

Fire Fighting Operations in Modern Road Tunnels

An Australasian Perspective

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2009 - Two Choices

- Learn the hard way
- Meet the challenge head on and learn all we can from the experience and knowledge of others



Voyage of Discovery 2010

- 10 week research fellowship studying Planning, Preparation and Response to Emergencies in Tunnels.
- USA (NYFD)
- Canada
- Germany
- Austria
- Denmark
- Sweden
- Norway
- Switzerland



The screenshot shows the website for the Winston Churchill Memorial Trust. The header features the trust's logo, which is a circular emblem containing a map of Australia and the text 'CHURCHILL TRUST'. To the right of the logo, the text reads 'WINSTON CHURCHILL MEMORIAL TRUST' and 'REWARDING AUSTRALIANS STRIVING FOR EXCELLENCE'. Below this is a navigation menu with links for 'ABOUT', 'FELLOWS', 'APPLY', 'NEWS', 'SPONSORS', and 'EVENTS'. A secondary navigation bar contains 'OUR FELLOWS', 'FELLOWS' ASSOCIATIONS', and '2015 CHURCHILL FELLOWS'. The main content area features a large photograph of a tropical beach with turquoise water and palm trees. Overlaid on this image is the name 'SHAN RAFFEL' in large white letters. Below the name, the following information is displayed: 'Year of Award: 2009', 'Award State: Queensland', and 'Emergency Services > Fire And Rescue'.

Case Study - High Risk

- Population 8.4 million
- Global finance and commerce hub
- Prime target for extremist terrorist groups
- Subway system with sections over 100 years old
- Over 1,000 km of track, 468 stations, with approximately 60% of this underground
- Weekday daily patronage exceeding 4.8 million passengers.
- 4 under river road tunnel links, one of which is the busiest road tunnels in America, with a traffic flow of approximately 120,000 vehicles/day

Your Not in Kansis Anymore

- In spite of this enormous risk, New York City has an exceptional safety record with underground infrastructure.
- Why?



Planning and Preparation

- NYC has a complex political structure with many overlapping areas of jurisdiction and responsibility at almost every level of government
- Large scale emergency incidents in tunnels (and other major infrastructure) cannot be effectively dealt with by any one organisation, agency, authority, or service
- So how do they deal with this less than ideal situation?

Fire/Transit Authority Cooperation

- Large shift in interagency cooperation in the early 1960
- Joint emergency planning
- Combined planning, prevention, and education programs between NYFD and Transit Authorities
- Regular cross training in fire prevention, firefighting, transit authority infrastructure, train construction, operations and communications
- 6 monthly inspections of emergency exits to increase familiarisation
- Resulted in a 50% reduction in the number of fires over 5 years

New Threats and Challenges

- 911 forever reinforced the need to prepare for deliberate acts of violence
- NYC remains a target prime for a number of extremist groups
- Major infrastructure is a prime target because of the impact an attack can have on the economy and security of the general public



Vigilance - Cooperation

- Increased use of CCTV and other means of intelligence gathering
- Increased awareness of the vital role the general public play in preventing incidents (e.g. Times Square SUV incident)
- Increased interagency communication and cooperation from prevention to response
- A strong Police presence (visible and less obvious)

Cross River Road, Rail, Bridge

- In order to overcome the cross jurisdiction issues, a 3rd entity was formed
- The New York New Jersey Port Authority manages the cross river infrastructure including airports and transit terminal
- Well funded, well equipped and very self sufficient
- Emergency response teams at all managed sites
- Equipment varying from short wheel based recovery/RIV to fire boats and airport tenders

So What Tunnel Features Require Special Solutions?

- Narrow roadways – Too narrow to turn an appliance around
- Visibility loss and heat build up (dependent on ventilation/deluge design and capacity)
- Difficulty getting equipment to the scene
- Traffic Density

Technical Solution – Narrow Tunnel

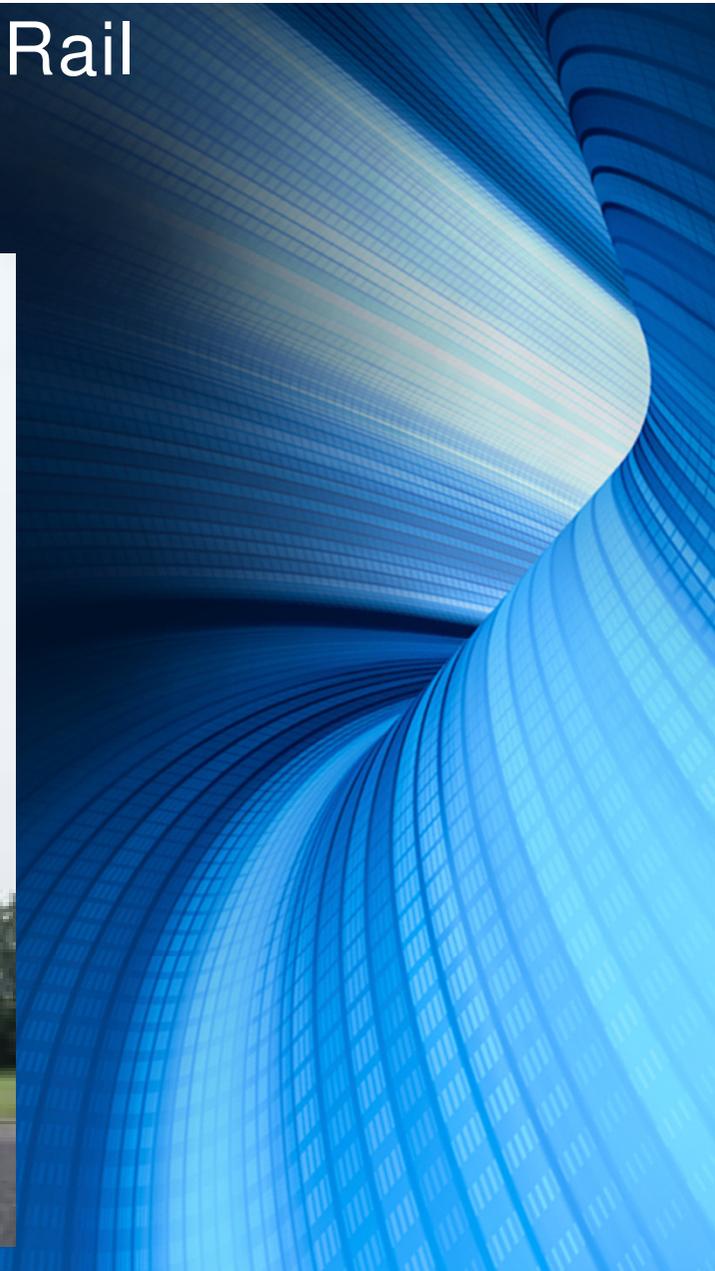


Technical Solution – Narrow Tunnel

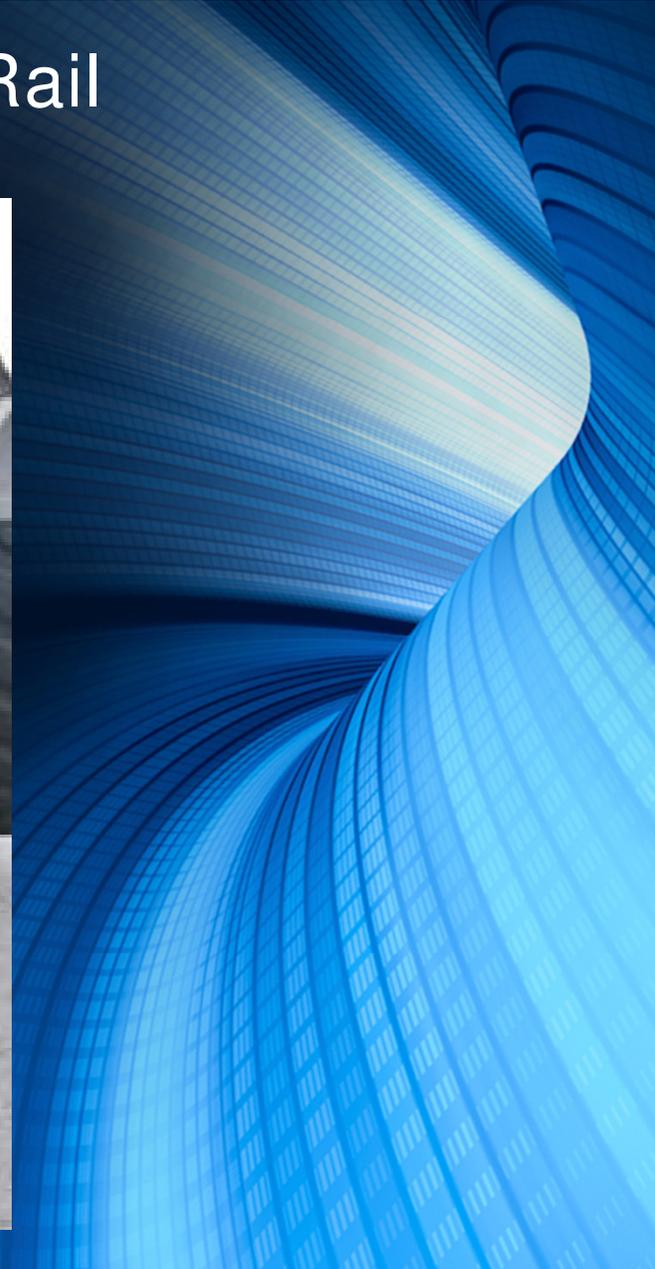


Access to Underground Rail

- Rosenbauer Rail Tunnel Fire and Heavy Rescue Tender



Access to Underground Rail



Access to Underground Rail

- Long duration SCBA can be connected to an onboard breathing air supply to conserve the cylinder capacity



Portable Equipment



- The fire appliance is basically a big red toolbox
- If the toolbox is not close to the point of work, then the equipment must be carried/transported manually
- Some of the rescue equipment is heavy

Initial Access Solutions

- Lightweight collapsible carts
- Electrically power carts
- Modified ATV's or light weight vehicles
- All are relatively easy to get to the track



Road Tunnel RIV



RIV



Reconnaissance
Stabilisation

- 2 x 25 l AFFF tanks
- 1 can be removed on a trolley
- SCBA
- First Aid Kit



Ventilation Support



Specialist Road Vehicles

Heavy Rescue Equipment
Long Duration SCBA
5000 l water tank
Bumper monitor

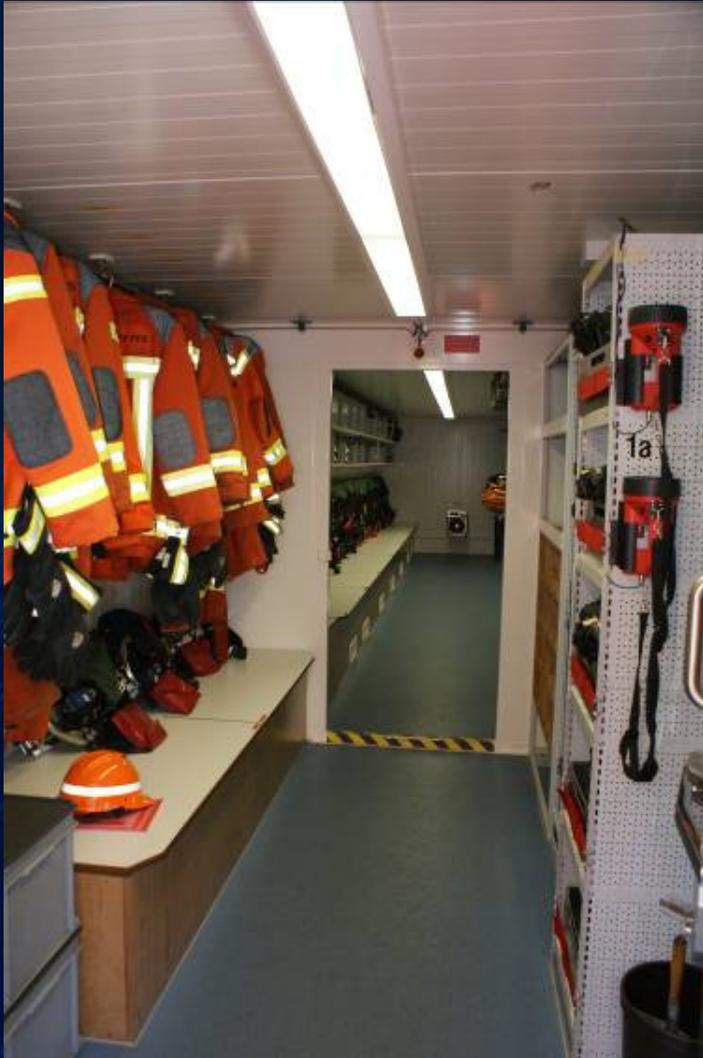


- CAFS
- FLIR
- PPV with fog

LRZ 08 Fire & Rescue Train



Worlds Best Practice in Rail Response



Worlds Best Practice in Rail Response

Emergency Rail Fire and Rescue Response Team
that is crewed 24/7 with 10 minute response time

Highly sophisticated Fire and Rescue Train with 3
specialised carriages including:

Heavy Rescue Mobile Workshop

Firefighting wagon with 44,000 litres of water,
1800 l of foam concentrate,

Pump capacity of 6000 lpm @ 10 bar

CAFS

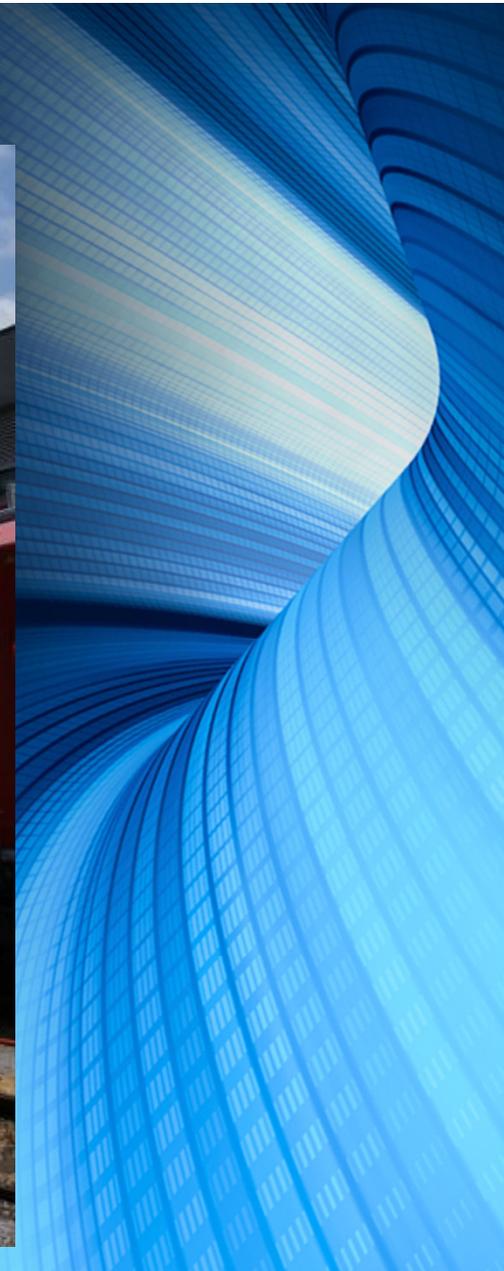
Pressurised Rescue Carriage with independent air
supply, airlock and advanced first aid capability



Protective Water Spray



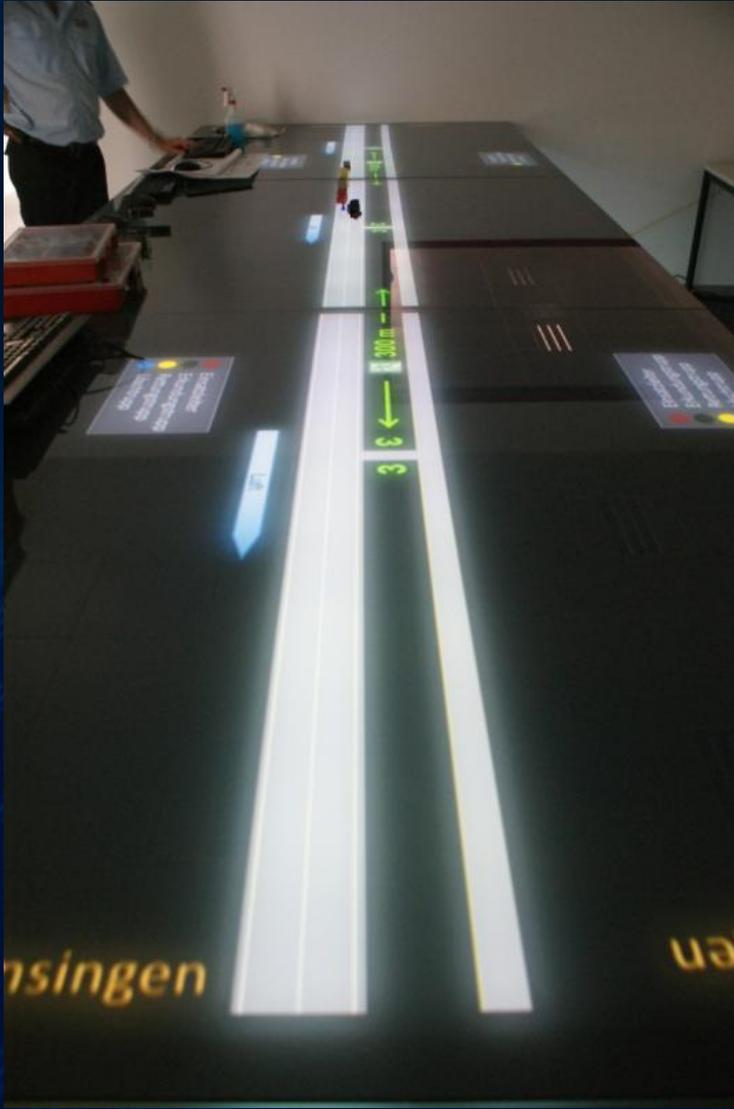
6000 LPM Monitor



So..... How Do We Prepare for High Risk – Low Frequency events?

- To some extent we can learn how to deal with “routine incidents” on the job
- The “non routine” and/or major incidents expose the depth of any organisation and it’s ability to accurately preplan and cooperate
- We cannot adequately prepare for major incidents by experiencing lots of them. The financial and human costs are just too high to learn that way!

Realistic Training Solutions



- Basic “table top” exercises can be cheap and foster an understanding of the “strategic level” considerations for the various agencies involved in a major incident.
- Lesson learnt from these exercise can play a major role in developing and refining interagency co-operation, communication, and training

Computer Technology

- Computer simulation can provide a cost effective multiagency training experience for the development of emergency responders involved in the strategic and tactical level of operations



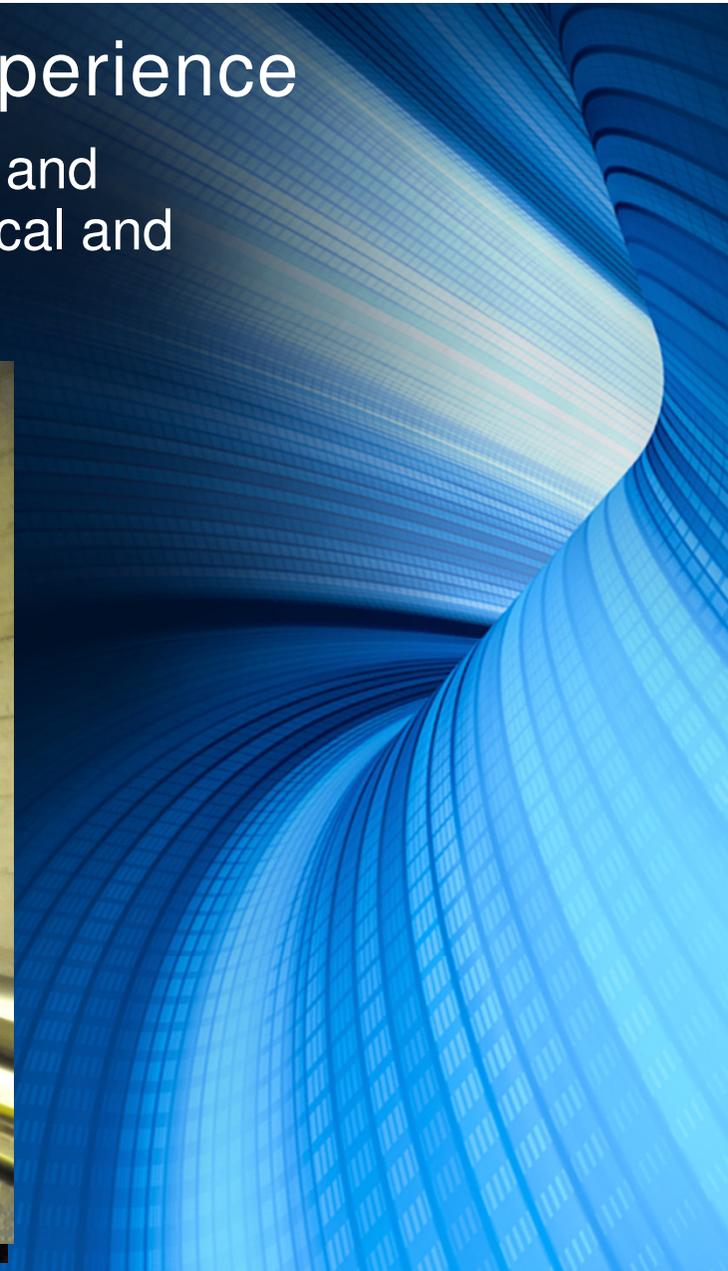
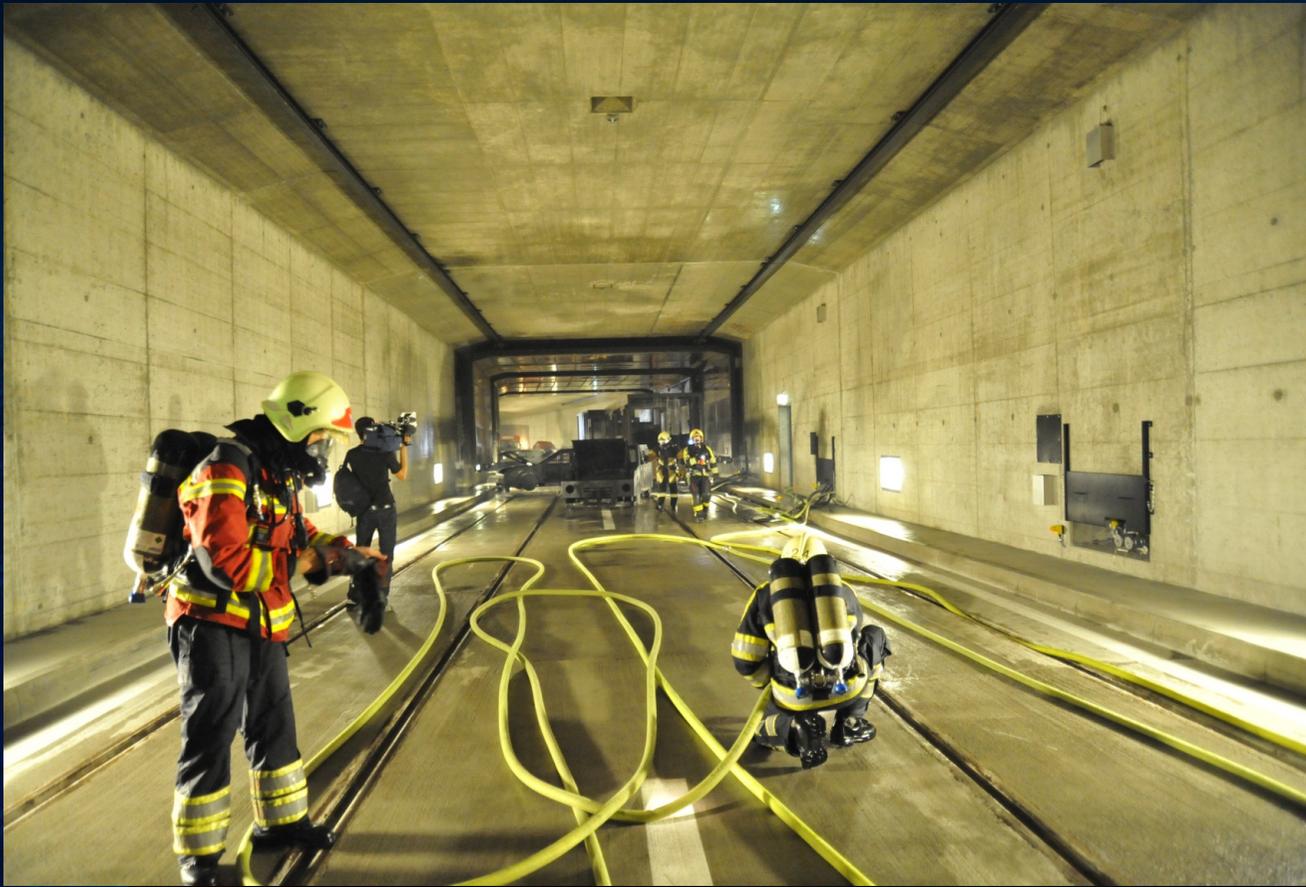
Field Exercises

- Multi agency field exercises require a higher level of commitment from all agencies, but allows for the proofing of the strategic planning and its effectiveness at the strategic and tactical level of operations



Creating a Realistic Experience

- Realism requires the use of a facility that can safely and realistically replicate the environment at a task, tactical and strategic level for the key combatant agencies



Essential Pre-incident planning info

- Normal access points
- Emergency access points
- Staging areas for emergency services
- Emergency egress/refuge
- Evacuation assembly points
- Ventilation system type and operational ability
- Fixed Fire Suppression Systems – Hydrants – booster connections
- Access to FIP, CCTV and other intelligence gathering
- Communications – WIP, radio repeaters, mobile phone cell repeaters

Initial Mission Critical Information

- Type of incident
- Exact Location
- Number of vehicles and people
- Internal conditions

- Evacuation in progress?
- What fixed installations are in operation? – Are they being effective

- BEST ACCESS (TCP initiated to support flushing of tunnel and clear access to emergency vehicles)

Response Basics – Defensive Approach

- Staged cautious response ensures the initial internal response is small
- Reconnaissance ensures additional resources are committed via the best access route and are aware of the internal conditions
- Divide incident into Zones, Cold, Warm and Hot
- Sectorise to maintain span of control
- Account for all resources on site – Human and Equipment

Issues for Fire Suppression?

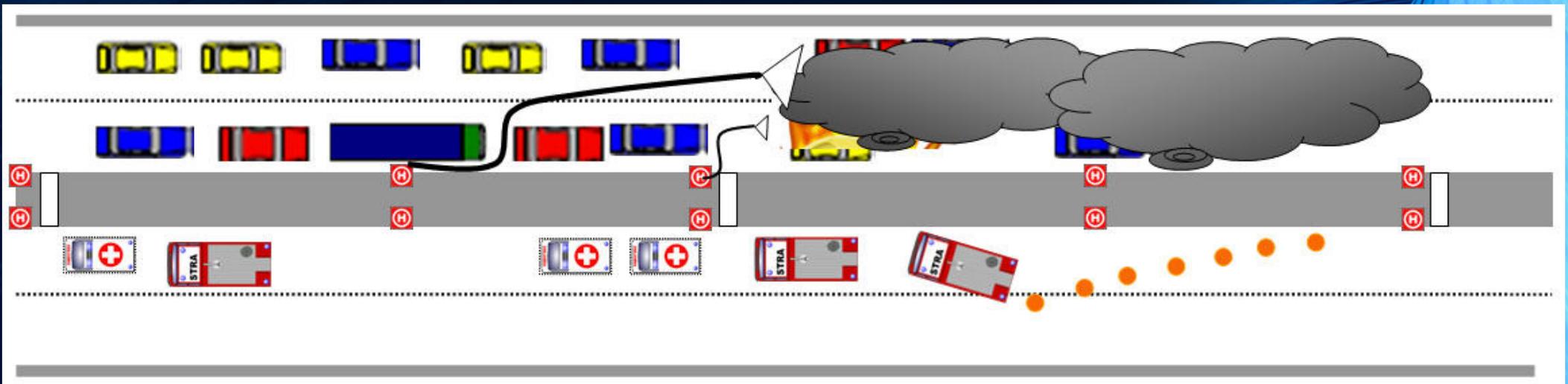
- Longitudinal ventilation draw air in through one portal and push smoke towards the other portal
- Vehicles down stream of the air flow will be subjected to heat and smoke
- Entry should never be attempted by driving into the path of smoke flow unless the ventilation system is designed to form smoke free zone – last resort!
- Danger to crews from traffic
- Inability to turn an appliance around
- The advantages of deluge are obvious!

Response Basics - Firefighting

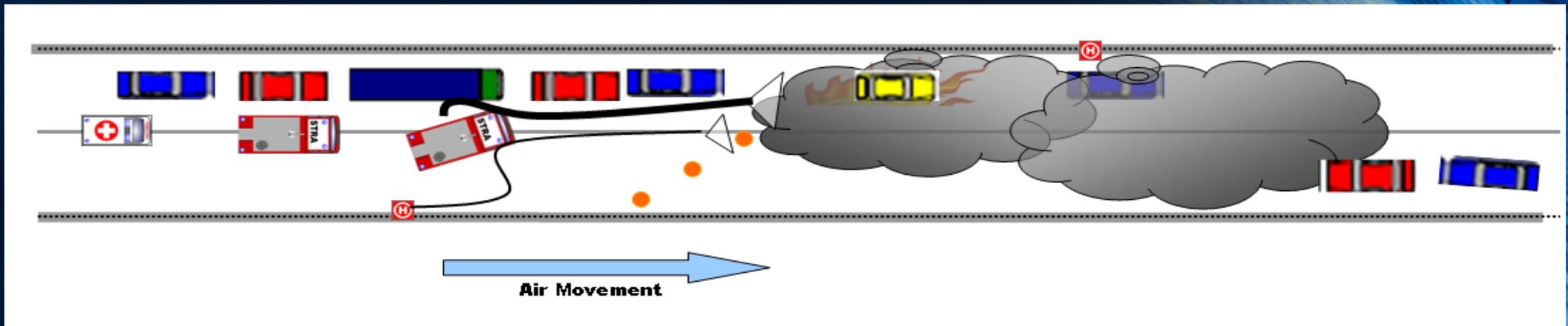
- Extended travel distances in suspect environments will require long duration SCBA (Major issue during construction)
- High heat will require frequent crew change over
- Officer with TIC used as a spotter to direct streams
- Extended hose lays require a staged approach

Response Basics

- Determine the nature, extent of the incident, and best access BEFORE making entry
- If the tunnel has a twin tube geometry access is normally via the non-incident tube to a cross passage upstream of the traffic flow



Response Basics - Single Tube



- In single tube bi-directional tunnels assess will depend on the design of the ventilation
- Extraction (transverse with addressable dampers) will assist in confining the smoke to a zone
- Deluge will help to confine fire (shielded)

Response Basics – Road Traffic Crash

- In single tube bi-directional tunnels assess will depend on the traffic conditions
- Single tube uni-directional sections are often accessed by contra-flow approach
- Best practice for twin tube is for initial response to proceed via non-incident tube in the normal direction of traffic flow
- Where ever possible, contra-flow should be avoided for the initial response
- In the case of multiple entrapments or injuries contra-flow can allow heavy equipment to be placed close to the scene and patient handling can be improved
- Hot or cold response approach

Getting it right – The “Internal” Challenges

One of the biggest challenges is overcoming **inter-agency (and in some cases intra-agency) boundaries**

Some challenges occur in the divisional or regional boundaries that are drawn between emergency services or service providers

The big picture is to ensure all parties focus on their responsibilities to the “customer”

Self interests is the natural enemy of cooperation

Conclusion

The site emergency plan must be based on an interagency risk identification approach

The plan must reflect the response strategies and capabilities of the key combatant and support agencies and should be in harmony with agency specific plans and procedures

Each agency needs to ensure familiarisation with the site and the procedures – lets not meet by accident!

Conclusion

Emergency plans must be practiced, tested and reviewed honestly (sometimes the truth hurts but the pain does not last when corrections are made)

Cooperation and Communication is more powerful than technology

Australasian Trend in Tunnel Design

- Fixed Fire Fighting Systems (FFFS) are **emerging as a standard feature** in large road tunnels
- Support rapid incident mitigation and egress
- **However, there is currently little guidance on how fire services can make the most effective use of the complex systems that are available**



What is Missing

- Specific guidance on maximising the benefits of FFFS and awareness of unique issues faced in these environment
- Firefighters and Tunnel Operators must understand the strengths and limitations of these complex systems if they are to be used to best advantage!
- This opinion is not limited to the authors
- *"For tunnels with fixed fire suppression systems, more research is necessary for the development of effective fire fighting operations. Based on the findings from the research, desirable operations should be developed and proposed."*
SP Report [3]



What could possibly go wrong?



- I would like, if I may, to take you on a strange journey.....
what could possibly go wrong?
- “Rocky Horror Picture Show”.

What are the Key Issues?



- Loss of **visibility** in the deluge zone - affecting operator CCTV and Fire Crews
- **Audibility** issues from high ambient noise from from deluge, ventilation, and evac messages that all combine to hinder all forms of communication
- **Water saturation and volume** affecting firefighting PPE, their ancillary equipment, and creating water run off containment issues

Imagine these conditions....



- Visibility is limited to **less than 1 metre**
- Water quickly penetrates your PPE and the **weight increases** from around 10 to 15 kg
- Water runs down your visor further obscuring your vision
- Your ability to hear or talk is severely hindered
- You are **immersed** in the sound of the deluge, the roar of the ventilation system and, the repetitive drone of the evacuation message echo's down the tube continually
- Even person to person communications is extremely difficult

Dix Report - Burnley

In a tunnel emergency, it is likely that the audio environment will be extremely compromised by the noise of the emergency ventilation system. Therefore, the use of two-way radios which rely upon the user hearing an audible signal to establish whether a channel is or is not available for emergency communications may not be appropriate.

PIARC has recognised the potential noise impact of jet fans during an emergency. They note:

“Jet fans operating in a tunnel can generate high noise levels, and can have adverse effects on speech transmission between people in the tunnel. This may become a safety issue when the noise level prevents the tunnel users from understanding what they were asked to do or when it makes it difficult for the firemen to communicate with each other ...”¹⁰

Burnley Tunnel Incident – 23 March 2007,
78:174, Arnold Dix

TCC has similar issues

- Once deluge has operated, **CCTV vision is lost** in the zone
- Massive volumes of water are **filling the sumps**
- Reluctance to shut down zones until firefighters on the scene give the order
- Fire Service reluctant to order shut down until it is communicated that **hand lines are in place and the fire is “controllable”** with these lines
- “Noise cancelling” helps cut out the background for communication **from the tube WIP to the TCC**, but.....
- Firefighters don't have **noise cancelling ears**, therefore, they are not able to benefit from noise cancelling technology when listening to the reply from the TCC or any other communication!
So 2 way communication is extremely difficult

Solutions

- **Awareness** of all stakeholders on the unique issues faced in each tunnel complex. Manage the limitations and use the **SIGNIFICANT** advantages to maximum advantage
- **Joint Planning** – Lets not meet by accident!
- **Joint Preparation** – Tabletop (Strategic), Field (Tactical/Task)
- **On-going Communication** – build rapport and mutual respect

The Alternative May Look Like This

Just Add...

- Extreme heat

Fire Fighting Operations in Modern Road Tunnels An Australasian Perspective



*“ We make a living
by what we get,
but we make a life
by what we give. ”*

Sir Winston Churchill

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Thank you!

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