Smoke Management : Its time is overdue

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A smoke management system can be defined as follows : "An engineered system that includes all methods that can be used singly or in combination to modify smoke movement, such as barriers, pressurisation and smoke exhaust systems."

India's teeming cities with their narrow lanes, densely populated areas, haphazard electrical wiring, cooking gas cylinders in kitchens, hazardous material dumps and virtually no fire-safety precautions, are virtually like tinder boxes, waiting to explode.

Fire can be caused by many means, any time and anywhere. An iginition due to a short circuit, unburnt cigarettes, leaking cooking gas and flamable liquids can cause fire which can snuff out many innocent lives. Fire requires only three components – fire load, oxygen and heat to occur hence the possibilities of a fire disaster are lurking everywhere.

One of the major causes of fire spread in an air conditioned building is the air distribution ductwork which, in simple terms is akin to a super highway that passes through all areas and compartments of a building, its function being to allow the flow of ventilation air to the entire building. Unfortunately in the event of a fire in any part of the building the same ductwork can become a super highway for the rapid spread of fire and smoke. This same duct (when used as a fire exhaust duct) can also be used to extract smoke from the fire area to provide sufficient time to allow occupants to escape and the fire service personnel to enter the building. As is well known it is almost certainly the smoke and the heat that kills people rather than the actual fire. Thus, air distribution ductwork can provide that vital margin of safety between life and death in case of a fire.

It is the management of the smoke which can, if not handled correctly, become the very provider of transmitting the fire from one compartment to another! Under certain conditions flashover may well occur and, given sufficient duration of the fire, the heat generation within the duct can itself heat up the next compartment through which it is passing until the temperature near the duct reaches a level sufficient to ignite nearby combustibles and thus spread the fire from the duct to the compartment.

The extraordinary thing is that as much as 90% of this ducting has been installed to provide the three principle criteria of fire protection i.e. stability, integrity and insulation around the world which contrasts

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noticeably with the majority of installations in the Asia Pacific region which are only required to provide stability and integrity.

It is this element of fire safety which is addressed by the addition of the third discipline of insulation i.e. that the temperature within the duct must not be allowed to transgress the walls of the duct and so create the danger of excessive radiation from heat build up outside of the duct.

The insulation criterion will also provide a very important fire safety element to individuals escaping through smoke darkened areas, or indeed the fire services personnel who have to enter a fire racked building, both of whom are capable of coming into contact with the ductwork. Without the insulation criterion the ducts would have a surface heat level that is more than capable of causing severe burns to hands, arms and face.

Smoke detectors, containment area, passive fire protection and automatic fire sprinklers - taken in concert, this quartet of construction features is responsible for an improving record of life and property protection in commercial buildings that have been constructed throughout the world over the past several decades. Unfortunately, some participants in building code development and enforcement processes attribute this safety record to sprinklers alone - an invalid and dangerous assumption.

Sprinklers alone - without limitations on containment size, without tested and inspected passive fire protection, and without smoke detection - cannot deliver equivalent results. It is crucial that the new building codes reflect a clear understanding of the systems nature of effective fire protection if we are to avoid sanctioning the construction of buildings that are code- compliant but unsafe for life and property.

According to "*America Burning Revisited*," published by NFPA, the United States along with Canada still has the worst fire death rate of all the industrialized countries for which we have comparable data. The US fire deaths per million of population is almost twice the average fire death rates for other industrialized countries.

Smoke kills approximately 75 percent of the fire victims across the world. These deaths occur in areas remote from the room of fire origin and are due to the toxic effects of the smoke as it migrates throughout a building. Smoke contaminates escape routes, including stairs, hallways and elevators, trapping occupants, inhibiting safe egress.

Why Must we Contain Smoke, Toxic Gases and Fire?

- 3/4 of all fire deaths are caused by smoke inhalation.

Source: Hall, Jr. John R. NFPA Fire Analysis & Research, Quincy, MA. "Burns, Toxic Gases, and other Hazards".

- Approximately 57% of people killed in fires are not in the room of the fire's origin.

Source: NFPA Fire Protection Handbook, 18th Ed. Table 1-1P. Pg. 1-15.

- Visibility - 47% of survivors caught in a fire could not see more than 12 feet away.

Source: NFPA Fire Protection Handbook, 18th Ed. Table 8-1P. Pg. 8-17.

- Smoke travels 40-70 metres per minute under fire conditions

Source: Estimate based upon ceiling jet velocity calculations for typical ceiling heights and heat release rates.

RA duct at the Pune Airport made of fire resistant material. Photo courtesy : Promat International.

Any ductwork is required to maintain fire resisting compartmentation. A general requirement used to exist worldwide to ensure that a building is provided with a level of structural fire protection and compartmentation such that the building is capable of surviving a full burn out even if sprinkler systems are installed. Nowadays modern fire engineered designs tend to allow a trade off between active and passive systems The older concept allows for the possibility of the sprinklers either failing to operate effectively due to poor maintenance, equipment failure or the inability to control an unexpectedly growing fire.

The rapidity and extent of the transmission of smoke through the ventilation system to remote parts of a building are of primary importance to life safety, particularly as the smoke is likely to contain toxic and/or noxious products of combustion. The areas contaminated will be determined by the comparative pressure conditions in parts of the building served by the system; these will result from:

1. expansion effects due to the fire;
2. buoyancy effects due primarily to the fire (particularly in vertical ductwork);
3. wind effects on the building;
4. stack effects; i.e., caused by the differences between the indoor and outdoor temperatures.

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There is potential for cool smoke and gases to spread through the system so long as the air handling plant continues to function and before fire dampers operate to isolate the fire area. Fire dampers, which are designed primarily to stop flames and hot gases passing from one area to another through the ductwork, are usually controlled by thermally actuated devices. Unless also actuated by smoke detectors, fire dampers will not close until the thermally actuated devices reach their operating temperature, and during this intervening period cool smoke may be drawn, or may diffuse into the system and be circulated to other areas as yet unaffected by fire. Careful control of the extract plant during this period can assist the removal of such smoke.

There are a number of methods of controlling the movement of smoke in buildings, and several reasons for wanting to do so. The need for smoke control in any building is usually decided in context of the means of escape, compartmentation and active suppression systems in the particular circumstances of that building. In general terms, smoke extraction should be considered and may be found particularly useful in the following circumstances:

a) Smoke extraction for life safety.

Smoke extraction for life safety purposes is of benefit in buildings where means of escape to the open air cannot be achieved within a short period of time and in which the means of escape could be severely contaminated with smoke and become impassable. Examples include shopping malls, atrium buildings, and high-rise buildings with phased evacuation (i.e. when a proportion of the occupants are expected to stay in the building throughout the duration of a fire).

b) Smoke extraction for fire-fighter access.

Buildings where either:

i) fire brigade access is difficult, e.g. basements, high-rise buildings

ii) rapid attack on a fire is desirable to reduce fire spread and property damage, e.g., high value warehouses, will benefit from the provision of an appropriate smoke extraction system.

c) Smoke extraction to clear smoke after a fire (smoke purging).

Buildings where smoke clearance by natural means may be difficult (e.g., basements, windowless buildings, and high-rise buildings without operable windows) may require a mechanical smoke purging system.

Methods for the Protection of Ductwork in a Passive Way

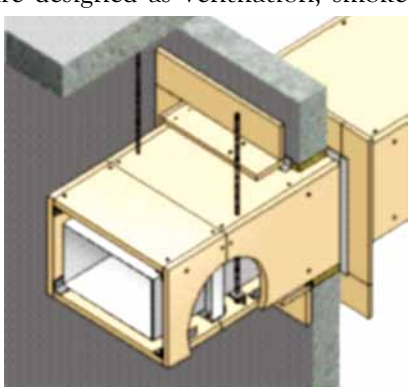
The ductwork itself forms a protected shaft. The fire resistance may be achieved by the ductwork material itself, or through the application of a protective material. The fire resistance of the ductwork, when tested from either side, should be not less than the fire resistance required for the elements of construction in the area through which it passes.

Satisfactory performance of fire resistance of ductwork enclosures is ascertained by compliance with one of the following:

(a) specifications tested or assessed under the appropriate Part of BS 476: Part 24 : 1987.
(b) appropriate British Standards or Codes of Practice.
(c) specifications referred to under NBC building regulations.

Post Cladding of Existing Sheet Metal Duct

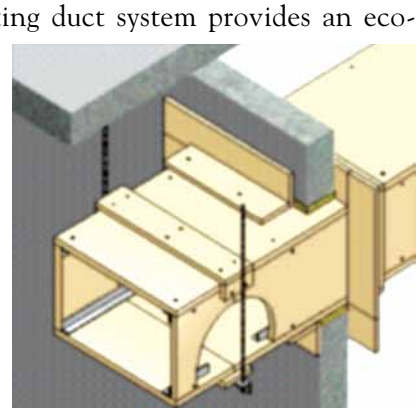
Duct cladding systems, constructed with mineral engineered boards, are designed as ventilation, smoke extract and kitchen extract duct systems to provide a fire resistance of two and four hours. The system design will depend on the performance requirements but normally comprises of mineral engineered boards secured to the steel ductwork with the help of a framework of steel hangers, angles or channels. The steel ductwork must be constructed in accordance with the requirement of DW/144- *Specifications for sheet metal ductwork-low, medium and high pressure/velocity air systems* (published by the Heating and Ventilating Associations), or equivalent specification e.g. SMACNA. The supporting hangers, supports and their fixing should be capable of bearing the load of the complete ductwork system including any applied insulation material or other services suspending from it.



A sheet metal duct covered with fire resistant cladding.

Self- Supporting Ducts

The self supporting duct system provides an economical and fire safe method of constructing natural and mechanical smoke extract and ventilation ductwork without steel lining. Lengths of the self supported duct system can be prefabricated offsite or constructed on site using min-



A duct made of fire resistant mineral board or self-supported duct.

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eral engineered board. This ensures that time spent on site is kept to a minimum, with little or no disruption to other trades. For selection of board thickness, it will not only depend on the required fire performance but also on the internal cross section of the duct and the operating pressures. With large ducts and medium to high operating pressures, internal stiffeners may be required.

Conclusion

A smoke management regime is imperative for use in modern buildings, given the wide use of plastics, laminates and other modern building materials. The volume of thick black highly toxic smoke emitted from fires in today's buildings is a natural killer. Without properly designed systems of smoke management in all its forms and disguises, constructed using properly tested, properly certified and properly installed duct systems, our buildings will remain death traps; lying in wait for the elderly, the very young, the sick and infirm, all those members of our society who are least able to look after themselves. Fire safety consciousness should be seen as a responsibility of all to reduce the havoc wreaked by fires in the country.

But the big question, as always, is: how soon, if ever, will we all wake up from this fire fear factor? Until we do, painful memories of past must be kept alive. ❖