KEY FACTS

- **400 AWARDS IN FIVE YEARS**
- **INDUSTRY-LEADING SAFETY MANAGEMENT**
- **£1.2bn MANAGEMENT, ENGINEERING AND DEVELOPMENT CONSULTANCY**
- **16k MORE THAN 16,000 STAFF**
- **USING OUR INGENUITY TO DELIVER LASTING VALUE FOR ALL**
- **HIGHEST ETHICAL STANDARDS**
- **150 YEARS' HERITAGE**
CONTENTS

- Background
- Methods Currently Used
  - Interpolation from Test
  - Calculation based on heat content (Calorific Value)
  - Boon-Chiam Method
  - HRRPUA (‘Duggan Method’)
  - CFD
- Discussion
- Conclusions
BACKGROUND

- **Definition of Peak Heat Release Rate**
  - ‘The rate of heat energy released during a rail vehicle flash-over fire’

- **Why is it Critical?**
  - Principally used to help define tunnel structural requirements and infrastructure ventilation requirements
  - Not Specified in EN45545

- **Critical Issues for Consideration**
  - Required Ignition Source Size
  - Rate of Fire Growth
  - Saloon fire only
**TYPE TESTS**

- **EU499 – 1990’s**
  - Contemporary ICE design – 13.7MW (77000MJ)
  - 1960’s Metro – 35MW (43000MJ)

- **Metro – 2012**
  - 1970’s? SLX1 Metro Car – 77MW
  - SLX1 Metro Car – SL C20 (1990’s) Interior Fit Out over existing interior– no flash over for nearly two hours – peak HRR 77MW (SLX 1 materials?)
  - Required Ignition Source for flashover 700-900kW*

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*Requires Luggage - EN45545 Ignition Source 5 peak is 150kW
Various Rail Administrations require 28000MJ for Metro Car Interior
  - Assume all combustibles consumed in 1 hour ~ 7.7MW

EU499 test results:
  - Peak HRR Not Proportional to Heat Content

Low Confidence in This Method
BOON CHIAM METHOD

- Developed for Singapore Metro Project: 2005
- Based on Heat Content and Small Scale Heat Release Test Results
- Considers Effects of Open Gangway Cars:
  - Risk that for open gangway cars – flashover will consume multiple cars simultaneously
  - Boon-Chiam proposes assumption that peak will progress 10% of car length in 1 minutes (~10 minute delay between individual cars)
HRRPUA – ‘DUGGAN METHOD’

- ‘Heat Release Rate per Unit Area’
- Uses ISO5660-2 Cone Calorimeter output data for each surface material in the design
For each material, calculate
- ISO5660-2 data * Area of Material used

Sum for all materials

Add Factor for Minor Materials

Add Factor for Ignition Source and Carry on Luggage

Report Predicted Value as Peak HRRPUA

Typical Limit for UK Metro Car = 8.8MW
COMPUTATIONAL ANALYSIS (CFD)

- Eg NIST FDS or CFAST, BRE Jasmine or Greenwich University SMARTFIRE.

- Input is ISO5660-2 data plus standard fire data (soot production levels etc).

- More complex analysis - uses repeated calcs in 3D cell mesh.

- Process usually used for developing fire, not flash over.

- Newer technique. Not accepted by everyone.
VALIDATION OF PEAK HRR

- Limited Validated Data
- Test data uses ‘one off tests’
  - Laboratory fire tests have high variability.
  - One off test uncertainty is higher.
- Calc. methods based on significant assumptions
Complete car length at flash-over.

No account of ‘fire break’ effects at large vestibules.

Some methods assume materials are 75% consumed, others assume materials are completely consumed.

How to account for imported materials – luggage/ ignition source.

What ventilation protocol.
PROPOSALS

- High infrastructure costs may block future projects.
- Accurate HRR calc. method is vital for infrastructure specification.
- Propose Future Joint Work Programme to Develop a Standardised Validated calculation method.
THANK YOU

- QUESTIONS AND DISCUSSION
USING OUR INGENUITY TO CREATE LASTING VALUE FOR ALL

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