



**Fire safety concepts and risk analysis in rolling stock –
Recent European and national German regulations for
railway vehicles and the acceptance of compensation
measures**

Institut für angewandte Brandschutzforschung
Institute for applied fire safety research



IFAB

4 Different Business Units

- **Fire & Smoke Testing**
- **Rail Consult**
- **Tunnel Consult**
- **Fire Protection Consult**





IFAB

Business Unit Rail Consult

- **Fire safety concepts and risk analysis**
- **RAMS/LCC analysis**
- **Consulting regarding recent standards**
- **CFD analysis**
- **1:1 full scale fire tests**
- **Smoke tests**



Content

- **Fire safety concepts and fire risk analysis**
- **European and national German regulations**
- **Compensation measures according to these regulations**

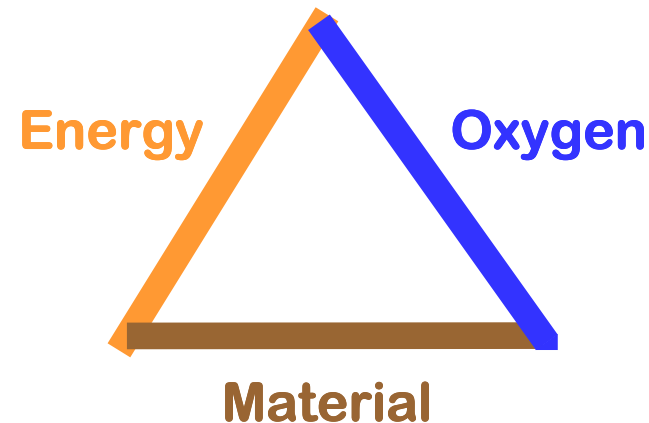


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- **Fire safety concepts and fire risk analysis**
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Fire safety concepts for Rail Vehicles

- Description of vehicle
- Protection aim
 - Protection of persons
 - (Protection of materials for help of protection of persons)
 - (Protection of material)
- Fire Risk analysis





Fire safety concept for Rail Vehicles

- **Measures (fire safety concept)**
 - Preventive measures
 - Measures for avoidance of fire spread
 - Measures for maintenance of performance
 - Measures for fire fighting



Fire safety concept for Rail Vehicles

- **Evacuation and rescue**
- **Annexes**
 - **Material certificates**
 - **Verification of compliance with appropriate standards**
 - **Drawings**
 - **Maintenance instruction, information...**
 - **Training information regarding fire safety**
 - **Approval and mode of operation protocols**
 - **Fire risk analysis**
 - **Etc.**



Fire safety concept for Rail Vehicles

- **Basis for fire safety concepts are built by regulations, specifications (like protection aims) and risk analysis**



Content

- Fire safety concepts and fire risk analysis
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- Compensation measures according to these regulations



European and national German Regulations

- Highest level consist of European Commission (EC) Guidelines (GL)
- EC-GL's must be transferred into national law by member states (e. g. TEIV in Germany)
- TSI's serve the implementation of EC-GL regarding interoperability (TSI's predominantly define funtional aims)
- TSI's are filled with content by the appropriate harmonised EN standards

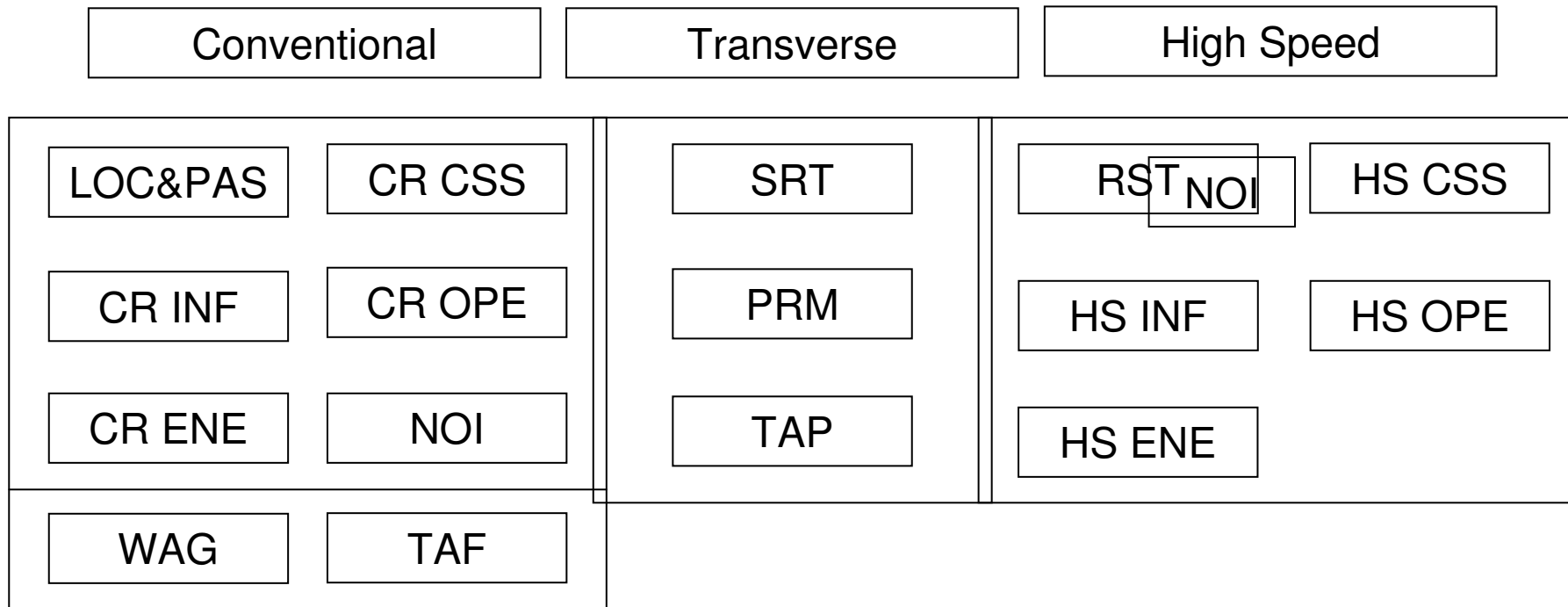


TEIV (Example for Germany)

- **Decree regarding interoperability in transeuropean rail**
- **Scope:**
 - Valid for German parts of the transeuropean rail system (including infrastructure and rail vehicles) → described in Annex 1 of TEIV
 - Not valid for:
 - Rail infrastructures of Service Equipment or vehicles which are intended to drive only on such infrastructures
 - Rail infrastructures and vehicles which are only used for historical or tourism purposes



Overview of TSI's





TSI SRT – Safety in railway tunnels

- **Geographical scope**
 - Trans-European conventional rail system as described in Annex I to Directive 2001/16/EC
 - Trans-European High-Speed rail system as described in Annex I to Directive 96/48/EC

TSI SRT – Safety in railway tunnels

- **Fire safety categories of passenger rolling stock**
 - **Rolling stock for tunnels up to 5 km in length (Category A)**
 - Side evacuation possible
 - Train will continue to drive to a safe area
 - Max. distance of safe area: 4 minutes running time at 80 km/h
 - If it is not possible for the train to continue, it will be evacuated using the Infrastructure facilities in the tunnel

TSI SRT – Safety in railway tunnels

- **Fire safety categories of passenger rolling stock**
 - **Rolling stock for all tunnels (Category B)**
 - Fire barriers are provided to facilitate the protection of passengers and staff from the effects of heat and smoke on board a burning train for 15 minutes
 - Fire barriers and additional measures for running capability would permit such trains to leave a 20 km long tunnel and reach a safe area, assuming the train is able to run at 80 km/h
 - If it is not possible for the train to leave the tunnel, it will be evacuated using the infrastructure facilities provided for the tunnel



TSI SRT – Safety in railway tunnels

- **Rolling stock in tunnels with underground stations**
 - **Are there underground stations as defined in chapter 1.1.4 of TSI SRT which are specified as locations for evacuation in the emergency plan and if the distances between consecutive underground stations and the nearest underground station to the portal are less than 5 km, the trains shall fulfil the requirements of category A.**

TSI HS RST – ‚Rolling stock‘ Sub-System

- **Geographical scope**
 - Trans-European high-speed rail system as described in Annex I to Directive 96/48/EC modified by Directive 2004/50/EC
- **Classification of trains:**
 - Class 1 trains: Maximum speed ≥ 250 km/h
 - Class 2 trains: Maximum speed 190-250 km/h
 - Trains with maximum speed higher than 351 km/h \rightarrow TSI HS RST will apply, but additional specifications are necessary

TSI HS RST – ‚Rolling stock‘ Sub-System

- **Fire safety**
 - **Category A: Rolling stock that is designed and built to operate on infrastructure with tunnels and/or elevated sections of maximum length of 5 km → 4 min. continuous operation required**
 - **Category B: Rolling stock that is designed and built to operate on all infrastructures (incl. tunnel length bigger than 5 km) → 15 min. continuous operation required**

Until EN 45545-2 is not published, national standards apply.



TSI CR LOC&PAS – Locomotives and Passengers RST

Applicable for:

- **Self-propelling thermal or electrical trains**
- **Thermal or electrical traction units**
- **Passenger Carriages**
- **Mobile railway infrastructure construction and maintenance equipment**
- **TEN track**

prEN 45545

- **Current status: Draft**
- **Applicable for track guided public passenger land transport vehicles such as:**
 - Locomotives and dedicated power vehicle (self-propelled);
 - multiple units;
 - coaches, including driving trailers;
 - light rail vehicles;
 - underground vehicles;
 - trams;
 - luggage and post vans running as part of a passenger train;
 - passenger occupied motor vehicle transporters;
 - track guided busses;
 - trolley busses (only in relation to the electrical equipment);
 - magnetic levitation vehicles

prEN 45545

Railway applications – Fire protection on railway vehicles

- **Part 1: General**
- **Part 2: Requirements for fire behaviour of materials and components**
- **Part 3: Fire resistance requirements for fire barriers**
- **Part 4: Fire safety requirements for railway rolling stock design**
- **Part 5: Fire safety requirements for electrical equipment including that of trolley buses, track guided buses and magnetic levitation vehicles**
- **Part 6: Fire control and management systems**
- **Part 7: Fire safety requirements for flammable liquid and flammable gas installations**



prEN 45545

Germany:

- **ad-hoc-group was built (VDB, DB AG, VDV, EBA, other)**
- **The requirements of prEN 45545 were discussed and implemented into „Regelungen für die brandschutztechnische Beurteilung von Eisenbah-Fahrzeugen in Deutschland“ (01.08.2010), but with several adjustments.**



**AEG – Allgemeines Eisenbahngesetz and
EBO – Eisenbahn-Bau- und Betriebsordnung**

- **AEG = General rail law**
- **To get an approval for vehicles on TEN tracks →
TSI's applicable**
- **To get an approval for vehicles on non TEN tracks
→ § 32 EBO**
- **EBO = Order regarding rail construction and
operation**

EBO – Eisenbahn-Bau- und Betriebsordnung

- **§2 General requirements**
 - Railroad systems and vehicles must be designed to fulfil requirements of safety and order
 - Requirements are fulfilled if:
 - Requirements in order are fulfilled
 - If not otherwise required recognised codes of practice must be fulfilled



Regelungen für die brandschutztechnische Beurteilung von Eisenbahn-Fahrzeugen in Deutschland

- **Regulations for assessment of fire safety in rail vehicles in Germany**
- **Applicable for rail vehicles according to DIN 25003**
- **Can be used for vehicles according to BOStrab (light rail)**
- **Refers to prEN 45545 but with some adjustments**
- **Valid until EN 45545 in force**



ARGE-Directives

- Fire Detection in Rolling Stock
- Firefighting in Railway Vehicles
- „Systemfunktionalität Brandmeldung und Brandbekämpfung in Schienenfahrzeugen“ (System functionality Fire Detection and Firefighting in Railway Vehicles)
- Valid for Germany, Austria and Switzerland. But are also used in other countries like Brazil, France, Italy...



ARGE Directive
„Fire Detection in Rolling Stock“
Procedure for the proof of function concerning
the placement of fire detectors in rooms
accessible to people, electric control cabinets
and areas of combustion engines
[Guideline / Inspection Procedure](#)



Content

- Fire safety concepts and fire risk analysis
- European and national German regulations
- **Compensation measures according to these regulations**

Compensation measures according to TSI's

- **Clear statement of compensation measures in TSI LOC&PAS → fire barriers can be compensated by fire fighting systems**
- **In TSI SRT and TSI HS RST no compensation measures implemented yet, but in Common Safety Methods (CSM) (EC No. 352/2009) evidence of equal safety is implemented → discrepancy between TSI's and CSM's**

Compensation measures according to TSI LOC&PAS

„Fire spreading prevention Measures (FSPM)

- **They ensure that fire and smoke will not extend in dangerous concentrations over a length of more than 28m within the passenger/staff areas inside a unit, for at least 15 minutes after the start of a fire.**
- **They are installed in each vehicle of the unit, which is intended to carry passengers and/or staff,**
- **They provide at least the same level of safety to persons on board as full cross section partitions, with an integrity of 15 minutes, which are tested in accordance with the requirements of EN 1363-1:1999 partition test and assuming the fire can start from either side of the partition.“**

Compensation measures according to TSI LOC&PAS

If the assessment of conformity to the requirements in clause 4.2.10.5 for FSPM is done with the help of computational fluid dynamics (CFD) simulations, these simulations shall be validated by 1:1 tests, conducted on a model representing the circumstances applicable to the unit which is subject to TSI assessment; the accuracy of the demonstration method shall be taken into account.



Compensation according to prEN 45545

- **No explicit reference to compensation measures**
- **But enquiries were sent to CEN and CENELEC (from Germany)**

Compensation measures according to EBO

§ 2 General requirements

- If at least evidence of equal safety can be provided recognised codes of practice can be neglected





Compensation measures according to „Regelungen für die brandschutztechnische Beurteilung von Eisenbahn-Fahrzeugen in Deutschland“

Chapter 3.1 – General:

- **If at least evidence of equal safety can be provided recognised codes of practice can be neglected**



Summary

- **Because of the variation of regulations, standards etc. it is necessary to harmonise this variety**
- **In the harmonised regulations, standards it is necessary to implement compensation measures**

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Thank you for your attention!

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