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International Research Project on Fire-Detection Technologies in Tunnels

Zhigang Liu and Ahmed Kashef
Fire Research Program, Institute for Research in Construction
National Research Council of Canada, Ottawa, Canada, K1A 0R6,
Kathleen H. Almand
The Fire Protection Research Foundation, Quincy, MA, USA 02169

Today's increase in road traffic, changes in vehicle mix, and new rolling stock have resulted in an increase in the incidence of fatal fires in tunnels. Recent catastrophic tunnel fires (e.g., the Mont Blanc tunnel, 1999, the Austrian Kaprun funicular tunnel, 2000, and the Swiss St. Gotthard tunnel, 2001) have not only resulted in loss of life and severe property damage, but also left the public with a lack of confidence in using such systems.

The tunnel environment is challenging for conventional fire protection systems and new approaches are becoming an imperative. For example, reliable and early fire detection in tunnels can provide the tunnel operator with an early warning of a fire incident and its location, allowing for timely activation of emergency systems such as the emergency ventilation system (Figure 1). Detection can make the difference between a manageable fire and one that gets out-of-control. Although there has been a lot of tunnel fire research done in Europe and some domestically, there's been very little done on the performance of detection systems.

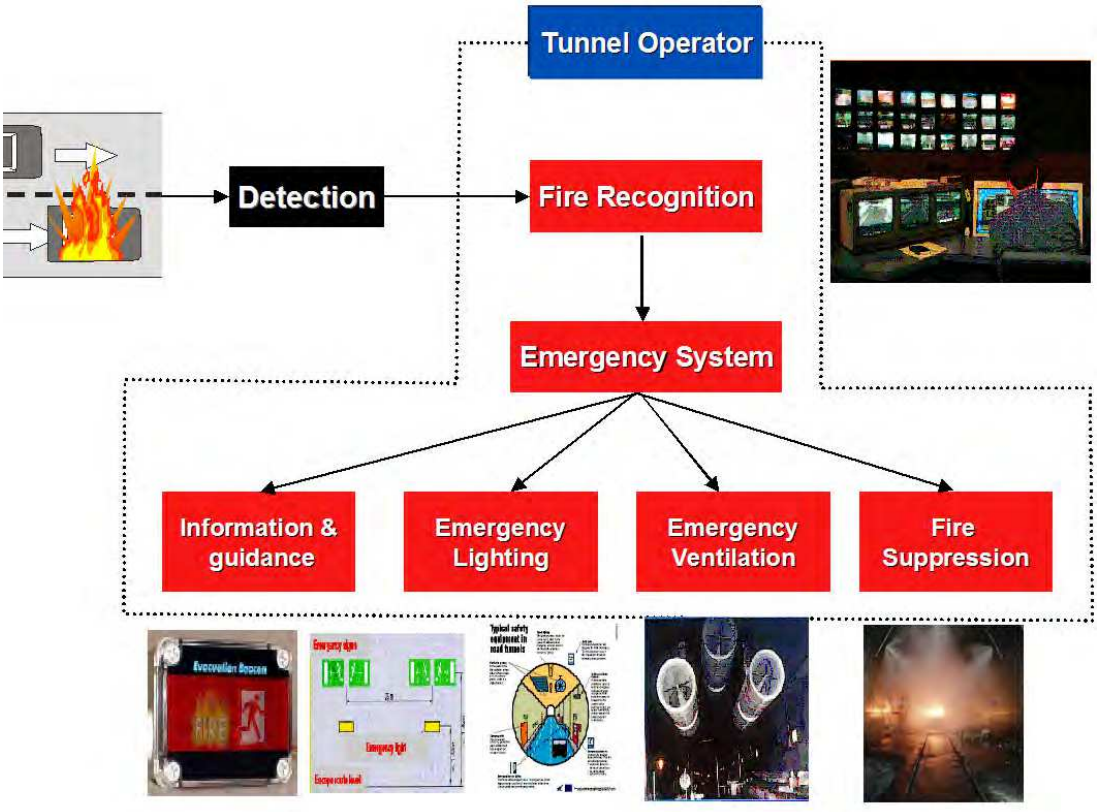

Figure 1. Role of detection in the fire protection of tunnel

The Fire Protection Research Foundation (FPRF) of the United States and the National Research Council (NRC) of Canada have joined in a two-year international research project to investigate currently available fire-detection technologies suitable for tunnel applications. The main idea of the study was to look at some of the strengths and weaknesses of the various types of detection systems and what can affect their performance in tunnel environments. The results of the study will provide information for use in the development of performance criteria, guidelines and specifications for tunnel fire-detection systems and will be used to update NFPA 502, Standard for Road Tunnels, Bridges, and Other Limited Access Highways. The results will also help optimize technical specifications and installation requirements of fire detection systems for tunnel applications. Although this research is being conducted on road tunnels, the findings should apply to other tunnels as well, such as subway systems.

NRC has conducted fire tests in a new Carleton University-NRC laboratory tunnel facility (about 10 m wide, 37.5 m long and 5.5 m high) to evaluate the performance of nine fire detection systems (Figure 2). These systems covered five different types of existing fire-detection technologies and included both traditional and newer options, such as fibre-optic temperature sensing and closed circuit television imaging systems (CCTV) detectors. Computational fluid dynamics simulations were also conducted in collaboration with Carleton University to investigate the impact of various tunnel fire scenarios on the performance of fire-detection systems. These scenarios included typical tunnel fire incidents, changes in tunnel ventilation conditions, and different tunnel geometries. On a larger scale, NRC conducted full-scale fire tests in an operating road tunnel in Montreal in collaboration with the Ministry of Transportation of Quebec (Figure 3). These tests were used to investigate the performance of fire detection systems in an operating tunnel environment.

Figure 2. Fire tests in a laboratory tunnel

Figure 3. Fire tests in a Montreal operating tunnel

In an effort to extend the investigation to study the performance of these detection systems in the harsh tunnel environment, a one-year investigation into the performance of fire-detection systems in the Lincoln tunnel in New York City is being conducted with the support of the Port Authority of New York and New Jersey and overseen by Hughes Associates. The

primary objective is to investigate the false alarm potential for the detection systems in a tunnel environment. In addition, a series of demonstration fire tests were also conducted and the performance of fire detection systems documented (Figure 4).

Figure 4. Fire tests in Lincoln Tunnel (photo provided by Hughes Associates)

There are 26 partners involved in the project, including research organizations and universities from Canada, the U.S. and Switzerland; the Quebec, Ontario and British Columbia ministries of transportation; the Port Authority of New York and New Jersey; manufacturers of fire-detection systems, as well as several international consulting firms, standards writing agencies and fire departments. The results of the project will be available in mid-2008.