Crossrail Fire Safety Designs

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• Introduction to Crossrail
• Mott MacDonald recent involvement in fire safety designs
• Rolling Stock
  – Reference design & compliance
  – Smoke spread study
  – Fire spread study
• Tunnel Fire Safety Systems
• Station Fire Safety Systems
• Future Crossrail Project Development
Crossrail will connect 37 stations, including Heathrow airport and Maidenhead in the west with Canary Wharf, Abbey Wood and Shenfield in the east.

28 existing surface stations upgraded (11 major reconstructions)

90km of existing surface network
Central Area of Crossrail Route Map

22km of new sub-surface twin-bore railway through London

8 new sub-surface stations
Mott MacDonald’s Recent Roles in the Crossrail Project

Mott MacDonald’s responsibilities in the key fire safety designs:

• fire safety aspects of the proposed open-wide gangway rolling stock;
• design fire size for the tunnel ventilation and platform smoke control systems;
• system-wide fire strategy for all of the tunnels;
• design of the smoke-control measures for the tunnels and all station platforms and of fire-fighting systems for the tunnels;
• fire strategies and fully-integrated detailed design for one of the major underground interchange stations at Liverpool Street.
Reference design for Crossrail carriage:

- Two five-car sets per train, with Open-Wide Gangway runs the full length of the train.
- 20m long per car with three sets of double passenger doors, except the driving vehicles which have only two.
- Design must demonstrate adhere to the *Code of Practice for Fire Precautions in the Design and Construction of Passenger Trains, BS 6853.*
- All materials to be used in the rolling stock design must be suitable for use within a Category 1a environment (trains, which predominantly use tunnels).
Rolling Stock – Geometry & Layout

The geometry and layout inside carriages influence the smoke spread characteristic and propagation of fire during a fire incident.
Rolling Stock – Smoke Spread Study

CFD techniques are used for the prediction of smoke propagation.

Results are analysed by reference to suitable tenable conditions for passenger, prior to evacuation starting.

Tenability conditions inside the carriage are assessed in terms of air temperatures, visibility levels, and carbon monoxide concentrations.

2 luggage cases, 16 kg
Test case burned for 30 mins
Calorimeter HHR = 284 kW peak @ 6 mins
Rolling Stock – Smoke Spread Study (2)

Fire Location

Car 1
Car 2
Car 3
Car 4

30sec
1min
1min 30sec
2min
2min 30sec
3min
4min
5min
Rolling Stock – Smoke Spread Study (3)
Rolling Stock – Smoke Spread Study (4)
Rolling Stock – Fire Spread Study

- Half carriage
- Open wide gangway
- Ignition source
- Platform-side doors
500kW baggage fire
Tunnels – Fire Safety System / Strategy

- Platform Extractions
  - Tunnel Extractions

Normal Conditions
1. Platform Fresh Air
2. Platform Cooling

Fire Conditions
3. Platform 1.1 MW Fire Smoke Extract
4. Train 8.8 MW Fire Smoke Extract
Stations – Fire Safety Systems

Station Overview
Stations – Fire Safety Systems

➢ Tunnel Ventilation

- Transformer Room
- Plantroom Ventilation
- LV Switchroom
- Tunnel Vent Fans
- Moorgate Shaft
- Sump

- Platform Ventilation
- Transformer Room
- LV Switchroom
- Tunnel Vent Fans
- Moorgate Shaft
- Sump

- Accommodation Ventilation
- Platform Ventilation
Stations – Fire Safety Systems

➢ Tunnel Ventilation

Blomfield

Moorgate
Emergency evacuation routes for Crossrail’s Liverpool Street station
Stations – Fire Strategy (2)

Escape routes – Street level

Moorgate

Blomfield
Stations – Fire Safety Design

- Open PSDs
- Down-stands
- Handrails
- Open-space to ambient
- OPE Grilles
- Columns
- Escalator
- Lift walls
- Down-stands
- Running tunnel
- Open PSDs
- Train
- Mott MacDonald
Stations – Fire Safety Design  

- Down-stand height from finished floor level = 4.75m
- 10m Visibility Envelope

- Incident side
- Non-incident side

Time 15 [s]
Stations – Fire Safety Design (3)

Down-stand height from finished floor level = 3.65m (deeper down-stand)

10m Visibility Envelope

Incident side

Non-incident side

Time 15 [s]
Stations – Analysis Result Comparisons

Down-stand height from FFL

4.75m

Visibility Contours

10m Visibility Envelope

Design Fail

4.25m

Visibility contours at 2.5m height [m]

Good

Bad

[Diagram showing visibility contours and 10m visibility envelope for 4.75m and 4.25m down-stands]
Stations – Analysis Result Comparisons (2)

<table>
<thead>
<tr>
<th>Down-stand height from FFL</th>
<th>Visibility Contours</th>
<th>10m Visibility Envelope</th>
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<tbody>
<tr>
<td>3.65m</td>
<td><img src="image1.png" alt="Visibility Contours" /></td>
<td><img src="image2.png" alt="10m Visibility Envelope" /></td>
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<td>2.80m</td>
<td><img src="image3.png" alt="Visibility Contours" /></td>
<td><img src="image4.png" alt="10m Visibility Envelope" /></td>
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Visibility contours at 2.5m height [m]

- Down-stand height from FFL

- Visibility Contours

- 10m Visibility Envelope

- Good Design

- Over Design
CFD Modelling Tools & Techniques

- 3D CAD Geometry
- Mesh Generation
- CFD Processing
- CFD Post-Processing
Future Crossrail Project Development

• Enabling works
• Portal construction already started
• All tunnelling awards have been awarded and first tunnelling work commences in Q1 2012
• Station construction is underway
• Plan opening date – 2018.
“Thank you for listening”

“Dankeschön”

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