In

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To: wtc@nist.gov
Subject: Public Comments to the NIST WTC Recommendations

Attached are Public Comments to the NIST WTC Recommendations being made by The National Council of Structural Engineering Associations (NCSEA) and correlated by Edwin T. Huston, PE, SE, Chair of the Code Advisory Committee, General Engineering Subcommittee. I may be reached by email at huston@smithhustoninc.com or by phone 206-448-8448.

Best Regards
Ed Huston

NCSEA Response to NIST Recommendations.doc

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Response made by The National Council of Structural Engineering Associations (NCSEA)
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Report Number: NCSTAR 1 Chapter 9 - Recommendations

Recommendation 1. NIST recommends that: (1) progressive collapse should be prevented in buildings through the development and nationwide adoption of consensus standards and code provisions, along with the tools and guidelines needed for their use in practice; and (2) a standard methodology should be developed—supported by analytical design tools and practical design guidance—to reliably predict the potential for complex failures in structural systems subjected to multiple hazards.

NCSEA Response:

1. The suggested methodology discusses the design for the removal of a single column or transfer beam. In the WTC collapse, more than 30 adjacent columns were removed. In the Oklahoma City Murrah Federal Building, four adjacent columns and the transfer beams above them were taken out. No design methodology can accommodate this level of destruction and result in useful buildings. This recommendation would not have changed the outcome of either of these events.
2. This recommendation calls for a building code change for all buildings. It would be prohibitively expensive and take huge amounts of time, effectively slowing down construction to a point that nothing could be built. If such standards are to be incorporated they should be tied to some high target classification of buildings, such as federal buildings, trade centers, or other iconic buildings. Otherwise this would be applied to two-story strip malls.
3. Developing such design protocols is more difficult for certain types of buildings. In a masonry or concrete building with long walls on all four sides, it is difficult to define what constitutes an element. Is it a 40-foot long wall that is one or more stories tall? What is an element in a wood framed building? The British experience has shown that enforcement for these classes of buildings has been problematic, and they have been working with it since 1970.
4. Some have suggested that tying a building together could lead to worse performance in a disaster. The loss of a critical element could cause connected elements, which otherwise would not have been affected, to be pulled into the failure. In fact, at the Pentagon, the presence of a building separation joint prevented the collapse of additional sections of the structure.

Recommendation 2. NIST recommends that nationally accepted performance standards be developed for: (1) conducting wind tunnel testing of prototype structures based on sound technical methods that result in repeatable and reproducible results among testing laboratories; and (2) estimating wind loads and their effects on tall buildings for use in design, based on wind tunnel testing data and directional wind speed data.

NCSEA Response: The effectiveness and reproduceability of wind tunnel tests is unrelated to the collapse of the WTC, or any other known terrorist attack. This recommendation would not fix any of the problems which occurred in this or other attacks, or problems that would occur under different attack scenarios

Recommendation 3. NIST recommends that an appropriate criterion should be developed and implemented to enhance the performance of tall buildings by limiting how much they sway under lateral load design conditions (e.g., winds and earthquakes).

NCSEA Response: Building sway is, in part, a function of the stiffness of the lateral force resisting system. The stiffness of the lateral force resisting system of the WTC is unrelated to the collapse of the WTC or to the loss of life of the WTC. The Pentagon and the Oklahoma City Murrah Federal Building did not have undesirable sway characteristics; in fact the Pentagon given its height and overall size would have been a very stiff building. This stiffness of these latter two buildings did not result in preventing collapse or lessening the loss of life in their partial collapses.

While building codes do not have specific limits for the sway of tall buildings under wind load design conditions, tall buildings are typically designed to meet relatively stringent sway criteria which have been developed based on occupant comfort. The existing criteria, which has been based in part on review of less than optimal performance of a few notable tall buildings, results in acceptable building performance.

This recommendation would not have changed the outcome of the WTC or other terrorist attacks and does nothing to prevent future building collapses and is therefore outside the scope of this investigation.

Recommendation 9. NIST recommends the development of: (1) performance-based standards and code provisions, as an alternative to current prescriptive design methods, to enable the design and retrofit of structures to resist real building fire conditions, including their ability to achieve the performance objective of burnout without structural or local floor collapse: and (2) the tools, guidelines, and test methods necessary to evaluate the fire performance of the structure as a whole system.

NCSEA Response: This appears to be a good objective. Should it be applied universally to all buildings, regardless of height, or should it be required for certain classes of buildings, such as federal buildings, trade centers, or other iconic buildings, or buildings over a certain height? Buildings with built-in "areas of refuge" should meet this performance objective.

For retrofit situations, with the retrofit the mandatory or would the retrofit be required if the building were being retrofitted for a change of occupancy? Would this requirement be triggered for retrofit of a percentage of the building's value? For example would it be required for the seismic retrofit of a tilt-up warehouse? The retrofit issue needs to be carefully considered. Past building code regulations regarding retrofits have proven to be barriers to improve building safety rather than promoting improved building safety. For example, if the owner wishes to seismically upgrade a building and at the same time must upgrade the mechanical and electrical systems, due to the code regulations triggered by the cost of the upgrade, the result in many cases is that nothing is upgraded.

As part of the development, there needs to be validation that the models actually predict "real" behavior.

Recommendation 11. NIST recommends that the performance and suitability of advanced structural steel, reinforced and pre-stressed concrete, and other high-performance material systems should be evaluated for use under conditions expected in building fires.

NCSEA Response: This appears to be a good objective. It is already a requirement of all building codes.

Recommendation 18. NIST recommends that egress systems should be designed: (1) to maximize remoteness of egress components (i.e., stairs, elevators, exits) without negatively impacting the average travel distance; (2) to maintain their functional integrity and survivability under foreseeable building-specific or large-scale emergencies; and (3) with consistent layouts, standard signage, and guidance so that systems become intuitive and obvious to building occupants during evacuations.

NCSEA Response: Prior to the adoption of the IBC or NFPA codes the three legacy codes had different requirements for remoteness of egress components. The effectiveness and safety record of the three legacy code requirements for remoteness should be evaluated. In different emergencies, different outcomes can occur. In some cases remoteness can be beneficial, in other cases the increased travel distance can be a hindrance.

Hardening of egress components could have significant and substantial impacts on building design. Hardening of these components will increase their stiffness and attract additional force to them if concrete or masonry enclosures are employed. This becomes a circular problem. As more force is attracted, more stiffness is required. It is also unclear just how "hard" these components should be. After the first WTC bomb attack, people were able to exit elevators by cutting through gypsum wallboard enclosures with penknives. This would not be possible if the enclosure had been "hardened". Finally, hardening of exit components could create new terrorist opportunities. A secondary bomb placed in a hardened stairwell could kill a tremendous number of people.

Standardized signage, which is intuitive and obvious, is an excellent recommendation. At the same time standardization of elevator buttons should be considered. The "open door", "close door", and "alarm" buttons should always be in the same location and in the same order on all elevators.

Recommendation 21. NIST recommends the installation of fire-protected and structurally hardened elevators to improve emergency response activities in tall buildings by providing timely emergency access to responders and allowing evacuation of mobility-impaired building occupants. Such elevators should be installed for exclusive use by emergency responders during emergencies. In tall buildings, consideration also should be given to installing such elevators for use by all occupants.

NCSEA Response: Currently, building codes already require elevators to return to the lobby during fire alarm so that emergency responders can use them. Elevator use by building occupants during a fire has not been shown to be an effective method of evacuation. If the elevator doors open into a smoke engulfed floor, the elevator occupants can die of smoke inhalation. The elevators, themselves, are already required to be housed within fire-protected enclosures.

Structurally hardening elevators is problematic. In some disasters, people have been able to escape from damaged elevators because they had not been hardened.

Recommendation 25. Nongovernmental and quasi-governmental entities that own or lease buildings and are not subject to building and fire safety code requirements of any governmental jurisdiction are nevertheless concerned about the safety of the building occupants and the responding emergency personnel. NIST recommends that such entities should be encouraged to provide a level of safety that equals or exceeds the level of safety that would be provided by strict compliance with the code requirements of an appropriate governmental jurisdiction. To gain broad public

confidence in the safety of such buildings, NIST further recommends that it is important that as-designed and as-built safety be certified by a qualified third party, independent of the building owner(s). The process should not use self-approval for code enforcement in areas including interpretation of code provisions, design approval, product acceptance, certification of the final construction, and post-occupancy inspections over the life of the buildings.

NCSEA Response: While it is true that many national and local state government buildings are not required to meet local city building codes, current practice is that these structures are designed to requirements that are equal or better than the requirements of the local codes. These agencies also already require internal review of the construction documents prepared by the Registered Design Professionals.

Recommendation 27. NIST recommends that building codes should incorporate a provision that requires building owners to retain documents, including supporting calculations and test data, related to building design, construction, maintenance and modifications over the entire life of the building. Means should be developed for offsite storage and maintenance of the documents. In addition, NIST recommends that relevant building information should be made available in suitably designed hard copy or electronic format for use by emergency responders. Such information should be easily accessible by responders during emergencies.

NCSEA Response: Many Building Departments already retain copies of the building plans. Whether these plans would be accessible during an emergency is another matter. Building Departments are not open 24/7. While it is possible to require building owners to retain copies of the building plans, it may not be possible to guarantee that those plans are accessible during an emergency. The person who knows where the plans are may not be available. If the plans are stored offsite, the storage facility may not be open at the time of the emergency. This would mean that the agencies of the possible first responders would have to have hard copy or electronic format copies of plans for all significant structures within their jurisdiction. This puts a tremendous burden on the agencies that provide the first responders. Finally, plans sets for tall buildings are very large and expertise is required to read and interpret the information. Will the agencies that provide first responders now need to have on staff structural engineers to provide these interpretation capabilities? These problems become even more formidable when the plan sets have to include modifications due to maintenance, alterations or tenant improvements.

This problem is compounded when calculations and test data must be available in addition to the plans sets. Furthermore, calculations become outdated due to building code changes and materials code changes long before the building has reached the end of its useful life. In emergency situation, even the personnel in the offices of the Registered Design Professionals will not have time to refer to and interpret the calculations and test data. This portion of this recommendation adds nothing to the emergency response in the time of a disaster.

Recommendation 28. NIST recommends that the role of the "Design Professional in Responsible Charge" should be clarified to ensure that: (1) all appropriate design professionals (including, e.g., the fire protection engineer) are part of the design team providing the standard of care when designing buildings employing innovative or unusual fire safety systems47, and (2) all appropriate design professionals (including, e.g., the structural engineer and the fire protection engineer) are part of the design team providing the standard of care when designing the structure to resist fires, in buildings that employ innovative or unusual structural and fire safety systems.

NCSEA Response: This calls for a building code change for all buildings. If such standards are to be incorporated they should be tied to some high target classification of buildings, such as federal buildings, trade centers, etc. Otherwise this would be applied to two-story strip malls. In modern building design, the vast majority of buildings constructed do not use the services of fire protection engineers. Requiring them increases the cost of building design without providing an equivalent benefit. Furthermore, when fire protection engineers are used in the design of significant structures, they are typically employed to reduce the cost of the structure and the cost of the fireproofing.

NIST has not shown that the use of fire protection engineers would have changed the outcome at either the WTC or the Pentagon.

Finally, the purpose of defining the Design Professional in Responsible Charge is so that there is one "go-to" person for the discipline in question. It does not preclude teamwork, as NIST seems to imply. This seems to be unnecessary.

Recommendation 29. NIST recommends that continuing education curricula should be developed and programs should be implemented for training fire protection engineers and architects in structural engineering principles and design, and training structural engineers, architects, and fire protection engineers in modern fire protection principles and technologies, including fire-resistance design of structures.

NCSEA Response: This is an excellent recommendation.

Recommendation 30. NIST recommends that academic, professional short-course, and webbased training materials in the use of computational fire dynamics and thermostructural analysis tools should be developed and delivered to strengthen the base of available technical capabilities and human resources.

NCSEA Response: This is an excellent recommendation.