

# **Introduction to Tunnel Fire Safety**

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## **Session 1: Fire behaviour in confined spaces**

Session 1 establishes the basics of fire behaviour in well ventilated conditions as well as in the conventional built environment. This is not tunnel-specific but the concepts are essential for later sessions. Concepts and topics covered include: The fire triangle, Evaporation of liquid fuels, Flammability, Flammability limits, Ignition, Heat release rate, Fuel and Ventilation control, Energy balance, Compartment fires.

## **Session 2: Tunnel environments and fire behaviour**

Session 2 discusses differences between compartment fires and tunnel fires. Initially the concepts are kept simple and idealised, adding complexity as we go. Concepts covered include: Natural Ventilation, Smoke movement and mixing, Mechanical Ventilation, Backlayering, Buoyancy, Throttling

## **Session 3: Fire growth and fire spread in tunnels**

Session 3 looks at real (experimental) fires in tunnels, and introduces Ingason's model of fire spread in Catastrophic Tunnel Fires, and how real vehicle fires behave in tunnels. Various influences on fire behaviour are discussed (ventilation vs fire size; ventilation vs fire spread; geometry vs fire size), and five mechanisms of spread are presented (with examples).

## **Session 4: Tunnel fire case studies**

Session 4 presents details of the fire dynamics during the Channel Tunnel fires (1996, 2006, 2008, 2015) as extended case studies. Also briefly discussed is the King's Cross underground fire (leading to identification of 'the trench effect'), and the Interstate 5 fire from California, which was not a long tunnel, but demonstrates how simple calculations can be used in investigation.

## **Session 5: Fixed Fire Fighting Systems**

Session 5 discusses some issues with the use of deluge and water mist systems in tunnels. What these are, what effects they have on fire, etc. Extinguishing and fire spread prevention are not guaranteed. But thermal management is achieved, (usually) life safety is improved, and structural protection is achieved. The session also briefly discusses active fire-fighting in the tunnel environment, which usually leads to an interactive discussion with delegates.

## **Session 6: Emergency evacuation from trains in tunnels**

The final session presents a theoretical case study, combining aspects from some of the earlier material with aspects of egress behaviour. The aim is to show that human behaviour matters, there is no simple ventilation solution to the problem of smoke, and sometimes not using a ventilation system is better than using it. Followed by a final discussion.