Meeting smoke, toxicity and flame retardancy requirements
for railway cable applications

Siobhan Ahern
Market Manager LSFOH

Maryline Desseix
Product Manager LSFOH

1. Fire Safety

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2. Flame Retardancy, Smoke, Toxicity

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3. Specifications

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4. Cable Applications

Fire Safety in Railway

- **Rail vehicles are highly vulnerable:**
  - Tunnels and elevated tracks make evacuation difficult and dangerous
  - High proportion of occupied space in a confined environment which is characteristic of rail transport
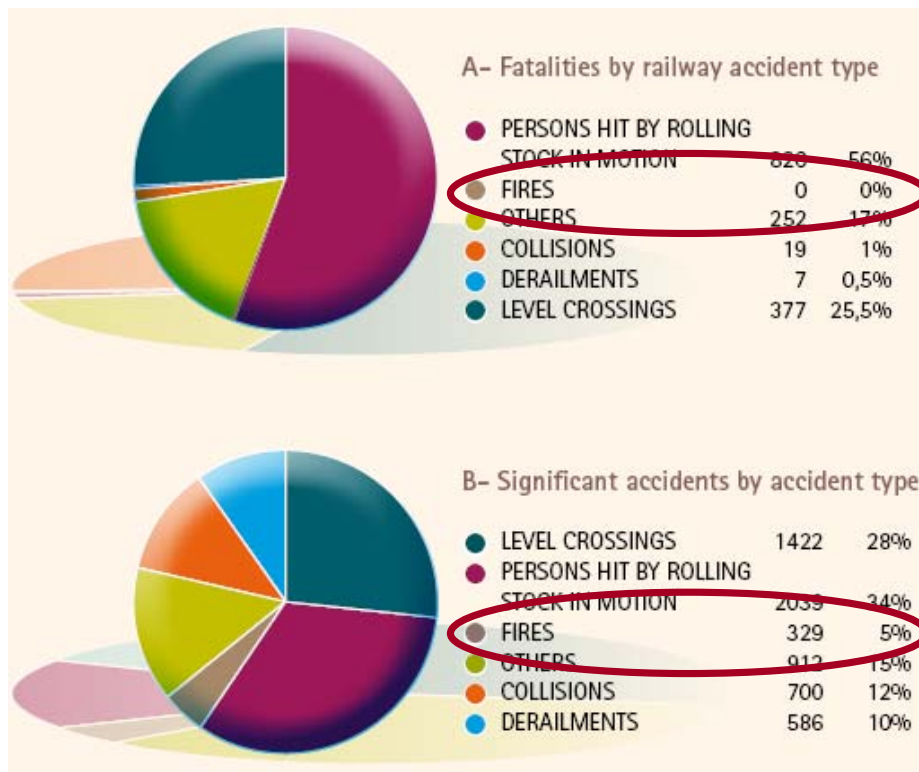
Fire Safety in Railway

Fire consequences:

- Passenger/staff killed or seriously injured

  - *In most cases of fire, asphyxiation from smoke and toxic fumes is the leading cause of death, not flames.*

- Damage to railway interiors; equipment & furnishings to be replaced

- Damage to railway infrastructure

Fire Safety in Railway

- 2008 Biennial report from the European Railway Agency

  - No fatalities

  - 329 significant accidents due to fires

A– Fatalities by railway accident type

PERSONS HIT BY ROLLING STOCK IN MOTION	820	56%
FIRES	0	0%
OTHERS	252	17%
COLLISIONS	19	1%
DERAILMENTS	7	0,5%
LEVEL CROSSINGS	377	25,5%

B– Significant accidents by accident type

LEVEL CROSSINGS	1422	28%
PERSONS HIT BY ROLLING STOCK IN MOTION	2039	34%
FIRES	329	5%
OTHERS	912	15%
COLLISIONS	700	12%
DERAILMENTS	586	10%

Courtesy of European Railways Agency:
http://www.era.europa.eu

Fire Safety in Railway

- **Railway interiors:**
  - Range of applications (seats, floors, walls, ceilings, cables)
  - Different fire safe materials
    - In case of fire: synergistic or cascading effect?

- **Material supplier role is important**
  - Work together with OEMs, designers & manufacturers to understand the requirements of the end application
  - Good understanding of fire standards: flame, smoke and toxicity of materials
  - Offer optimum choice of materials
  - Bring new solutions for safer rail vehicle development:
    - Fire safe and environmentally friendly material solutions.

Flame Retardancy

- **Flame retardant**
  - A substance added to a material or inherent in the material type, which suppress or delay the appearance of a flame and/or reduce its propagation rate.

- **Flame retardant uses**
  - Provide fire safety by preventing the fire or retarding its spread.
  - Make it possible to meet strict fire protection requirements
  - Protect lives and property

Polymer Flame Retardant Technologies

Halogen	Halogen-Free	LSFOH	
Flame Retardant	Flame Retardant	Flame Retardant	**To prevent a fire, or limit its development**
	Halogen-free	Halogen-free	**No corrosive halogen acid gas emission**
		Low Smoke	**In a fire, people are able to see their way to escape**
		Low Toxicity	**In a fire, people are not overcome by fumes during their escape**

Increasing Safety: Flame Retardant

- **Flame retardant materials can help increase the flash over time and escape time**
- **Flash over:**
  - The temperature point at which the heat in an area is high enough to spontaneously ignite all flammable materials.
  - In an enclosed space a small fire can quickly reach it's flash point

Courtesy of Fireflash:

www.fireflash.nl

Increasing Safety: Low Smoke

⊃ **Reduce smoke generation by reducing particle emission**

Halogen-Free

HFFR systems
– but not low smoke

AMONIUM POLY PHOSPHATE

MELAMIN CYANURATE SYSTEM

⊃ May not see exits
⊃ Breathing may be difficult

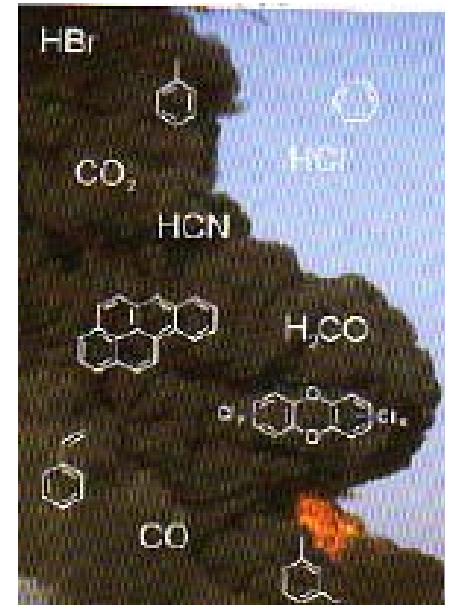**LSFOH**

PolyOne ECCOH™

PolyOne LSFOH technology ECCOH PF 4142

⊃ People find escape
⊃ Fire fighters quickly find source of fire

Increasing Safety: Low Toxicity

- **Reduce toxicity & corrosivity of gases evolved during the combustion**

- **Combustion gases:**
  - Poisonous: CO, CO_2 (all materials), HCN (some HFFR)
  - Irritants: NO_x, SO_2 (all materials)
  - Irritants and corrosive : HCl, HBr, HF (Halogen)

- **Depends on both polymer and flame retardant technology used.**

LSFOH ➡ Reduced emissions of toxic fumes & corrosive gases

Flame Retardants Comparison

⊃ **Balance between fire safety & mechanical properties**

	Halogen	**Halogen-Free**		**LSFOH**
Technology	Bromine, chloride, fluorine	Phosphorus	Melamine Cyanurate	ECCOH™ LSFOH
Flame test				
Processing	☺	☹	😐	😐
Mechanical Properties	☺	☺	☺	😐
Density	☺	☺	☺	☹
Dripping	😐	☹	☹	☺
Smoke	☹	😐	😐	☺
Toxicity	☹	😐	😐	☺
Corrosivity	☹	😐	😐	☺

Material Fire Specifications

○ **Main requirements for railway are:**

	Flame Propagation	Toxicity	Smoke Generation
Country Specific	The ability of a material to withstand ignition, and to limit propagation of the flame.	Evaluated by referencing the specified emissions limit for toxic fumes	Measure of the opacity of smoke generated.
France	NF T 51-071 & NF C 20-455	NF16 101	NF16 101
U.K.	EN ISO 4589-3	BS 6853 Annex B.	BS 6853 Annex D
Germany	DIN 53438 Parts 1 to 3 & E DIN 54 837	DIN E 150 5659-2	
US	ASTM E 162	SMP 800C	ASTM E 662

○ **European regulation: EN 45545**

  ○ Harmonize the requirements for fire safety of passengers and staff on railway vehicles that operate within Europe.
  FIRST

  ○ Flame spread–Ignitability–Rate of heat release–Smoke-Toxicity

Railway Cables

➔ **Used in variety of infrastructure and rolling stock applications:**

Control

Trackside communication

Data

Telecommunications:
fibre optic, copper cables

Signal

Video

Speed control

Local links

Central Office & Platforms

Co-axial

Power cable: HV, MV, LV
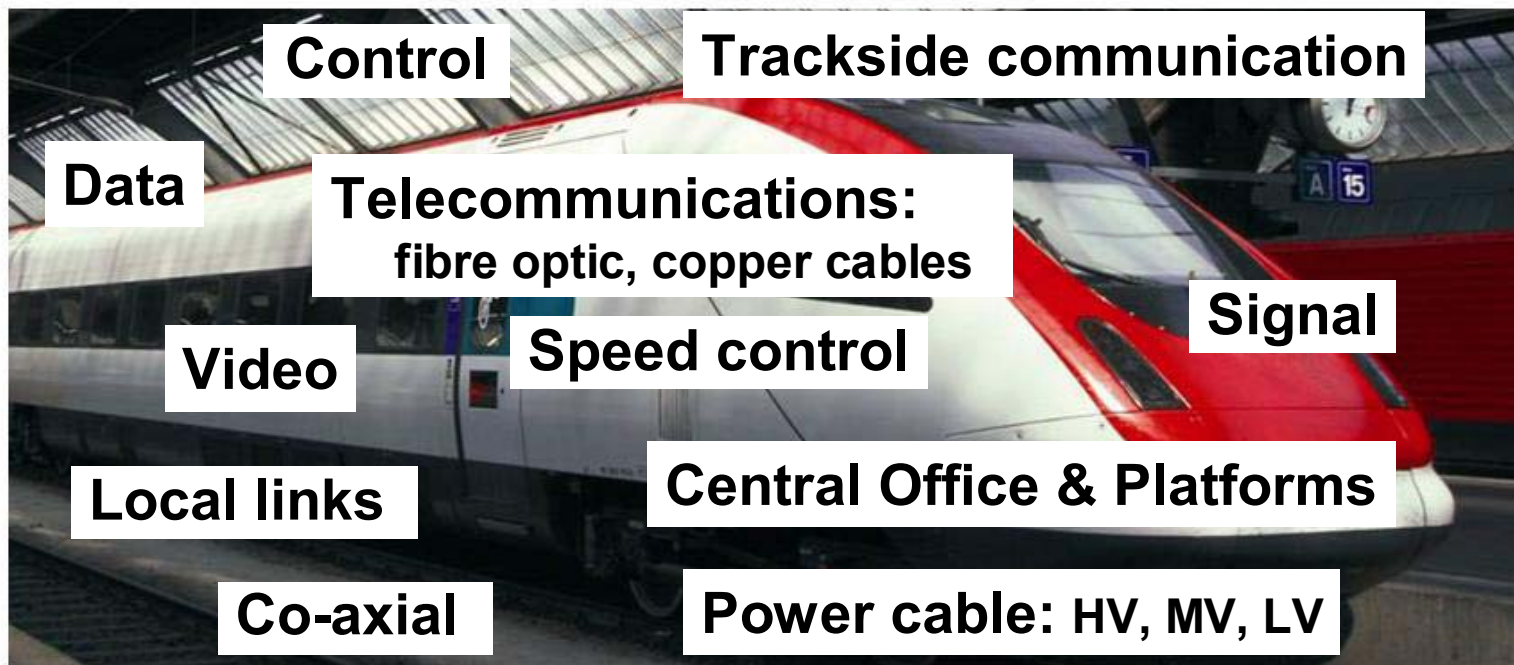
Rolling Stock Cable

⮷ **High performance cable:**

    ⮷ Increasing need to reduce both size and weight of cable.

    ⮷ Led to the development of both miniaturized cables and high-temperature cables with enhanced performance.

    ⮷ Viewed as a critical cable application due to positioning along the railcar and length

Rolling Stock Cable: PolyOne Solution

⊃ **Main Requirements:**

⊃ Fire safe: flame retardant, low smoke & low toxicity properties

⊃ Mineral oil resistance (IRM 903, IRM902: 7days 70 & 100°C)

⊃ Operating temperature from -40°C up to 120°C, even 125°C

Rolling Stock Cable: PolyOne Solution

- **PolyOne Solution:**
  - EN 50264:
    - Insulation & sheathing ECCOH™ 5806 crosslinked
  - EN 50306:
    - Sheathing ECCOH™ 5806 crosslinked
    - Insulation ECCOH™ 5806 crosslinked (under evaluation)
  - GB/T12528.2008, TB/T1484.2001:
    - Insulation & sheathing ECCOH™ 5806 crosslinked (under evaluation)

  * Crosslinking can be achieved
    with OnCap™ Dry Silane or
    E-beam technologies

Infrastructure Cable: PolyOne Solution

- ## Rail vehicles are in close proximity to infrastructure

  - Infrastructure cables are also submitted to stringent specifications

- ## Main Requirements:

  - Flame retardancy & low smoke

  - Low toxicity & corrosivity

  - Operating temperature from -40°C to 90-120°C

  - Good weatherability

Infrastructure Cable: PolyOne Solution

➲ **PolyOne Solution:**

   ➲ Insulation: ECCOH™ 6000

   ➲ Sheathing, oil plus: ECCOH™ 5803 or ECCOH™ 5806 thermoplastic

   ➲ Sheathing according to NYCT: ECCOH™ 5806 crosslinked

Fire Alarm Cable: PolyOne Solution

○ **Fire alarm systems are also key to improve safety on board.**

1) Fire sensor cabling system:
   ○ To ensure early detection of a fire

○ **Main Requirements:**
   ○ Low melting temperature
   ○ Halogen-free flame retardant
   ○ Low smoke & toxicity

○ **PolyOne Solution:**
   ○ ECCOH™ 5260, melting at 60°C
   ○ ECCOH™ 5280, melting at 80°C

Fire Alarm Cable: PolyOne Solution

2) Fire survival cabling system:

➲ To ensure essential circuits continue to operate during fire

➲ **Main Requirements:**

➲ Very high flame retardancy with high char formation

➲ Halogen-free flame retardant

➲ Low smoke & toxicity

➲ **PolyOne Solution:**

➲ ECCOH™ 5549/1

Conduit, Panels, Clamps: PolyOne Solution

- **During a fire, the fire rating of each material and application is key.**

  - Need to consider flame retardancy, smoke and toxic gas emissions of the entity.

- **ECCOH™ PF: LSFOH with enhanced stiffness**

  - Rigid electrical conduit: ECCOH™ PF 2037, ECCOH™ PF4142
  - Corrugated conduit: ECCOH™ PF4142
  - Wall panels: ECCOH™ PF 4130
  - Clamps, accessories: ECCOH™ PF 1045, ECCOH™ PF4130

PolyOne LSFOH Offering

- **Environmentally friendly flame-retardant solutions (LSFOH)**
  - While it is important that materials be <u>flame retardant</u>, its equally important that the materials emit very low <u>levels of smoke</u>, and that the <u>smoke contains little that could harm</u> passengers attempting to escape.

- **Extensive market knowledge & expertise**
  - Market leaders in Europe with ECCOH™ brand
  - Long term partnerships with customers & suppliers

- **Technology leader**
  - Wide range of high performance solutions
  - Global product range

PolyOne Offering

➲ **Complete solution provider due to synergies with other PolyOne products:**

  ➲ Color & additive concentrates

  ➲ Specialty engineered material compounds

Halogen ➜ **Halogen-Free** ➜ **LSFOH** ➜

➲ **Material supplier should guide material choice:**

  ➲ Understand which specifications need to be met both now and in the future

  ➲ Optimum material choice: balance fire performance and mechanical properties

THANK YOU !

For further information contact:

PolyOne Belgium SA

Rue Melville Wilson 2 - 5330 Assesse

BELGIUM

Tel.: +32 (0) 83 660 211

Email: eccoh@polyone.com

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