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Comfort and safety in the Millennium Dome

by Nigel Hiorns, Buro Happold, Leeds, UK, Yehuda Sinai and Mark Owens, AEA Technology

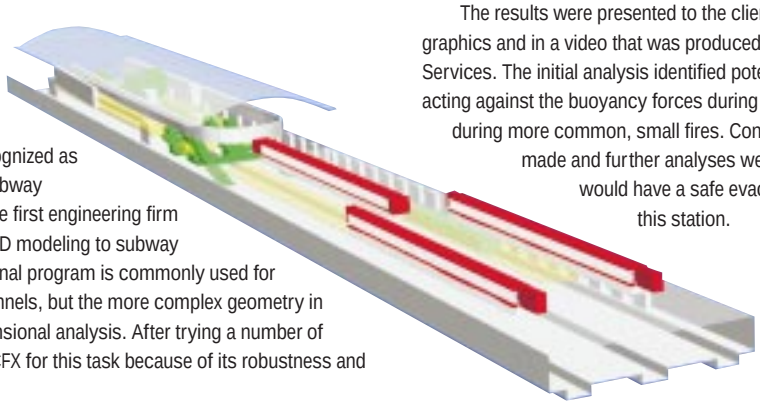
ANALYSIS OF SUBWAY FIRE VENTILATION

by Dan McKinney, ICF Kaiser Engineers, California, USA

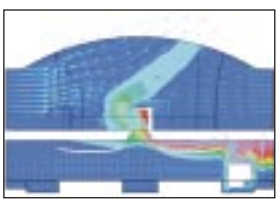
ICF Kaiser Engineers, Inc. is an engineering firm with a long history in the transportation industry. Recognized as an innovator in the field of subway ventilation, ICF Kaiser was the first engineering firm in North America to apply CFD modeling to subway station fires. A one-dimensional program is commonly used for modeling fire scenarios in tunnels, but the more complex geometry in stations requires three-dimensional analysis. After trying a number of products, ICF Kaiser chose CFX for this task because of its robustness and flexibility.

Recently, ICF Kaiser used CFX to perform a transient simulation of a rapid-transit train fire in the new station at the San Francisco International Airport. This is an elevated, but almost fully enclosed, facility. Buoyancy-driven natural ventilation was designed as the primary means of smoke removal for one half of the station area. Since this is a non-standard approach for transit stations, careful analysis was required. The CFX model simulated the multiple levels of the station and included details such as columns, stairs, escalators, ventilators and dividing walls. An initial steady-state run established the starting conditions, particularly the wind, for the transient study. A fire was then simulated by adding sources of heat and smoke. The fire was developed gradually over the simulation period and the distribution of heat and smoke at different intensities was used to evaluate the effectiveness of the smoke removal.

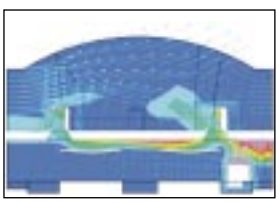
The results were presented to the client both in a report with extensive graphics and in a video that was produced by AEA Technology Visualization Services. The initial analysis identified potential problems caused by wind acting against the buoyancy forces during the early stages of fire growth or during more common, small fires. Consequently, design changes were made and further analyses were conducted to ensure patrons would have a safe evacuation route in case of a fire in this station.



Model of the station showing the trainways and column wall in the lower level, the monitors (ventilators) on the roof at one end (red) and the stairs to a separate airport light rail station on the other end. The canopy and walls of the light rail station on the upper level are also shown.



A section through the fire zone showing smoke distribution and velocity vectors from a large train fire. The smoke collects in the upper levels and flows out of the vents after enough heat reaches the vent to overcome the wind resistance. The outdoor wind was modeled as blowing into the vents as a worst case.



A section showing smoke distribution and velocity vectors through a different region of the fire. Smoke stays above the suspended ceilings, but spreads completely across the station.