Hot issues in Fire Engineering

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Static Smoke Exhaust in Big Halls with High Occupancy

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Static smoke exhaust systems with natural vents are starting to be commonly installed in large halls of tall height in the Far East. Natural venting system is sometimes more preferred because it would not take up spaces for housing the fans and ducts of the mechanical exhaust system. It gives better interior view and the associated cost might be lower. Most of them are horizontal ceiling vents installed at the roof. Some of such systems were put in cargo terminals with low occupant loading.

The driving forces for natural ventilation [1] are stack effect due to temperature differences between indoor and outdoor; wind-induced action; and buoyancy of smoke. In areas with low temperature difference between indoor and outdoor, stack effect is only significant in tall lift shafts or staircases [2]. Wind-induced air flow is a transient phenomenon depending on the ambient conditions. Buoyancy of the hot smoke layer is strong for a big fire. Therefore, natural vent design was based on removing smoke by taking buoyancy as the driving force.

Depending on the geometry of the environment of the hall, ambient wind might induce positive or negative pressure differentials at the windward and leeward sides [3]. The ceiling vent might become an air intake point rather than an extract point [4-7]. The instanteous vent pressure relative to pressure distribution inside the hall is a key point. Under extreme conditions, air downward wind pressure above the vent might be greater than the upward pressure induced by buoyancy. Therefore, pressure distribution must be calculated carefully while designing static smoke exhaust systems in large halls with high occupancy.

Static smoke exhaust system should be designed carefully in underground subway stations adjacent to shopping areas. This is because the occupancy loading is very high in most of the operation time. If the service of the subway system is suspended, say due to signal failure as experineced many times, the station will be fully crowded with passengers. Further, air flow would be induced by big fires in the hall. This might even give ‘fire wind’ depending on the fire load density and how the combustibles are burnt. Air pressure distribution would

be affected by location of air intake and operation of fire suppression system. Note that air movement would also be induced while operating the sprinkler system. Fire hazard should be reviewed thoroughly while using static smoke exhaust systems in very deep undergroud subway stations which are always fully crowded with passengers. This is very different from cargo terminals [8] with low occupancy.

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