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"RETHINKING EGRESS": THE WORKSHOP PART 1

By Richard Schulte

A revolution in thinking in the building fire protection field occurred in the late 1960's and early 1970's. Prior to that time, it was generally accepted that sprinkler protection only provided protection for property. Today, the primary use of sprinkler protection is to protect building occupants and property protection is considered to be a secondary use of sprinkler protection.

Another inflection point in the building fire protection field appears to have occurred on September 11th, 2001. The terrorist attack on the World Trade Center towers has brought concerns about the safety of tall buildings to the forefront.

A revolution in thinking in the building fire protection field occurred in the late 1960's and early 1970's.

The final report on the investigation into the collapse of the World Trade Center (WTC) towers by the National Institute of Standards and Technology (NIST) was issued in September 2005. Included in the NIST report were recommendations for making buildings, principally high rise buildings, "safer".

Recommendations included in the NIST report on the WTC collapse addressed the need for improvements in the egress facilities provided in high rise buildings. In order to begin the implementation of the egress recommendations, NIST sponsored a conference on high rise building egress titled "Rethinking Egress: A Vision for the Future". This conference was held on April 1-3, 2008 at the Airlie (House) Conference Center in Warrenton, Virginia.

Another inflection point in the building fire protection field appears to have occurred on September 11th, 2001.

Minutes of the conference are included in **NIST Technical Note 1647** dated November 2009. Excerpts from Technical Note 1647 include the following:

"*New technologies, design challenges, and research are rapidly redefining the state-of-the-art in building evacuation. Therefore, the time is right to rethink the entire infrastructure of egress from buildings. Approximately 40 experts from a variety of disciplinary backgrounds assembled in Warrenton, VA from April 1-3, 2008 in order to consider building evacuation, starting with a blank sheet of paper.*" (Page 3)

"*Of the 30 recommendations published in the final report of the Federal Investigation into the Collapse of the World Trade Center, several focused on providing reliable egress for occupants from high-rise buildings. . .*" (Page 4)

"*A novel workshop, composed of a broad spectrum of disciplinary experts, provided a forum for discussion and innovative insights. The principal objective of the workshop was to facilitate a reassessment and definition of egress objectives and to develop a vision for the future of the means of egress. . .*" (Page 4)

"*An objective is a statement of something that one desires to achieve in a given decision context. The decision context for this workshop was emergency egress from large buildings.*" (Page 4)

"*The seven fundamental objectives identified by the participants were:*

- *Save lives and prevent injuries to occupants*
- *Save lives and prevent injuries to firefighters/responders*
- *Minimize property damage*
- *Minimize impact on property operations*
- *Minimize economic costs*
- *Reduce stress*
- *Reduce grief* "

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"*Additionally, 12 categories of means objectives were identified. These included:*

- *Enhance detection*
- *Maximize situation awareness*
- *Make people feel safe*
- *Minimize response time*
- *Enhance communications*
- *Enhance safety*
- *Facilitate responder access*
- *Isolate fire*
- *Minimize evacuation time*
- *Improve knowledge about the system*
- *Improve education and training*
- *Provide easy egress procedures*
- *Enhanced Event Detection*
- *Other Alternatives*

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"*Finally, roughly ten percent of the alternatives (37) were selected for preliminary evaluation, which approximated a cross section of the total list.*" (Page 6)

"*In conclusion, the workshop produced hundreds of alternatives for improving egress from buildings during fire emergencies. No single alternative addresses all egress objectives; however, with further research and study, some combinations of alternatives have the potential to rethink the entire means of egress from buildings.*" (Page 6)

"*Following the Federal Investigation of the Collapse of the World Trade Center* [towers] *and subsequent report, the National Institute of Standards and Technology (NIST) partnered with the National Institute of Building Sciences and its Multihazard Mitigation Council (MMC) to implement recommended changes to existing standards of practice and building codes and standards. Of the 30 recommendations published in the final report, several focused on providing reliable egress for occupants from high-rise buildings. Specifically, "building evacuation systems should be improved to include: system designs that facilitate safe and rapid egress; methods for ensuring clear and timely emergency communications to occupants; better occupant preparedness for evacuation during emergencies; and incorporation of appropriate egress technology."*" (Page 10)

"*Following the Federal Investigation of the Collapse of the World Trade Center* [towers] *and subsequent report, the National Institute of Standards and Technology (NIST) partnered with the National Institute of Building Sciences* [NIBS] *and its Multihazard Mitigation Council (MMC) to implement recommended changes to existing standards of practice and building codes and standards. . .*"

"*During its deliberations, the MMC committee reviewing the report recommendations concluded that the use of elevators for evacuation and firefighter access in high-rise buildings had the potential to revolutionize the process of evacuation to such a significant degree that a complete reevaluation of egress systems was warranted. A workshop of multidisciplinary experts in the field would provide a forum for discussion and innovative insights.*" (Page 10)

"*The principal objective of the workshop was to facilitate a reassessment and definition of egress objectives and to develop a vision for the future of the means of egress. As the genesis of the workshop was the findings from the Investigation of the World Trade Center collapse, a particular emphasis was placed on egress from tall buildings.*" (Page 12)

"*The principal objective of the workshop was to facilitate a reassessment and definition of egress objectives and to develop a vision for the future of the means of egress.*"

"*An alternative is defined as any action that is totally under the control of a decision maker that may influence the degree to which at least one of the objectives of emergency egress is achieved. The decision maker can decide to implement it or decide not to implement it. Every alternative should at least contribute positively to achieving one of the means objectives or one of the fundamental objectives. If this did not happen, then of course there would be no reason to consider it.*" (Page 15)

"*During the workshop, there was a discussion about whether the term alternative should be something different including option, tactic, strategy, choice and so forth. In this document, we mean that the alternatives are the aggregation of any of those similar ideas, where similar means something under the control of decision makers that can be done that would influence egress.*" (Page 15)

"*Note that most alternatives are not complete solutions. Rather, one might rather think of these as elements of alternatives. Specifically, one could do something that would facilitate movement of disabled people in stairways in a particular building. This does not mean that would be the only thing that would be done to facilitate emergency egress. Other alternatives that might reduce the size of a fire once it had started in a building or that would better communicate information to people about how to egress in the event of an emergency could also be implemented. Thus, it is appropriate to consider many of the alternatives generated in this workshop as elements of what might be considered a complete package of potential solutions.*" (Page 15)

"*. . .It seems reasonable that there would be thousands of potential alternatives that could facilitate emergency egress from buildings. The set of alternatives documented here, and their categories, begin to define the full scope for most of the types of alternatives that might be feasible within a 10-20 year period. We believe that additional types of alternatives can likely be identified and within both new and existing categories, additional focus in creating alternatives would be useful.*" (Page 16)

"*Jason Averill of NIST opened the workshop by welcoming everyone present, along with the wider audience participating via webcast. First, Averill highlighted some of the constraints of current egress systems and practices in high rise buildings. A concept as simple as building stairs is poorly understood: for example, how much benefit is conveyed to the occupants by an incremental change in stair width? Given the substantial up-front, life-cycle, and opportunity costs of stairwells, Averill argued that a stronger technical basis for performance should be established.*" (Page 17)

"*Averill contended that the current state of egress requirements reflects three realities: lack of basic research, lack of concentrated effort directed at the problem, and regulatory inertia. This workshop was seen as a first step towards defining an egress system which is reliable, robust, cost effective, and well-understood.*" (Page 17)

"*Russ Sanders reviewed fire department operations with respect to building occupant and firefighter safety. As a context for operations, Sanders discussed risk assessment and mitigation. Risks for the fire service responding to a building fire tend to increase with the height of the building for several reasons:*

- *Most aerial apparatus can reach only 8 stories. This removes the option of rescue by fire department ladder above 8 stories.*
- *Master streams are rarely effective and therefore, the fire service is forced to rely on offensive interior operations, which tend to be the most dangerous operations.*
- *Lead times to get people and equipment (tools and air bottles, e.g.) high in a building can be significant.*
- *The taller the building, the larger the number of people who can be caught above the fire.*"

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"*. . .For example, one of the most complex aspects of high-rise firefighting is ventilation. While the fire service puts out a fire with water, it controls the fire by controlling the ventilation. Properly controlled ventilation can dramatically reduce the risks to the occupants and firefighters, while improper ventilation can result in civilian or firefighter deaths.*" (Page 18)

"*Most aerial apparatus can reach only 8 stories.*"

"*The only way for the fire service to verify that a building has been evacuated is to conduct both a primary and secondary search. This requires that the fire service maintain control and integrity (free of smoke and heat) of the stairwells.*" (Page 18)

"*Jacobsen then discussed some of the many problems with integrating all of this information into a single systems approach:*

- *Systems issues are multiscale and multiphysics.*
- *Uncertainty propagation in the system can overwhelm the utility of the output. However, one approach is to consider the use of reduced-order models.*
- *Codes and regulations need to keep up with "cyberphysical"systems: IT controlling physical systems.*
- *The information should be available in multiple locations: off-site (en-route for firefighters) and on-site (through a fire panel).*

- *Information flows are diffuse and lack organization. Opportunities for analysis and presentation to occupants and firefighters should be considered, such as decision support tools.*

- *The human-machine interface requires development.*

- *Current generation predictive models currently are computationally expensive. New techniques in reductive methods should be considered in order to produce answers on the time scale required for actionable results.*

- *The interfaces between components are where many problems emerge. The systems are dynamic; in particular, the time scales do not always align.*"

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"*. . . Growing economies are building towers taller than ever before. Along with the height of the building come increasing demands for security at several levels: perimeter, enclosure, core, and emergency access core. These requirements often conflict with the goals of building egress and emergency services ingress. One solution which included use of pressurization systems and protected elevators currently utilized in high-rise design was reviewed.*" (Page 20)

"*The majority of tall buildings are mixed-use buildings.The use-groups often found at highest portions of super-tall buildings (observation decks, restaurants, hotels, assembly spaces, e.g.), often include occupants who are unfamiliar with the egress systems in the building, which creates a particular challenge for high-rise egress design.*" (Page 20)

"*Finally, Galioto compared the increased risk of designing high-rise buildings to the increased risk of ships out at sea. Those ships require life boats which are able to protect passengers from an adverse event on the ship. Super-high-rise buildings require innovative egress solutions which are comparable to the risks inherent to the building under consideration.*" (Page 20)

"*The factors which influence human behaviour are well-known. By consolidating and implementing this body of knowledge, egress performance can be improved. Key findings include:*

- *Panic can happen, but is rare and words cannot prevent or cause panic. However, building design can influence panic: e.g., doors that swing outwards and sufficiency of egress paths.*

- *Building evacuation is not a continuous process. It happens in "umps and bumps."*

- *Alarms should interrupt ongoing life. However, the alarm simply sends people in search of additional information. People don' remember indicators, unless the indicator is drilled into people, relentlessly. To alert people, the alarm should be as intrusive as possible.*

- *People are hard-wired to think they are safe, that disasters happen to other people, and therefore, that it is probably a false-alarm.*

- *Conflicting information abounds. Formal alerts compete with informal alerts, which are cues from the surrounding environment that something is wrong.*

- *Seconds of delay can cost lives in a fire emergency, but people are wired to perceive that they are safe. Until they confirm the risk through milling (talking with other people) or external cues, occupants will delay.*

- *When instructions are delivered to occupants, several aspects of communication are well established in the literature:*

  - *Channels: the more the better. If you want people to take an action, warn them through as many channels as possible and ensure consistency amongst channels.*

  - *Frequency: the same message should be repeated as many times as possible; Madison Avenue has known for years that people will not remember something until you repeat it ten times.*

  - *Content: the single most important message that can be delivered to an occupant is what you want them to do. Don't talk about the fire or the earthquake, but give them specific, actionable advice.*

  - *Style: keep it simple, precise, authoritative, accurate, and avoid jargon. Be internally consistent.*

  - *Source: tell them who is speaking. The most authoritative source is different depending on the situation, but surveys indicate that firefighters are the most authoritative source in the United States (but for only 35% of the population).*

- *Cues are critical. Fire trucks, smoke, flames, and floor wardens who are leading an evacuation are all strong cues. Meanings may be different, however, depending on the filters that occupants bring to the event. Filters include education, age, gender, race, language, associations with co-workers, parental status, social isolation, experience, etc.*

- *Information needs do not cease when the alarm is sounded. Once the occupants are started, they still require additional guidance.*

(Pages 20 and 21)

"*Najib Abboud discussed how the patterns of increased urbanization are driving the trend towards taller buildings. The trend is being set on a worldwide stage, and is currently focused on multi-use skyscrapers (vertical cities). The driving force behind the multi-use prototype is risk management: if one real estate sector is down, the other use groups can maintain a revenue stream for the owner.*" (Page 21)

"*The first challenge is establishment of public policy. Standardization sets a level playing field from an economic perspective. Without standards, few projects will break the trend. What is safe? What is life safety? How long do you need the building to stand? These are the public policy questions that codes and standards need to specify. The technical challenges are achievable once the public policy is established.*" (Page 21)

> "*Panic can happen, but is rare and words cannot prevent or cause panic.*"

"*The second challenge is to integrate fire engineering with structural engineering. The two disciplines are as unintegrated as can be. The only way that structural engineers can think of fire is as a load. Conversely, the information needs to be provided to the structural engineer in those terms: intensity, duration, location, and statistical probability. Hurricanes and earthquakes are reduced to return frequency, and fire needs to be considered similarly.*" (Page 21)

"*The third challenge is to adopt lightweight, flexible materials which can resist a variety of loads, including blast, fire, and vandalism. Traditional materials are either too heavy to build tall buildings with or too light to resist the variety of loads imposed.*" (Page 21)

"*To conclude the invited presentations portion of the workshop, Bud Nelson shared his experience with the 1971 Airlie House Conference of High Rise Life Safety, which served as an inspiration for the current workshop. The objective of the 1971 conference was to bring independent disciplines together and develop the concept of a systems approach to fire in high-rise buildings. The first element of the systems approach was the threat from fire. The second element was force modification (sprinklers, compartmentation, etc). The third element was to protect the exposed. All of these systems concepts can be translated directly to an analysis of the egress system. However, much additional research will be required in order to prevent 'garbage in, gospel out.'*" (Page 22)

> "*To conclude the invited presentations portion of the workshop, Bud Nelson shared his experience with the 1971 Airlie House Conference of High Rise Life Safety, which served as an inspiration for the current workshop.*"

"*The 1971 workshop had tremendous impact on the design of today' high rise buildings, including the advent of deterministic modelling. Concepts of fire safety evaluation system, performance based design, and systemic building design can trace many of their roots right back to the Airlie House Conference Center.*" (Page 22)

"*Considerable discussion was devoted to the sky bridge concept and the idea of buildings sharing resources and equipment. Opinions varied on the ideas. It was noted that the use of sky bridges is being explored in Australia, but that it is a massive undertaking that requires a totally new way of thinking and modifications to building codes. Others indicated that the concept is a difficult one to use and should be considered only on a case by case basis. Still others suggested that egress is only one benefit of sky bridges; they can be used to create an urban network with vertical links within buildings and people become familiar with their evacuation routes because those are the routes they use on a daily basis. One group member mentioned the 1969 book, Urban Design Manhattan, which explored the idea of interconnecting buildings on many levels but did not specifically address emergency egress. A proposal for redevelopment of the World Trade Center complex called for the use of sky bridges, but it was unsuccessful; it would have been a very good example of how to develop a large site into one complex of functional, integrated buildings. Technical design issues involving such things as different response frequencies were mentioned as were the legal issues (not simply a contractual issue but also an entitlement issue in real estate law). It was noted that elevators account for about 15 percent of a tall building's energy usage and that sky bridges linking lower floors could reduce elevator use and, consequently, energy use and cost.*" (Page 24)

"*Differences in function – high rise buildings of mixed occupancy and use, assembly buildings, and general use buildings – were discussed in terms of the impact building use has on egress system requirements.*" (Page 24)

"*The general consensus was that information and communication techniques are most in need of improvement.*" (Page 25)

"*Averill pointed out that NIST has started a systematic program of data collection of fire drills in buildings. This covers multiple occupancies, heights, and counter flow issues. A matrix exists that we're trying to fill out over time in order to find out how these systems behave. Another aspect of the study is the human behavior issues. We have all the equipment to gather this data but have encountered problems gaining access to buildings. He continued that there are differences between fire drill data and real emergency data and of course right now only fire drill data is available.*" (Page 25)

"*A few key concepts were persistent themes throughout the workshop and are summarized below:*

- *Information is crucial. Gathering it. Processing it. Communicating it. In an era of change, no aspect of building evacuation is changing faster than information. With power, however, comes responsibility. Simply because we CAN collect a piece of information, does not mean that we should force feed that to our e-mergency responders, our building managers, or our occupants. It must be carefully assessed and presented in a manner which incorporates what we know about human factors, social psychology, and situation awareness. Above all, however, information must not be ignored.*

- *Building evacuation procedures must be robust and adaptable. The procedures must adapt to (a) changes in the event and (b) different threats and scenarios.*

- *Design must make egress systems (first) obvious and intuitive and (second) integrated into the everyday use of the building, without compromising our growing desire for physical security. Elevators may be an alternative which allows occupants in tall buildings to go out the way they came in, as well as provide egressibility to persons with mobility impairments, in the same way the ADA provided accessibility.*

- *Solutions which can apply to the existing building stock as well as our new construction will have greater impact in terms of the number of people and lives affected.*

- *Technology should be harnessed to deliver notification and induce direct action. Cell casting, desktop computer interruption, PDA's, cable television, improved signage, and other modes should deliver reliable, timely, updated information targeted to specific people.*"

- *We need to ensure accurate, timely, and reliable communications for firefight-ers. Firefighters need a way to communicate to the occupants and a way to obtain information from the occupants.*

- *As a community, cost-benefit analysis of many of the alternatives needs to be considered. However, cost-benefit analysis requires a measure of performance and an assessment of cost. In many cases we fall short of both.*

- *Finally, evacuation will not always be the preferred solution. Protect in place, phased evacuation, and areas of refuge may minimize business interruption, as well as minimize harm to occupants. The nature of the threat will dictate the appropriate response.*

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"**Minimize economic costs**

Reduce societal cost of loss of lives
Reduce societal cost of protecting lives
Reduce business cost of protecting lives
Ensure cost effective construction and operational costs
Reasonable costs – first and continuing
Minimize or reduce the cost in terms of disruptions caused by evacuation
Minimize or reduce the cost of enabling the actual evacuation
Use no more resources than society is willing to expend
Provide solutions that are cost effective
Decrease cost of building and variety of buildings
Reduce egress costs and carbon footprint
Maximize return
Decrease cost of the building
Prevent law suits"

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"**Minimize impact on property operations**

Prevent loss of business
Minimize impact on building operations
Minimize negative impact on the functionality of the building
Allow normal functioning of building
Avoid unnecessary disruptive evacuations"

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"**Minimize evacuation time**

Reduce time
Minimize total egress time
Decrease evacuation time
Provide high-capacity/short time egress
Enable immediate start of evacuation
Simplify egress process
Speed up building evacuation
Provide efficient egress system
Create efficient handicap egress
Provide equality for egress of disabled and able bodied occupants
Develop methods to increase speed of evacuation
Quickly move/guide population away from harm (smoke, fire, biological, chemical)
Ability to coordinate an orderly exit
Provide uncompromised pathways
Provide the earliest possible notification"

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“ALTERNATIVES INVOLVING BUILDING CONSTRUCTION CHANGES

Lightweight innovative materials for egress paths
Control fuel load to avoid evacuation
Enhanced fire resistive construction for high-rise buildings
Reduce fuel loads in buildings
Limit use of combustible materials
Self-protected buildings –sprinklers, fire/smoke resistant construction
Prevent fires from occurring in the first place through material selection and control
Build buildings to egress standards
Protected corridors, stairways, skybridges
Harden existing buildings
Develop new structure external to existing buildings
Place exit signs high and low
Battery backup for egress lighting
Hardened evacuation routes
Design buildings not to collapse
Shorten evacuation routes
Mechanize evacuation routes (moving walkways, elevators)
Improve quality of egress routes – finishes, natural light, view
Adequate lighting
Adequate width/capacity of egress
Adequate signage
Smoke control system with training for fire department use
Protected exit route
Install readily visible directional indicators at key locations
Normal and emergency movement systems should be integrated
Egress systems designs that reflect human behavior
Pressurized stairwell
Effective smoke control
Move standpipes
Separate emergency cores
Create horizontal and vertical compartmentation
Use horizontal dimension for egress rather than rely on vertical
Improve visibility of signage
Require battery back-up and emergency generators
Increase use of daylight through windows and skylights
Build-in ergonomics to system designs
Require separation of egress paths
Make exits attractive, functional and normally used
Color stairs make them more user friendly
Alternate discharge at base of building
Horizontal exits
Building subdivision
Confining smoke, heat, and fire to a small portion of the building
Fire/smoke isolation of elevators the lobbies
Flashing exit signs
Require/provide manual and automated vent opening in buildings
Provide hardened floors at intervals in tall buildings
Durable (temp, smoke, impact) enclosure envelope
Enhance illumination
Ensure smoke control has an emergency power supply or that all dampers are fail safe
Improve signage
Provide large “fire doors”to compartmentalize large floor plans

Prevent smoke from entering stairs
Structure the building for dispersion (allow for evacuation without competition)
Enhance visibility of exit signs: larger, flashing or digital signage
Enhance paths to exits with pavement markings
Locate exits in generally used areas such as toilets
Place painted or tiled lines to the exits
Flashing or re-designed signs"

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"ALTERNATIVES INVOLVING ELEVATORS

Simultaneous use of elevators and stairs
Use elevator or other mechanical means
Protected elevators for disabled
Protected elevators for evacuation of transitional refuge areas
Hardened elevators
Protected elevator lobbies
More aggressively educate officials, owners, and providers about the benefits of protected elevators
Use elevators
Provide incentives to increase elevator use
State-of-the-art-elevators
Training and drills in the elevators (maybe video training)
Use of elevators for egress
Require elevators vestibules in all buildings with elevators
Provide equipment hoist/shaft for fire fighting equipment
"Hardened"elevators with reliable, alternative power
Improve elevator doors to reduce smoke stratification in buildings –may increase evacuation time
Make use of elevators accepted by the public
Lock out and tag out elevator power"

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"ALTERNATIVES INVOLVING SOCIETAL/REGULATORY/LEGAL CHANGES

Don't build high buildings
Develop risk "scale" for building occupants
Bill for response based on risk
Incorporate response costs in investment, design and development cost
Revalue sprinklers (in real costs)
National standards for crowd management and evacuation training
Tear down tall buildings
National high-rise building codes that require modern egress
Increase integration of rules such as emergency and security to reduce conflicts
Quantitative performance criteria
National standard for emergency action protocols
Make occupants more fit
Staggered density in buildings
Provide immunity from lawsuits for research-driven approaches
Standardize evacuation procedures across country by emergency type
Prevent lawsuits

Standardize inspection program and testing
Limit tradeoffs
False alarm requirements with penalty for false alarms
Legislate immunity for performance-based design
Require regular testing and inspection
Required modeled systems to be tested after installed
Look at evacuation from an urban scale
Develop threat strategies and evacuation strategies
Share emergency systems with multiple buildings
Standardize egress strategies according to type of emergency
Annual tests of emergency systems: generators under full load, fire pumps, egress
Restrict the heights of tall buildings
More research money for egress studies to obtain more realistic and up to date data
Analyze time necessary to evacuate building safely prior to spending money
Improve public education on eating healthy to reduce obesity problem in this country
Limit assembly occupancies at the top of buildings
Require periodic tests of smoke control systems
Don' reduce the fire-resistance of building elements when sprinklers are installed
Ensure decision makers consider cost/benefit analysis for each alternative
Change standards and regulations"

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"ALTERNATIVES TO ENHANCE STAIRWELL EVACUATION/REDUCE STAIRWELL LOAD

Multiple and wide staircases
Install tracks in stairwell handrails for trolley seats to be used by all occupants
Use electroluminescent strips in hotels
Recalculate stair widths
Set doors to stairs to allow for traffic flow
Positive pressure for stairwells
Increase stair capacity
Increase number of stairs
Force stair usage in everyday activities
Use vestibule for hose line deployment without contamination of stairwell
Paint stairs in white paint
Widen the stairs
Remove fire equipment from stair towers
Design stairs with fire fighting procedures in mind
Positive air pressure in stairs
Wider stairs
Dedicated egress stairs for responders
Develop periodic 'rest areas' within stair towers
Require some level of hardening at exit (stair) enclosure
Third stairwell for fire fighters"

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"ALTERNATIVE IMPACTING THE DESIGN PROCESS/RISK INFORMED PERFORMANCE-BASED DESIGN

Base designs on risk assessments
Model-based evaluation of designs
Standardize design basis events and performance objectives to set public policy
Develop cost/benefit tools to deal with rare, high consequence events
Use modeling to estimate evacuation time for buildings for different circumstances
Consider worst-case scenarios and build in countermeasures
Use modeling to estimate evacuation time for buildings for different circumstances
Use egress modeling to choose between alternative evacuation strategies in response to designated scenarios
Perform engineering analysis to evaluate emergency procedures
Improve accuracy of evacuation software
Egress models should consider more threats than just fire
Perform cost/benefit analysis of solutions
Publish articles on scenarios which need to be considered
Design for hazmat and weapons of mass destruction, including chemical detectors
Use performance-based criteria for all threats, more than just fires
Develop process for creating threat scenarios and performance basis for providing alternatives acceptable to stakeholders
Base design on risk and performance-based design
Develop an understanding of all of the events that would prompt full building evacuation
Establish risk factors"

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"ALTERNATIVES THAT INVOLVE EVENT PROCEDURAL CHANGES

Believable defend in place strategy
Ensure egress is only in response to real incident
Ensure equal use of egress routes
Design emergency procedures effectively
Establish evacuation procedures for disabled occupants
Guidelines for occupant evacuation
Stairs to refuge floors, elevators from there
Emergency procedures manuals
Decision support systems
Design unique procedures for each specific type of emergency
Allow use of "normal" elevators as long as possible
Standardize evacuation strategies
The use of staff in a more significant role in guiding occupants out of the building
Better use of fire wardens – maybe they are the first ones out (follow the leader)
Occupant procedures that actually take into account what people WILL do
Practice egress with real event scenarios – blocked stairs, theatrical smoke, fire department in stairs
If we know that milling will occur, establish groups (evacuation groups of the occupants) to facilitate the process (since we know that they will likely get into groups anyway)"

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Analysis

As with the NIST WTC towers collapse investigation, the NIST WTC 7 collapse investigation and other fire investigations conducted by the National Institute of Standards and Technology, the NIST "Rethinking Egress" Workshop fails to lay the foundation for the proceedings. Before analyzing and offering commentary on the excerpts above, let's take a look at the safety statistics.

The following statistics on fire fatalities which occur in high rise buildings in the United States are contained in a report published by the National Fire Protection Association (NFPA) titled *High Rise Building Fires* authored by John R. Hall, Jr., Fire Analysis and Research Division, and dated June 2009:

Civilian Fire Fatalities-U.S. High Rise Buildings			
	Office Bldg.	Hotels	Apartment Bldg.
1985	1	0	54
1986	1	0	32
1987	2	5	46
1988	0	8	83
1989	0	5	97
1990	0	7	76
1991	0	0	23
1992	1	0	31
1993	0	0	43
1994	0	0	51
1995	0	0	53
1996	0	8	56
1997	0	6	27
1998	0	0	35
Total:	**5**	**39**	**707**
Annual Average:	**< 1**	**3**	**51**

Based upon recent statistics collected and published by the National Fire Protection Association, it can be determined that roughly 95 percent of the civilian fire fatalities in building structure fires in the United States occur in residential occupancies. The number of civilian fire fatalities which occur in residential occupancies provided with sprinkler protection is a mere handful.

Again, based upon statistics collected by the NFPA, the number of civilian fire fatalities which occur in commercial (non-residential) occupancies in the United States varies between 100 and 200 and, once again, the presence of sprinkler protection reduces the number of civilian fire fatalities in commercial (non-residential) to a handful.

Given the statistics above, it seems obvious that the reason that NIST never makes reference to the building safety statistics is that the statistics clearly show that both low rise buildings provided with sprinkler protection and high rise buildings in the United States are exceedingly "safe".

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The basis for NIST's efforts to make buildings, particularly high rise buildings, "safer" is based upon concept of "multi-hazard" design. NIST is on record indicating that high rise buildings should not only be designed to protect occupants against fire, but simultaneous building hazards such as the combination of fire and wind events. In addition, NIST is on record indicating that high rise buildings need to be designed with chemical, biological or radiological (CBR) attacks in mind. Despite the fact that it is NIST's opinion that buildings should be designed for "multi-hazard" events and for CBR attacks, to date, NIST has not provided a generalized risk analysis regarding the occurrence of such events. In other words, NIST has not provided the private sector with an estimate of the frequency of occurrence of "multi-hazard" events or CBR attacks.

With the above background as a foundation, we can now proceed with a discussion of the excerpts from the "Rethinking Egress" Workshop.

(Continued in Part 2)

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