A legacy to learn from

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1993 sees the 40th anniversary of a fire at the General Motors Automatic Gearbox Plant at Livonia, Michigan. *Charles Green examines the legacy of Livonia.

Above: one of Colt's smoke ventilators is put through its paces

The shockwaves caused by the destruction by fire of General Motors' automatic gearbox plant at Livonia, Michigan on August 12th 1953 were profound. By common consensus, such a fire in such a building was impossible. Not only was the steel structure of the building non-combustible, but it also housed largely non-combustible materials used in the manufacture of a non-combustible product. But the inconceivable did happen and the total losses from the fire were estimated at $28 million.

The legacy of Livonia has been equally influential. The incident demonstrated, perhaps for the first time, the extent of the risk to large, undivided, flat roofed industrial buildings from the rapid spread of smoke and hot gases. The recommendations made in its aftermath have set the tone for smoke ventilation ever since.

At Livonia, the generation of smoke and hot gas had been so fast that the resultant concentration of heat had not only exacerbated the fire damage through actual combustion but also by overheating the structural framework of the building. In so doing, it had exploded the theory that buildings constructed from non-combustible materials were inherently safer and had shown that where inadequate fire protection methods exist, fume, smoke and burning contents can make a building untenable in a matter of minutes.

Emergency ventilation

In the light of Livonia, General Motors initiated a research programme in association with the Armour Research Foundation's Heat Power Research Laboratory to determine the fundamentals on which suitable standards of emergency ventilation could in future be based. The research examined optimum sizes and locations for roof ventilators in industrial buildings and studied the impact of other factors on the venting characteristics. Consideration was also given to the effect of water sprinkler systems when used in conjunction with roof ventilation, negative internal pressures caused by powered ventilation and the influence of outside winds.

The investigation concluded that the fire at Livonia had produced large volumes of hot gas at the ceiling, the heat from which had caused fatal damage to the structure of the building. The pattern of the Livonia fire suggested that a system of emergency ventilation at roof level to rapidly exhaust at least a proportion of the accumulated hot gas would slow down the spread of the fire, make its containment easier and help preserve the structure of the building. It was also felt that such a ventilation system would offer added protection to the relatively large floor areas required for efficient, large scale manufacturing operations.

The research was conducted using a scale model of an industrial building with fire and smoke generating equipment. It resulted in the recommendation that emergency roof ventilation for effective smoke and heat release should be provided in all new and existing buildings through the combined use of roof ventilators or monitors and draft curtains; that gravity-type roof ventilation should provide minimum vent to floor area ratios of 1:150 in areas of minor hazard, 1:100 in areas of normal hazard and 1:30 in areas of special hazard and that roof monitors for ventilation should be provided in all new buildings, spaced according to whether the area beneath was one of minor, normal or special hazard.

On the basis of this report, Colt sponsored further research work at the Fire Research Station which resulted in the publication of Fire Research Technical Papers No.7 and No.10. The findings from the reports have formed the basis of smoke ventilation in single storey industrial and warehouse buildings. Colt has continued to carry out collaborative research with the FRS and this has resulted in design guidance for smoke control in shopping malls and atria.

The most important aspect of any smoke control system is to ensure that the occupants can evacuate the building and reach safety. The next most important consideration is to save the building, its contents and the surrounding properties. If smoke from the fire is not adequately ventilated, it will quickly build down to ground level. The resultant poor visibility would complicate possible escape from the building and hamper effective fire fighting.

As a result, smoke ventilation systems are engineered so that smoke from a fire is held at high level in predesignated resevoirs, restricting its spread to the rest of the building while the occupants can escape from beneath the smoke layer with relative ease. This will also provide clearer visibility at floor level enabling fire fighters to do their job in less punishing conditions and removing the risk to them from the type of roof collapse or explosion common in unvented buildings. Today, smoke from a fire is vented out from the roof reservoir by an extract system with replacement air provided by vents in the unaffected resevoirs or from low level inlets.

Secondary fires

A properly designed ventilation system can also keep the temperature of the smoke below 200°C, reducing the prospect of secondary fires from radiant heat. This minimises the risk of a Livonia-style structural collapse.

The importance of Livonia in an historical context cannot be denied. Although the types of building have become more complex and the technology more advanced, it was the fire at Livonia which led to the opening of a market in active smoke ventilation and whose legacy remains the basis of all active smoke control.

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