Is It Safer to Switch Ventilation off in a Tunnel Fire?

Dr Fathi Tarada
Mosen Ltd
Motivation

- Ventilation should be switched off in bidirectional tunnels
- Many tunnels switch off their ventilation system initially, if an incident is detected
- Excessive airflow can ‘fan the fire’
- Fire suppression can be more effective if ventilation is switched off
- So: is it safer to switch ventilation off in a tunnel fire?
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Longitudinal Smoke Ventilation
## Longitudinal Ventilation

**World Road Association Guidance**

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<th>PRINCIPLE FOR LONGITUDINAL VENTILATION</th>
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<td>A</td>
<td>Unidirectional traffic <strong>without</strong> traffic congestion</td>
<td>Flow velocities in the direction of traffic to prevent or at least minimize backlayering of smoke</td>
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<tr>
<td>B</td>
<td>Unidirectional traffic <strong>with</strong> traffic congestion</td>
<td>Relatively low flow velocities (e.g. $1.2 \pm 0.2$ m/s) in the direction of traffic in order to minimize flow spread upstream, allow smoke stratification, support dilution of toxic gases and enable people to escape.</td>
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<tr>
<td>C</td>
<td>Bidirectional traffic</td>
<td>Relatively low flow velocities should be maintained, to avoid flow reversal unless circumstances dictate otherwise (for example fires near portals), allow smoke stratification and enable people to escape in both directions.</td>
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Differing Country Approaches

- Ventilation control system is considered standard in a number of European countries including Switzerland and Austria, but not in the UK.
- Austria: air velocity in unidirectional traffic between 1.5 m/s to 2 m/s, and for bidirectional traffic between 1 m/s and 1.5 m/s.
- For unidirectional traffic without congestion, German RABT guidelines require a minimum velocity of the air flow exceeding the critical velocity for smoke control.
Risks of Over-Ventilation

- Destruction of any smoke stratification
- Lengthening of affected tunnel chainage
- Enhancement of fire heat release rate

![Graph showing the relationship between ventilation velocity and a parameter k for 1 lane and 2 lane tunnels.](image-url)
Tunnel Fire Suppression
Dartford Tunnel Fires 2016
Dartford Crossing

Northbound traffic

Southbound traffic
Dartford Tunnels

- Two tunnels, each 1,430 m long
- Northbound traffic in both tunnels (normal operation)
- Longitudinal ventilation via jetfans
- Fire suppression via high-pressure deluge
- Ventilation switched off initially in case of an incident
- Slides originally presented by Graham Pearce and David Cook of Connect Plus Services at UK Tunnel Form, Oct 2016
Fire Incident 1

- Saturday 2\textsuperscript{nd} July 2016
- Time: 12:48
- East (right-hand) tunnel, northbound direction
- Approximately 300m from entrance portal
- Relatively light traffic with low % HGVs
Time from incident: 00:00:00

Car Breaks Down
Time from incident: 00:02:40
Time from incident: 00:06:25

Passing Traffic
Time from incident: 00:06:35

Traffic Stops
Time from incident: 00:10:20

Smoke Detection
Fire Suppression Deployment Sequence

- The most northerly zone deploys first
- The zone centered on the incident deploys second
- The most southerly zone deploys last

Fire Zone 7N
Fire Zone 7S
Fire Zone 6N

Fire Point 7
Fire Point 6
Time from incident: 00:11:30

Fire Suppression
Time from incident: 00:14:10
Fire Incident 1 - Outcomes

• From car stopping to both tunnels fully open to traffic: 1 hour 22 minutes
• No injuries
• Minor damage to anti-skip surfacing
• Self-evacuation reinforced by public address message
• Herd effect
Fire Incident 2

• Sunday 11\textsuperscript{th} September 2016
• Time: 03:55
• East (right-hand) tunnel
• Approximately 400m from exit portal
• Light traffic with low %HGVs
Fire Incident 2 - Outcomes

- Stopped vehicles detected by incident detection system
- Traffic stopped immediately (no evacuation)
- Fire suppression activated
- Fire & Rescue Service responded in line with procedures
- Incident cleared and tunnels open in 1 hour, 23 minutes
Conclusions

• Only minimal ventilation may be required in case of fire in tunnel with fire suppression

• Consider piston effect, wind stagnating at portals and meteorological pressure differences

• Excessive ventilation may be counter-productive