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Reputation Resources Results

TECHNOTES

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TRANSIT STATION FIRES

PART 1 – PROBLEM OF SEPARATION OF EXHAUSTS AND INTAKES

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Smoke exhaust can be drawn back into a station causing severe hazards for people exiting and emergency services personnel.

Fire in a tunnel or transit station can lead to the rapid spreading of hot toxic smoke within minutes. The primary goals are to evacuate people safely and to provide acceptable conditions for emergency services personnel.

Many transit systems have emergency ventilation systems to assist with these goals. Exhaust fans are meant to remove smoke and also draw fresh air into the station. The design of these systems is intended to keep exit pathways relatively clear of smoke.

More than 100 killed in Taegu South Korea, February 18, 2003

Often, the design has smoke exhausted to the atmosphere at grade-level vents or elevated discharges through sidewall vents. Make-up air is drawn down into the station through pedestrian entranceways, emergency exits and mechanical intakes.

Design performance of these emergency ventilation systems assumes that the make-up air will be fresh and clean; however, the smoke exhaust locations are often located too close to make-up air locations. Therefore, there can be a relatively high risk of re-entrainment of dense smoke back into the station and exit pathways, obstructing exits and delaying emergency response measures. Even at street level, dense smoke can cause visibility problems for emergency services personnel.

The above reinforces the considerable importance in understanding the impact of emergency ventilation systems on emergency response measures and, where possible, having adequate separation of exhaust and make-up air locations.

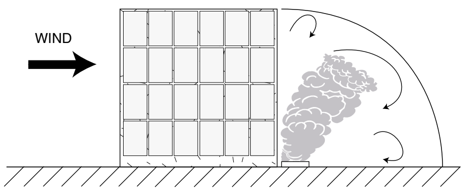
Key Design Factors

There are different design issues associated with ground level and roof level intakes, which are dependent on the types of exhaust sources present at a particular site. Parameters critical in understanding the potential impact of emergency ventilation systems on emergency response measures include:

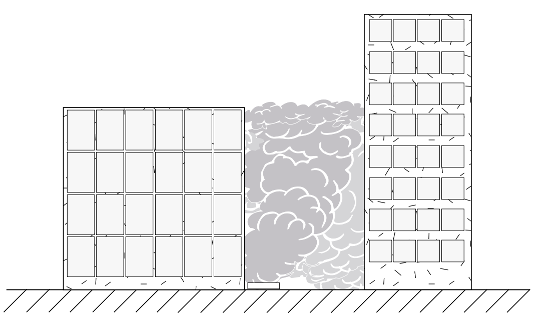
- Separation distance and line of sight between identified exhaust sources and intake receptors
- Complexity of the wind fields at the site
- Effects of obstructions and other complexities in the physical environment
- Severity of concern for re-entrainment (i.e., the possible consequences of various levels of impact on receptors)
- Current emergency response measures and timing of response, and in particular their reliance on adequate performance of the emergency ventilation system

Complex Wind Flows Around Buildings

Potentially problematic dispersion can occur from a ground-level release scenario. As shown in the figures, the smoke exhausted from the emergency ventilation system may be trapped against a building where the plume can be caught in a cavity-wake flow pattern. This limits dilution with separation distance within the cavity. In this case, drawing make-up air from the upwind side of the same building, from roof level, or from well-ventilated locations in the area should be considered.



Smoke trapped in a cavity-wake flow pattern



Smoke trapped in an urban street canyon or valley
(many wind directions)

HISTORY OF SUBWAY / TUNNEL FIRES

The issue of fire in tunnels and subway stations is not a new problem. There have been several underground fires in the past decades all over the world. These historical events illustrate the prevalence of the issue, and the importance of an effective emergency ventilation system.

Some of the past tunnel / subway fires include:

November, 1982	Afghanistan	Tanker explosion, Salang Tunnel (>150 killed)
November, 1987	London, U.K.	Escalator fire, King's Cross Subway Station (30 killed, including 1 firefighter)
December, 1990	New York, NY, U.S.A.	Electrical fire, tunnel near Clark St., Brooklyn (2 killed)
July, 1995	Toronto Canada	Fire, Sheppard Avenue Subway Station
March, 1999	France / Italy	Truck fire, Mont Blanc Tunnel (39 killed)
July, 2001	Baltimore, Maryland, U.S.A.	Train Fire, Howard Street Train Tunnel
October, 2001	Switzerland	Vehicle fire, Gotthard Alpine Tunnel (11 killed)
February, 2003	Taegu, South Korea	Train fire (arson), Chungang-ro Subway Station (>100 killed, >100 injured)

Designing Effective Solutions

Where possible, the design of exhausts and intakes for emergency ventilation systems in tunnels and stations should be optimized to minimize potential re-entrainment of smoke during a fire.

Experience with urban wind flows and numerical modeling can be effective at identifying problems and solutions. Physical scale modeling with tracer gas testing in a wind tunnel is the most accurate and cost effective means of simulation to quantify the success of recommended solutions.

For ground-level intakes, smoke exhaust from stations should be high on a building, ideally at roof level. For ground-level exhausts, the building itself should be used to protect ground-level intakes, where possible. In other instances, significant separation distances may be required.

If protection of intakes is not possible, then it may be necessary to use model results to identify reduced dilution areas in order to revise existing emergency response plans.

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