Jernbanetilsynet Seminar

Oslo, 17.10.2007

TramTrain and its safety issues

- experience and approaches

Axel Kühn, Karlsruhe

Jernbanetilsynet Seminar

Oslo, 17.10.2007

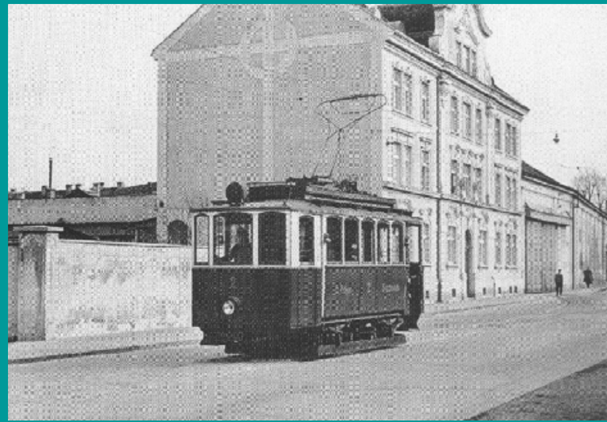
TramTrain and its safety issues

- and what does the new EN15227 mean for TramTrain schemes?

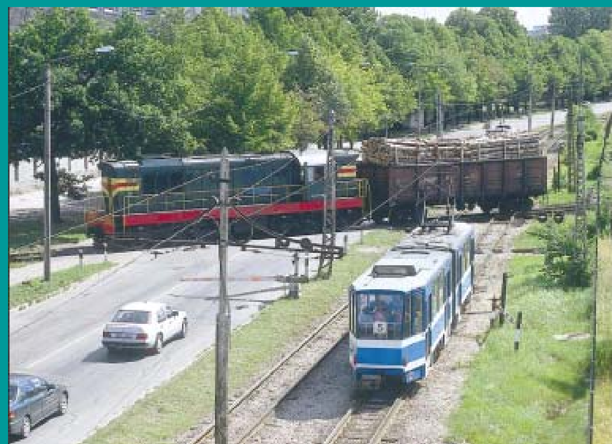
Axel Kühn, Karlsruhe

Definitions

TramTrain <> TrainTram



What are we talking about?



Definitions

Heavy Rail network

Urban rail network (existing/planned)

TramTrain

Tramway derived vehicles operate on heavy rail infra-structure; dual-mode operation

- **Karlsruhe**
- **Saarbruecken**
- **Kassel**
- **Nordhausen**
- **Chemnitz**
- **Rijn-Gouwe-Lijn**
- **Alicante**
- **Mulhouse**
- **Liberec**
- **...**

TrainTram

Railway derived (Diesel) vehicles operate on urban rail (tramway) infrastructure

- **Zwickau**
- **Riverline**
  Camden-Trenton
- **Aachen (planned)**
- **...**

Conversion

Former railway alignments are converted for light rail/tramway operation; electrification with tramway voltage; with or without track-sharing

- **Manchester**
- **Karlsruhe (partly)**
- **Kassel (partly)**
- **Chemnitz (partly)**
- **Oporto**
- **Aulnay-Bondy**
- **...**

MetroTrain

Metro vehicles use heavy rail infrastructure

- **Tyne&Wear Metro Sunderland**

??? kN

Crashworthiness??

Tramway ≥200kN

LightRail (EU) ≥600kN

TramTrain ≥600kN

Train (EU) ≥1500kN

LightRail (US) ≈1500kN

Train (US) ≥3000kN

German approach (derived from Karlsruhe pilot)

Operational patterns similar to track-sharing have been introduced in Karlsruhe as early as 1960, when tram-way vehicles equipped with ATP started to operate under 750V overhead power supply on the reshaped private “Albtalbahn“ railway together with Diesel freight trains.

Safety

German approach (derived from Karlsruhe pilot)

Karlsruhe's first TT-services to Pforzheim and Bretten (1991/92) approved by DB at this time without detailed risk and safety assessments!

Concentration was on the pure technical side with regard to the technical equipment of the vehicle (ATP, radio communication etc.) and derailing issues at specific railway points.

German approach (derived from Karlsruhe pilot)

Safety

Approval for early projects was always only for specific routes or network sections!

Not possible in these days to operate the Karlsruhe vehicles elsewhere without additional route specific approval procedures!


TRANSPORTCONSULT International Berlin GmbH

Gutachten zum
Einsatz von Leichten Nahverkehrstriebwagen (LNT)
im Mischbetrieb mit EBO-Fahrzeugen
auf Eisenbahnstrecken des öffentlichen Verkehrs

- Erläuterungsbericht -

FE-Nummer:	70 404/92
Auftraggeber:	Der Bundesminister für Verkehr Referate A 24/E 15
Auftragnehmer:	TRANSPORTCONSULT International Berlin GmbH

Berlin, den 05.11.1993

German approach (derived from Karlsruhe pilot)

A general light rail vehicle safety approach was taken in 1993-95 by the German ministry of transport, the starting point being not only the Karlsruhe model, but the aim to develop lighter (and cheaper) Diesel rail vehicles for rural railway services (e.g. Siemens REGIOSPRINTER).

LNT-regulations

Leichte Nahverkehrs Triebwagen (=LNT)

Eisenbahn-Bundesamt

Nachweis gleicher Sicherheit

- Gesamtrisiko darf sich gegenüber regelgerechtem EBO-Betrieb nicht erhöhen
- Risikokompensation innerhalb des Gesamtsystems ist zulässig

Dipl.-Ing. (TU) Hans-Heinrich Graurf

LNT-regulations

Leichte Nahverkehrs Triebwagen (=LNT)

Eisenbahn-Bundesamt

Lösungsansatz

- Crashvermeidung statt Crashfestigkeit
- Schutz des leichten Fahrzeugs vor Regelfahrzeugen durch die Sicherungselemente der Eisenbahn
  - Zugbeeinflussung
  - Strecken- / Bahnhofsblock
  - Gleisfreimeldeanlagen
  - Zugfunk
- Eigenschutz des leichten Fahrzeugs durch hohes Bremsvermögen gem. BOStrab

Dipl.-Ing. (TU) Hans-Heinrich Grauf

LNT-regulations

Leichte Nahverkehrs Triebwagen (=LNT)

Eisenbahn-Bundesamt

LNT-Bedingungen (Stand: 1994)

Nebenbahn			Hauptbahn					
bis 50 km/h	bis 80 km/h	über 80 km/h	bis 80 km/h	bis 90 km/h	bis 100 km/h	bis 120 km/h	bis 160 km/h	über 160 km/h
	Hauptsignale, Signalabhängigkeit, technische Zugfolgesicherung Flankenschutz, Zugbeeinflussung Zugfunk							LNT-Fahrten nicht zulässig
		Verbot, mit Regelfahrzeugen in Gleise zu rangieren, die mit LNT besetzt sind						
			Gleisfreimeldeanlagen für Gleise, die im Mischbetrieb befahren werden					
				bes. Überwachung d. Betriebsführung				
					Signalisierung von Gegen-fahrten	technische Sicherung von Gegenfahrten (Gleiswechsel-betrieb)		
							Tunnel nicht zulässig	

Dipl.-Ing. (TU) Hans-Heinrich Grauf

DIN 5560

New (additional) approach from 2002

Eisenbahn-Bundesamt

EBA

neuer Ansatz: EBO-Kompatibilität

- Bemessung der Fahrgastzelle nach DIN 5560
- Crash-Kompatibilität zu EBO-Fahrzeugen
- definierte Stoßableitung in unkritische Bereiche der Fahrzeugzelle
- mittleres Bremsvermögen mind. 2,8 m/s²

LNT ⇨ Tram-Train

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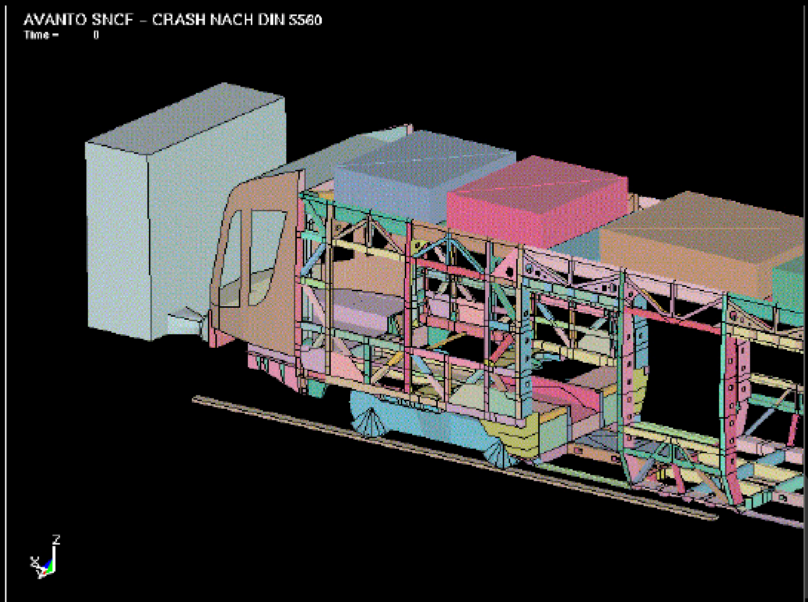


DIN 5560

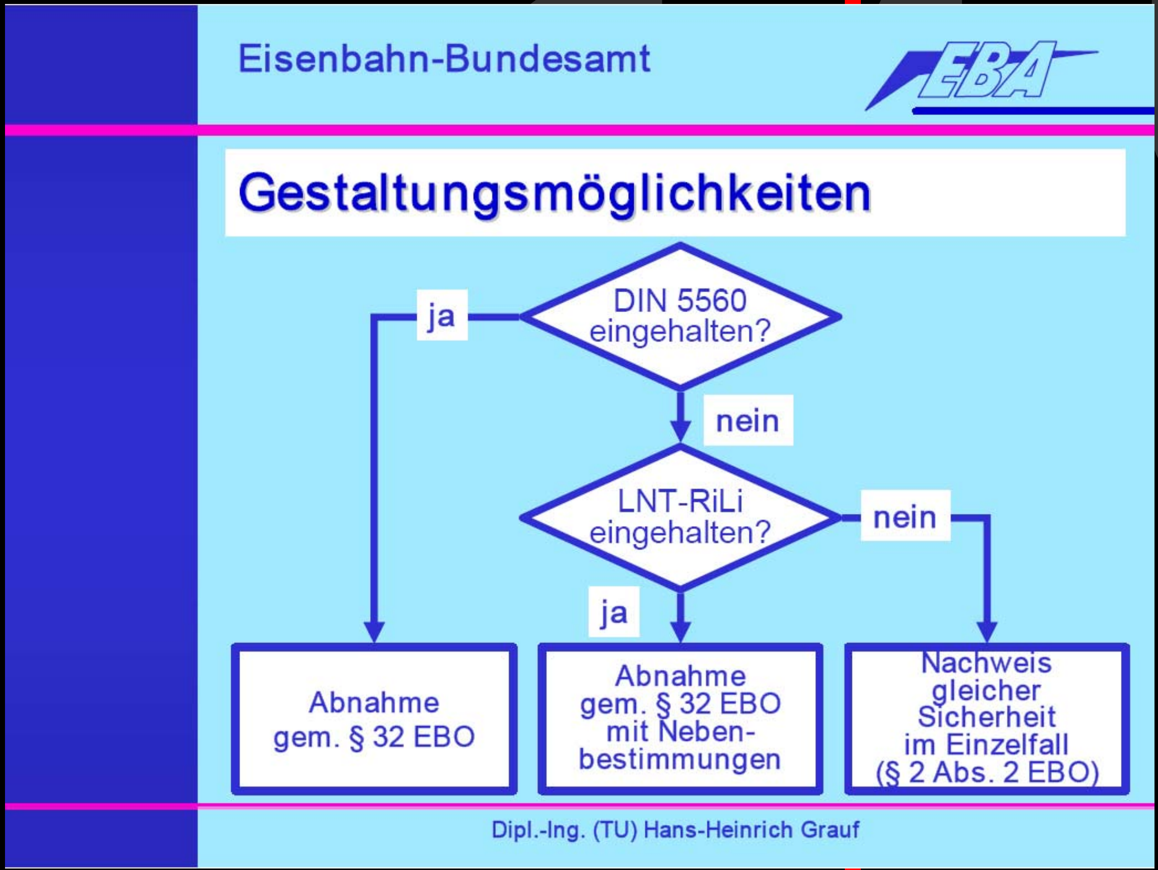
Siemens AVANTO first TT-vehicle with crash-nose according DIN 5560!

A German standard applied by SNCF for their TT-vehicle!

"Quite unbelievable, but the truth ☺"

DIN 5560

offered additional approach ...



Safety

EN 15227

is a “taking further” of DIN 5560 on European level!

Further improves “passive safety” – contradiction to “active safety” approach of TT??

EN 15227

4 vehicle categories; TT in category III

Crashworthiness of Rail Vehicles

DB Mobility Networks Logistics

Passive safety basic elements

European railway vehicle categories (prEN 15227, Table 1)

Category	Definition	Examples of vehicle types
C-I	Vehicles designed to operate on TEN routes, international, national and regional networks (which have level crossings)	Locomotives, coaches & fixed units
C-II	Urban vehicles designed to operate only on a dedicated railway infrastructure, with no interface with road traffic	Metro vehicles
C-III	Light rail vehicles designed to operate on urban or regional networks, in track-sharing operation, and interfacing with road traffic	Tram trains, periurban tram
C-IV	Light rail vehicles designed to operate on dedicated urban networks interfacing with road traffic	Tramway vehicles

EN 15227

3 (4) crash scenarios, first two derived from DIN 5560!

Crashworthiness of Rail Vehicles

DB
Mobility Networks Logistics

Passive safety basic elements

European railway design collision scenarios outline (prEN 15227, Table 2)

Design collision scenario	Collision obstacle	Operational characteristics of requirement	Collision Speed - km/h				Collision partner and conditions
			C-I	C-II	C-III	C-IV	
1	Identical train unit	All systems	**36**	**25**	**25**	**15**	Identical train unit
2	80-tons wagon	Mixed traffic with vehicles equipped with side buffers.	**36**	Na	**25**	n.a.	See Annex C.2 for wagon specification
	129-tons regional train	Mixed traffic with vehicles with a central coupler	na	Na	**10**	na	See Annex C.3 for representation of regional train
3	15-tons deformable obstacle	TEN & similar operation with level crossings	**V_{lc} – 50 ≤ 110**	na	**25**	na	See Annex C.4 for representation of large obstacle
	3-tons rigid object	Urban line not isolated from the road traffic.	na	na	na	**25**	See Annex C.5 for representation of obstacle
4	Small, low obstacle	Obstacle deflector requirements to be achieved	See table 3	See table 3	See table 3	**na**	If the risk due to this scenario is broadly acceptable no obstacle deflector is required, as defined below.

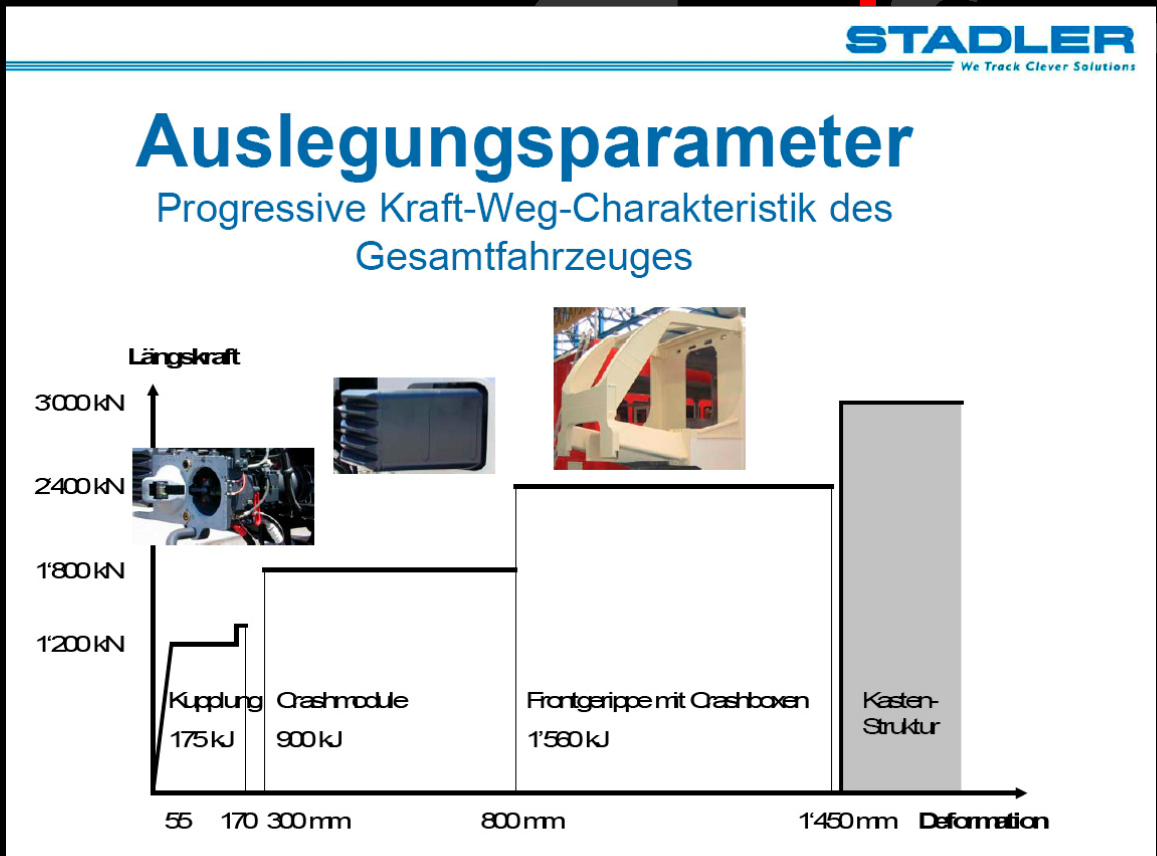
International Transit Studies Program
Berlin Meeting 18.10.2006

Compared to vehicle category I, lower requirements for TT in III!

25km/h takes into account better braking capabilities!

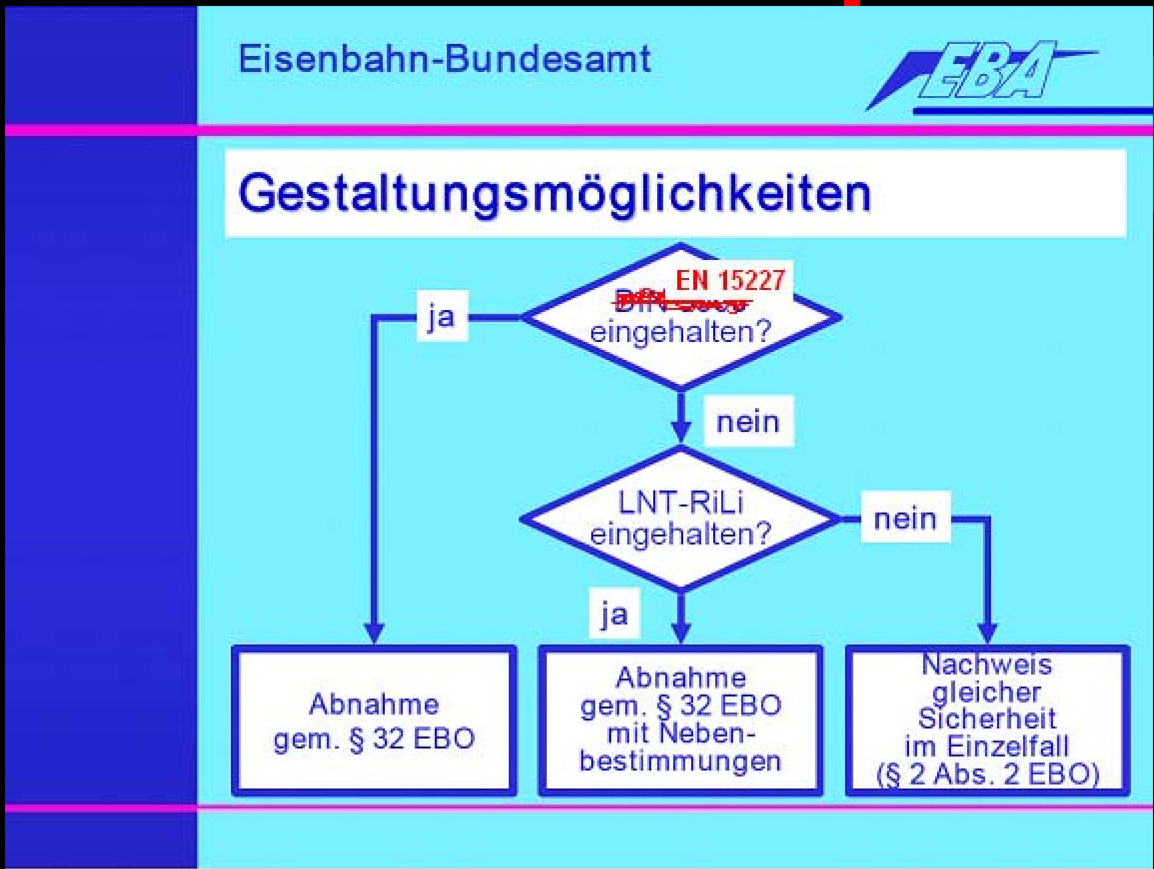
EN 15227

For category I this means up to 3000kN crashworthiness!



EN 15227 in Germany

Choice continues ...



Safety

EN 15227
in other countries

"No choice" as no operational "safety helmet" via LNT-regulations ...

So far apart from Germany "case based" approach with specific safety assessments for each system (France, Netherlands).

Safety

EN 15227
in other countries

EN15227 can be fulfilled by TT-rolling stock:
→new Alstom DUALIS does already,
→Siemens AVANTO does for scenario 1+2,
→Alstom RegioCitadis can be adapted!

Safety

EN 15227 in other countries

However: more weight and higher rolling stock costs could be involved!

Specific route characteristics (e.g. no level crossings) will also allow to exclude specific scenarios.

Safety

Conclusion

EN15227 not “the end” for TT; if all other factors/issues justify the choice of a mixed-mode system, then safety will not be “the killer”.

EN15227 can be even seen as advantageous by delivering a clear EC-rule and avoiding to negotiate endlessly for “local regulations”!

www.tramtrain-generation2.com
www.lightrail.nl/TramTrain
www.lightrail.nl/Regiorail
www.lightrail.nl/studytours
www.lightrail.nl/kuehn

Contact