

FIRE PROTECTION

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Stakeholders develop fire scenarios for tunnel

By Rob Bartlett

The design fire size for a road tunnel has far-reaching implications on the design and costs of the tunnel structure and fire and life safety systems. A risk review process, as used on the Tugun Bypass on the Gold Coast,

has significant benefits in obtaining a minimum cost fire and life safety solution which meets the broad requirements of the project stakeholders.

The maximum tunnel design fire size has traditionally been quantified in the

design criteria (typically 50MW), based on urban location, speed limited to 80km/h and exclusion of dangerous goods. An alternative approach was necessary to address the Tugun Bypass design criteria.

The project involved the design and construction of 7km of new motorway and a 340m long tunnel. These developments were intended to improve interstate travel through the Gold Coast, and to relieve the impact of traffic congestion on the local roads at Tugun. The project was designed and constructed under the PacificLink Alliance between Queensland Main Roads, SMEC and Abigroup. As a sub-consultant to SMEC, Norman Disney & Young was responsible for the design of the tunnel and motorway services. The project opened to the public six months ahead of the contract schedule in 2008, while maintaining total costs below the original budget.

The original project brief prescribed a maximum 100MW design fire. This was subsequently amended to make determination of the design fire size a responsibility of the Alliance team.

Identification of the full range of possible fire risks and threats – from initiation to the unmanageable, and review of the consequences – required a process that clearly demonstrated an exercise of duty of care to both stakeholders and public.

A Risk Review Workshop Process was decided, initiated in conjunction with Risk & Reliability Consultants (R2A). Over 20 stakeholder groups were involved, so a range of separate briefing sessions was held with each of the individual stakeholder groups. These included:

- design and construction team members
- local councils
- road authorities
- airport authorities



The Tugun Bypass Tunnel constructed under the extension of the main runway of the Gold Coast Airport.

The lead story details the design and development of fire safety scenarios for the Gold Coast's Tugun Bypass tunnel. Other stories cover fire safety innovation in a building in Melbourne's Docklands, a new award-winning fire extinguishing system, the upcoming 2011 Fire Safety Engineering conference and some of the year's other fire safety events.

- fire brigades, including local commands
- environmental departments
- dangerous goods departments.

A preliminary fire scenario and impact review matrix (or vulnerability matrix) was prepared for stakeholders which listed, on separate axes, foreseeable fire threats and entities which could be impacted by those threats. An assessment of consequences for each scenario followed, graded from "no impact" to "multiple fatalities", inclusive of the impact of potential dangerous goods fires, and the effect of the deluge system on dangerous goods which may react with water.

The probability of each fire scenario was assessed (whether credible or not), and whether systems or procedures could be put in place to mitigate the risks. For example, it was agreed that design to accommodate an aircraft misjudging the runway, colliding with the tunnel and bursting into flames was unwarranted, as the likelihood of such was extremely low.

A workshop with external stakeholders tested the credible fire scenarios and proposed precautions, and explored whether any other credible fire scenarios should be considered. A systematic review by stakeholders, and preparation of profiling sheets, recorded the group's comments on the severity of each threat, and the expected precautions or controls.

The outcomes from the workshop were used in the development of incident management plans and safety integrity levels (SIL), looking at:

- probability of occurrence
- in-site control barriers to identify or avert hazards, such as normal traffic management, CCTV and early public hazard advice
- potential sequence of events in terms of decision making, response, and fire or control system activation times.

The combined effect of these items established that the required levels of system reliability were met with only the tunnel control and monitoring system SIL rated.

The preliminary risk evaluation process established 35 tunnel fire threat scenarios.



Smoke testing in the Tugun Bypass Tunnel, March 2008.

Following the stakeholder consultation process this was reduced to 13 credible fire scenarios. Similarities within these scenarios permitted a detailed fire engineering analysis of seven. Four controlled tunnel fire scenarios were analysed – when the deluge system was activated – yielding predicted fire heat release rates in the order of 7MW. Three maximum test cases analysed the effect of a heavy goods vehicle entering the tunnel with a fully developed non-dangerous goods fire on board. These test cases yielded the maximum predicted fire size of 100MW.

Other outcomes of the risk review process identified:

- early activation of the deluge system (even if the vehicle contains dangerous goods) minimised the likelihood of the fire penetrating the packaging and exposing the dangerous goods load
- flammable liquid fuel fires are limited by the pool size – dependent on the amount of fuel, the slope of the road and the capacity of the drainage system

- high quality traffic management systems and incident management plans are vital to the prevention, detection and management of incidents, and minimisation of consequences.

While large infrastructure projects have the potential for extreme consequences resulting from fire and life safety risks, the probability of such outcomes remains low. A risk review process harnesses the collective experience of the design and construction team, government, emergency services, and environmental and specialist risk personnel.

With an agreement on credible fire scenarios, the fire engineering analysis and design of fire and life safety and control systems can be tailored to the unique circumstances of a project. The result is cost-effective solutions at the desired level of safety and reliability acceptable to all stakeholders. ■

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