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PMSC LIMITED PRESENTATION

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Cresta Court Hotel Altrincham, UK.

"For the Isograph European User Group Meeting 2004

" Fire Risk Assessment for a High Speed Train"

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STRUCTURE OF THIS PRESENTATION

- Fire Safety Principles
(Deterministic Fire Testing of Materials)

- Types of Fire Modeled

- Overview of Fire Safety Features

- Fire Risk Assessment Methodology

- Event Tree Structure

- Assignment of Consequences

- Calculation of Risk

- Demonstration of ALARP

- QESTIONS & ANSWERS

FIRE SAFETY PRINCIPLES

- Reaction to fire (materials performance)
  - Spread of flame
  - Flame propagation
  - Smoke density
  - Toxic fumes

- Resistance to fire (prevention of fire spread)
  - Fire barriers
  - Fire dampers

- Fire detection and suppression
  - Smoke and heat detectors
  - Fire extinguishing systems

- General fire safety measures
  - Vital system integrity
  - Evacuation planning
  - Electrical equipment enclosures

MATERIALS TESTING & SELECTION

- The performance of materials and fire barriers in vital to passenger and train staff safety

- Materials should selected using an internationally recognised standard (i.e. BS 6853)

- Materials should be tested and selected based on key reaction to fire properties
    - BS 476 part 6 – flame propagation
    - BS 476 part 7 – surface spread of flame
    - BS 6853 Annex B – toxic fumes
    - BS 6853 Annex D – smoke density

- Some exceptions to the test criteria can be justified by additional design measures or ‘best available technology’

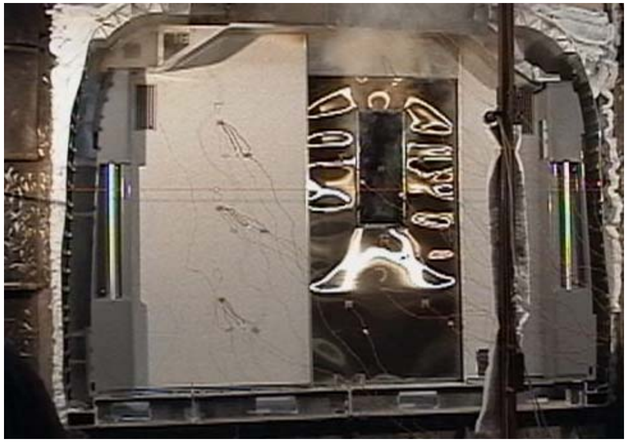
RESISTANCE TO FIRE TESTING

•The separation of areas of the train is vital to protecting the passengers

•Compliant design can be achieved in steel, stainless steel or aluminium materials

•Development of smoke and fire seals to control smoke release and integrity

•Integrity and insulation testing can be Undertaken in accordance with an internationally recognised standard (i.e. BS 6853)



TYPES OF FIRE MODELED

The fire types below might be typical of those selected for modeling:-

- **Fires inside the Train**

  - Fire in Luggage Rack
  - Fire in Toilet
  - Fire in Electrical Cabinet
  - Fire in the cab or behind driver area

- **Fires Outside the Train**

  - Fire in Main Transformer
  - Fire in Converter Inverter
  - Fire due to stuck Brake

OVERVIEW OF FIRE SAFETY FEATURES

• Selection of Materials and Provision of Rated Fire Barriers

• Provision of Smoke Detection Systems

• Use of Fire Wires on Under-frame or inside cabinets (indicated back in cab)

• Provision of Hand Held Fire Extinguishers in saloons and or Train Masters room (if any)

•Provision of Communication Systems
 - Between Driver and Train Master
 - Between Driver and Central Control
 - Between Driver/Central Control/Train Master and Passengers

FIRE RISK ASSESSMENT METHODOLOGY

- Event Tree Based
- Supported by Fault Trees for detection systems
- CCF assessment undertaken using UPBFM
- Key Human Errors modeled using HEART
- Spreadsheet methods used for CCF and HEART
- Using Consequence categories based on Equivalent Fatalities (EF= Fatalities+Major Injuries/10 + Minor Injuries/200)
- Rule Based assignment of Consequences
- Mix of generic and specific rail data

FIRE RISK ASSESSMENT METHODOLOGY

(General Assumptions Made – some examples)

• **Errors committed by Central Control have been neglected**

• **Train is assumed to be at 100% capacity**

• **Fire Barriers are assumed to be rated for 15 minutes**

• **If passengers gain egress to adjacent car then unless driver Commits an error the train will reach a place of safety Before the fire reaches them.**

• **Various assumptions are made regarding the specific Location of fire extinguishers**

CCF ANALYSIS
(Using Unified Partial Beta Factor Method)

DESIGN
- **Redundancy & Diversity**
- **Understanding**
- **Analysis**

OPERATION
- **Man Machine Interface**
- **Safety Culture**

ENVIRONMENT
- **Control**
- **Tests**

Beta Factors applied to each occurrence of multiple Redundant components in the model

HUMAN ERROR MODELING

- Using HEART
- Identify appropriate Base Event
- Assess Performance Shaping Factors
- Derive Human Error Probability
- Key errors modeled include:- driver errors, Train Master and passenger errors

EVENT TREE STRUCTURE

Typical Event Tree Nodes might be:-

- **Where is the fire?**
- **Where is the Train at the time of the fire?**
- **Is the Train at full line speed?**
- **Do the Train Detection Systems work?**
- **Does the driver take correct action once the fire is discovered?**
- **Do passengers successfully evacuate affected car?**
- **Does the fire escalate?**
- **Does Train stop in a place of safety?**
- **Can affected passengers safely egress from the Train?**
- **Can passengers be recovered safely by the Train Operating Company?**

ASSIGNMENT OF CONSEQUENCES

SEVERITY	PERSONNEL	SYSTEM	ENVIRONMENTAL
Disastrous	Not defined in EN50126	Not defined in EN50126	Not defined in EN50126
Catastrophic	Multiple deaths and/or widespread fatal illness	Loss of a critical physical asset. Leading to failure of a critical system such as signalling potentially leading to catastrophic disruption to the running of the Railway	Significant, prolonged or widespread damage to a habitat or species
Critical	Single death and/or multiple severe injuries or occupational illnesses	Major system loss, mission failure. Major disruption caused.	Major damage or medium-term damage of a habitat or species
Marginal	Single severe injury or occupational illness and / or multiple minor injuries	System damaged, lost functionality. Interference with non critical systems	Small-scale, short-term damage to a habitat or species
Negligible	Minor injury or occupational illness	Minor damage to system. System not functioning as intended however not affecting any other system	Minor local damage to a habitat or species

ASSIGNMENT OF CONSEQUENCES

- **Each event tree uses rule sets**

- **eg where driver can take correct action and passengers Can accomplish safe egress – Negligible Consequences are assigned**

- **eg. Where driver fails to take correct action, the train fails to stop in a place of safety and the fire is in cars 1 or 12 – Catastrophic Consequences are assigned.**

The rule set ensures an internally consistent assignment of consequences At each end point in the event tree.

CALCULATION OF RISK

- **Event Tree assigns consequence**
- **Frequency of each Consequence category**
- **Convert frequency information into % of risk target used by using weighting Factors for each consequence category**

Weighting Factor= (N /Km) x100%/Risk Target

Where N is the No of Equivalent Fatalities and Km is the No of Passenger Km per year

And Risk targets are presented in units of Equivalent Fatalities per Km

DEMONSTRATION OF ALARP

- Each Line in the Event Tree reviewed

- Consequence Assignment Rule identified

- Numerical frequency cf to Client Criteria

- If Risk=D Acceptable no further action taken

- If Risk=C Acceptable with Review – design features reviewed

- No UD Undesirable or UN Unacceptable sequences identified

(However if there had been, a specific ALARP Design review To assess additional measures would have been required)

DISCUSSION/QUESTION & ANSWERS

Thanks for listening are there any Questions ?

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