From: Wayne.D.Holmes, P.E., FSFPE <wholmes@hsb.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : wholmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : Various
Paragraph : Recommendation No. ALL
Comment : Each recommendation should propose specific improvements to building standards, codes, and practices based on the technical causes of the WTC Tower failures or technical aspects of evacuation and emergency response to the 9/11 WTC incidents.
Comment Reason : In order to affect changes through codes and standards making organizations, specific recommendations are necessary.

The recommendations contained in NCSTAR 1 outline general actions to be taken by others with respect to proposed changes in codes, standards, and practices. There are no specific improvements or revisions in the recommendations that can be implemented directly into codes, standards, and procedures.

Public Law 107-231, National Construction Team Act, establishes National Construction Safety Teams whose duties include to □recommend, as necessary, specific improvements to building standards, codes, and practices based on findings&□ In the preface to NCSTAR 1, it is stated that a specific objective of the NIST WTC Investigation is to □identify, as specifically as possible, areas in current building and fire codes, standards, and practices that warrant revision.□

While the wording in the duties and objectives of Public Law 107-231 and NCSTAR 1, respectively, differ slightly, each identifies the need to be specific in recommended improvements or revisions to codes and standards. In compliance with the Act and so that the organizations responsible for implementing changes in codes and standards can take appropriate actions to make specific changes in codes and standards deemed appropriate by the National Construction Safety Team, each of the recommendations should contain specific recommendations for proposed changes in codes and standards.

Revision Suggestion : Revise each recommendation to make specific recommendations for specific improvements to building codes, standards, and practices.

2005 WTC Report Comment Application 1.0, dlowe@nist.gov, rev. 6/21/2005

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To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : Various
Paragraph : Recommendation No. ALL
Comment : Each of the Recommendations, and their supporting text, should be revised based on their risk-significance and cost-benefit.
Comment Reason : I support making risk-effective and cost-beneficial changes in codes and standards for fire protection of buildings and fire safety of occupants.

However, NCSTAR 1 and other NIST reports related to the WTC incidents do not indicate the level of risk reduction to be derived or the benefit to be gained by implementing the recommendations based on the cost to implement the recommendations.

Executive Order 12866 requires that federal agencies consider cost and benefit in changes to regulations. Agencies must consider the degree and nature of risks to assure that regulations are cost-effective. In assessing costs and benefits, agencies must assure that regulations impose the least burden on society taking into account the consequences and costs of intended regulations.

It is recognized that NIST is not implementing any regulations with the recommendations in NCSTAR 1 but it is clear that NIST recommending changes in regulations that, if implemented, will likely result in significant societal costs. Neither the costs to implement nor the reduction in risk to the public have been identified, quantified, or analyzed.

While NIST may not be subject to E.O. 12866 because it is not implementing any regulations, NIST is recommending the implementation of recommendations to change regulations or create new regulations at some levels. Section 9 of Public Law 107-231, National Construction Safety Act, states that NIST shall promote the adoption by the Federal Government of the recommendations for specific improvements to building standards, codes, and practices. The intent of E.O. 12866 for cost-benefit analysis of significant regulations should be followed. Irrespective of the Executive Order, cost-benefit analysis and risk significance information from NIST are necessary to support the recommendations and to assist standards-making organizations in making informed decisions to implement the recommendations in codes and standards.

While it might be possible to implement the recommendations, it is not clear

that it is necessary to implement the recommendations based on their cost-effectiveness, risk-effectiveness, response to credible risks, need for implementation for all tall or low-rise buildings, and their overall societal impact.

Revision Suggestion : Additional supporting information on cost-benefit should be provided in the recommendations and NIST WTC report(s) supporting documentation.

2005 WTC Report Comment Application 1.0, dlowe@nist.gov, rev. 6/21/2005

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Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 202, 204, 211
Paragraph : Recommendation No. 1, 4, 9, 17
Comment : Recommendations should be restated to address only hazards that are reasonably credible and risks that are significant for broad application.
Comment Reason : Building design processes and national consensus codes and standards should be supported by analytical design tools and practical design guidance. However, it must be recognized that building design practices must provide benefits commensurate with their costs to implement.

It is seldom cost-beneficial for building designs to include provisions to mitigate the effects of all accident scenarios, including all possible but non-credible scenarios, and all hazards, including possible but non-credible hazards. Rather, practical designs should include evaluation of reasonably credible scenarios and hazards in lieu of all possible scenarios and hazards. While it might be possible to design and construct buildings to withstand all scenarios and hazards, such buildings might not be cost-beneficial or practical to construct and use.

The Society of Fire Protection Engineers recognizes this approach in the SFPE Engineering Guide to Performance-Based Fire Protection. This guide advises in Section 8.4 that it is usually necessary to reduce the number of event scenarios to be evaluated from the entire population of possible scenarios to a manageable number of scenarios for design. Representative, bounding, or reasonably worst case scenarios may be used. Building characteristics, loads, and initiating events must be considered when developing design scenarios.

Current practice in fire protection engineering does not consider all possible fire hazards or fire scenarios when developing fire hazard analyses, fire risk analyses, or fire design analyses. Rather, hazards and scenarios to be considered are limited to those which are deemed to be credible. This is true even for very high consequence structures and occupancies.

For example, the U.S. Department of Energy (USDOE) has very rigorous requirements for fire hazard analyses for facilities processing, handling, or storing special nuclear materials. Such analyses are not required to consider events that are of such low likelihood as to be considered non-credible. Depending on how it is applied, the definition of a credible event is subject to interpretation but can be and is quantified in many applications.

The fact that a particular event has occurred does not necessarily make that event a credible event for future design consideration. Events of extremely low likelihood need not be used for future design as a credible event. NIST describes the □Maximum Credible Fire□ for WTC in NIST Special Publication 1000-5, Appendix Q. Therein, NIST describes the Maximum Credible Fire as one that has:

- No sprinkler protection credited for suppression or control
- No active fire fighting
- Fuel load of 10 psf
- Two stories of fire involvement
- Free ventilation by broken windows
- 50 sq. ft. of air leakage between floors

Note that the Maximum Credible Fire for WTC as assumed by NIST does not include breach of nine floors, massive damage to important structural columns, and extensive damage to SFRM While such damage did occur in an unusual event, this scenario is not a credible event scenario.

All buildings in the United States need not be designed to mitigate the effects of highly unusual events such as those that might be introduced by maliciously placed incendiary devices, bombs, missiles, or incoming aircraft. All tall buildings in the United States do not need to be designed to mitigate such events. While it might be possible to do so, it would not likely be cost-beneficial, would not likely be risk-significant, and could result in buildings which are impractical for use or comfort.

Risk is defined by two components: the likelihood of an event and the consequences of an event. The recommendations in NCSTAR 1 address only the consequences of an event as a risk reduction strategy. It is doubtful that it is a risk-beneficial or cost-beneficial national strategy to endure the high costs to implement the recommendations for a large population of buildings. The risk of terrorist attacks, although quite real, is low when compared to the large inventory of buildings that would be affected by the recommendations and the cost to implement the recommendations. A more effective risk reduction strategy would be to reduce the likelihood of an attack on a building. This strategy, of course, is beyond the purview of NIST or the building design, construction, and operations community. The recommendations to mitigate the effects of building accidents to include all scenarios, including terrorist attacks, are inappropriate.

NIST should limit its comments and recommendations to credible hazards and event scenarios. Society will judge what are credible and acceptable risks and this societal response will be reflected in the development of requirements in consensus codes and standards.

Revision Suggestion : 1. Revise Recommendations 1, 4, and 9 to address only credible hazards and event scenarios. (See Holmes Comment Nos. 5, 8, 9, 10, 11, 12, and 17)

2. Delete Recommendation No. 17. (See Holmes Comment Nos. 20 and 21)

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Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
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Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 203-206, 208, 216
Paragraph : Recommendation No. 2, 3, 4, 6, 9
Comment : Recommendations should address only aspects of building and fire code requirements that might have had some effect on the results of the WTC failures and are applicable to other buildings subject to credible fire events or similar events.
Comment Reason : Improvements are desirable for fire protection of buildings and fire safety of occupants. However, it is recognized that the results of a specific fire event are not always applicable to a wide range of buildings or unrelated events.

Under Public Law 107-231, National Construction Safety Team Act, which established the bases for the NIST WTC Investigation National Construction Safety Team, the Team was directed to make recommendations, as necessary, for specific improvements in building standards, codes, and practices based on findings related to technical causes of the WTC Tower failures and technical aspects of the WTC evacuation and emergency response procedures. In developing the recommendations contained in NCSTAR 1, NIST has expanded the application of technical information derived from the WTC investigation to apply to other buildings and other events even though the findings are unrelated to the outcome of the 9/11 WTC events.

It is inappropriate to extrapolate findings that would have had no effect on the outcome of the extreme events of the 9/11 WTC attacks and apply them broadly to buildings subject to credible fire events.

Revision Suggestion : 1. Delete Recommendation No. 2.
2. Delete Recommendation No. 3.
3. Revise Recommendation No. 4.
4. Delete Recommendation No. 6.
5. Delete Recommendation No. 9, Sub-item b.
6. Delete Recommendation No. 9, Sub-item d., last sentence.

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Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
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Report Number : NCSTAR 1
Page Number : 202
Paragraph : Recommendation No. 1, Paragraph a., Sentence 1; and Paragraph b, Sentence 1.
Comment : Revise Paragraph a, Sentence 1 to read, □Progressive collapse should be prevented for credible accident scenarios in buildings.□

Revise Paragraph b, Sentence 1 to read, □A robust, integrated predictive capability should be developed, validated, and maintained to routinely assess the vulnerability of whole structures to the effects of credible hazards.□ (Delete □potential□.)

Comment Reason : Consistent with NIST Recommendation No. 1, building design processes and national consensus codes and standards should be supported by analytical design tools and practical design guidance. However, it should be recognized that building design practices must provide benefits commensurate with their costs to implement.

It is seldom cost-beneficial for building designs to include provisions to mitigate the effects of all accident scenarios, including all possible but non-credible scenarios, and all hazards, including possible but non-credible hazards. Rather, practical designs should include evaluation of reasonably credible scenarios and hazards in lieu of all possible scenarios and hazards. While it might be possible to design and construct buildings to withstand all scenarios and hazards, such buildings might not be cost-beneficial or practical to construct and use.

The Society of Fire Protection Engineers recognizes this approach in the SFPE Engineering Guide to Performance-Based Fire Protection. This guide advises in Section 8.4 that it is usually necessary to reduce the number of event scenarios to be evaluated from the entire population of possible scenarios to a manageable number of scenarios for design. Representative, bounding, or reasonably worst case scenarios may be used. Building characteristics, loads, and initiating events must be considered when developing design scenarios.

Current practice in fire protection engineering does not consider all possible fire hazards or fire scenarios when developing fire hazard analyses, fire risk analyses, or fire design analyses. Rather, hazards and scenarios to be considered are limited to those which are deemed to be credible. This is true even for very high consequence structures and occupancies.

For example, the U.S. Department of Energy (USDOE) has very rigorous requirements for fire hazard analyses for facilities processing, handling, or storing special nuclear materials. Such analyses are not required to consider events that are of such low likelihood as to be considered non-credible. Depending on how it is applied, the definition of a credible event is subject to interpretation but can be and is quantified in many applications.

The fact that a particular event has occurred does not necessarily make that event a credible event for future design consideration. Events of extremely low likelihood need not be used for future design as a credible event. NIST describes the □Maximum Credible Fire□ for WTC in NIST Special Publication 1000-5, Appendix Q. Therein, NIST describes the Maximum Credible Fire as one that has:

" No sprinkler protection credited for suppression or control
" No active fire fighting
" Fuel load of 10 psf
" Two stories of fire involvement
" Free ventilation by broken windows
" 50 sq. ft. of air leakage between floors

Note that the Maximum Credible Fire for WTC as assumed by NIST does not include breach of nine floors, massive damage to important structural columns, and extensive damage to SFRM While such damage did occur in an unusual event, this scenario is not a credible event scenario.

On Page 193 of NCSTAR 1-1 it is inferred that requirements for fire protection should be risk-consistent with respect to the design-basis hazard. Design-basis hazards for buildings should be limited to reasonably credible hazards and not include highly unusual hazards of incredibly low likelihood.

NIST should limit its comments and recommendations to credible hazards and event scenarios. Society will judge what are credible and acceptable risks and this societal response will be reflected in the development of requirements in consensus codes and standards.

Consideration of fire scenarios or progressive collapse scenarios should be limited to credible scenarios and should not include all possible scenarios. The text in NIST Recommendation No. 1 should be revised accordingly.

Revision Suggestion : Revise Paragraph a, Sentence 1 to read, □Progressive collapse should be prevented for credible accident scenarios in buildings.□

Revise Paragraph b, Sentence 1 to read, □A robust, integrated predictive capability should be developed, validated, and maintained to routinely assess the vulnerability of whole structures to the effects of credible hazards.□ (Delete □potential□.)

From: Wayne.D.Holmes, P.E., FSFPE <Wayne_Holmes@hsb.com>
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Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 203
Paragraph : Recommendation No. 2
Comment : Delete Recommendation No. 2 as not relevant to the results of the September 11, 2001 WTC events and not pertinent to national standards development as mitigating requirements for building response to this type of event.
Comment Reason : It is an interesting revelation from the NIST evaluation that there are inconsistent methods and results of methods for evaluation of wind loads on tall buildings. However, there is no evidence presented that the wind load design of the WTC had a significant effect on the consequences that resulted from the 9/11/2002 attacks on the towers. Further, there is no historical evidence that wind load design requirements or test methods have resulted in unsafe design of tall buildings.

Thus, there is no basis for NIST to recommend that standards development activities be diverted to address performance standards for wind tunnel testing or estimating wind loads and their effects. Rather, the limited resources of the standards development community should be focused on more important issues as identified in other NIST recommendations.

NCSTAR 1, Table 9-1, documents that this recommendation is unrelated to the outcome of the 9/11/2001 attacks on the WTC towers.

Revision Suggestion : Delete Recommendation No. 2.

2005 WTC Report Comment Application 1.0, dlowe@nist.gov, rev. 6/21/2005

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Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 203
Paragraph : Recommendation No. 3
Comment : Delete Recommendation No. 3 as not relevant to the results of the September 11, 2001 WTC events and not pertinent to national standards development as mitigating requirements for building response to this type of event.
Comment Reason : It is an interesting revelation from the NIST evaluation that conventional strength-based design methods do not limit deflections due to wind or earthquake. However, there is no evidence presented that this had a significant effect on the consequences that resulted from the 9/11/2002 attacks on the towers. Further, there is no historical evidence that the lack of design requirements have resulted in unsafe design of tall buildings.

Thus, there is no basis for NIST to recommend that standards development activities be diverted to address criterion to limit sway under lateral load design conditions. Rather, the limited resources of the standards development community should be focused on more important issues as identified in other NIST recommendations.

NCSTAR 1, Table 9-1, documents that this recommendation is unrelated to the outcome of the 9/11/2001 attacks on the WTC towers.

Revision Suggestion : Delete Recommendation No. 3.

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Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 204
Paragraph : Recommendation No. 4
Comment : Delete □(especially for tall buildings greater than 20 stories in height)□ in Recommendation No. 4.
Comment Reason : The establishment of technical bases for construction classification and fire rating requirements is desirable. Technical bases are useful in establishing goals, objectives, and criteria for performance-based design and analysis.

However, there is no technical basis for establishing a threshold of 20 stories in height. If it is important to evaluate and establish technical bases for construction classification and fire rating requirements for buildings, it is likely important for buildings of heights less than 20 stories.

NCSTAR 1, Table 9-1, documents that this recommendation is unrelated to the outcome of the 9/11/2001 attacks on the WTC towers.

Revision Suggestion : Delete □(especially for tall buildings greater than 20 stories in height)□ in Recommendation No. 4.

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Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 204
Paragraph : Footnote No. 21
Comment : Revise Footnote No. 21 as follows:
1. Delete □which were originally developed for buildings with less than 20 stories in height□ in the second sentence.
2. Delete the word, □generally□ in the second sentence.
3. Delete the last three sentences.

Comment Reason : The establishment of technical bases for construction classification and fire rating requirements is desirable. However, the following comments are offered to improve Recommendation No. 4, Footnote No. 21:

1. There is no technical basis for establishing a threshold of 20 stories in height. There is no technical evidence presented in the NIST WTC reports that fire resistance rating requirements developed for buildings less than 20 stories are inappropriate for buildings greater than 20 stories. If one accepts the unsubstantiated hypothesis that the existing fire resistance rating requirements are inappropriate for tall buildings, then it is also quite likely that the fire ratings are inappropriate for buildings less than 20 stories where the fire hazards might be more severe and the consequences of fire or building collapse might be even more severe for occupants than in tall buildings.

2. The use of the descriptor, □generally□ makes this a very vague statement. The statement in this footnote that there is □considerable conservatism in those requirements□ indicates that the requirements are adequate for safety. This infers that requirements which have □generally decreased□ are not insufficient.

3. The statement that consequences to occupants on upper floors (20 stories and above) are more severe is a generality or speculation which is unsupported. Depending on specific circumstances, occupants on lower floors could be more severely impacted by a given fire than those on upper floors.

Revision Suggestion : Revise Footnote No. 21 as follows:

1. Delete □which were originally developed for buildings with less than 20

stories in height□ in the second sentence.

2. Delete the word, □generally□ in the second sentence.

3. Delete the last three sentences.

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Name : Wayne D. Holmes, P.E., FSFPE
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Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 204
Paragraph : Recommendation No. 4
Comment : Delete □and full evacuation of occupants□ from Bullet No. 1.
Comment Reason : The establishment of technical bases for construction classification and fire rating requirements is desirable. However, no technical basis has been established to support the supposition that building designs should anticipate full evacuations in all cases.

For most fire events, or other emergency events, full evacuation of occupants is unwarranted and could, in fact, create greater exposure to harm for building occupants. Except for extreme events, it is not necessary to design buildings for full evacuation. Building designs, building design requirements, and occupant emergency movement procedures should not require full evacuation except where indicated by credible event scenarios. It is not prudent, risk-effective, or cost-effective to design all buildings for full evacuation.

The concepts of protect in place, horizontal exits, places of refuge, and similar schemes are recognized in existing building and life safety codes and have been effectively used in existing buildings. There are no technical bases presented to indicate that these concepts are inadequate for existing and new buildings, except for extreme conditions, and there is no basis for not recognizing these concepts in new and existing buildings. As evidenced by NFPA statistics, the historical fire and life safety record in commercial and high rise buildings is excellent with the current practices that do not require design for full building evacuation.

NCSTAR 1, Table 9-1, documents that this recommendation is unrelated to the outcome of the 9/11/2001 attacks on the WTC towers.

Revision Suggestion : Delete □and full evacuation of occupants□ from Bullet No. 1.

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Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 204
Paragraph : Recommendation No. 4
Comment : Add a footnote to Bullet No. 4 as follows:

A Maximum Credible Fire Scenario includes conditions that can be reasonably anticipated related to building construction, occupancy and fire loads, ignition sources, compartment geometry, fire control methods, and similar factors as well as reasonably anticipated adverse conditions. A Maximum Credible Fire Scenario does not include highly unlikely, although possible, events or combinations of events.

Comment Reason : The establishment of technical bases for construction classification and fire rating requirements is desirable. However, technical bases should be related to reasonably credible events. Additional guidance is needed to define credible fire scenarios so as not to imply that all possible events need to be addressed.

It is seldom cost-beneficial for building designs to include provisions to mitigate the effects of all accident scenarios, including non-credible scenarios. Rather, practical designs should include evaluation of reasonably credible scenarios in lieu of all possible scenarios. While it might be possible to design and construct buildings to withstand all fire scenarios, such buildings might not be cost-beneficial or practical to construct and use.

The Society of Fire Protection Engineers recognizes this approach in the SFPE Engineering Guide to Performance-Based Fire Protection. This guide advises in Section 8.4 that it is usually necessary to reduce the number of event scenarios from the entire population of possible scenarios to a manageable number of scenarios for design. Representative, bounding, or reasonably worst case scenarios may be used. Building characteristics, loads, and initiating events must be considered when developing design scenarios.

Current practice in fire protection engineering does not consider all possible fire scenarios when developing fire hazard analyses, fire risk analyses, or fire design analyses. Rather, fire scenarios to be considered are limited to those which are deemed to be credible. This is true even for very high consequence structures and occupancies.

For example, the U.S. Department of Energy (USDOE) has very rigorous

requirements for fire hazard analyses for facilities processing, handling, or storing special nuclear materials. Such analyses are not required to consider events that are of such low likelihood as to be considered non-credible. Depending on how it is applied, the definition of a credible event is subject to interpretation but can be and is quantified in many applications.

The fact that a particular event has occurred does not necessarily make that event a credible event for future design consideration. Events of extremely low likelihood need not be used for future design as a credible event. NIST describes the □Maximum Credible Fire□ for WTC in NIST Special Publication 1000-5, Appendix Q. Therein, NIST describes the Maximum Credible Fire as one that has:

- No sprinkler protection credited for suppression or control
- No active fire fighting
- Fuel load of 10 psf
- Two stories of fire involvement
- Free ventilation by broken windows
- 50 sq. ft. of air leakage between floors

Note that the Maximum Credible Fire for WTC as assumed by NIST does not include breach of nine floors, massive damage to important structural columns, extensive damage to SFRM, and the introduction of 10,000 gallons of jet fuel and 13 tons of combustible materials from the aircraft. While such damage and additional hazards did occur in an unusual event, this type of scenario is not a credible event scenario.

On Page 193 of NCSTAR 1-1 it is inferred that requirements for fire protection should be risk-consistent with respect to the design-basis hazard. Design-basis hazards or assumed Maximum Credible Fires for buildings should be limited to reasonably credible hazards and scenarios and not include highly unusual hazards or scenarios of incredibly low likelihood.

NIST should limit its comments and recommendations to credible event scenarios. Society will judge what are credible and acceptable risks and the societal response will be reflected in the development of requirements in consensus codes and standards.

Revision Suggestion : Add a footnote to Bullet No. 4 as follows:

A Maximum Credible Fire Scenario includes conditions that can be reasonably anticipated related to building construction, occupancy and fire loads, ignition sources, compartment geometry, fire control methods, and similar factors as well as reasonably anticipated adverse conditions. A Maximum Credible Fire Scenario does not include highly unlikely, although possible, events or combinations of events.

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Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 204
Paragraph : Recommendation No. 4
Comment : In Recommendation No. 4, Bullet No. 6, insert □large but reasonably credible, in-situ□ to replace □unusually large□.
Comment Reason : The intent of this recommendation should not be to include usually large fuel concentrations that might be introduced by maliciously placed incendiary devices, bombs, missiles, or incoming aircraft. The statement in Bullet No. 6 is subject to misinterpretation to include such unusual fuel loads. An □unusually large□ fuel load is very nonspecific and subjective. Rather, the intent of the recommendation should be to include large, in-situ fuel loads that can be reasonably and credibly anticipated.

Revision Suggestion : In Recommendation No. 4, Bullet No. 6, insert □large but reasonably credible, in-situ□ to replace □unusually large□.

2005 WTC Report Comment Application 1.0, dlowe@nist.gov, rev. 6/21/2005

X-Sieve: CMU Sieve 2.2
From: Wayne.D.Holmes, P.E., FSFPE <Wayne_Holmes@hsb.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1
Date: Thu, 28 Jul 2005 10:18:35 -0400
Organization: NIST/BFRL Web Site
X-Mailer: SA-SMTPMail 1.0 (http://www.aspstudio.com)
X-MailScanner:
X-MailScanner-SpamScore: sss
X-MailScanner-From: wayne_holmes@hsb.com

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Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 204
Paragraph : Recommendation No. 4
Comment : In Recommendation No. 4, Bullet No. 6, insert □large but reasonably credible, in-situ□ to replace □unusually large□.
Comment Reason : The intent of this recommendation should not be to include usually large fuel concentrations that might be introduced by maliciously placed incendiary devices, bombs, missiles, or incoming aircraft. The statement in Bullet No. 6 is subject to misinterpretation to include such unusual fuel loads. An □unusually large□ fuel load is very nonspecific and subjective. Rather, the intent of the recommendation should be to include large, in-situ fuel loads that can be reasonably and credibly anticipated.

Revision Suggestion : In Recommendation No. 4, Bullet No. 6, insert □large but reasonably credible, in-situ□ to replace □unusually large□.

2005 WTC Report Comment Application 1.0, dlowe@nist.gov, rev. 6/21/2005

From: Wayne.D.Holmes, P.E., FSFPE <Wayne_Holmes@hsb.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 205
Paragraph : Recommendation No. 5
Comment : Delete □century-old□ from the first sentence of Recommendation No. 5.
Comment Reason : The establishment of technical bases for construction classification and fire rating requirements is desirable. Technical bases are useful in establishing goals, objectives, and criteria for performance-based design and analysis. Recommendations related to this should be succinct and objective.

The fact that ASTM E-119 was initially developed in 1907 is not germane. This standard, and other similar standards, have been continuously updated through the consensus standards process to the current time. Fundamental materials testing standards for fire and other exposures do not necessarily become obsolete solely due to age as inferred by this statement. Fundamental material properties and response of materials due to fire exposure have not changed in 100 years.

This is true in all engineering disciplines including, but not limited to Fire Protection Engineering. In Mechanical Engineering or Materials Engineering, the Charpy Test is globally used to evaluate ductile-brittle behavior of metals and the resistance of metals to sudden, brittle facture. The Charpy Impact Test was developed very early in the twentieth century and is widely used as described in ASTM E-23, Standard Test Methods for Notched Bar Impact Testing of Metallic Materials. This test is as applicable today as it was in the early 1900□s because the fundamental properties of materials and response to external stimuli have not changed. The same is true for the fundamental properties of materials and response to fire exposure.

Improvements in the technical bases for fire resistance testing might be desirable. However, it is not considered pertinent that the fundamental testing method was developed in the last century and this type of statement should not be cited in the recommendation.

NCSTAR 1, Table 9-1, documents that this recommendation is unrelated to the outcome of the 9/11/2001 attacks on the WTC towers.

Revision Suggestion : Delete □century-old□ from the first sentence of Recommendation No. 5.

2005 WTC Report Comment Application 1.0, dlowe@nist.gov, rev. 6/21/2005

From: Wayne.D.Holmes, P.E., FSFPE <Wayne_Holmes@hsb.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 206
Paragraph : Recommendation No. 6
Comment : Delete Recommendation No. 6
Comment Reason : The performance and durability of SFRM are important in the overall performance of many buildings in response to fire. However, the performance and durability of SFRM was not a significant factor in the results of the terrorist attack on the WTC. The damage to the structural steel members and SFRM was due to incredible circumstances. The applied thickness, durability, and inspection procedures for the SFRM at the WTC were also not a significant contributor to the results of the WTC incidents.

In NCSTAR 1, Section 6.14.4 (p. 145) and Section 8.2, Objective 2, (p. 172) it is stated that □the existing condition of the insulation prior to aircraft impact, which was found to be mostly intact, and the insulation thickness on the WTC floor system did not play a significant role in initiating collapse of the towers□ and □an intense, conventional fire, in the absence of structural and insulation damage, would not have led to the collapse of a WTC tower.□ Reasonable conclusions from these statements are that the SFRM was in good condition prior to aircraft impact, was of sufficient thickness to prevent collapse of the towers from intense fires, and the towers would not have collapsed if it had not been for the extreme damage by aircraft impact. It is not reasonable to expect that SFRM in-service performance should include the ability to withstand the extreme loads imposed by aircraft impact.

There is no evidence, based on NCSTAR 1, that the in-service performance of SFRM as used in buildings for conventional fires, even extreme conventional fires, is deficient.

While further development of methods for evaluating the in-service performance of SFRM is desirable, Recommendation No. 6 is not a relevant conclusion based on the WTC incidents.

NCSTAR 1, Table 9-1, documents that this recommendation is unrelated to the outcome of the 9/11/2001 attacks on the WTC towers.

Revision Suggestion : Delete Recommendation No. 6.

2005 WTC Report Comment Application 1.0, dlowe@nist.gov, rev. 6/21/2005

From: Wayne.D.Holmes, P.E., FSFPE <Wayne_Holmes@hsb.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 207
Paragraph : Recommendation No. 8
Comment : Revise Recommendation No. 8 to delete □tall□ in the second sentence and add □required by the building code to have a fire resistance rating□ at the end of the sentence such that the sentence reads, □Such a provision should be applied to all buildings required by the building code to have a fire resistance rating.□
Comment Reason : This recommendation contains a statement that burnout without collapse □should apply to all tall buildings.□ The need for a building to sustain burnout without collapse is not unique to tall buildings. This recommendation might be applicable to buildings regardless of height.

On the other hand, it is not necessary that all buildings be capable of sustaining burnout without collapse. Small or inconsequential buildings of ordinary construction need not be required to sustain burnout without collapse.

The societal need for some buildings to sustain burnout without collapse will be reflected in the model buildings codes. Thus, the recommendation should be addressed toward those buildings for which the building code requires fire resistant structural ratings.

Revision Suggestion : Revise Recommendation No. 8 to delete □tall□ in the second sentence and add □required by the building code to have a fire resistance rating□ at the end of the sentence such that the sentence reads, □Such a provision should be applied to all buildings required by the building code to have a fire resistance rating.□

2005 WTC Report Comment Application 1.0, dlowe@nist.gov, rev. 6/21/2005

From: Wayne.D.Holmes, P.E., FSFPE <Wayne_Holmes@hsb.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 208
Paragraph : Recommendation No. 9
Comment : Delete Recommendation No. 9, Sub-item b.
Comment Reason : The use of standard methodologies and performance-based methods for fire scenarios for use in design and analysis of structures to resist fire is desirable. Some methods are described in the SFPE Engineering Guide to Performance-Based Fire Protection. This guide advises in Section 8.4 that it is usually necessary to reduce the number of event scenarios from the entire population of possible scenarios to a manageable number of scenarios for design. Representative, bounding, or reasonably worst case scenarios may be used. Building characteristics, loads, and initiating events must be considered when developing design scenarios.

Consideration of fire scenarios should be limited to credible scenarios and should not include all possible scenarios. Depending on specific circumstances, multiple compartment or multiple floor fire scenarios might not be credible fire scenarios.

It is therefore unnecessary for Recommendation No. 9 to specify that multi-compartment or multi-floor scenarios must be included as stated in Sub-item b. Standard methodologies are sufficiently addressed in Recommendation No. 9, Sub-item a.

NCSTAR 1, Table 9-1, documents that this recommendation is unrelated to the outcome of the 9/11/2001 attacks on the WTC towers.

Revision Suggestion : Delete Recommendation No. 9, Sub-item b.

2005 WTC Report Comment Application 1.0, dlowe@nist.gov, rev. 6/21/2005

From: Wayne.D.Holmes, P.E., FSFPE <Wayne_Holmes@hsb.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 208
Paragraph : Recommendation No. 9
Comment : Delete the last sentence of Recommendation No. 9, Sub-item d.
Comment Reason : The development of new test methods or the enhancement of existing test methods to support performance-based methods for design and analysis is desirable. However, there is no technical evidence presented that would support that the development of new standard fire exposures must be developed in order to support a performance objective of burnout without collapse.

NCSTAR 1, Table 9-1, documents that this recommendation is unrelated to the outcome of the 9/11/2001 attacks on the WTC towers.

Revision Suggestion : Delete the last sentence of Recommendation No. 9, Sub-item d.

2005 WTC Report Comment Application 1.0, dlowe@nist.gov, rev. 6/21/2005

From: Wayne.D.Holmes, P.E., FSFPE <Wayne_Holmes@hsb.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 208
Paragraph : Recommendation No. 10
Comment : Delete Recommendation No. 10
Comment Reason : The development of enhanced means of providing fire resistance properties of building materials and systems is desirable. However, there is no evidence from the WTC investigation that would support the need for development of new fire resistive coating materials, system, and technologies with significantly enhanced performance and durability to provide protection following major events based on the results of the WTC incidents. SFRM do not need to be expected to respond to highly unusual events such as aircraft impact. Rather, fire resistive coating materials, systems, and technologies should cost-effectively and risk-effectively be expected to respond to reasonably credible fire scenarios.

The performance and durability of SFRM was not a significant factor in the results of the terrorist attack on the WTC. The damage to the structural steel members and SFRM was due to incredible circumstances. The applied thickness, durability, and inspection procedures for the SFRM at the WTC were also not a significant contributor to the results of the WTC incidents.

In NCSTAR 1, Section 6.14.4 (p. 145) and Section 8.2, Objective 2, (p. 172) it is stated that □the existing condition of the insulation prior to aircraft impact, which was found to be mostly intact, and the insulation thickness on the WTC floor system did not play a significant role in initiating collapse of the towers□ and □an intense, conventional fire, in the absence of structural and insulation damage, would not have led to the collapse of a WTC tower.□ Reasonable conclusions from these statements are that the SFRM was in good condition prior to aircraft impact, was of sufficient thickness to prevent collapse of the towers from intense fires, and the towers would not have collapsed if it had not been for the extreme damage by aircraft impact. It is not reasonable to expect that SFRM in-service performance should include the ability to withstand the extreme loads imposed by aircraft impact.

The explanation of Recommendation No. 10 on p. 208 of NCSTAR 1 alludes to technical barriers to the introduction of new structural fire resistance materials, systems, and technologies. Since NCSTAR 1 does not identify any such existing technical barriers, this statement is unsupported and inappropriate.

With the exception of the WTC incidents, existing fire resistive coating systems have demonstrated a reasonable history in maintaining structural stability of buildings response to credible fires. Recommendation No. 10 is unwarranted as a direct result of the WTC incidents.

Revision Suggestion : Delete Recommendation No. 10

2005 WTC Report Comment Application 1.0, dlowe@nist.gov, rev. 6/21/2005

From: Wayne.D.Holmes, P.E., FSFPE <Wayne_Holmes@hsb.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 209
Paragraph : Recommendation No. 12
Comment : Delete Recommendation No. 12.
Comment Reason : The enhancement of technology related to active fire protection systems is desirable. However, the performance and redundancy of active fire protection systems were not factors in the collapse of the WTC towers. Had it not been for the severe damage created by the aircraft impact, the WTC towers would not have collapsed, even without the provision of automatic sprinklers or other active fire protection systems. It is impossible to conclude from the WTC incidents that there is a national need to enhance the performance and redundancy of active fire protection system.

There is no technical evidence presented to indicate that building heights, building populations, open spaces, compartmentation, fuel loads, or other factors have increased risks beyond those which are currently address by codes and standards. The national standards and building codes have evolved to adequately address current hazards. The statements in Recommendation No. 12 about the □greater risks□ and need for enhancement of performance and redundancy of active fire protection systems are speculative and not supported by facts.

The performance statistics related to automatic sprinkler systems and other active fire systems in response to reasonably anticipated fire scenarios are excellent. No level of enhancement of the performance or redundancy of active fire protection systems would have changed the results of the WTC attacks. The failure of the active and passive fire protection systems in the WTC towers was not a result of a single-point failure but multiple system failures due to highly unusual events. The existing levels of performance and redundancy of active fire protection systems are sufficient current for buildings subjected to credible fire scenarios.

Revision Suggestion : Delete Recommendation No. 12.

2005 WTC Report Comment Application 1.0, dlowe@nist.gov, rev. 6/21/2005

From: Wayne.D.Holmes, P.E., FSFPE <Wayne_Holmes@hsb.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 211
Paragraph : Recommendation No. 17
Comment : Delete Recommendation No. 17.
Comment Reason : The safety of occupants due to fires or similar emergencies can be accomplished by a systematic balance of building systems and features, occupant response, and emergency response. No technical basis has been established to support the supposition that building designs should anticipate full evacuations in all cases.

Full building evacuation is one means of helping to assure the safety of occupants but it is not the only means. In many cases, full evacuation of occupants is unwarranted and could, in fact, create greater exposure to harm for building occupants. Except for extreme events, it is not necessary to design buildings for full evacuation. Building designs, building design requirements, and occupant emergency movement procedures should not require full evacuation except where indicated by credible event scenarios. It is not prudent, risk-effective, or cost-effective to design all buildings for full evacuation.

The concepts of protect in place, horizontal exits, places of refuge, and similar schemes are recognized in existing building and life safety codes have been effectively used in existing buildings. There are no technical bases presented to indicate that these concepts are inadequate for existing and new buildings, except for extreme conditions, and no basis for not recognizing these concepts in new and existing buildings. As evidenced by NFPA statistics, the historical fire and life safety record in commercial and high rise buildings is excellent with the current practices that do not require design for full building evacuation.

Revision Suggestion : Delete Recommendation No. 17.

2005 WTC Report Comment Application 1.0, dlowe@nist.gov, rev. 6/21/2005

From: Wayne.D.Holmes, P.E., FSFPE <Wayne_Holmes@hsb.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 212
Paragraph : Recommendation No. 18
Comment : Delete Recommendation No. 18
Comment Reason : The safety of occupants due to fires or similar emergencies can be accomplished by a systematic balance of building systems and features, occupant response, and emergency response. No technical basis has been established to support the supposition that building designs should anticipate full evacuations in all cases.

Existing codes and standards provide for adequate means of egress for emergency movement of occupants in response to credible emergency scenarios if the provisions of the codes and standards are rigorously enforced.

As noted in the NIST reports, the Life Safety Code and building codes provide requirements for separation and remoteness of means of egress components. These requirements, if adopted and enforced, are adequate.

The integrity of means of egress stairwells is implicitly provided by robust constructions that must meet the requirements for fire protection rated assemblies including the hose stream test. These constructions provide for reasonable integrity of the enclosures for other reasonably anticipated loads. Aircraft impact is not a reasonably anticipated load. Although NCSTAR 1-1, Finding No. 8 suggests that concrete or reinforced concrete block walls might have provided increased integrity for the stairway enclosures, this statement is speculative. There is no evidence to suggest that such constructions would have withstood the aircraft impact. There is no evidence presented in the NIST WTC report that the stairwells existing at the time of the incident would not have maintained their integrity if exposed to accidental loads or reasonably anticipated risks that would be expected in an office tower. Further, there are no historical records that indicate that stairwells in other buildings are deficient in their ability to maintain integrity under anticipated accidental loads.

The Life Safety Code and building codes provide requirements for identification and standard signage for means of egress. These requirements, if adopted and enforced, are adequate.

Recommendation 18 is unwarranted and unnecessary. The issue of enforcement of means of egress requirements is sufficiently covered by Recommendation No. 26.

Revision Suggestion : Delete Recommendation No. 18.

2005 WTC Report Comment Application 1.0, dlowe@nist.gov, rev. 6/21/2005

From: Wayne.D.Holmes, P.E., FSFPE <Wayne_Holmes@hsb.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 216
Paragraph : Recommendation No. 25
Comment : Delete Recommendation No. 25.
Comment Reason : There is no evidence in the NIST reports to indicate that compliance with building and fire codes was deficient such that the results of the attacks on the WTC towers would have been any different than what occurred. It is stated on p. xlvi of NCSTAR 1 that □The departures from the building codes and standards did not have a significant effect on the outcome of September 11.□

The existing codes and standards provide for third-party acceptance of building designs, independent from the building owner(s), by the Authority Having Jurisdiction. Enforcement of this requirement is sufficiently covered by Recommendation No. 26.

There is no evidence to support that yet another level of independent verification or certification is warranted or cost-effective if the Authority Having Jurisdiction exercises its responsibility for enforcement and verification.

NCSTAR 1, Table 9-1, documents that this recommendation is unrelated to the outcome of the 9/11/2001 attacks on the WTC towers.

Revision Suggestion : Delete Recommendation No. 25.

2005 WTC Report Comment Application 1.0, dlowe@nist.gov, rev. 6/21/2005

From: Wayne.D.Holmes, P.E., FSFPE <Wayne_Holmes@hsb.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 217
Paragraph : Recommendation No. 27
Comment : The purposes of documentation retention and accessibility should be more specifically stated in Recommendation No. 27.
Comment Reason : Proper documentation of designs for all stakeholders is desirable. In addition to providing documentation for emergency responders and for post-incident evaluations, proper documentation of building design, features, and emergency systems provides all stakeholders with valuable information to maintain the building and its systems and features throughout the life of the building. The documentation provides valuable information for decision making to assure that modifications to the building to not compromise the original design intent. Information on fire safety documentation and specifications is contained in Chapter 12 of the SFPE Engineering Guide to Performance-Based Fire Protection.

Revision Suggestion : Add the following statement to Recommendation No. 27:

In addition to providing documentation for emergency responders and for post-incident evaluations, proper documentation of building design, features, and emergency systems provides all stakeholders with valuable information to maintain the building and its systems and features throughout the life of the building. The documentation provides valuable information for decision making to assure that modifications to the building to not compromise the original design intent. Information on fire safety documentation and specifications is contained in Chapter 12 of the SFPE Engineering Guide to Performance-Based Fire Protection.

2005 WTC Report Comment Application 1.0, dlowe@nist.gov, rev. 6/21/2005

From: Wayne.D.Holmes, P.E., FSFPE <Wayne_Holmes@hsb.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 7/28/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : Various
Paragraph : Recommendation No. ALL
Comment : Each recommendation should propose specific improvements to building standards, codes, and practices based on the technical causes of the WTC Tower failures or technical aspects of evacuation and emergency response to the 9/11 WTC incidents.
Comment Reason : In order to affect changes through codes and standards making organizations, specific recommendations are necessary.

The recommendations contained in NCSTAR 1 outline general actions to be taken by others with respect to proposed changes in codes, standards, and practices. There are no specific improvements or revisions in the recommendations that can be implemented directly into codes, standards, and procedures.

Public Law 107-231, National Construction Team Act, establishes National Construction Safety Teams whose duties include to □recommend, as necessary, specific improvements to building standards, codes, and practices based on findings&□ In the preface to NCSTAR 1, it is stated that a specific objective of the NIST WTC Investigation is to □identify, as specifically as possible, areas in current building and fire codes, standards, and practices that warrant revision.□

While the wording in the duties and objectives of Public Law 107-231 and NCSTAR 1, respectively, differ slightly, each identifies the need to be specific in recommended improvements or revisions to codes and standards. In compliance with the Act and so that the organizations responsible for implementing changes in codes and standards can take appropriate actions to make specific changes in codes and standards deemed appropriate by the National Construction Safety Team, each of the recommendations should contain specific recommendations for proposed changes in codes and standards.

Revision Suggestion : Revise each recommendation to make specific recommendations for specific improvements to building codes, standards, and practices.

2005 WTC Report Comment Application 1.0, dlowe@nist.gov, rev. 6/21/2005

From: Wayne.D.Holmes, P.E., FSFPE <Wayne_Holmes@hsb.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR1-6B

Information Submitted on: 8/3/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR1-6B
Page Number : 2
Paragraph : Section 1.3 Test Variables
Comment : There is a need to identify an important test variable, test furnace heating conditions, which is not identified in this section.
Comment Reason : In this section, NIST implies that it has identified the important test variables and those are (1) fireproofing thickness, (2) constraint conditions, and (3) scale of the test. What NIST has totally missed is the most important variable in fire resistance testing, that being the difference in heating conditions. While ASTM E-119 specifies a standard temperature versus time profile, ASTM E-119 does not specify a standard heating profile. While the temperature indicates a potential for heating of test specimen, it does not define the heat exposure to the specimen. Heating conditions can vary significantly from test to test within a particular test furnace (repeatability) and even more significantly from furnace to furnace (reproducibility). Tests performed on the larger ULC furnace might not be comparable to a similar test on the smaller UL furnace even though the same temperature versus time profile is reproduced.

The measured temperature within a furnace is not a reliable measurement of the heat flux produced in the furnace. Heat flux drives the response of the specimen being tested. The size and geometry of the furnace, the thermal inertia of the furnace lining, and the emissivity of the furnace gases will greatly influence the heat flux that is experienced by the specimen.

Kanury and Holve concluded (Kanury A. M., and Holve, D. J, A Theoretical Analysis of the ASTM E-119 Standard Fire Test of Building Construction and Materials, Menlo Park, CA, Stanford Research Institute, 1975):

□Radiant heat transfer is the dominant heat transfer mode. Reradiation properties of the exposed material have an influence on the fire resistance time. Thus, the true measure of fire severity is given by the heat flux to the specimen, a function of both the furnace temperature and emissivity.

The exact temporal distribution of temperature exposure has little effect on the fire endurance time as compared to the standard ASTM E-119 T(t) curve. Future improvements of the ASTM E-119 test should focus more on the control, measurement, and specification of the heat flux exposure condition rather than the furnace temperature history.

Furnace emissivity has appreciable effect on endurance time, even though the relation is less than linear. An increase in emissivity from 0.2 to 0.6 increases the net flux by 80% and decreases the fire endurance time by 30%□

In Section 4.5, Instrumentation, the report describes radiometers used to measure and characterize the furnace environment during the tests. It states that the location of the radiometers is given in Appendices D and F. However, the location of the radiometers is not clearly indicated in those Appendices.

In Section 6.1, Comparison of Results, the average furnace temperatures, as measured by the ASTM E-119 standard thermocouples, is shown. While this demonstrates that the furnace temperatures measured in the four tests were comparable, it does not demonstrate that the heating conditions were similar.

Section 6.1.2, Furnace Temperature Environment, indicates that additional instrumentation was included to □further characterize the thermal environment of the exposing fire.□ While the measurements from the thermocouples reflect the temperature conditions in the furnace, the true thermal environment can only be assessed with the reporting of the heat fluxes measured by the radiometers. NIST failed to report the radiometer measurements in this section. Complete data from the radiometers should be reported in this section.

Some, very limited information about furnace heat fluxes is reported, in part, in Chapter 5, Test Results. This information can be found only in Figures Nos. 5-11, 5-12, 5-48, 5-49, 5-64, and 5-65. This information is summarized below:

Test 1 ULC, 35 ft., Restrained
West Radiometer
Heat Flux Range: 10-50 kw/m2
Mean Flux: 20 kw/m2 (estimated)
East Radiometer
Heat Flux Range: 10-60+kw/m2
Mean Flux: 40 kw/m2 (estimated)

Test 2 ULC, 35 ft., Unrestrained
No radiation data reported

Test 3 UL, 17 ft., Restrained
South Radiometer
Heat Flux Range: 20-135 kw/m2
Mean Flux: 90 kw/m2 (estimated)

North Radiometer
Heat Flux Range: 20-110 kw/m2
Mean Flux: 70 kw/m2 (estimated)

Test 4 UL, 17 ft., Unrestrained
South Radiometer
Heat Flux Range: 5-40 kw/m2 (prior to failure)
Mean Flux: 25 kw/m2 (estimated)

North Radiometer
Heat Flux Range: 20-100+ kw/m2
Mean Flux: 95 kw/m2 (estimated)

Figure 6-2 implies that the heating conditions between the two furnaces were similar. The data for two plate thermocouples were plotted only for Tests Nos. 2 and 4. Similar data for Tests Nos. 1 and 3 were not given or plotted to show correlation. Figure 6-3 clearly shows a significant difference in recorded temperatures for the south plate thermocouple in the range beyond 50 minutes. Thus, there are only three sets of date, total, for the four tests, from which it was concluded that the fire exposures for both furnaces were equivalent. The lack of correlation among all of the plate thermocouples and the radiometers in the four tests on two different furnaces is unexplained and unresolved. The limited data based on three thermocouples, ignoring the non-corroborative data of one thermocouple and the wide variation in readings from the radiometers, does not support the conclusion in Section 6.1.2 that "The ASTM E-119 fire exposures for both furnaces used in this study were essentially equivalent." There is an attempt to imply that the heating exposures in the two furnaces were identical based on incomplete data and without mention or explanation of the variation in radiometer data. Based on the radiometer data, one cannot reasonably conclude that the heating conditions were identical even though the temperature profiles for two of the plate thermocouples are similar. NCSTAR 1-6B should provide some rational explanation for the discrepancies in data between the two furnaces or revise the statements about similar heating conditions in the two furnaces.

There is clearly a significant difference in heating conditions between the ULC and UL furnaces despite the fact the both furnaces followed the same temperature versus time curve. Such a large difference in heating conditions would have a considerable effect on the response of the tested specimen.

There is a large difference in the thermal exposures between the large scale ULC tests and the smaller scale UL tests. The results of the tests on the two furnaces are not directly comparable. The NIST report fails to recognize or report on the difference in test conditions.

NIST missed an important opportunity to make a specific recommendation for improvement of fire resistance test methods. To be comparable between tests (repeatability) and comparable among all tests (reproducibility), and to provide data for analytical methods, fire resistance test methods should include a requirement for specification, measurement, and reporting of furnace heat flux. Heat flux measurements are required in ASTM E-1529 but not in ASTM E-119 and standards similar to ASTM E-119.

Revision Suggestion : Section 1.3, Test Variables, should be revised by NIST to indicate that all test variables have not been identified and isolated. The most significant variable in fire resistance testing is the heat flux in the furnace. The different heating conditions between the two test furnaces used in this evaluation have not been identified or analyzed.

The NIST report should clearly indicate the difference in heating conditions among the tests and comment on the lack of correlation between the ULC and UL tests. Comment on the fact that the specific, single tests performed for this investigation are neither repeatable nor reproducible would be appropriate.

NCSTAR 1-6B should provide some rational explanation for the discrepancies in data between the two furnaces or revise the statements about similar heating conditions in the two furnaces.

2005 WTC Report Comment Application 1.0, dlowe@nist.gov, rev. 6/21/2005

From: Wayne.D.Holmes, P.E., FSFPE <Wayne_Holmes@hsb.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR1-6B

Information Submitted on: 8/3/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR1-6B
Page Number : 47
Paragraph : Chapter 5 Test Results
Comment : Numerical data output from all instrumentation including shielded thermocouples, plate thermocouples, aspirated thermocouples, and radiometers should be included in Chapter 5, Test Results.
Comment Reason : Some, very limited information about furnace heat fluxes is reported, in part, in Chapter 5, Test Results. This information can be found only in Figures Nos. 5-11, 5-12, 5-48, 5-49, 5-64, and 5-65. This information is summarized below:

Test 1 ULC, 35 ft., Restrained
West Radiometer
Heat Flux Range: 10-50 kw/m2
Mean Flux: 20 kw/m2 (estimated)

East Radiometer
Heat Flux Range: 10-60+kw/m2
Mean Flux: 40 kw/m2 (estimated)

Test 2 ULC, 35 ft., Unrestrained
No radiation data reported

Test 3 UL, 17 ft., Restrained
South Radiometer
Heat Flux Range: 20-135 kw/m2
Mean Flux: 90 kw/m2 (estimated)

North Radiometer
Heat Flux Range: 20-110 kw/m2
Mean Flux: 70 kw/m2 (estimated)

Test 4 UL, 17 ft., Unrestrained
South Radiometer
Heat Flux Range: 5-40 kw/m2 (prior to failure)
Mean Flux: 25 kw/m2 (estimated)

North Radiometer
Heat Flux Range: 20-100+ kw/m2
Mean Flux: 9 5 kw/m2 (estimated)

Figure 6-2 implies that the heating conditions between the two furnaces were similar. The data for two plate thermocouples were plotted only for Tests Nos. 2 and 4. Similar data for Tests Nos. 1 and 3 were not given or plotted to show correlation. Figure 6-3 clearly shows a significant difference in recorded temperatures for the south plate thermocouple in the range beyond 50 minutes. Thus, there are only three sets of date, total, for the four tests, from which it was concluded that the fire exposures for both furnaces were equivalent. The lack of correlation among all of the plate thermocouples and the radiometers in the four tests on two different furnaces is unexplained and unresolved. The limited data based on three thermocouples, ignoring the non-corroborative data of one thermocouple and the wide variation in readings from the radiometers, does not support the conclusion in Section 6.1.2 that "The ASTM E-119 fire exposures for both furnaces used in this study were essentially equivalent." There is an attempt to imply that the heating exposures in the two furnaces were identical based on incomplete data and without mention or explanation of the variation in radiometer data. Based on the radiometer data, one cannot reasonably conclude that the heating conditions were identical even though the temperature profiles for two of the plate thermocouples are similar. NCSTAR 1-6B should provide some rational explanation for the discrepancies in data between the two furnaces or revise the statements about similar heating conditions in the two furnaces.

There is clearly a significant difference in heating conditions between the ULC and UL furnaces despite the fact the both furnaces followed the same temperature versus time curve. Such a large difference in heating conditions would have a considerable effect on the response of the tested specimen.

There is a large difference in the thermal exposures between the large scale ULC tests and the smaller scale UL tests. The results of the tests on the two furnaces are not directly comparable. The NIST report fails to recognize or report on the difference in test conditions.

Complete numerical data is needed and should be reported for informed analysis of test results.

Revision Suggestion : Add to Chapter 5, Test Results:

□Numerical data output from all instrumentation including shielded thermocouples, plate thermocouples, aspirated thermocouples, and radiometers are reported in Chapter 5, Test Results.□

(Include tables of all numerical data output)

From: Wayne.D.Holmes, P.E., FSFPE <Wayne_Holmes@hsb.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR1-6B

Information Submitted on: 8/3/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR1-6B
Page Number : 96
Paragraph : Section 6.1.2 Furnace Temperature Environment
Comment : While the measured temperatures in the two furnaces were similar, the heating environments, as evidenced by the radiometer data, were not equivalent.
Comment Reason : Some, very limited information about furnace heat fluxes is reported, in part, in Chapter 5, Test Results. This information can be found only in Figures Nos. 5-11, 5-12, 5-48, 5-49, 5-64, and 5-65. This information is summarized below:

Test 1 ULC, 35 ft., Restrained
West Radiometer
Heat Flux Range: 10-50 kw/m2
Mean Flux: 20 kw/m2 (estimated)

East Radiometer
Heat Flux Range: 10-60+kw/m2
Mean Flux: 40 kw/m2 (estimated)

Test 2 ULC, 35 ft., Unrestrained
No radiation data reported

Test 3 UL, 17 ft., Restrained
South Radiometer
Heat Flux Range: 20-135 kw/m2
Mean Flux: 90 kw/m2 (estimated)

North Radiometer
Heat Flux Range: 20-110 kw/m2
Mean Flux: 70 kw/m2 (estimated)

Test 4 UL, 17 ft., Unrestrained
South Radiometer
Heat Flux Range: 5-40 kw/m2 (prior to failure)
Mean Flux: 25 kw/m2 (estimated)

North Radiometer
Heat Flux Range: 20-100+ kw/m2
Mean Flux: 95 kw/m2 (estimated)

Figure 6-2 implies that the heating conditions between the two furnaces were similar. The data for two plate thermocouples were plotted only for Tests Nos. 2 and 4. Similar data for Tests Nos. 1 and 3 were not given or plotted to show correlation. Figure 6-3 clearly shows a significant difference in recorded temperatures for the south plate thermocouple in the range beyond 50 minutes. Thus, there are only three sets of date, total, for the four tests, from which it was concluded that the fire exposures for both furnaces were equivalent. The lack of correlation among all of the plate thermocouples and the radiometers in the four tests on two different furnaces is unexplained and unresolved. The limited data based on three thermocouples, ignoring the non-corroborative data of one thermocouple and the wide variation in readings from the radiometers, does not support the conclusion in Section 6.1.2 that "The ASTM E-119 fire exposures for both furnaces used in this study were essentially equivalent." There is an attempt to imply that the heating exposures in the two furnaces were identical based on incomplete data and without mention or explanation of the variation in radiometer data. Based on the radiometer data, one cannot reasonably conclude that the heating conditions were identical even though the temperature profiles for two of the plate thermocouples are similar. NCSTAR 1-6B should provide some rational explanation for the discrepancies in data between the two furnaces or revise the statements about similar heating conditions in the two furnaces.

There is clearly a significant difference in heating conditions between the ULC and UL furnaces despite the fact the both furnaces followed the same temperature versus time curve. Such a large difference in heating conditions would have a considerable effect on the response of the tested specimen.

There is a large difference in the thermal exposures between the large scale ULC tests and the smaller scale UL tests. The results of the tests on the two furnaces are not directly comparable. The NIST report fails to recognize or report on the difference in test conditions.

Complete numerical data is needed and should be reported for informed analysis of test results.

Revision Suggestion : The statement on p. 96 under □Plate Thermocouple Measurements□ that states, □Thus, the ASTM E 119 fire exposure for both furnaces used in this study were essentially equivalent□ should be changed to □The measured furnace temperatures, as indicated by the plate thermocouples, for the two furnaces followed the temperature vs. time curve specified by ASTM E 119. However, the radiometer data indicated that the heating conditions in the two furnaces were not the same. The temperatures recorded by the shielded thermocouples for furnace temperature control as specified by ASTM E-119 are not those that are plotted in Figures 6-2 and 6-3.□

2005 WTC Report Comment Application 1.0, dlowe@nist.gov, rev. 6/21/2005

From: Wayne.D.Holmes, P.E., FSFPE <Wayne_Holmes@hsb.com>
To: wtc@nist.gov
Cc: dlowe@nist.gov
Subject: WTC Draft Final Report Comment Form for Report: NCSTAR 1

Information Submitted on: 8/3/2005.

Name : Wayne D. Holmes, P.E., FSFPE
Affiliation :
Email Address : Wayne_Holmes@hsb.com
Phone : 860-722-5621
Report Number : NCSTAR 1
Page Number : 205
Paragraph : Recommendation 5
Comment : Recommendation 5 is a very general and vague statement about improvement to the standard fire resistance test method. A specific recommendation should be made that ASTM E-119 and similar test methods should be improved to require a specific heating profile based on heat flux in the furnace.
Comment Reason : NIST missed an important opportunity to make a specific recommendation for improvement of fire resistance test methods. To be comparable between tests (repeatability) and comparable among all tests (reproducibility), and to provide data for analytical methods, fire resistance test methods should include a requirement for specification, measurement, and reporting of furnace heat flux. Heat flux measurements are required in ASTM E-1529 but not in ASTM E-119 and standards similar to ASTM E-119.

It is generally recognized in the fire protection profession that ASTM E-119 tests, based on a temperature vs. time profile, are not repeatable or reproducible. This is addressed, in part, in NCSTAR 1, Recommendation 5. Successful tests are often reported on the basis of passing a single test which might not be repeated on the same test furnace or reproduced on another test furnace. The ASTM E-119 standard contains the warning that □no comprehensive test program has been conducted to develop data on which to derive statistical measures of repeatability (within-laboratory variability) and reproducibility (among-laboratory variability).

While ASTM E-119 specifies a standard temperature versus time profile, ASTM E-119 does not specify a standard heating profile. While the temperature indicates a potential for heating of test specimen, it does not define the heat exposure to the specimen. Heating conditions can vary significantly from test to test within a particular test furnace (repeatability) and even more significantly from furnace to furnace (reproducibility). Tests performed on the larger ULC furnace might not be comparable to a similar test on the smaller UL furnace even though the same temperature versus time profile is reproduced.

The measured temperature within a furnace is not a reliable measurement of the heat flux produced in the furnace. Heat flux drives the response of the specimen being tested. The size and geometry of the furnace, the thermal inertia of the furnace lining, and the emissivity of the furnace gases will greatly influence the heat flux that is experienced by the specimen.

Kanury and Holve concluded (Kanury A. M., and Holve, D. J, A Theoretical Analysis of the ASTM E-119 Standard Fire Test of Building Construction and Materials, Menlo Park, CA, Stanford Research Institute, 1975):

□Radiant heat transfer is the dominant heat transfer mode. Reradiation properties of the exposed material have an influence on the fire resistance time. Thus, the true measure of fire severity is given by the heat flux to the specimen, a function of both the furnace temperature and emissivity.

The exact temporal distribution of temperature exposure has little effect on the fire endurance time as compared to the standard ASTM E-119 T(t) curve. Future improvements of the ASTM E-119 test should focus more on the control, measurement, and specification of the heat flux exposure condition rather than the furnace temperature history.

Furnace emissivity has appreciable effect on endurance time, even though the relation is less than linear. An increase in emissivity from 0.2 to 0.6 increases the net flux by 80% and decreases the fire endurance time by 30%□

In Section 4.5 of NCSTAR 1-6B, Instrumentation, the report describes radiometers used to measure and characterize the furnace environment during the tests.

In Section 6.1 of NCSTAR 1-6B, Comparison of Results, the average furnace temperatures, as measured by the ASTM E-119 standard thermocouples, is shown. While this demonstrates that the furnace temperatures measured in the four tests were comparable, it does not demonstrate that the heating conditions were similar.

Section 6.1.2 of NCSTAR 1-6B, Furnace Temperature Environment, indicates that additional instrumentation was included to □further characterize the thermal environment of the exposing fire.□ While the measurements from the thermocouples reflect the temperature conditions in the furnace, the true thermal environment can only be assessed with the reporting of the heat fluxes measured by the radiometers. NIST failed to report the radiometer measurements in this section. ASTM E-119 does not require measurement of, reporting of, or control of heat flux within the test furnace.

Some, very limited information about furnace heat fluxes is reported, in part, in Chapter 5 of NCSTAR 1-6B, Test Results. This information can be found only in Figures Nos. 5-11, 5-12, 5-48, 5-49, 5-64, and 5-65. This information is summarized below:

Test 1 ULC, 35 ft., Restrained
West Radiometer
Heat Flux Range: 10-50 kw/m2
Mean Flux: 20 kw/m2 (estimated)

East Radiometer
Heat Flux Range: 10-60+kw/m2

Mean Flux: 40 kw/m2 (estimated)

Test 2 ULC, 35 ft., Unrestrained
No radiation data reported

Test 3 UL, 17 ft., Restrained
South Radiometer
Heat Flux Range: 20-135 kw/m2
Mean Flux: 90 kw/m2 (estimated)

North Radiometer
Heat Flux Range: 20-110 kw/m2
Mean Flux: 70 kw/m2 (estimated)

Test 4 UL, 17 ft., Unrestrained
South Radiometer
Heat Flux Range: 5-40 kw/m2 (prior to failure)
Mean Flux: 25 kw/m2 (estimated)

North Radiometer
Heat Flux Range: 20-100+ kw/m2
Mean Flux: 95 kw/m2 (estimated)

Figure 6-2 of NCSTAR 1-6B implies that the heating conditions between the two furnaces were similar. The data for two plate thermocouples were plotted only for Tests Nos. 2 and 4. Similar data for Tests Nos. 1 and 3 were not given or plotted to show correlation. Figure 6-3 clearly shows a significant difference in recorded temperatures for the south plate thermocouple in the range beyond 50 minutes. Thus, there are only three sets of date, total, for the four tests, from which it was concluded that the fire exposures for both furnaces were equivalent. The lack of correlation among all of the plate thermocouples and the radiometers in the four tests on two different furnaces is unexplained and unresolved. The limited data based on three thermocouples, ignoring the non-corroborative data of one thermocouple and the wide variation in readings from the radiometers, does not support the conclusion in Section 6.1.2 of NCSTAR 1-6B that "The ASTM E-119 fire exposures for both furnaces used in this study were essentially equivalent." There is an attempt to imply that the heating exposures in the two furnaces were identical based on incomplete data and without mention or explanation of the variation in radiometer data. Based on the radiometer data, one cannot reasonably conclude that the heating conditions were identical even though the temperature profiles for two of the plate thermocouples are similar. NCSTAR 1-6B should provide some rational explanation for the discrepancies in data between the two furnaces or revise the statements about similar heating conditions in the two furnaces.

There is clearly a significant difference in heating conditions between the ULC and UL furnaces despite the fact the both furnaces followed the same temperature versus time curve. Such a large difference in heating conditions would have a considerable effect on the response of the tested specimen.

There is a large difference in the thermal exposures between the large scale

ULC tests and the smaller scale UL tests. The results of the tests on the two furnaces are not directly comparable. The NIST report fails to recognize or report on the difference in test conditions.

Public Law 107-231, National Construction Team Act, establishes National Construction Safety Teams whose duties include to □recommend, as necessary, specific improvements to building standards, codes, and practices based on findings&□ In the preface to NCSTAR 1, it is stated that a specific objective of the NIST WTC Investigation is to □identify, as specifically as possible, areas in current building and fire codes, standards, and practices that warrant revision.□

While the wording in the duties and objectives of Public Law 107-231 and NCSTAR 1, respectively, differ slightly, each identifies the need to be specific in recommended improvements or revisions to codes and standards. In compliance with the Act and so that the organizations responsible for implementing changes in codes and standards can take appropriate actions to make specific changes in codes and standards deemed appropriate by the National Construction Safety Team, each of the recommendations should contain specific recommendations for proposed changes in codes and standards.

NIST has the opportunity, if not the obligation, to make specific recommendations for improvement in the standard test method for fire resistance tested of building construction and materials. A specific recommendation should be made that ASTM E-119 and similar test methods should be improved to require a specific heating profile based on heat flux in the furnace.

Revision Suggestion : Add an additional recommendation following Recommendation 5 (or amend Recommendation 5) as follows:

□To more effectively represent heating conditions, to improve repeatability and reproducibility of test results, and to facilitate analysis and extrapolation of fire resistance test results, standard fire resistance test methods should specify a standard heating profile based on heat flux in the test furnace.□

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