SCHULTE & ASSOCIATES
Building Code Consultants
880D Forest Avenue
Evanston, IL 60202
fpeschulte@aol.com
847/866-7479

LOOKING BACK:
A PERSPECTIVE ON HIGH RISE BUILDING FIRE SAFETY

By Richard Schulte

In the 1960's, high rise building fire protection consisted of fire resistive building construction, a fire alarm system, smokeproof exit stair enclosures and a standpipe system. Back then, it was widely accepted that sprinkler protection only provided property protection and that sprinkler protection was not capable of protecting building occupants from fire and smoke.

In the 1960's, high rise building fire protection consisted of fire resistive building construction, a fire alarm system, smoke-proof exit stair enclosures and a standpipe system.

In the late 1960's and early 1970's, the perception that sprinkler protection was only capable of providing property protection was challenged and the Sears Tower in Chicago became the first tall building to be protected throughout by a sprinkler system. The problem with sprinkler protection used as a tool to protect the occupants of tall buildings from fire was cost. Installing sprinkler protection in high rise buildings was an expensive proposition. In order to make the installation of sprinkler protection in high rise buildings more palatable, a number of reductions in the requirements for passive fire protection, including reductions in the structural fire resistance requirements and the elimination of fire dampers, were permitted in sprinklered high rise buildings.

Today, of course, the installation of sprinkler protection in high rise buildings is considered to be standard engineering practice and the fire record of high rise buildings protected by a sprinkler system speaks for itself. A major fire has never occurred in a high rise building protected throughout by a sprinkler system in the United States.

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Typically, the number of fire fatalities which occur in U.S. high rise office buildings on an annual basis is either zero or one. This statistic includes both sprinklered and unsprinklered high rise office buildings. Similarly, the number of fire fatalities which occur in U.S. high rise residential buildings protected by a sprinkler system is also near zero. In high rise residential buildings protected by a sprinkler system, fire fatalities are normally limited to occupants who are intimate with the fire (*e.g.*, occupants who fall asleep while smoking in bed).

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Although the fire safety record of high rise buildings protected by a sprinkler system in the United States is unblemished for nearly 4 decades, the terrorist attacks on the World Trade Center towers prompted another look at the safety of high rise buildings by the Building and Fire Research Laboratory (BFRL) at the National Institute of Standard and Technology (NIST).

While there is little doubt that high rise buildings protected by a sprinkler system are "safe" buildings, NIST found that high rise buildings are not "safe enough", and developed recommendations for making high rise buildings even "safer". These recommendations were published in NIST's report on its investigation into the collapse of the World Trade Center tower in the fall of 2005 and again in NIST's report on its investigation into the collapse of the WTC 7 Building in the fall of 2008.

The absence of justification for making and implementing the recommendations to make high rise buildings "safer", particularly given the safety record of high rise buildings in the United States protected by a sprinkler system, is reason to take a second look at the NIST investigations into the collapse of the World Trade Center towers and the WTC 7 Building.

Despite the fact that NIST provided little or no justifications for its recommendations for making high rise buildings "safer", the International Code Council (ICC) and the National Fire Protection Association (NFPA) implemented NIST's recommendations by including more restrictive code provisions for high rise buildings in the model building codes published by these two organizations. The absence of justification for making and implementing the recommendations to make high rise buildings "safer", particularly given the safety record of high rise buildings in the United States protected by a sprinkler system, is reason to take a second look at the NIST investigations into the collapse of the World Trade Center towers and the WTC 7 Building.

Chapter 1 of the NIST report on the collapse of the WTC 7 Building, NCSTAR 1-9, provides a brief summary of the events which occurred in Lower Manhattan on September 11th. This summary is as follows:

"*On September 11, 2001, at 8:46:30 a.m. EDT, five hijackers few American Airlines Flight 11 (AA 11), a Boeing 767-200ER aircraft, into the north face of World Trade Center (WTC) 1 at a speed of about 440 mph. At 9:02:59 a.m., five other hijackers flew United Airlines Flight 175, also a Boeing 767-200ER aircraft, into the south face of WTC 2 at a speed of about 540 mph. . .WTC 2 collapsed at 9:58:59 a.m. EDT, followed by the collapse of WTC 1 at 10:28:22 a.m. EDT.*

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The collapse of WTC 1 caused structural damage to WTC 7, a 47 story building [located] *to the north of the WTC complex. . . .The collapse of WTC 1 also resulted in initiation of fires on at least 10 floors of WTC 7. . .and loss of city water that supplied the automatic sprinkler system in the lower zone of WTC 7. After nearly 7 hours of burning, WTC 7 collapsed at 5:20:52 p.m. EDT.*"

On October 15, 2001, Jon Magnusson put the collapse of the WTC towers into perspective at a meeting of the Council of Tall Buildings and Urban Habitat (CTBUH). Magnusson's remarks included the following statements:

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"*As we look at where we should spend dollars and shape public policy, it needs to be on airplane security and not on changing things in buildings. Frankly, it doesn't matter what sprinkler system you have, or how many stairwells you have, or how wide they are, or what the response time is if the building has been cut in half by an airplane.*"

Approximately six months after 9/11, on March 6, 2002, the Congressional Science Committee held a hearing on the terrorist attacks. Comments by the chairman of the Science Committee, Representative Sherwood Boehlert, as well as some of the witnesses at that hearing, are of interest in this discussion. Congressman Boehlert's remarks included the following:

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> "*The Committee decided to move forward for two fundamental reasons. First, we believe that we owe it to the victims and their families to learn everything possible about what happened in those horrifying first hours of September 11th—not just to satisfy their immediate needs and yearnings, but to ensure that such a catastrophic building failure, and the resulting loss of life, never happen again.*"

> "*Another significant lesson of the Trade Center collapse is that we need to understand a lot more about the behavior of skyscrapers and about fire, if we are going to prevent future tragedies.*"

> "*. . .but to ensure that such a catastrophic building failure, and the resulting loss of life, never happen again.*"

> "*But this hearing is not so much about the past, as it is about ensuring that we protect lives in the future.*"

Robert F. Shea, Acting Administrator, Federal Insurance and Mitigation Administration of the Federal Emergency Management Agency (FEMA) was the first witness before the Science Committee. Mr. Shea's testimony included the following:

> "*. . . its conclusions and recommendations* [referring to the FEMA study issued May, 2002] *will help guide future investigative and research efforts connected primarily to understanding the performance of buildings when subjected to extreme conditions.*"

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"*This study* [again referring to the FEMA study issued May, 2002] *represents an important first step in suggesting how the technical resources of the nation can be brought to bear on protection of lives and property.*"

The final witness before the committee was Dr. Bement, the director of NIST. Dr. Bement's testimony included the following:

"*The tragedy that the United States experienced on September 11, 2001, was unprecedented when compared with any prior accident, natural disaster, or terrorist/war attack. The collapse of the twin World Trade Center towers was the worst building disaster in human history. . .*"

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"The implementation of the results of such an investigation would be critical to restore public confidence in the safety of tall buildings nationwide, enhance the safety of fire and emergency responders, and better protect people and property in the future. To cite one example, the February 4th issue of 'Crain's New York Business' reports that an increasing number of tenants are leaving the Empire State Building, which is again the tallest building in New York City, because of fears of another terrorist attack. Anecdotal evidence also suggests that building vacancy rates have doubled in Manhattan, despite the 15 million square feet of space that was lost on September 11th.

"*Fourth, to study procedures and practices used to provide adequate structural reserve capacity to resist abnormal loads (e.g. blast, explosion, impact due to aircraft or flying debris from tornadoes, accidental fires, and faulty design and construction), especially those that can be anticipated prior to construction (e.g. impact of a Boeing 707)*. . ."

"The Building and Fire Research Laboratory is the foremost fire research laboratory in the United States, and through the National Earthquake Hazards Reduction Program (NEHRP) NIST is the principal agency for research and development to improve building codes and standards. . ."

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"*The goal of this broader program would be to produce cost-effective retrofit and design measures and operational guidance for building owners and emergency responders.*"

"*Current building design practice does not consider fire as a design condition. Instead, structural fire endurance ratings are prescribed in building codes using standard tests on individual components. The current testing standards are based on work carried out at NIST in the 1920s. They do not represent real fire hazards in modern buildings. They also do not consider the fire performance of structural connections or of the structural system as a whole, or the multiple performance demands on fireproofing materials.*"

"*The goal of this broader program would be to produce cost-effective retrofit and design measures and operational guidance for building owners and emergency responders.*"

"*In short, NIST would provide the technical basis and guidance for fire safety design and retrofit of structures, the predictive tools and test methods for fire resistance determination, and the performance criteria for fireproofing materials. In addition, NIST proposes to develop guidance and retrofit technologies to enhance building egress in emergencies, practical tools and guidance to enhance the safety and effectiveness of fire and emergency responders, and improved models of occupant behavior and response to enhance evacuation and communication in emergencies.*"

"*Yet, the United States has not developed standards, codes, and practices to assess and reduce this vulnerability. Adding to the problem for modern structures is their smaller margin of safety—and the reserve capacity to accommodate abnormal loads—due to increased efficiency in the use of building materials and refinements in analysis techniques. . .*"

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"*The final program element supports a construction-industry-led roadmapping effort to reflect changed priorities for development and deployment of safety and security standards, technology, and practices.*"

"*The effort would complement and support parallel efforts of technical organizations to improve standards, codes, and practices.*"

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"*In the wake of September 11th, the private sector's willingness to take necessary corrective action to strengthen building codes and standards is extraordinarily strong.*"

In a press conference following the Congressional Science Committee hearing on March 6, 2002, Representative Connie Morella had this to say regarding NIST's proposal to the Committee:

"*The importance of this work can't be overstated. Research into this disaster is the only way we have any chance of preventing the next one and Congress needs to move swiftly to formalize the way we evaluate catastrophic building collapse. Fortunately, we have an advanced federal laboratory dedicated to such research. The National Institute of Standards and Technology is uniquely position*[ed] *to conduct extensive investigations into the structural failures of the World Trade Center and suggest appropriate new standards and potential retrofits. . .*"

"*Research into this disaster is the only way we have any chance of preventing the next one. . .*"

Clearly, the members of the Congressional Science Committee were under the impression that NIST would be developing means and methodologies to address terrorist attacks on newly constructed buildings and also developing cost-effective methods of strengthening existing buildings to better resist terrorist attacks. Just as clearly, the director of NIST, Dr. Arden Bement, stated that that is exactly what NIST intended to do in NIST's investigation into the collapse of the World Trade Center towers.

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Interestingly enough, when NIST published its draft report on its investigation into the collapse of the World Trade Center towers in June 2005, there was no mention of how to prevent mass casualties in the event of a terrorist attack. Instead, NIST indicated that the recommendations contained in its investigation report were intended to address simultaneous "multi-hazard" scenarios, with no mention as to exactly what "multi-hazard" scenarios were intended to be addressed. In other words, NIST took a "bait and switch" approach with regards to securing funding from Congress for their investigation.

Also interestingly enough, the Congressional Science Committee permitted itself to be "hoodwinked" by NIST and apparently did not question, at least publicly, why NIST did not address the issue of terrorist attacks in its investigation report and recommendations.

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Despite NIST's assertion that the private sector was motivated "*to take necessary corrective action to strengthen building codes and standards*" and "*take aggressive remedial to minimize future losses*", the private sector, for the most part, opposed the implementation of NIST's recommendations for making "buildings safer". The private sector remained unconvinced as to the need to "*strengthen building codes and standards*" simply because NIST provided no concise rationale for its recommendations included in its final report on the WTC towers collapses (issued in the fall of 2005).

Despite NIST's assertion that the private sector was motivated "*to take necessary corrective action to strengthen building codes*" and "*take aggressive remedial to minimize future losses*", the private sector, for the most part, opposed the implementation of NIST's recommendations for making "buildings safer".

Despite the private sectors' reservations regarding the need to implement NIST's recommendations, NIST, with the assistance of Congress, was able to bully the ICC and the NFPA into implementing the recommendations. While the model building codes used in the United States now contain more restrictive requirements for the construction of high rise buildings, these more restrictive provisions have yet to be actually utilized due to the severe downturn in the building construction industry which began in 2008.

The downturn in the building construction industry, in effect, presents another opportunity to review the implementation of the NIST recommendations in model codes developed by the ICC and the NFPA. Given that any more restrictive code regulations have a negative impact the number and size of the buildings which are constructed, it seems reasonable that all of the provisions contained in buildings codes and standards, including the new provisions for high rise buildings based upon the NIST recommendations, should be reviewed for their efficacy in providing "safer" buildings.

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