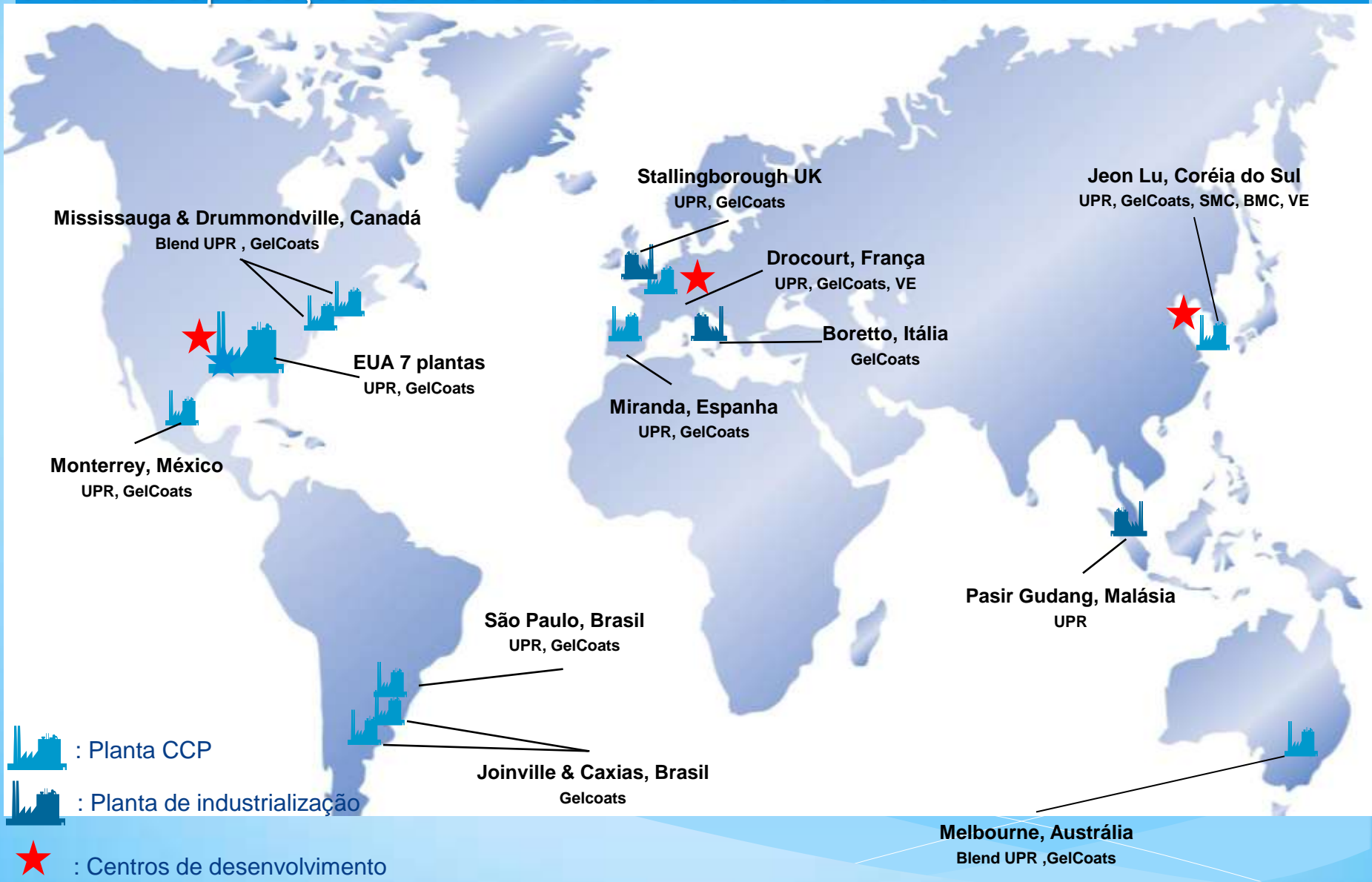


CCP Composites



Unidades de produção e centro de desenvolvimento no mundo



20 unidades de produção incluindo 5 de mistura e 4 de industrialização

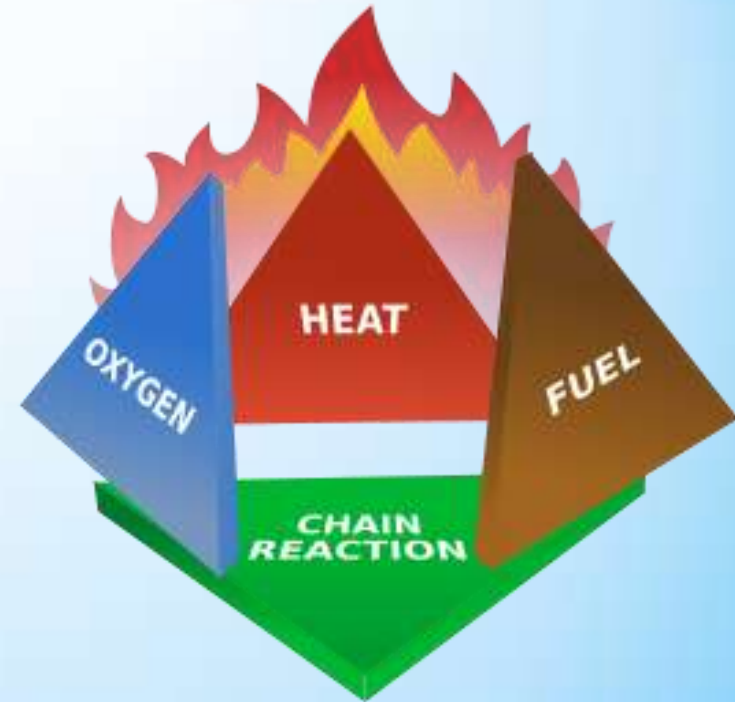
Halogen Free Intumescent FR solutions for Aircraft Interiors, Mass Transit and Architectural Panels

Rick Pauer, Market Manager



Four Mechanisms of Fire Retardation

- **Dilution of Gas Phase-** Inert gas (CO₂) 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.**
- **Intumescent materials are Flame Retardant not Fire Resistant.**

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.



20 second burn video of UPR, FR UPR
and Intumescent technology



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.



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





Intumescent resins and gel coat

FB H 81269 TF - General Purpose Applications in Hand Lay UP and Spray Up.

FB H 81270 TF- Aerospace, Hand Lay up and Spray up.

Lightweight at < 1.40 specific gravity

FB P 81091 TF- Pultrusion Applications

FB I 81268 F- RTM and Infusion

FB M 81266TF- Heat cure, closed molding

FB 2330- FB Gel Coat (<1.44 specific gravity)

Quick review of intumescent 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.
- Meets **Low Smoke** generation specifications of ASTM E 662 and EN/ISO 5659-2
- Meets **Low Toxicity** standards of Bombardier SMP800C and EN TS 45545-2 annex C

Quick review of intumescent 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**
- **Utility boxes with FR specs**
- **Usually requires corrosion resistance**

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

Main Market Segments for FR Resins

Architectural

- **Panels (interior and exterior)**
- **Building Materials (< 40 feet)**
- **Facades**
- **Theme Parks (i.e. Disney, Universal)**

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

The aeronautic grade of the intumescent system meets the following AITM specifications:

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)

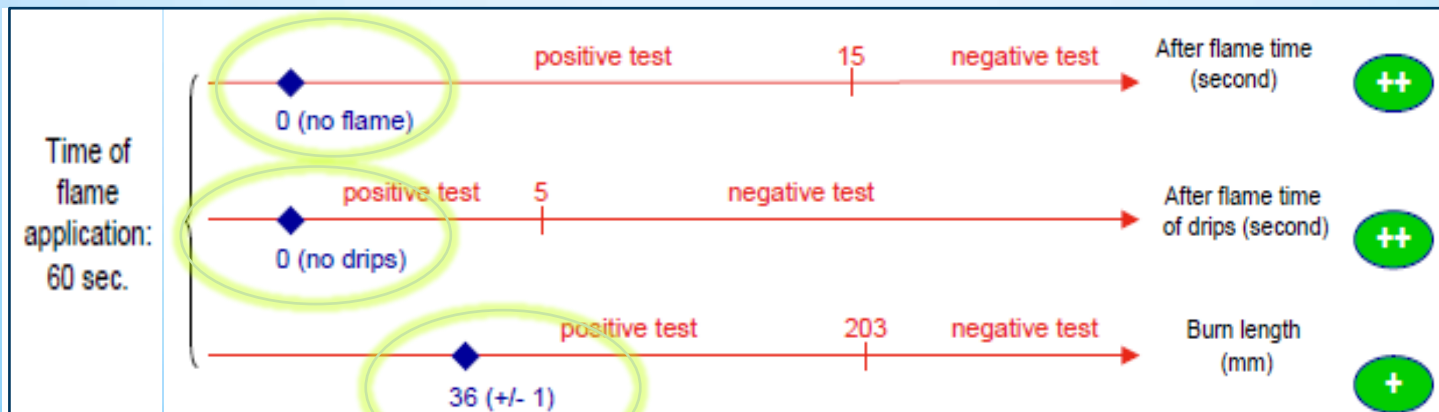
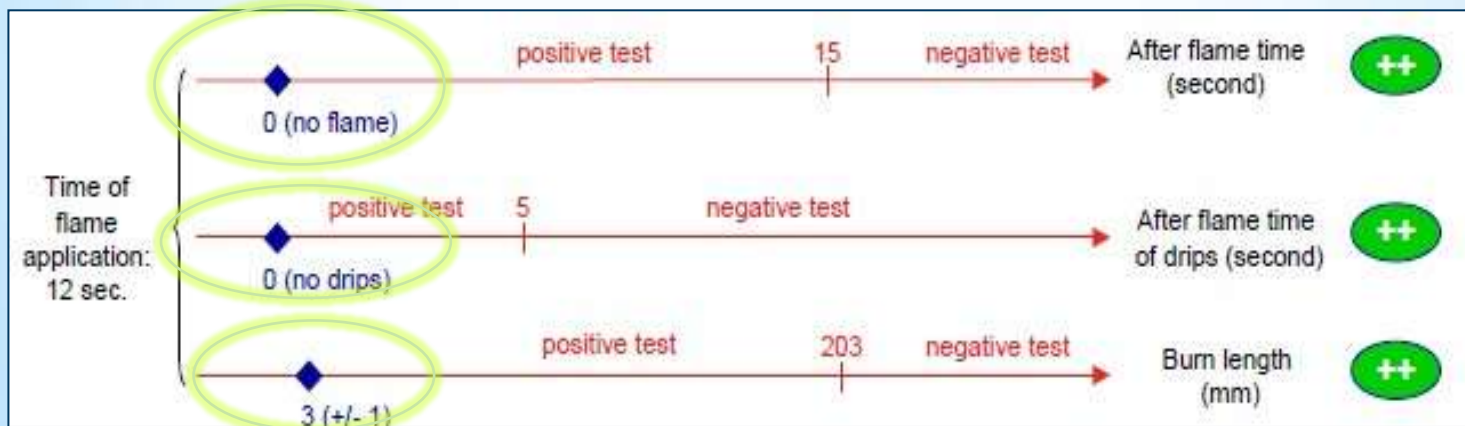
All AITM tests hereafter have been done with a laminate made of:

- 450 g/m² CSM (~20% in weight)
- FB 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:

Intumescent resin is compliant at both 12 sec and 60 sec flame applications



Intumescent laminate results

w/FB gel coat provide similar or better results

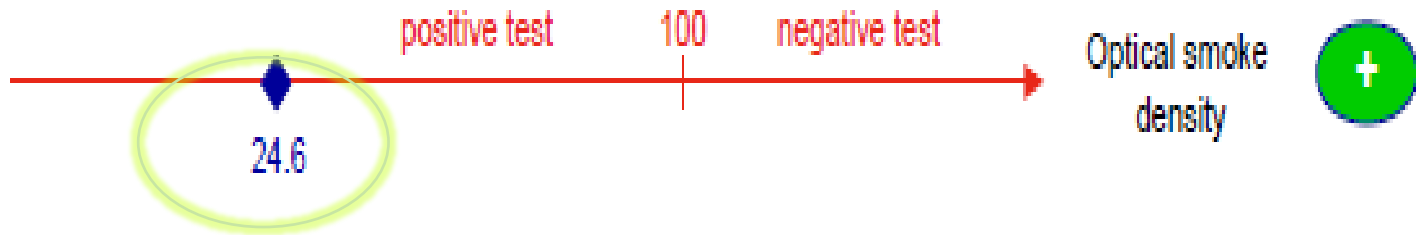


Airbus standard for interior parts

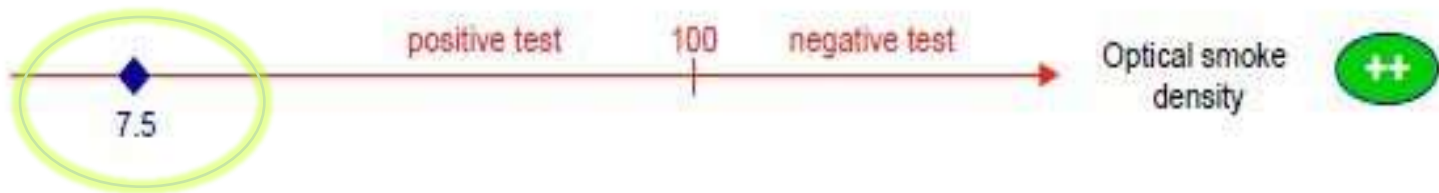
AITM 2.0007 – Smoke Opacity:

Intumescent resin is compliant in both Flaming and Non-Flaming Mode

1) Flaming mode:



2) Non-flaming mode:



Intumescent laminate results

w/FB gel coat provide similar or better results

Airbus standard for interior parts

AITM 3.0005 – Smoke Toxicity:

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	++

Laminate results

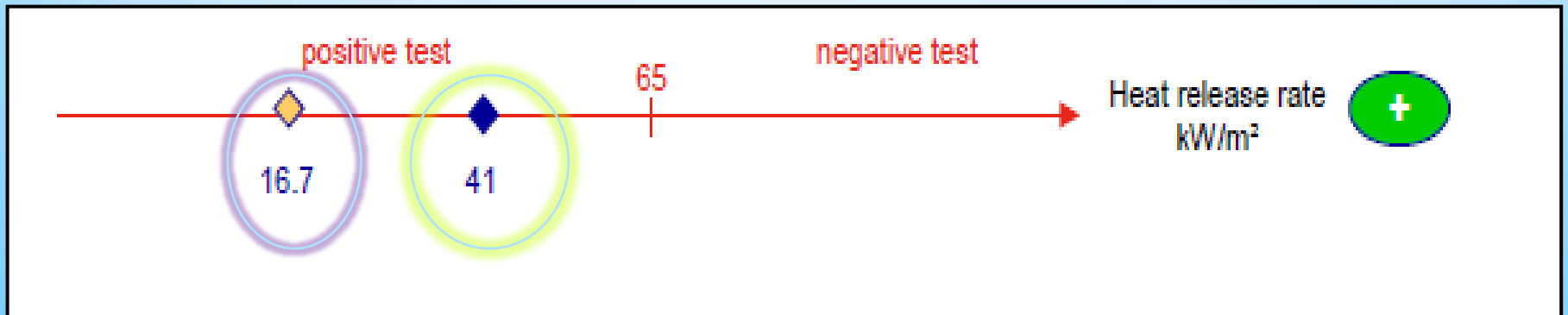
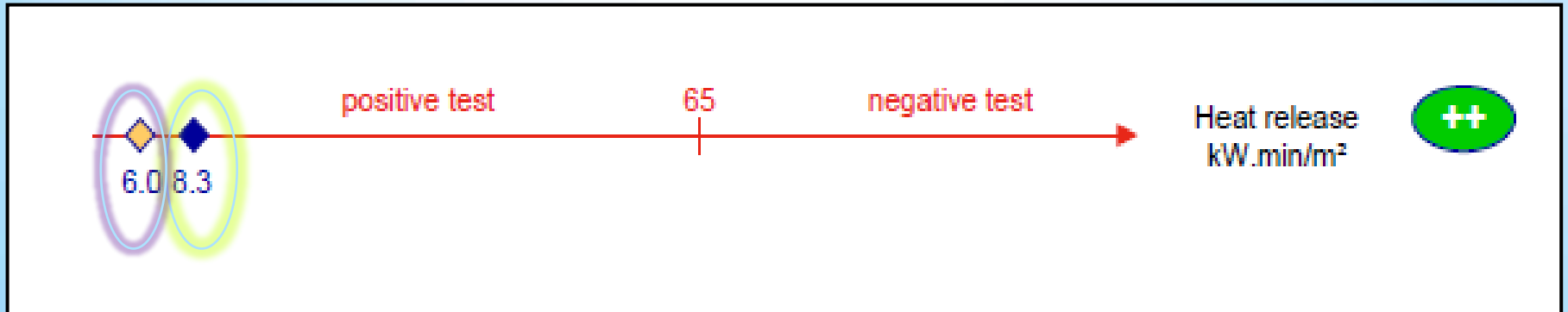
w/FB gel coat provide similar or better results

Airbus standard for interior parts

AITM 2.0006 – Heat Release (OSU test):

Intumescent resin and gel coat are compliant.

Note: improvement with intumescent gel coat



 Intumescent laminate results

 Laminate with FB 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 45545-2 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 <ul style="list-style-type: none"> • Specific Optical Density (D_s) at 1.5 min • Specific Optical Density (D_s) at 4.0 min 	Flaming	Non-Flaming
	$D_s = 8$ $D_s = 60$	$D_s = 1.3$ $D_s = 18$
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

Laminate- All flammability tests run with FB82169 TF resin, 3 plies of 1.5 oz. CSM (22%). Resin catalyzed with 0.05% Cobalt 12% and 1.0% DDM-9 peroxide. Post cured @150F for 4 hours. All results are max detected concentrations.

Hazardous levels

- EN 45545-2 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

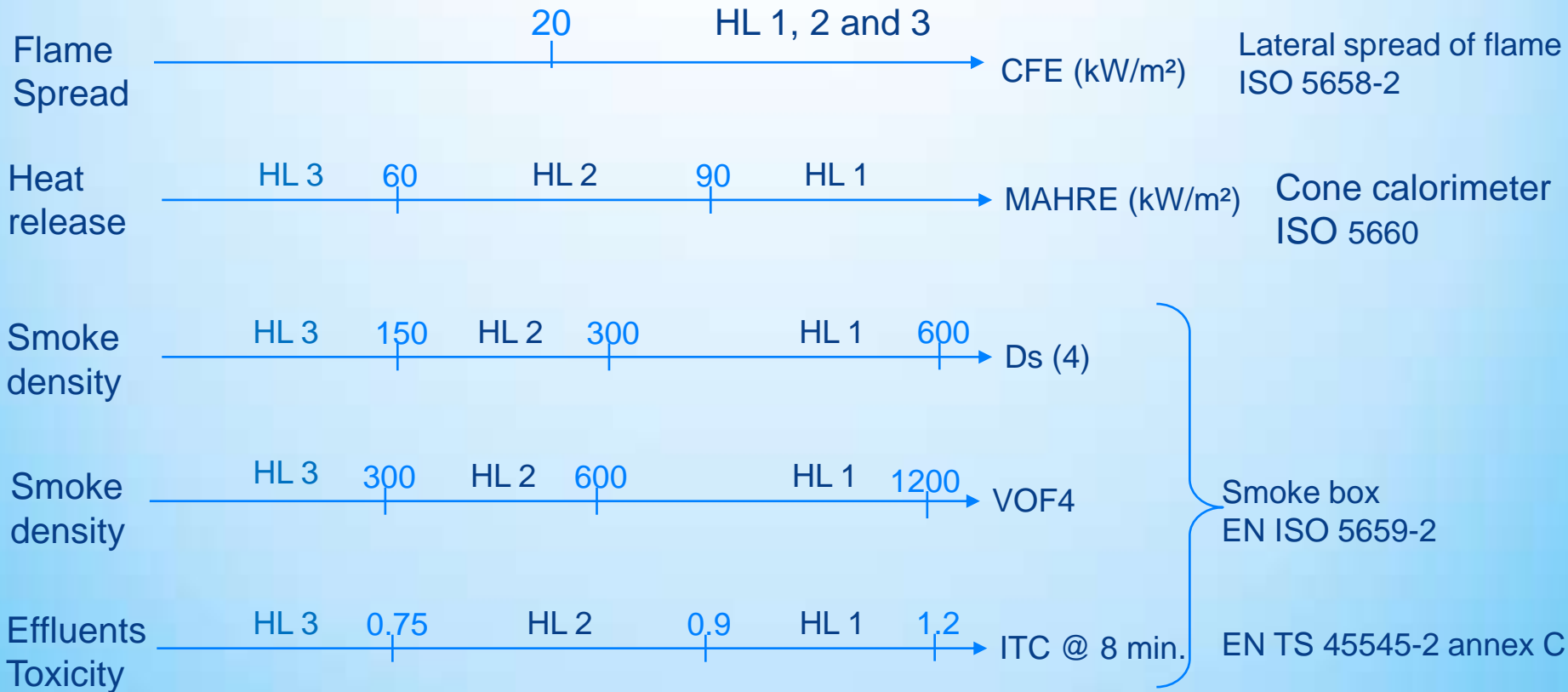


EN 45545							
Operation category				Type of train			
	Infrastructure	Evacuation	Line	Standard vehicle*	Automatic vehicle	Double-decked vehicle	Sleeper
1	Not determined by underground sections, tunnels and/or elevated structures	With means of safe side evacuation	Mainline, regional, urban & suburban	HL1			HL2
2			Urban & suburban	HL2			
3	Determined by underground sections, tunnels and/or elevated structures	Without means of safe side evacuation	Mainline & regional	HL2			HL3
4			Mainline, regional, urban & suburban	HL3			

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

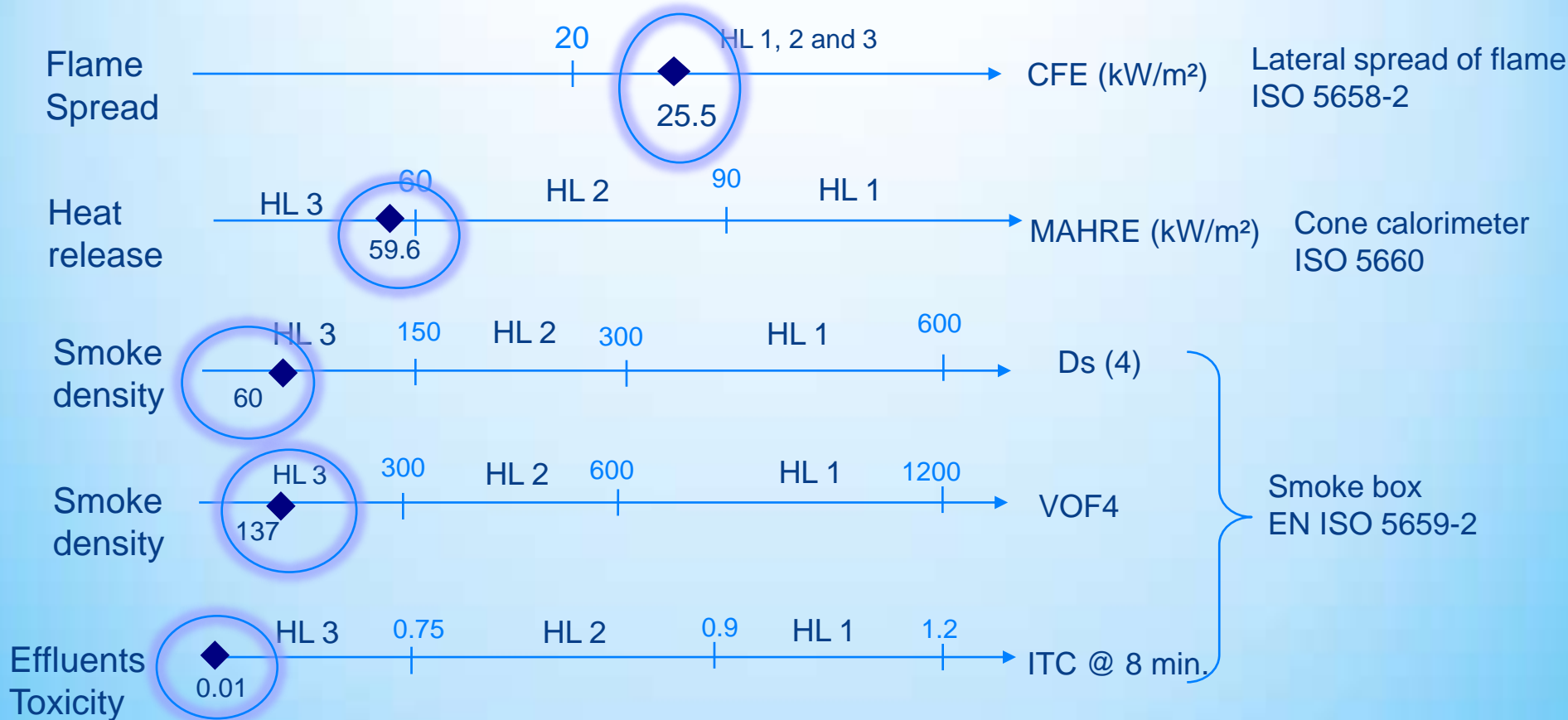
FIRST criteria according HLs and test methods

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



Evaluation of RTM molded coupons

Based on 4 mm thick laminates, made of FB 2330, FB 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: FB H 81269 TF
- 2: FB P 81091 TF
- 4: FB 2220 gel coat
- 5: FB 2330 gel coat

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: FB H 81269 TF
- 2: FB P 81091 TF
- 3: FB I 81268 F
- 4: FB 2220 gel coat
- 5: FB 2330 gel coat

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

Non-gel coated

**0.030" thick
Gel coated
(in mold)**

30 sec direct
torch, Gel
coated side

30 sec direct
torch, No gel
coat

Bag molded laminate: Two
layers 18 oz. mat on both
sides of 1" thick Balsa



$\frac{3}{4}$ " thick plywood,
post applied with
intumescent gel
coat at 0.030".
Direct torched for
30 seconds

Note: No laminate, post applied
gel coat only

Intumescent system Performance Advantages, especially versus Phenolic

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



Theme Parks, Animated Figures

**Stanford University
Bing Concert Hall
842 seat
Opened Jan. 2013**





New Flyer Bus

Photo courtesy
Carlson Fiberglass,
Winnipeg

Bombardier Transportation INNOVIA Monorail 300 system - 24-kilometre system in São Paulo, Brazil, will be the world's largest and highest capacity monorail (2016)



San Francisco Museum of Modern Art

- 10 stories tall, 125 meters long Facade
- 700+ FRP panels, roughly 1.8 meter by 10 meter each
- Saved 250 metric tons of steel over using GFRC
- NFPA 285 and 286 Approved Panels





NFPA 285,
30 min test



NFPA 286,
30 min test





Thank You! / Obrigado!