Fire Protection

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A Balanced Opinion on Building Fire Protection?

A short (one page) article titled "Life Safety in High-Rise Buildings After 9/11" written by W. Gene Corley, P.E. appeared in the spring 2003 issue of *Fire Protection Engineering* magazine, the official magazine of the Society of Fire Protection Engineers (SFPE). Mr. Corley, a structural engineer employed by Construction Technology Laboratories, Inc., was part of the team that performed the preliminary study of the collapse of the World Trade Center and wrote the Federal Emergency Management Agency (FEMA) report titled "World Trade Center Building Performance Study: Data Collection, Preliminary Observations and Recommendations" published in May 2002.

The following are a few excerpts from Mr. Corley's article:

"By 1927, the Uniform Building Code, written by western United States building officials, required buildings that were taller than 8 stories or 85 feet have fire resistance of structural elements of three hours for floors, four hours for columns and beams."

"Following the adoption of fire-resistance requirements for high-rise buildings, the experience has been very good. No modern fire-protected building had collapsed as a result of a burnout prior to 9/11. Similarly, the fire related casualty rate for occupants of high-rise buildings has been extremely low."

"In the 1970s [,] it became clear to model code groups that sprinkler systems in high-rise buildings would further reduce the property losses during a fire."

"Sprinkler systems are mandatory by these codes [the International Building Code and NFPA 5000] in all buildings that exceed 12 stories or 180 feet. While sprinklers can be expected to reduce property loss and contain many fires when they work properly, sprinklers cannot always be expected to function. Sprinklers can malfunction due to inadequate inspection, willful shutoff of valves, or catastrophic events interrupting the water supply. Since inspection and maintenance of sprinklers are seldom mandatory in commercial buildings, the potential failure rate is of concern."

Despite the recognition that sprinkler systems do not always function properly, model building codes have continued to reduce the fire-resistance requirements of structural elements where sprinklers are used...These reductions in structural safety are based on a growing belief that fire-protected buildings will not collapse, even in a burnout."

"Sprinklers should continue to be mandatory in high-rise buildings. However, it is clear some fires in buildings, both low-rise and high-rise, cannot be controlled. When control is lost, a burnout will occur. For the life safety of those who may be trapped in the building and of those who must fight these fires, the design objective should be that no collapse occurs with a burnout. Also, the burnout considered should be related to the amount of fuel in the building if the fuel exceeds the amount that would produce a standard ASTM E119 fire."

It is my opinion that the fire record of high-rise buildings has been far better that just "very good."

"The lessons from the horrible tragedy of 9/11 should be used to improve the safety of later generations who live and work in high-rise buildings."

This article is of interest for a number of reasons: First, it contains a number of obviously erroneous statements and, second, the article appeared in the SFPE magazine, erroneous statements and all.

In the article, Mr. Corley asserts that the fire record of high-rise buildings "has been very good." He also states that "the fire related casualty rate for occupants of high-rise buildings has been extremely low." Although this may just be a matter of semantics, it is my opinion that the fire record of high-rise buildings has been far better that just "very good," it has been excellent, particularly in recent years. NFPA statistics, which have been cited in previous columns in *Plumbing Engineer*, indicate that fewer Americans die each year as a result of fires in high-rise buildings than those who die as a result of being struck by lightning. There are notable exceptions to this statement, however. In 1980, more than 80 people died in a fire at the MGM Grand Hotel in Las Vegas. One also might cite the fire at the World Trade Center towers on 9/11; however, that fire resulted from a "military-style" attack on the towers, hence, this fire is a special case.

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Mr. Corley also states in the article that "in the 1970s it became clear to model code groups that sprinkler systems in high-rise buildings would further reduce the property losses during a fire." This statement indicates that Mr. Corley is not acquainted with the history of the development of the high-rise provisions in the 1970s. The inclusion of the requirement to provide sprinkler protection in high-rise buildings had nothing to do with "property losses" whatsoever. Sprinkler protection was mandated in high-rise buildings to provide protection for the occupants and to provide protection for fire department personnel.

Not only is Mr. Corley's research into the history of the high-rise provisions lacking, but so is his research into the requirements for sprinkler protection contained in the International Building Code and NFPA 5000. He writes that "sprinkler systems are mandatory by these codes [referring to the IBC and NFPA 5000] in all buildings that exceed 12 stories or 180 feet." In fact, the 2000 edition of the International Building Code (IBC) requires sprinkler protection to be provided throughout all buildings that have floors with a design occupant load of greater than 30 people who are located more than 55 feet above the lowest level of fire department access (see the IBC for exceptions to this requirement).

Additionally, the IBC requires sprinkler protection in all hotels/motels with interior corridors, regardless of the building height, and hotels/motels with exterior egress balconies that are more than three stories in height measured above the lowest level of exit discharge. Furthermore, the IBC requires that all multi-family residential (apartment) buildings that are three or more stories in height (including stories classified as basements) or that include more than 16 dwelling units (regardless of the building height) be provided with sprinkler protection. NFPA 5000 requires office buildings classified as high-rise buildings (buildings with a height exceeding 75 feet measured from the lowest level of fire department vehicle access to the elevation of the highest normally occupied floor) must be protected by a sprinkler system. NFPA 5000 also requires that all hotels/motels – except hotels/motels with exterior egress balconies that are three stories or less in height – must be protected by a sprinkler system.

NFPA 5000 also requires that all apartment buildings be protected by a sprinkler system (with exceptions for apartment buildings designed as townhouses). The actual requirements for sprinkler protection contained in both the International Building Code and NFPA 5000 are far more restrictive than indicated by Mr. Corley. A review of these requirements clearly demonstrates that the rationale behind the requirements to provide sprinkler protection is occupant (life) safety, not property protection. Of course, the installation of sprinkler protection will always provide protection for property.

Mr. Corley again alludes to sprinklers and property protection, stating that "while sprinklers can be expected to reduce property loss and contain many fires when they work properly, sprinklers cannot always be expected to function. Sprinklers can malfunction due to inadequate inspection, willful shutoff of valves, or catastrophic events interrupting the water supply." Mr. Corley's statement is, of course, true. Sprinkler systems do occasionally fail, but his statement infers that sprinkler system failures are common events and that the sprinkler system failures result in major catastrophes. If this were actually the case, Mr. Corley should be able to cite cases where the failure of a sprinkler system to control a fire resulted in major life loss. Other than the World Trade Center disaster, I have no recollection of a catastrophic fire occurring in a high-rise building that was protected throughout by a sprinkler system.

In this same paragraph, Mr. Corley states "since inspection and maintenance of sprinklers are seldom mandatory in commercial buildings, the potential failure rate is of concern." Obviously, he is unfamiliar with build-

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ing and fire prevention code requirements regarding the testing and maintenance of sprinkler system installations. In addition to the requirements contained in building and fire prevention codes, NFPA 13 specifically requires compliance with NFPA 25, the *Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems*. Non-compliance with the testing and inspection requirements contained in NFPA 25 is a code violation. It is true, however, that the requirements contained in NFPA 25

Fewer Americans die each year as a result of fires in high-rise buildings.

are often not enforced by the code enforcement authorities typically responsible for enforcing the fire prevention code – the fire service.

Mr. Corley also writes, "despite the recognition that sprinkler systems do not always function properly, model building codes have continued to reduce the fire-resistance requirements of structural elements where sprinklers are used...These reductions in structural safety are based on a growing belief that fire-protected buildings will not collapse, even in a burnout." This statement again shows a lack of a historical perspective on the "trade-off" in structural fire resistance when sprinkler protection is provided in high-rise buildings. This reduction in the structural fire protection dates back to the development of the high-rise provisions in the early and mid 1970s. More than a quarter century of experience with "trade-offs" in structural fire protection when sprinkler protection is provided clearly has demonstrated that sprinkler systems are sufficiently reliable to justify this "trade-off."

NFPA fire statistics show a dramatic reduction in the number of civilian fire deaths (down from 7,395 deaths in 1977 to 4,045 deaths in 2000), civilian fire injuries (down from 31,190 injuries in 1977 to 22,350 injuries in 2000) and firefighter deaths (down from 157 deaths in 1977 to 102 deaths in 2000) in the last quarter century, despite the fact that the population of the United States has grown from 226 million people in 1980 to 280 million in 2000. While there are numerous factors that account for these reductions, including safer electrical and heating equipment, fewer people smoking, the installation of smoke detectors in dwelling units, better code enforcement and better fire departments, Mr. Corley provides no evidence that buildings are less "safe" because of reductions in the structural fire protection of buildings allowed when sprinkler protection is provided.

In the second to last paragraph in the article, he states that "sprinklers should continue to be mandatory in high-rise buildings." Given his previous statements regarding

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the lack of reliability of sprinkler systems, one certainly wonders why Mr. Corley would continue to support the installation of sprinkler protection in high-rise buildings. Surely, when it comes to the protection of the occupants of high-rise buildings and firefighters, and a choice between structural fire protection and sprinkler protection, it is clear that sprinkler systems provides far superior protection when compared to structural fire protection.

The second to last paragraph in the article continues with "however, it is clear some fires in buildings, both low-rise and high-rise, cannot be controlled. When control is lost, a burnout will occur. For the life safety of those who may be trapped in the building and of those who must fight these fires, the design objective should be that no collapse occurs with a burnout. Also, the burnout considered should be related to the amount of fuel in the building if fuel exceeds the amount that would produce a standard ASTM E119 fire." While Mr. Corley's topic appears to be confined to high-rise buildings, the above statement expands his opinion on the structural stability of buildings under fire conditions to both high-rise and low-rise buildings. In essence, he is advocating the elimination of unprotected wood and unprotected steel construction, in both sprinklered and unsprinklered buildings, regardless of the size or use of the building. A bold proposal to be sure, but Mr. Corley offers no statistics to support his proposal. Just how many American civilians and firefighters typically die each year as a result of structural collapses caused by fire?

It is interesting to note in the statement quoted in the preceding paragraph that Mr. Corley proposes that buildings should be constructed to remain stable during a "burn-out" of the building, but he doesn't provide any elaboration on the conditions under which the "burn-out" occurs. Should the design of the building anticipate structural damage before the fire occurs, as in the World Trade Center disaster, for instance? And what fuel should the building design assume is burning during the "burn-out?" The fuel typically found in the building, or should the design anticipate that a large flammable liquids fire occurs on multiple floors, as in the World Trade Center disaster, for example?

The article concludes with the statement that "the lessons from the horrible tragedy of 9/11 should be used to improve the safety of later generations who live and work in high-rise buildings." Yes, the collapse of the World Trade Center towers was a horrible tragedy, yet, fortunately, the design of the building was able to limit the number of fatalities to roughly 3,000 people. That is fewer than the number of Americans who died as a result of traffic accidents in the month of September 2001, and fewer than the number of Americans who have died in traffic accidents each and every month thereafter. As a safety engineer, it seems like common sense to me that the death of more than 40,000 Americans on our nation's roads each year is a far greater tragedy than the World Trade Center disaster, and that addressing our nation's traffic safety problem should be a far higher priority than addressing the problem of building collapse due to terrorist attacks. □

About the Author

Richard Schulte is a 1976 graduate of the fire protection engineering program at the Illinois Institute of Technology. After working in various positions within the fire protection field, he formed Schulte & Associates in 1988. His consulting experience includes work on the Sears Tower and numerous other notable structures. He has also acted as an expert witness in the litigation involving the fire at the New Orleans Distribution Center. He can be contacted by sending email to rschulte@plumbingengineer.com.

Mr. Schulte's several previous columns comprising a series on the World Trade Center collapse can be downloaded (in PDF format) from the ***Plumbing Engineer*** *Web site, www.plumbingengineer.com. They are located in the "Resources" section.*

