Tram-train in the UK?

INCOSE
25th February 2009

By Giles Thomas
What is a tram train?

• “a light rail vehicle capable of operating on a street tramway and a conventional railway”
What is tram train?

- A combination of train qualities in a tram
- through inner city streets
  - boarding at street level
- on main railway track
  - Mixing with heavy rail traffic
- Karlsruhe-model
Development in Europe

- 1961 – Conversion of Albtalbahn narrow gauge to tramway, Karlsruhe
- 1991- Bretten line converted to tram train, Karlsruhe
- 1991-2008 – Expansion of Karlsruhe network to over 500km
- 1990s – Expansion in Germany – Saarbrucken, Kassel, Zwickau
- 2000 onwards – Netherlands, France
  - RandstadtRail, Gouda, Paris, Mulhouse, Lyon and more
- All dual voltage electric except Kassel – Diesel/electric trams and Zwickau – diesel DMUs
Development of the Tram-train network in Karlsruhe, Germany.
Development of the Tram-train network in Karlsruhe, Germany.

1996
Development of the Tram-train network in Karlsruhe, Germany.

2003-2007
Karlsruhe growth 1992 - 2003

Passengers / day

Network Rail
Short film
A UK tram-train trial

Objectives

1. Understand the changes to industry costs of operating a lighter weight vehicle with track brakes on the national rail network

2. Determine changes to technical standards required both to allow inter-running of light weight tram vehicles with heavy rail passenger and freight traffic and to gain the maximum cost benefit from tram-train operation

3. Gauge passenger perception and acceptance of light rail tram-train services

4. Determine the practical and operational issues of extending tram-trains from the national rail network to on-street running
Tram-train trial route selection

**Legend**
- Selected Stations
- Network Rail Infrastructure
- South Yorkshire Supertram Infrastructure
- Tram Train Phase 1
- Tram Train Phase 2
- Urban Areas

**Huddersfield to Barnsley (dedicated tram train operation):**
- Rural route.
- 21 miles single track with two passing loops.
- Existing services of hourly local Northern Rail trains.
- Severe axle weight restriction near Huddersfield bars route to freight and heavier forms of passenger trains.
- Line speed typically 50 mph.
- Some short gradients up to 1:50.
- Line of sight operation proposed.

**Barnsley to Meadowhall Interchange (dual running):**
- Secondary route.
- 12½ miles double track.
- Up to four local and inter urban passenger services per hour with little freight operations.
- Line speed typically 70 mph.
- Some gradients up to 1:100.

**Meadowhall Interchange to Sheffield (dual running):**
- Primary route.
- Part of a designated TENS route.
- 3½ miles double track.
- Up to 10 local, inter urban and long distance passenger services each hour with significant freight movements.
- Line speed up to 90 mph.
The challenges posed by light rail operating in a heavy rail environment – system issues

- **lighter car body construction**
  - does not comply with requirements railway rolling stock

- **low weight**
  - Light rail vehicle detection experience

- **low floor**
  - High platforms (915mm)

- **small wheels, increased back to back**
  - risk derailment in switches and crossings
  - Risk of derailment on curves

- **Operation**
  - Road to timetabled rail
Lighter car body construction

- **problem**: strength car body for a light rail vehicle is 40% of requirement railway rolling stock
  - increased risk casualties during collision
- **typical mitigation**: better train protection
  - Dutch fitted (ATB) automatic train protection system monitors drivers action, automatic emergency brake
  - Tram-train trial is planning to fit TPWS
  - Use of track brake at level crossings
  - integral safety plan using a risk based approach
Low weight

• **problem**: insufficient electrical contact between wheel and rail (“loss of shunt”) due to low weight
  – failing vehicle detection by “track-circuits”
    • not working level-crossing warning installations (barriers/warning lights/bells)
    • conflicting train movements
• **typical mitigation**: train detection independent of electrical contact
  – application of axle-counters
  – experience of operating TI21
  – Track circuit actuators
• **problem**: existing platforms are too high

• **Typical mitigation**: build low platforms closer to track
  – lower existing high platforms
  – provide opposite existing platforms
  – extension of lateral platform
  – alongside track without existing platform
low floor and level access

- Group Standards
- EU Interoperability
- 4’ fencing
Wheel rail interface

• **problem**: wheels smaller than railway requirements
  – derailment risk due to insufficient guidance in switches and crossings

• **mitigation**: review of tolerances in new and worn situation

• **measure**: reducing groove width of frog in new situation
Wheel/rail differences

- **Problem**: Tram requirements are different from ‘heavy rail’:
  - Thinner flanges (wider flange ‘back-to-back’ dimensions) for running on grooved rail
  - Shallower flange heights/shapes for grooved rail and flange tip running

![Diagram of wheel profiles](NetworkRail)
Tram train wheelset characteristics

- **mitigation**: European rail systems use raised check rails on curves and S&C
- Tram train wheel profiles have a ‘stepped’ flangeback to give 2 back-to-back dimensions
  - 1380mm at running rail height
  - 1360 at check rail height
UK specific mitigation

• Absence of raised check rails means that a stepped flange back cannot be used (unless we fit them)
• Possible solutions for trial
  – Use a P8 wheel profile
    • Does not test true tram train operation- still only a train, just shaped like a tram (from a WRI perspective)
  – Use a tram wheel profile, but use a 1360mm back-to-back
    • Still does not test tram train operation- looks a bit more like a tram
    • Would test curving performance & wear of profile
    • Restricted to operation on NR infrastructure, could not run ‘on street’
  – Use a tram or tram train wheel profile with a 1380mm back-to-back
    • True tram train operation
    • But
      – Would it be possible to operate without raised check rails (particularly S&C)?
      – Are there solutions apart from raised check rails?
      – What are the risks of operation with wider back-to-back spacing, and what would need to be done to gain approval?
Organisational and legal system issues associated with Phase II

- Who owns the infrastructure?
- Who owns the vehicles?
- Who manages the reconstruction?
- Who is responsible for safety?
- Can operations of train and light rail be mixed?
- Who pays for it all?
- Who takes the political responsibility?
• Risk analysis of tram train operation
  – Acceptable crash worthiness
  – Acceptable train detection system
  – Acceptable wheel profile
• Standards for tram train operation established with UK Tram and ORR (HMRI)
• Benefits of tram train operation quantified to inform promoters of tram train schemes
• Guidelines on the suitability of tram train for potential applications produced