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**FACTS DON'T MATTER:
"HIGH PERFORMANCE" BUILDINGS**

By Richard C. Schulte

According to statistics compiled by the National Fire Protection Association (NFPA), 200 or fewer Americans typically die annually as a result of fires in commercial (non-residential) buildings. In recent years, the annual number of fire fatalities which occur in commercial (non-residential) buildings has fallen to roughly 100. Given that the population of the United States now exceeds 300 million people, it can be stated that the rate of fire fatalities which occur in commercial buildings in the US ranges somewhere between 1 fatality per 1.5 million people and 1 fatality per 3 million people.

The number of Americans who die as a result of fire in residential occupancies protected by a sprinkler system is either zero or very near zero.

If you look at the NFPA statistics in recent years, typically a little over 80 percent of the fire fatalities which occur in the US occur in residential occupancies, however, this statistic is deceiving because this statistic does not differentiate between sprinklered and non-sprinklered residential occupancies. The number of Americans who die as a result of fire in residential occupancies protected by a sprinkler system is either zero or very near zero.

The National Fire Protection Association also collects statistics on fire fighter fatalities. In recent years, the annual number of on-duty fire fighter fatalities which occur in the United States is typically around 100. Given that the combined number of professional and volunteer fire fighters in the United States is roughly one million, the fatality rate for fire fighters is roughly 1 fatality for each 10,000 fire fighters annually.

The annual number of fire fighter fatalities which occur while actually fighting fires is typically around 40 and the actual cause of many of these fatalities is the poor physical health of the fire fighter.

Like the residential fire fatality statistics, the fire fighter fatality statistic cited above is also a little deceiving. The NFPA fire fighter fatality statistic includes fatalities for all causes while on duty. Hence, the fire fighter fatality statistic includes fatalities such as those caused by traffic accidents returning from fire/medical calls and while performing routine duties such as fire prevention inspections. The annual number of fire fighter fatalities which occur while actually fighting fires is typically around 40 and the actual cause of many of these fatalities is the poor physical health of the fire fighter. As would be expected, the majority of fire fighter fatalities which occur as a result of fighting fires in buildings occur in residential occupancies which are not protected by a sprinkler system. The annual number of fire fighter fatalities which occur fighting fires in buildings protected by a sprinkler system is typically near zero.

While sprinkler systems are our most efficient and effective fire fighting tool for fires which occur in buildings, it must be acknowledged that sprinkler systems are not 100 percent reliable. Again, according to statistics published by the NFPA, sprinkler system performance is considered to be effective in 91 percent of fires (which are large enough to activate the system). Once again, this statistic is deceiving because this statistic is an average for all types of sprinkler systems (i.e. wet systems, dry systems, etc.) and all types of occupancy classifications. In the case of residential occupancies, where more than 80 percent of the fire fatalities occur in the US, the NFPA statistics indicate that sprinkler system operate effectively in 96 percent of fires (large enough to activate the system).

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Once again, according to statistics complied by the National Fire Protection Association, the main reason that sprinkler systems fail to operate effectively is a closed water supply valve. The statistics on sprinkler system failures indicate that 63 percent of the failures of sprinkler systems to operate (discharge water) are due to closed water supply valves. Given that it is relatively easy for fire department personnel to detect closed water supply valves in sprinkler systems, the average effectiveness of sprinkler systems could easily be increased to 94 percent (on average) if fire departments actually enforced the maintenance provisions contained in the fire prevention code.

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Given the statistics indicated above, one could reasonably conclude that the solution to the "fire problem" in the United States is the increased use of sprinkler protection in buildings. There is one problem with this solution, however. Providing sprinkler protection in buildings is still relatively costly, although far less costly than it was 35 years ago.

When the sprinkler system installation cost reductions brought about by technological innovation in the industry are combined with the reductions in passive fire protection, providing sprinkler protection in buildings (where no significant savings in property insurance costs are available) becomes feasible.

Although the cost of providing sprinkler protection in buildings has been significantly reduced by technological innovations in sprinkler system design and installation over the last 3 decades, i.e. innovations such as the use of grooved piping systems, thinner wall steel pipe, plastic piping materials, quick response sprinklers, extended coverage sprinklers etc., another means of making the installation of sprinkler protection more affordable is through reductions in code requirements for passive fire protection, more commonly known as to as sprinkler "trade-offs". When the sprinkler system installation cost reductions due to technological innovation are combined with the reductions in passive fire protection, providing sprinkler protection in buildings (where no significant savings in property insurance costs are available) becomes feasible. In fact, it was these reductions in passive fire protection requirements which were responsible for installation of sprinkler systems in many buildings over the last 30 years, including high rise buildings, apartment buildings and even 1- and 2-family dwellings.

There are a number of types of passive fire protection and the capability of the various types of passive fire protection to provide redundant fire protection varies.

In the past ten years or so, there has been concerted efforts by the manufacturers of passive fire protection products to remove many of the incentives (cost reductions) included in buildings codes for the installation of sprinkler systems. The rationale for this effort used by the passive fire protection product manufacturers is that sprinkler systems are not 100 percent reliable and, given this, redundant fire protection is needed for both the protection of the building occupants and the building itself in the event of sprinkler system failure. Inherent in this argument for the need for both sprinkler protection and passive fire protection is the unstated assumption that passive fire protection actually provides redundant fire protection.

Does passive fire protection provide redundant protection for sprinkler protection? The answer to that question is both yes and no. There are a number of different types of passive fire protection and the capability of the various types of passive fire protection to provide redundant fire protection varies.

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In the case of structural fire protection, if the sprinkler system is operational and effectively controls the fire, the structural fire protection provided by the sprinkler system is, in effect, infinite. There is little doubt that passive structural fire protection is capable of providing protection equivalent to the protection provided for the building structure by a sprinkler system assuming that the structural fire protection has been properly installed and remains in place at the time of the fire. The probability that the initial installation of structural fire protection has been properly installed and then is maintained varies with the type of passive fire protection provided.

While the structural fire protection provided by reinforced concrete construction is highly reliable, the probability that "(ceiling) membrane protection" will be properly installed and then be maintained for decades is relatively low. Often times "membrane" protection depends upon dampers being installed, and then being maintained properly, and upon the protection of penetrations of the membrane being properly maintained. The maintenance of dampers and the protection of penetrations is problematic at best.

The probability that the initial installation of structural fire protection has been properly installed and then is maintained varies with the type of passive fire protection provided.

In the case of floor construction, if the sprinkler system is operational, it has been demonstrated that the spread of fire through improperly protected floor penetrations can be prevented. In the event of the failure of the sprinkler protection, the capability of the floor construction to prevent the spread of fire between floors is dependent upon the protection of the floor penetrations. Regardless of whether or not floor penetrations are initially protected properly, the capability of the floor construction to prevent the spread of fire is still dependent upon the maintenance of the floor as a barrier to fire spread. Without periodic inspections to verify the maintenance of the floor construction as a barrier to fire spread, the likelihood that the floor construction will be properly maintained as a fire barrier over the life of a building is certainly not very high.

In the case of wall construction provided to compartment floors into separate areas, the reliability of the compartmentation once again depends upon proper installation and then continued maintenance of the walls used to form the boundaries of the compartment, including the protection of door openings and ventilation system penetrations. What is the probability that fire door assemblies and fire dampers will be properly maintained over the course of decades? Once again, probably not very high. Certainly, there is no way that the probability of maintaining the compartmentation of floors using fire resistive wall construction would be anywhere in the neighborhood of the probability of effective sprinkler system operation.

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While, in theory, passive fire protection is capable of providing protection similar to that provided by sprinkler protection, there are at least two functions that sprinkler protection is capable of performing that passive fire protection simply cannot replicate. One of these functions is the capability of sprinkler protection to protect occupants in the room of origin from the effects of fire, including occupants who are intimate with the fire.

The other function that may not be equaled by passive fire protection is the capability to protect occupants on the floor of origin from the effects of fire without the need for evacuation of the floor of origin. What this implies is that sprinkler operation is not only capable of reducing ceiling temperatures in the room or area of fire origin and throughout the floor, but is also capable of limiting the production of smoke by limiting the size of the fire and, in many cases, by extinguishing the fire prior to the arrival of fire fighters. While passive fire protection is theoretically capable of limiting the size of the fire, passive fire protection is certainly not capable of extinguishing the fire.

Is sprinkler protection the only protection which is necessary to protect a building and its occupants from fire?

Is sprinkler protection the only protection which is necessary to protect a building and its occupants from fire? In many cases, the answer to this question is yes, however, to my knowledge, no one in field of fire protection believes that the only fire protection feature which should to be provided for a building is sprinkler protection. Most, if not all professionals in the field believe that redundant protection should be provided. The debate in the field instead has centered on how much redundant protection is necessary in a building protected by a sprinkler system.

While the debate with the passive fire protection interests over how much building fire protection is enough fire protection has continued for over a decade, a new proposal in this debate has recently surfaced. This proposal developed by the Portland Cement Association (PCA) is titled "*Proposed Amendments to the International Building Code, 2009 edition, Relating to High Performance Building Requirements for Sustainability*" dated October 2009. Excerpts from commentary included in this document include the following:

> "*Sustainability is the main difference between a high performance code and a minimum building code such as the International Building Code. Sustainability takes on many forms related to building design, construction, functionality, life cycle costs and impact to the environment. This code incorporates all of these features and combines them into a comprehensive high performance sustainable building code.*" (Section C101.3)

> "Permitting sprinkler trade-offs for fire safety, structural integrity and egress, raises the potential for death, injury, facility shutdown, repair construction, worker displacement and other hindrances to efficient facility operations."

> "***HIGH PERFORMANCE FIRE SAFETY.*** *Throughout the International Building Code (as well as other building codes), fire resistance ratings, egress widths, travel distance and many other safety features are relaxed or completely eliminated due to the presence of an automatic sprinkler system, while the building height is allowed to be increased by 1 story and areas increased by 200 to 300 percent. While these systems* [referring to sprinkler systems] *have a good record in controlling fire and allowing escape, they are still vulnerable to human factors. National Fire Protection Association (NFPA) states that sprinkler failure rates, called accidental fire events, are at best currently over 10 percent. These statistics do not include instances when the system was shut off either intentionally or by accident. Permitting sprinkler trade-offs for fire safety, structural integrity and egress, raises the potential for death, injury, facility shutdown, repair construction, worker displacement and other hindrances to efficient facility operations. If a sprinkler malfunction or failure occurs, building elements that have been allowed a reduction in hourly ratings are the only immediate defense remaining to contain or stop the spread of fire. The resiliency of high performance buildings depends on both active suppression and passive compartmentation without allowable hourly reductions, to reasonably guarantee that fire does not spread past the area or room of origin.*" (Chapter 4 Commentary)

"*The first option mandates non-combustible construction for Group I-1, R-1 and R-2 occupancies. The second option mandates protected construction for all groups except Groups F-2 and S-2. The values in the table were modified to provide an inherently fire-rated non-combustible separation between dwelling and sleeping units.*" (Table C503)

> "Requires a two-hour separation between dwelling units and sleeping units as well as hourly separation between other occupancies."

"*Requires a two-hour separation between dwelling units and sleeping units as well as hourly separation between other occupancies. Passive non-combustible compartmentation between residential dwelling and sleeping units coupled with sprinkler protection throughout will provide residents with an area of refuge within their own unit. The containment of fire to the room of origin will allow the facility to remain in operation and eliminate the displacement of residents from the facility.*" (C707.3.10)

> "All buildings, other than Groups F-2 and S-2, containing combustible material shall be provided with an automatic sprinkler system in high performance buildings."

"*Requires that except in Groups F-2 and S-2, approved automatic sprinkler systems shall be provided throughout all new buildings. All buildings, other than Groups F-2 and S-2, containing combustible material shall be provided with an automatic sprinkler system in high performance buildings.*" (C903.2)

"*Removes the NFPA 13R option for residential type occupancies. NFPA 13R sprinkler systems were removed from the code based on their reduced property protection features.*" (C903.3.1.2)

"*Requires at least one occupant evacuation elevator when an elevator is required. The feature will provide for the self-evacuation of those with accessibility needs.*" (C1007.2.1)

Discussion

Prior to embarking on a discussion of the excerpts above, it is necessary to correct a number of factual errors in the commentary written by the technical staff at the PCA.

The commentary describes the International Building Code and other codes, such as the Life Safety Code and the NFPA Building Code (NFPA 5000) as "minimum" codes. While it is indeed true that the International Building Code and codes developed by the National Fire Protection Association are intended to set minimum requirements for building construction, the provisions contained in these codes can in no way be considered to be minimal. The level of fire safety provided for both building occupants and fire fighters by compliance with the IBC or the NFPA codes is extremely high. It should be noted that both the IBC and NFPA codes, as well as their predecessors, the regional model building codes, are responsible for the excellent fire safety record of commercial buildings that are reflected in the fire statistics previously cited and both the IBC and NFPA codes now require that all residential occupancies, including 1- and 2-family dwellings, be protected by a sprinkler system.

The level of fire safety provided for both building occupants and fire fighters by compliance with the IBC and the NFPA codes is extremely high.

The statistics on sprinkler system failure previously cited are based upon Dr. Hall's work published in a paper titled "U.S. Experience with Sprinklers and Other Automatic Fire Extinguishing Equipment " dated January 2009.

The PCA commentary also states that the failure rate of sprinkler systems exceeds 10 percent and that this failure rate statistic does not include failures caused by closed water supply valves. This statement is nothing but a myth propagated by the passive fire protection industry and is based upon an analysis of sprinkler system statistics by William Koffel of Koffel & Associates, Inc. in 2005. (Koffel's work was commissioned by a trade association of passive fire protection manufacturers, the Alliance for Fire and Smoke Containment and Control.) The statistics on sprinkler system failures included in Koffel's analysis have since been disproved by an analysis by Dr. John R. Hall, Jr. of the Research Division of the National Fire Protection Association. The statistics on sprinkler system failure previously cited are based upon Dr. Hall's work published in a paper titled "*U.S. Experience with Sprinklers and Other Automatic Fire Extinguishing Equipment* " dated January 2009.

Given the extensive debate on the issue of the reliability or failure rate of sprinkler systems since Koffel's paper was issued, there is no reason why the technical staff of the Portland Cement Association should not be aware of more accurate statistics on the reliability/failure rate of sprinkler systems. Since the NFPA refuted the sprinkler system failure rate statistic cited by the Portland Cement Association in January 2009, the only seemingly reasonable explanation for citing the erroneous statistic is that this was done intentionally. This, of course, calls into question all of the fire safety aspects of PCA's proposal.

The assumption made in PCA's proposal is that the more fire protection features included in a building, the "safer" the building from a fire safety perspective. While this seems logical, at least on the surface, there is a point where the incremental increase in the level of safety provided by additional fire protection features provides no significant increase in the level of safety.

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One example of the flaw in this concept is increasing the fire resistance rating of a column from 2 hours to 3 hours provides no significant increase in the level of fire safety provided if the exposure to the column is limited to the equivalent of a 1 hour exposure to the ASTM E119 time-temperature curve. Similarly, increasing the design density for a sprinkler system from 0.10 gpm/SF to 0.20 gpm/SF where the system protects a light hazard occupancy provides no significant increase in the level of safety provided given that a density of 0.10 gpm/SF is more than adequate to control a fire in a light hazard occupancy. Obviously, there is a multitude of other similar examples where providing additional fire protection provides no measurable increase in the level of safety provided for a building. Based upon just the strength of these two examples, it seems reasonable, and obvious, to conclude that the entire basis for the PCA proposal is fundamentally flawed.

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From the perspective of public policy, building codes should seek to balance fire safety versus the cost of providing fire safety. In other words, building codes should provide "balanced fire safety", rather than "balanced fire protection" advocated by the passive fire protection interests. If sprinkler protection is capable of reducing the number of fire fatalities to zero, or very close to zero, in buildings which are designed to take advantage of the reductions in passive fire protection, then there is simply no reason not to allow the sprinkler "trade-offs". The NFPA statistics previously cited indicate that this is indeed the case. Hence, there appears to be little reason to adopt the proposal by the Portland Cement Association.

Clearly, the approach that the Portland Cement Association has taken in its proposal is to "throw money" at a problem without attempting to justify whether or not it makes sense to increase our expenditures relative to the "problem". In its commentary on the proposal, the Portland Cement Association has not attempted to make a case that fire protection beyond that which is already mandated by the IBC and the NFPA codes is essential for the protection of the public and is a cost-effective approach to providing fire protection for both the general public and fire fighters. It is assumed that the reason why PCA has not attempted to provide a technical justification for its proposal is that there is none.

Conclusion

The fire statistics collected by the National Fire Protection Association clearly show that buildings protected by a sprinkler system are "safe" buildings even when reductions in passive fire protection are permitted and that sprinkler protection is a highly reliable form of building fire protection. Given our past experiences with passive fire protection (without sprinkler protection), the same cannot necessarily be said of passive fire protection.

If there is a concern about the reliability of sprinkler protection, the average failure rate of sprinkler protection can be reduced from the current 9 percent to 6 percent (or even less) simply by enforcing the maintenance provisions presently contained in the fire prevention codes promulgated by the International Code Council and the National Fire Protection Association.

If there is a concern about the reliability of sprinkler protection, the average failure rate of sprinkler protection can be reduced from the current 9 percent to 6 percent (or even less) simply by enforcing the maintenance provisions presently contained in the fire prevention codes promulgated by the International Code Council and the National Fire Protection Association.

Given that existing health problems are responsible for many of the fire fighter fatalities which occur each year in the United States, the only way to make significant progress in reducing the number of fire fighter fatalities is to address health issues in the fire service. The building code changes proposed by the Portland Cement Association will have little impact on the number of fire fighter fatalities since these proposals don't address the primary cause of fire fighter fatalities-heart disease.

Sustainable building construction is "doing more with less". The way to "do more with less" as far as building fire safety is concerned is to provide sprinkler protection in buildings and then properly maintain the sprinkler protection throughout the life of the building. A properly maintained sprinkler system essentially eliminates the need for much of the passive fire protection provided in buildings and can also be used to reduce the number of fire fighters necessary to provide fire protection for a municipality.

Sustainable building construction is "doing more with less".

The most effective and cost-efficient investment in fire protection is making sure that sprinkler protection is properly installed and then properly maintained over the life of a building. Much, if not most of the redundant fire protection proposed by the Portland Cement Association would simply be unnecessary if the maintenance provisions for sprinkler system contained in fire prevention codes were actually enforced. In other words, from a fire safety perspective, good code enforcement is the key to "sustainable" buildings.

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