM E84

Main Market Segments for FR Resins

- **Military/Aerospace**
 - **MIL-STD-2031 (SH), Fire and Toxicity Methods and Qualification Procedure for Composite Material Systems on Naval Submarines**
 - **MIL-R-21607 Various Marine and Shore Uses**
- **Interiors of Planes, Cargo Bins, Etc.**
 - **Aircraft Cargo Bins FAR 25.855**
 - **Aircraft Interiors FAR 25.853**

Interior parts specifications, Airbus specific

CCP Composites has developed an aeronautic grade of its' intumescent FireBlock system that can meet the following AITM specifications (Norsodyne™ H81370 TF, with 2330 gel)

AITM 2.0002 – Fire spread-12 and 60 sec vertical; (ASTM F501 FAR 25.853a)

AITM 2.0007 – Smoke opacity (NBS Smoke, ASTM F814)

AITM 3.0005 – Fumes toxicity (SMP800)

AITM 2.0006 – Heat release and heat release rate; OSU Heat Release, ASTM E906 (modified)

All AITM tests hereafter have been done with a laminate made of:

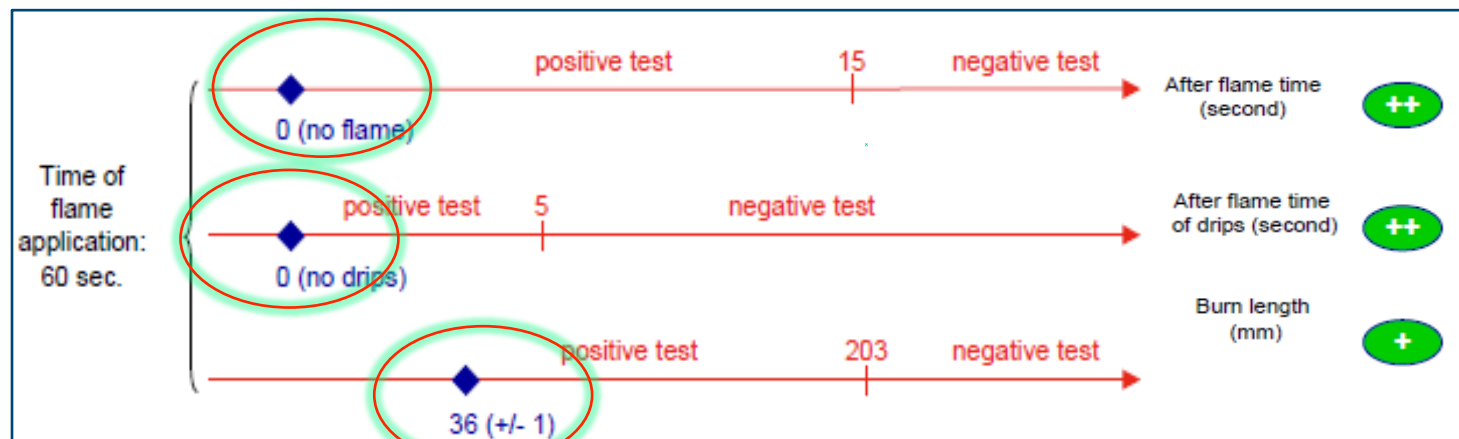
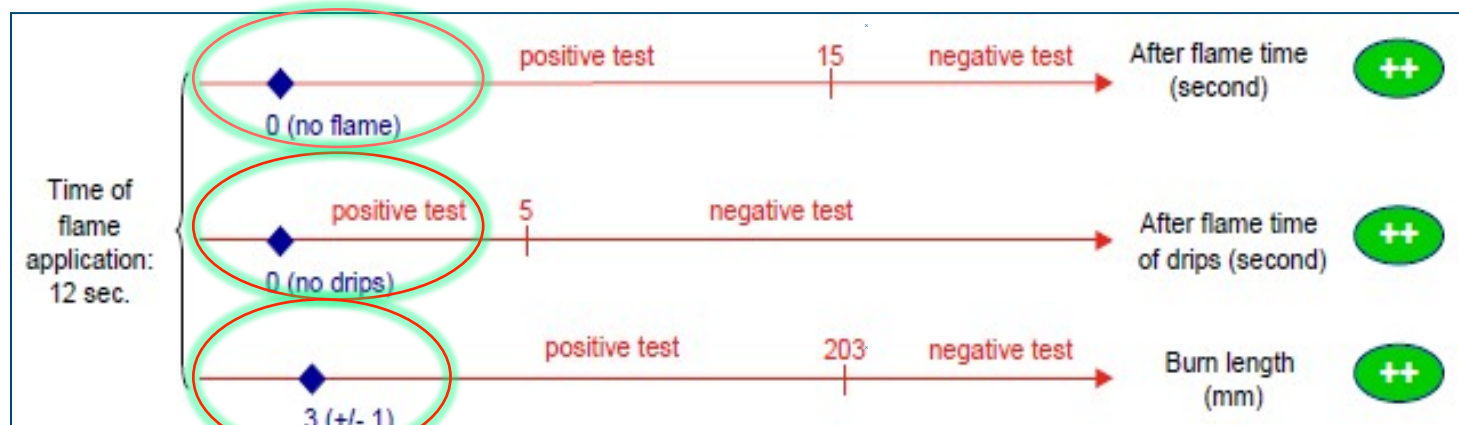
- 450 g/m² CSM (~20% in weight)
- Norsodyne H 81370 TF (~80% in weight)
- Gelcoat POLYCOR 2130 PA (400-500 mm, 16-18 mil) if mentioned

Airbus standard for interior parts

AITM 2.0002 - Fire spread:



FireBlock intumescent resin is compliant at both 12 sec and 60 sec flame applications



FireBlock laminate results

w/FireBlock gel coat provide similar or better results

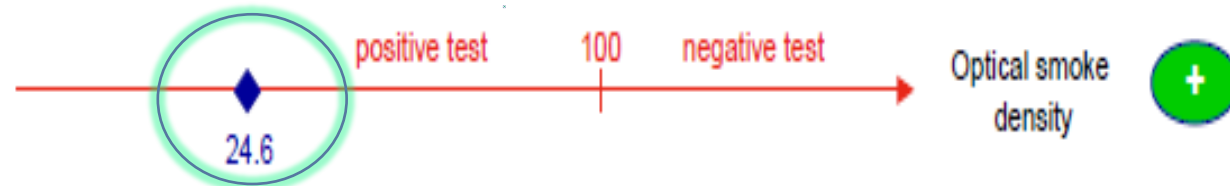
Airbus standard for interior parts

AITM 2.0007 – Smoke Opacity:

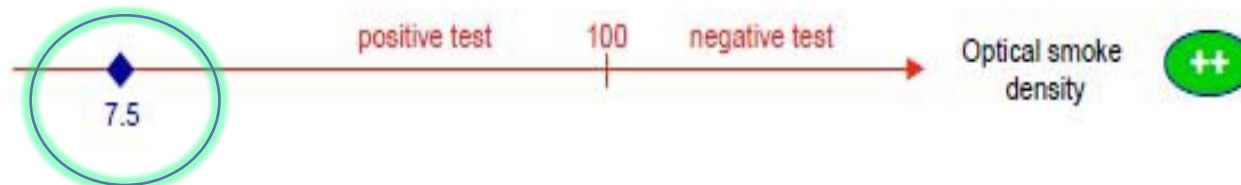


FireBlock intumescent resin is compliant in both Flaming and Non-Flaming Mode

1) Flaming mode:



2) Non -flaming mode:



FireBlock laminate results

w/FireBlock gel coat provide similar or better results

Airbus standard for interior parts

AITM 3.0005 – Smoke Toxicity:



**FireBlock Intumescent Resin is Compliant for Airbus (below),
as well as Boeing and Bombardier (HBr <100 ppm)**

Gas	Concentration limit (ppm)	Results		Conclusion
		Flaming mode	Non flaming mode	
HF	100	0	0	++
HCl	150	0	0	++
HCN	150	20	0	++
SO ₂ / H ₂ S	100	< 20	< 20	+
NO / NO ₂	100	< 5	0	++
CO	1000	100	0	++

FireBlock laminate results

w/FireBlock gel coat provide similar or better results



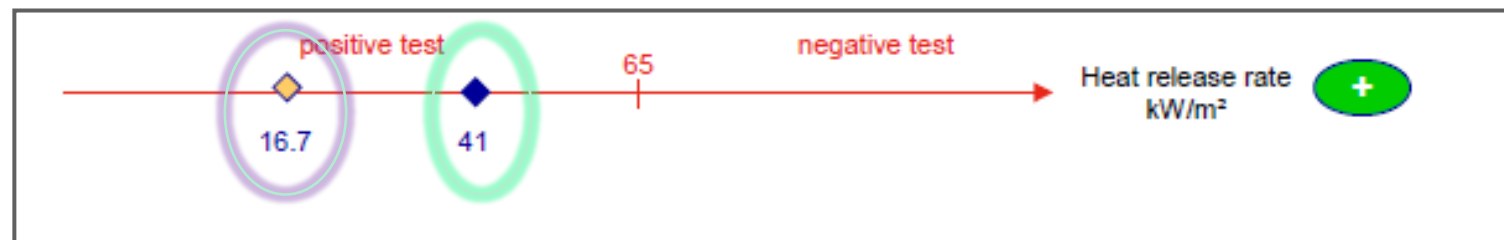
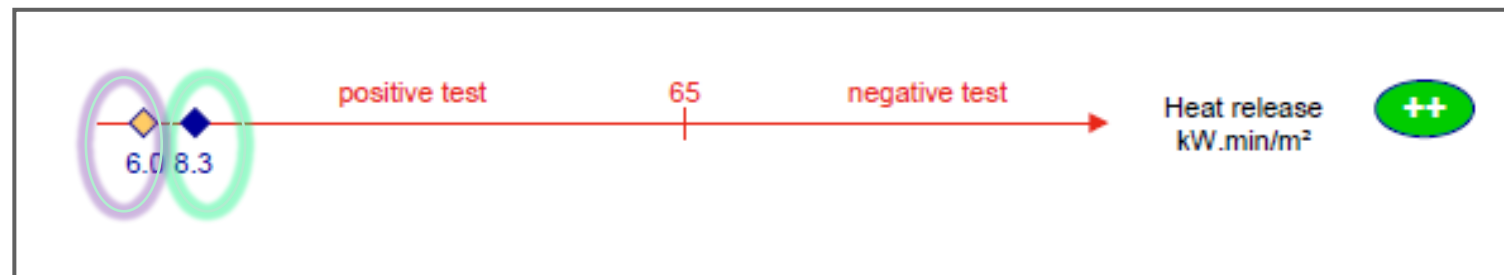
Airbus standard for interior parts

AITM 2.0006 – Heat Release (OSU test):



FireBlock intumescent resin and gel coat are compliant.

Note: improvement with intumescent gel coat



FireBlock laminate results



FireBlock laminate with gel coat results



Main Market Segments for FR Resins

- **Transportation/Mass Transit**
 - **Buses**
 - **Trains**
 - **Subways**
 - **Ferries**

**Common test to pass is UL 94V-0, ASTM E-662,
Bombardier SMP800-C in N. America and
EN TS 4554-2 in Europe**

Test	Results ⁽¹⁾	
UL 94	V-0 Rating	
ASTM E162-08 Surface Flammability of Materials using a Radiant Heat Energy Source	Flame Spread Index, $I_s = 10$	
ASTM E 662 Optical Smoke Density	Flaming	Non-Flaming
	- Specific Optical Density (D_s) at 1.5 min - Specific Optical Density (D_s) at 4.0 min	$D_s = 1.3$ $D_s = 18$
Bombardier SMP 800-C ⁽²⁾	Flaming – Passed CO – 636 CO ₂ – 17,778 HBr – Not detected HCl – Not detected HCN – Not detected HF – Not detected NO _x – 86 SO ₂ – Not detected	Non-Flaming – Passed CO – Not detected CO ₂ – 1,361 HBr – Not detected HCl – Not detected HCN – Not detected HF – Not detected NO _x – Not detected SO ₂ – Not detected

(1) Laminate – All flammability tests run on a laminate consisting of **NORSODYNE[®] H 82169 TF** resin matrix reinforced with 3 plies of 1.5 oz CSM. The resin was catalyzed with 0.05% Cobalt 12% and 1.0% DDM-9. The glass content was 22%. The panel was post cured for 4 hours at 150°F.

(2) Results shown are maximum concentrations.

Hazardous levels

- EN 45545 describes three « Hazardous Levels » for wall and ceiling lining – R1 category, HL3, HL2 and HL1 from the most severe to the less
- Required rating level is defined according to the type of train (or metro or tramway) and its operation category

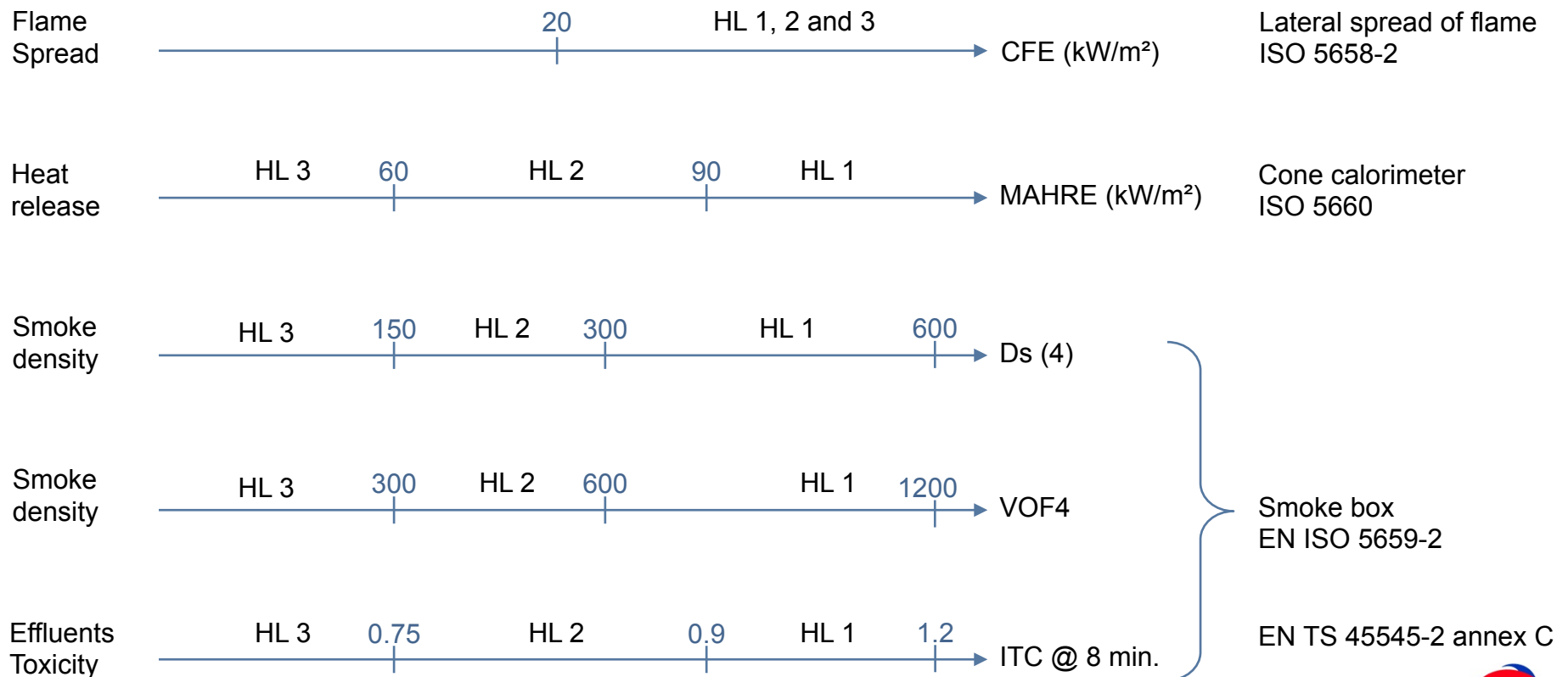


EN 45545							
Operation category				Type of train			
	Infrastructure	Evacuation	Line	Standard vehicle*	Automatic vehicle	Double-decked vehicle	Sleeper
1	Not determined by underground sections, tunnels and/or elevated structures	With means of safe side evacuation	Mainline, regional, urban & suburban	HL 1			HL 2
2			Urban & suburban	HL 2			
3			Mainline & regional	HL 2			HL 3
4	Determined by underground sections, tunnels and/or elevated structures	Without means of safe side evacuation	Mainline, regional, urban & suburban	HL 3			

*: the term "train" also covers trams and metros

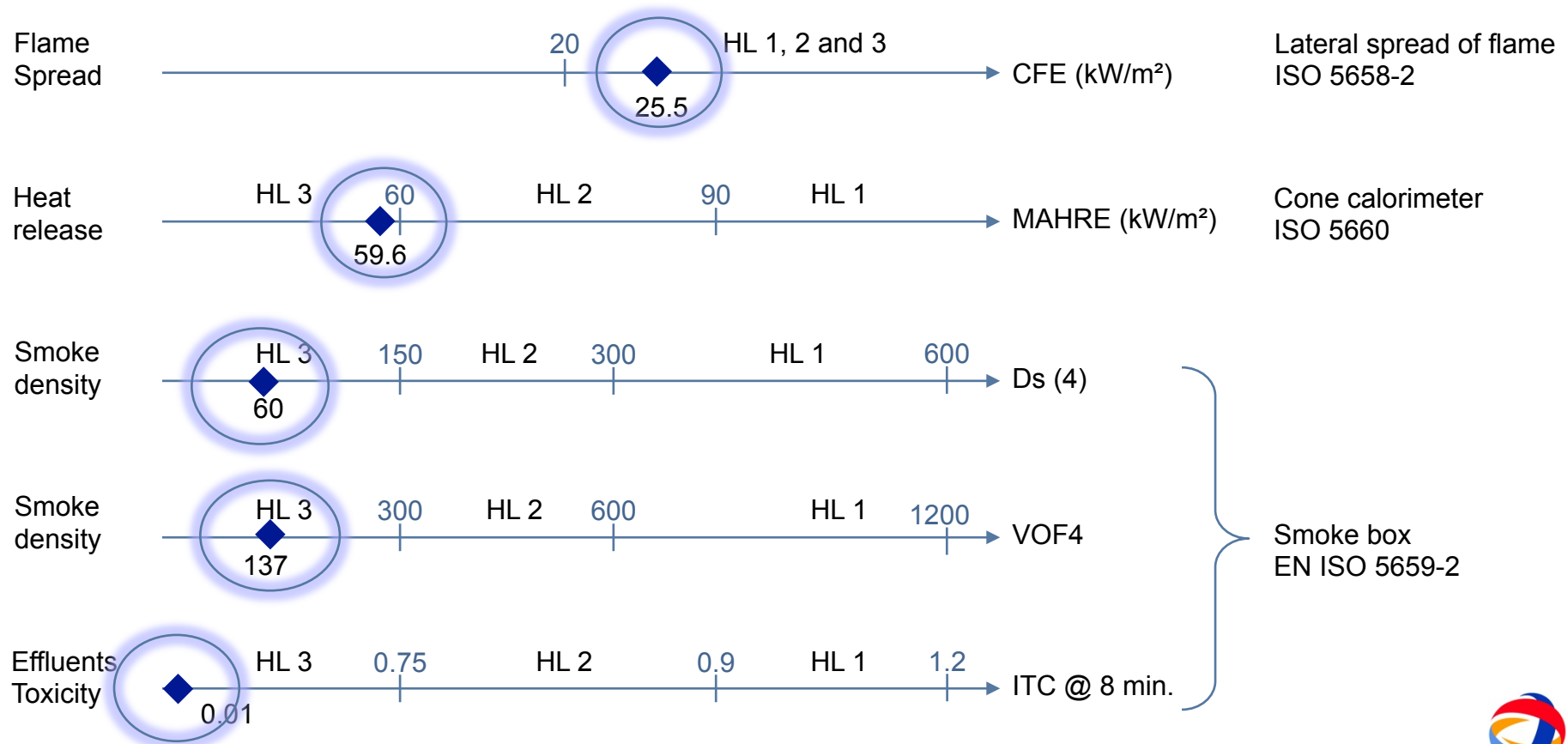
FIRST criteria according HLs and test methods

► Requirements for each criteria for wall and ceiling lining – R1 category



Evaluation of RTM molded coupons

Based on 4 mm thick laminates, made of Polycor® 2330 PA,
Norsodyne® I 81268 F and Rovicore™ FR 450 D3 450.
Tested under **EN TS 45545 cat. R1**



Fire certificates for intumescent resin series



Country / Area	Standard	Rating	Panel	Official certificate
Europe	EN 45545 (Railway)	HL 2	UPR ¹ laminate (20% glass, CSM 450)	CREPIM approval
		HL 3	GC ⁴ (400 µm) + UPR ¹ laminate (20% glass)	
France	NF P 92-507 (Building, Railway)	M1	UPR ¹ laminate (20% glass, CSM 450) with or without GC ^{4,5} (400µm)	Yes
	NF F 16-101 (Railway)	F1		Yes
Germany	DIN 5510 (Railway)	S4 SR2 ST2		Yes
Spain	UNE 23727	M1	GC ⁴ (1000 mm) + UPR ¹ laminate (30% glass) + TC ⁴ (1000 mm)	Yes

1: Norsodyne® H 81269 TF

2: Norsodyne® P 81091 TF

4: Polycor® 2220

5: Polycor® 2330

Fire resistance has to be re-assessed with each intumescent resin version since process employed may have a great impact on fire resistance



Fire certificates for intumescent resin series



Country / Area	Standard	Rating	Panel	Official certificate
UK	BS 6853	Cat. 2	GC (1000 µm – double gelled) + UPR ¹ laminate (20% glass)	Yes
	BS 476, Part 6	Class 0		Yes
	BS 476, Part 7	Class 1	GC (1000 µm) + UPR ¹ laminate (20% glass)	Yes
USA	ASTM E 84	Class 1 FSI < 25 Smoke < 450	UPR ³ laminate (25% glass)	Yes
	ASTM E 162	FSI = 10	UPR ¹ laminate (10% glass)	Yes
	ASTM E 662	compliant		Yes
	UL 94	V-0		Yes
	SMP 800 (Bombardier)	compliant		Yes

1: Norsodyne® H 81269 TF

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Fire resistance has to be re-assessed with each intumescent resin version since process employed may have a great impact on fire resistance



FireBlock Performance Advantages, especially versus Phenolic

- Room temperature cure - with peroxide initiators
- Formaldehyde and water free – No outgassing/porosity
- No acid catalyst needed - no need for special tooling
- No 80°C post cured required – improved productivity
- Longer material shelf life by 2-3X
- Improved cosmetics with the gel coat
- Improved mechanical properties
- Cost competitive with phenolic at similar specific gravity
- CMR and Halogen free
- Process friendly- Can be used in Hand Lay, Spray up, RTM and Pultrusion. Infusion and Pre-preg ???