

*The tunnel portal just before completion.*

## Sydney Harbour Tunnel Fire System

Hazel Baker reports on a fire suppression system designed by ACADS' Hyena software for the Sydney Harbour Tunnel.

The Hyena hydraulic analysis computer program, which is licensed and maintained by the ACADS Building Services Group, ranks highly amongst building services design professionals for its comprehensiveness and ease of use. One of its largest and most unusual recent applications was in the design of the sprinkler system for the Sydney Harbour Tunnel.

The Sydney Harbour Tunnel is 2260 metres long, one of the longest in the world. Since it carries many tens of thousands of motor vehicles every day, an accident, with attendant smoke and fire and injury, is a distinct probability. Firefighting in this enclosed space represents a formidable challenge.

During the design process there was very close co-operation between all the parties to the construction, notably tunnel builder Transfield Kumagai, the NSW Roads and Traffic Authority, the NSW Fire Brigade, and Eagle Consulting Group, the company which designed the fire system.

Between them they agreed on the installation of six systems:

- under-road vehicle detectors to monitor incidents;
- closed circuit television;
- thermal fire detection systems above each carriageway;
- manually operated deluge systems, which are designed to swamp a fire, covering designated zones of each carriageway; and
- hydrants and hose reels, and a control centre with computer facilities to help select the best deluge zones for a particular fire. This was in addition to audio and visual warnings and instructions to motorists.

The brief to Eagle Consulting Group was to design a fire detection and suppression system. Both the system design and the equipment chosen had to guarantee sufficiently superior performance to meet the unique conditions of a fire occurrence in a traffic tunnel environment. As a project, the tunnel was unique because of its length, location and the projected traffic volume. According to Rick Foster, the fire consultant who did the design, the most difficult and critical aspect of designing a fire detection and suppression system was the effect of the ventilation on the fire plume and hot gases released from the fire.

***"...an accident, with attendant smoke and fire and injury, is a distinct probability..."***

The ventilation station in the Sydney Harbour Tunnel is approximately half way along its length. As a result the ventilation effect is very complex and not uniform throughout the tunnel.

This could become even more complicated in the event of a moving fire, such as an errant truck. Road tankers and vehicles carrying hazardous materials are not allowed to travel through the tunnel but plans had to take that possibility into account.

"In developing these alternatives, one of the areas that I paid particular attention to was water supplies and the performance of the system," said Rick Foster.

"This meant we had to make the best use of the water

without putting pumps in. We used Hyena to do alternative designs for the length of each of the deluge zones.

"If you vary the length of the deluge zone you vary the water requirements. What you want to end up with is a balance that will make best use of the available water with the economy of having zones of appropriate length."

He used Hyena initially for some hydraulic analyses of various options to see which would make best use of the available water supplies.

***"...road tankers and vehicles carrying hazardous materials are not allowed to travel through the tunnel but plans had to take the possibility into account..."***

"We came up with several major alternatives which then had to be costed. We also looked at some of the types of materials to be used such as piping and how it would be joined, and fed those numbers into the equation."

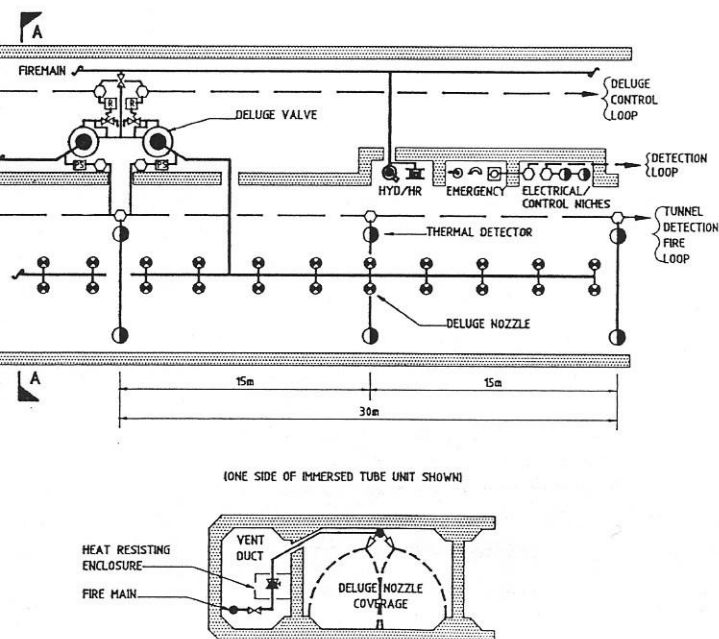
The designs Foster's team came up with not only met the design criteria but also represented considerable cost savings on the initial designs.

"We also did some computer modelling of the detectors, bearing in mind that our role was to provide means to detect and control fires, not necessarily to extinguish them. That's the role of the Fire Brigade."

They were then asked to prepare Phase 2 of the project which was to carry out a more detailed design so that the project could be tendered on, including guaranteed performance flows and pressures along the tunnel for the deluge systems — all 156 of them, placed every 30 metres along the tunnel.

"We had to do extensive calculations," said Rick Foster.

GEC Alstrom was the services contractor which then subcontracted the specific fire work to Wormald Fire Systems.



Typical detection zone.

As Hyena was used on all the calculations Rick Foster could give an unqualified approval to it for this major job.

Rick Foster ran his Hyena program Version 2.7 on an Amstrad PC512. This is a basic and somewhat elderly machine so it demonstrates that the structure of Hyena is such that even simple computers can cope with very large calculations. The tunnel is 2.5 km long and some of the calculations ran to 20 to 30 pages of printout.

"It enabled us to determine hundreds of hydraulic areas very quickly, and allowed us to do a detailed analysis on a pipe-by-pipe basis on flow and pressure in any particular section," he said, adding that this was on a total of 7.5 km of fire mains.

"It also enabled us to use the reference point system within the program and run the basic program just by activating different reference points for different areas.

"Hyena is a very simple, useful tool. The way it's structured it always makes multiple tasks very easy to perform, and easy to analyse the output."

In Phase 3, Eagle was appointed by Transfield Kumagai to carry out the details of the fire mains.

"We were also asked to do a hydraulic analysis of the rising mains system to discharge the water out of the tunnel," said Foster. "Again, the Hyena program proved to be a most appropriate tool."

*Eagle Consulting Group is currently involved in the upgrade of the fire systems for the Sydney Opera House, part of the total \$64million upgrade. At the time of the interview they had completed about 90 per cent of the documentation for it.*

### Hyena Computer Program

The Hyena computer program yields an hydraulic analysis of fire sprinkler and/or hydrant systems. It is an adaptation of a program developed by Compyro Consultants Ltd and the University of British Columbia in Canada to suit design practice in Australia and New Zealand.

The program may be used to analyse automatic fire sprinkler systems with a simple end-, side- or centre-fed configuration or more complicated looped and gridded systems.

It may also be used to analyse fire hydrant and hose reel installations or combined sprinkler, hydrant and/or hose reel systems.

With a given-sized network, the program performs a complete hydraulic analysis determining the water flow in and pressure drop through each pipe in the entered network, taking account of all fittings entered by the user.

Hyena may be licensed through ACADS for installation on a mainframe or microcomputer. Alternatively, organisations which are members of ACADS may access the program on any of the bureaux where ACADS has the program mounted and supported.

For more information about Hyena and other ACADS software programmes, contact the Building Services Group, ACADS, 16 High Street, Glen Iris, Vic 3146. Tel (03) 885 6586; fax (03) 885 5974.