Reducing the risk of bus fires

- Intersec, Dubai – January 19, 2016
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Overview

1. Short introduction of SP
2. Bus fires – a common issue world wide – some statistics
3. Current and upcoming regulations
4. How do bus fires occur
5. Preventive fire safety
6. Identified areas of further research
7. Summary
1. Short introduction of SP

- SP Group owners: 100% RISE
- Subsidiaries: 10
- Employees: 1500
- Turnover: SEK 1487 million
- Customers: More than 10,000
Activities

1. Short introduction of SP
SP’s Mission

1. Short introduction of SP

To provide a safer environment for passengers and drivers.
2. Bus fires – a common issue worldwide – some statistics

- 350 - 400 bus fires are reported every year in Germany
- Bus fires has almost doubled in Finland over the last 10 years
- An average of six bus or school bus fire reported every day in USA
Bus fires in Sweden – 2005-2013

- 71% of all bus fires originate from the engine compartment
3. Current and upcoming regulations
Poor fire safety regulations for buses

- UN ECE - United Nations Economic Commission for Europe
- UNECE Regulation 118 burning behaviour of interior materials
  - other international systems, i.e. for ships and for trains, a more holistic view of fire safety
- UN ECE Regulation 107 – fire detection

Are matches fire safe?
Forthcoming improvement of regulations

- Proposal for amendment of **UN ECE Regulation 107** ECE/TRANS/WP.29/GRSG/2014/6 (Fire suppression systems)

- Fire suppression systems in engine compartment will be mandatory for all single-deck, double-deck, rigid or articulated vehicle of category M2 or M3.

- Member state is one of the Contracting Parties that have signed and agreed to the UNECE Vehicle Regulations - 1958 Agreement.
4. How do bus fires occur

- Age of Bus
- Maintenance Issues
- Equipment Failure
- Design
- Vehicle Accident/Collision
- Arson

![Diagram showing factors contributing to bus fires](image)
5. Preventive fire safety

To improve preventive fire safety:

- Safety features
- Fire Risk Assessments, Inspections (Fire Risks), Improved Processes – innovative new approach
- Further research
Preventive fire safety

Aspects that must be considered:

- Fire initiation
- Fire growth
- Fire resistance
Implementing safety features into new bus designs

- OEMs tend to put new safety features on based on demand from their customers - operators/transit authorities.

- How do we get operators/transit authorities to adopt a new safety feature with a “we don’t need it” attitude if they can’t measure the benefits in their metrics?

- Short of legislation or regulations that mandate a new safety feature – new ways have to be found to make operators/transit authorities metrics look better.
What controls the decisions on cost?

Funding and Revenue Sources

Public Transit (city buses)
- Government funding to provide a service to the public
- Bus fares
- Grants

Coaches (tour buses)
- Ticket sales

Metrics – how do they measure success

Public Transit (city buses)
- On-time service
- % of vehicles available for revenue service
- Customer surveys

Coaches (tour buses)
- Ticket Sales
- Customer Surveys

New ways have to be found to make operators/transit authorities metrics look better
5. Preventive fire safety

The cost of improvement

- Euro I
- Euro II
- Euro III
- Euro IV
- Euro V
- Euro VI

Images of materials and performance indicators:
- DPF
- EMIS
- Emissions
- Weight
- plastics
- Noise
- Insulation
- Heat
- Fuel Load
- Oxygen

Timeline:
- 1992
- 2013
Preventive fire safety

- Safety features
  - automatic fire suppression systems
  - portable fire extinguishers
  - gas leak detection systems
The fire event

Detect
- Alert Driver
- Acknowledge Risk

Safety of Passengers
- Prevent introduction of toxic fumes
- Shutdown (HVAC)
- Safely Stop Bus
- Evacuate Passengers

Control
- Fire growth (engine/cooling fan)
- Shutdown Engine
- Shut Off Batteries

I SMELL SOMETHING BURNING

YOUR BUS IS ON FIRE

Start Fire
Automatic detection and suppression

**Detect**
- Alert Driver

**Safety of Passengers**
- Alert Driver
- Shutdown (HVAC)
  - Prevent introduction of toxic fumes

**Control**
- Fire growth (engine/cooling fan)
  - Safely Stop Bus
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Start Fire
Automatic detection and suppression

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**Control**
- Fire growth (engine/cooling fan)
  - Shutdown Engine
  - Shut Off Batteries
  - Discharge Extinguisher

5. Preventive fire safety – Safety features
Benefits

AUTOMATIC FIRE SUPPRESSION SYSTEMS
REMOVE THE HUMAN FACTOR

- Alert Driver
- Shutdown (HVAC)
- Shutdown Engine
- Shut Off Batteries
- Discharge Extinguisher

ALLOW THE DRIVER TO FOCUS ON THE SAFETY OF THE PASSENGERS

- Safely Stop Bus
- Evacuate Passengers
Voluntary certification - Fire suppression systems

- Common platform for securing minimum level of safety and security
- Tested in a well-defined and objective way with realistic fire hazards that can occur on a bus based on sound science
- Components tested for harsh environments to secure survivability
- Ensures good distribution and amount of suppression agent
- Re-ignition protection
- Repeatable and reproducible
-mark certificate holders

www.sp.se/safebus/certified

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Preventive fire safety

- Fire Risk Assessments, Inspections (Fire Risks), Improved Processes – innovative new approach
The Fire Timeline (Stages)

Fire Risk Assessment
Inspection (Fire Risks)
Improved Processes
  • Maintenance
  • Documentation
Warning Labels

Hydraulic Hose
Electrical Cable

Fire Detectors

Optical (flame)
Thermal (heat)

INCIPIENT
SMOKE
FLAME

5.00
1.00
0.00

FRA, Inspections, Improved processes
P-certification for vehicle manufacturers, operators and authorized service centers (workshops) with regard to fire safety

Three different types of certification

- Vehicle manufacturer
- Operator
- Service center
-certification

- Certification of fire risk mitigation process
- Manufacturers/body builders/operators/authorized service centers (workshops)
- Entire design/manufacturing/assembly/maintenance process
- Highest level of safety that is practicable to keep the risks as low as reasonably practical
-certification - requirements

5. Preventive fire safety – FRA, Inspections, Improved processes
SPCR 190 - Certification rules

Certification is composed of the following elements:

1. Risk assessment
2. Quality procedures and configuration management (document control)
3. Safety certification training program
4. Reporting of thermal events – database
5. Initial assessment of the manufacturers FPC
6. Annual audits of the FPC. Follow-up risk assessment on selected bus model every year.
Risk assessment

- Investigation of predictive failure modes for high risk components
- Facilitating the rapid identification of pending failures to hoses and lines carrying flammable fluids or components that have greatly exceeded their operational parameters
SP method 5289 - risk assessment procedure

Identify Hazards/Risks

QA inspectors

Assess

Eliminate, control or accept

Design engineers

File

5. Preventive fire safety – FRA, Inspections, Improved processes

SP Technical Research Institute of Sweden

SPCR 190 - Certification rules
Risk mitigation

Recommendations for:

- **Risk elimination** - Design for Minimum Risk
- **Control** - Incorporate safety devices
- **Acceptance** - Develop Procedures and Training during all phases of the life cycle of the system
Application of results

- Future design improvements
- Enhancements to maintenance documents
- Operation manuals and practices
- Replacement cycles of critical components etc.
Safety certification training program

- Mandatory education and training
  - design engineers
  - production quality control inspectors
  - maintenance personnel

5. Preventive fire safety – FRA, Inspections, Improved processes
Safety certification training program

- Training in vehicle fire risk assessment
- Study of hazards specific to different types of vehicles and fuels.
Reporting of thermal events - database

- Procedures for linking information, data and experience from actual thermal incidents in the field to the design engineers, production quality control inspectors and SP.
Savings by implementing innovative new approaches

- Majority of the fires are related to a component failure
- Component failure is a cost driver and measured by the metrics
- Innovative approaches - prevention and better indication of pre-mature failures
- Risk Assessment – replacement cycles of critical components
- Less component failures
- Less downtime
- Better metrics
- Less fires
- COST SAVINGS
Preventive fire safety

- Further research
6. Identified areas of further research

Identified areas of further research
Wheel well fires

- Difficult to detect and suppress
- The exposed environment and risk of deep seated fire
- Tyre pressure/temperature monitoring systems - one method for early detection
- Other methods need to be explored
Bulkheads/fire partitions

- The bulkheads between high risk areas such as the engine compartment and the passenger compartment can allow toxic fumes and flames to spread into the passenger compartment.

- New materials and the increased complexity of systems connecting the engine compartment to the driver area might increase fire hazards.
Detection systems

- Ongoing project - FFI (Strategic Vehicle Research and Innovation) fire alarm systems in heavy vehicles
- Development of a new test method and proposal of a standard for fire detection and fire alarm systems in heavy vehicles
Use of flammable material in high risk areas

- Continuous need for lighter, less costly materials in high risk areas
- Few standards and regulations regarding the flammability and toxic fume production of such material
- Necessary to establish adequate performance requirements for the use of flammable material in high risk areas in buses and coaches
Electrical fires

- Most electrical fires are the result of an **arch** caused when **insulation** around the wire is **compromised** due to:
  - Physical damage (abrasion)
  - Heat degradation (too close to a turbo or other heat source)
  - Overcurrent/overloads
  - Poor Connections

- Electrical arcs and short circuits do **not always trip protective devices**, e.g. fuses

- **Early detection methods** such as current monitoring or better circuit protection should be explored
Alternative fuels

- New fuels (energy carriers) such as E85, LPG, CNG, hydrogen and batteries mean new fire safety risks
- Fuel tanks containing the new fuels must be designed and constructed so that the risk of fire does not increase during normal use
- Not make the consequences of an accident more serious if the vehicle is involved in a fire
- In the case of electrically powered vehicles, voltages are much higher than in other vehicles could produce arcs that could in turn cause fires
- Other means of fire-fighting techniques
Post crash-fires

- Sudden impact of the fuel tanks might create an increased pressure risking mist of diesel oil spraying from the tank when getting in contact with hot surfaces like an exhaust initiating the fire in the buses.
Interior materials

- Full scale fire tests of coaches have been conducted
- Once flames reach the passenger space, flashover will occur quickly
- Toxic fume levels occur after approx. 5 minutes
- Current regulation UNECE Reg.118 – burning behaviour of interior materials inadequate
6. Identified areas of further research

AN increase of 10 ° above max temp can shorten Hose life by half.
Summary

- Bus fires – a common issue world wide
- Currently poor fire safety regulations for buses
- Preventive fire safety
  - Reduction of loss of buses
  - Securing business continuity
  - Enhancing goodwill
- More research is needed
- Isolated events seldom lead to a fire... but more often the combination of several events. Experience should be used for prevention not as a lesson
4th International Conference on Fires in Vehicles - FIVE 2016

- October 5 - 6, 2016
- Baltimore ∞ USA
- www.firesinvehicles.com

Event partner:

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