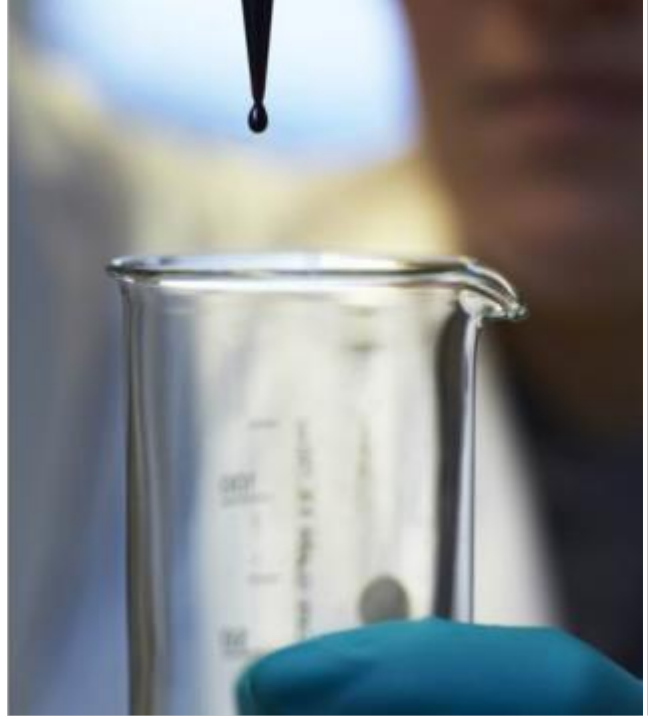
BUS FIRE SAFETY

2018-01-29

Michael Försth

RISE Research Institutes of Sweden

Fire Research



Three have become one - RISE

The RISE institutes Innventia, SP and Swedish ICT have merged in order to become a stronger research and innovation partner for businesses and society.

Facts about **RISE**

- 2016 RISE had a turnover of just ≈ 250 MEuro
- 2 200 employees, 30 % with a PhD

RISE Fire Research

- Staff: About 165 comprising 4 professors, 21 PhD:s, 10 PhD students, MSc:s, engineers and administrative personnel

Sweden (Borås laboratory)

Norway (Trondheim)

Outline

- Bus fires background
- Recent fire safety development
  - Interior materials
  - Fire suppression
  - Fire detection
  - Prevention/Safety management
- Ideas for further development
  - Toxicity
  - Fire detection
  - Protection of energy storage

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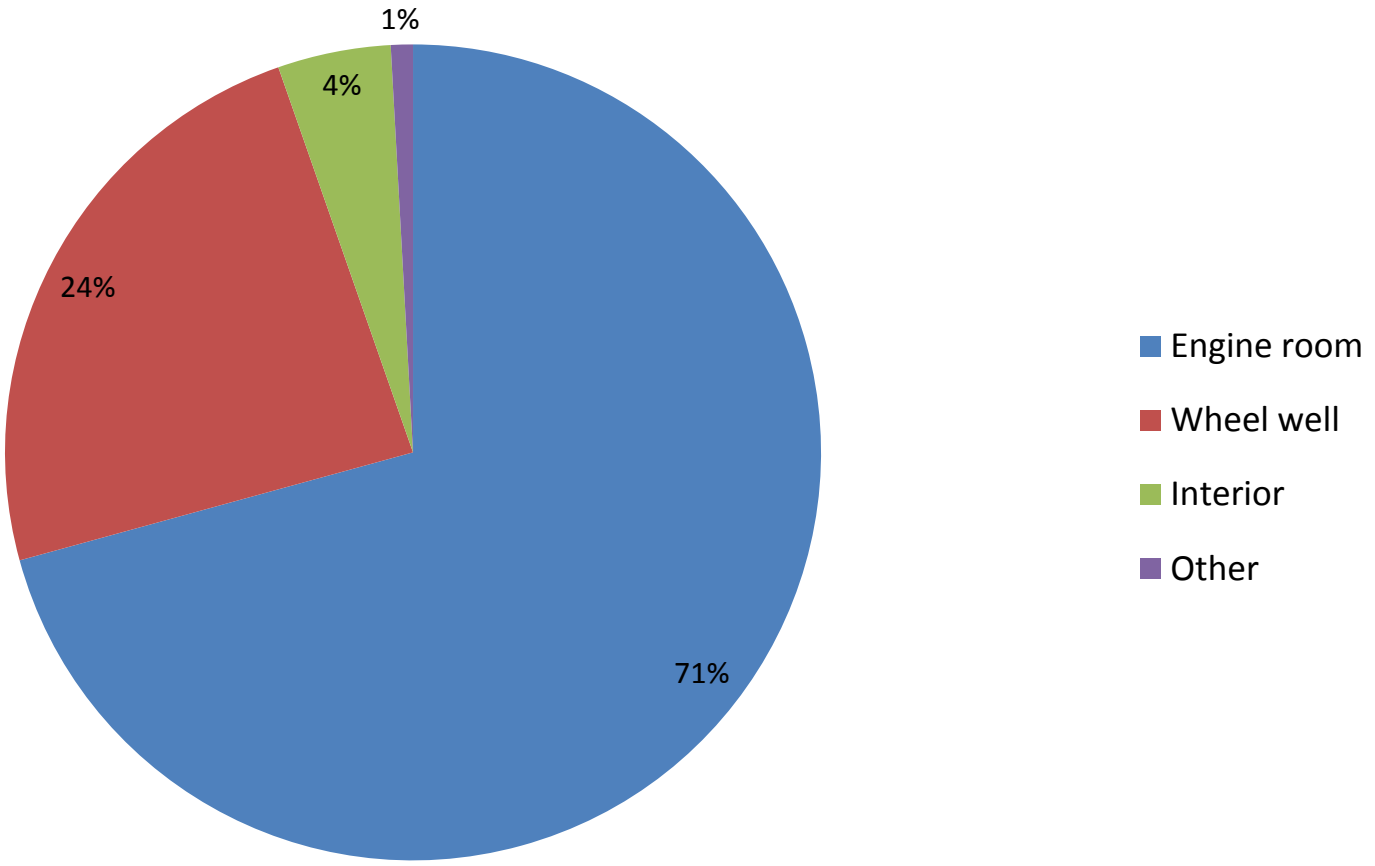
Background

In Sweden fires are reported for 1% of buses annually, and 10% of all buses are involved in a fire during their service life.

This means that, in percentage, about 5-10 times as many buses catch fire as do heavy goods vehicles.

Background


Start of bus fires 2005-2013 in Sweden, known cases
1%
4%
24%
71%
Engine room
Wheel well
Interior
Other

Background

Before 2004:

Approximately six to seven complete burnouts of buses each year in Sweden due to fires that started in the engine compartment.

2004:

Swedish insurance companies requested that all buses should be equipped with an approved fire suppression system in the engine compartment.

2004-2012:

No complete burnouts of buses due to such fires

Regulations and legislation works!

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Bundesanstalt für Materialforschung und -prüfung

Sicherheit in Technik und Chemie

- 24.01.2018

BUS FIRE SAFETY – INTERIOR MATERIALS

Anja Hofmann-Böllinghaus

www.bam.de

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Fire causes

Fire origin: in 80 % the engine area

Bildquelle: dpa (2009)

Electrical failure

Bildquelle: DEKRA (2010)

Bildquelle: NIST (2007)

Wheels

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Statistics

- Bus fires in Germany:
  - every second/third day (own web search)
  - 161 fires in 2009 in busses with insurance (GDV)
  - app. 350 – 400 Busse per year (PUPA 2010)

- Sweden: 80 busses (Swedish Transport Agency)
- USA: 0,8% per 100.000 busses (GBH International)

- internal investigation of a German bus association: 1 % of the busses per year

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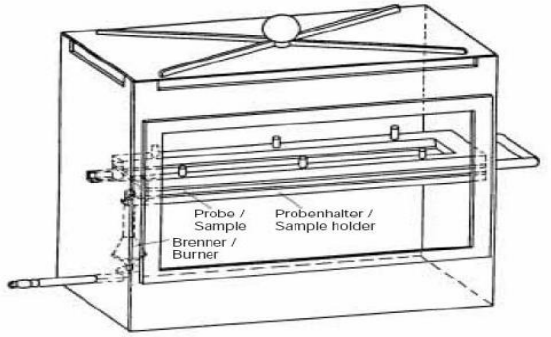
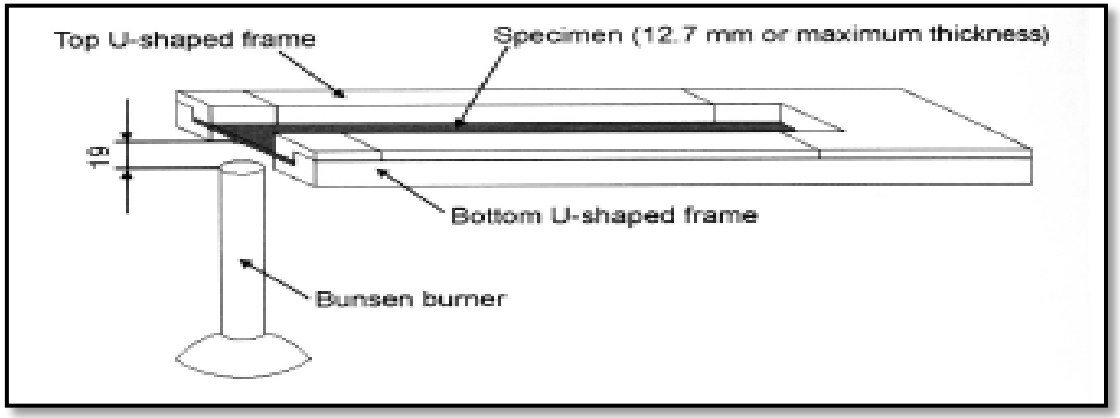
Fire safety standards

- Fire safety for buses: *EU guideline 95/28/EG*
- Fire tests: *FMVSS 302*
- Worldwide harmonized standard
- FMVSS 302 was developed in the 1960ties



- ISO 3795 (International)
- DIN 75200 (Germany)
- ST 18-502 (France)
- BS AU 169 (UK)
- JIS D 1201 (Japan)

- GS 97038 (BMW)
- DBL 5307 (Daimler)
- FLTM-BN 24-2 (Ford)
- GM 6090 M (GM)
- MES DF 050D (Mazda)
- ES–X60410 (Mitsubishi)
- PTL 8501 (Porsche)
- D45 1333; (Renault)
- STD 5031,1 (Volvo)
- TL 1010 (VW)



Operation conditions

- Operation conditions of buses and trains are widely comparable
- Bus interior materials were tested according to CEN/TS 45545-2

Coaches and long distance trains

City buses and trams

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Post-collision fires

- In U.S.A. 31 vehicle fires are reported per hour and these are responsible for around 300 deaths. These fires are involved in 12 % of fire deaths.
- Trends indicate that the survivable collision energy will continue to increase and, at the same time, the probability of post-crash fires rises with the collision energy
- As crashes are expected to become more survivable with advanced technology, fire events might become even more relevant

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Ensuring fire safety in buses

Michael Försth,
Asbjørn Hagerupsen, Jan Petzäll

Statens vegvesen

Vägverket

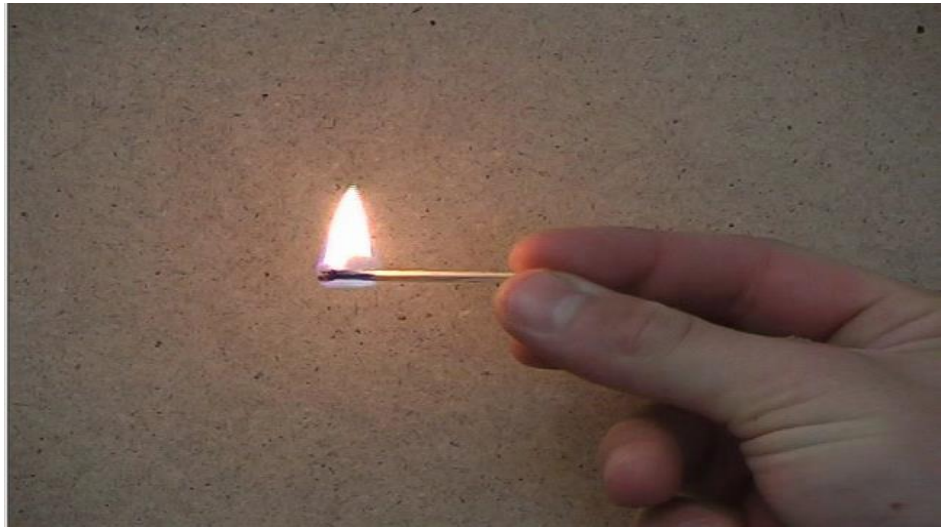
RI.SE

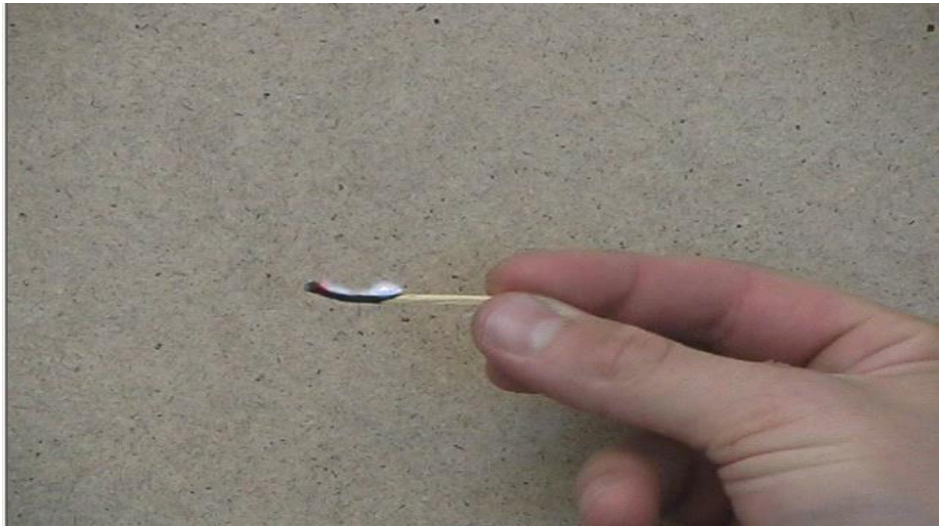
Problem: Regulation No. 118 – burning rate test

- (See documents GRSG 94-33, 94-17, 93-15, 92-18, 91-19, 90-32, 90-16, 89-33, 89-23, and 88-21)
- Test of horizontal flame spread (ISO 3795, FMVSS 302)

- The test only considers horizontal flame propagation, and contains additional technical shortcomings such as interrupted combustion when test object burns too fast and falls apart.

Are matches fire safe?





Solution: Proposed fire tests for Reg. No. 118

- Use of four established ISO/CEN tests, applied world-wide:
  1. Flame spread for surface linings
  2. Flame spread for floorings
  3. Test for production of smoke and toxic gases
  4. Measurement of heat release from a seat

- These are established test methods in transportation (e.g. trains – EN 45545-2)
- → Complying materials exist on the market

1. Proposed alternative test for Flame Spread

- Flame spread test for surface linings

- Criterion for trains: Critical Flux at Extinguishment ≥ 20 kW/m2

2. Proposed alternative test for Flame Spread

- European harmonised flooring test

- Criterion: Critical Heat Flux at extinguishment ≥ 6 kW/m². Same as for floors on trains.

3. Proposed test for Smoke and Toxic Gas production

- Smoke test and analysis of toxic gases

- Criteria: Requirements on smoke density and concentration of toxic species.

4. Proposed test for Seats

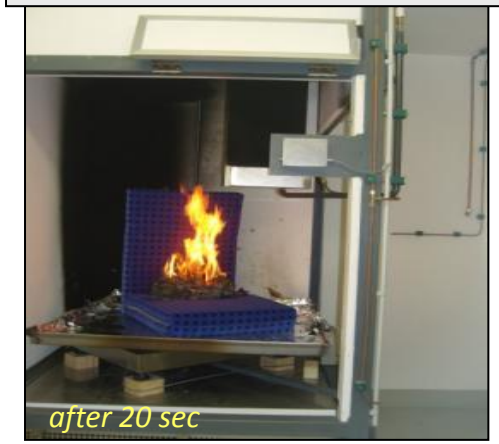
- Measurement of heat release

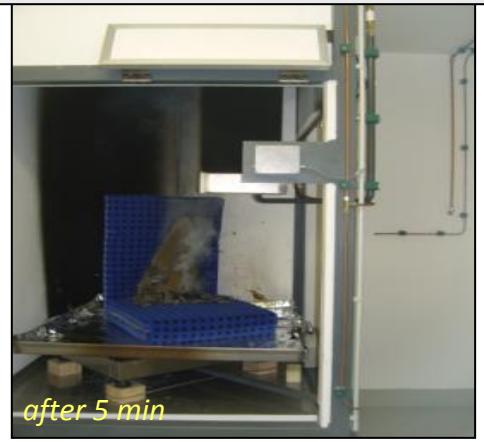
- Criterion: Maximum Average Rate of Heat Emission < 50 kW. Same as for seats on trains.

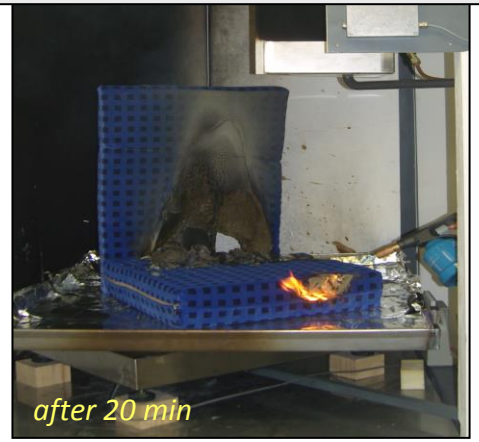
Observations

Bus upholstered seat

Railway upholstered seat







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ProdNo.	ISO 3795 / FMVSS 302 	ISO 6941 	ISO5658-2 / SSoF 
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2	pass	pass	pass
3	fail	pass	fail
4	pass	pass	fail
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6	pass	fail	fail
7	pass	fail	pass
8	pass	fail	pass
9	pass	pass	pass
10	pass	pass	pass
11	pass	fail	fail
12	pass	fail	fail
13	pass	fail	fail
14	pass	pass	fail
15	pass	pass	pass
16	pass	pass	pass
17	pass	pass	pass

Conclusions

- Lack of requirements for an acceptable level of fire safety for interior materials. (Replacement of horizontal burning rate test with vertical burning rate test was however a step in the right direction.)

- This can be accomplished using established international fire tests, already used for train interiors. Therefore complying materials already exist on the market

- A proposed solution was presented in draft amendment to Reg. No. 118 in informal document GRSG 95-19.

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Automatic fire suppression systems for engine compartments in coaches and buses: regulations and standards.

Presentation at GRSG 98, May 3-7, 2010

Asbjørn Hagerupsen[1], Jan Petzäll[2] and Michael Försth[3]

[1]Norwegian Public Roads Administration
[2]Swedish Transport Agency
[3]SP Technical Research Institute of Sweden

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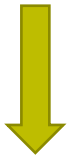
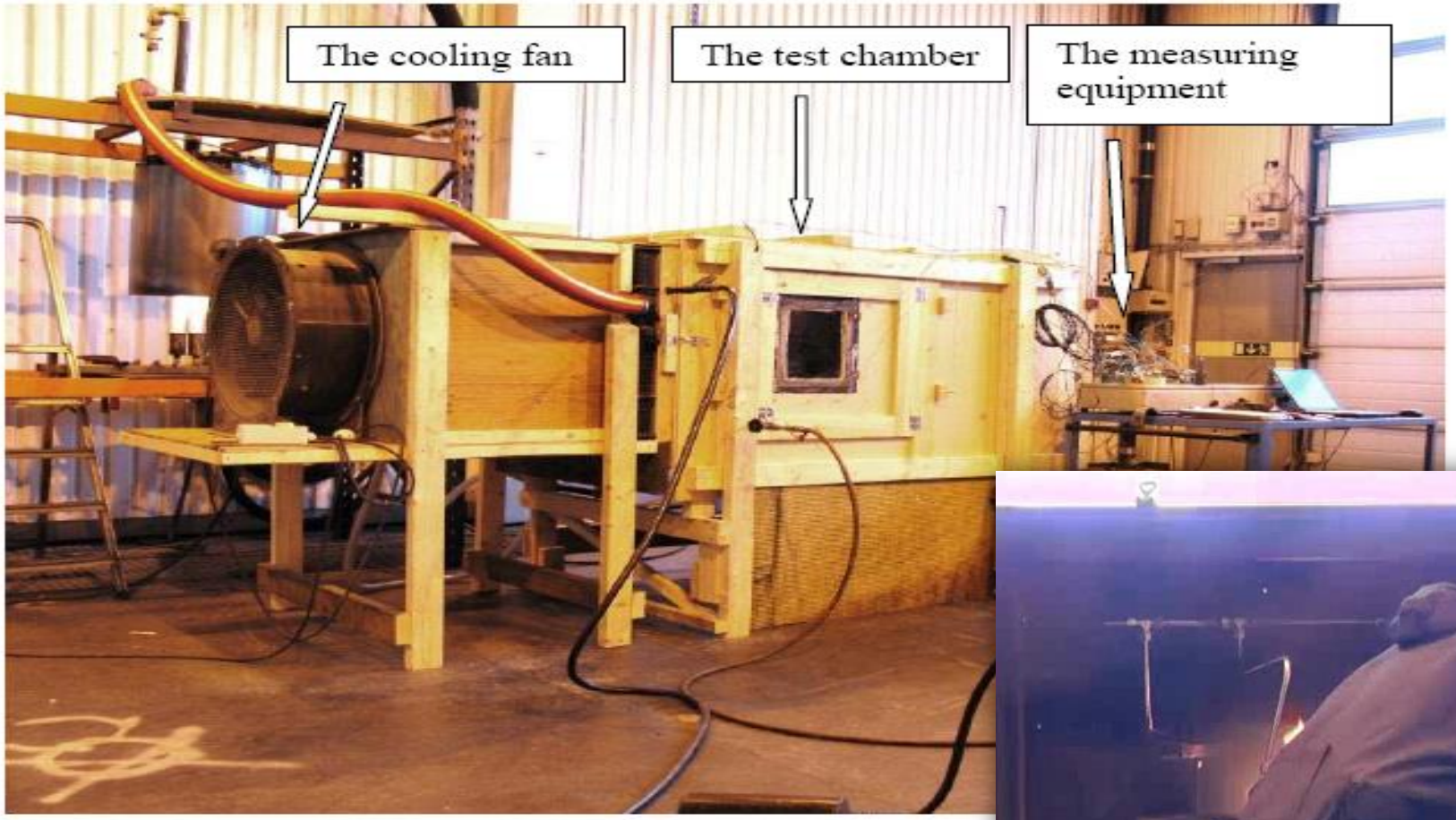


Amendment of Regulation No. 107



SP Report 2008:41

Test method – a new approach

- New approach: Combine repeatable test methods with realistic fire scenarios

Identified properties which are important to include in the test:

- Complex geometry with many obstructions
- High air flow
- Multiple fire locations
- Different fire scenarios
- Hot surfaces with re-ignition potential
- Two parts of the project:
  - Fire suppression performance (finalized in 2013) →Amendment of Regulation No. 107
  - Fire detection capability (finalized 2016)

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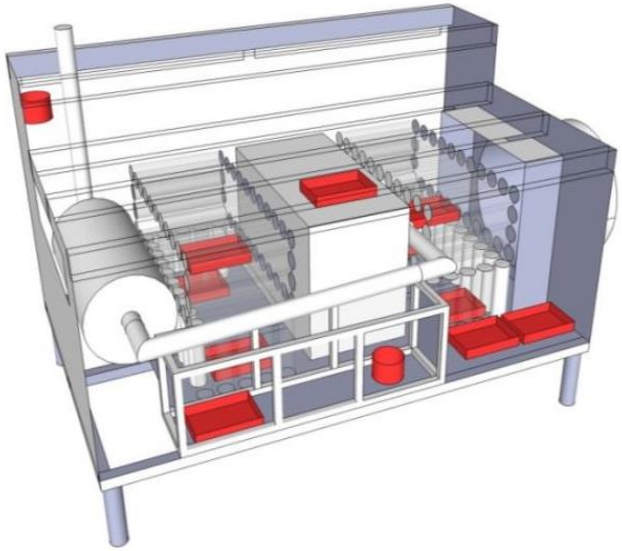
SP method 5320 – testing of fire detection systems

- Test method for fire detection systems installed in engine compartments of heavy vehicles



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Preventive fire safety

Safety Management with regard to fire

P-certification for vehicle manufacturers, operators and service centers (workshops) with regard to fire safety

- vehicle manufacturer
- operator
- workshop

SPCR - Certification rules

SPCR 191 - Certification rules for operators with respect to vehicle fire safety

- Co-operation with IRU

IRU International Road Transport Union

operator

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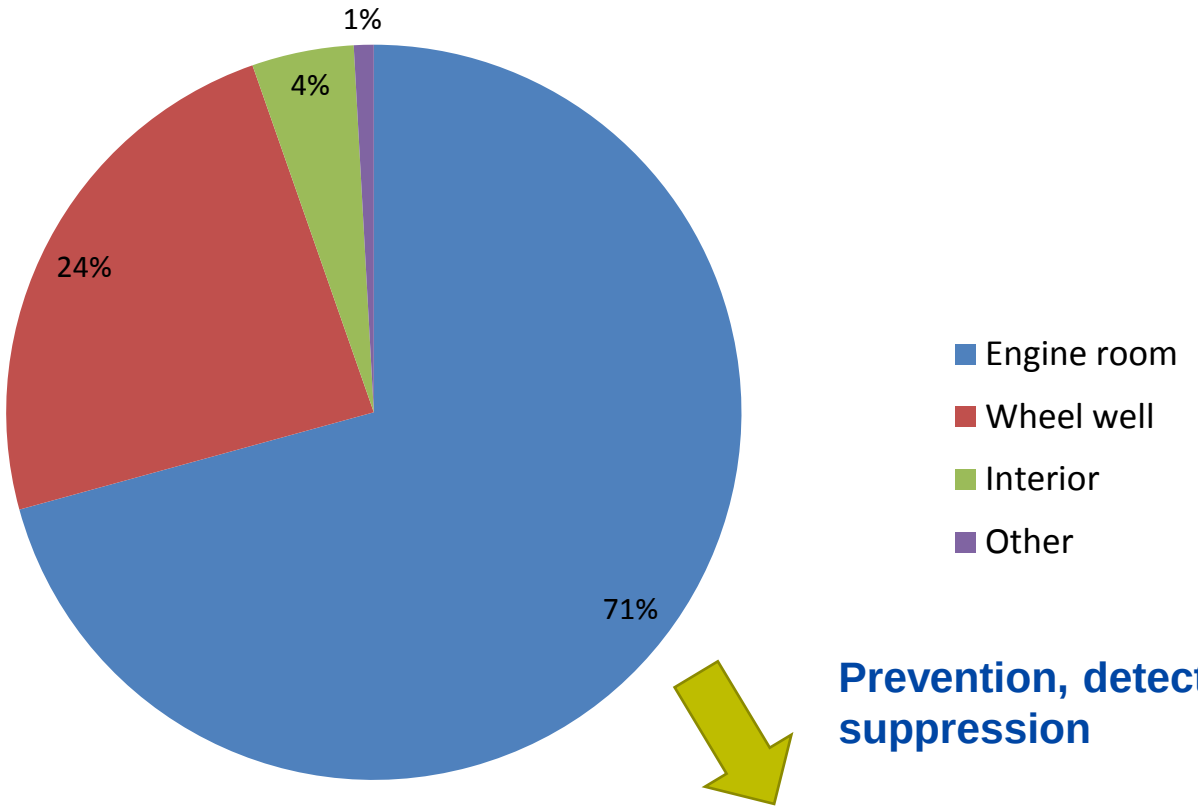
Gap analysis

**Prevention, detection,
fire hardening, prolonging tenability
conditions in passanger compartment**



**Prevention, detection,
suppression**

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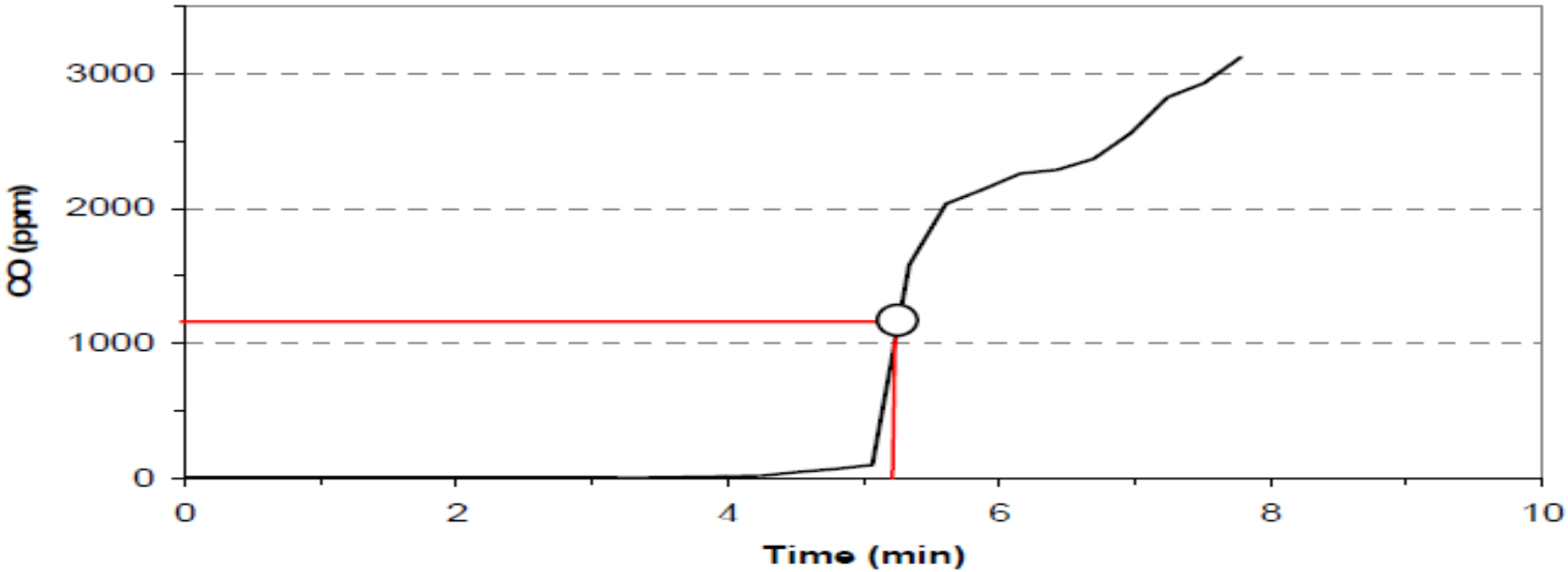
Toxicity



Focus on the production of toxic gases, <u>starting from the side of the expected fire</u>.

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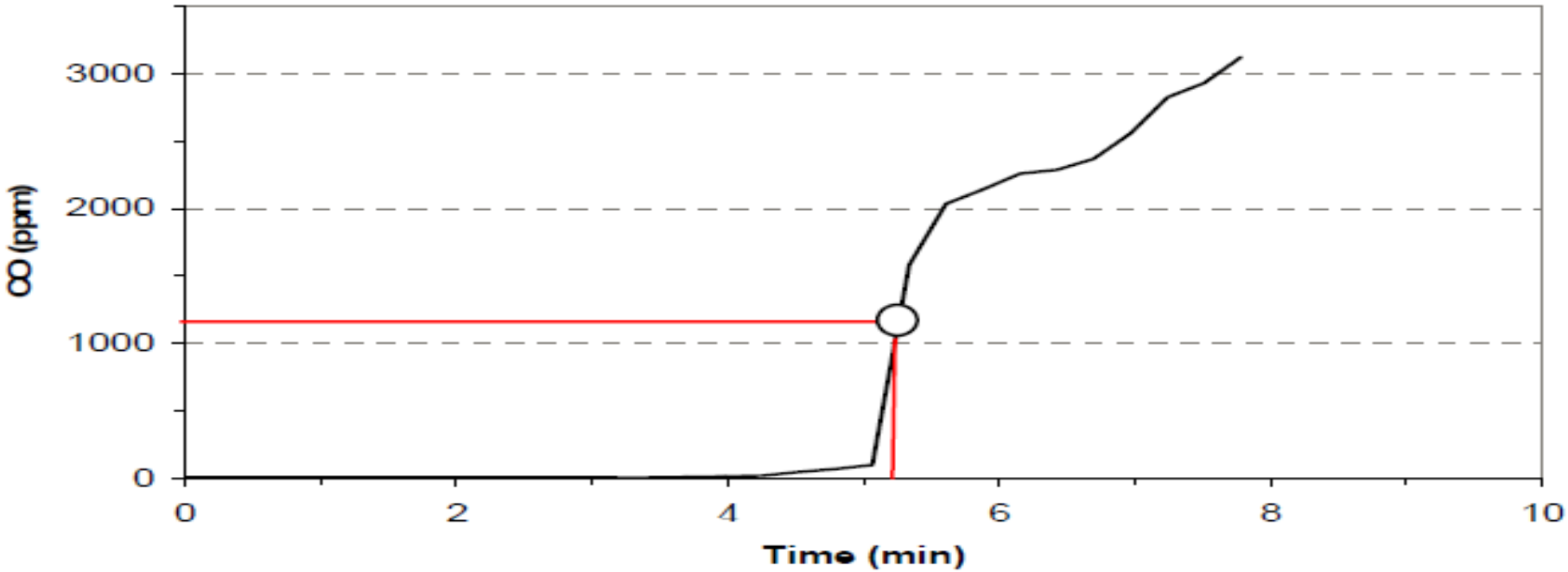
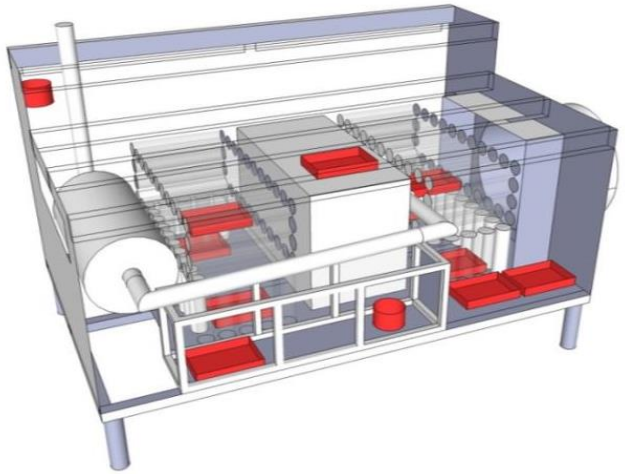
Detection





Regulation No 107

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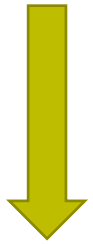

Requirement for improved protection of energy storage (e.g. fuel tanks)

Acknowledgements

- Transportstyrelsen (Sweden)
- Statens vegvesen (Norway)
- FFI (Strategic vehicle research and innovation, Sweden)
- BAM
- SP/RISE

THANK YOU, QUESTIONS?

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Fire Research