# Public Comments Received by NIST on DRAFT Reports:

NIST NCSTAR 1A Report on the Collapse of World Trade Center Building 7 - DRAFT for Public Comment

NIST NCSTAR 1-9 Structural Fire Response and Probable Collapse Sequence of World Trade Center Building 7, Volume 1 - DRAFT for Public Comment

NIST NCSTAR 1-9 Structural Fire Response and Probable Collapse Sequence of World Trade Center Building 7, Volume 2 - DRAFT for Public Comment

NIST NCSTAR 1-9A Global Structural Analysis of the Response of World Trade Center Building 7 to Fires and Debris Impact Damage - DRAFT for Public Comment

DRAFTS FOR PUBLIC COMMENTS
August 2008

http://www.nist.gov/el/disasterstudies/wtc/wtc_draftreports.cfm

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**Submission Process for Public Comments**

- The National Institute of Standards and Technology (NIST) released three draft reports documenting the Federal Building and Fire Safety Investigation of the World Trade Center Disaster – WTC 7. These reports include the draft summary report on the Investigation of WTC 7, 1 project report, and supporting technical topic report. The reports were released to the public on August 21, 2008.
- Comments were especially encouraged on the draft summary report, which contains the principal findings and recommendations for changes to codes, standards, and practices. Comments were accepted via Web site, e-mail, fax, and regular mail.

**Comments were submitted by:**

- Council on Tall Buildings and Urban Habitat
- ICC
- NFPA
- Hughes Assoc.
- PANYNJ
- Silverstein
- Weidlinger Assoc., Najib Abboud
- Robins, Kaplan, Miller & Ciresi
- Skyscraper Defense, Dan Goodwin
- AE911Truth, James Gourley
- AE911Truth, Richard Gage
- Anders Björkman
- Arthur Scheuerman
- Andy MacDougal
- Andrew Ostler
- Brad Ream
- Brandon Johnson
- Bruce Stahlberg
- Charles Clifton
- Charlie Carter

- Chris Johnson
- Christopher Bollyn
- Christopher Simmler
- Dan Barron
- Dan Noel
- Daniel Kuhn
- Dan K
- Dave Collins
- David Chandler
- David Proe
- David Proe/Ian Thomas
- Diane Horning
- Don Meserlian
- Duke
- Earl Staelin
- Eli Rubenstein
- F.R. Greening
- Field McConnell/David Hawkins
- James David
- James Hatton
- James Legault
- JC/Justin
- Jeff Tanzer
- Jeffrey Hoffman
- Jim Braun
- John Brown
- John Wyndham
- Jonathan Cole
- Joseph Ciolino
- Joseph Nobles
- Judy Wood
- Justin Keogh
- Keith Crawford
- Kevin Jaeger
- Kevin Ryan
- Lance Denny
- Leo Razdolsky
- lilmag
- Mark Krulewitch
- Mark Phillips
- Marton Szebeni
- Massimiliano
- Michael Andregg
- Michael Smith
- Michael Swanson
- Mike Shea
- Nancy Hall
- Phillip Tompkins
- Pieter Blue
- Rich Schulte
- Richard Caruana
- Rick James
- Robert Korol
- Robert Tharp
- Ryan Owens
- Skeptosis
- Srinivasa Sarma
- Stephen St. John
- Tim Sharpe
- Vesa Raiskila
- Zach Botttner

Council
on
Tall Buildings
and
Urban Habitat

# The Council on Tall Buildings and Urban Habitat

## Comments

**on the**

***"Structural Fire Response and
Probable Collapse Sequence of
World Trade Center Building 7
August 2007"***

***Prepared and Issued by
The National Institute of Science and Technology
(NIST)
as a Draft Report
for Public Comment***

**October 2008**

**Compiled by the CTBUH Fire & Safety Working Group**
**Chaired by Simon Lay and Daniel O'Connor**


**Principal Authors**

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**October 2008**

# 1. Introduction

In August 2008, NIST issued their report on the Structural Fire Response and Collapse Sequence of World Trade Center Building 7, for Public Comment.

This brief report contains feedback from the Council on Tall Buildings and Urban Habitat on the NIST report. The Council's key interest in the NIST study is an understanding of the collapse sequence and one of NIST's key objectives, which was to "identify, as specifically as possible, areas in the current building and fire codes, standards and practices that warrant revision."

The Council believes that the NIST report is a responsible attempt to find the cause of the failure, and finds that the report has investigated many of the probable causes. The Council has several technical questions about details of the modeling; but we would not expect that to change the conclusions: that the floor beams failed due to fire, which led to buckling of the internal columns resulting in global failure.

However, the Council feels that the report does not adequately investigate the implications that this failure has on the design practice for tall buildings, as per Objective No. 4 in the NIST report. Although the NIST report clearly identifies factors that could have mitigated the structural response (Chapter 14.6), it does not investigate how effectively changes to design practices could have improved performance.

The NIST report recommends that in the future, buildings should be designed so that they do not collapse, even in an extreme fire, and even if the sprinkler system fails or is overwhelmed by the fire. The approach recommended by NIST is essentially a performance-based approach which explicitly checks the performance of structure in fire. This approach is becoming commonplace for some buildings which are considered special due to their extreme height or complex design. However, such an approach is less common for more typical high-rise buildings.

The Council supports the use of Performance-Based Design (PBD) for tall buildings. However, within the industry there is a lack of knowledge and consensus about how PBD should be implemented and there is a need for the industry to share knowledge and develop an understanding. The Council does encourage NIST to set an example in this respect and hypothesize a performance-based approach to WTC 7 and identify what specific structural changes would have made this building perform to an "acceptable" level.

There is a common premise that in order to achieve the necessary level of fire resistance, every structural element must equally conform to the minimum fire protection requirements. This is a convention that is not necessarily required by building codes, which only ask that the fire resistance be achieved, and do not specify exactly how this is done. Many PBD studies have demonstrated that varying the fire protection regime across the structural elements of a building can enhance the performance in fire, without additional cost, and often at a reduced cost.

The Council does not agree with the NIST statement that the failure was a result of the buckling of Column 79. We believe that the failure was a result of the collapse of the floor structure that led to loss of lateral restraint and subsequent buckling of internal columns.

The Council would like to make it clear that it sees no credibility whatsoever in the 911 'truth movement' and we believe, with the vast majority of tall building professionals, that all the failures at the WTC (WTC 1, 2, 5, 6 and 7) were a direct or indirect result of the planes that were flown into the two towers. We have carefully looked at the evidence that the 911 'truth movement' presents and we cannot see any credible scientific evidence of a controlled demolition on WTC 7 or any of the other WTC buildings. The Council considers that the 'truth movement' is a distraction and should not obfuscate the performance issues which should be at the center of the debate about how best to continue to improve and develop fire and life safety in tall buildings.

## 2. Background

The National Institute of Science and Technology (NIST) issued its draft report on the fire and collapse of World Trade Center 7 in August 2007, and was issued for public comment. Our report contains the formal response by the CTBUH that has been compiled by the Council's Fire & Safety Working Group, led by Simon Lay, Daniel O'Connor, and David Scott.

The Council has solicited technical discussion through an online forum located at www.ctbuh.org. Tower 7 collapsed as a result of the fire that was ignited during the 9/11 terrorist attack. The report concludes that the collapse was solely a result of the fires that started on ten levels following the initial attack. The failure occurred approximately eight and one-half hours after the first attack. The collapse of WTC 1 and 2 severed the water mains, reducing the capacity for suppression by sprinklers and consequently the firefighting effort was abandoned after the collapses of the twin towers.

NIST notes that the structural failure was caused by the effects of thermal expansion. Fire engineers are well aware that the effects of thermal expansion and thermal contraction (during the cooling phase) are often substantially more significant than the effects of heat reducing the strength of materials. This understanding needs to extend to architects and engineers who are involved in the high-rise industry and an introduction to the subject is described in the paper David Scott presented at the NIST national workshop on Prevention of Progressive Collapse, July 2002. The paper – "Fire Induced Progressive Collapse" – authored by Scott, Lane and Gibbons can be found online and on the CTBUH website.

This CTBUH report contains various technical comments on specific chapters of the NIST report. However, the primary focus is the NIST recommendations and the NIST objective – namely, to identify what parts of current practice need to be reviewed and improved.

The NIST report has identified a series of complex structural effects which led to the collapse of WTC. The Council believes that these mechanisms can be adequately understood and predicted using information and design methods that are available today, even if these are not currently found in many building codes. The Council considers that fire and structural engineers do have the capacity to design safe, tall buildings.

## 3. Initiating Event Hypothesis (Chapter 8)

This section summarizes CTBUH comments on Chapter 8 of the NIST report. Several conclusions drawn in the NIST report on the contribution of structural components in failure initiation are unexpected and have raised concerns within the Council. These conclusions involve the role of both shear studs and local global buckling of the floor beams in failure initiation. The Council believes that the local connection performance was a significant part of the global failure and would like to have seen a more explicit analysis of the connection failure. (See also comment on Chapters 11-13.)

The NIST analysis (p. 353), shows that shear studs and the bolts holding the primary Column 79 failed before the temperature of the steel reached 200˚C. This implies a fundamental weakness that would be picked up by a conventional PBD analysis. These temperatures are very low compared to a fire protection test that assumes that steel loses strength at 550˚C.

The failure of shear studs is surprising, and has been modeled in a very simplistic way, which may overestimate the failure of this element. Prior studies and real fire cases have not previously identified shear stud failure as a significant possibility.

Perhaps the temperature regime of the slabs may have impacted on the stud failure prediction. If the top of the slabs were modeled as being hotter than the underside of the slabs, that might cause an upward bow, against the typical downward deflection of the steel deck, adding stress to the shear studs.

Adequately designed shear studs can play a significant role in the stability of the structure under fire conditions, and the NIST study should not be taken to indicate that failure of shear studs is likely, only that this was an assumption within the model. It is unclear what the effect of a more accurate shear stud model would have produced in the NIST study, and in the somewhat extreme case of WTC 7 (given the multiple fire floors) it is unlikely that a significantly different overall conclusion might be reached. However, in more typical fire scenarios, shear studs can still provide a significant benefit.

It is difficult to understand why the top bolts of the girder would fail at connection to Column 79. Such failure would mean the slab had moved relative to Column 79.

The finite analysis model applied was limited (Fig 8-22), and this may have restricted the ability of the model to pick up all the local effects around Column 79.

One important question that should be addressed is “Did NIST review and evaluate any cooling cycle effects?” If cooling had started after the bolts connecting to Column 79 had failed, would the connection be stable?

It is surprising to see in-plane buckling of the beam as being a key generation of the initial failure, since it would be expected that the floors would bend out of the way on their major axis, combined with a local buckling of the bottom flange, like those found in the Cardington Fire Tests.

On page 330, NIST states that "the challenge was to determine if a fire-induced floor system failure could occur in WTC 7 under an ordinary building contents fire." But we cannot identify where in the report they address this challenge. The studies of the fire spread, without the initial structural damage, still assume fire spread on multiple floors, which is, in itself, a consequence of the initiating terror attack.

The report is rather confusing because the floor analysis is considered in Sections 8, 11 and 12. It would be better if there was a complete reconciliation of the analysis models.

## 4. Fire Analysis and Simulations (Chapter 9)

Critical to the implementation of PBD is the establishment of reasonable and justified criteria on which the performance of a developed design can be based. This section of the NIST report identifies fire intensities and extents that are assumed to have existed within WTC 7 prior to its collapse. However, the Council has found it unclear how these assumed conditions relate to NIST recommendations for PBD of tall buildings in the future. The Council believes it is important for NIST to explicitly discern the facets of the WTC 7 study that it recommends for inclusion in PBD of other structures. Discussed below are specific assumptions whose applicability to general structural design has been called into question.

NIST estimated a combustible fuel load of 20kg/m$^2$ for open plan office areas and 32kg/m$^2$ for areas with a cubicle layout. Are these the fuel intensities that NIST would recommend for a PBD and how are these values justified?

The NIST report proposes a very intense fire 250MW under Level 13, the floor that lasted for 2 hours. Is this a design intensity that NIST would recommend for offices?

It appears that the fire on Level 12 had passed its peak in the area of Column 79. Is it possible that failure occurred as part of the cooling cycle?

## 5. Structural Heating (Chapter 10)

Why was Floor 7 so hot when there was no floor or fire at Level 6. When NIST refers to Floor 7 do they mean the floor or the ceiling of the seventh floor?

After approximately two hours the floor slab temperature reached over 675°C. What was the distribution of heat through the concrete slab? The temperature distribution in the slab can often have a significant effect on the floor performance and the stresses on the shear studs.

In simulations A and B, the floors are subject to critical heat for less than an hour. Does this imply that the tower floors would have collapsed under a normal fire if the sprinklers did not work? If NIST is advocating that engineers analyze building performance as part of the normal design process, then surely they can answer the challenge they set normal designers. Did their analysis show that the building would fail under a normal contents fire?

## 6. Structural Analysis and the Cause of Failure (Chapters 11-13)

In these sections NIST states that the initial failure was caused by the failure of the floor system, in particular the connections to Column 79, that led to the column becoming excessively slender and buckling. These statements contradict the summary section 14.3.4 that identifies the initiating event as the buckling of Column 79. We strongly believe that the initiating event was the failure of the floor and the girder connections to the main column and that this should be documented in Section 14.3.4.

The report does not describe the detail failure mechanism of the girder connection to Column 79. Since this was critical to the failure we would expect to see diagrams of it, in its deflected, deformed shape immediately prior to collapse.

The connections models (e.g., Fig. 11-15) do not appear to reasonably reflect the important effect that the slab has on the connection performance.

## 7. Summary and Recommendations (Chapter 14)

The report says that improvements to the frame, connections, and long spans could have mitigated the collapse. The industry needs to understand the main characteristics of the building which led to the collapse, and needs to understand the types of details and configurations that create poor performance, and why.

The fire-induced failure of WTC 5/6 showed designers that short, slotted holes at the end of stub cantilever primary girder connections work under dead and live load conditions, but do not work in fire conditions, even if the beams are properly fire protected. What did the failure of WTC 7 show and what can be done to make a similar building perform better?

1) If the primary girder had shear studs would the floor have failed?
2) If the girders had fin plates or end plates would the building have survived?
3) Did the floors fail on the heating or cooling cycle, and theoretically which was worse?
4) How effective was the slab to tie the floors over the column, and what were the catenary forces and how effective was the reinforcement?

5) Normal fire codes assume a fire only occurs on one floor and much of the fire protection design is to stop flame spread between floors. WTC 7 started with fires on 10 floors and the report is vague about whether this had an impact on the failure.
6) Would the tower have failed if the fire was only at one level? The report is not clear on this issue.

NIST recommends a Performance-Based Design approach as a general standard on tall buildings. Can the issues above be verified by a simple performance-based design check, and if not, then surely NIST should qualify its recommendation for this approach as a basis for future design.

## 8. Performance Based Design

NIST is suggesting that the building community design all buildings by modeling fire performance. The implication is that this is not difficult and can be part of the normal process. The Council requests that NIST take the WTC 7 floor plan, model it in fire and change the design to make it work in a fire, showing the public what it takes and how easy it would be. In that way designers could see the type of changes that would need to be incorporated in the design.

Is it possible that small changes to connections or shear studs could have a major impact on the performance of the floor?

Normal codes assume that there is a fire on only one floor at a time. Does NIST recommend that all floors should be considered on fire? Based on the WTC 7 fire it could be assumed a maximum of 2 floors, but some other fires have had many floors on fire. What guidance would NIST give?

If we keep on adding up extreme approaches, we could get some extreme buildings. Is it appropriate to realistically consider the following assumptions simultaneously:

- The sprinklers do not work
- Fire fighting does not occur, and
- 2, 5, 10 levels are on fire simultaneously
- The fire lasts for 7 hours?

The Council agrees with NIST's support of performance-based design for tall buildings. Performance-based design can often lead to higher safety levels, more collapse prevention, and often results in more fire protection in some areas and less in others.

## 9. NIST Recommendations

The comments in this section refer to several of the NIST recommendations in Chapter 5, on the Final Report of the Collapse of World Trade Center Building 7, issued as a Draft for Public Comment.

**General Statements**

We do not agree that "The intent of current practice, based on prescriptive standards and codes, is to achieve life safety, not collapse prevention."

Traditionally, building codes have prescribed property protection, and minimizing the loss to the building and its contents is still a major consideration. Only in the last 50 years has there been more emphasis on "life safety." We would suggest that a better wording would be "The intent of current practice of all building codes is to achieve optimum levels of life safety and structural integrity."

**Buildings should not collapse in infrequent (worst-case) fires, without sprinklers**

While in principle the Council agrees with "the key premise of NIST's recommendations is that buildings should not collapse in infrequent (worst-case) fires that may occur when active fire protection systems are rendered ineffective, e.g., when sprinklers do not exist, are not functional, or are overwhelmed by the fire," there are several factors that need to be considered.

From a historical perspective, sprinklers and fire fighting have been incredibly effective at preventing collapse of tall buildings and preserving life safety. It should be recognized that WTC 7 was subjected to extreme events of failed sprinklers, extensive impact damage, no firefighting and simultaneous fires in ten floors. Is it reasonable to consider that this extreme event be considered a design case? It would be useful if NIST could document what "performance" the WTC 7 floor would give under a normal design fire.

We recognize that it is becoming increasingly common for designers of tall or iconic buildings to design these buildings using a performance-based approach, and frequently part of the performance requirement will be to prevent collapse prevention under a full flash-over fire without sprinklers. However, this is rarely combined with structural impact damage or multiple level fires.

We do not believe that it is reasonable to require all buildings to perform with extreme fires without sprinklers. There may be better value solutions for different building types and forms. For many buildings, duplicate fire risers and/or back up water supplies may well be an acceptable alternative. We should also expect that as performance-based design becomes more common, the lessons learned from it will start to be applied to other buildings. Once performance-based design becomes an industry norm, we would agree that it would be appropriate to apply it to all buildings

**Increased Structural Integrity to Prevent Progressive Collapse**

NIST recommends the development of codes and standards to prevent progressive collapse of structures of buildings subject to multiple hazards.

There has been an extensive debate about the appropriate level of design of buildings to mitigate the potential of progressive collapse. It is not possible to design buildings to withstand all potential combination of all extreme events. Based on discussions, most of the Council prefers to see a performance-based design approach for mitigation of progressive collapse.

The Government Services Agency (GSA) has introduced onerous requirements for progressive collapse mitigation (Progressive Collapse Analysis and Design Guidelines for New Federal Office Buildings and Major Renovation Projects, June 2003). It is not clear if these GSA measures, which are very severe, would have prevented the WTC 7 collapse, since even the GSA rules do not require consideration of fire conditions.

We do not agree with the NIST comment which links design for progressive collapse mitigation and the design for fire-induced progressive collapse mitigation. These issues are quite different and it is misleading to connect them. Normal progressive collapse design does not consider performance in fire conditions. Only Performance-Based Fire Design looks at potential progressive collapse under fire conditions.

**Enhanced Fire Endurance of Structures**
NIST recommends that all buildings should be enhanced to avoid collapse in worst-case fires without sprinklers, and are suggesting that a performance-based design approach would be able to do this.

The Council would like NIST to show the industry what changes to WTC 7 would have resulted in an improved and acceptable performance. This investigation would help the industry understand what NIST is recommending. In particular, the Council is interested to see if some simple changes to the floor structure and detailing could have improved performance considerably, and from experience on other projects, this is often the case.

NIST has recommended improvement to connections and framing systems to improve performance and we agree that this issue needs to be better understood. The Council is of the view that this issue needs to be addressed in more detail in the NIST report.

If NIST were to improve the design of WTC 7 up to a level that they deemed acceptable, then such an exercise would be an example to the industry of what NIST is recommending for future design. If NIST expects the industry to do this work, it should not be enormously difficult to do.

## 10. CTBUH Conclusions

The Draft NIST Report on World Trade Center 7 is a comprehensive assessment of the events that led to its collapse.

The Council does not agree with the NIST statement that the failure was a result of the buckling of Column 79. We believe that the failure was a result of the collapse of the floor structure that led to loss of lateral restraint and then buckling of internal columns. This is an important distinction, as NIST appears to be seeking improved performance from floors rather than columns.

The Council would like to know if there are any simple changes to the floors and connections that would have resulted in a better performance than occurred.

The Council would like to understand how the floors would have performed in an analysis of a design flash-over fire, without sprinklers. This would correlate a real failure with a normal performance-based analysis, and help to increase the understanding of performance-based design procedures.

NIST has suggested some comprehensive changes to the design process that they recommend for consideration in future codes development. These changes need considerable work prior to being incorporated in any codes or standards. However, the Council agrees that performance-based design methods should be the method of choice for large and complex buildings, and these methods also allow both typical fire safety and more extreme events to be studied..

These comments are made by The Council on Tall Buildings and Urban Habit as part of the NIST public consultation process. The Council hopes that these comments will assist NIST in improving and developing the draft version of the report.

INTERNATIONAL CODE COUNCIL

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September 11, 2008

WTC Technical Information Repository
National Institute of Standards and Technology
Stop 8610
Gaithersburg, MD 20899-8610

Attention: Mr. Stephen Cauffman

Subject: Responses to Request for Public Comments on NICSTAR 1A, Final Report on the Collapse of World Trade Center Building 7 (August 21, 2008)

Dear Mr. Cauffman:

The International Code Council® (ICC®) submits the attached comments to the National Institute of Standards and Technology (NIST) on the NIST NICSTAR 1A- Final Report on the Collapse of World Trade Center Building 7. The ICC would like to commend NIST and its contractors on the quality and thoroughness of the report. The professionalism exhibited by the report is commendable and demonstrates to the public the high level of technical expertise and management excellence of NIST and its public and private sector partners. This expertise is especially important in the evaluation of the collapse of World Trade Center Building 7, which has been the subject of intense public and media attention.

The ICC is a 40,000+ member association dedicated to building safety and fire protection. The ICC mission is to provide the highest quality codes, standards, products, and services for all concerned with the safety and performance of the built environment. This mission and the activities of the ICC directly relate to providing a safe physical environment through the adoption of, and implementation of, codes and standards developed under the auspices of the ICC, and the availability of a robust infrastructure established by ICC to support those codes and standards. We do want to emphasize that while the International Code Council sponsors and manages the process for the development of its model codes, neither the Code Council as an entity, nor its individual staff, write the codes, nor make proposals, or take positions on proposals to modify them.

The 13 model codes developed under the auspices of the ICC, with the involvement of all interested and affected parties, serve as a baseline for the design, construction, operation and maintenance of the majority of both public and private sector buildings in the U.S. Through the adoption and implementation of ICC's codes by Federal agencies such as GSA, Department of Defense, and State Department, and by every state that has a statewide code as well as many jurisdictions in those few states still lacking a statewide code, buildings are safer than ever for occupants and users.

We note as a general point that the report makes reference only to the International Building Code, one of the 13 model codes. (There is a footnote reference to the International Performance Code for Buildings and Facilities, at pg. 65) It is important to note that the vast majority of the local, state, and federal entities where the ICC codes are enforced have adopted several, if not all of the International Codes published by ICC. This fact is especially relevant since many of the recommendations in the report touch directly on issues addressed by the International Fire Code and the International Performance Code for Buildings and Facilities. A chart of adoptions of the various codes is attached to this letter for informational purposes

The International Fire Code, International Building Code, International Existing Buildings Code, and 10 other ICC codes contribute to making the built environment safer, both for newly constructed and renovated buildings as well as for existing buildings, through fire and safety inspections.

We appreciate that NIST has sponsored an effort to participate in and promote code changes consistent with the earlier WTC reports in the ICC code development process. NIST issued its final report on WTC 1 and 2 in September 2005. Since then, the ICC has completed two cycles of code development. The timing of the report was such that approximately 20 code changes were submitted for the 2006/2007 cycle, with code changes due March 24, 2006. This cycle concluded with the 2007 Final Action Hearings and the publication of the 2007 Supplement. This was followed by the current code development process, the 2007/2008 cycle, with approximately 45 code changes submitted by the August 20, 2007, deadline. Final disposition on these code changes will not occur until the 2008 Final Action Hearings, slated for September 17-23, 2008. Approved changes from both cycles will then be published in the 2009 editions of the I-Codes, and adopted beginning in 2009 by adopting authorities. The changes relating to the WTC event would be incorporated into either the IBC or the IFC, depending on the purview of the change.

During these two cycles of code development, the following issues related to the 30 recommendations reported by NIST have been considered (listed in no specific order):

- Progressive/structural collapse
- Wind tunnel testing
- Structural frame
- Spray on fireproofing – material parameters and inspection parameters
- Fire exit drills/evacuation plans
- Exit path markings
- Exit continuity/transfer corridors
- Additional exit stairs for fire fighting
- Exit remoteness
- Exit enclosure integrity

- Occupant use of elevators for egress
- Fire command center communication systems
- Emergency responder communication systems
- Fire service use of elevators
- Redundancy of sprinkler systems
- Burnout
- Risk assessment for large and/or iconic buildings
- Stairway communication

It is anticipated that ICC will continue to see code change proposals in cycles to come, and we encourage NIST's participation in this process. The high level of expertise, solid research and sound technical reasoning of NIST experts are valued by code development professionals, and lead to better code provisions when those experts participate in the process. The next code change deadline for proposed changes is March 24, 2009.

The International Code Council believes that the process being used by NIST to facilitate translating the results of the NIST investigation into suitable and enforceable provisions of the ICC International Codes has worked well. The process has allowed experts with extensive experience and training to advocate code changes in a process that also involves construction interests, building owners and others with direct responsibility for the safety of building occupants, and the obligation to manage buildings that meet tenant needs effectively and competitively.

The attached comments focus on specific areas in the NIST report that are associated with building regulations, codes, standards and related issues on which ICC feels uniquely qualified to comment. All comments are in the form requested by NIST, listing the comment, the report number, page, sentence and/or paragraph and then the reason and suggested revision. In some instances the comments are editorial in nature or suggest clarifying language. Other comments are more general and we trust they will be considered in the collaborative and supportive spirit in which they are intended.

One common thread in a number of ICC's comments is the manner in which the reports refer to building regulations, codes, model codes, building codes, standards, and similar terms and then also refer to specific documents such as the NYC Building Code (NYCBC), the International Building Code, etc. While NICSTAR 1A does a better job of specifying which code is being commented on than the earlier reports relating to the WTC buildings, there are still instances where it is not clear what code is being described, and whether the comment relates to current circumstances in 2008, or circumstances at the time of construction of the building in 1987, or with respect to the New York City Building Code (NYCBC) of 1968.

Another common thread in the document is the referencing of NFPA 5000 as well as the International Building Code, as if the two documents are equivalent and equal alternatives. While we appreciate NIST's desire to be fair, and to avoid favoring one document over another, the fact is that NFPA 5000 is a proposed code, not currently adopted by any major jurisdiction in the United States. (See the attached chart of code adoptions.) There is no reason to make reference to provisions in a document that is at best prospective, has not been adopted and is therefore not in use as an enforced code in U.S. jurisdictions.

To avoid confusion, we have suggested several specific deletions, but would encourage NIST to reconsider making reference to a code whose relevance is at best hypothetical since it is not currently in use by any major U.S. jurisdiction.

These reports will be read with interest by the U.S. lay audience as well as a number of technical and non-technical entities in other countries and for this reason ICC feels it is important to be clear, consistent and precise when discussing building regulations and associated terms, whether in general or with respect to specific documents. For this purpose we have suggested two basic acronym and definition additions.

We look forward to providing any and all information NIST may request or require and stand ready to assist through our relationships with state and local officials and the US building community.

Sincerely,

David L. Karmol
Vice President, Federal and External Relations

**Comments of the International Code Council on NIST NCSTAR 1A, Final Report on the Collapse of World Trade Center Building 7**
**September 12, 2008**

All comments below are to NCSTAR 1A, and all page references are to the pagination of that document. The format, as requested by NIST, is the location by page and paragraph or sentence, the reason for the change, and suggested language.

1. Missing Acronym, pg. xxiii, between IBC and NFPA. Reason: Acronym ICC is not defined, although it is used in the document in a footnote on page 65.

Suggested language:
"ICC International Code Council"

2. Missing definition, pg xxiii, before NFPA. No definition is provided in the document for the term "model building code" which is used first at pg 55, Sec. 4.6, second bullet. This term should be defined so the reader understands how model codes are developed and how they come to be adopted by local government jurisdictions, with or without modifications, and then enforced by local building code and fire safety officials.

Suggested language:
"Model building code- a comprehensive regulatory framework document that is developed and maintained by a standards organization independent of the jurisdiction responsible for enacting and enforcing the building code. Typically, model building codes are adopted by states or local jurisdictions as legally enforceable building codes, often with modifications to meet local conditions and circumstances. Model codes are generally maintained through an open process, on a regular development cycle, and re-adopted by the enforcing authority on a periodic basis."

3. Reference to new technology should be added, pg xxxv, Lettered Paragraph J: Building Information Modeling (BIM) software allows building documents to be securely maintained and updated in a BIM over the life of the building.

Suggested language:
At the end of the paragraph, add: "Building documents should be maintained in a Building Information Modeling system (BIM), and such documents should be updated and maintained in a secure BIM during the building life."

4. Incorrect comparison, pg. 51, second to last bullet. Comparison between a proposed code and a code actually in use in 50 states and federal agencies is inappropriate. The bullet speaks of stairwell capacity which was not a factor in the loss of WTC 7, nor was it causative of any injuries or deaths. The report should not be used to compare apparent differences between a proposed code (NFPA 5000) and a contemporary code used throughout the country (IBC).

Suggested language:

Delete: ", but not the 2003 edition of NFPA 5000."

5. Incorrect comparison, pg. 51, last bullet. Comparison between a proposed code and a code actually in use in 50 states and federal agencies is inappropriate. The report should not be used to compare apparent differences between a proposed code (NFPA 5000) and a contemporary code used throughout the country (IBC). In addition, the item suggests that the 2000 edition of the IBC is the current edition. This is incorrect- the current version is the 2006 edition.

Suggested language:
Revise the final sentence to read: "On some floors the separation of the stairwell doors was below the remoteness requirements in the IBC, 2006 edition (current)."

6. Insufficient reference, pg 53, first bullet under Sec. 4.5.2. Due to the confusion about what codes and standards were in use, and/or enforced at the time of construction, this paragraph should clarify what codes and standards NIST believes the building was "generally consistent with."

Suggested language:
At the end of the existing sentence, after the word standards, add: ", in effect at the time of construction."

7. Incorrect statement concerning current practice today, page 53, last bullet. Statement that design did not explicitly evaluate fire effects, which was typical engineering practice at the time and continues to remain so today, is incorrect.

Suggested language:
Modify sentence to read: "...the design did not explicitly evaluate fire effects, which was typical engineering practice at the time. Today, the ICC Performance Code for Buildings and Facilities (ICC-PCBF) addresses this issue. Section 1701.2.7 of the ICC-PCBF explicitly requires, 'Facilities shall be arranged, constructed and maintained so as to limit the impact of a fire on the structural integrity of the facility.' "

8. Incomplete statement regarding progressive collapse, pg. 55, sec. 4.6, bullet 2. Statement is that current model codes do not address progressive collapse. There have been two proposals to the IBC which were recommended for disapproval by the IBC structural committee at the first hearing of the code development cycle. One was proposed by the ICC Ad Hoc Committee on Terrorism Resistant Buildings (S5-06/07) and the other, during the current code development cycle, was proposed by NCSEA Ad Hoc Joint Industry Committee on Structural Integrity (S101-07/08). Refer to the code change monographs for more information and reasons for the recommended disapproval. S101-07/08 has public comments by *MMC Committee for Translating the NIST World Trade Center Investigation Recommendations into Building Codes* so it will be considered at the ICC Final Action Hearing in Minneapolis, MN, September 17-23, 2008. If approved, it would appear in the IBC, 2009 edition.

9. Misleading language, pg.60, Recommendation C. "NIST recommends evaluating, and where needed improving, the technical basis for determining appropriate construction classifications and fire rating requirements, and making related code changes."
We wish to make clear that ICC staff do not create or develop the technical basis for the codes. The International Code Council manages an open, transparent and balanced process that is open to all interested parties to submit proposed changes, as well as any supporting documentation for such changes. ICC then publishes the resultant code, and provides technical support to anyone implementing the code.
We invite and encourage proposals to make enhancements to our codes and standards. Proposed code changes succeed if they are supported by valid technical and experiential reasons, and effectively address issues such as enforceability, safety and cost-effectiveness critical to the building sector and regulatory officials responsible for enforcing the codes.

10. Incorrect reference, pg. 61, Recommendation E. There is a reference to the "2007 Supplement to the International Building Code" For accuracy, the reference should be made to the specific edition of the IBC that the supplement pertains to, and mention should be made of the publisher of the supplement, so the reader can locate or obtain the document, if desired.

Suggested language:
"2007 Supplement to the 2006 IBC (published by the ICC)"

11. Incomplete reference, pg.62, Recommendation G. The first paragraph recommends development of standards and codes provisions, without mentioning the ICC Performance Code for Buildings and Facilities, developed and published by ICC- even though this code is later mentioned in a footnote on page 65.

Suggested language:
Add the end of the paragraph, add a new sentence: "The International Code Council (ICC) publishes the 2006 Performance Code for Buildings and Facilities (PCBF), which presents regulations based on outcome rather than prescription. It encourages new design methods by allowing the designer and contractor to apply broader set of parameters for meeting the intent of the International Codes. Section 1701.2.7 of the ICC-PCBF explicitly requires, 'Facilities shall be arranged, constructed and maintained so as to limit the impact of a fire on the structural integrity of the facility.'"

12. Additional reference recommended, pg.65, Recommendation J. ICC supports the recommendation that building owners retain documents, and suggests a reference to Building Information Modeling software as a vehicle for such records retention in a usable format.
Suggested language: Following the first sentence in the Recommendation, add: "Building Information Modeling (BIM) software should be utilized to allow for efficient and secure storage and retrieval of relevant information relating to buildings, and will facilitate access by first responders and others who need quick access to relevant information about the building."

13. Additional information, pg 65, Recommendation K. ICC endorses the recommendation and suggests that NIST refer to the Integrated Project Delivery project of the American Institute of Architects as part of this recommendation.
Suggested language:
At the end of the Recommendation, add: "The emerging practice of Integrated Project Delivery, a project of the American Institute of Architects (AIA), is ideally suited to this suggestion, and can be utilized in conjunction with Building Information Modeling (BIM) software."

# NFPA COMMENTS TO NIST ON THE FEDERAL BUILDING AND FIRE SAFETY INVESTIGATION OF THE WORLD TRADE CENTER BUILDING 7 INVESTIGATION

# SEPTEMBER 15, 2008

## INTRODUCTION

NFPA is pleased to present comments to NIST on their comprehensive study of the World Trade Center (WTC) Building 7 collapse. The level of effort, study, analysis and examination of the Building 7 collapse was an apparent and obviously complex endeavor due to the myriad and complex circumstances involved. NIST is commended for also taking the time to consider, and ultimately discount alternative and unconventional scenarios such as the controlled demolition theories. The members of the National Construction Safety Team (NCST), the contributing NIST staff, as well as the private contractors and consultants are to be applauded for their commitment to this project as well as the public members of the NCST Federal Advisory Committee for their oversight of the project.

The previously released NCST reports issued on WTC 1 and 2 in 2005 have served as an important framework for discussion and change in many of the NFPA codes and standards in the last 3 years. NFPA was already implementing and considering revisions to NFPA codes, standards, programs and policies prior to release of the 2005 studies.

In our 2005 comments, we stated that *It should be noted, however, that it is not only possible, but likely, that after a thorough and detailed analysis of some of the NCST recommendations, there simply may not be enough sufficient detail or compelling evidence to promulgate a change to a particular code or standard* and that statement is equally applicable to the WTC 7 study. Moving forward, NFPA is making a commitment to NIST to continue to study, review and evaluate the new recommendations in this latest study and we continue to evaluate the status of the 30 recommendations from the 2005 study.

The overlap recommendations from the WTC 1 and 2 studies as well as the new recommendation in the WTC 7 study, while clearly written, still leave open the question as to what design hazards and scenarios are realistic for building performance. While the WTC 1 and WTC 2 studies considered a clear combination of severely compromised structural integrity coupled with a severe fire, the WTC 7 outcome appears to focus on an atypical and not considered fire event.

The debate about whether building regulations should address events associated with normal building hazards (single ignition point assumptions for fire) or more extreme events such multiple and near simultaneous ignition points will be a main focus before consensus is reached on the new/primary recommendation and finding addressed in the WTC 7 study.

The comments contained within this document have been prepared by the staff of NFPA and have not been reviewed or endorsed by any of the NFPA Technical Committees or relevant NFPA advisory committees. That process is ongoing and will continue into the future once the final report is issued.

Our comments have been arranged so as to generally follow the major NCSTAR section and chapter headings of the report. When possible, our comments will refer to specific sections of the NIST study to make sure we have correlated our responses to the recommendations, findings or supplemental information contained within the report. In most cases, NFPA's comments may be as simple as agreeing with the recommendation or finding, agreeing with the recommendation or finding in principle or in some cases, disagreeing with the recommendation or finding. Regardless of our comments on the report, NFPA plans to fully consider the depth and breadth of the recommendations in future revision cycles of the relevant NFPA codes and standards, research programs or public education programs and instruction efforts.

# SUMMARY

## NFPA's Initial Reactions and Comments

The draft report by NIST on August 18, 2008 is what NFPA believes to be a very thorough, technical, scientific study of a building loss investigation that is only rivaled by the WTC 1 and WTC 2 study released in 2005. Additionally, NFPA is pleased to see the work effort of NIST resulting in positions on many controversial and sometimes, unpopular subjects. The need to conduct more research in numerous areas is quite clear. In addition, the need to parse the recommendations that may only be appropriate for a September 11, 2001 attack (or similar extreme event) versus lower magnitude events that may have severe consequences is an important distinction.

While NFPA documents –primarily NFPA 101®, *Life Safety Code*® and NFPA 5000®, *Building Construction and Safety Code*® have implemented changes in response to several of the 30 recommendation from the 2005 study, the new and unique recommendation for the WTC 7 study is unlikely to be a quick fix or rapid change. In fact, it is entirely unclear at this point in time if the fire protection engineering and structural engineering community will be quick to embrace the recommendation to the extent that NIST may desire. As noted by several comments in the 2005 study, a number of the recommendations from NIST were qualitative, somewhat undefined and left open to interpretation.

How codes and standards organizations, building owners, engineers or architects will *"…evaluate buildings to ensure the adequate fire performance of the structural system*." will have as many responses as there are buildings. More troubling however, is the implication that this is not being done now. While the entities that deal with these issues day in and day out know that this type of evaluation is considered-either through prescriptive requirements or performance based design analysis- the public at large is sure to have their confidence in the design community somewhat taken aback by such a statement-especially when it appears in at least one of the NIST news releases on the study.

NFPA will, nonetheless, take full advantage of the effort by NIST with the primary recommendation and subject it to our codes and standards development process as well as the related program activities that we have at our disposal such as the NFPA Technical Committee process, the High Rise Building Safety Advisory Committee (HRBSAC) and The Fire Protection Research Foundation (FPRF) among others. NFPA has committed its own resources to look at these complex and highly specialized issues over the years and has had much success in implementing meaningful change.

Following the release of the final WTC 7 report, NFPA staff will:

a. Review the report recommendations to determine the best course of action for each, within the NFPA codes and standards process or in other research, advisory committee or education areas within NFPA
b. Determine the status of each recommendation within NFPA's activities (Some have already been acted on; some are in process; some are not yet developed where NFPA has a clear position.)
c. Develop a schedule, specifying priorities, for actions on the recommendations

Once the final report is released, the aforementioned and continuing review of the 30 recommendations from the 2005 study and the new recommendation included in the WTC 7 study will continue to be a focus of NFPA committees and projects. As before, the practicality or impracticality of the new recommendations and the extent to which the recommendation is justified or defined, and the best approach to integrate the recommendation, if feasible, will be considered for inclusion into appropriate design practice in the coming years.

## NFPA COMMENTS ON THE RECOMMENDATIONS

NFPA has addressed the substance of the NIST report in two ways. First, we have laid out a broad reaction and response to the new recommendation. This section provides input and response to NIST and also notes what NFPA committee projects or programs are likely to be asked to look at the details of the related recommendations.

The second part of our response provides comments directly on several of the NCSTAR documents. This portion identifies changes that we believe need to be made to clarify, revise or correct in the final report from NIST. We have elected to not address the other 12 recommendations as our comments from 2005 would be largely unchanged. For convenience purposes, we have appended our comments from 2005 at the end of our comments section in Annex A.

## NFPA'S INITIAL COMMENTS AND REACTIONS

**5.1.2** **Recommendation B.** NFPA agrees that some, but not necessarily all buildings should be evaluated to consider failure of one or more built in features or systems under varying fire conditions. In addition, the effect of certain long term heating/cooling cycles on structural connections with long span members is an area requiring further investigation. Fire test protocols are not necessary inadequate as they stand today, but certainly consideration can be given to allow them to expand into other areas, to provide other information and to be reconfigured to look at newly introduced pass/fail criteria. See related comment on Recommendation D.

The reference to *worst-case design fires* is a wide open suggestion that is very difficult to define or refine. A conventional structural fire that has simultaneous ignition points on at least 10 floors is not close to realistic. If that becomes defined as the worst-case fire, and if you somehow can design for that event, then why not consider simultaneous ignition on 12 or 15 or 20 stories? If anything, the recommendation needs to consider the expected or most likely ignition scenario that morphs into a worst case (i.e. uncontrolled) design fire. That translates to a single ignition point that grows to uncontrolled fire conditions on a floor with subsequent fire spread to other floors. This is a worst-case and is the exception to fire performance and outcomes.

A principal finding for Objective 1 says WTC 7 had characteristics that were similar to other high rise fires. A significant and major difference once again relates back to the multiple ignitions on multiple floors of the WTC 7 scenario. This was not a circumstance or characteristic of any of the fires noted and is a very important distinction. First Interstate (Los Angeles-1988), Meridian Plaza (Philadelphia-1991), Parque Central (Caracus-2004) and Windsor Tower (Madrid-2005) would be typically classified as a worst-case. These fires all involved complete burnout with either no local collapse or limited local collapse. None of the events resulted in catastrophic global collapse.

If the Building 7 study had shown that a single ignition point coupled with uncontrolled fire growth, automatic sprinklers not available and subsequent fire spread to upper, multiple floors would have resulted in local collapse and ultimately catastrophic progressive or disproportionate collapse-that perhaps would have been a more realistic concept to consider. It does not appear that this type of analysis was done. This scenario is an example of a realistic fire that is worst-case. This does appear to match closely to the NIST description of *Characteristics of Infrequent (Worst-Case) Fire Events*.

This approach (also discussed in Recommendation C) allows a situation to be considered in the context of a single ignition point fire. In fact, Fire Design Scenario No. 8 from NFPA 5000 considers this exact circumstance:

> **5.5.2.8* Design Fire Scenario 8.** Design Fire Scenario 8, which is a fire originating in ordinary combustibles in a room or area with each passive or active fire protection system or fire protection feature independently rendered ineffective, shall address the concern regarding each fire protection system or fire protection feature, considered individually, being unreliable or becoming unavailable. This scenario shall not be required to be applied to fire protection systems or fire protection features for which both the level of reliability and the design performance in the absence of the system or feature are acceptable to the authority having jurisdiction.

The five bullet points that appear as sub-items as a part of the recommendation could then be considered in a more realistic manner. In the scenario noted above, related goals and objectives could be considered and might include:

-Are all occupants able to evacuate safely prior to onset of a local collapse?

-Are all occupants able to evacuate safely prior to onset of a disproportionate collapse?

-What are the property conservation and loss of mission consequences resulting from a local or disproportionate collapse?

- What are the property conservation and loss of mission consequences resulting from a local or disproportionate collapse on neighboring structures?

- What are the hazard consequences resulting from a local or disproportionate collapse on first responders?

This level of flexibility would then allow a designer to select a set of performance goals and objectives that are typically in excess of what current era codes and standards require and permit an analysis to be done on the various outcomes. In some cases, an acceptable solution and outcome may be to provide defensive fire suppression actions only provided the occupants are all able to evacuate.

While the NIST report accurately notes that the temperature that Column 79 may have been exposed to what was below the temperature that a thermal failure would have been expected-as were the structural members for the floor assembly, it should not be inferred that the fire played no role in the failure of the column. It is conclusive that the fires caused failure of the floor assemblies –and that the initial failure (local collapse) of floor 13 triggered the collapse of additional weakened floors thus leading to global collapse of the entire structure. Loss of the floor assemblies due to fire did however have an obvious impact on the load redistribution of the column-to the point that buckling failure occurred.

**<u>5.1.2</u>** **Recommendation D.** NFPA continues to largely be in agreement with this provision as presented and has initiated and completed a specific action on this recommendation. The Fire Protection Research Foundation has completed a report in June 2007 on improving the fire resistance testing of the ASTM E119 test. The report, *Fire Resistance Testing for Performance-based Fire Design of Buildings*, presents a study undertaken by the Foundation to develop the technical basis for changes and additions to ASTM E119 so that measurements and results can be used in performance-based design, without compromising the traditional use of the test standard for prescriptive building code compliance.

The goal of this project was to identify the needed capabilities of a standard fire resistance test to support Performance-Based Structural Fire Engineering (PBSFE). The goal of the work was not to alter this prescriptive-based system. Rather, the goal of this work is to provide a partial basis for a complementary performance-based system for the provision of structural fire protection. The report provides recommendations to the test methods of the standard fire resistance test in three different areas: thermal/heat transfer, structural performance, and test documentation.

Most directly related to the work of the NIST WTC 7 study were the recommendations for structural performance. The report recommends the following changes to the standard fire resistance test in regards to structural performance:

- **Assembly End Restraint**
  Place load cells at the assembly end boundaries to record magnitude of thermal restraining forces throughout test duration: minimum of three cells at one edge of furnace for the top, center, and bottom of a middle beam or stud of assembly.

- **Deflections**
  Record, as a minimum, the time-history of transverse deflections at mid-span in all primary structural members (beams, joists, columns, and wall studs) of the assembly, together with axial shortening of loaded columns and wall studs.

- **Strain Gauges**
  Require high-temperature strain gauges at critical sections (typically ends and/or mid-span) of main structural members (beams, joists, columns, wall studs) and of other important load transfer elements (shear studs, metal deck, floor slabs and reinforcement, and connections).

- **Standardized Assembly Load Application**
  Superimposed loading on all assemblies should only be applied through mechanical or hydraulically-controlled apparatus.

- **Specification of Maximum Superimposed Design Load**
  The standard should require the maximum assembly design load to be based on the greater of the design load computed from either allowable stress design or

limit states-LRFD and the controlling strength failure mode to be used for each type of assembly construction.

- **Minimum Assembly Size**
  Specified minimum sizes of construction assemblies should be as follows: walls and paritions-100 sq ft with neither dimension less than 9 ft, columns –not less than 9 ft length, floors/roofs – 180 sq ft, with neither dimension less than 12 ft, beams – not less than 12 ft-span length. Standards-making bodies should consider the formation of furnace classes to recognize furnace capabilities larger than the minimum size.

- **Size Effects and Experimental Scaling**
  Employ dimensional scaling principles in the design of the test assembly to represent the actual construction applications.

- **Mandatory Fire Testing Under Design Load to Structural Failure**
  All assembly fire tests should be conducted under maximum design load until an imminent or actual structural failure limit state is attained, or until an major integrity breach occurs, irrespective of the assembly‘s other thermal conditions.

- **Actual Strength of Assembly Structural Materials at Ambient Temperature**
  Material strength tests should be performed on samples extracted from the primary structural assembly members to determine their actual mechanical properties at ambient (including yield and ultimate strength, and elastic modulus).

- **Determination of Structural Properties at Elevated Temperatures**
  Material strength tests should be performed on materials used in the primary structural assembly members to determine their actual mechanical properties at high temperatures (including yield and ultimate strength, and elastic modulus).

- **Inclusion of Load Eccentricity for Walls and Columns**
  Require column and wall tests to be conducted with a minimum d/6 eccentricity of axial compression load from centerline, where d is the depth of column or wall.

- **No Hose Stream Test Requirement for Walls and Partitions**
  Hose stream test procedure and its acceptance criteria for walls and partitions are no longer required.

- **Structural Instrumentation Check/Calibration**
  Prior to initiation of fire test, check/calibrate all of assembly‘s structural instrumentation (transducers, strain gauges, load cells) under superimposed load.

Fire Protection Research Foundation has taken the initiative to recognize where improvements and additions are needed in the standard fire resistance test. NFPA strongly agrees that current practice does not fully address all of the issues that are present in structural fire performance today and fully supports continued research as recommended by the report.

This report addresses the recommendations set forth by the NIST WTC 7 report. Please see Annex B for a copy of the full report (also available for download at www.nfpa.org).

# ANNEX A

## NFPA COMMENTS TO NIST

## AUGUST 2005

The following are the basic recommendations from NIST and NFPA's initial comment and reaction to the 8 subject groups and 30 recommendations.

### Group 1. Increased Structural Integrity

**The standards for estimating the load effects of potential hazards (e.g., progressive collapse, wind) and the design of structural systems to mitigate the effects of those hazards should be improved to enhance structural integrity.**

**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.**

NFPA Comment: This recommendation will need further discussion and debate as it does not stipulate the extent of the multiple hazards to be considered, what load conditions should be assumed, what percentage of load path members would be assumed to be unavailable, and on how many floors those members would be missing.

NFPA believes that progressive collapse should be prevented and that it ultimately should be addressed by building regulations and design methods. However, the concept deserves further study. A clear delineation between what is defined as progressive collapse versus disproportionate collapse must be established and plainly defined.

The degree to which progressive collapse can be addressed is dependent upon the threat/hazard to be considered. Most scenarios would dictate that a progressive collapse of a building would be initiated by a substantial event such as an explosion rather than the type of events considered by current codes. The techniques used to protect against progressive collapse also need to be further analyzed. Mitigation techniques may need to consider more than just the loss of a single column or load path. Additionally, the impact of any potential solutions on other design objectives also needs to be thoroughly considered. This recommendation is of the type that may only be needed to be considered for select icon or symbolic buildings. Any such collapse scenarios, and their associated designs would require a comprehensive risk analysis to better identify the threat/hazard to be protected against. NFPA further believes that the collection of existing data on the hazard level with respect to progressive collapse is needed, and that other kinds of data such as that which shows how many deaths have resulted from disproportionate collapse also needs to be collected. Policy wise, organizations such as the Structural Engineering Institute of ASCE and the National Council of Structural Engineering Associations (NCSEA) should be tasked with development of key guidelines or manuals to address this concept.

NFPA PROJECTS: Technical Committee on Fundamentals (BLD-FUN); Technical Committee on Structures and Construction (BLD-STR); Technical Committee on Building Construction (BLD-BLC).

**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.**

NFPA Comment: Comparing state of the practice from 1964 to the tools available in 2002 does not seem to be a fair judgment. Such tools are available and have been in use for decades. This recommendation would seem to be asking for refinement of these tools, but not a mandate to use them. Policy wise, organizations such as the Structural Engineering Institute of ASCE and the National Council of Structural Engineering Associations (NCSEA) should be tasked with development of key guidelines or manuals to address this concept.

NFPA PROJECTS: Technical Committee on Structures and Construction (BLD-STR);

**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).**

NFPA Comment: It would appear that the drift limit criteria associated with seismic design already exists to address this recommendation. Serviceability criteria also would seem to drive this limitation more than wind or seismic design. There is no immediate evidence that something is amiss within this area of tall building design. Policy wise, organizations such as the Structural Engineering Institute of ASCE and the National Council of Structural Engineering Associations (NCSEA) should be tasked with development of key guidelines or manuals to address this concept.

NFPA PROJECTS: Technical Committee on Structures and Construction (BLD-STR)

### Group 2. Enhanced Fire Resistance of Structures

**The procedures and practices used to ensure the fire resistance of structures should be enhanced by improving the technical basis for construction classifications and fire resistance ratings, improving the technical basis for standard fire resistance testing methods, use of the "structural frame" approach to fire resistance ratings, and developing in-service performance requirements and conformance criteria for spray-applied fire resistive materials.**

**<u>Recommendation 4.</u> NIST recommends evaluating, and where needed improving, the technical basis for determining appropriate construction classification and fire rating requirements (especially for tall buildings greater than 20 stories in height)—and making related code changes now as much as possible—by explicitly considering factors including:**

**• timely access by emergency responders and full evacuation of occupants, or the time required for burnout without local collapse;**

**• the extent to which redundancy in active fire protection (sprinkler and standpipe, fire alarm, and smoke management) systems should be credited for occupant life safety;**

**• the need for redundancy in fire protection systems that are critical to structural integrity;**

**• the ability of the structure and local floor systems to withstand a maximum credible fire scenario without collapse, recognizing that sprinklers could be compromised, not operational, or non-existent;**

**• compartmentation requirements (e.g., 12,000 $ft^2$) to protect the structure, including fire rated doors and automatic enclosures, and limiting air supply (e.g., thermally resistant window assemblies) to retard fire spread in buildings with large, open floor plans;**

**• the impact of spaces containing unusually large fuel concentrations for the expected occupancy of the building; and**

**• the extent to which fire control systems, including suppression by automatic or manual means, should be credited as part of the prevention of fire spread.**

NFPA Comment: Ideas in this recommendation are continuously under review, scrutiny and debate-and not just for tall buildings. The fact is, we have had excellent performance in high-rise building fires when the combination of passive and active features was present. The recent history of high-rise building fire that included total or near total burnout of significant parts the structure, including Meridian Plaza (1991); Parque Central (2004) Windsor Towers (2005) would suggest that we are doing much of this at present. These buildings sustained long duration fires (18 plus hours) without suffering global collapse. This recommendation can, and should, be used to determine if such sustained burnouts are acceptable, and if demolition of the structure after the event is an acceptable property, financial and economic loss.

NFPA is in general agreement with the recommendation that a more technical basis for the determination and use of construction classifications be pursued, and notes that NFPA has and continues to pursue this overall objective through its codes and standards development process. NFPA understands this comment to mean that NIST has not indicated that there is a problem with the current system of construction classification but that the current system should be based on a more technical and scientific basis.

More specifically, NFPA believes that the ultimate successful implementation of this recommendation is largely dependent upon how some of the other recommendations are addressed. For example, re-considering the determination of construction type, which is dependent upon the test method utilized to arrive at a fire resistance rating, cannot be pursued until the test protocols are evaluated, as suggested by NIST Recommendation #5. With regard to considering specific factors as identified in the bulleted items of Recommendation #4, these also cannot be properly addressed until other recommendations are considered. For instance, the timely evacuation of occupants in bullet item one would be a function of the potential use of new evacuation means such as the use of elevators as noted in recommendation #20. The very complex and interconnected issues raised by Recommendation #4 are in need of further study. Performance and reliability of automatic sprinkler systems in Recommendation #12 seems to be called into question, which will impact any changes derived from Recommendation # 4. Automatic sprinkler performance has been , and continues to be excellent. A more specific research agenda and procedure in addressing this very comprehensive recommendation needs to be developed.

With regard to further categorizing tall buildings based upon height, NFPA believes that this subject deserves more immediate attention and should be specifically addressed based upon the current construction classification system, and then re-evaluated if a new approach for construction classification is developed. One suggestion that NFPA will pursue is to look at a segmentation of high rise building levels and determine if a risk indexing system may be implemented based upon a certain height category. All NFPA technical committees responsible for NFPA 101 and NFPA 5000 should provide further input as any such categorization may be occupancy dependent.

NFPA also notes that the basis for requiring a certain type of construction classification is a function of the threats/hazards to be protected against. The types of threats/hazards to be considered by building regulations and building designs need to be better quantified. NFPA's Technical Committee on Fundamentals (BLD-FUN) and NFPA's occupancy committees could provide further input in this regard.

A small, but important point (the sixth bullet) in this recommendation is crucial and will require attention as it relates to location and placement of day tanks and routing of the fuel lines to emergency generators and fire pumps in all structures. NFPA agrees that consideration must be given to the impact on a building structure due to the presence of unusually large amounts of hydrocarbon fuel, such as was stored in WTC 7 for the numerous emergency generators located in WTC 7. Continuous discharge of fuel for these generator sets may have contributed to the collapse of WTC 7 once one or more of the fuel lines failed allowing the fuel to be ignited and burn unimpeded.

NFPA requirements for storage of liquid fuel inside a building for the operation of stationary engine-driven or stationary turbine-driven equipment ( e.g., fire pumps, electric generators) are contained in Chapters 6, Fuel Supply – Liquid, of NFPA 37-2002, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*. The requirements are similar but not identical to the requirements in the Building Code of the City of New York (BCNYC).

Several issues identified in Chapter 12 of NCSTAR 1-1 need to be considered and studied by NFPA's Technical Committee on Internal Combustion Engines, including but not limited to the following:

- Maximum fuel storage capacity allowed unenclosed, i.e., not in a dedicated enclosure. This includes so-called base tanks and day tanks.

- Maximum fuel storage capacity allowed in dedicated fire-rated enclosures and the required fire resistance of the enclosure walls, floor, and ceiling.

- Need for active fire suppression systems designed for the quantity of fuel present.

- Need for specific protection requirements for fuel piping leading from lower floor storage tanks to upper floor stationary engines. (NOTE: NFPA 37 simply refers to NFPA 30-2003, *Flammable and Combustible Liquids Code*, for piping design and installation. NFPA 30 does not contain specific requirements that fuel piping in a building be contained within a dedicated shaft.)

- Need for specific piping system components to shut down fuel supply pumps if a break in the piping occurs.

NFPA 37 is currently being revised and the next edition is scheduled for publication in the first Quarter, 2006. The Technical Committee on Internal Combustion Engines will address these issues during the next document revision cycle.

As with other recommendations, NFPA notes that this recommendation and its associated bulleted items calls for the greater use and application of risk and hazard analyses for building design, and that the factors identified by NIST in the recommendation be considered in these analyses. Many of the tools and data needed to properly conduct this risk evaluation might not be available at present thus presenting some unique challenges as this effort moves forward.

NFPA understands that the bulleted items are intended to serve as factors which might or should be considered in the determination and use of construction types, and that the bulleted items are not intended to serve as standalone recommendations.

NFPA views these recommendations as long term objectives which will result in a more technical and scientific basis for building regulations.

NFPA PROJECTS: All Technical Committees responsible for NFPA 101 and NFPA 5000 (BLD-AAC, SAF-AAC) ;Technical Committee on Flammable and Combustible Liquids (FLC-AAC); Technical Committee on Emergency Power Supplies (EPS-AAA); Technical Committee on Internal Combustion Engines (INT-AAA).

**<u>Recommendation 5.</u> NIST recommends that the technical basis for the century-old standard for fire resistance testing of components, assemblies, and systems should be improved through a national effort. Necessary guidance also should be developed for extrapolating the results of tested assemblies to prototypical building systems.**

NFPA Comment: While the test protocols have been used for a very long time, there is nothing striking or remarkably wrong with the tests. The third bullet item under Part a. has been a focal point of the AISC Fire Engineering Committee since May of 2001. In other cases, the need to evaluate construction assemblies under simulated load conditions has also been in discussion. A review of the NFPA 251/ASTM E119/ UL 263 time-temperature curve in comparison to the data that has been collected in real world laboratory fires is reasonable to determine if these test protocols should be modified.

NFPA is in agreement with this recommendation for improving the technical basis for determining fire resistance ratings. NFPA notes that pursuing this recommendation might result in less fireproofing in some instances and more fireproofing in other cases as the current test procedure (NFPA 251/ ASTM E119/UL 263) is considered by many to be conservative on a macro scale even though it does not completely address details such as connection methods. The implementation of this recommendation will require further study and additional research. As a part of the evaluation of these test procedures, a joint effort by NFPA, ASTM and UL will be proposed by the Fire Protection Research Foundation (FPRF) to study the issues, the similarities and the differences between the test protocols versus actual fires and relevant ISO standards to determine if the test protocols need to be or should be changed.

NFPA PROJECTS: Technical Committee on Fire Protection Features (BLD-FIR); Technical Committee on Fire Tests (FIZ-AAA); Fire Protection Research Foundation.

**Recommendation 6. NIST recommends the development of criteria, test methods, and standards: (1) for the in-service performance of spray-applied fire resistive materials (SFRM, also commonly referred to as fireproofing or insulation) used to protect structural components; and (2) to ensure that these materials, as-installed, conform to conditions in tests used to establish the fire resistance rating of components, assemblies, and systems.**

NFPA Comment: Quality control associated with field preparation and application of SFRM is a legitimate concern. Firestop Contractors International Association (FCIA) has initiated work on standards and procedures to address this particular need. These standards, once completed, should be recognized and adopted by models codes and standards. The life of use issue associated with SFRM is also critical. Inspection procedures, on site repair and environmental exposure are all key factors in determining the effectiveness of the material.

NFPA is in agreement with this recommendation to improve the overall performance of SFRM. Further, it is noted that in addition to the specific items listed in the recommendation, particular attention should be given to the application of fireproofing on all structural shapes and sizes. Fire service representatives on NFPA‘s HRBSAC expressed specific concern with regard to small diameter structural elements such as bar joists. SFRM standards from organization such as FCIA and AWCI should be reviewed for reference by NFPA 5000 and NFPA 101. A need to address the appropriate criteria for abrasion, vibration, shock and impact of SFRM under expected service conditions also exists. Enforcement of the integrity of SFRM throughout the life of the building also needs to be addressed by this recommendation.

NFPA PROJECTS: Technical Committee on Fire Protection Features (BLD-FIR); Technical Committee on Fire Tests (FIZ-AAA); Technical Committee on Structures and

Construction (BLD-STR); Technical Committee on Building Construction (BLD-BLC); Technical Committee on Fire Prevention Code (UFC-AAA).

**Recommendation 7. NIST recommends the nationwide adoption and use of the "structural frame" approach to fire resistance ratings.**

NFPA Comment: This approach, now recognized in both model building codes, simply addresses the potential for a "weakest link". While the basis of the recommendation is now addressed in the 2006 edition of NFPA 5000, the term "structural frame" should be better defined for future editions of the model codes. For example, is the term to include the full load path of all structural members? Thermal failure of a beam or girder connected to a main support column carrying a gravity load-and that is essential to the stability of the structure-can impact the load path. This recommendation only addresses that particular scenario.

NFPA PROJECTS: Technical Committee on Structures and Construction (BLD-STR); Technical Committee on Building Construction (BLD-BLC); Technical Committee on Fire Tests (FIR-AAA).

### Group 3. New Methods for Fire Resistance Design of Structures

**The procedures and practices used in the fire resistance design of structures should be enhanced by requiring an objective that uncontrolled fires result in burnout without local or global collapse. Performance-based methods are an alternative to prescriptive design methods. This effort should include the development and evaluation of new fire resistive coating materials and technologies and evaluation of the fire performance of conventional and high-performance structural materials. Technical and standards barriers to the introduction of new materials and technologies should be eliminated.**

**Recommendation 8. NIST recommends that the fire resistance of structures should be enhanced by requiring a performance objective that uncontrolled building fires result in burnout without local or global collapse.**

NFPA Comment: This recommendation lumps two very different outcomes together-that being total burnout without local or global collapse. The fire events noted in Recommendation 4 did result in local, but not global collapse. The design level of preventing local collapse during a total burnout does not appear to be realistic unless the current cadre of expected fire scenarios are enhanced and made substantially more conservative. This would result in system redundancies and robustness that will LIKELY be difficult to justify from an economic and experiential point of view. Global collapse from a typical or anticipated fire event is certainly an unwanted outcome-but such cases simply do not exist for the high-rise building environment. NFPA suggests that this recommendation be parsed to separately address local collapse (which seems more acceptable) from global collapse (which seems wholly unacceptable)

A need exists to better define what is meant by "uncontrolled building fires". Is it intended that this term include only those types of fires already addressed by building and fire regulations, or is it to include other threats/hazards such as hostile acts and explosions? NFPA notes that where building collapses have occurred as a result of fire, the failures were primarily a result of the inadequate application of code mandated provisions and maintenance of fire protection features rather than from any shortcoming associated with building regulations or design methods.

NFPA PROJECTS: Technical Committees on Structures and Construction (BLD-STR), Technical Committees on Building Construction (BLD-BLC); Technical Committee on Fundamentals (BLD-FUN); Technical Committee on Fire Risk Assessment Methods (FIR-AAA)

**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.**

NFPA Comment: Performance Based Design (PBD) methods already exist in NFPA 1, NFPA 101 and NFPA 5000. These can be applied equally to new construction or existing buildings. The same discussion with respect to local and global collapse (Recommendation 8) also applies here. PBD will also have to be measured against prescriptive design to assure it is not providing a lower level of performance in any manner.

NFPA believes that ongoing efforts are needed in the development of tools, data and training for the better implementation of performance-based design methods.

NFPA PROJECTS: Technical Committee on Fundamentals (BLD-FUN).

**Recommendation 10. NIST recommends the development and evaluation of new fire resistive coating materials, systems, and technologies with significantly enhanced performance and durability to provide protection following major events.**

NFPA Comment: This recommendation should not be de-coupled from recommendation No. 6. There are no technical barriers that NFPA is aware of to such systems or materials and NFPA agrees with this recommendation that new building materials be evaluated for their fire resistant characteristics. The testing and listing laboratories such as UL, FM Global, Omega Point and Southwest have the ability to test innovative materials.

NFPA PROJECTS: Technical Committee on Fire Tests (FIZ-AAA); Technical Committee on Building Construction (BLD-BLC).

**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.**

NFPA Comment: Use of material such as fire resistive steel (FRS), concrete filled tube (CFT) and use of similar existing innovations (water filled tube WFT) have the potential to become more mainstream. Provided any of the materials or composites provides the same or higher level of protection than the current offering of construction materials, such options should be considered and more fully developed. NFPA comments on Recommendation #10 also apply here.

NFPA PROJECTS: Technical Committee on Fire Tests (FIZ-AAA); Technical Committee on Building Construction (BLD-BLC); Fire Protection Research Foundation

## Group 4. Improved Active Fire Protection

**Active fire protection systems (i.e., sprinklers, standpipes/hoses, fire alarms, and smoke management systems) should be enhanced through improvements to design, performance, reliability, and redundancy of such systems.**

**Recommendation 12.** **NIST recommends that the performance and redundancy of active fire protection systems (sprinklers, standpipes/hoses, fire alarms, and smoke management systems) in buildings should be enhanced to accommodate the greater risks associated with increasing building height and population, increased use of open spaces, available compartmentation, high-risk building activities, fire department response limits, transient fuel loads, and higher threat profile.**

NFPA Comment: This recommendation should be broken down into a broader category-namely to look at various risks associated with various segments of tall buildings. While the recommendations are appropriate to look at, other parts of the report only seem to focus on a 20 story differentiation. Consideration of a schedule for high rise buildings (perhaps 4 or 5 categories-see NFPA comments on related subject in Recommendation #4) would be more appropriate. The taller the building, i.e. the greater the perceived risk , construction features and systems with added redundancies or robustness of systems could be increased in some manner.

A means for better understanding and quantifying the impact, performance and reliability of fire protection systems should be pursued. A distinction should also be emphasized between enhancing the effectiveness of such systems and evaluating their appropriateness with respect to specific hazards/threats.

One starting point to consider, revolves around the CTBUH *Building Enhancement Guidelines*. These guidelines, released in May of 2002 provide potential augmentation features that could be applied to increase the reliability of certain building systems and features. In this realm, the systems would be enhanced or hardened to be able to manage certain design hazards that are normally not contemplated in codes. The NFPA HRBSAC is considering a concept (modeled on the LEEDS system) that would provide a point score system for certain system features or enhancements that are best described as "code-plus" designs. Work in this area will likely be in collaboration with NIST and CIB.

It should be noted that the Technical Correlating Committee for the National Electrical Code (NEC) has established a task group to specifically look at the hazard scenarios identified by DHS and to determine what (and where) enhancements to building electrical services could be made to increase the reliability/robustness of such systems.

NFPA PROJECTS: Technical Correlating Committee on Automatic Sprinklers (AUT-AAC); Technical Committee on Fire Pumps (FIM-AAA); Technical Committee on Standpipes (SPI-AAA); Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Correlating Committee on National Electrical Code (NEC-AAC); Technical Committee on Emergency Power Supplies (EPS-AAA); Technical Committee on Smoke Management Systems (SMO-AAA).

**Recommendation 13. NIST recommends that fire alarm and communications systems in buildings should be developed to provide continuous, reliable, and accurate information on the status of life safety conditions at a level of detail sufficient to manage the evacuation process in building fire emergencies, and that standards for their performance be developed.**

NFPA Comment: Timeliness of accurate information for the occupants during large scale building emergencies is of crucial importance. The hardware and software necessary to achieve this is available. Knowing when to give direction, and what direction to give is of paramount importance. This recommendation is closely aligned with Recommendation 16 and 19.

NFPA PROJECTS: Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC).

**Recommendation 14. NIST recommends that control panels at fire/emergency command stations in buildings should be adapted to accept and interpret a larger quantity of more reliable information from the active fire protection systems that provide tactical decision aids to fireground commanders, including water flow rates from pressure and flow measurement devices, and that standards for their performance be developed.**

NFPA Comment: The benefit of having flow rate data available at the command center is not obvious. What other information was being considered when this recommendation was being drafted?

NFPA PROJECTS: Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Correlating Committee on Automatic Sprinklers (AUT-AAC); Technical Committee on Fire Service Occupational Safety (FIX-AAA).

**Recommendation 15. NIST recommends that systems should be developed and implemented for: (1) real-time off-site secure transmission of valuable information from fire alarm and other monitored building systems for use by emergency responders, at any location, to enhance situational awareness and response decisions and maintain safe and efficient operations[32]; and (2) preservation of that information either off-site or in a black**

**box that will survive a fire or other building failure for purposes of subsequent investigations and analysis. Standards for the performance of such systems should be developed, and their use should be required.**

NFPA Comment: Alarm transmission information is routinely backed up and available at central station monitoring facilities. If the only purpose for having this is for event reconstruction, such data already exists in most cases. If it is for use during an event, a point of information overload may be reached. Under some circumstances, too much information becomes less than useful. NIST should particularly pay attention to comments from fire department personnel and OEM managers on this recommendation.

NFPA PROJECTS: Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Committee on Fire Service Occupational Safety (FIX-AAA).

## Group 5. Improved Building Evacuation

**Building evacuation should be improved to include system designs that facilitate safe and rapid egress, methods for ensuring clear and timely emergency communications to occupants, better occupant preparedness for evacuation during emergencies, and incorporation of appropriate egress technologies.**

**Recommendation 16. NIST recommends that public agencies, non-profit organizations concerned with building and fire safety, and building owners and managers should develop and carry out public education campaigns, jointly and on a nationwide scale, to improve building occupants' preparedness for evacuation in case of building emergencies.**

NFPA Comment: This type of action should have been standard protocol pre September 11. High rise building evacuation is a complex subject and while partial relocation of occupants is still the preferred method, we now know that:
A. It may not always be the preference of the occupant;
B. Some building events-fire, power failure, bomb threat-require special approaches, and a full building evacuation may be needed.

At present, NFPA does offer guidelines, both in pamphlet form and on the NFPA website concerning evacuation protocols from high rise buildings. NFPA will pursue the development of additional education programs in this regard and establish cooperative agreements with other organization that have similar interests (BOMA, CTBUH, GSA, ULI). In all cases, any such programs or educational initiatives must be inclusive of persons with all manner of disabilities. See related item in Recommendation #20.

NFPA PROJECTS: Technical Correlating Committee on Safety to Life (SAF-AAC); Technical Committee on Fire Prevention Code (UFC-AAA); Public Education Section; DARAC.

**Recommendation 17. NIST recommends that tall buildings should be designed to accommodate timely full building evacuation of occupants due to building-specific or large-scale emergencies such as widespread power outages, major earthquakes, tornadoes, hurricanes without sufficient advanced warning, fires, accidental explosions, and terrorist**

**attack. Building size, population, function, and iconic status should be taken into account in designing the egress system. Stairwell and exit capacity should be adequate to accommodate counter flow due to emergency access by responders.**

NFPA Comment: Full building evacuation concepts are an important consideration, but should not be viewed as the preferred or optimum choice for a tall building. Width of stairs in high rise buildings has been a discussion topic for decades, not years. While the concept of sizing the stairs for the largest floor population is workable for typical or expected scenarios, there are definitive concerns for mass evacuation of the building coupled with issues of counter-flow by first responders. The 2006 editions of NFPA 101 and NFPA 5000 include a new stair width design concept that incorporates cumulative population use of the stairs. An aggregate of the floor populations will trigger an increase in stair width (from 44 inches to 56 inches) where 2000 or more occupants are expected to use a given stair.

NFPA does believe that a better understanding of the evacuation and egress of building occupants is necessary. Data and methods need to be further developed to help understand occupant behavior and to determine the length of time needed to evacuate building occupants. Scenarios should include various types of evacuation such as partial evacuation or relocation concepts, full evacuation, defend in place concepts, use of elevators, escape devices, and other alternate means of escape. Availability and reduction of egress routes should be also considered. NFPA notes that the term ―timely” is largely a function of the threat/hazard to be considered and is likely to require risk analysis. Building-specific and large-scale emergencies need to be quantified. It should also be recognized that rapid evacuation of all building occupants could place them in greater danger. The effect of evacuation planning and drills should be quantified, and efforts in limiting the number of trips and falls should also be pursued.

NFPA PROJECTS: Technical Committee on Means of Egress (BLD/SAF-MEA); Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Committee on Fire Service Occupational Safety (FIX-AAA); Research Section; Fire Service Section, Public Education Section.

**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.**

NFPA Comment: This recommendation is disconcerting in that it introduces a major assumption of a ‗large scale‘ emergency, yet states in item b. this is not an aircraft impact. What event(s) would fit into this category? The recommendation also attempts to sweep into it design of other systems and features such as elevators. NFPA recommends that the subject in Recommendation #18 regarding ―large scale” emergency be removed from the list and described as a separate point of philosophical discussion. The on-going debate about whether building regulations should address events associated with normal building hazards, or more extreme events such as hostile acts and explosions will have to be settled first before consensus is reached on this subject.

NFPA agrees with that part of the recommendation regarding consistent layout and signage and the use of features that will make the egress system more intuitive. NFPA 72, *National Fire Alarm Code*, has accepted a series of proposals for the 2007 edition that will introduce the concept of *Exit Marking Audible Notification Appliances*. Such components have the ability to direct occupants by sound to the exit locations.

NFPA also agree that remoteness of exits should be studied, as current remoteness provisions might not be adequate for other than fire events. Areas that NFPA Technical Committees will study include concepts of a more robust building core, or more robust stair construction and the reduction of remoteness of exits in sprinklered buildings.

NFPA PROJECTS: Technical Committee on Means of Egress (BLD/SAF-MEA); Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC).

**Recommendation 19. NIST recommends that building owners, managers, and emergency responders develop a joint plan and take steps to ensure that accurate emergency information is communicated in a timely manner to enhance the situational awareness of building occupants and emergency responders affected by an event. This should be accomplished through better coordination of information among different emergency responder groups, efficient sharing of that information among building occupants and emergency responders, more robust design of emergency public address systems, improved emergency responder communication systems, and use of the Emergency Broadcast System (now known as the Integrated Public Alert and Warning System) and Community Emergency Alert Networks.**

NFPA Comment: This subject closely aligns with Recommendation #13. Similar technologies are deployed at the US Capitol complex to provide an alert status to the approximately 30,000 staff, occupants and visitors who may be present on a given day. Recent work underway at NFPA, and that was initiated at the request of the US Air Force on Mass Notification systems will help to codify and standardize some of these protocols.

NFPA PROJECTS: Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Committee on Building Systems (BLD-SYS); Fire Service Section; Public Education Section; Metro Chiefs.

**Recommendation 20. NIST recommends that the full range of current and next generation evacuation technologies should be evaluated for future use, including protected/hardened elevators, exterior escape devices, and stairwell navigation devices, which may allow all occupants an equal opportunity for evacuation and facilitate emergency response access.**

NFPA Comment: This subject was part of the theme at a NIST sponsored workshop in 2004. Recommendation #21 on elevator use is going to happen sooner rather than later. Last resort escape devices are gaining some recognition and use, but integration of such devices into the built environment must be carefully managed. And there can be no expectation, however, that current technologies will have an impact on September 11 type events.

The term ―stairway descent devices” has been used in NFPA 101 and NFPA 5000, and it is recommended that NIST use the same terminology in lieu of stairwell navigation devices.

NFPA PROJECTS: Technical Committee on Means of Egress (BLD/SAF-MEA); Technical Committee on Building Systems (BLD-SYS); DARAC; Public Education Section.

## Group 6. Improved Emergency Response

**Technologies and procedures for emergency response should be improved to enable better access to buildings, response operations, emergency communications, and command and control in large scale emergencies.**

**<u>Recommendation 21.</u> 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.**

NFPA Comment: Broad use of elevators well into a building fire or other emergency event will offer a means of attaining a more timely evacuation of very tall buildings as noted in Recommendation #17. Work in this particular area is likely within three years of completion and implementation. If possible, NIST and ASME should fast track this particular project so as to allow the hardened elevator concept to be realized sooner if possible.

The effort being organized by NIST and ASME is of crucial importance to ensure that current technology (both hardware and software) can adequately address the associated safety, functional and operational concerns with using the elevators as described. In particular, concerns with elevator shunt trips, the filling of shafts with smoke, the operation of equipment under adverse conditions such as when wet from fire suppression operations or systems and the need to provide direction to the occupants must be addressed.

A dedicated use elevator as described only for the exclusive use of emergency responders, i.e. fire fighters is open to discussion. In some cases, on site fire ground operations in a high-rise building may take 15 to 20 minutes to commence from time of the first alarm. If a goal truly is to strive for timely evacuation, this is a significant portion of time where the elevators may be in recall mode and are not being utilized. Keeping elevators available for use by building occupants, or at least building occupants with mobility impairments, during this time period, vastly improves the chances of meeting Recommendations #17 and #21.

NFPA suggests that the use elevators should be as a minimum, under exclusive authority of the fire service and other first responders such as fire wardens, security personnel and other authorized on site personnel who may be adequately trained to use the elevator. Ideally, use of the elevators by the occupants should be a longer term goal to strive for. In particular, anything that can be done allow mobility impaired occupants access and use of the elevators under emergency conditions should be pursued as quickly as possible.

Structurally hardened (properly protected) elevators also need to be further defined as well as the threats/hazards to be considered. The CTBUH *Emergency Evacuation Elevator Systems Guideline* (September 2004) provides a definitive starting point for elevator evacuation concepts.

NFPA PROJECTS: Technical Committee on Means of Egress (BLD/SAF-MEA); Technical Committee on Building Systems (BLD-SYS); Technical Committee on Uniform Fire Code (UFC-AAA); Technical Committee on Fire Service Occupational Safety (FIX-AAA); DARAC; Public Education Section; Fire Service Section; Metro Chiefs.

**Recommendation 22. NIST recommends the installation, inspection, and testing of emergency communications systems, radio communications, and associated operating protocols to ensure that the systems and protocols: (1) are effective for large-scale emergencies in buildings with challenging radio frequency propagation environments; and (2) can be used to identify, locate, and track emergency responders within indoor building environments and in the field.**

NFPA Comment: First responder communication systems must be robust enough to allow uninterrupted, reliable communication between fire, police and OEM officials for all building emergencies and not just the large scale event mentioned. The particular problem of needing reliable and dependable communication systems that work from inside of any building environment to both internal and external locations is crucial.

NFPA PROJECTS: Technical Committee on Fire and Emergency Service Organization and Deployment — Career (FAC-AAA); Technical Committee on Fire and Emergency Service Organization and Deployment — Volunteer (FAD-AAA) ;Technical Committee on Fire Service Occupational Safety (FIX-AAA) ; Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Committee on Public Emergency Service Communication (PUF-AAA); National Electrical Code Committee (NEC-AAC);Fire Service Section; Metro Chiefs.

**Recommendation 23. NIST recommends the establishment and implementation of detailed procedures and methods for gathering, processing, and delivering critical information through integration of relevant voice, video, graphical, and written data to enhance the situational awareness of all emergency responders. An information intelligence sector should be established to coordinate the effort for each incident.**

NFPA Comment: Related to Recommendation #15, this concept must remain manageable by that individual or sector. One concern may be too much information.

NFPA PROJECTS: Technical Committee on Fire and Emergency Service Organization and Deployment — Career (FAC-AAA); Technical Committee on Fire and Emergency Service Organization and Deployment — Volunteer (FAD-AAA); Technical Committee on Fire Service Occupational Safety (FIX-AAA) ; Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Committee on Public Emergency Service Communication (PUF-AAA); Technical Committee on Pre-Incident Planning (PIP-AAA);Fire Service Section; Metro Chiefs.

**Recommendation 24. NIST recommends the establishment and implementation of codes and protocols for ensuring effective and uninterrupted operation of the command and control system for large-scale building emergencies.**

NFPA Comment: Circumstances by which a governmental entity establishes a command authority that is event dependent is critical. Smaller jurisdictions may have a one stop procedure-regardless of the event. Larger jurisdictions may have a complex system that has different lead agencies for different events. Such protocols should consider the event, mutual aid from surrounding jurisdictions, and thresholds for assistance from state and federal government agencies.

Jurisdictions at all levels need to develop and implement protocols that clear lines of authority are established in advance of major emergencies. The recommendations made in the report very clearly outline the steps that jurisdictions should take to improve their command and control of large-scale incidents.

NFPA PROJECTS: Technical Committee on Fire and Emergency Service Organization and Deployment — Career (FAC-AAA); Technical Committee on Fire and Emergency Service Organization and Deployment — Volunteer (FAD-AAA); Technical Committee on Fire Service Occupational Safety (FIX-AAA); Technical Committee on Public Emergency Service Communication (PUF-AAA); Technical Committee on Pre-Incident Planning (PIP-AAA); Fire Service Section; Metro Chiefs.

## Group 7. Improved Procedures and Practices

**The procedures and practices used in the design, construction, maintenance, and operation of buildings should be improved to include encouraging code compliance by nongovernmental and quasi-governmental entities, adoption and application of egress and sprinkler requirements in codes for existing buildings, and retention and availability of building documents over the life of a building.**

**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.**

NFPA Comment: The recommendation should also extend to federal agencies as well. This recommendation is simply good practice-both business and neighbor. The terms –non-governmental and quasi-governmental" should be deleted. Additionally it should address those situations where no Authority Having Jurisdiction exists, where the local governing building regulations do not need to be adhered to by the party constructing the building, and where self-certification in the private sector occurs.

NFPA PROJECTS: Technical Committee on Fundamentals (BLD/SAF-FUN); Technical Committee on Uniform Fire Code (UFC-AAA); IFMA; AEBO Section

<u>**Recommendation 26.**</u> **NIST recommends that state and local jurisdictions should adopt and aggressively enforce available provisions in building codes to ensure that egress and sprinkler requirements are met by existing buildings. Further, occupancy requirements should be modified where needed (such as when there are assembly use spaces within an office building) to meet the requirements in model building codes.**

NFPA Comment: While retroactive imposition of building safety standards can be intrusive, it is none-the-less good practice. Grandfathering concepts that allow other than imminent hazards to remain in place have proven to be problematic. At first pass, this recommendation needs to be modified somewhat to distinguish between removal of grandfathering clauses and complying with requirements for new construction during renovation type projects. The thresholds' for change is quite different in these two concepts.

Certain requirements for existing buildings such as those pertaining to sprinkler protection and fire resistance should meet the same level of safety required for new construction when a renovation in contemplated. Additional regulations for existing buildings, such as those currently found in NFPA 101, should be developed and adopted. NFPA 101 does not recognize the –grandfathering concept"-instead, it mandates a minimum level of safety and performance that applies retroactively to a building. NFPA is strongly in support of the recommendation that high rise buildings be retrofitted with automatic sprinkler systems. This provision is currently a requirement of NFPA 1 and NFPA 101.

NFPA PROJECTS: Technical Committees for the Life Safety Code (SAF-AAC) and Building Code (BLD-AAC); Technical Committee on Uniform Fire Code (UFC-AAA); IFMA; AEBO Section.

__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[45]. 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.**

NFPA Comment: The retention of documents- including as built drawings, relevant calculations and O&M manuals is important for future modifications or work on the building. What type, and how much information should be available to first responders will be a function of the extent to which government entities adapt to items in Recommendations 15 and 23. Local issues with regard to information required by first responders, the format of the information, and how much information is necessary must also need to be addressed.

NFPA PROJECTS: Technical Committee on Fire and Emergency Service Organization and Deployment — Career (FAC-AAA); Technical Committee on Fire and Emergency Service Organization and Deployment — Volunteer (FAD-AAA); Technical Committee on Fire Service Occupational Safety (FIX-AAA); Technical Committee on Pre-Incident Planning (PIP-AAA); Fire Service Section; Metro Chiefs.

__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 systems, 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.**

NFPA Comment: Use of all appropriate design professionals should be integrated into this recommendation. Unusual structural design applications must be over seen by a structural engineer; unusual mechanical design applications must be overseen by a mechanical engineer. Codes should continue to advance the concept of *Design Professional in Responsible Charge*, or *Registered Design Professional*, but state licensing boards should be responsible for establishing the areas of practice for a given project.

__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.**

NFPA Comment: This recommendation embraces a concept that is long overdue. In some case, fire safety needs and concerns are addressed almost as an afterthought. Fire protection engineers want to offer solutions to everyday prescriptive-based designs but also to innovative architectural designs. Likewise, it is important for the architectural community to be aware of the limits in fire protection engineering. Work among affiliated groups such as NFPA, SFPE, AIA, NCSEA and ASCE among others would help with the cross knowledge application desired by this recommendation.

NFPA PROJECTS: Professional Development Division.

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

NFPA Comment: Such course offering currently exist and broader availability of these programs will help everyone to perform more concise analyses of buildings designs with respect to fire events. Work among affiliated groups such as NFPA, SFPE, AIA, NCSEA and ASCE among others would help with the cross knowledge application desired by this recommendation.

NFPA PROJECTS: Fire Science and Technology Educators Section

# ANNEX B

## FPRF Report

## June 2007

# Fire Resistance Testing
# For Performance-based Fire Design of Buildings

*Final report*

Prepared by:

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RESEARCH FOUNDATION

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# FOREWORD

The ASTM E119 test procedure (or equivalent) is used to determine whether a construction assembly or structural element meets the fire resistance rating requirements specified in prescriptive building codes. Fire statistics indicate that these requirements appear to be adequate in meeting the intended fire safety objectives of the prescriptive codes. In recent years it has become more common to design buildings for fire safety on a performance basis. The standard fire resistance test in its present form is not designed to provide discrete information that can be used in support of performance-based structural fire design. The technology of the test standard could be improved to make the measurements and results more useful for performance-based fire design.

This report presents the results of a study undertaken by the Foundation to develop the technical basis for changes and additions to ASTM E119 so that measurements and results can be used in performance-based design, without compromising the traditional use of the test standard for prescriptive building code compliance.

The Research Foundation expresses gratitude to the report authors Craig Beyler, Jesse Beitel, Nestor Iwankiw, and Brian Lattimer of Hughes Associates, Inc.; and the Project Technical Panelists and Principal Sponsors listed on the following page.

The content, opinions and conclusions contained in this report are solely those of the authors.

# Fire Resistance Testing
# For Performance-based Fire Design of Buildings

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# FIRE RESISTANCE TESTING
# FOR PERFORMANCE-BASED FIRE DESIGN OF BUILDINGS

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June 18, 2007

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**The Technical Basis of a Fire Resistance Test for Performance-Based Fire Design of Buildings**

## 1.0 INTRODUCTION

There is an ongoing trend in Fire Protection Engineering toward Performance-Based Design (PBD) and toward rational engineering of fire protection in lieu of prescriptive requirements. This approach requires engineering data that existing test methods, like ASTM E 119 (American Society for Testing and Materials), are not currently configured to provide (Grosshandler, 2002). The lack of engineering data from standard fire resistance test methods requires that performance-based design utilize data obtained from ad hoc test methods performed outside of the scope of standard test methodologies. This process is lacking in both standardization and efficiency.

In addition to other limitations with respect to test procedures, measurements, and reporting, reproducibility of standard furnace testing has always been a serious issue. Fire resistance tests are unique within the fire test world in that the apparatus is only generally specified in the test standard. Fuels, burners, furnace linings, furnace dimensions, loading levels, and loading mechanisms are either unspecified or only generally specified. This has led to the situation that test results cannot be reproduced from laboratory to laboratory. This situation causes significant problems in a performance-based design environment.

The goal of this project is to identify the needed capabilities of a standard fire resistance test to support Performance-Based Structural Fire Engineering (PBSFE). A test plan outline to develop and validate the proposed capabilities, procedures, and instrumentation has been developed and is included in this report. The test plan outline provides an approach to evaluate the ability of the recommendations to be implemented, and to evaluate the value added by the recommendations. The recommendations developed in this report are intended to apply to the entire range of fire resistive assemblies. However, the accompanying test plan outline utilizes two common building elements; composite concrete slab/steel beam floor assemblies and gypsum-protected load bearing steel-stud walls as test beds for the evaluation of the recommendations. It is intended that such testing will provide a partial basis for the inclusion of the recommendations into a test standard. It is envisioned that the work will support the ongoing development of fire resistance test methods in ASTM E 5.

While there is emerging interest in Performance-Based Structural Fire Engineering, it is understood that the existing test methods that support prescriptive requirements will be needed for the foreseeable future. It is recognized that some of the recommendations in this report may be applicable to existing test methods that support current prescriptive design approaches. Recommendations that may be applicable to existing test methods are summarized in Section 6.4.

The existing test methods and the listings that have resulted from application of these test methods are a significant legacy that has served the fire community since the 1920s. The combination of the test methods, the listings, and prescriptive fire resistance requirements of the building codes have resulted in very satisfactory overall fire performance of buildings. The goal of this work is not to alter this prescriptive-based system. Rather, the goal of this work is to provide a partial basis for a complementary performance-based system for the provision of structural fire protection. Given the long history of the prescriptive-based system, discussions of the provisions of a new performance-based system will inevitably include a juxtaposition of the properties of the new performance-based system relative to the existing prescriptive-based system. These juxtapositions inevitably focus on the shortcomings of the prescriptive system with respect to performance-based design. The simple fact is that the design approaches are different and have different requirements. It is appropriate for the development of performance-based methods to grow out of our extensive experience with the prescriptive system. When elements of the prescriptive system are highlighted as not appropriate for performance-based design, these are simply expressions of the differences in the requirements of the two systems and are not appropriately regarded as failures of the prescriptive system. The prescriptive approach has provided very satisfactory results in application. It is simply hoped that the performance-based system can provide similarly satisfactory or better results in a more cost-effective manner.

### 1.1 Ongoing Developments in Structural Fire Protection Design Methods

In the area of engineered structural fire protection, there are many ongoing organizational efforts to develop the required design method infrastructure. The Society of Fire Protection Engineers (SFPE) has a committee working on a standard for determination of the design fire exposure. SFPE is also in the process of constituting a committee to develop a standard on the thermal/heat-transfer portion of the design process. The National Fire Protection Association (NFPA), meanwhile, is developing a standard for fire loads for structural fire protection design. These committees are coordinating their efforts to produce a suite of documents that collectively support PBSFE.

While the American Society of Civil Engineers (ASCE) had announced some time ago its intention to produce a document in the structural portion of the design process, it seems that this process has not yet materialized (ASCE Committee for Structural Design for Fire Conditions is charged with development of a Performance-Based Fire Design Standard). There is no doubt that the SFPE efforts on the heat-transfer portion and ASCE's efforts on the structural portion will require data that cannot be obtained using current test methods.

In that vein, there is a task group working within ASTM E 05.11 (Fire Resistance) that is developing a guidance document for conducting nonstandard furnace tests. All these activities have European counterparts generally encompassed by the Eurocode suite of documents. Based upon the various ongoing related activities, there is a genuine need to develop means for integrating standardized fire resistance test results into the performance-based structural fire engineering process.

### 1.2 Outline of the Analysis Approach

The approach to analyzing the recommendations for fire resistance testing in support of PBSFE begins by reviewing the PBSFE design process. Based upon the needs of PBSFE and the research literature, recommendations are developed in the areas of heat-transfer/thermal response, structural performance, and test documentation. The recommendations are first stated, and then the basis for the recommendation is developed from the research literature. Appendix A includes a bibliography of research in structural fire engineering.

## 2.0 PERFORMANCE-BASED STRUCTURAL FIRE ENGINEERING (PBSFE)

While the field of Performance-Based Structural Fire Engineering is in the developmental stage, the overall structure of the process has been well defined for some time. Grosshandler (2002) outlined the process in summarizing a recent fire resistance workshop. The process includes both design and analysis components. The analysis components involve the definition of the design fire exposure, the thermal/mechanical response of the structural assembly (including any fireproofing materials), and structural response of the structural system. The broader design processes are shown in Figure 1, including inputs from building code requirements and inputs from assembly listings. Here we take a broad view of assembly listings to include any engineering data that can be deduced from the testing involved in the development of the listing (despite the fact that such test data is not made public by the listing organization or test sponsors at the current time) or fire resistance testing not associated directly with the listing process. The recommendations developed in this report are intended to provide additional engineering information and data from the activity noted in Figure 1 as "Assembly Listing and Data." These infrastructure components are shown above the dashed line, while the actual design portion of the process is shown below the dashed line. The design components include the architectural and structural designs of the building, which form the basis for the fire engineering design.

The fire engineering begins with the development of a design fire exposure to the structure. This normally takes the form of a time-temperature curve based upon the fire load, ventilation, and thermal properties of the bounding surfaces (walls, floor, and ceiling). Design fire loads are dependent upon the occupancy and other fire protection features of the building. Significantly, with respect to furnace testing, the performance of the boundaries to limit fire spread is the primary component of defining the design fire area. Often the exposed fire area is defined by boundaries with sufficient fire resistance to prevent fire spread under the design fire load density. It is significant to note that the time-temperature curves developed in compartment fires most often exceed the time-temperature curves used in the test methods like ASTM E 119. As noted by Drysdale (1999), this has been recognized but tacitly accepted since the 1920s in the setting of prescriptive fire resistance requirements for buildings.

Based upon the architectural and structural designs, the design fire is used to develop the passive fire protection design. This involves the selection of fire resistive assembly constructions for use as walls, columns, and floor/ceiling assemblies. The assemblies are selected to survive the design fire exposure, to be consistent with the architectural/structural design, and to provide cost-effective protection. It would be normal to develop more than one set of conceptual designs for further evaluation.

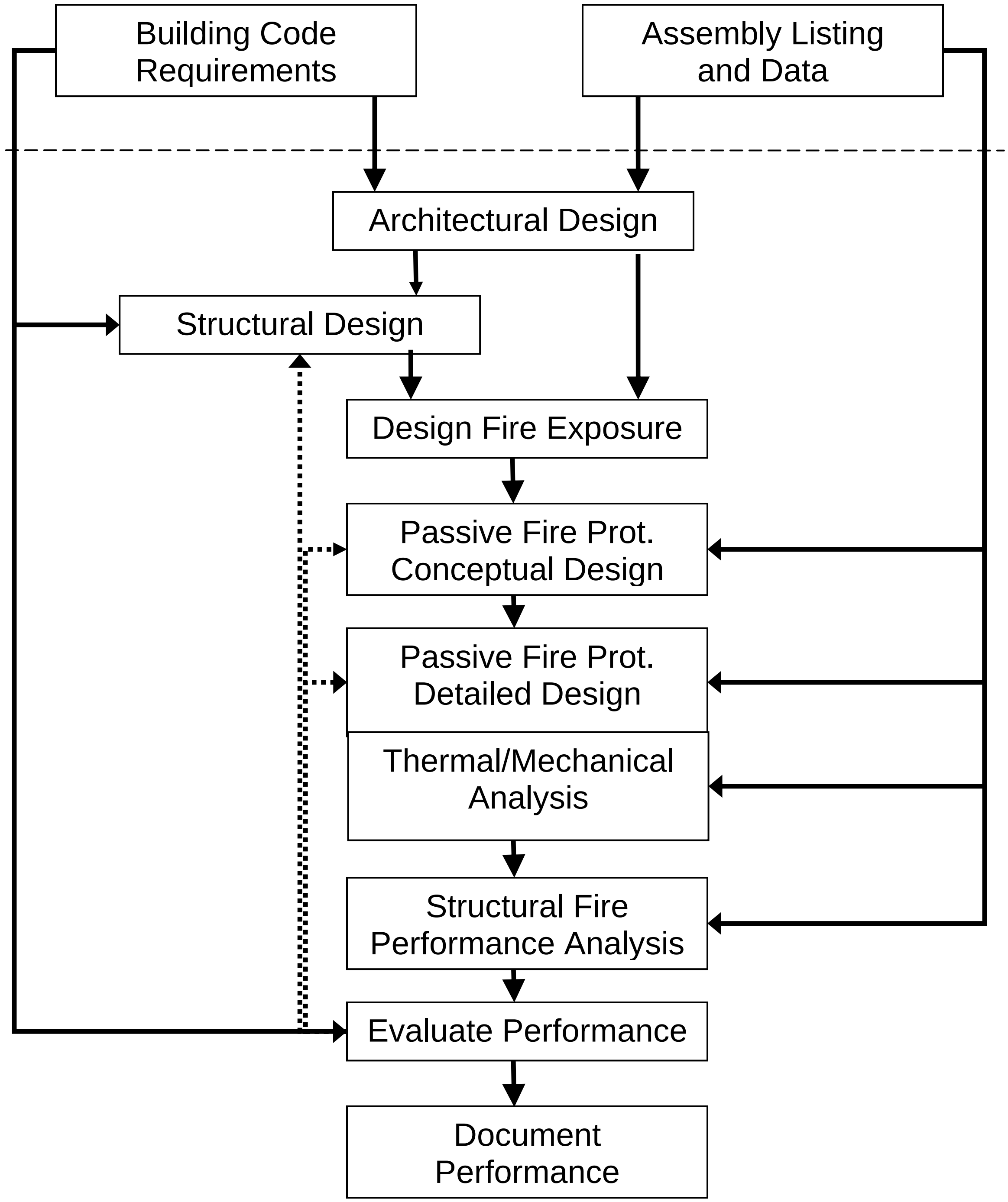



Figure 1. Performance-based structural fire engineering (PBSFE) design process.

Detailed design involves the use of thermal/mechanical models to assess the performance of each conceptual design, resulting in trial protection thicknesses based upon tentative thermal failure criteria. It is typical to perform two-dimensional heat-transfer analyses, but three-dimensional analyses are sometimes required. It is significant that existing models cannot deal with the mechanical performance of the assembly in any substantive manner. Loss of physical integrity of a material or the assembly cannot be modeled at this time. The designer relies entirely upon the results of testing to assure that physical integrity is maintained over the design exposure period. In most cases, the engineer will seek to use materials and assemblies that can be relied upon to maintain integrity, or alternatively simple, and somewhat ad hoc, assumptions about material loss are made in the design calculations.

The final analysis process is the prediction of structural performance of the structure under design loads with the structural elements heated according to the heat-transfer analysis. This analysis can be performed for individual elements, for the substructure in the fire area, or for the complete structural system. Typically, multiple analyses are performed with more detailed analysis at the element level and more basic analysis at the structural system level.

Based upon the performance of the system, redesign may be indicated. This could include changes to the structural design (especially if changes here could allow removal of fireproofing altogether), changes in the passive design concept (e.g., change insulating material), or alterations in the detailed design of the passive fire protection (modify the thicknesses of the insulation). Other redesign aspects are possible, but these are the most common.

As indicated in Figure 1, the assembly listing and data that is, or could be, included in the listing documentation can contribute to the passive fire protection design, the thermal/mechanical analysis, and the structural fire performance analysis. It is important to note that the listing documentation (e.g., the test report) is not a public document under the current system so that these can only be used with the assistance of the owner of the listing. In addition, the current listing may not be directly supported by reported tests. Testing may have been performed with an old version of the protective material and the current material may be accepted under the listing based upon the listing agency's engineering judgment. While this may be satisfactory for prescriptive use of the product, it has serious limitations with respect to PBSFE.

Other data sources, not shown in Figure 1, also contribute to these design and analysis processes. These include other published data concerning temperature dependent structural properties of materials and thermal properties of insulating materials. While some of this data is produced using standard methods, other data is obtained via ad hoc testing methods.

The analysis methods employed in the design process may vary from special purpose software to general heat-transfer or structural analysis software. Some software is developed by the designer, some is developed by government laboratories, and some is commercial software. There is a specific need to address applicability, validation, and verification of these methods for use in specific Performance-Based Structural Fire Engineering (PBSFE) designs.

It is the vision of this report that a fire resistance test in support of PBSFE should be a part of the validation and verification (V&V) basis for the application of analysis tools to specific fire resistance designs. All needed data to support the analysis should be developed through tests designed for that purpose (e.g., thermal properties and structural properties). The furnace test should be conducted and instrumented to provide high quality data and boundary conditions to form a data set that can be predicted using the analysis tools. The successful prediction of the test would form a partial basis for demonstrating the applicability of the models to the particular fire resistance design. The test would further identify any mechanical behaviors such as erosion, cracking, spalling, shrinkage, fastener failures, warpage, and other behaviors that need to be mitigated in the design or accommodated in the design calculations.

There is a wide range of testing and reporting aspects of standard fire test methods that are required to support PBSFE. These include simple characterization of the test article and the properties of the component materials, as well as substantive measurements made and the conduct of the test itself. It has been recognized for many decades that realistic fire exposures can exceed the exposure in ASTM E 119 and that the exposure conditions to the assembly vary among furnaces operated in a manner consistent with existing test methods. There is also a need to develop and validate thermal properties of insulating materials and the methods and instrumentation of standard test methods to support PBSFE. There are definite unresolved issues concerning the structural conduct of the test to assure that the results are applicable to longer spans and connections found in actual construction. This brings to the fore issues of structural scaling laws, and the use of structural rather than thermal endpoints for the test. Issues also exist with the conduct of the test with respect to failure criteria. Valuable failure mode data can be provided by the practice of "testing to failure." These and other issues have received varying levels of attention in the testing and research literature. There is no doubt that a new fire resistance test method can become a valuable tool in PBSFE design. The recommendations included in the following sections are in support of this objective.

## 3.0 TEST METHOD RECOMMENDATIONS – THERMAL/HEAT-TRANSFER

The test requirements with respect to the thermal aspects of the test method involve measurements/instrumentation, furnace-operating conditions, and test documentation. These requirements relate to the representation of realistic fire exposures and production of data that can directly support PBSFE. The recommendations are followed by a discussion of the issue and the basis for the recommendation.

Heat-transfer analysis through an assembly exposed to fire conditions must be conducted using models that have been verified and validated (V&V) with data that is representative of the expected fire conditions. Guidance is provided in this section of the report to develop a furnace test that generates thermal response data that can be used to V&V heat-transfer models. Data collected will provide a means for engineers to V&V models for predicting the variables of potential concern in a fire resistance simulation including temperature profiles through the assembly, temperature rise of an item placed against the unexposed side of the assembly, and total heat flux off the unexposed side and/or through transparent portions of the assembly.

Furnace construction and control are detailed to provide a consistent, repeatable exposure that minimizes the effects of test article construction on the exposure conditions. A furnace calibration test is recommended to quantify the thermal exposure onto a test article. This should be done through the measurement of total heat fluxes from the furnace onto the test article as well as the thermal response of noncombustible boards with known thermal properties. With this data, heat-transfer models can be used to predict temperature profiles through the noncombustible boards, demonstrating the capability of the model to predict heat transmission due to a furnace exposure. These procedures minimize furnace-to-furnace differences and provide a basis for validating the model performance with the furnace to be used to test the assembly to be used in PBFPE. This procedure will directly support round-robin comparisons of furnaces to insure the consistent application of the test method among laboratories.

The recommended furnace exposure conditions are based on an upper bound of conditions that have been measured in compartment fire testing, including temperature, pressure, and oxygen levels. By conducting tests at the upper bound of possible conditions, the performance of the assembly has been evaluated over the range of potential fire exposures. The use of an upper-bound exposure condition to evaluate materials or assemblies will provide some assurance that for most materials, performance under a less severe exposure will not result in a degradation of performance. When extrapolating performance from one fire exposure to a more severe fire exposure, there are no assurances that the performance of materials or assemblies will be predictable. Some materials may perform well at elevated temperatures, while other materials may expand, contract, warp, spall, change phase, debond, or crack, and fasteners may fail. Materials may lose integrity and fall off from the surface. Many of these phenomena and failure modes cannot be predicted using the current state-of-the-art models. Therefore, testing products at the upper bound of temperature level expected is currently the only way to demonstrate the overall performance of a material.

A model that is validated against this upper-bound exposure data will also be demonstrated to be appropriate for predicting the thermal response of the assembly over the range of exposures. Temperature data can be used to demonstrate that the thermal properties being used in the heat-transfer analysis are appropriate. In cases where material failures occur (i.e., fall off the exposed side), the through-thickness temperature data can be used to understand when such failures may occur and data could be used to assist in developing/validating constitutive models to predict these failures. Through model validation with the calibration test, as well as the test on the actual assembly, the heat-transfer model could be used with confidence to predict thermal response of the assembly during compartment fire exposures.

## 3.1 Instrumentation

### 3.1.1 Furnace Temperature Control

*Recommendation T-1: Plate thermometers should be used to measure furnace temperature and control the furnace exposure. There should be nine plate thermometers equally distributed across the test specimen surface. Plate thermometers are typically placed 0.10 m (4 in.) away from the sample; however, a larger spacing is desired to prevent them from potentially being damaged by failing test articles. Testing needs to be performed to demonstrate that a larger spacing does not affect the thermometer measurement.*

Engineers need a repeatable furnace exposure that is as independent as possible from the test article construction and the furnace details. This will allow modelers to use the thermal exposure calibration test described in Section 3.2 as a basis for the thermal exposure in all tests. In order to provide a repeatable furnace exposure, the furnace temperature measurement used to control the furnace should not be sensitive to test article construction and furnace details.

Plate thermometers have been documented to provide a more repeatable exposure furnace-to-furnace and within the same furnace with different types of test articles. Based on analysis by Babrauskas and Williamson (1978), Wickstrom (1989, 1997) developed the plate thermometer to provide a temperature measurement that had no radiative view of the test article, to remove the variation due to thermocouple design and bead size, to reduce the effects of variations in furnace construction, and to result in a heat-transfer coefficient similar to a test specimen.

Plate thermometers have been shown to minimize the variation in exposure measured within different furnaces. Testing with different furnaces has demonstrated that using plate thermometers to control furnace temperature reduces the effects of different furnace linings (van der Luer and Twilt, 1999, Harada et al., 1997, Davies and Dewhurst, 1996, Cooke, 1994), furnace depths (Harada et al., 1997, Fromy and Curtat, 1999, Cooke, 1994), and furnace gas emissivity through burning different fuels (Cooke, 1994, Harada et al., 1997, Fromy and Curtat, 1999). Testing has also demonstrated that plate thermometers provide a more consistent thermal exposure, independent of the thermal properties of the test specimen (van de Leur and Twilt, 1999).

The thermal exposure produced when the furnace exposure is controlled using plate thermometers has been shown to be less severe than furnaces controlled using shielded thermocouples in the early portions of the test (up to about 10 minutes), but more severe than furnaces controlled with bare thermocouples throughout the test. Compared with shielded thermocouples, Sultan (2006) determined that controlling the furnace with plate thermometers produced a less severe exposure during the initial 10 minutes of the test, but thereafter the exposures were similar. Compared with furnaces controlled with bare thermocouples, van der Leur and Twilt (1999) measured that furnaces controlled by plate thermometers resulted in higher temperatures (as measured using 1-mm diameter sheathed thermocouples) during the entire test, compared with temperatures measured when the furnace was controlled with 1-mm sheathed thermocouples.

Plate thermometers are typically placed 0.10 m (4 in.) from the specimen surface. This is done to keep the thermometer as close as possible to the test article so that the thermometer is measuring the exposure seen by the test article. In performing tests to failure, test articles may deflect more than 0.10 m (4 in.) into the furnace, which could potentially damage plate thermometers. As a result, plate thermometers need to be located as much as 0.30 m (12 in.) from the test article to allow room for it to deflect and fail. Wickstrom (1998) states that the location of the plate thermometer away from the test article is not expected to influence the plate thermometer furnace temperature measurement. Testing is recommended to verify that the plate thermometer measurement is not significantly influenced by the increased offset from the test article.

<u>Furnace Differential Pressure</u>

*Recommendation T-2: Tests should be performed with a positive furnace pressure (relative to laboratory conditions) across the entire test article. All furnace pressures* *should be measured using the tube sensor provided in ISO 834 and EN1363-1. In a vertical furnace, pressure should be measured at the bottom and top of the test specimen. The neutral plane in the furnace should be maintained at the bottom of the test specimen with no limit on the pressure at the top of the specimen. In a horizontal furnace, the furnace pressure should be measured at one location and maintained at a minimum of 20 Pa. Pressure tube sensors should be located at the same distance away from test articles as the plate thermometers.*

Fully-developed fires will always produce a positive pressure gradient across ceilings and a majority of the boundary height relative to ambient conditions. In these areas of positive pressure, hot gases are driven through small openings that develop in the assembly causing damage to the internal portions of the assembly. Hot gas migration through the assembly may also give rise to ignition on the unexposed side of the assembly in these local areas of weakness. As a result, it is recommended that furnace tests be performed with a positive furnace pressure so that the effects of hot gas transmission through the assembly can be observed.

The differential pressure between ambient and a compartment containing a hot gas layer will vary due to hydrostatics through the following relation,

$$\Delta P = g\left(\rho_f - \rho_a\right)h \qquad (1)$$

where $g$ is the gravitational constant (9.81 m/s$^2$), $\rho_f$ is the gas density inside the fire compartment, $\rho_a$ is the ambient gas density at the same elevation, $h$ is the elevation above a datum where the pressure between ambient and the compartment is equal (i.e., neutral plane) (m). Applying the ideal gas law to Equation (1), the differential pressure can be transformed into a function of temperature,

$$\Delta P = 352.8g\left(\frac{1}{T_f} - \frac{1}{T_a}\right)h \qquad (2)$$

with $T_f$ being the gas temperature inside the fire compartment (K), $T_a$ being the ambient gas temperature (293 K), and the coefficient 352.8 kg/m$^3$-K being the reference density multiplied by the reference temperature.

In a compartment fire, the differential pressure per unit height above the neutral plane will be 7.5-9.0 Pa/m with a temperature of 800–1200$^{o}$C, respectively. From ISO 834 and EN1363-1, furnaces have a similar increase in differential pressure with height (8–8.5 Pa/m); though this will obviously be a function of temperature inside the furnace. In vertical furnace tests, there will be a pressure distribution along the height of the test article. As a result, it is recommended that pressure be measured at two elevations within the furnace to quantify the pressure gradient within the furnace during the test.

At an elevation 2.4 m (8 ft) above the neutral plane of a compartment fire, the pressure will be approximately 18–22 Pa for gas temperatures in the range of 800–1200$^{o}$C. These pressures are similar to the 20 Pa pressure recommended in ISO 834 and EN 1363-1 for horizontal furnaces. In vertical furnace tests, ISO 834 and EN 1363-1 stipulate that the neutral plane inside the furnace should be located 0.50 m above the bottom test article but the pressures at the top of the test article should not be greater than 20 Pa. When necessary, the neutral plane inside the furnace will be moved upward to ensure that the pressure at the top of the test article does not exceed 20 Pa. In real fires, elevations along a wall greater than 2.4 (8 ft) above the neutral plane can have pressures in excess of 20 Pa when gas temperatures range from 800–1200$^{o}$C. Therefore, in wall tests it is recommended that the entire wall be kept at positive pressure (i.e., neutral plane at the bottom of the test article) with no limit on the pressure at the top of the test article.

In furnace tests, it is recommended that the differential furnace pressure be positive across the entire test article. The furnace differential pressure should be measured through a furnace pressure measurement and a laboratory pressure measurement at the same elevation. The furnace pressure should be measured using the tube sensor provided in ISO 834 and EN1363-1. The tube sensor should be located inside the furnace where it will not be subject to direct impingement of the convection currents from flames or in the path of the exhaust gases directly out of the burners. Pressure tubes should be horizontal both in the furnace and as they exit through the furnace wall, making the tubing elevation the same both on the inside and outside of the furnace. Any vertical section of tube should be at room temperature. In a vertical furnace, pressure should be measured at the bottom of the test specimen and the top of the test specimen. The neutral plane in the furnace should be maintained at the bottom of the test specimen with no limit on the pressure at the top of the specimen. In a horizontal furnace, the furnace pressure should be measured at one location immediately below the test assembly and maintained at a minimum of 20 Pa. Pressure tube sensors should be located at the same distance away from test articles as the plate thermometers.

Furnace Oxygen Concentration

> *Recommendation T-3: Furnace oxygen concentration should be measured in the furnace stack and maintained at greater than 6% during the test. Gas samples should be continuously drawn out of the duct through a sampling line and measured using a paramagnetic type oxygen analyzer. The recommended sampling probe should be similar to the sampling probe used in duct measurements of hood calorimeters*.

A range of oxygen levels may exist during the course of a compartment fire. This may vary from zero to several percent in the upper portions of a compartment during fully-developed fires (Gross and Robertson, 1965). From a fire resistance perspective, one of the implications of the presence of oxygen is that it allows char oxidation to occur which results in faster degradation of material. This has been noted in furnace testing to result in marked differences in fire resistance performance of wood stud assemblies. In furnace testing, it is also desirable to have excess oxygen within the furnace to allow combustible test articles to burn as they could in compartment fires.

It is recommended that the oxygen concentration during the test be above 6% during the furnace test. This was developed based on oxygen concentration requirements in other fire resistance test standards as well as oxygen concentrations measured in the upper-layer of fully-developed fires. The fire resistance standard EN 1363-1 requires that a minimum oxygen concentration of 4% be maintained within the test furnace during the course of the fire test.

Gross and Robertson (1965) measured oxygen concentrations ranging from 0–11% in fully-developed compartment fires.  Based on these results, and taking into account that a combustible assembly may deplete some oxygen in the furnace, furnace oxygen concentrations should be maintained at or above 6% during the test.

Unexposed Side Temperatures

*Recommendation T-4: The unexposed side temperatures should be measured with a thermocouple placed between the specimen and a noncombustible, insulating pad.  The insulating pad should be a low density, low thermal conductivity material with known thermal properties.  The pads should be approximately 0.15 m (6 in.) square and 25 mm (1-in.) thick and placed in at least three locations that provide a range of heat-transfer performance.*

The ignition of combustible materials on the unexposed side of an assembly is one of the standard measures of fire resistance performance.  In performance-based design, items may be in contact with the assembly or may always be offset from the assembly.  To support calculations where items may be in contact with the assembly, the unexposed side temperature should be measured with a noncombustible, insulating pad mounted onto the unexposed side.  This data can be used by engineers to demonstrate that their models are capable of predicting the heat-transfer through the assembly with a material on the unexposed side blocking heat and mass transfer losses.

Ignition of materials due to hot surfaces has been reviewed by Schwartz and Lie (1985) and Babrauskas (2007).  Ignition was characterized as either visible glowing or flaming.  The temperatures range from 300$^{o}$C to as high as 950$^{o}$C.  The materials that ignited close to 300$^{o}$C were cotton waste at 298$^{o}$C and a roof assembly (five layers of roofing felt, bitumen, and 2-in. polystyrene foam) at 325$^{o}$C.

The difference in temperatures of materials when ignited by hot surfaces, and those measured by ASTM E 119 insulation pads, was reviewed by Schwartz and Lie (1985).  This included testing conducted at UL and NRC-Canada.  In all tests, the materials were placed on the unexposed side of concrete and were exposed to an ASTM E 119 fire exposure.  The effects of drafts on ignition temperatures were not explored.  Results from the two series of tests are provided in Figures 2 and 3.  Most of the tests at UL were glowing ignition, while all the tests at NRC-Canada were flaming ignition.  Ignition times in most tests were after 1–2 hours of exposure.  As seen in these figures, the material temperature was higher than the temperature measured using the ASTM E 119 pad.  The exceptions to this were the tests with wooden strips and the roofing assembly test.  In the tests with the wooden sticks, the sticks bowed away from the concrete, resulting in a lower material temperature.

There was no apparent physical explanation for the magnitude of the deviation between the material ignition temperature and the ASTM pad temperature.  Considering all of the data, the material ignition temperature was on average 61$^{o}$C higher than temperatures measured using the ASTM E 119 pad with a standard error of ±64$^{o}$C.  This makes the potential disagreement between the pad temperature and the material temperature at ignition as much as 125$^{o}$C.

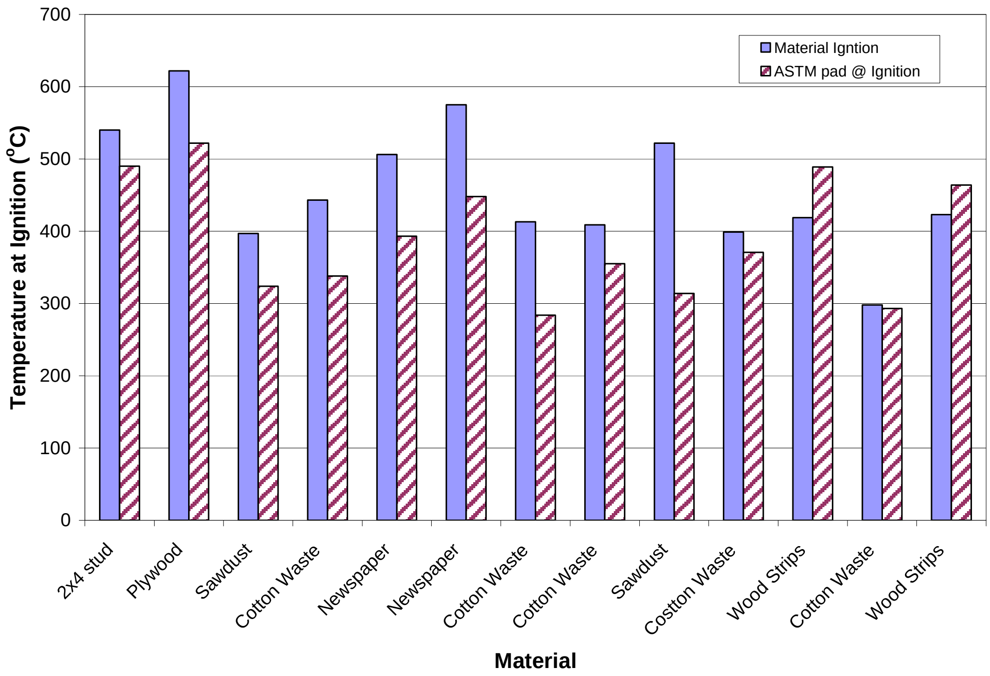



Figure 2. UL tests measuring temperature of material ignition and ASTM E 119 temperature.

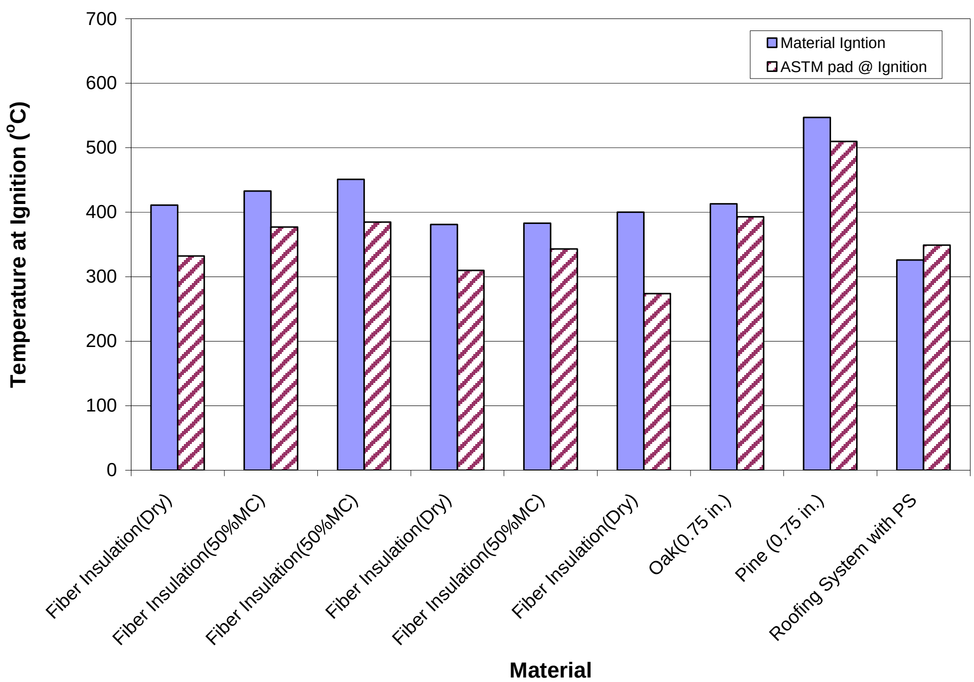



Figure 3. NRC-Canada tests on material ignition in contact with concrete along with ASTM E 119 pad temperatures.

The recommended unexposed side temperatures should be measured using a noncombustible, insulating pad. The pad should be 0.15 m (6 in.) square, which is similar in size to the ASTM pad. However, the thickness should be increased to about 25 mm (1.0-in.) so that temperatures are closer to those measured for actual materials in contact with the unexposed side of the assembly. The board should be a low density, low conductivity ceramic fiber board with known thermal properties. Some recommended boards include UNIFRAX Duraboard LD and FireMaster board made by Thermal Ceramics. The board should be mechanically attached to the unexposed side of the assembly with a bare bead, glass braid, 24-gauge, Type K thermocouple sandwich between the assembly and the board. If significant moisture is expected on the unexposed side, the bare bead thermocouple can be replace with a 1.0 mm diameter, Type K Inconel-sheathed thermocouple.

Total Heat Flux off the Unexposed Side

> *Recommendation T-5: The total heat flux from the unexposed side of the assembly should be measured using a Schmidt-Boelter type water-cooled total heat flux gauge. At a minimum, a heat flux gauge should be placed near the center of the test article and as close as possible to the unexposed side. In cases where the assembly contains a transparent section, a heat flux gauge should also be placed at the center of the transparent section as close as possible to the unexposed surface.*

Heat transmitted off the unexposed side of the assembly may pre-heat and ignite materials located close to the assembly or may impede the movement of people by the assembly. This will be particularly important in assemblies, which contain sections that are transparent (e.g., glazing). This data can be used by engineers to demonstrate that their models are capable of predicting the heat-transfer off the unexposed side of the assembly and through transparent areas of the assembly.

The total heat flux gauge should be a Schmidt-Boelter water-cooled total heat flux gauge, with a 0-25 $kW/m^2$ range. A range of 0–100 $kW/m^2$ should be used for assemblies that include glazing. To ensure a high view factor between the gauge and the unexposed side of the test article, the gauge should be located as close as possible to (within 0.15 to 0.3 m) and near the center of the assembly. With radiation calculations being sensitive to the offset between the surface and heat flux gauge, the distance the heat flux gauge is located from the unexposed side surface should be recorded so that the data can be used for model validation.

Furnace Velocity

> *Recommendation T-6: Velocity measurements inside the furnace should not be made.*

While it is important to create a realistic convective environment in the furnace, it is difficult to conduct meaningful velocity measurements in the furnace where the flow is expected to be complex. As a result, no velocity measurements are recommended inside the furnace. (See furnace burner recommendations below for additional information).

Temperature Profile through Test Specimen

Recommendation T-7: Temperatures should be measured through the thickness of the test assembly at locations that are representative of the different heat-transfer paths within the assembly. Repeat temperature profiles are recommended in case some thermocouples fail during the test.

Predicting the correct temperature profile is a critical aspect of predicting heat transmission through the assembly as well as the structural response. Temperature data can be used to demonstrate that the thermal properties being used in the heat-transfer analysis are appropriate. In cases where materials may lose integrity (i.e., fall off the exposed side), the through-thickness temperature data can be used to understand when such failures may occur and could be used to assist in developing/validating constitutive models to predict these failures. The strength of materials is also strongly influenced by temperature; therefore, predicting the correct temperatures will affect the predicted structural response.

The temperature through the depth of the test article should be measured at a minimum of two locations. Temperatures should be measured at locations that will provide a method for validating the heat-transfer through the assembly. Test articles that have a relatively uniform composition (e.g., concrete) will likely require two temperature profiles, while assemblies with studs will require at least four temperature (i.e., one at the stud, one between studs, and repeat measurements at a similar location). Internal temperatures should be measured at no less than three locations along the specimen thickness. For a specimen that consists of layers of materials, the temperature should be measured at each material interface. More complicated structural members (e.g., I-beams) will likely need thermocouples at several locations to provide sufficient data to validate the heat-transfer model. At each location, thermocouples in a profile should be within 0.075 m (3 in.) of the profile location.

The surface temperature on the exposed side of the specimen should be measured with a ceramic braid, 24-gauge, and Type K bare bead thermocouple. The thermocouple bead as well as the lead wire inside the furnace should be placed in contact with exposed surface of the test surface of the test article.

The surface temperature on the unexposed side of the specimen should be measured using an optical pyrometer with a wavelength range suitable for accurately measuring the surface temperature on the unexposed side.

Internal temperatures should be measured using Inconel-sheathed Type K thermocouple, with a sheath diameter of 1.0 mm. Inconel-sheathed thermocouples are required to prevent thermocouples from shorting out due to moisture in specimen materials. Thermocouples must remain in the plane of measurement for at least 50 mm (2 in.). If possible, thermocouples should be applied during construction and should be extended out of the side of the specimen. When thermocouples must be fed out of the unexposed side of the test article, the area around the thermocouple must be sealed to prevent premature hot gas transmission through the assembly at this location.

Gas Temperature Measurement

*Recommendation T-8: Gas temperatures on the exposed and unexposed side of the test specimen should be measured using aspirated thermocouples. Gas temperatures should be measured at each location where a temperature profile is being measured. Aspirated thermocouples should be placed as close as possible to the test article surface.*

Heat-transfer analysis of the assemblies may require the use of the gas temperature on both sides of the test article. Depending on the analysis, gas temperature may be needed to calculate the appropriate heat-transfer coefficient and may be used in defining the boundary condition. Gas temperatures should be measured as close as possible to the boundary surface to obtain a measure of the temperature affecting the convective heat-transfer at the surface. Using aspirated thermocouples with a high aspiration velocity provides a measure of the actual gas temperature without the effects of radiation from the surroundings. This gas temperature measurement will be used to support heat-transfer calculations but will not be used to control furnace conditions.

## 3.2 Furnace Construction and Operation

Furnace Time-Temperature Exposure Curve

*Recommendation T-9: The furnace time-temperature exposure should linearly increase to 1200$^{o}$C in six minutes and remain constant at 1200$^{o}$C for the remainder of the test.*

Performance-based design analysis should be performed using models that have been shown to predict product performance over the expected temperature range. At high temperatures, material behavior can become unpredictable and material failures may occur that were not expected based on data trends at lower temperatures. As a result, using models to predict material behavior outside their validation temperature range is not acceptable engineering practice. Fully-developed compartment fires may produce gas temperatures that range from 500$^{o}$C to in excess of 1200$^{o}$C. The gas temperature reached inside a compartment will depend on compartment geometry as well as its contents. To perform analysis on an assembly that may be exposed to compartment fire conditions, the model should be validated to gas temperatures that represent an upper-bound to those expected in a compartment fires. Historically, furnace fire exposures inside buildings have not been representative of the rate of rise and magnitude of temperatures in compartment fires. However, furnace fire exposure curves for products used in off-shore platforms as well as tunnel applications, are more consistent with the rise time and temperature levels measured in these environments. The proposed curve provides an upper-bound time-temperature curve that is consistent with the rise time and levels of temperatures possible in compartment fires. This curve can be used to evaluate the performance of products under higher temperatures that these products may be exposed to during compartment fires and can serve to validate model predictive capability for this product over the expected temperature range.

Furnace Exposures

There are several furnace fire exposures used throughout the world to evaluate the fire resistance of products. These fire exposures have peak temperatures ranging from 1050$^{o}$C to

1350°C after a three-hour exposure, see Figure 4. The type of exposure used depends on the end-use application of the product. Tunnel and off-shore oil rig applications have the highest temperature, most severe fire exposures, while less severe exposures are used for different building applications.

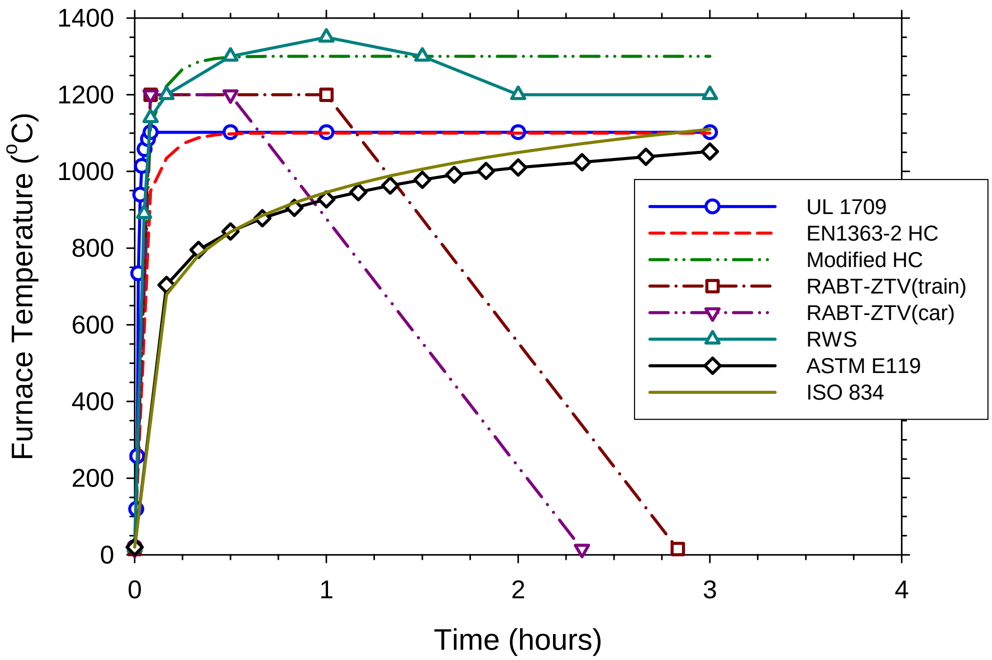



Figure 4. Furnace time-temperature exposure curves.

The ASTM E 119 and ISO 834 time-temperature curves are perhaps the most common furnace exposures used in fire resistance testing. These furnace exposures are used to evaluate the fire resistance of structural elements on buildings, ships, and in some transportation applications (e.g., railcars). ASTM E 119 is primarily used in North America, while ISO 834 is used more internationally (e.g., Europe and Australia). As seen in Figure 4, the two time-temperature curves are similar with the ISO 834 temperatures being slightly higher at times greater than one hour. The ASTM E 119 furnace exposure is measured using shielded thermocouples, while the ISO 834 furnace exposure is measured using sheathed thermocouples.

Though the time-temperature curves in these tests are similar, the actual heat flux exposure early in the ASTM E 119 fire exposure is more severe due to the type of thermocouples used to control the furnace (Harmathy et al., 1987, Babrauskas and Williamson, 1978). The European standard EN1363-1 uses the ISO 834 time-temperature curve, but the furnace is controlled using plate thermometers. Plate thermometers provide a more severe exposure compared with ISO 834 thermocouples for the test duration (Fromy and Curtat, 1999, van der Luer and Twilt, 1999). Sultan (2006) found that plate thermometers resulted in a slightly less severe exposure during the first 10 minutes of the test, compared with ASTM E 119 shielded thermocouples. Thereafter, the thermal exposures were the same for the plate thermometer and the E 119 thermocouples.

The total heat flux measured in an ASTM E 119 furnace test is provided in Figure 5 for a wall and floor furnace. Total heat fluxes were measured using a water-cooled Gardon gauge. In this test, gaseous fuel was used and the temperature was controlled with ASTM E 119 shielded thermocouples (Sultan, 2004). The wall furnace was lined with ceramic fiber while the floor furnace was lined with brick. The same furnace controlled with a plate thermometer provided similar heat flux levels at times after 10 minutes. Also provided in the plot is the blackbody heat flux based on the furnace temperatures specified in ASTM E 119. As seen in the **figure**, the blackbody heat flux is similar to heat fluxes measured in the furnace except during the initial 10 minutes.

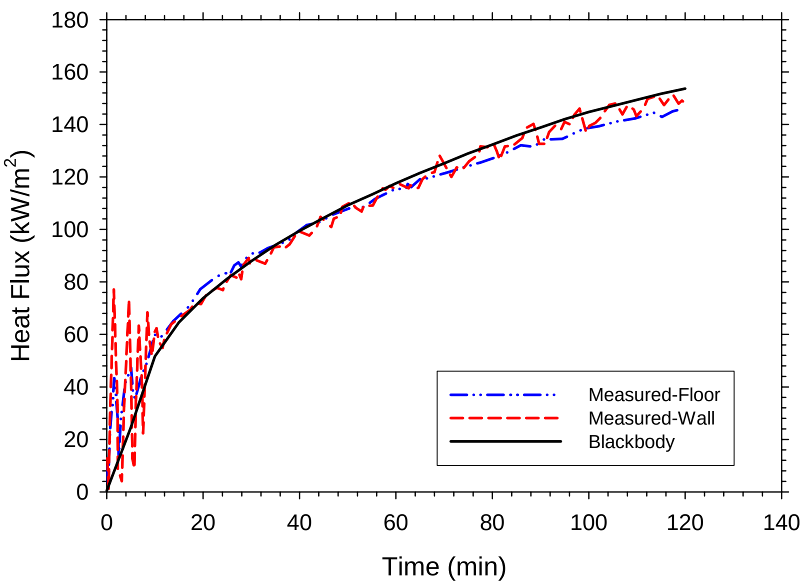



Figure 5. Heat flux measured during ASTM E 119 furnace exposure in floor and wall furnaces Blackbody heat flux was calculated from ASTM E 119 furnace temperature curve.

The higher temperature fire exposure curves in Figure 4 are used to evaluate products used in petrochemical, off-shore oil platform, and some tunnel applications. The UL 1709 hydrocarbon pool fire exposure and the EN 1363-2 hydrocarbon curve (HC), are typically used for off-shore oil platform applications, while the other higher temperature curves are used to represent a large fire inside a tunnel.

The UL 1709 and EN 1363-2 both have a maximum gas temperature of 1100°C; however, the UL 1709 exposure reaches 1100°C faster than the EN 1363-2 exposure. The UL 1709 reaches a peak temperature of 1100°C in 5 minutes, while the EN 1363-2 is approximately 1100°C after 25 minutes. Unique among the fire resistance standards, UL 1709 also has a heat flux requirement. During a calibration test with a UL 1709 exposure, the heat flux as measured from a water-cooled heat flux gauge mounted to a calibration specimen, must be 204±16 kW/m$^2$ while the furnace temperature is 1093±111°C. This heat flux is approximately equal to the blackbody heat flux at the furnace temperature (i.e., 1093°C results in a blackbody flux of 197 kW/m$^2$).

The curves for tunnel applications have peak temperatures that range from 1200–1350°C. The RABT-ZTV curves were developed in Germany to represent different vehicle fires in tunnels. These curves reach a peak temperature of 1200°C in 5 minutes and remain at 1200°C for 30–60 minutes. Thereafter, the temperatures decrease linearly with time to ambient conditions after 2.5–3.0 hours. Estimated peak heat fluxes, as the blackbody flux using the peak furnace temperature, in these tests are 267 kW/m$^2$. A modified version of the EN1363-2 HC curve has been used in France to represent fires in tunnels. The Modified HC curve peaks at 1300°C instead of 1100°C. Estimated peak heat flux in this test, based on the blackbody flux using the peak furnace temperature, is 347 kW/m$^2$. The RWS fire curve was developed by the Rijkswaterstaat, Ministry of Transport in Netherlands based on results from testing conducted by TNO in the Netherlands. The RWS curve peaks at a temperature 1350°C, which is the highest of all time-temperature curves. Estimated peak heat flux in this test, based on the blackbody flux using the peak furnace temperature, is 393 kW/m$^2$. The potential for these temperatures in tunnel fires was verified through vehicle testing in the Runehamar test series, where temperatures ranging from 1280–1365°C were measured (Lonnermark and Ingason, 2005).

Compartment Fires

Gas temperatures in compartment fires will be dependent on a number of variables including fuel type, compartment size, compartment boundary thermal properties, ventilation (i.e., door size), and fire stoichiometry.

Thomas and Heselden (1972) evaluated the effect compartment geometry (compartment and door size) on the gas temperature. Figure 6 contains the results of tests on wood cribs (Thomas and Heselden, 1972) as well as non-cellulosic materials (Bullen and Thomas, 1978). Through these tests, the gas temperature was determined to be a function of the opening factor,

$$O = \frac{A_T}{A\sqrt{H}} \tag{3}$$

where $A_T$ is the internal surface area of the walls and ceiling excluding the door area (m$^2$), $A$ is the area of the door (m$^2$), and $H$ is the door height (m). The highest gas temperatures were measured at an opening factor in the 10–20 range. At lower opening factors, larger door sizes prevented the development of high gas temperatures due to higher air flow into the compartment and more heat loss through the door. At opening factors greater than 10, limiting the ventilation reduced the fire size that could be supported inside the compartment, thus reducing the maximum gas temperature that could be produced.

The impact of fire stoichiometry and fuel type can be seen in Figure 6 through the tests on the plastics and alcohol (Bullen and Thomas, 1978). In these tests, the opening factor is constant but the fuel type and stoichiometry of the fire is being varied. As seen in the figure, gas temperatures can vary by 200°C by changing these variables. The highest gas temperatures will be produced by fuels that require less energy to volatilize and when the compartment fire has an equivalence ratio equal to one (i.e., stoichiometric burning).

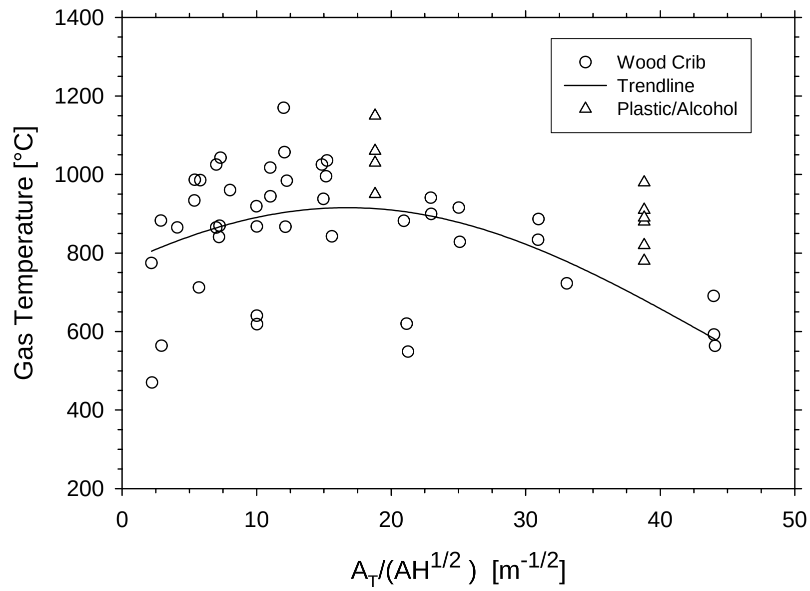



Figure 6. Compartment fire gas temperatures as a function of opening factor.

The SFPE committee on Standard on Calculating Fire Exposures to Structures has compiled a database of 139 compartment fire tests. This database was used to evaluate the appropriate furnace exposure. As seen in Figure 7, the fuels in these tests ranged from wood cribs, to furniture, to plastics. Compartments included in this database were mostly large-scale as shown in Figure 8.

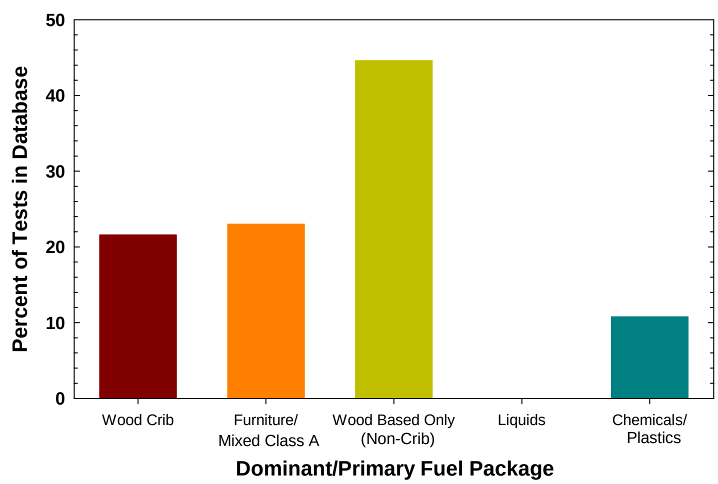
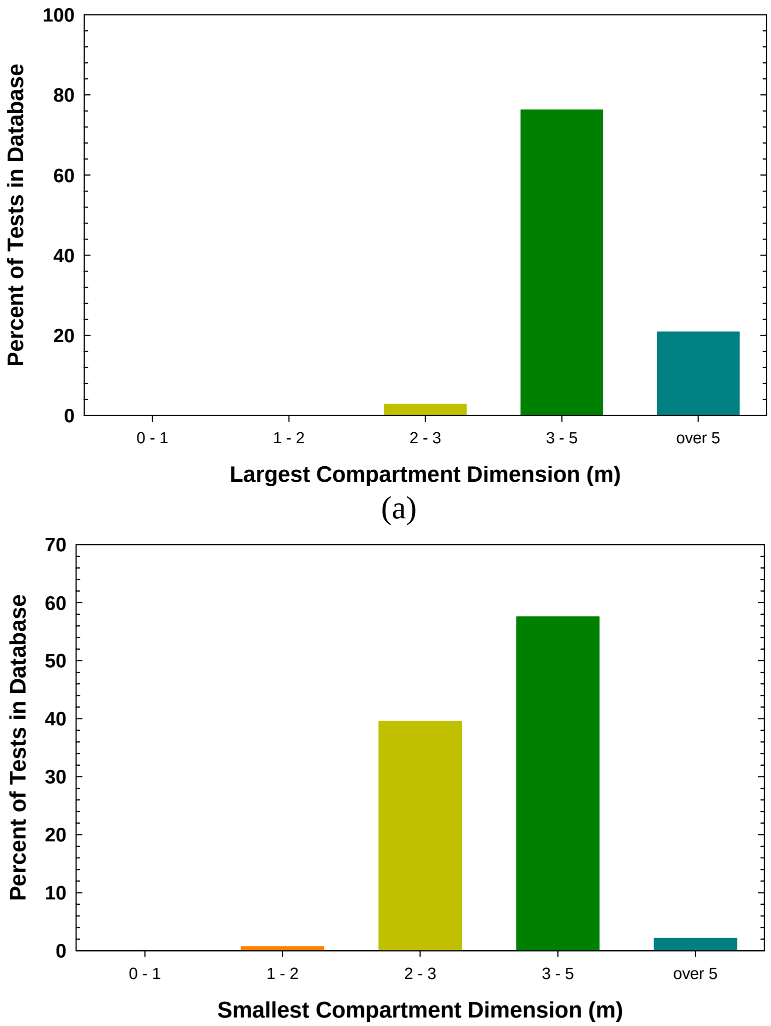



Figure 7. Fuels burned in compartment fire tests.




(a)

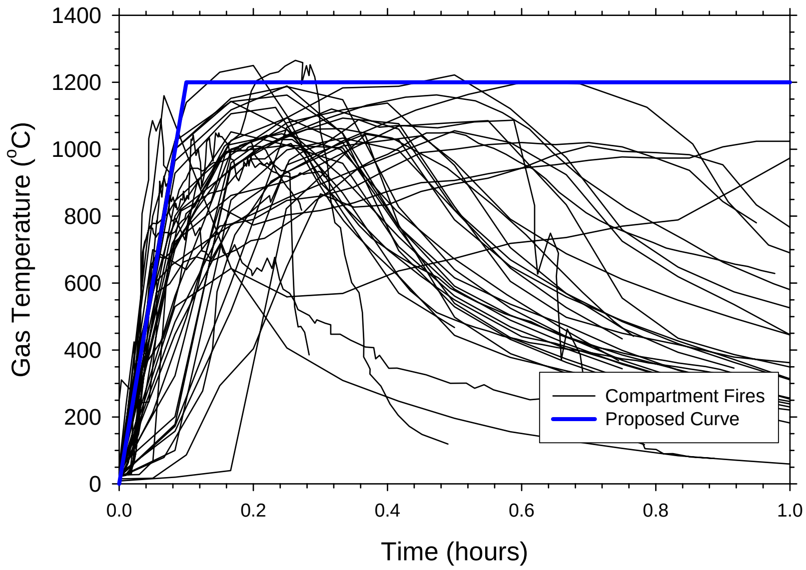


(b)

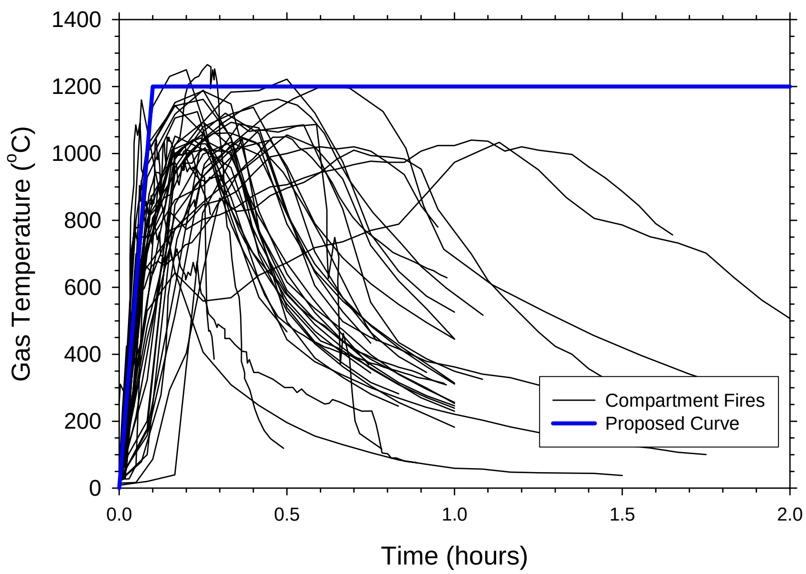
Figure 8. Compartment dimensions in compartment fire tests.

A plot of the average gas temperature as a function of time for tests with average temperatures exceeding 1000°C is provided in Figure 9. Figure 10 is a plot of the peak gas temperatures measured in these same tests. As shown in these figures, in many tests there is a rapid rise in gas temperature during the initial five minutes of the fire with temperatures in several tests exceeding 1000°C at this time. Post-flashover gas temperatures exist in many tests for 1–2 hours before decaying. Figures 9 and 10 also contain the proposed furnace time-temperature exposure, which increases linearly to 1200°C in six minutes and remains constant at 1200°C for the remainder of the test.

As seen in Figures 9 and 10, the proposed time-temperature curve provides a reasonable upper-bound to the test data.

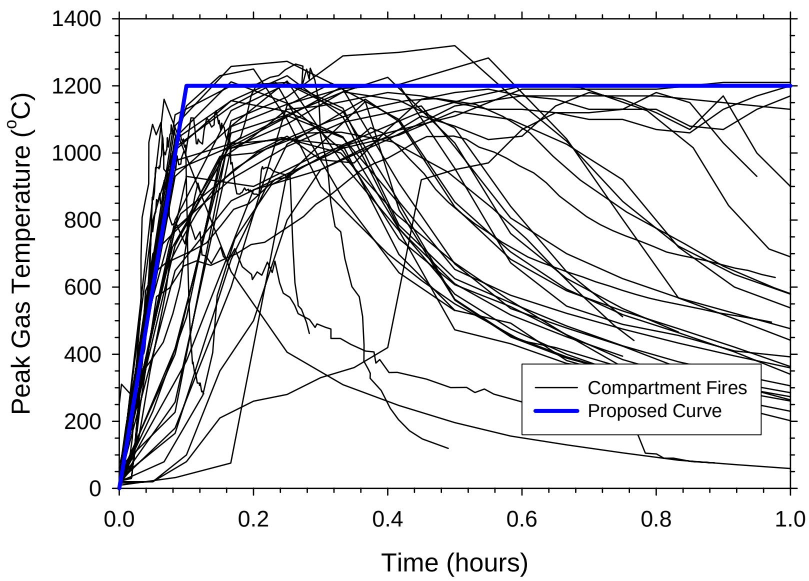



(a)

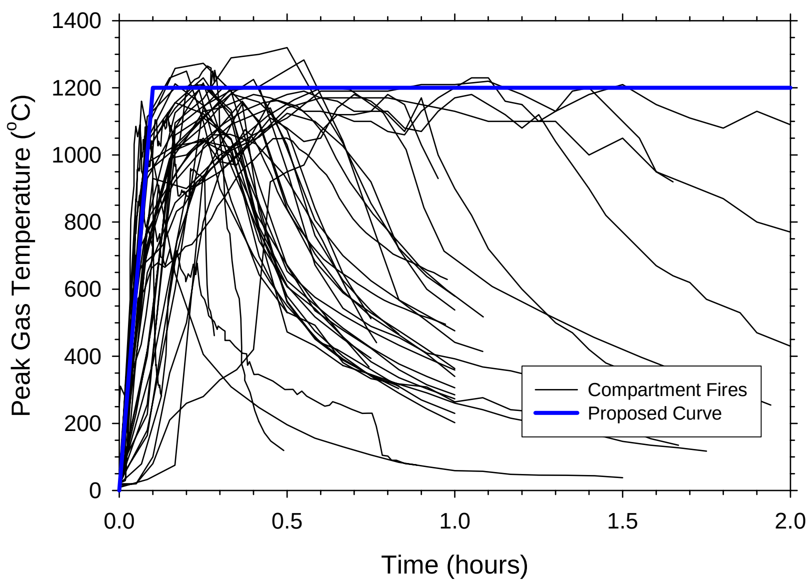



(b)

Figure 9. Average gas temperature in compartment fires as a function of time compared with the proposed time-temperature curve (a) after 1 hour and (b) after 2 hours.




(a)




(b)

Figure 10. Peak gas temperature in compartment fires as a function of time compared with the proposed time-temperature curve (a) after 1 hour and (b) after 2 hours.

Heat flux levels to the walls and ceiling of a compartment containing a fully-developed fire were measured by Tanaka et al. (1985). Tests were performed using a propane gas burner in a full-scale compartment (2.4 m high, 2.4 m wide and 3.66 m deep) with different door sizes. Heat fluxes were measured using Schmidt-Boelter type, water-cooled, total heat flux gauges. Gas temperatures in tests where heat flux was measured, ranged from 150°C–1100°C. Through these data, the heat flux at the top of the walls and ceiling in the compartment is reasonably estimated by the blackbody heat flux using the gas layer temperature. As a result, heat fluxes inside a compartment with a gas temperature of 1200$^{o}$C would be expected to be 267 kW/m$^2$.

Effect of Exposure on Product Performance

The use of a severe exposure condition to evaluate materials or assemblies will provide some assurance that for most materials, performance under a less severe exposure will not result in a degradation of performance. When extrapolating performance from one fire exposure to a more severe fire exposure, there are no assurances that the performance of materials or assemblies will be predictable. Some materials may perform well at elevated temperatures, while other materials may expand, contract, warp, spall, go through phase changes, debond, or crack; fasteners may fail, and lose integrity and fall off from the surface. Many of these types of phenomena and failure cannot be predicted using the current state-of-the-art models. Therefore, testing products at the highest temperature level expected is currently the only way to demonstrate the performance of a material.

Materials that perform well at elevated temperature may just need to be thicker to obtain the desired level of performance at higher temperature. The UL Fire Resistance Directory provides design listings (i.e., minimum product thicknesses) which will provide a specific fire resistance rating when tested in accordance with various standard fire test methods, such as ASTM E 119 and UL 1709. Some products have been tested against these two standards, specifically for structural steel column protection. Broad product categories of materials include sprayed fire-resistive materials, intumescent coatings, intumescent mat products, and high-temperature board products. In all design listings reviewed, it becomes apparent that as the exposure severity increases (from ASTM E 119 to UL 1709), the minimum material thickness required to achieve the same hourly fire resistance rating must also increase.

An example of this is demonstrated in Table 1 by the increase in thickness of the amount of fireproofing required to protect a steel member when exposed to a UL 1709-type exposure versus an ASTM E 119-type exposure condition. For the same material, the thickness required to protect a W10 x 49 steel column increases as the fire exposure becomes more severe.

Table 1. Fireproofing Thickness for Steel Member

| **Rating Time (hrs.)** | **E 119 Thickness (in.) [UL, 2006a]** | **UL 1709 Thickness (in.) [UL, 2006b]** |
|---|---|---|
| 1 | 0.69 | 1.0 |
| 2 | 1.13 | 1.38 |
| 3 | 1.56 | 1.75 |
| 4 | 1.94 | 2.13 |

Other materials may only provide adequate performance over a specific temperature. At higher temperatures, the material may behave unexpectedly. One example of this was the use of mineral fiber insulation used on fire zone boundaries of U.S. Navy ships. A 1-in. thickness of mineral wool insulation provided a 30-minute fire-resistance rated bulkhead/deck when tested per the ASTM E 119 fire exposure (Scheffey et al., 1991). In the early 1990s, the U.S. Navy reevaluated the fire exposure potential for bulkheads and decks based on lessons learned from the USS Stark incident. This work effort lead the U.S. Navy to require a UL 1709 fire exposure to evaluate insulation materials. In 1993, additional test work showed that 1 in. of mineral wool insulation, when exposed to the UL 1709 fire exposure, provided a fire resistance rating of approximately 9.5 minutes and a 2-in. thickness of mineral wool provided a fire-resistance rating of approximately 11 minutes (Beitel et al., 1993). This significant reduction in performance was a result of the mineral wool exhibiting a phase change at the higher UL 1709 temperatures and melting/vaporizing off the steel base assembly. Thus, it is very clear that materials and their performance can change when the fire exposure conditions change.

Another example of differing material performance at elevated temperatures is the study performed by Nyman (2002) on the fire performance of several gypsum wallboard assemblies when exposed to compartment fires. The failure times and mode in the furnace tests were compared with those measured and observed in the compartment fire tests. Furnace tests were conducted at the Building and Research Association of New Zealand (BRANZ) using the AS 1530 Part 4 fire resistance test procedure, which is similar to the ISO 834 test method. The compartment fire testing was also conducted at BRANZ. In these tests, the compartments had dimensions of 2.4 m x 3.6 m x 2.4 m high, and a single doorway (size varied), provided ventilation of the compartment. The various walls and ceilings in each compartment were constructed using different assemblies such that several different constructions could be tested in a single compartment test. The fire sources consisted of a combination of textile-covered, polyurethane foam and wood cribs.

Table 2 provides a summary of several of these assemblies and the test results. The failure time in the compartment fire tests was shorter in the three assemblies shown in Table 2. In addition, the failure mode was different in the compartment fire tests compared with the furnace test. Assembly #1 failed due to unexposed surface temperature rise in both the furnace test and in the compartment tests. Assemblies #3 and #7 failed due to unexposed surface temperature rise in the furnace test, but in the compartment tests failure was judged to have occurred due to integrity failure. In these cases, it was determined that the steel studs experienced rapid and sizable deflections causing the gypsum plasterboard to fail. Figures 11–13 contain plots of compartment fire gas temperatures in the center of the room in the three tests where these assemblies were included. The plots show the gas temperatures in the upper part of the room are generally higher that than the ISO 834 fire exposure curve. The higher gas temperatures in the compartment fire tests had an impact not only on the time to failure but also on the mode of failure.

Table 2. Fire Performance of Gypsum Board in Standard Tests and Compartment Fire Tests

| **Assembly No.** | **Description** | **Failure Time (min) and Mode** | |
|---|---|---|---|
| | | **Furnace Test** | **Compartment Fire*** |
| 1 | 1 layer of 10-mm "Fyreline" plasterboard on each side of 90 x 45-mm timber studs at 600 mm OC – load bearing | 42 (heat transmission) | 21/18 (heat transmission) |
| 3 | 1 layer of 13-mm Standard plasterboard on each side of 63 x 34-mm steel studs at 600 mm OC – non-load bearing | 34 (heat transmission) | 19/17 (integrity**) |
| 7 | 1 layer of 13-mm "Fyreline" plasterboard on each side of 63 x 34 mm steel studs at 600-mm OC – non-load bearing | 63 (heat transmission) | 35 (integrity**) |

*Failure time room test – Assemblies 1 and 3 – First time is from Compartment Test #1 and second time is from Compartment Test #3. Failure time for Assembly 7 is from Compartment Test #2.
**Integrity failure due to steel studs deflecting causing plasterboard to fall off on exposed surface.

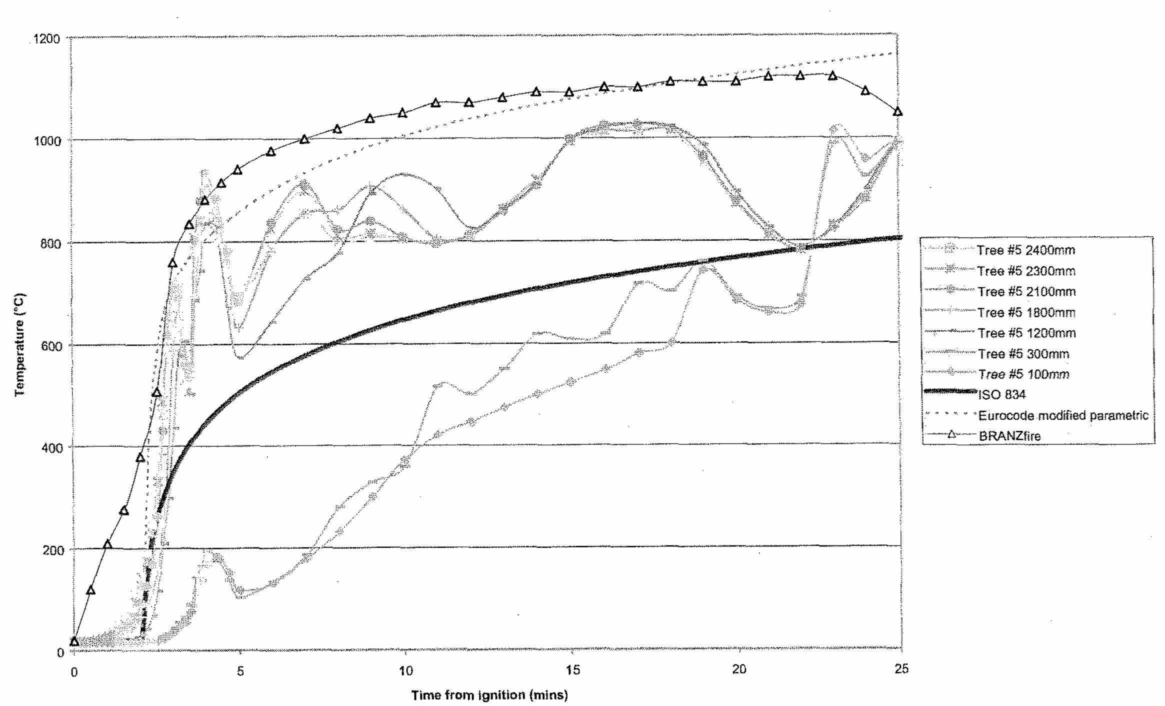



Figure 11. Compartment Test #1 exposure at tree 5.

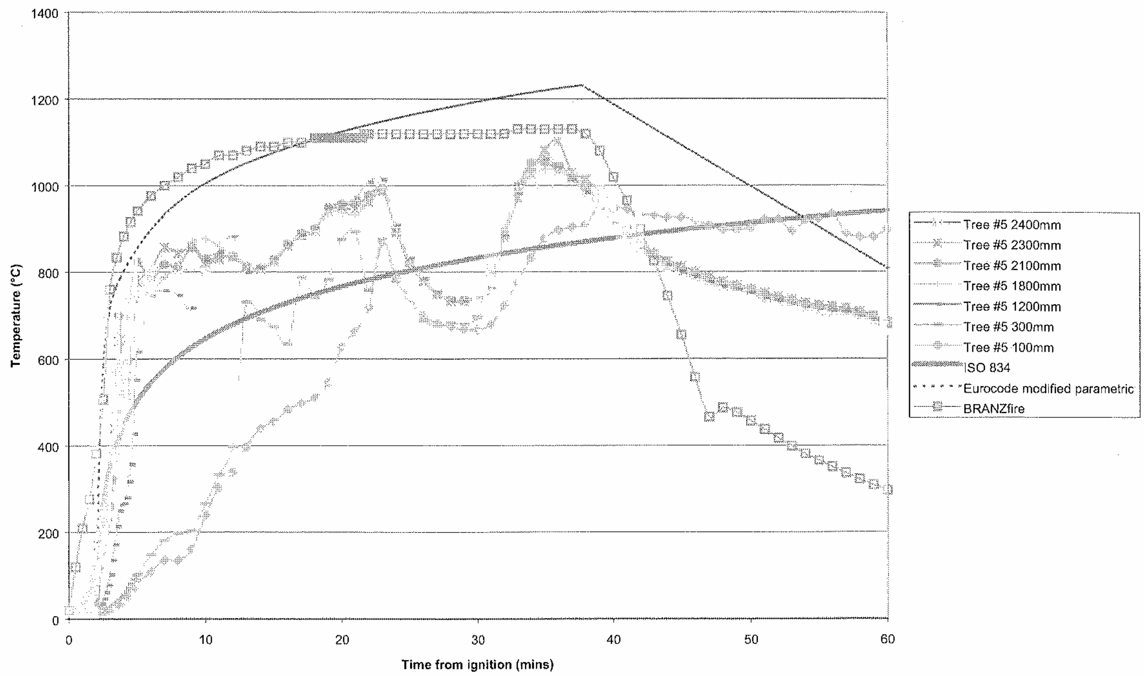



Figure 12. Compartment Test #2 exposure at tree 5.

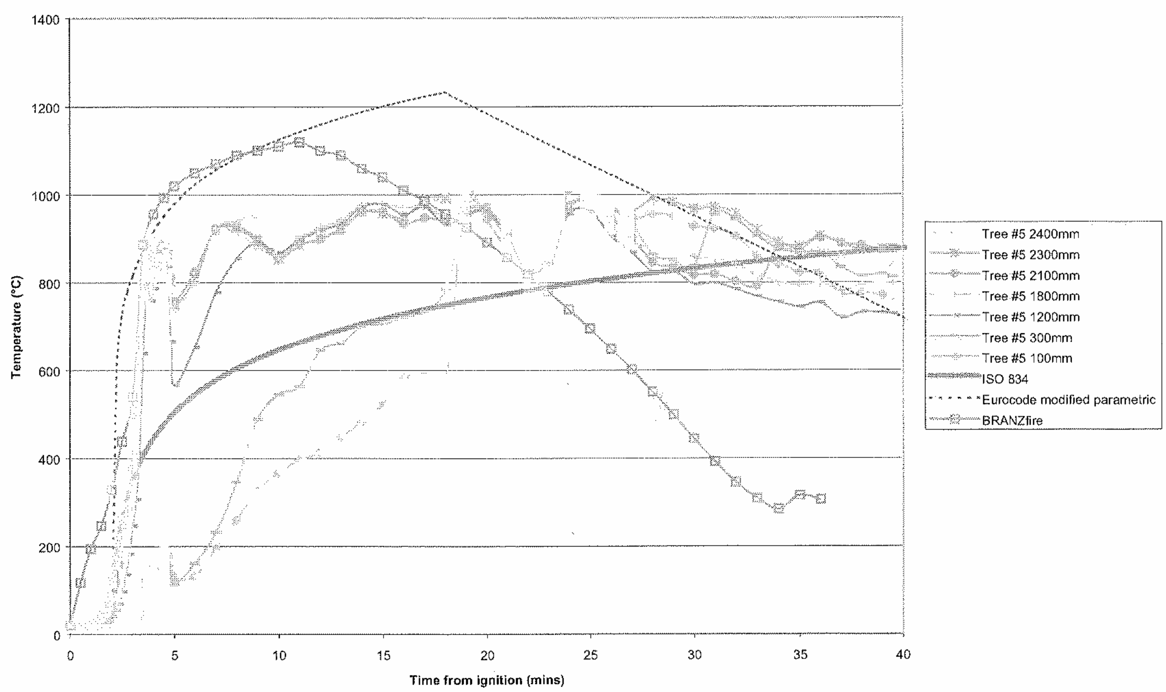



Figure 13. Compartment Test #3 exposure at tree 5.

Intumescent materials are another type of material used to provide acceptable fire resistance performance for structural elements; however, the performance of these materials may be highly variable from product to product. Two broad classes of intumescent materials have been specifically developed for distinctly different markets. Both are used for the protection of structural steel, however, the exposure conditions for which they have been designed are significantly different. Thin-film intumescent materials have been specifically designed for use in the less-severe ASTM E 119 fire exposure conditions. Epoxy-based intumescents were designed to withstand the more severe UL 1709 fire exposure. Many epoxy-based intumescents that are listed under UL 1709 ,also have ASTM E 119 listings. However, there are numerous other intumescent coatings that have ASTM E 119 listings but do not have UL 1709 ratings. Though some of these coatings may not be capable of achieving a UL 1709 rating due to the environmental exposure requirements, many ASTM E 119 listed intumescents (not listed in UL 1709) may not produce durable chars or have adhesion properties sufficient to survive the UL 1709 fire exposure. The formation and degradation of these chars as well as the adhesion of the intumescent are not readily modeled and predicted performance is only recommended over the range of conditions at which it has been tested.

## Calibration Test

*Recommendation T-10: A calibration test should be conducted with a noncombustible boundary containing instrumentation to quantify the thermal exposure. Instrumentation installed in the boundary should include total heat flux gauges and calibration boards instrumented with thermocouples. Instrumentation should be installed in at least five locations (center of each quadrant and center of the boundary) to quantify the furnace exposure. The calibration test should be performed for one–hour using the required furnace exposure and instrumentation.*

Modeling the heat-transfer through a test article exposed to furnace conditions requires an understanding of the exposure provided by the furnace to the test article. Despite all efforts to construct furnaces similarly, each furnace will likely produce different exposure environments. As a result, a calibration test is required on each furnace to quantify the exposure level produced by the furnace. The calibration test is instrumented to provide heat flux levels and gas temperatures produced by the furnace. In addition, temperatures will be measured through the thickness of noncombustible board with known properties to provide model validation data. Instrumentation will be placed at five locations over the sample surface to provide information on the uniformity of the environment produced by the furnace.

The noncombustible boundary with instrumentation is shown in Figure 14. The noncombustible boundary should be constructed of steel studs covered with two layers of 15.9-mm (0.625-in.) thick Type X drywall and 50.8-mm (2-in.) thick ceramic fiber insulation on the exposed surface. Instrumentation will be installed in the noncombustible boundary in at least five locations including the center of each quadrant and the center of the entire boundary. Instrumentation will include total heat flux gauge, an aspirated thermocouple on the exposed and unexposed side of the boundary, and a calibration board installed with thermocouples.

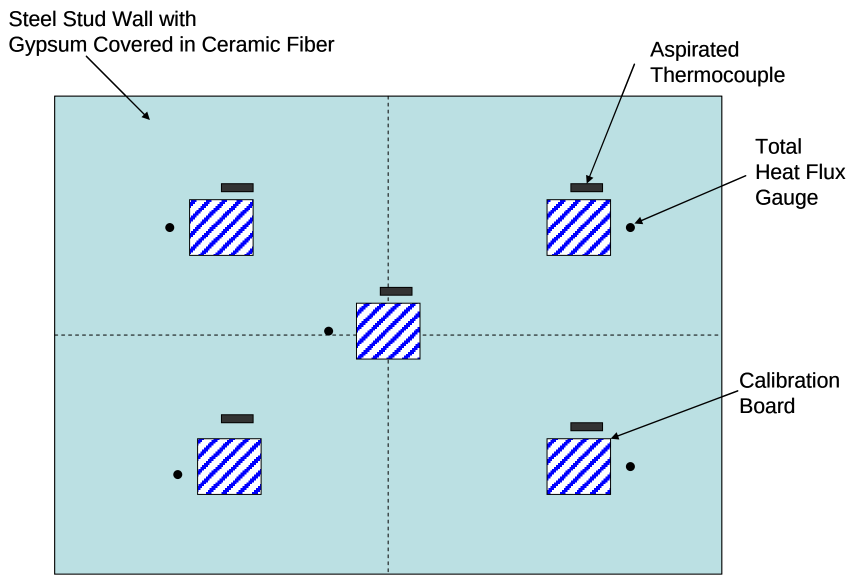



Figure 14. Calibration test noncombustible boundary with instrumentation.

Calibration boards should be located in the center of each quadrant of the noncombustible boundary and the center of the entire boundary. Total heat flux gauges should be installed in the noncombustible boundary at the mid-height and approximately 0.10 m (4 in.) from the side of each calibration board. Total heat flux gauges should be water-cooled Schmidt-Boelter type heat flux gauges with an upper range of 300 $kW/m^2$. Aspirated thermocouples should be located just below the top of the calibration board, within 25 mm (1 in.), with the thermocouple as close as possible to the calibration board to measure the gas temperature governing the convection across the sample. The location of the gas temperature measurement should be consistent with what will be used in the furnace testing on actual test articles.

Calibration boards should be 0.46-m (18-in.) by 0.46-m (18-in.) by 50.8-mm (2-in.) thick ceramic board. Examples of some acceptable boards include UNIFRAX Duraboard LD and FireMaster board made by Thermal Ceramics. The calibration boards should be installed in the noncombustible boundary so that the surface of the calibration board is flush with the surface of the ceramic fiber insulation on the exposed surface. Calibration boards should have a thermocouple installed at the exposed surface and internally at depths of 6.4 mm (0.25 in.), 12.7 mm (0.5 in.), 19.0 mm (0.75 in.), 25.4 mm (1.0 in.), and 38.1 mm (1.5 in.). The exposed surface thermocouple should be a 24-gauge bare bead thermocouple with at least 50.8 mm (2 in.) of thermocouple wire in the plane of measurement. The leads of the wire should be pushed through board for attachment to the data acquisition. Internal thermocouples should be 1.0-mm diameter Inconel-sheathed thermocouples. The unexposed side temperature should be measured using an optical pyrometer. All temperature measurements should be within 0.075 m (3 in.) of the center of the calibration board. After thermocouples are installed, the boards should be oven dried and then placed in a desicator until testing.

Furnace Lining Material

*Recommendation T-11: All interior furnace surfaces should be lined with a ceramic fiber material.*

Fire resistance furnaces have traditionally been lined with high temperature refractory brick materials commonly used in commercial furnaces. These refractory bricks are a low-density material (approximately 50 lbs/ft$^3$ (775 kg/m$^3$) and have a maximum operating temperature of approximately 2600°F (1425°C). When used in a fire resistance furnace, the refractory brick has a high thermal inertia, relative to the fire exposure period (typically 1 to 2 hours). This thermal inertia results in the refractory brick absorbing significant amounts of heat during the initial portions of the test (first 15 minutes), producing a dominantly convective heat environment within the test furnace. The furnace environment within the furnace transitions to a highly radiative environment once the brick temperature equalizes with the furnace air temperature.

To minimize the heating time of the furnace apparatus, thus resulting in less heat loss/absorption to the furnace walls, lining the inside surfaces of the furnace with a ceramic fiber insulating material is recommended. Experimental studies reported by Harada et al. (1997) demonstrated that a key aspect of the furnace environment was the absorption coefficient of the furnace gas, k, which is a function of gas temperature and the composition of the furnace gas. Tests conducted in a furnace lined with a ceramic fiber insulation material demonstrated small variation in measured test specimen temperatures as a function of furnace depth, with variations decreasing as the furnace depth increases. A similar trend was observed in furnaces lined with refractory brick, however, the temperature measurement variations increased for the similar exposure conditions. These tests demonstrate the ability of the ceramic fiber to heat up faster, resulting in a more uniform exposure temperature, and the development of a radiation dominant furnace environment. Analysis conducted by Babrauskas and Williamson (1978) support the use of ceramic fiber insulation materials used as the lining materials on developing a more uniform heat flux within the test furnace which results in improved furnace control.

The major conclusion from the work reported by Harada et al.(1997), indicated that the wall lining material was the dominant factor that influenced the heat impact on the exposed surface of the test specimen. Wall lining materials with a low thermal inertia, such as ceramic fiber insulating material, will result in improved furnace environment uniformity.

Minimum Furnace Depth

*Recommendation T-12: The minimum furnace depth should be 4 ft (1.2 m).*

Studies conducted by Harada et al. (1997) and Fromy and Curtat (1999) investigated the effect of furnace depth on the furnace environment. The work by Harada et al. (1997) evaluated furnace depths of 0.6 ft,(0.17 m), 1.6 ft (0.5 m), 3 ft (0.95 m), and 9.8 ft (3.0 m). The results of the tests indicated that as the furnace depth increased, the radiative heat increased proportionally. Furnace depths slightly greater than 4 ft (1.2 m) showed a convergence in the predicted specimen surface temperatures. The non-dimensional furnace depth parameter, kD, relates the furnace environment with the furnace depth. As kD increases, the exposed face specimen temperature uniformity converges.

Fromy and Curat ( 1999) reported the results of testing conducted in furnaces having depths of 2 ft (0.6 m), 4 ft (1.2 m), and 5 ft (1.5 m). As the depth of the furnace increased, variations in the exposed surface temperature decreased. These results indicated that as the depth of the furnace increased, the furnace environment volume became more uniform, and local effect from burners and re-radiation from the furnace walls decreased.

By increasing the non-dimensional furnace depth factor, kD, a more uniform furnace environment can be produced. The studies reported above indicate that a minimum furnace depth of 4 ft (1.2 m) would be expected to produce a uniform furnace environment which will reduce uncertainties and variability in the test conduct related to furnace construction.

Burner Fuel

*Recommendation T-13: Propane gas should be used as the furnace fuel in all fire resistance furnaces.*

Furnaces in the U.S. and in Europe use a variety of fuels to provide the heat input into the test furnace. In the U.S. gaseous fuel, either natural gas or propane, is used as the burner fuel. In some overseas furnaces, liquid fuels (heavy oil or kerosene) are used. Testing conducted by Cooke (1994) evaluated the thermal environment impact on a calibration sample in a number of furnaces located overseas. Two of the furnaces used natural gas as the burner fuel and one furnace used oil. The results of the testing did not specifically focus on the impact of the burner fuel on the furnace environment and performance of the calibration specimen, however, it was noted that the oil-fired furnace produced a more thermally-severe furnace environment compared to the natural gas fired environment. Numerical studies conducted by Sultan and Denham (1997), Sultan, Harmathy, and Mehaffey (1986), and Sultan (1996) all recognize that the absorption coefficient for the furnace hot gasses will vary with the type of burner fuel. Typically, the absorption coefficient is lower for gaseous fuels and higher for liquid fuels. As the furnace gas absorption coefficient increases, the severity of the exposure increases correspondingly. Systematic studies of propane versus natural gas do not appear to be available in the literature. Such a study would be of value to the fire resistance testing community.

Recognizing that liquid fuels will produce a more severe fire exposure, there exist practical operational and safety issues related to using liquid fuels sprayed into a closed environment. The spraying of a liquid fuel into a furnace may result in the build-up of residue on the furnace walls as a function of time, which may lead to increased maintenance costs. Safety systems would need to be implemented to insure the spraying system can be adequately secured upon termination of a fire test. Commercial gas-fueled burners are readily available with appropriate safeguards for ensuring gas flow is secured upon termination of a test. The burning of liquid fuels may not be as clean as gaseous fuels, therefore, requiring additional environmental considerations for the utilization. Many municipalities already contain the infrastructure to provide natural gas via underground supply lines or liquid propane via truck. Of the two, storage of liquid propane, used with an appropriate vaporization system, can maximize the on-site storage capability for conducting large-scale furnace testing.

Type of Burner

*Recommendation T-14: Pre-mixed burners should be used in all fire resistance furnaces.*

Two basic types of burners are currently used in existing fire resistance test furnaces; pre-mixed burners and diffusion burners. Control of the furnace temperature using diffusion burners typically involves adjusting the raw gas flow into the furnace to maintain the required temperature level. With this type of burner set-up, openings into the test specimen may require flowing additional raw gas into the furnace to maintain the furnace temperature. This can result in incomplete combustion within the test furnace. The installation of the "burners" in the test furnace requires careful placement as these burners typically produce a large flame plume, which depending on the relative location of the test sample to the burners, may result in undesirable localized heating effects.

Pre-mixed burners carefully control the amount of fuel and combustion air injected into the burner and into the test furnace resulting in a very uniform flame shape and heating capability. This results in a burner flame, which is easily controllable, and with combustion that is more complete. The air-gas mixture can be adjusted to suit a range of furnace conditions, providing operational flexibility not available with diffusion burners. These burners also produce high gas velocities inside the furnace, which is desired to produce an environment similar to that of a fully-developed compartment fires.

Secondary Air Capability

*Recommendation T-15: When necessary, a means for providing secondary air should be provided such that the minimum oxygen content within a furnace is not less than 6%.*

Maintaining a minimum oxygen concentration within the test furnace is desired to produce conditions that could be obtained in compartment fires and to support the combustion and char oxidation of combustible test samples such as wood. See Section 3.1.1 for a detailed discussion. A minimum oxygen concentration of 6% was determined to be reasonable. A secondary airflow path into the furnace may be required to maintain this oxygen level, especially in cases where the test article is combustible. Sufficient oxygen make-up air should be available to maintain oxygen levels with oxygen depletion due to burning test articles.

Exhaust Control

*Recommendation T-16: A means for controlling the internal furnace pressure (e.g., damper in exhaust stack) should be provided.*

Fully-developed fires will always produce a positive pressure gradient across ceilings and a majority of the boundary height relative to ambient conditions. In these areas of positive pressure, hot gases are driven through small openings that develop in the assembly causing damage to the internal portions of the assembly. Hot gas migration through the assembly may also give rise to ignition on the unexposed side of the assembly in these local areas of weakness. As a result, it is recommended that furnace tests be performed with a positive furnace pressure so that the effects of hot gas transmission through the assembly can be observed.

Furnaces should contain a means for controlling the pressure inside the furnace during the test. As described in Section 3.1.1, a positive furnace pressure (relative to the laboratory) will be maintained across the entire test article in both vertical and horizontal tests. In vertical tests, the neutral plane in the furnace needs to be maintained at the bottom of the test article to have the entire test article at positive pressure. There should be no limit on the pressure at the top of the test article; for a 2.4-m (8-ft) high-test article the pressure at the top will be approximately 18–22 Pa depending on the gas temperature. In horizontal tests, the furnace should be maintained at 20 Pa during the entire test. The damper system should be designed and demonstrated to be capable of meeting these requirements, with some lead way to account for leakage through the assembly.

## 3.3 Thermal Properties of Materials

*Recommendation T-17: The thermal and physical properties of materials in the test article assembly should be measured. Thermal properties (conductivity, specific heat capacity, heat of decomposition) should be measured at temperatures as close to the highest temperature the material is expected to reach during the test. Physical properties (density, moisture content, expansion/contraction, decomposition kinetics) should also be measured as a function of temperature up to temperatures the material is expected to reach during the test. Thermal property test should be performed on materials taken from the same lot of materials used to construct the test article.*

The accuracy in predicting the heat-transfer through the test article assembly during the test, as well as other exposure conditions will be dependent on knowledge of thermal properties of materials in the assembly. Thermal properties should be known over the temperature range at which the materials are expected to be exposed.

Thermal properties for noncombustible materials can be obtained as a function of temperature. However, thermal properties are more difficult to obtain for materials that lose mass through either moisture-loss or degradation or materials that are deformable or not dimensionally stable. Several methods have been developed to determine thermal properties of materials at elevated temperatures with limited success on thermal properties in excess of 800$^{o}$C (Henderson et al., 1981, 1982, 1983, Kokkala and Baroudi, 1993, Lundkvist et al., 1991, Jansson, 2004, Lattimer and Ouellette, 2004, 2006, Mehaffey et al., 1994, Sheppard and Gandhi, 1993). All of these methods are inverse heat-transfer methods where a model is used along with material temperatures measured under controlled conditions to determine the thermal properties required to obtain the measured response. Particular problems have been cited when attempting to measure properties of materials that degrade at particular temperatures. To overcome this difficulty, Henderson et al. (1982, 1983) and Lattimer and Ouellette (2004, 2006) conducted thermal property measurements on undegraded samples up to temperatures where degradation was expected. Thermal properties were determined for a degraded sample over the entire temperature range, and the thermal properties during degradation were calculated based on the fraction of degradation.

## 4.0 TEST METHOD RECOMMENDATIONS – STRUCTURAL PERFORMANCE

The test requirements, with respect to the structural aspects of the test method, involve measurements/instrumentation, test procedures, and test documentation. These requirements relate to the production of data that can directly support PBSFE. The recommendations are followed by a discussion of the issue and the basis for the recommendation. The test procedures are subdivided into instrumentation, general, and load/scale issues.

### 4.1 Instrumentation

Assembly End Restraint

> *Recommendation S-1: Place load cells at the assembly end boundaries to record magnitude of thermal restraining forces throughout test duration: minimum of three cells at one edge of furnace for the top, center, and bottom of a middle beam or stud of assembly.*

Structural modeling of the test results requires the inclusion of boundary conditions. Without these, no meaningful predictions of the test can be performed and as such, validation of the model through comparison with the results of furnace fire testing is not possible.

The fire test results recently reported in NIST NCSTAR 1-6B, as well as those from some non-standard fire tests, such as Cardington (University of Edinburgh, 2000 and Bailey, 2004) bring close scrutiny to issues of end conditions. A fully unrestrained end condition clearly represents a unique boundary condition of free expansion without any thermally-induced reactions, but the restrained condition includes a wide range of potential thermal restraints, from moderately stiff to fully rigid (Lim, Buchanan, and Moss (2004).

Another common source of confusion, particularly to structural engineers and architects, is that thermal restraint is not necessarily synonymous with structural end restraint: simple and modest steel shear connections for beam framing, which are considered to be rotationally unrestrained with negligible moment-resisting strength, have been shown to represent adequate thermally restrained conditions for most cases of both composite and non-composite steel-concrete floor systems (Gewain and Troup, 2001).

The default assembly support condition is just simple bearing on the furnace boundary. For the default bearing or end-connected assembly support condition, a complete description and quantitative characterization of the actual physical restraint provided during the fire test is very pertinent to the fire response of the assembly. Use of load cells at the restrained assembly boundaries to measure the thermally-induced forces that develop during the test would be quite illuminating in recording the assembly-to-frame interface conditions. A minimum of three load cells at a beam or stud end location within the assembly interior is recommended to measure both the total axial thrust and bending moments that occur from the thermal restraint. Additional such instrumentation for other beam or stud ends would serve to confirm similar restraint in other parts of the assembly or to demonstrate its variability. This information will provide quantitative structural data that can be converted for use in PBSFE relative to actual connections and assembly support stiffness.

Deflections

> *Recommendation S-2: Record, as a minimum, the time-history of transverse deflections at mid-span in all primary structural members (beams, joists, columns, and wall studs) of the assembly, together with axial shortening of loaded columns and wall studs.*

Besides strength, the stiffness of a fire-resistive assembly is an important performance factor. Assembly deflections are not only a lead indicator of structural distress in the element tested, but large deflections also can lead to damage of its fire protection materials as well as damage to adjacent construction. Even without failure of the tested assembly, large fire-induced deflections can cause breaches of adjacent horizontal and/or vertical fire barriers, thereby leading to fire propagation into additional compartments. Therefore, transverse (out of plane) deflections of the structural members (beams, joists, wall studs, or columns) should be recorded by transducers, at least at their mid-spans, to provide the time-history of the deflection profile. For multiple beams, joists, or studs within an assembly, each member should be so instrumented, or at least those within the central, more flexible, region of the assembly. For axially loaded walls and columns in compression, the time-history of axial shortening at the load points should also be required.

Digital photo or video has additional value, especially in recording lateral or torsional deflections. Subsequent image analysis can provide quantitative deflection data.

Strain Gauges

> *Recommendation S-3: Require high-temperature strain gauges at critical sections (typically ends and/or mid-span) of main structural members (beams, joists, columns, wall studs) and of other important load transfer elements (shear studs, metal deck, floor slabs and reinforcement, and connections).*

Strains in the primary structural member section (beam/joist, wall stud, or column) should be monitored with high-temperature strain gauges, at least at both of the outside section edges and at its mid-depth, at the end supports and mid-span. Strains in the metal deck, concrete slab, any shear studs (for composite steel beams) and/or steel reinforcement in the concrete slab or wall should also be instrumented at supports and mid-span, as a minimum. Such strain data provides key information on load paths, identifies the local member areas where inelastic (yielding) material response is occurring and whether it is tensile or compressive, thereby revealing the critical structural locations for force redistribution and resistance mechanisms with time. Measured strains can also be related by compatibility to thermally-induced elongations and assembly restraint to better quantify these test assembly variables. Such localized and detailed structural response information cannot be deduced solely from measured deflections that are more representative of the overall gross response.

Non-standard fire tests, such as the Cardington building tests conducted in the UK over the last 10 years (University of Edinburgh, 2000 and BRE 215-741), usually supplement thermocouple and deflection results with strain readings for such purposes. Special high-temperature strain gauges are available for applications up to about 500–600ºC. Beams and columns, concrete slabs and its reinforcing mesh or rebar, and any connection elements can be instrumented for strain. Figure 15 shows strain data for bolts in steel connection at elevated temperatures from BRE 215-741.

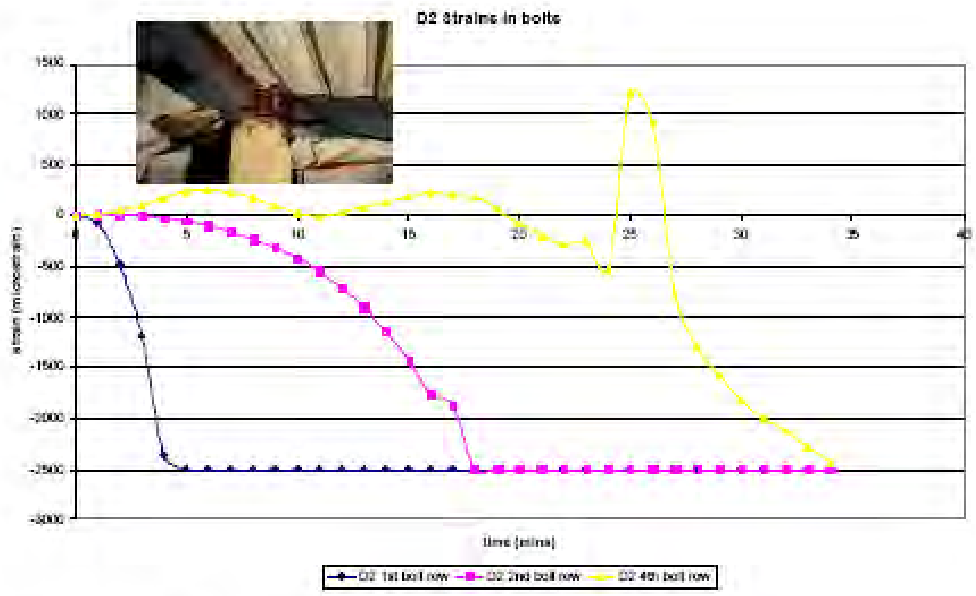



Figure 15. Bolt strain data from BRE 215-741.

This level of test data acquisition and documentation, as summarized in Table 3 and Figure 16, should be provided.

Table 3. Test Instrumentation Recommended for Acquisition
of Structural Performance Data (see Figure 16)

| Measurement | Instrumentation |
|---|---|
| *Time-history of transverse (out-of-plane) deflections for all structural members* | *Transducers at assembly mid-span (minimum) for each member* |
| *Time-history of axial shortening for axially loaded walls and columns* | *Transducers at assembly load point (min)* |
| *Measure thermal restraint forces and bending moments at structural member end* | *Minimum of three load cells at beam or wall stud end, located at center of section and at both outside edges.* |
| *Time-history of strains in primary member section (beam, column or wall stud), metal deck, shear studs, steel rebar in concrete* | *High-temperature strain gages at outside edges and mid-depth of main structural section, centrally located in deck and rebar, base of shear studs - at end supports and mid-span (min) – see Figure 3* |

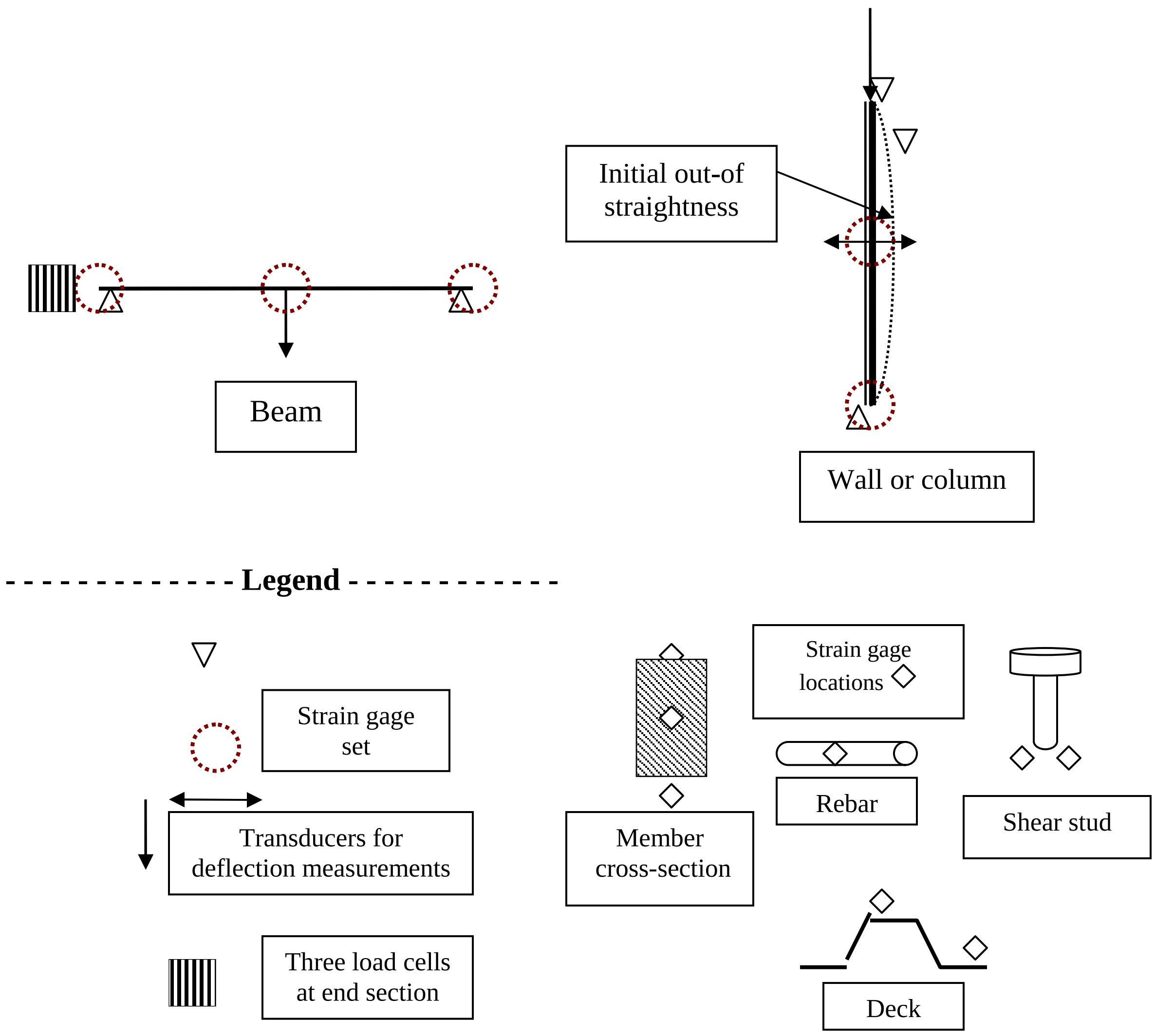



Figure 16. Illustration of recommended additional instrumentation for structural fire performance.

## 4.2 Furnace Operation and Load/Scale

<u>Standardized Assembly Load Application</u>

*Recommendation S-4: Superimposed loading on all assemblies should only be applied through mechanical or hydraulically-controlled apparatus.*

In addition to hydraulic/mechanical equipment, current testing practices often include use of other types of floor or beam load application, such as water-filled tanks, concrete blocks, or sand bags. While there may be some merit or convenience in using the latter for lightly loaded specimens not tested to their maximum design limit, use of such constant weights is inherently less accurate and consistent than load control equipment that has been properly calibrated and serviced. Inconsistencies and differences in the load application methodology alone may lead to discrepancies between tests and/or laboratories. The bulky natural weights can obscure needed detailed observations of the assembly's unexposed side condition relative to any openings, cracks, spalling, or fire penetration. At larger floor/beam deflections during the fire exposure, lateral contact among the stacked weights can be induced which would alter the actual gravity load distribution on the assembly. Moreover, in fire tests that reach actual structural failure, the danger to personnel and damage potential to the laboratory furnace is less with controlled loads than with stacked tank, block, and bag weights, whose support and stability cannot be readily maintained after floor/roof collapse.

For all these reasons of control, accuracy, and safety, it is recommended that loading be standardized and restricted to only hydraulic/mechanical means. It is recognized that to attain the desired pattern of uniformly distributed floor design loading in this manner, it will necessitate a series of multiple jacks, with corresponding spreader and reaction beam configurations. Appropriate guidance in this regard must still be developed to avoid assembly overload from too few or inadequately positioned concentrated loads that do not reproduce the intended characteristic response of uniformly distributed design loads.

Specification of Maximum Superimposed Design Load

*Recommendation S-5: The standard should require the maximum assembly design load to be based on the greater of the design load computed from either allowable stress design or limit states-LRFD and the controlling strength failure mode to be used for each type of assembly construction.*

As with the thermal aspects of the test, it is necessary to provide loads that create the maximum allowable structural conditions so that potential serious failure modes can be realized in the test. Lesser loading would not provide full expression of assembly response potentials, leading to the potential for unanticipated failure modes in the field.

Over the last couple of decades, the alternative ultimate strength, limit states, or LRFD approach has evolved into an equally acceptable methodology that can result in different design solutions from working stress. In particular, it is possible to realize large maximum design load increases with the newer limit states/LRFD of up to 33–50% for some situations, such as composite steel-concrete beams. With this development and the broad acceptance in U.S. building codes of both design methods, there is no longer a unique maximum design load for a given assembly that is independent of the selected design method (ultimate strength or working stress). In some cases, it is also not clear which strength failure mode is to be considered for the assembly design.

Canada currently only allows use of limit states design, and has accordingly revised its CAN/ULC-S101-04 standard to specify how maximum assembly loads for standard fire tests are to be determined. It also addresses the typical strength limit states (bending, shear, compression, or tension) for which maximum design strength of the different assembly elements are to be computed. The latter guidance would be particularly helpful in the structural loading and analysis of multiple-part members, such as open-web joists, trusses, and non-standard girders. Additional provisions in this regard are needed in any test method in support of PBSFE. The conservative resolution of this issue in the presence of two structural design alternatives in the U.S. is to specify the maximum assembly design load as the highest load produced by working stress or limit states/LRFD, based on actual tested ambient material strength. In most typical cases, this maximum design load would be based on the ultimate strength/limit states/LRFD methods. Since testing to structural failure is the objective, restricted load tests at substantially less than the full design level may not reach this endpoint, or do so at significantly prolonged fire exposure times.

As a minimum, for purposes of PBSFE development, the applied load magnitude, type, and its design basis, as employed in the test, would add much needed clarity to the experimental results.

<u>Minimum Assembly Size</u>

> *Recommendation S-6: Specified minimum sizes of construction assemblies should be as follows: walls and paritions-100 sq ft with neither dimension less than 9 ft, columns – not less than 9 ft length, floors/roofs – 180 sq ft, with neither dimension less than 12 ft, beams – not less than 12 ft-span length. Standards-making bodies should consider the formation of furnace classes to recognize furnace capabilities larger than the minimum size.*

While ever-larger furnaces and test assemblies are desirable to limit the extent of the scaling extrapolation required, the realities are that existing laboratory facilities were built for the current E 119, and similar ISO 834, minimum assembly size requirements (Beitel and Iwankiw, 2002). Marginal size changes from the nominal 10 x 12 ft vertical furnaces for wall and columns tests and 14 x 17-ft horizontal furnaces for floor/roof tests would be substantially meaningless toward enhancing the fidelity of test results. Only rather large increases of at least 2–3 times the current limits would enable more fully capturing the nature of continuous building construction. However, these greatly-increased assembly sizes would necessitate major new capital expenditures on bigger furnaces and ancillary test equipment, with the recurring expense of fire testing accordingly escalating. These major budget and cost factors are likely to constrain the demand and short-term availability of necessary facilities for large tests.

At this time, while fire testing development of larger assemblies is certainly encouraged, it is felt that this goal can best be accomplished in the near future within the context of special purpose projects, and not on a regular recurring basis. It is concluded that sufficient benefits for PBSFE can be more practically achieved in the shorter term through the other recommendations and without any change in the minimum assembly size.

Given the clear value of larger test specimens, it is desirable to create a number of furnace size classes so that the construction and use of larger furnaces can be recognized and the enhanced value of larger-scale testing can be reflected in the V&V requirements for models to be employed in PBSFE.

Size Effects and Experimental Scaling

*Recommendation S-7: Employ dimensional scaling principles in the design of the test assembly to represent the actual construction applications.*

Laboratory furnaces are limited in size and depth, and this necessarily constrains the dimensions of assemblies that can be tested (Beitel and Iwankiw, 2002). Consequently, to date, most tests have been conducted full-scale on relatively small, shallow (not more than about 18 inches depth) and shorter span assemblies (less than about 17 ft) Restrictions have been imposed on the minimum structural sizes for which the rated assembly is applicable. However, it is known that long and short span floors/beams and walls/columns (often expressed in terms of a slenderness ratio of unbraced length divided by section depth or by its radius of gyration) can exhibit different structural behavior and have different strength limit states. The assembly depth can thereby be related to its span length as a contributing factor to the structural behavior. Bending and stability are the primary response modes for longer members, while shorter members are controlled by shear and axial section capacity.

In order to observe the full possible range of structural fire behavior, effects of longer spans and/or the larger assembly depths, which are actually used in construction, should be evaluated, since these could be more critical than shorter assembly spans and smaller depths. This approach would involve fire testing scaled specimens under load, which better represent reality. These geometric variables can be tested in practical furnace size and laboratory facility constraints using reduced-scale loaded assemblies and scaling laws to represent deeper trusses, bigger or taller columns and walls.

Dimensional analysis and structural similitude techniques to enable experimental test result correlations between full-size prototypes and scaled physical models have existed since the early-mid 20th century (Handbook on Experimental Mechanics, 1987, Bazant et al., 1996, Simitses and Rezaeepazhand, 1992) Preservation of key non-dimensional parameter(s) in the governing response equation(s) controls the experimental set-up and correlation of results. The fundamental differential equation for equilibrium of an elastic beam-column is given in Eq. 4, without regard to sign convention of the individual terms, and subject to material first yielding limits for axial and bending stresses:

$$\begin{gathered} EI\frac{d^2y}{dx^2} = Py(x) + M(x) \\ \text{subject to} \\ P \le F_y A \ \text{ and} \\ M(x) \le F_y S \end{gathered} \qquad (4)$$

where

E I = elastic bending stiffness of the structural member, assumed as constant for prismatic section (force*lengths$^2$)

$\frac{d^2y}{dx^2}$ = second derivative of transverse member deflection relative to length, (length$^{-1}$) also known as curvature of neutral surface

P = centrally applied axial load, (force)

y(x) = transverse member deflection, function of length, x, along member, (length)|

M(x) = bending moment from continuity, axial load eccentricity and/or transverse member loads, function of length, x, along member, (force*length)

$F_y$ = material yield stress, (force/length$^2$)

A = member cross-section area, (length$^2$)

S = member section modulus, (length$^3$)

Elastic column stability for compressive axial loads is influenced by the secondary bending term, P y(x), which disappears for a pure beam with no axial force (P=0). For assessment of ultimate member structural strength and failure, utilization, or demand-to-capacity, ratio is the key invariant. If the model and prototype are built from the same materials, this ratio can be simply replaced by stress level. For these conditions and if structural member dimension of the model relative to prototype, 0<s<1.0, is the primary scaling variable for its cross section and span length, the following scaling is necessary for complete test similitude and dimensional consistency of Eq. 4:

- Member span, length: s
- Member section area (A), length$^2$: $s^2$
- Moment of inertia (I) of member, length$^4$: $s^4$
- Concentrated load (P), force: $s^2$
- Line load, force/length: s
- Bending moment (M), force*length, and section modulus (S), length$^3$: $s^3$
- Uniformly distributed load, stress, and E (Young's Modulus), force/length$^2$: 1.0

Scaling (½-size floor truss depth and span, with doubling of applied load to produce equivalent steel stresses) was successfully employed in the recent NIST WTC floor truss fire resistance testing. (NIST NCSTAR 1-6B) Appropriate test provisions for furnace-scaled assembly testing should be developed, along with guidelines for application of results. Criteria for how and when large geometric changes in assembly span and depth can affect their fire resistance should be formulated, along with requirements for when assemblies must undergo additional scaled tests to account for these possible size effects in their fire resistance rating in lieu of extrapolation. Floor systems and columns appear to be the most likely candidates for such reduced scale testing. However, it is recognized that consistent scaling of concrete floor slabs may be problematic due to lack of sufficient control over aggregate size and internal moisture/humidity content. Furnace-scaled specimens can be considered to be about approximately ½ to ¼ size of the real prototype.

Some adaptation of full-scale to reduced, furnace-scaled fire testing of assemblies (in particular for beams, roofs, and composite steel-concrete floors) should be accomplished in the relative short-term. It would provide much needed supporting data to supplement or replace the current extrapolation of results of larger and heavier construction.

General guidance on the design of scaled furnace assemblies is needed by the fire resistance testing community and this is included as a general recommendation in Section 6.2.

### 4.3 General

Mandatory Fire Testing Under Design Load to Structural Failure

> *Recommendation S-8: All assembly fire tests should be conducted under maximum design load until an imminent or actual structural failure limit state is attained, or until an major integrity breach occurs, irrespective of the assembly's other thermal conditions.*

Oftentimes, the limiting criterion for a fire resistance rating time is either thermal or the test is simply terminated because a desired rating time target had been achieved. Under these circumstances, structural failure of the fire test assembly is never reached. The importance of continuing fire tests to structural failure, despite any rating time considerations, lies in gaining a fuller understanding of the actual structural limit states that can be encountered as the assembly reaches its failure time. These ultimate fire performance facts are not at all evident when the test is prematurely stopped, sometimes well in advance of even any visible structural distress. All loaded fire tests should continue until an imminent or actual structural limit state (failure condition) is reached.

In the recent NIST WTC collapses investigation (NIST NCSTAR 1-6B), four standard fire resistance tests were conducted on the floor truss system with different protection thicknesses and test conditions. While the E 119-based rating time was determined to be between ¾–2 hrs., the floors continued to support load without collapse for over 2 hours.

This observation, among others, reinforces the need to test to failure and to clearly identify the structural failure time and failure mode. The type of actual or imminent structural failure mode (bending, stability, fracture) or assembly integrity breach (burn-through or flame penetration through assembly or the furnace enclosure) should be clearly identified and reported.

The practical implication of this approach is that test duration should be limited by laboratory safety. Termination of a test would be indicated by fire penetration or burn-through of the assembly, or other breaches of the furnace enclosure or test apparatus that would pose a danger to the laboratory staff and facility. This structural failure/integrity endpoint of the test would generate much additional valuable information at a relatively small increment of effort. The time, mode and mechanism of the assembly failure should be clearly described (ductile, brittle, in bending, shear, tension, squash, or buckling) and documented as part of the standard.

Actual Strength of Assembly Structural Materials at Ambient Temperature

> *Recommendation S-9: Material strength tests should be performed on samples extracted from the primary structural assembly members to determine their actual mechanical properties at ambient (including yield and ultimate strength, and elastic modulus).*

Typical structural testing requires knowledge of the actual stress-strain properties and dimensions of the specimen material(s) at ambient temperatures. This mechanical property data is needed to accurately correlate the experimental results to predictor equations or analyses that utilize the material's yield or ultimate strength. Simple use of the minimum specified strength gradation of the structural material for this purpose is inadequate and could be grossly misleading for interpretation of the results, especially if the actual strength is substantially different (either more or less) from its nominal value. Current standards have no detailed requirements for determination of actual strength properties of the test assembly's structural materials, other than the general recording of their physical properties. The latter is mostly interpreted as being identification of the materials and their product designations, together with overall assembly dimensions. Often, the characteristic 28-day compression strength of poured concrete has been experimentally verified through standard ASTM C 39 cylinder tests and reported. However, the real steel, wood, or masonry properties of test assemblies commonly are not more precisely documented other than their nominal size and grade designation. Yet, it is possible, even currently probable for some lower grade, mild structural steels such as ASTM A 36, that their actual material strength may be 50% higher than its minimum nominal value. (ANSI/AISC 341-05). Petterson and Wittenveen (1979) cited examples in the 1970s of such artificial increases in fire resistance rating time achieved principally because the base structural material had an actual strength 25% higher than nominal.

Use of production mill certificates that show measured ambient strength of the material origination lot of the structural member is more reliable than mere dependence on nominal values, but due to potential variability within the lot as well as piece identification and tracking errors, this may also not be necessarily representative of the material to be fire tested. The best approach is to require standard ASTM strength tests of material samples used in the assembly construction, to include:

a. ASTM A 370-06, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products;*
b. ASTM E 8-04, *Standard Test Methods for Tension Testing of Metallic Materials;*
c. ASTM C 31/C31M-06, *Standard Practice for Making and Curing Concrete Test Specimens in the Field,* American Society for Testing and Materials, West Conshohocken, PA;
d. ASTM C 39/C39M-05e1, *Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens;*
e. ASTM C 1314-03b, *Standard Test Method for Compressive Strength of Masonry Prisms;* and
f. ASTM D 198-05a, *Standard Test Methods of Static Tests of Lumber in Structural Sizes*.

Explicit requirements for structural material strength determination to this effect should be provided in the test standard.

Determination of Structural Properties at Elevated Temperatures

*Recommendation S-10: Material strength tests should be performed on materials used in the primary structural assembly members to determine their actual mechanical properties at high temperatures (including yield and ultimate strength, and elastic modulus).*

The major mechanical properties needed for structural fire resistance engineering are yield and ultimate strength, Young's (elastic) modulus, and stress-strain curves. The first two strength and stiffness parameters as a function of temperature, may be deduced from a series of stress-strain data. All materials exhibit degradation of their ambient mechanical properties with higher temperatures, and this representation, often depicted as a percentage of ambient, or so-called retention ratio, is crucial to an accurate modeling of fire resistance, and ultimately any fire-induced collapse prediction.

In contrast to long-standing test standards for determination of ambient material strength, such as A370-06 tensile testing for steel, none exists for such applications at high temperatures. The determination of high temperature mechanical properties requires a heating apparatus (oven) in combination with the conventional load testing equipment. The material specimen can either be heated to certain uniform temperatures and then load-tested until failure to develop a family of stress-strain curve for those temperatures, or it can be loaded at various constant levels inside an oven and heated to increasing temperatures until a creep failure occurs. A correlation could be made between these two sets of high temperature results.

Published information exists from various sources, domestic and international, on the "typical" mechanical properties of traditional structural materials (commonly steel, concrete, wood or masonry) at the high temperatures that could be experienced during a fire exposure. (SFPE, 2002 and ASCE Manual #78, 1992, among others). However, many of these tests were done decades ago, on generic material grades customary for that time and country, and with experimental procedures that were not entirely consistent for all, including differences in applied strain rates, instrumentation, data interpretation, and consideration of creep. This accounts for some of the additional scatter of these reported results. While it has been demonstrated that material retention ratios at high temperatures can be similar within a given material class, a substantially different response can be manifest in a separate class of the same material. For example, SFPE (2002) and other literature show that high strength concrete and steel will perform differently at high temperatures than their lower "normal" strength counterparts. Therefore, a related uncertainty of how far to extrapolate existing retention ratio data to other conventional material grades, types, or species or to specialty products, i.e., what are the specific limits of existing data applicability. Of course, as newer construction materials evolve into more common practice, such as resin-based, polymer composites, steel-concrete composite construction, steel cables or pre-stressing strands, fiber-reinforced concrete or even more higher strength steels and concretes, their high-temperature mechanical properties will need to be established.

To resolve these issues, supplemental high temperature testing for mechanical properties of the test assembly materials could be made mandatory, in general. However, this would severely burden every E 119 test and likely produce many redundant results. A more efficient alternative is central development within a separate program the standard procedures for such testing of these properties to conduct sufficient high temperature experiments of the common construction materials and grades, compile and publish the results for engineering applications. The recent WTC investigation Report NIST NCSTAR 1-3D provides an excellent central source of test data and available references on mild structural steel, together with revised best-fit formulations for the basic steel mechanical properties as a function of temperature, including the rarely reported Poisson's ratio. As the common construction materials and grades are likely to change over time, this high temperature material testing and official documentation should be periodically repeated, perhaps every 10–20 years, for validation and/or recalibration. If modern material property data is not available, it will be necessary for the materials to be tested in conjunction with the furnace testing.

In addition to the basic mechanical properties at elevated temperatures, the gross behavior of the assembly materials during the test fire exposure must be described, especially with regard to its damage/degradation through spalling, charring, and the like. This is further discussed under documentation.

Inclusion of Load Eccentricity for Walls and Columns

> *Recommendation S-11: Require column and wall tests to be conducted with a minimum d/6 eccentricity of axial compression load from centerline, where d is the depth of column or wall.*

Most of the structural column fire resistance ratings have been derived from tests on unloaded, nominally straight specimens that are fully engulfed (uniformly heated) in the fire, and that are subject only to temperature endpoints. Use of this type of critical steel temperature test obscures a great deal of real fire response information for the member. Effects of accidental load eccentricity, initial column curvature or imperfections, column mechanical strength properties, length slenderness ratio, and type of structural failure (squash or stability/buckling) under fire exposures are relatively unknown.

In addition, compression members can potentially experience non-uniform heating in real fires (for example, in perimeter framing or tall columns subjected to lower, partial height heating), which will cause bowing curvatures (Cooke, 1988) due to thermal gradients through the section depth (see Figure 17). These induced thermal curvatures reduce the strength of the members due to P-delta effects, and hence, influence the stability of the columns. Such thermal effects will depend on whether the fire totally engulfs a given structural column, in which case similar thermal exposures on all sides can be expected, (uniform heating) or if not, gives rise to the non-uniform heating cases.

This behavior at elevated temperatures, as well as the adherence of the fire protection material under lateral column deflections, will only become manifest when columns are tested until actual/incipient failure under maximum design load and without temperature limits. The benefit of using different strength grades of column materials for fire resistance will also become better established.

As illustrated in Figure 17, non-uniform heating can be full height, but incomplete fire exposure of entire column section contour or a partial height exposure of some or all the section contour. Loaded column tests with non-uniform heating are expected to show asymmetric structural response and failure mechanisms that are not obviated from the currently unloaded, uniformly-critical E 119 temperature tests with their idealized conditions. Similar performance differences can exist for some wall assemblies due to non-uniform heating, applied load and deformation, even for non-loadbearing elements such as those that may be used as fire separations for large record storage compartments (Beyler and Iwankiw, 2005). Bailey (2004) reported that during the Cardington building tests in the UK, a non-loadbearing compartment wall failed during the fire due to large deflections imposed from adjacent beam framing.

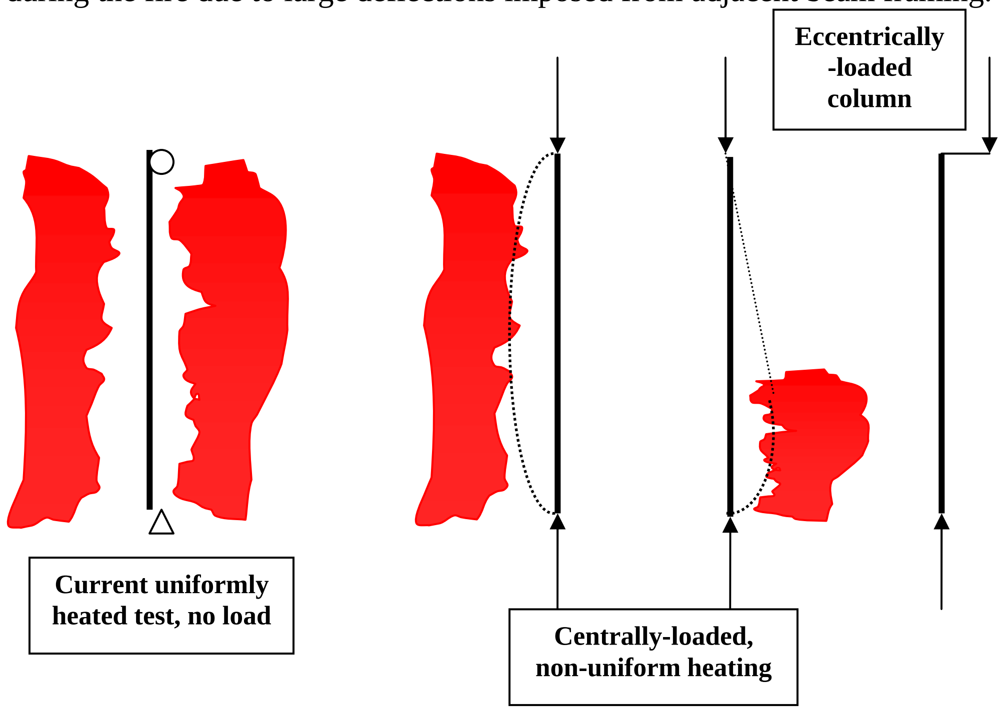



Figure 17. Column fire-testing alternatives.

A number of recent papers have addressed the fire resistance of light wood and steel-framed walls. In Alfawakhiri et al. (1999), and Alfawakhiri and Sultan (1999), the authors cite the paucity of experimental data on loadbearing light-frame walls with steel studs. Greater research focus in this area is endorsed, along with more complete instrumentation of standard test assemblies for structural property and response variables in order to expand performance-based fire design options. Clancy (2002a and 2002b), Clancy and Young (2004) developed predictive time to failure models and comparison tests on wood stud walls with gypsum board. Buckling effects, wall crookedness, stud size, spacing, charring, variability of wood and gypsum properties, as well as loadbearing and non-loadbearing applications were studied. Kodur et al. (1999), Alfawakhiri and Sultan (2000), Sultan (1995), and Alfawakhiri et al. (2000) present additional standard fire test results for lightweight steel framed walls, along with analytical modeling that correlates with this test data. Feng et al. (2003) and Feng and Wang (2005) reported experimental and analytical findings on cold-formed steel wall studs with gypsum board. Effects of channel section sizes and spacing, thermal bowing, stability and loading were examined under standard fire exposures.

Provision for investigating loaded column and wall response under non-uniform fire exposure should be studied, as this may be a more severe condition than uniform heating. In the interim, a surrogate approach for simulation of wall and column assembly strength degradation due to geometric imperfections and additional non-uniform heating effects is the imposition of a minimum eccentricity for compressive loads. Minimum compressive load eccentricity is already required in some test standards and structural design methods.

At this time, in view of the eccentricity requirements contained in ASTM E 72 for wall panel strength tests and those implied in ACI 318 for structural concrete design in compression, a load eccentricity of d/6 from the wall or column centerline is recommended, where d is the actual depth of the wall stud perpendicular to the wall or the largest depth of the column. This d/6 value also has a theoretical engineering basis in the so-called "kern" distance for a compressively loaded rectangular section, which is the maximum eccentricity in such a member that will still maintain all combined material stresses in compression, without any net tension from the eccentric bending. This load eccentricity should be applied toward the assembly side such as to magnify the fire and thermally-induced effects as a worst case. Steel and concrete members will bow towards the fire-exposed side due to thermal gradients and steel expansion; hence, the compressive load eccentricity should be applied away from the furnace to exaggerate this curvature. On the other hand, wood tends to bow away from the fire due to asymmetric charring deterioration; hence, its d/6 load eccentricity should be applied towards the furnace. Prior to the test, any initial wall or column geometric imperfections, such as vertical out-of straightness, should be measured and documented.

<u>No Hose Stream Test Requirement for Walls and Partitions</u>

> *Recommendation S-12: Hose stream test procedure and its acceptance criteria for walls and partitions are no longer required.*

The hose stream test provides little substantive information to either current life safety practices or PBSFE. The interpretation of its results is not well defined, and the hose stream application may be conducted after two alternative fire exposure durations. The use of the hose stream test is in direct conflict with the requirements of the "test to failure" approach adopted here.

<u>Structural Instrumentation Check/Calibration</u>

> *Recommendation S-13: Prior to initiation of fire test, check/calibrate all of assembly's structural instrumentation (transducers, strain gauges, load cells) under superimposed load.*

The functionality and accuracy of all the structural instrumentation installed on the assembly should be checked under load immediately prior to the fire ignition. This process should include comparison of the expected elastic deflections and strains of the structural members under load to those recorded just prior to the fire test. Any installation corrections or replacements of instrumentation can then be made, as needed. An easy method for similar pre-test verification of the load cells (for boundary restraint) should be developed and implemented.

## 5.0 TEST METHOD RECOMMENDATIONS – TEST DOCUMENTATION

The proposed test requirements for procedures, instrumentation, or load/scale issues will all necessarily require accompanying documentation, as outlined herein in 5.1–5.6.

### 5.1 Furnace Description

- Lining (T-11)
- Dimensions (T-12)
- Gas type (T-13)
- Burner description (T-14)
- Secondary air flow rate (T-15)

### 5.2 Furnace Exposure Conditions and Instrumentation

- Furnace temperature measurement (T-1)
- Target fire exposure curve including tolerances (T-9)
- Pressure measurement and location(T-2)
- Oxygen concentration sampling description and analyzer for measurement (T-3)

### 5.3 Calibration Test Results

- Thermal (T-10)
- Structural (S-13)

### 5.4 Specimen/assembly Description

- General – size/dimensions (S-6), ambient material strengths (S-9)

All the test assembly original conditions (structural framing and span, loading, end supports) should be accurately provided. In addition, the description and major properties of the fire protection materials should be provided. For compressively-loaded assemblies (walls and columns), initial-out-straightness of the test assembly and other imperfections should be regularly measured and recorded, as this could be an important factor in its ultimate strength.

- Instrumentation (type and locations) – thermal (T-4, T-5, T-7, and T-8) and structural (S-1, S-2, and S-3)
- Superimposed loading – design basis and magnitude, application means (S-4, S-5, S-11)
- Conditioning – e.g., curing of concrete, of protective materials, etc.

## 5.5 Test Results

- Time-history records of all measured values
- Pertinent visual observations – discoloration, damage and detachment of protective and structural materials, cracking, spalling, buckling, creation of gaps-openings, flame and gas penetration, other unusual behavior

During the test, the time of occurrence and type of major structural damage, such as local buckling of steel, detachment of metal deck from slab, spalling or crushing of concrete, fractures and cracks, splitting or ignition/charring of wood and the like should be documented. The ignition and charring of wood is well-documented. However, though research literature on fire-induced concrete spalling exists, such as the more recent contributions of Bostrom et al. (2004), and Breunese and Fellinger (2004), such spalling damage in concrete is still not known in sufficient scientific rigor to be predictable or controllable. Therefore, if spalling in concrete or other unusual high temperature material behavior is manifest during the fire test, the nature and occurrence time of this phenomenon, along with its accompanying conditions should be documented.

Equally important, other observations on degradation, damage, distortion or detachment of the fire protection material, that could accelerate thermal penetration of the assembly during the test, should be made.

- Identification of Structural Failure Endpoint Time and Mode(s) (S-8)
- Other – photographs, videos, identification of any malfunctioning of instrumentation or test apparatus, possibly sample extraction of residual assembly materials

## 5.6 Post-Test Inspection

- Thermal damage – material state, char extent and depths, spalling area and depths, burn-through areas, missing/detached protection material, etc.
- Structural – local and global damage (cracking, spalling, buckling, fractures, char-reduced sections, etc.)

The ambient, post-test (cold) condition of the assembly should be well-documented, in particular all the fire protection and structural damage, and final displaced configuration of the assembly. This information would reveal any changes and additional damage from thermal contraction after the fire and during the cooling stage.

## 6.0 GENERAL RESEARCH RECOMMENDATIONS IN SUPPORT OF PBSFE

While the objective of this project was to develop recommendations for testing in support of PBSFE, a number of general research topics were brought to light in the course of the work. These topics are introduced in the following subsections for reference. The topics are neither complete nor novel, but bear enumeration.

### 6.1 Develop Guidelines for Definition of Imminent Structural Failure

Recommendation S-8 calls for testing under full design load until structural failure is reached, or until an integrity/safety breach occurs. Much is left to the subjective judgment of the laboratory staff or the test sponsor as to when structural failure is imminent immediately prior to any total specimen collapse. The purpose of this recommendation is to develop a common set of Guidelines that can be used in the determination of imminent failure. The Guidelines are intended to facilitate safe and effective laboratory operations and provide greater test termination consistency among laboratories.

Large, uncontrolled deflections are usually the best indicator of an imminent failure. Harmathy (1967) addresses such for steel beam supported floors. In contrast to ductile failures that develop more gradually, brittle fractures or instability can occur almost instantaneously without forewarning and are much less predictable. The laboratory is usually very careful in trying to prevent full assembly collapse in order to avoid any personnel injuries and to safeguard its furnace and instrumentation. That is why a reliable predictive limit for imminent structural failure of the test assembly, at least for ductile response, is desirable. These, and more general unresolved issues in practice with identification of structural "failure" during a fire, were raised by Lane (2003).

Rapidly increasing ("runaway") deflections and loss of stiffness can often be seen real-time during the fire test on the plot of assembly deflection time-history. Current standards do not provide any definitive criteria on exactly when ductile deflections are to be regarded as being uncontrolled, with failure being imminent. Ryan and Robertson (1959) had developed arguably the first deflection failure criteria for steel beams tested in a standard E 119 fire test under full load (Ryan and Robertson, 1959). One of these postulated limits is the magnitude of the maximum beam transverse deflection, formulated from curve fit of test data in consistent length units of inches as

$$\delta = \frac{L^2}{800d} \tag{5}$$

where

$\delta$ = maximum beam transverse deflection during the fire exposure, in
$L$ = beam span length, in
$d$ = beam section depth, in

Due to the difficulty of representing in a simplified manner all the other specimen design variables, such as material properties, member sizes, and end connection restraint for this critical deflection value, Ryan and Robertson (1959) proposed a second accompanying limit that checks the rate of transverse deflection. This criterion draws from the experience that specimen failure is imminent when the deflection itself is not only sufficiently large, but also when it starts increasing at a rapid, or "runaway" rate, indicated by the slope of the deflection time-history curve. Such an accelerated rate of deflection signals pending beam instability. This second limit postulated by Ryan and Robertson, 1959, is expressed as the hourly rate of fire induced deflection equaling or exceeding $L^2/(150d)$. The authors recommend the structural failure time of the beam, floor or roof assembly be taken as the time when both of these limiting criteria are exceeded.

These, or comparable, beam, floor and roof deflection criteria should be developed for adoption to explicitly define imminent structural failure for ductile materials. Several international fire standards, such as ISO 834, BS 476 and DIN 4102, have already included similar type of deflection-based criteria for "loadbearing capacity," not only for members in bending, but also for axially loaded elements in compression (columns and walls). These ISO 834 limits are shown in Eq. 6, with both criteria necessary to be exceeded for failure identification. These deflection limits are substantially higher than those originally proposed by Ryan and Robertson (1959). For flexural elements and $D \geq L/30$:

$$D = \frac{L^2}{400d}$$

$$\frac{dD}{dt} = \frac{L^2}{9000d} \tag{6}$$

where

D, dD/dt = limiting flexural deflection, mm, and rate of deflection, mm/min, respectively
L = clear span of assembly, mm
d = bending section depth, mm

For axially loaded elements:

$$C = \frac{h}{100}$$

$$\frac{dC}{dt} = \frac{3h}{1000} \tag{7}$$

where

C, dC/dt = limiting axial shortening, mm, and rate of axial shortening, mm/min, respectively
h = initial element height, mm

These and additional recommendations should be developed as Guidelines to minimize risk of sudden brittle fractures or stability collapses in order to preserve general safety and mitigate damage to the laboratory facility. In addition to any specific deflection-based indexes, monitoring and interpretation of temperature readings, observations on the physical deterioration of the assembly, duration of the fire exposure, and similar factors should be addressed. The resulting Guidelines will provide a common and rational platform for identification of the imminent structural failure test endpoint for typical conditions.

### 6.2 Develop Guidance for the Design of Furnace Assemblies and Application of Results

Test method provisions for furnace-scaled assembly testing and guidelines for application of results should be developed. Criteria should be provided for when and how furnace-scaled fire tests can be used and interpreted relative to actual construction via extrapolation of results to larger and heavier assemblies. This need follows directly from Recommendation S-7 to employ dimensional scaling principles in the design of the test assembly to represent the actual construction applications.

### 6.3 Conduct a Round-robin using the Furnace Calibration Test Method

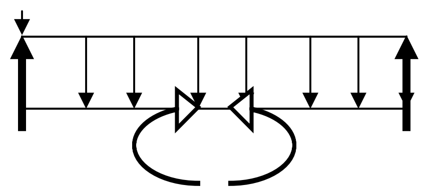
A round-robin using the furnace calibration test (Recommendation T-10) would provide important data and evaluation of the relative operating performance of existing laboratory furnace. Given the differences in size, depth, fuels, burners etc of the existing furnaces, the round-robin would also serve to evaluate the potential effects of not controlling the furnace operation as recommended in this report. The round-robin would provide testing and statistical analysis in support of test method development, standardization, and analysis of variances.

### 6.4 Develop Test Procedure and Data on Fire Performance of Common Structural Connections

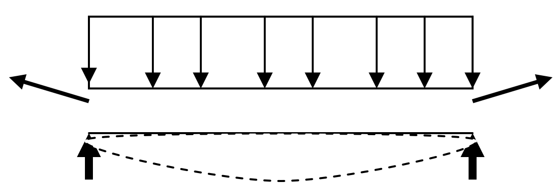
FEMA 403 and NIST NCSTAR 1-6B identify structural connections under fire exposures as a vital area for further study. Very few fire tests have been conducted on assemblies with real end connections, in place of the common insertion of the assembly frame into the furnace. Most assemblies typically have simple bearing supports butted against the test frame for floors and roofs, or to the load device for walls. While the current prescriptive code provisions in the U.S. requiring fire protection of connections to be at the same level as for the most highly rated adjoining structural member have generally been considered adequate, the fire response of connections, of its constitutive elements and details (bolts, welds, reinforcing bars and development lengths, ties, etc.) is not well understood or developed. Moreover, the ductility, or lack thereof, of connections under potentially very high strain demands and reduced strength at elevated temperatures could be a critical factor in the integrity assessment of adjacent structural member(s) and framing, as well as for development of any secondary load redistribution paths. The Cardington building tests amply demonstrated this aspect of real structural fire performance (University of Edinburgh, 2000 and BRE 215-741).

End connections and member splices are conventionally detailed only for the design loads required by the applicable building code, which primarily involve shear forces and/or bending moments for moment frames, axial tension or compression and/or shear for braced frames and trusses. Columns typically carry only compression loads, but may experience uplift for some braced frame conditions. Ordinary structural design for beams and floors does not regularly include the secondary effects of larger axial tension forces and strains from catenary action (see Figure 18) that are likely to become manifest only under the final strength limit states of fire exposure, blast, or impacts. One example of this type of tensile limit state in a connection is the beam splice failure during the 9-11 disasters in WTC 5, as described in the FEMA 403 Report.

One approach to acquire fire performance data on connections is to require every assembly to be detailed and tested with real connections. However, development of standard provisions for such would be rather difficult, given the wide variety of alternative connection types and details, and it would regularly encumber every test. It is likely better to allow the assembly supports to continue being of the customary fitted/bearing type within the test frame, or at the sponsor's discretion, use of actual structural connections should be permitted.



Bending/Shear at Service Conditions



Catenary Action at Ultimate

Figure 18. Change in floor system resistance from primary bending to catenary action.

A seemingly more viable alternative is to develop in a special research study a unique set of fire test criteria and results for a suite of typical steel connectors (mechanical fasteners, welds, shear studs), connections and steel reinforcing details (longitudinal rebar, shear stirrups, ties, etc.) for steel, concrete and masonry that form typical simple (shear only) and rigid (moment-resisting) connections, composed of different base materials in beam-to-beam and beam-to-column designs. This could be done within or separate from the standard review. Given suitable instrumentation and loading, important new information on connection ductility, force transfer mechanisms, and their ultimate failure limit states under load and high temperature exposures would be thereby obtained, including effects from cooling after the fire. These connection results could supplement the conventional assembly ratings, and form a basic set of input properties for modeling of connections in PBSFE.

### 6.5 Develop and Standardize Test Methods for High Temperature Thermal, Physical, and Structural Properties of Materials

In support of Recommendations T-17 and S-10, test methods for high temperature thermal, physical, and structural properties of materials are needed. Thermal properties (conductivity, specific heat capacity, heat of decomposition) need to be measured at temperatures as close to the highest temperature the material is expected to reach. Physical properties (density, moisture content, expansion/contraction, decomposition kinetics) also need to be measured as a function of temperature up to temperatures the material is expected to reach. Material strength tests need to be performed on materials used in the primary structural assembly members to determine their actual mechanical properties at high temperatures (including yield and ultimate strength, and elastic modulus.

While there are a number of test methods available for these measurements, none of them are fully satisfactory and none are accepted as standards for this use. Research is needed to develop and evaluate the available methods. This will support the selection of the best methods that can then be subjected to V&V and ultimately become accepted standard test methods for this application.

### 6.6 Compile Fire Test Database

Compilation of a comprehensive database on all fire tests of an assembly, including those that were not successful, is recommended. Fire resistance data and rating results from any fire test can differ, sometimes quite markedly from one identical test to another, both in terms of recorded thermal and structural performance. This is due to the many random experimental variables and inaccuracies (laboratory facilities and practices, furnace temperatures and pressures, loading, instrumentation, test frame boundary conditions), combined with differences in actual material properties and workmanship quality of the individual assembly construction. At times, multiple fire resistance tests have been conducted for an assembly to achieve a desired rating outcome, and only the single best “passing” test is used as the benchmark for the fire resistance listing.

The actual “track” record, including any failed or unsatisfactory tests, assembly modifications, and variability of fire tests should be compiled in a database. This information would serve to not only assess the test variability, but also provide additional model validation benchmarks.

The database will not only provide a much better understanding of fire performance, but also give invaluable specific results against which structural fire design and analysis tools can be validated and calibrated.

### 6.7 Analyze Repeatability (Scatter) of Tests

A rigorous statistical study of the random variations in standard fire tests (as compiled in the database) should be performed to determine the expected probability distribution of experimental results for identical or similar assemblies. To the extent possible, the variability of all the experimental and assembly-specific factors should be established. Such rationally assigned statistics of the published test data could be used to improve interpolation of existing test results and to assess validation accuracy of analytical models, whose solutions otherwise may not exactly match the output of any single test.

# 7.0 SUMMARY OF RECOMMENDATIONS

## 7.1 Furnace Instrumentation Recommendations

Recommendation T-1: Furnace Temperature Control – Plate thermometers should be used to measure furnace temperature and control the furnace exposure. There should be nine plate thermometers equally distributed across the test specimen surface. Plate thermometers are typically placed 0.10 m (4 in.) away from the sample; however, a larger spacing is desired to prevent them from potentially being damaged by failing test articles. Testing needs to be performed to demonstrate that a larger spacing does not affect the thermometer measurement.

Recommendation T-2: Furnace Differential Pressure – Tests should be performed with a positive furnace pressure (relative to laboratory conditions) across the entire test article. All furnace pressures should be measured using the tube sensor provided in ISO 834 and EN1363-1. In a vertical furnace, pressure should be measured at the bottom and top of the test specimen. The neutral plane in the furnace should be maintained at the bottom of the test specimen with no limit on the pressure at the top of the specimen. In a horizontal furnace, the furnace pressure should be measured at one location and maintained at 20 Pa. Pressure tube sensors should be located at the same distance away from test articles as the plate thermometers.

Recommendation T-3: Furnace Oxygen Concentration – Furnace oxygen concentration should be measured in the furnace stack and maintained at greater than 6% during the test. Gas samples should be continuously drawn out of the duct through a sampling line and measured using a paramagnetic type oxygen analyzer. The recommended sampling probe should be similar to the sampling probe used in duct measurements of hood calorimeters.

Recommendation T-4: Unexposed Side Temperatures – The unexposed side temperatures should be measured with a thermocouple placed between the specimen and a noncombustible, insulating pad. The insulating pad should be a low density, low thermal conductivity material with known thermal properties. The pads should be approximately 0.15 m (6 in.) square and 25 mm (1 in.) thick and placed in at least three locations that provide a range of heat-transfer performance.

Recommendation T-5: Total Heat Flux off the Unexposed Side – The total heat flux off the unexposed side of the assembly should be measured using a Schmidt-Boelter type water-cooled total heat flux gauge. At a minimum, a heat flux gauge should be placed near the center of the test article and as close as possible to the unexposed side. In cases where the assembly contains a transparent section, a heat flux gauge should also be placed at the center of the transparent section as close as possible to the unexposed surface.

Recommendation T-6: Furnace Velocity – Velocity measurements inside the furnace should not be made.

Recommendation T-7: Temperature Profile through Test Specimen – Temperatures should be measured through the thickness of the test assembly at locations that are representative of the different heat-transfer paths within the assembly. Repeat temperature profiles are recommended in case some thermocouples fail during the test.

Recommendation T-8: Gas Temperature Measurement – Gas temperatures on the exposed and unexposed side of the test specimen should be measured using aspirated thermocouples. Gas temperatures should be measured at each location where a temperature profile is being measured. Aspirated thermocouples should be placed as close as possible to the test article surface.

## 7.2 Furnace Operations Recommendations

Recommendation T-9: Furnace Time-Temperature Exposure Curve – The furnace time-temperature exposure should linearly increase to 1200°C in six minutes and remain constant at 1200°C for the remainder of the test.

Recommendation T-10: Calibration Test – A calibration test should be conducted with a noncombustible boundary containing instrumentation to quantify the thermal exposure. Instrumentation installed in the boundary should include total heat flux gauges and calibration boards instrumented with thermocouples. Instrumentation should be installed in at least five locations (center of each quadrant and center of the boundary) to quantify the furnace exposure. The calibration test should be performed for one-hour using the required furnace exposure and instrumentation.

Recommendation T-11: Furnace Lining Material – All interior furnace surfaces should be lined with a ceramic fiber material.

Recommendation T-12: Minimum Furnace Depth – The minimum furnace depth should be 4 ft (1.2 m).

Recommendation T-13: Burner Fuel – Propane gas should be used as the furnace fuel in all fire resistance furnaces.

Recommendation T-14: Type of Burner – Pre-mixed burners should be used in all fire resistance furnaces.

Recommendation T-15: Secondary Air Capability – When necessary, a means for providing secondary air should be provided such that the minimum oxygen content within a furnace is not less than 6%.

Recommendation T-16: Exhaust Control – A means for controlling the internal furnace pressure (e.g., damper in exhaust stack) should be provided.

Recommendation T-17: Thermal Properties of Materials – The thermal and physical properties of materials in the test article assembly should be measured. Thermal properties (conductivity, specific heat capacity, heat of decomposition) should be measured at temperatures as close to the highest temperature the material is expected to reach during the test. Physical properties (density, moisture content, expansion/contraction, decomposition kinetics) should also be measured as a function of temperature up to temperatures the material is expected to reach during the test. Thermal property test should be performed on materials taken from the same lot of materials used to construct the test article.

## 7.3 Structural Instrumentation Recommendations

Recommendation S-1: Assembly End Restraint – Place load cells at the assembly end boundaries to record magnitude of thermal restraining forces throughout test duration: minimum of three cells at one edge of furnace for the top, center, and bottom of a middle beam or stud of assembly.

Recommendation S-2: Deflections – Record, as a minimum, the time-history of transverse deflections at mid-span in all primary structural members (beams, joists, columns, and wall studs) of the assembly, together with axial shortening of loaded columns and wall studs.

Recommendation S-3: Strain Gauges – Require high-temperature strain gauges at critical sections (typically ends and/or mid-span) of main structural members (beams, joists, columns, wall studs) and of other important load transfer elements (shear studs, metal deck, floor slabs and reinforcement, and connections).

## 7.4 Structural Operations Recommendations

Recommendation S-4: Standardized Assembly Load Application – Superimposed loading on all assemblies should only be applied through mechanical or hydraulically controlled apparatus.

Recommendation S-5: Standardized Assembly Loading – The standard should require the maximum assembly design load to be based on the greater of the design load computed from either allowable stress design or limit states-LRFD and the controlling strength failure mode to be used for each type of assembly construction.

Recommendation S-6: Minimum Assembly Size – Specified minimum sizes of construction assemblies should be as follows: walls and partitions – 100 sq ft with neither dimension less than 9 ft, columns – not less than 9 ft. length, floors/roofs – 180 sq ft, with neither dimension less than 12 ft, beams – not less than 12 ft span length. Standards making bodies should consider the formation of furnace classes to recognize furnace capabilities larger than the minimum size.

Recommendation S-7: Size Effects and Experimental Scaling – Employ dimensional scaling principles in the design of the test assembly to represent the actual construction applications.

Recommendation S-8: Mandatory Fire Testing Under Design Load to Structural Failure – All assembly fire tests should be conducted under maximum design load until an imminent or actual structural failure limit state is attained, or until an major integrity breach occurs, irrespective of the assembly's other thermal conditions.

Recommendation S-9: Actual Strength of Assembly Structural Materials at Ambient Temperature – Require material strength tests be performed on samples extracted from the primary structural assembly members to determine their actual mechanical properties at ambient (including yield and ultimate strength, and elastic modulus).

Recommendation S-10: Determination of Structural Properties at Elevated Temperatures – Material strength tests should be performed on materials used in the primary structural assembly members to determine their actual mechanical properties at high temperatures (including yield and ultimate strength, and elastic modulus).

Recommendation S-11: Inclusion of Load Eccentricity for Walls and Columns – Require column and wall tests to be conducted with a minimum d/6 eccentricity of axial compression load from centerline, where d is the depth of column or wall.

Recommendation S-12: No Hose Stream Test Requirement for Walls and Partitions – Hose stream test procedure and its acceptance criteria for walls and partitions are no longer required.

Recommendation S-13: Structural Instrumentation Check/Calibration – Prior to initiation of fire test, check/calibrate all of assembly's structural instrumentation (transducers, strain gauges, load cells) under superimposed load.

## 7.5 Recommendations Potentially Applicable to Existing Test Methods

While the objective of this project was to develop requirements for testing in support of PBSFE, many of the recommendations could be implemented within the context of the existing tests used in prescriptive design. The recommendations developed here fall into three categories; 1) fully capable of being implemented in existing test methods, 2) potentially capable of being implemented into existing test methods with minor modifications to the test standard, and 3) require major modifications to existing test standards. The category classification of the recommendations is shown in Table 4.

Recommendations falling into Category 1 are generally recommendations that add instrumentation that is not required in the existing standards. The recommendations do not restrict what is allowed in any way, but rather supplement the requirements of existing tests.

Recommendations falling into Category 2 are incremental changes or restrictions that go beyond the requirements of the existing test methods, but would not require major modifications to the test standard.

Recommendations falling into Category 3 are major departures from the existing test methods that could not be accommodated as incremental changes.

Table 4. Applicability to Existing Test Methods

| Recommendation | Category |
|---|---|
| T-1: Furnace Temperature Control | 2 |
| T-2: Furnace Differential Pressure | 2 |
| T-3: Furnace Oxygen Concentration | 2 |
| T-4: Unexposed Side Temperatures | 2 |
| T-5: Total Heat Flux off the Unexposed Side | 1 |
| T-6: Furnace Velocity | 1 |
| T-7: Temperature Profile through Test Specimen | 1 |
| T-8: Gas Temperature Measurement | 1 |
| T-9: Furnace Time-Temperature Exposure Curve | 3 |
| T-10: Calibration Test | 2 |
| T-11: Furnace Lining Material | 2 |
| T-12: Minimum Furnace Depth | 2 |
| T-13: Burner Fuel | 2 |
| T-14: Type of Burner | 2 |
| T-15: Secondary Air Capability | 2 |
| T-16: Exhaust Control | 2 |
| T-17: Thermal Properties of Materials | 1 |
| S-1: Assembly End Restraint Measurement | 1 |
| S-2: Deflections | 1 |
| S-3: Strain Gauges | 1 |
| S-4: Standardized Assembly Load Application | 2 |
| S-5: Standardized Assembly Loading | 2 |
| S-6: Assembly Size | 2 |
| S-7: Size Effects and Experimental Scaling | 2 |
| S-8: Fire Testing to Structural Failure | 2 |
| S-9: Actual Strength of Structural Materials at Ambient Temperature | 1 |
| S-10: Determination of Structural Properties at Elevated Temperatures | 1 |
| S-11: Inclusion of Load Eccentricity for Walls and Columns | 2 |
| S-12: No Hose Stream Test Requirement for Walls and Partitions | 2 |
| S-13: Structural Instrumentation Check/Calibration | 1 |
| Test Documentation | 1 |

Category 1- supplemental to existing test method
Category 2- incremental changes or restrictions to existing test method
Category 3- major departure from the existing test

## 8.0 PROPOSED EXPERIMENTAL RESEARCH

A test plan outline involving composite concrete slab/steel beam floor assemblies and gypsum-protected load bearing steel-stud walls assemblies has been developed to evaluate the feasibility and value of the instrumentation and operations recommendations. The test plan outline also calls for reporting consistent with the documentation recommendations of this report. The test plan outline is provided in this section of the report. Other experimental research proposals are included in the general research recommendations of Section 6.

### 8.1 Test Plan Outline

This test method is intended to support the continuing development and use of Performance-Based Structural Fire Engineering (PBSFE). This supplementary test plan outline reflects the majority of the recommendations for enhanced fire resistance testing of building construction assemblies. Its objective is to provide the key variables and configuration of two test assemblies for a series of fire tests intended to further explore, validate and/or refine the test recommendations and criteria.

As specified by the Fire Protection Research Foundation (FPRF) for this Project, light frame walls and composite steel/concrete floors are to serve as the generic two assembly types for this testing assessment. HAI selected the particular construction described herein based on their representative nature of the assemblies of interest, the specifics of which can be adjusted at the discretion of FPRF, including the identification of particular proprietary products. These selections of the test assemblies were made based on their prevalent fire resistance rated construction as determined from HAI project experience including listings in the 2007 UL Fire Resistance Directory.

This test plan outline contains the essential information for FPRF to plan the test program and to finalize assembly details and test series parameters. The specific nature of the assemblies, variables to be changed, number of repeat tests, and intended test duration are all important considerations in this regard that are addressed. To avoid repetition, it is assumed that the reader is familiar with and has ready access to the HAI report (Beyler et al., 2007). For the sake of brevity, the test requirements simply reference the parent report and its various itemized recommendations, which contain their background and more specific details.

This outline provides general test requirements and those specific to the light frame wall and the composite floor assemblies.

#### 8.1.1 General Requirements

The general requirements are:

- The minimum furnace depth (both horizontal and vertical furnaces) is 4 ft (Per Recommendation # T-12)
- All interior furnace surfaces are to be lined with ceramic fiber materials. (Per Recommendation # T-11)
- The furnaces will be fired using propane gas. (Per Recommendation # T-13)

- The furnaces will use premixed burners. (Per Recommendation # T-14)
- The furnaces will be equipped with a controlled source of secondary air for minimum oxygen content of 6% throughout test. (Per Recommendation # T-3 & T-15)
- Furnace shall be fired to follow the recommended time/temperature curve. (Per Recommendation # T-9)
- Plate thermometers will measure and control the fire exposure. (Per Recommendation # T-1)
- The fire tests will be conducted under positive furnace pressure across the entire test assembly, with laboratory capability to accordingly monitor and adjust pressure. (Per Recommendation # T-2 & T-16)
- Velocity measurements within the furnace are not required. (Per Recommendation # T-8)
- Minimum assembly sizes shall be as specified in ASTM E 119. (Per Recommendation # S-6)
- Both temperatures and heat flux on the unexposed side of the assembly be measured and recorded. (Per Recommendation # T-4 & T-5)
- Aspirated thermocouples will record the gas temperatures on the exposed and unexposed sides. (Per Recommendation # T-8)
- Temperature profiles through the assembly be measured and recorded. (Per Recommendation # T-7)
- Prior to the test, a general calibration of the thermal instrumentation is required. In this calibration test, plate thermometers used to control the furnace shall be installed at the location desired in the actual testing with some select measurements at other distances from the test article to evaluate the impact of thermometer offset on furnace temperature measurement. (Per Recommendation # T-10)
- The structural instrumentation requires load cells for measuring thermal end restraint, transducers for deflection data and high-temperature strain-gages at critical assembly locations. See specific test details below for locations. (Per Recommendation # S-1, S-2 & S-3)
- The live load shall be applied via hydraulic/mechanical equipment. (Per Recommendation # S-4)
- The maximum assembly design load shall be based on the ultimate strength/LRFD method. (Per Recommendation # S-5)
- For walls, a specific compression load eccentricity shall be used. (Per Recommendation # S-12)
- No hose stream test shall be conducted. (Per Recommendation # S-14)
- Continue the test until either an actual or an imminent structural failure occurs or occurrence of a major breach in the assembly or until safety considerations dictate. Unless other guidelines or criteria for imminent failure in ductile bending and axial compression are determined, the deflection-based limits described in Recommendation S-9 be used. (Per Recommendation # S-8 & S-9)
- Supplementary testing of the key protection and structural materials is necessary to identify their relevant ambient and high-temperature properties. Samples of materials

used in constructing the assemblies should be set aside for use in conducting thermal and mechanical property testing. (Per Recommendation # T-17, S-10 and S-11)

- Test documentation includes assembly dimensions, construction and instrumentation details, initial conditions, raw and processed data of all instrumentation, photos, and visual observations of damage, unusual behavior, and failure mode(s).
- Each test assembly will be run in duplicate in order to assess reproducibility of results, and possibly to correct any problems with the first iteration.

### 8.1.2 Light Frame Walls

Light frame walls consist of either wood or cold-formed steel studs protected by gypsum board or plaster. Consequently, heavy concrete or masonry walls are not considered to be within this category of building construction.

The strategy for planning this set of wall tests is to evaluate the performance of the common construction of this type using the proposed test procedure. Since the test procedure focuses on both thermal and structural performance during fire exposure, it was necessary for the wall assemblies to be load bearing and be tested at their maximum design load. It was also decided to use cold-formed steel studs rather than wood studs due to the wide use of steel studs and the much greater variability of wood stud properties.

Common fire-resistance rated light wall construction is typically constructed by applying gypsum wallboard to each side of the steel studs. Test Wall Assembly No. 1 will have one layer of ⅝ inch thick, Type X gypsum board on each side of the studs and a layer of 3.5-inch thick mineral wool insulation (4 lb/ft$^3$ density) installed in the cavities. Test Wall Assembly No. 2 and Wall Assembly No. 3 will have two layers of ⅝ inch thick, Type X gypsum board on each side of the studs and a layer of 3.5-inch thick mineral wool insulation (4 lb/ft$^3$ density) installed in the cavities. Each wall will have overall dimensions of 10 ft, high x 12 ft wide.

Table 5 provides a summary of the test wall assemblies.

Table 5. Test Matrix – Wall Assemblies

| Test No. | Studs | Cavity Insulation | Gypsum Wallboard Facers | Loading |
|---|---|---|---|---|
| 1A | Steel – 3½-in. deep, 20-ga., 24-in. OC | 3½-inch thick - (4 lb/ft3 density) | 1 layer of ⅝-in. thick, Type X on each face – Vertically applied – joints staggered | Centrally |
| 1B | Steel – 3½-in. deep, 20-ga., 24-in. OC | 3½-inch thick - (4 lb/ft3 density) | 1 layer of ⅝-in. thick, Type X on each face – Vertically applied – joints staggered | Centrally |
| 2A | Steel – 3½ in. deep, 20-ga., 24-in. OC | 3½-inch thick - (4 lb/ft3 density) | 2 layers of ⅝-in. thick, Type X on each face – Vertically applied – joints staggered | Centrally |
| 2B | Steel – 3½-in. deep, 20-ga., 24-in. OC | 3½-inch thick - (4 lb/ft3 density) | 2 layers of ⅝-in. thick, Type X on each face – Vertically applied – joints staggered | Centrally |
| 3A | Steel – 3½-in. deep, 20-ga., 24-in. OC | 3½-inch thick - (4 lb/ft3 density) | 2 layers of ⅝-in. thick, Type X on each face – Vertically applied – joints staggered | Eccentrically |
| 3B | Steel – 3½-in. deep, 20-ga., 24-in. OC | 3½-inch thick - (4 lb/ft3 density) | 2 layers of ⅝-in. thick, Type X on each face – Vertically applied – joints staggered | Eccentrically |

In order to assess the potentially adverse effects of compressive load eccentricity as recommended in Recommendation S-12, a centrally loaded wall configuration will also be tested with eccentrically applied maximum design load for direct comparison with the predecessor assembly. At this time, in view of the eccentricity requirements in ASTM E 72 for wall panel strength tests and those implied in ACI 318 for structural concrete design in compression, a load eccentricity of d/6 off the wall centerline is recommended, where d is the actual depth of the wall stud perpendicular to the wall (see Figure 19) .

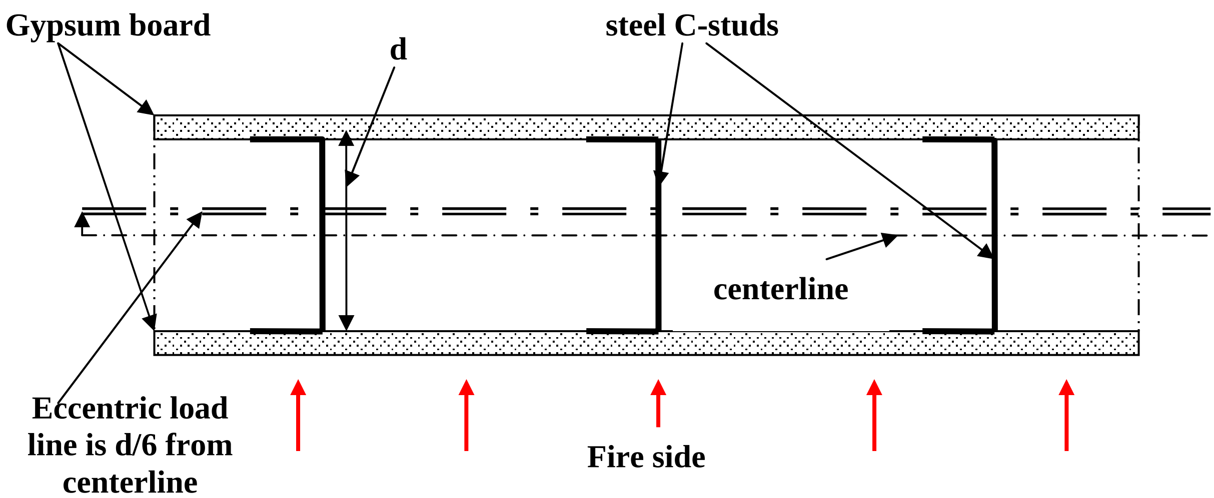



Figure 19. Cross-section of Proposed Wall Assembly, including Eccentric Load Line (away from fireside for steel studs only) – (cavity insulation not shown).

Instrumentation of each wall will consist of:

1. Structural Instrumentation: (see Figure 20)

   a. Deflections – transducer at mid-span of each wall stud for transverse deflection, and at top of studs for axial shortening (2/stud x 6 studs = 12 total)

   b. Strain gauges for steel wall studs – for central and approx. ¼-points of wall - both flanges and center of web, at both stud ends and at mid-span (3 studs x 3 locations x 3/location = 27 total)

   c. Restraint - load cells at top, middle and bottom of wall stud on one end (3 total)

2. Thermocouples for assembly, see Figures 20 and 21, (in addition to furnace control thermocouples) – (78 total)

   a. Wall studs – at both flanges and mid-web, for central and approx. ¼-points of wall, at mid-span and both ends

   b. Gypsum board and cavity insulation (see Figure 21) – for central and approx. ¼-points of wall, at mid-height and both ends, at stud and 12 inches away from these 3 studs, at exterior and interior of exposed and unexposed sides, and at middle of wall cavity insulation

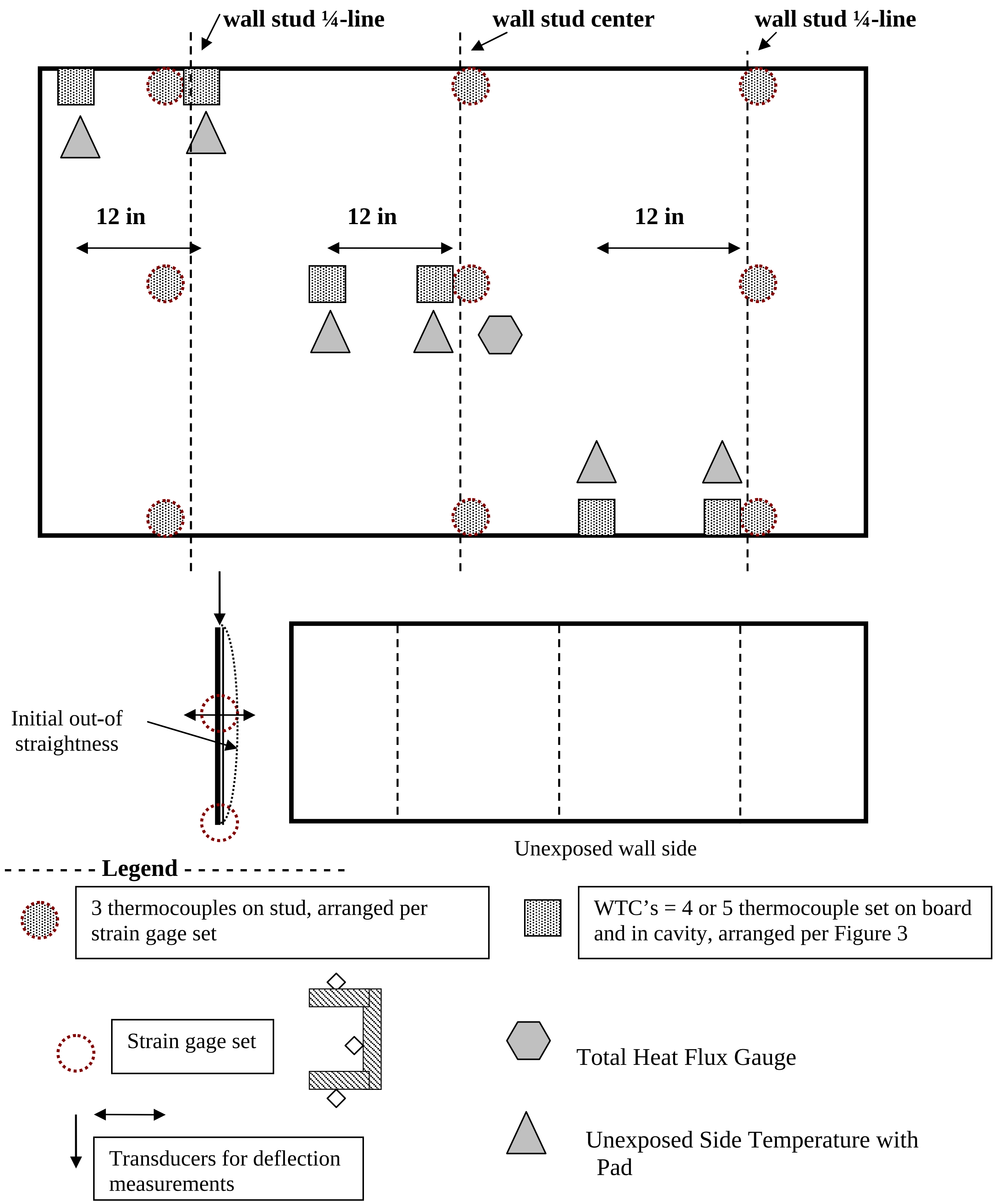



Figure 20. Elevation Layout of Structural and Thermal Instrumentation for Wall Assemblies.

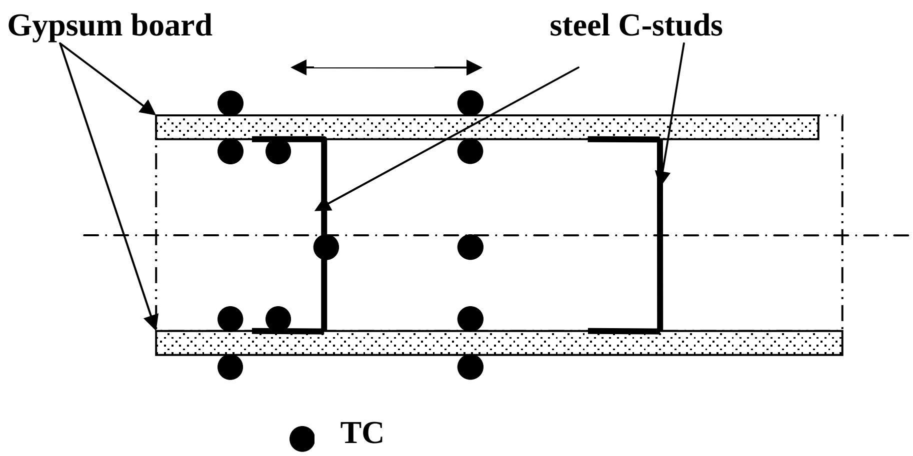



Figure 21. Cross-section for thermocouple (TC) layout – Wall No. 1.

The instrumentation for Wall Assembly No. 2 and No. 3 is similar to that for Wall assembly No. 1 except for additional TCs added between the layers of gypsum wallboard. This is shown in Figure 22.

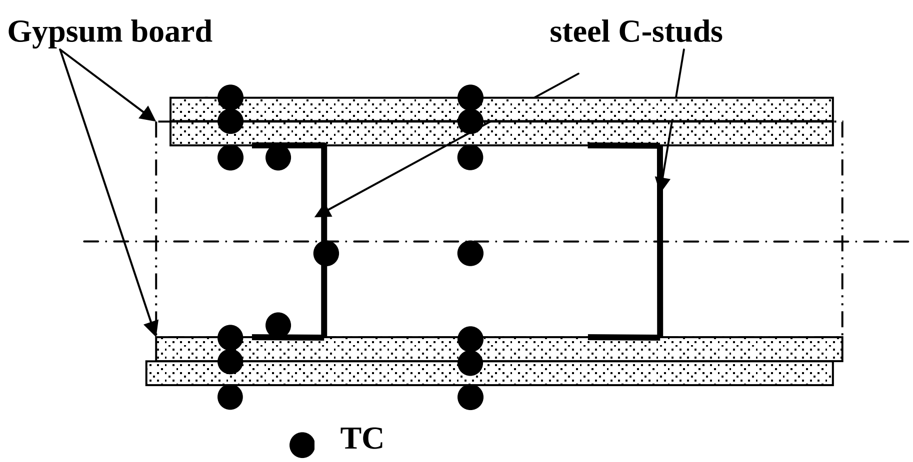



Figure 22. Cross-section for thermocouple (TC) layout – Wall Nos. 2 & 3.

8.1.3 Composite Steel Beam with Concrete Floor

This type of very common floor construction generically consists of either a poured in-place concrete on metal deck supported by protected, steel wide flange beams or joists or a poured in-place reinforced concrete slab supported by protected, steel wide flange beams or joists. Composite action between the concrete and deck and between the concrete and beams (through shear studs) is typically employed for efficiency. Since the reinforced concrete slab composite floor assembly could exhibit different thermal restraining forces and concrete slab response (spalling) than the concrete on metal deck assembly, it was decided to employ both types of floor construction in this test series.

The selection of the floor assembly details (concrete weight and thickness, depth of metal deck, etc.) and minimum spray-applied fire resistive material (SFRM) thickness on the beams will largely depend on its required level of fire resistance. A range of such protected assemblies is available for floor designs. For purposes of establishing the complete description of the test assembly configuration, it was decided to base this prototype on approximately a conventional 2-hr. restrained assembly and 2-hr. unrestrained beam commonly required for this type of floor system, with protection enhancements due to the more severe proposed fire exposure. Therefore, the proposed baseline floor assemblies are as follows:

The first assembly will employ a metal deck and its construction is proposed to be:

1. Poured in place concrete: normal strength, either normal weight (NWC) or lightweight (LWC), with thickness above metal deck of 4 ½ inches (NWC) to 3 ¼ inches (LWC), with 6 x 6, 10 x 10 SWG welded wire fabric

2. Unprotected steel floor deck: 3 inches deep, galvanized composite units of 24-inch width, blend of cellular and fluted, ribs perpendicular to supporting steel beam

3. Rolled steel beam, probably W8 x 28 shape, Grade 50 (ASTM A 992 or equivalent), with shear studs for composite action with concrete

4. SFRM **–** on beam only, minimum 35 pcf density, installed per appropriate UL XR ratings for UL 1709 exposure, contour protection thickness to be determined (about 1 inch)

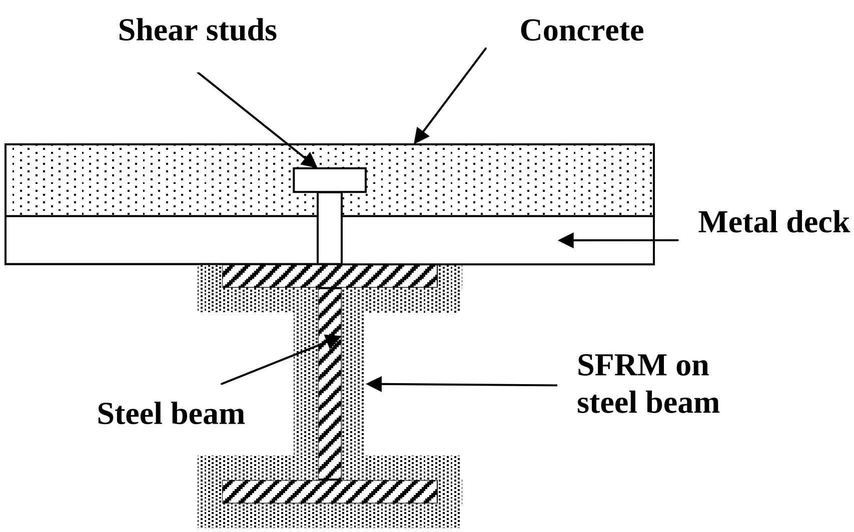



Figure 23. Cross-section of concrete/metal deck & steel beam composite floor assembly.

The second test assembly will not employ a metal deck and its construction is proposed to be:

1. Poured in place concrete slab (unprotected): 5 inch thickness, normal strength, either normal weight (NWC) or lightweight (LWC), with reinforcing steel bars designed per ACI 318 provisions

2. Rolled steel beam, probably W8x28 shape, Grade 50 (ASTM A 992 or equivalent), with shear studs for composite action with concrete

3. SFRM – on beam only, minimum 35 pcf density, installed per appropriate UL XR ratings for UL 1709 exposure, contour protection thickness to be determined (about 1 inch)

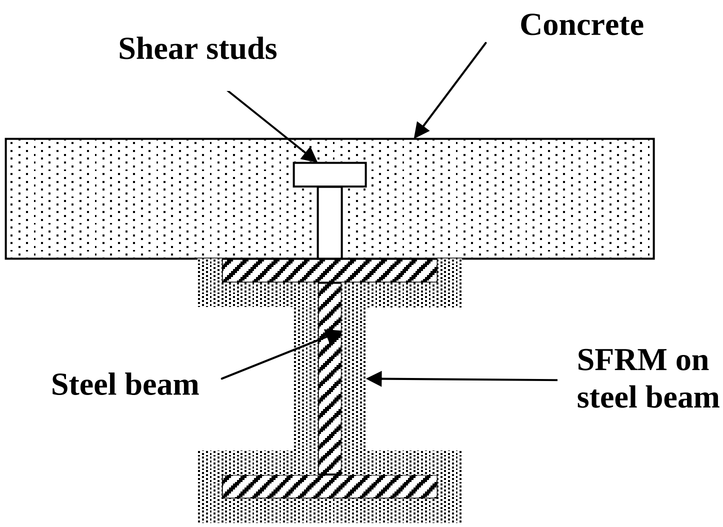



Figure 24. Cross-section of reinforced concrete & steel beam composite floor assembly.

Table 6 provides a summary of the test floor assemblies.

Table 6. Test Matrix – Floor Assemblies

| Test No | Floor Assembly |
|---|---|
| 4A | Concrete floor with metal deck |
| 4B | Concrete floor with metal deck |
| 5A | Reinforced concrete slab |
| 5B | Reinforced concrete slab |

The instrumentation for the concrete/metal deck floor assembly will consist of:

1. Structural Instrumentation: (see Figures 25 and 26)

    a. Deflections – transducer at mid-span of steel beam, at center of each side of metal deck's mid-span (3 total)

b. Strain gauges – (27 total)

   i. Steel beam – middle of top and bottom flanges, and center of web – at both beam ends and at mid-span (9 subtotal)

   ii. Metal deck – at above mid-span deflection locations, bottom and top rib surfaces (6 subtotal)

   iii. Shear studs – bottom of two studs near beam mid-span, bottom of two studs near each quarter-points of beam span (6 subtotal)

   iv. Concrete – top and middle of thickness above deck, at mid-span of beam; at top and middle thickness above deck at deck mid-span locations (6 subtotal)

c. Restraint – load cells at top, middle and bottom of beam on one end (3 subtotal)

2. Thermocouples for assembly (in addition to furnace control thermocouples) (48 total):

   a. Beam – top and bottom flanges, and mid-web at mid-span and at each quarter-points of span

   b. Deck – same as for strain gauge locations

   c. Concrete – same as for strain gauge locations

The instrumentation for the reinforced concrete floor assembly will consist of:

1. Structural Instrumentation: (see Figures 25, 26)

   a. Deflections – transducer at mid-span of steel beam, at center of each side of slab's mid-span (3 total)

   b. Strain gauges – (27 total)

      i. Steel beam – middle of top and bottom flanges, and center of web – at both beam ends and at mid-span (9 subtotal)

      ii. Shear studs – bottom of two studs near beam mid-span, bottom of two studs near each quarter-points of beam span (6 subtotal)

      iii. Concrete – at top, middle and bottom of slab thickness, at mid-span of beam; and at the two slab mid-span locations for deflections (9 subtotal)

      iv. Steel reinforcing bars – over beam mid-span and at center of each side of slab's mid-span (3 subtotal)

v. Restraint – load cells at top, middle and bottom of beam on one end (3 total)

2. Thermocouples for assembly (in addition to furnace control thermocouples) (48 total):

   a. Beam – top and bottom flanges, and mid-web at mid-span and at each quarter-points of span

   b. Concrete slab – same as for strain gauge locations

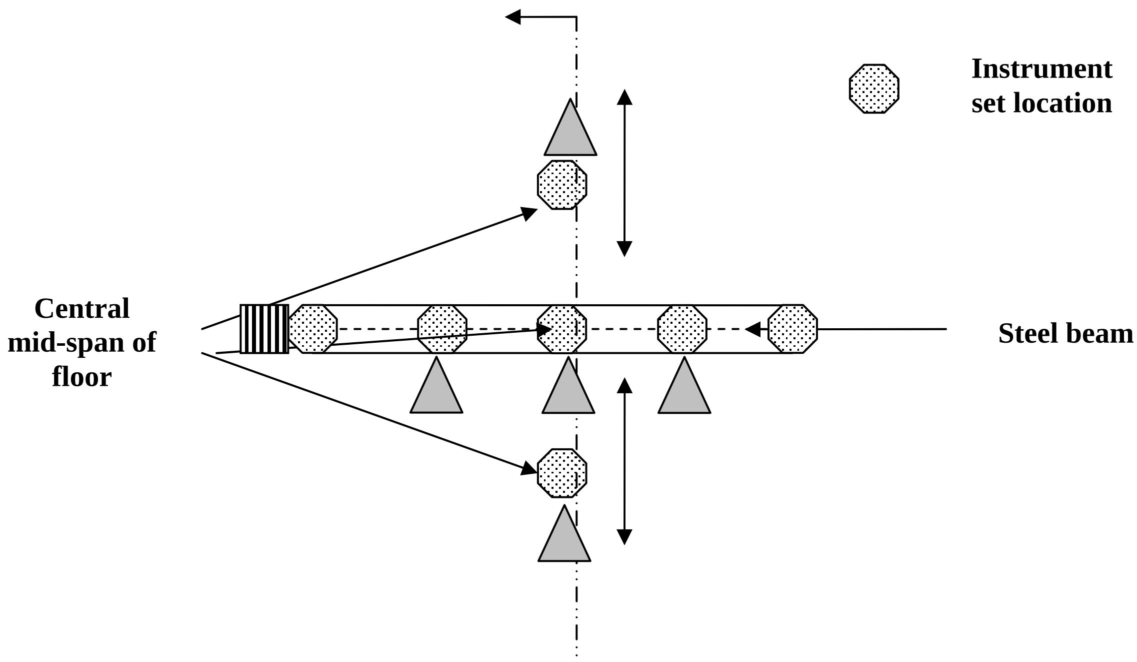



Figure 25. Schematic plan view of instrumentation set locations for deflections, strain gauges and thermocouples of floor assembly.



Section

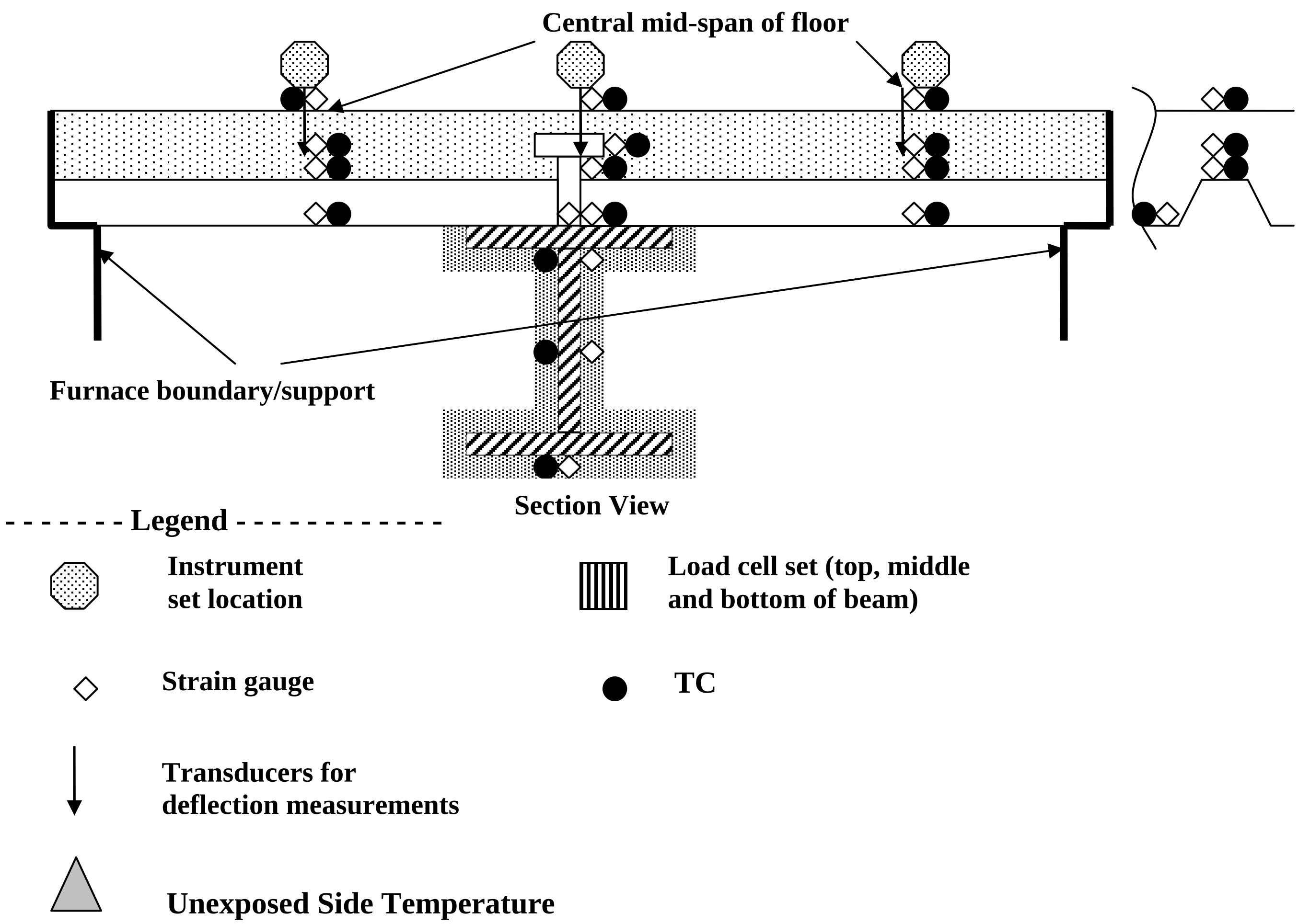



Figure 26. Schematic section view of instrumentation set locations for deflections, strain gauges, and thermocouples of floor assembly.

Cost Estimates

At this point in time, it is not possible to provide a precise cost per test due to many factors such as costs for materials, instrumentation, lab capabilities to meet requirements, etc. However, based on HAI's experience with these types of tests, and assuming, the laboratory has the capability to meet the test requirements, it is estimated that approximate test costs are:

- Furnace calibration tests – 2 @ $20,000 per test
- Wall assembly tests – 6 @ $25,000 per test
- Floor assembly tests – 4 @ $50,000 per test

## 9.0 SUMMARY

Based upon this investigation it is indeed possible for fire resistance testing to provide critical data for use in performance-based structural fire engineering. The needs of PBSFE differ from the prescriptive design approach. This investigation has identified seventeen specific test method recommendations relating to thermal aspects of fire resistance testing, including instrumentation and operation of the furnace. In addition thirteen specific test method recommendations relating to the structural aspects, including structural instrumentation and operation of the furnace. In addition, recommendations for documentation of test procedures and results were provided. A number of general research areas that would serve the development of PBSFE were identified. Collectively, the recommendations and research areas identified provide a way forward to the achievement of PBSFE.

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**THE PORT AUTHORITY** OF NY & NJ

*Francis J. Lombardi, P.E.*
*Chief Engineer*

September 15, 2008

Dr. Shyam Sunder
Director and Lead Investigator
Building and Fire Research Laboratory
National Institute of Standards and Technology
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Gaithersburg, MD 20899-1000

**SUBJECT: DRAFT OF THE FINAL REPORT ON THE COLLAPSE OF WORLD TRADE CENTER BUILDING 7**

Dear Dr. Sunder:

I would like to compliment you and your staff for the tremendous effort in preparing the draft report that was released on August 21, 2008.

From the Port Authority's perspective, two statements in the second paragraph on page xxxiii in the report NCSTAR 1A require some clarification.

- *"The installed thickness of the thermal insulation on the floor beams was below that required for unsprinklered or sprinklered buildings..."*
  The design documents submitted by Silverstein Properties, Inc., and approved by the Port Authority, clearly specified a fire rating of two hours for the beams, as required by the code. Other places in the NIST report recognized this fact that the installed thickness of the thermal insulation on the floor beams was at or above that required. It is also important to note in the report that as per the Building Code of the City of New York, the installed fireproofing was subject to "controlled inspection" and the Architect/Engineer of Record was responsible for the verification of the thickness for code compliance of the fireproofing as installed.

- *"The stairwells were narrower than those required by the NYCBC..."*
  This statement regarding the stairs is based on NIST's own calculation of the net floor area of 34,800 sq. ft. and a corresponding occupant load of 348 (NCSTAR 1-9, page 309). Net floor area for determining the occupant load is defined in NYCBC to be the horizontal occupiable area, excluding the thickness of walls and partitions, columns, furred-in spaces, fixed cabinets, equipment, and accessory spaces such as closets, machine and equipment rooms, toilets, stairs, halls, corridors, elevators, and similar unoccupied spaces. NIST's calculation excluded only the core area, and therefore overstates the net floor area and the corresponding occupant load. Although the net floor area was not specifically indicated on the submitted

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design documents, after deducting all the unoccupied spaces, the Architect of Record would have, in all probability, calculated the net area and occupant load properly, in reaching his conclusion that the two 56 to 58 inch-wide stairs in the building were adequate.

It is my hope that NIST will include these clarifications in its final report. I would also suggest removing the qualifying word "*generally*" from the first sentence in the second paragraph on page xxxiii in the report NCSTAR 1A, in order for these statements to be understood in the proper context.

Additionally, the Port Authority does not have its "own building code"; however it has been the Port Authority's longstanding policy to comply with building codes of the local jurisdictions. The statement, "*...and to construct under its own building code.*" in NCSTAR 1A, Page 1, 1st paragraph, is not accurate and should be corrected accordingly.

I offer the following additional comments for consideration in finalizing the report:

- Refer to NCSTAR 1A, Page xxxii, 1st paragraph, last sentence, "*However, the collapse of WTC 7 highlights the importance of designing fire-resistant structures where sprinklers are not present...*" Although the collapse of WTC 7 is a direct result of extraordinary events – the attacks of 9/11 – it is important to note that all occupants safely evacuated the building and the structure continued to burn unattended by the Fire Department for more than 7 hours.

- Similarly, NIST does not take into account the likely damage to the sprinkler system from debris, in addition to the loss of the water source. NIST also appears to suggest that using the NYC water mains as the only water source was problematic. In all but the most unusual of circumstances, such as 9/11, the water mains are the best and most reliable source of water.

- The report's conclusions do not take into account the debris damage to the building's exterior, including the loss of columns in the southwest corner and damage to the south side. There are eyewitness accounts and photographs which show that debris caused extensive damage to the building's exterior.

- Finally, the recommendations, as drafted, suggest specific relevance to WTC 7 when, in fact, the recommendations relate to and should be followed for all tall buildings.

Sincerely,

for Francis J. Lombardi, P.E.
Chief Engineer

## Stephen Cauffman

**From:** wtc@nist.gov
**Sent:** Tuesday, September 09, 2008 2:55 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Submittal of Comments - NIST WTC7 report
**Attachments:** Submittal of Comments.doc

>X-Sieve: CMU Sieve 2.3
>X-ME-UUID: 20080903074132172.0430B7000092@mwinf2e24.orange.fr
>From: Anders Björkman <anders.bjorkman@wanadoo.fr>
>To: <wtc@nist.gov>
>Subject: Submittal of Comments - NIST WTC7 report
>Date: Wed, 3 Sep 2008 09:41:15 +0200
>X-Mailer: Microsoft Outlook Express 6.00.2900.3138
>X-Proofpoint-Virus-Version: vendor=fsecure
>engine=1.12.7160:2.4.4,1.2.40,4.0.166
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>X-PP-SpamDetails: rule=spampolicy1_notspam
>policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0
>bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx
>engine=5.0.0-0805090000 definitions=main-0809030004
>X-PP-SpamScore: 0
>X-NIST-MailScanner: Found to be clean
>X-NIST-MailScanner-From: anders.bjorkman@wanadoo.fr
>X-NIST-MailScanner-Information:
>
>Dear Madame/Sir,
>
>pls find attached and below comments re subject.
>Hopefully you find the comments of interest that will enable you to
>improve the draft report.
>Please acknowledge receipt and I.D. number and
>person(s) handling the comments, if that is part of your procedures.
>
>Kind regards
>
>Anders Björkman
>
>
>Submittal of Comments - NIST WTC7 report
>
>
>
>Name: Anders Björkman, 6 rue Victor Hugo, F 06240 France
>Affiliation: President, Heiwa Co, European Agency for Safety at Sea
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>Reference number: 2008/9/001
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>Date: 9/3/2008
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>
>Report Number: NIST NCSTAR 1-9 Volume 2 Page Number: 455-536

>Paragraph/Sentence: Chapter 11 - 11.2 ANSYS Model, 11.3 Analysis
>results
>
>
>
>Comment No. 1: In structural damage analysis - as opposite to
>structural design analysis - it is not load paths of the intact
>structure that is of interest, but the path of failures from the first
>small local failure due to a known cause (e.g. fire/heat/thermal
>expansion) to the end of destruction including all structural failures
>in between as a consequence of the first, small failure. Such a damage
>analysis shall identify the critical failure in the path, i.e. could
>that critical failure be avoided; the destruction would have been
>arrested there. Most local failures in steel structures luckily do not
>progress to create a critical failure that causes the complete
>structure to globally collapse. The destruction is generally arrested
>long before that.
>
>
>
>The NIST WTC7 draft report unfortunately fails to do this proper
>structural damage analysis:
>
>
>
>It is not clear in what order the various local structural failures
>take place in the ANSYS model, what elements/nodes are affected,
>details of failure, cause of failure and consequence of failure
>(serious or can it be ignored?) and how the boundary conditions (loads
>on columns at floor 16) are affected.
>
>
>
>Reason for Comment: The ANSYS model, only 16 floors high in lieu of 47,
>consists of primary (vertical steel columns connected to ground),
>secondary (horizontal and sloping steel beams connected to primary
>parts) and tertiary parts (e.g. floor elements and walls connected to
>secondary parts; beams) and associated connections, and it is of vital
>importance to know the order or path of failures. We know that the
>structure at ambient temperature is very low stressed and thus looks
>very safe. Purpose of the exercise is to find the critical, proximate
>failure that caused the collapse.
>
>
>
>Fire/heat/thermal expansion may affect a tertiary member that heats up
>quicker than adjacent secondary members and the local connections may
>fail and the tertiary part is out of action but it hardly affects the
>effectiveness of the secondary parts, which of course is verified when
>the FEA analysis is re-done after each failure. The secondary parts and
>their connections (bolted or welded) to primary parts are much stronger
>than those of tertiary parts and will deflect and deform with the
>primary parts and it is highly unlikely that thermal expansion will
>produce forces that break the much stronger connections between
>secondary and primary parts. It is noted that a critical failure mode
>may be buckling of one primary structure column losing supports by
>secondary structure floor beams.
>

>
>
>Suggestions for Revision: Chapter 11.2 to be expanded with a list of
>all local failures in order of occurrence with details and seriousness
>as outlined above in Comment No. 1. After each failure the condition of
>the model is evidently re-analysed by FEA and the results of each
>element (primary, secondary and tertiary) summarized in Chapter 11.2.
>Doing that we will know when the situation becomes really serious, e.g.
>when/if a primary part starts to get affected. Evidently a global
>collapse is only possible if primary structural parts are affected and
>we are interested in all local failures leading to that critical
>failure; the proximate cause of collapse. The draft report Chapter 11
>is incomplete in this respect.
>
>Example how to improve the report:
>
>1. Tertiary structural elements connected to a floor beam fail due
>heat/thermal expansion.
>These failures/causes are easy to list.
>
>2. Secondary structural elements (beams with or w/o floor elements)
>connected to a column fail.
>These failures and their causes should also be easy to list, but here
>the explanations must be more complete. If, e.g. a beam connection to
>the column becomes disconnected, we must know exactly how and why
>(because you do not expect that to happen).
>
>3. Primary structural elements (e.g. column 79) fail. If cause of
>failure is buckling due to loss of supports of secondary floor beams
>(and not thermal expansion), say so, but explain how many secondary
>structural beams must fail before the critical failure of the primary
>column becomes imminent. This failure to a column evidently affects the
>boundary conditions, so you have to move on the next model to find out
>what really happens outside the model.
>
>Unfortunately you do not know if this failure of a column in the ANSYS
>model is the critical one, as you do not know what happens above floor
>16.
>Evidently a failed column cannot carry any load, so either the load
>carried drops off or is transmitted to other elements, but in either
>case the boundary conditions changes; the loads applied at floor 16 change!
>
>It would be very easy to extend the ANSYS model to 47 floors to solve
>that uncertainty. Then you can see how each failure below floor 16
>affects the load distribution above floor 16. Thus it is suggested that
>the ANSYS model is also extended to floor 47 in your final
>analysis/report.
>
>
>
>
>
>Report Number: NIST NCSTAR 1-9 Volume 2 Page Number: 537-600
>Paragraph/Sentence: Chapter 12
>
>
>Comment No. 2: The LS-DYNA 47 floors model is very big with >3 million
>elements and >3.5 million nodes and the data of a partly damaged ANSYS

>model incl. boundary conditions is copy/pasted into it to represent the
>starting
>(stable?) condition with local damages below floor 16. As shown in
>Comment No. 1 the details of the damaged ANSYS model are not clear and
>it is not certain, if it represents a realistic starting condition.
>Another question is if you can copy/paste data of a locally damaged
>structure into an undamaged one? What about the boundary conditions at
>floor 16? Another question is the reliability of the LS-DYNA software.
>Has it been tested properly? It does not seem to be commercially
>available.
>
>
>Reason for Comment: The LS-DYNA, like the ANSYS model, consists of
>primary (vertical columns connected to ground), secondary (horizontal
>and sloping beams connected to primary parts) and tertiary parts (e.g.
>floor and wall elements connected to secondary parts; beams) and
>associated connections, and it is again of vital importance to know the
>order or path of failures. We know that the structure at ambient
>temperature is very low stressed and thus looks very safe.
>
>
>
>Heat/thermal expansion may at this time have affected tertiary parts
>below floor 16, the local connections of which may have failed and the
>tertiary part is out of action and it has apparently affected the
>effectiveness of the secondary parts, but the situation is not clear
>(as Chapter 11 is incomplete). The secondary parts and their
>connections to primary parts are much stronger than tertiary parts and
>will deform and deflect with the primary parts and it is highly
>unlikely that thermal expansion will produce forces that break the
>connections between secondary and primary parts. However, it is assumed
>here that some secondary and primary parts below floor 16 have actually
>failed (causes to be established) and shifted a column (No 79?) out of
>initial locations affecting the boundary conditions at floor 16, but
>that the structure below floor 16 is still stable.
>
>
>
>It is of vital interest to know how these local failures below floor 16
>immediately affect the virtually undamaged structure above, when (A)
>the analysis starts (how serious are the failures below?) and (B) every
>further failure that follows below and above floor 16 and finally, (C)
>at the end, when all parts are rubble.
>
>
>
>It is evidently possible that when a primary column fails below floor
>16, the load on it is transmitted to adjacent columns via intact
>structure above floor 16, i.e. the boundary conditions must be modified
>in the ANSYS model analysis. Was it done?
>
>
>
>It is not clear how and why the software LS-DYNA can keep track of
>parts that are completely disconnected from the structure due to
>multiple failures.
>
>

>Suggestion for Revision: The method to
>copy/paste details of the ANSYS (Chapter 11) model at end of assumed
>failures below floor 16 produces uncertainties.
>
>
>
>It would be better to start afresh with the LS-DYNA model as completely
>free of failures and then input all the local - serious (?) failures
>- one by one - as identified in the ANSYS model below floor 16 and
>listed in Chapter 11.3 and see what happens everywhere at every
>initial, local failure and then proceed with the further failures, one
>by one, away from the first local non-critical failures, until the
>critical failure and its cause are identified.
>
>
>
>Chapter 12 thus to be expanded with a list of all further local
>failures above and below floor
>16 in order of occurrence with details and seriousness as outlined
>above in Comment No. 1.
>After each failure the condition of the model is evidently re-analysed
>by FEA and the results of each element (primary, secondary and
>tertiary) summarized in Chapter 12.4.
>
>
>
>Doing that we will know when the situation becomes really serious, e.g.
>when/if other primary parts (than column no. 79) start to get affected
>and why and what the real, proximate failure of total collapse is - the
>critical failure - and when it occurs in the failure path. Looking at
>the ANSYS model data only, it seems that column 79 could collapse
>completely due to a known cause (buckling), but that it would be the
>end of the local (serious) destruction. The other columns should not be
>affected!
>
>
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>But apparently the failure of column 79 causes further failures of
>other primary parts and it needs to be explained - the failure path is
>to be extended. So Chapter 12 must be expanded with details of further
>failures leading to the final, critical one - the proximate failure
>initiating the global collapse. Would that proximate failure have been
>avoided for any reason, the destruction would have stopped then and
>there.
>
>Example:
>
>4. It is found that primary structural element column no. 79 fails due
>to buckling.
>
>5. It is further found that this failure (4.) causes identical,
>mechanical failures to secondary structure (beams) that
>
>6. in turn causes damages to adjacent primary structural columns that
>fail that
>
>7. in turn causes further failures to secondary structure (beams) that
>

>8. in turn causes damages to adjacent primary structural columns that
>fail, etc.
>
>
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>The critical failure or failures and its cause (buckling of column no.
>79 - failure no. 4 - and unknown effects of the beam(s)) are thus those
>no. 5 above, as then the global collapse starts.
>Would that or those failures have been avoided (by clever design?) the
>global collapse would not have taken place.
>
>
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>Evidently the failures continue, after the critical one has been
>reached, until total destruction, which of course is of less
>importance. But it is very good, that you do the analysis to the end;
>then also details of elements/parts getting completely detached from
>the structure can be identified (and later be compared with what was
>found in the rubble) in the report and how these loose parts are
>assumed to load, slip off or jam the structure after being detached.
>
>
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>Evidently a global collapse is only possible if all primary parts of
>the structure are affected but we are interested in all local failures
>leading to the first critical failure that causes/initiates the
>collapse, e.g. no. 5 in the example above. The draft report is
>incomplete in this respect and should be expanded.
>
>
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>I am personally quite surprised that the small local failures down
>below around a few columns are not arrested, when running out energy to
>produce further failures up top. Just because one or two column fails
>due to local failures, should not cause other, complete intact columns
>to fail far away.
>
>
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>Actually, if the LS-DYNA software can produce what is suggested, it
>should be able to simulate all the structural conditions from (A) the
>completely intact, prior fire, cold condition,
>(B) all the part damaged conditions due local failures with still
>intact structure left including (C) the critical failure condition,
>when further destruction starts by gravity alone, and not least, (D)
>the end condition, when all structural parts or sub-assemblies are
>disconnected in the rubble at equilibrium on the ground.
>
>
>
>There are (D) huge blocks of structure in the rubble with broken
>primary parts (columns). The LS-DYNA software apparently can simulate
>how these big blocks bounded by failed elements came about, e.g. how
>the primary columns were sheared off away from bolted and welded
>connections, and ended up as seen on many photos. It is also a good
>test to verify the reliability of the LS-DYNA software, details of
>which are completely unknown to me. (Only reference to LS-DYNA is a
>user's manual of little value).

>
>
>
>If the LS-DYNA software is as good as suggested, it can be used in
>analysing structural damages in ship collisions and thus improve safety
>at sea (my principal interest).
>
>
>
>Summary of Submittal of Comments
>
>
>
>By using two complete (47 floors) models (ANSYS and LS-DYNA) to
>simulate the failures' path(s) leading to the critical failure
>initiating collapse, the reliability of the final result will improve.
>
>All failures in the path(s) should be described, particularly when
>secondary and primary structural elements start to fail and the status
>(stress or FoS levels) of the structure after each failure.
>
>The critical failure, e.g. the failure of a secondary structural
>element - a beam, that initiates the global collapse, must be described
>in detail and how it can affect undamaged remote structure, i.e. other
>primary columns, by e.g.
>load transfers as calculated by the software.
>
>As load transfers are only possible via secondary structure and
>connections, you wonder why not only those secondary parts fail,
>leaving the intact primary structure unloaded and unaffected (as they
>are also connected/supported by other beams that do not fail), i.e. the
>report must clearly explain why WTC7 collapsed like a house of cards
>that has never happened before.
>
>
>
>End
>
>

**Submittal of Comments - NIST WTC7 report**

Name: Anders Björkman, 6 rue Victor Hugo, F 06240 France
Affiliation: President, Heiwa Co, European Agency for Safety at Sea (address as above)
Contact: +336 61725424, **anders.bjorkman@wanadoo.fr**
Reference number: 2008/9/001
Date: 9/3/2008

Report Number: NIST NCSTAR 1-9 Volume 2
Page Number: 455-536
Paragraph/Sentence: **Chapter 11 - 11.2 ANSYS Model, 11.3 Analysis results**

**Comment No. 1**: In structural *damage* analysis - as opposite to structural *design* analysis - it is not load paths of the intact structure that is of interest, but the *path* of failures from the first small local failure due to a known cause (e.g. fire/heat/thermal expansion) to the end of destruction including *all* structural failures in between as a consequence of the first, small failure. Such a *damage* analysis shall identify the *critical* failure in the path, i.e. could that *critical* failure be avoided; *the destruction would have been arrested there*. Most local failures in steel structures luckily do not progress to create a critical failure that causes the complete structure to globally collapse. The destruction is generally arrested long before that.

The NIST WTC7 draft report unfortunately fails to do this proper structural *damage* analysis:

It is not clear in what order the various local structural failures take place in the ANSYS model, what elements/nodes are affected, details of failure, cause of failure and consequence of failure (serious or can it be ignored?) and how the boundary conditions (loads on columns at floor 16) are affected.

**Reason for Comment**: The ANSYS model, only 16 floors high in lieu of 47, consists of primary (vertical steel columns connected to ground), secondary (horizontal and sloping steel beams connected to primary parts) and tertiary parts (e.g. floor elements and walls connected to secondary parts; beams) and associated connections, and it is of vital importance to know the order or path of failures. We know that the structure at ambient temperature is very low stressed and thus looks very safe. Purpose of the exercise is to find the critical, proximate failure that caused the collapse.

Fire/heat/thermal expansion may affect a tertiary member that heats up quicker than adjacent secondary members and the local connections may fail and the tertiary part is out of action but it hardly affects the effectiveness of the secondary parts, which of course is verified when the FEA analysis is re-done after each failure. The secondary parts and their connections (bolted or welded) to primary parts are much stronger than those of tertiary parts and will deflect and deform with the primary parts and it is highly unlikely that thermal expansion will produce forces that break the much stronger connections between secondary and primary parts. It is noted that a critical failure mode may be buckling of one primary structure column losing supports by secondary structure floor beams.

**Suggestions for Revision**: Chapter 11.2 to be expanded with a list of all local failures in order of occurrence with details and seriousness as outlined above in Comment No. 1. After each failure the condition of the model is evidently re-analysed by FEA and the results of each element (primary, secondary and tertiary) summarized in Chapter 11.2. Doing that we will know when the situation becomes really serious, e.g. when/if a primary part starts to get affected. Evidently a global collapse is only possible if primary structural parts are affected and we are interested in all local failures leading to that critical failure; the proximate cause of collapse. The draft report Chapter 11 is incomplete in this respect.
Example how to improve the report:
1. ***Tertiary structural elements** connected to a floor beam fail due heat/thermal expansion.* These failures/causes are easy to list.
2. ***Secondary structural elements** (beams with or w/o floor elements) connected to a column fail.* These failures and their causes should also be easy to list, but here the explanations must be more complete. If, e.g. a beam connection to the column becomes disconnected, we must know exactly how and why (because you do not expect that to happen).
3. ***Primary structural elements** (e.g. column 79) fail.* If cause of failure is buckling due to loss of supports of secondary floor beams (and not thermal expansion), say so, but explain how many secondary structural beams must fail before the critical failure of the primary column becomes imminent. This failure to a column evidently

affects the boundary conditions, so you have to move on the next model to find out what really happens outside the model.
Unfortunately you do not know if this failure of a column in the ANSYS model is the *critical* one, as you do not know what happens above floor 16. Evidently a failed column cannot carry any load, so either the load carried drops off or is transmitted to other elements, but in either case the boundary conditions changes; the loads applied at floor 16 change!
It would be very easy to extend the ANSYS model to 47 floors to solve that uncertainty. Then you can see how each failure below floor 16 affects the load distribution above floor 16. **Thus it is suggested that the ANSYS model is also extended to floor 47 in your final analysis/report.**

Report Number: NIST NCSTAR 1-9 Volume 2
Page Number: 537-600
Paragraph/Sentence: **Chapter 12**

**Comment No. 2:** The LS-DYNA 47 floors model is very big with >3 million elements and >3.5 million nodes and the data of a partly damaged ANSYS model incl. boundary conditions is copy/pasted into it to represent the starting (stable?) condition with local damages below floor 16. As shown in Comment No. 1 the details of the damaged ANSYS model are not clear and it is not certain, if it represents a realistic starting condition. Another question is if you can copy/paste data of a locally damaged structure into an undamaged one? What about the boundary conditions at floor 16? Another question is the reliability of the LS-DYNA software. Has it been tested properly? It does not seem to be commercially available.

**Reason for Comment:** The LS-DYNA, like the ANSYS model, consists of primary (vertical columns connected to ground), secondary (horizontal and sloping beams connected to primary parts) and tertiary parts (e.g. floor and wall elements connected to secondary parts; beams) and associated connections, and it is again of vital importance to know the order or path of failures. We know that the structure at ambient temperature is very low stressed and thus looks very safe.

Heat/thermal expansion may at this time have affected tertiary parts below floor 16, the local connections of which may have failed and the tertiary part is out of action and it has apparently affected the effectiveness of the secondary parts, but the situation is not clear (as Chapter 11 is incomplete). The secondary parts and their connections to primary parts are much stronger than tertiary parts and will deform and deflect with the primary parts and it is highly unlikely that thermal expansion will produce forces that break the connections between secondary and primary parts. However, it is assumed here that some secondary and primary parts below floor 16 have actually failed (causes to be established) and shifted a column (No 79?) out of initial locations affecting the boundary conditions at floor 16, but that the structure below floor 16 is still stable.

It is of vital interest to know how these local failures below floor 16 immediately affect the virtually undamaged structure above, when (A) the analysis starts (how serious are the failures below?) and (B) every further failure that follows below and above floor 16 and finally, (C) at the end, when all parts are rubble.

It is evidently possible that when a primary column fails below floor 16, the load on it is transmitted to adjacent columns via intact structure *above* floor 16, i.e. the boundary conditions must be modified in the ANSYS model analysis. Was it done?

It is not clear how and why the software LS-DYNA can keep track of parts that are completely disconnected from the structure due to multiple failures.

**Suggestion for Revision:** The method to copy/paste details of the ANSYS (Chapter 11) model at end of assumed failures below floor 16 produces uncertainties.

It would be better to start afresh with the LS-DYNA model as completely free of failures and then input all the local - serious (?) failures - one by one - as identified in the ANSYS model below floor 16 and listed in Chapter 11.3 and see what happens everywhere at every initial, local failure and then proceed with the further failures, one by one, away from the first local non-critical failures, until the critical failure and its cause are identified.

Chapter 12 thus to be expanded with a list of all further local failures above and below floor 16 in order of occurrence with details and seriousness as outlined above in Comment No. 1. After each failure the condition of the model is evidently re-analysed by FEA and the results of each element (primary, secondary and tertiary) summarized in Chapter 12.4.

Doing that we will know when the situation becomes really serious, e.g. when/if other primary parts (than column no. 79) start to get affected and why and what the real, proximate failure of total collapse is - the *critical* failure - and when it occurs in the failure path. Looking at the ANSYS model data only, it seems that column 79 could collapse completely due to a known cause (buckling), but that it would be the end of the local (serious) destruction. The other columns should not be affected!

But apparently the failure of column 79 causes further failures of other primary parts and it needs to be explained - the failure path is to be extended. So Chapter 12 must be expanded with details of further failures leading to the final, critical one - the proximate failure initiating the global collapse. Would that proximate failure have been avoided for any reason, the destruction would have stopped then and there.
Example:
**4.** It is found that ***primary structural element column no. 79 fails*** due to buckling.
**5.** It is further found that this failure (4.) causes identical, mechanical failures to **secondary structure** (beams) that
**6.** in turn causes damages to **adjacent primary structural columns** that fail that
**7.** in turn causes further failures to secondary structure (beams) that
**8.** in turn causes damages to **adjacent primary structural columns** that fail, etc.

The *critical* failure or failures and its cause (buckling of column no. 79 - failure no. 4 - and unknown effects of the beam(s)) are thus those no. **5** above, as then the global collapse starts. Would that or those failures have been avoided (by clever design?) the global collapse would not have taken place.

Evidently the failures continue, after the *critical* one has been reached, until total destruction, which of course is of less importance. But it is very good, that you do the analysis to the end; then also details of elements/parts getting completely detached from the structure can be identified (and later be compared with what was found in the rubble) in the report and how these loose parts are assumed to load, slip off or jam the structure after being detached.

Evidently a global collapse is only possible if *all* primary parts of the structure are affected but we are interested in the local failures leading to the first *critical* failure that causes/initiates the collapse, e.g. no. 5 in the example above. The draft report is incomplete in this respect and should be expanded.

I am personally quite surprised that the small local failures down below around a few columns are not arrested, when running out energy to produce further failures up top. Just because one or two column fails due to local failures, should not cause other, complete intact columns to fail far away.

Actually, if the LS-DYNA software can produce what is suggested, it should be able to simulate all the structural conditions from (A) the completely intact, prior fire, cold condition, (B) all the part damaged conditions due local failures with still intact structure left including (C) the *critical* failure condition, when further destruction starts by gravity alone, and not least, (D) the end condition, when all structural parts or sub-assemblies are disconnected in the rubble at equilibrium on the ground.

There are (D) huge blocks of structure in the rubble with broken primary parts (columns). The LS-DYNA software apparently can simulate how these big blocks bounded by failed elements came about, e.g. how the primary columns were sheared off away from bolted and welded connections, and ended up as seen on many photos. It is also a good test to verify the reliability of the LS-DYNA software, details of which are completely unknown to me. (Only reference to LS-DYNA is a user's manual of little value).

If the LS-DYNA software is as good as suggested, it can be used in analysing structural damages in ship collisions and thus improve safety at sea (my principal interest).

**Summary of Submittal of Comments**

By using two complete (47 floors) models (ANSYS and LS-DYNA) to simulate the *failures' path(s)* leading to the critical failure initiating collapse, the reliability of the final result will improve.
All failures in the path(s) should be described, particularly when secondary and primary structural elements start to fail and the status (stress or FoS levels) of the structure after each failure.

The *critical* failure, e.g. the failure of a secondary structural element - a beam, that initiates the global collapse, must be described in detail and how it can affect undamaged remote structure, i.e. other primary columns, by e.g. load transfers as calculated by the software.
As load transfers are only possible via secondary structure and connections, you wonder why not only those secondary parts fail, leaving the intact primary structure unloaded and unaffected (as they are also connected/supported by other beams that do not fail), i.e. the report must clearly explain why WTC7 collapsed like a house of cards that has never happened before.

End

## Stephen Cauffman

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 10:06 AM
**To:** Stephen Cauffman
**Subject:** Fwd: Comments on the WTC 7 Draft Reports

>X-Sieve: CMU Sieve 2.3
>X-Originating-IP: [98.202.49.82]
>X-Originating-Email: [nsa.mil@9ox.net]
>X-Sender: nsa.mil@9ox.net
>From: nsa.mil@9ox.net
>To: wtc@nist.gov
>Subject: Comments on the WTC 7 Draft Reports
>Date: Sat, 23 Aug 2008 09:23:54 -0600
>X-Mailer: Microsoft Outlook Express 6.00.2900.5512
>X-OriginalArrivalTime: 23 Aug 2008 15:23:55.0460 (UTC)
>FILETIME=[41A5E840:01C90534]
>X-Spamgourmet:
>X-Proofpoint-Virus-Version: vendor=fsecure
>engine=1.12.7160:2.4.4,1.2.40,4.0.166
>definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
>X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0
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>definitions=main-0808230067
>X-PP-SpamScore: 0
>X-NIST-MailScanner: Found to be clean
>X-NIST-MailScanner-From: nsa.mil@9ox.net
>X-NIST-MailScanner-Information:
>
>Name: Andrew Ostler
>
>Affiliation: Not Applicable
>
>Contact: nsa.mil@9ox.net
>
>Report Number: NCSTAR 1 to 1-8, all inclusive
>
>Page Number: All pages reviewed
>
>Paragraph/Sentence: All paragraphs reviewed
>
>Comment: See below
>
>Reason for Comment: Apparent omission of key facts
>
>Suggestion for Revision: A sound explanation for high temperatures
>
>
>My comments are very simple - all educated Americans are likely to
>understand them;
>
>
>1) Five days after 9/11, why did NASA measure high surface temperatures
>exceeding 1300 degrees Fahrenheit at the three sites where World Trade

>Center buildings collapsed?
>
>
>2) Why did NIST fail to even mention once, in it's thousands of pages
>of investigation, these publicly available facts from the United States
>Geological Survey and the National Aeronautics and Space
>Administration?
>
>
>This data was released to emergency response teams on the 18th of
>September, 2001, and is publicly available at:
>http://pubs.usgs.gov/of/2001/ofr-01-0429/thermal.r09.html
>
>
>Reviewing every single NIST World Trade Center publication, including
>the 2635 pages of the most recent drafts, which give the appearance
>that the investigation was extensive and thorough, I have not found
>even a single mention of this data. The impression is that these facts
>were willfully ignored.

From: andrew macdougal <andymac9674@yahoo.com>
Subject: wtc 7
To: wtc@nist.gov

dear sirs-
i apologize that this wtc 7 "hot potato" was carelessly tossed to you all. no surprise to me that it took 3 years for this investigation to run it's course. i know that in the future you all at the NIST will be bombarded with criticism over the investigation but please know that at least one of us out here "from the wilderness" don't have any ill feelings towards any of you at the NIST tasked with this impossible mission/investigation. surely all the "911 truth" doubters that were a part of this investigation now know what many million americans already knew...the buildings were destroyed by a carefully designed yet unconventional controlled demolition. No other explanation for the unusually high temperatures at all 3 sites of collapse other than an alumino-thermic reaction. too bad you all were forced to sacrifice your credibility...though, i truly understand...it's a lot easier than giving up your retirement/careers. again, my condolences. it's bull shit that this whole thing happened in the first place and it's especially terrible that you all were tasked with trying to fabricate a(nother) government investigation into the most flawed part of the 911 lie: the improbable and strange free fall speed collapse of WTC 7.

the path to peace runs through 911 truth
sincerely-
andy macdougal
essex, ny

ps: was wtc 7 supposed to be pulled at the same time as the north tower? did something go wrong with the demolition sequence? THAT should be your next investigation!

From: Acaj1@aol.com
Subject: Questions on building 7 report.
To: wtc@nist.gov

Mr. Sunder,

Questions on Building 7 report.

1. What length of various size and weight "I" beam and girder is considered long span?

2. Normally beams don't detach from the columns or girders from expansion effects. What exactly was the mechanism of detachment?

3. Many engineers think that expansion effects will not detach the long span beams and they say contraction of the expanded sagging beam after the fire burns out will detach the beams. Could you explain why you left this out?

4. You did not mention thermal bowing which occurs because the lower flange of the beam expands faster than the top. What exactly does thermal bowing cause? Pull-in forces? Torque forces? Buckling of beams?

5. Will the computer model that you used be available to Architects and Engineers to check their present buildings and design new ones.

Arthur Scheuerman
Ret. Battalion Chief, FDNY

---

From: "Brad Ream" <bream@centerville.k12.in.us>
To: <wtc@nist.gov>
Subject: WTC 7 Comment and Question

How did NIST explain the piece of evidence found in the WTC 7 rubble as described below? The New York Times described this evidence as the "greatest mystery of all".

I would like to know if NIST determined what caused this piece of structural steel to melt in a normal office fire, an office fire that would not even begin to reach the required temperatures to melt steel?

I will be sharing your response with my students.

**Source: Journal of Materials**

# An Initial Microstructural Analysis of A36 Steel from WTC Building 7

**J.R. Barnett, R.R. Biederman, and R.D. Sisson, Jr.**

A section of an A36 wide flange beam retrieved from the collapsed World Trade Center Building 7 was examined to determine changes in the steel microstructure as a result of the terrorist attack on September 11, 2001. This building was not one of the original buildings attacked but it indirectly suffered severe damage and eventually collapsed. While the exact location of this beam could not be determined, the unexpected erosion of the steel found in this beam warranted a study of microstructural changes that occurred in this steel. Examination of other sections in this beam is underway.

## ANALYSIS

Rapid deterioration of the steel was a result of heating with oxidation in combination with intergranular melting due to the presence of sulfur. The formation of the eutectic mixture of iron oxide and iron sulfide lowers the temperature at which liquid can form in this steel. This strongly suggests that the temperatures in this region of the steel beam approached ~1,000°C, forming the eutectic liquid by a process similar to making a "blacksmith's weld" in a hand forge.

Mr. Brad Ream M. Ed.
Centerville Senior High School
Social Studies Department-World Geography
Varsity Football: Defensive Coordinator
Phone-765-855-5768-Ext:2009
Email: bream@centerville.k12.in.us

## Stephen Cauffman

**From:** wtc@nist.gov
**Sent:** Tuesday, September 09, 2008 2:54 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Comments on WTC 7 failure analysis report


>X-Sieve: CMU Sieve 2.3
>DomainKey-Signature: a=rsa-sha1; q=dns; c=nofws;
> s=s1024; d=yahoo.com;
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>h=X-YMail-OSG:Received:X-Mailer:Date:From:Reply-To:Subject:To:MIME-Vers
>ion:Content-Type:Message-ID;
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>JjN6Gl_yY-
>X-Mailer: YahooMailWebService/0.7.218.2
>Date: Sun, 31 Aug 2008 08:55:10 -0700 (PDT)
>From: Brandon Johnson <bj_ninetysix@yahoo.com>
>Reply-To: bj_ninetysix@yahoo.com
>Subject: Comments on WTC 7 failure analysis report
>To: wtc@nist.gov
>X-Proofpoint-Virus-Version: vendor=fsecure
>engine=1.12.7160:2.4.4,1.2.40,4.0.166
>definitions=2008-08-30_01:2008-08-28,2008-08-29,2008-08-30 signatures=0
>X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0
>spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0
>classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000
>definitions=main-0808310048
>X-PP-SpamScore: 0
>X-NIST-MailScanner: Found to be clean
>X-NIST-MailScanner-From: bj_ninetysix@yahoo.com
>X-NIST-MailScanner-Information:
>


>I am submitting comments on your final report on WTC 7 collapse NCSTAR
>1A. It pertains to your conclusions, not specific grammatical and
>calculation errors(although there are many of them).
>First of all, the idea that thermal expansion is the cause of failure
>is ridiculous. As an American tax payer, I am appalled that after the
>time and money you have wasted, the best you could come up with for the
>failure of WTC 7 is "thermal expansion". I am sure you are aware of
>the Cardington University experiment in which a steel framed building
>with out fire proofing was subjected to blazing inferno(which there is
>no video evidence for such a fire in WTC 7). There were no failures in
>this experiment, only some minor buckling.
>Next, you admit to not recovering any steel for testing but still able
>to rule out explosives. I would like to point you to video evidence of
>explosions which you claim did not occur and which I know you will not
>watch. Please see:
>http://www.youtube.com/watch?v=0YvrKfWkxdw and
>http://www.youtube.com/watch?v=z9CXQY-bZn4 "Keep your eye on that

>building, it'll be coming down soon."
>Finally, your previous analysis of seismic data is the most laughable.
>Specifically how even after manipulating times for collapses and
>retention times, the seismogram still shows an energy event before any
>visible signs of collapse that is equal to or greater than that of the
>entire buildings collapse. It is ridiculous to explain this away as
>the failure of a single column or some other light debris moving.
>History has proven that explosives are better and exciting the
>platelets that building collapses and is the only logical explanation
>for the massive energy picked up by seismographs. See this analysis for
>more information on why your conclusions are not only a guess but a
>very misleading and completely wrong guess:
>http://www.studyof911.com/forum/index.php?s=17448f307fe935d0cadb1a02e78
>26e24&showtopic=286&st=0&p=707&#entry707
>In addition, there are many letters questioning your conclusions
>here: http://journalof911studies.com/letters.html
>
>Thanks for taking the time to read my comments(even though I seriously
>doubt you will).
>
>
>
>

To: wtc@nist.gov
From: Bruce Stahlberg <arturo@bitstream.net>
Subject: Question regarding World Trade Center #7 report

Dear NIST,

In reading your report regarding the collapse of World Trade Center #7, I did not see anything about the likelihood that fires were the main reason for the collapse. The reason I ask this is that since fire has never brought down a building in this manner before and it is indeed a rare event, what is the probability that we have found the most likely reason? Is there a level of confidence that can be stated as a percentage?

It would seem that this is an important aspect of any hypothesis to be able to say with a high level of confidence that we have found the reason for an event to have happened, in this case the complete collapse of a 47 story building.

Thanks and look forward to an answer to this inquiry.

Bruce Stahlberg
3008 41st Avenue South
Minneapolis, MN 55406

From: Benjamin Stein <bstein@nist.gov>
To: Stephen Cauffman <cauffman@nist.gov ...snip... wtc@nist.gov" <wtc@nist.gov>
Subject: FW: World Trade Centre No 7 Request for more information

Dear Steve and Shyam,
I received this note from a professor in New Zealand; I will make sure that he sees the additional volumes besides 1A.
Ben

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From: Charles Clifton [c.clifton@auckland.ac.nz]
Sent: Tuesday, August 26, 2008 7:25 PM
To: ben.stein@nist.gov
Cc: Jonathan Barnett
Subject: World Trade Centre No 7 Request for more information

Dear Ben,

I am an Associate Professor in Civil Engineering (equivalent to Professor in the USA academic system) at the University of Auckland, New Zealand. My areas of special knowledge are in the behaviour and design of steel buildings for severe earthquake and severe fires. I am relatively new to this position, with the knowledge being acquired in my previous 25 years as the Structural Engineer for the New Zealand Heavy Engineering Research Association, HERA.

As the principal person responsible for the implementation of fire engineering in steel structures in New Zealand, I have always had a keen interest in the behaviour of the World Trade Centre buildings 1, 2 and 7 from the attack to the collapse of each building, to see what lessons can be learned and so mitigate against this happening in new steel building construction. There has been a lot of interest in these buildings in New Zealand and I attach a copy of the latest presentation that I gave in 2004 to the New Zealand Institute of Quantity Surveyors in September 2004. This included some postulated details on the collapse of WTC7, which I obtained from the sketchy information available at the time.

I am also involved in development of new fire engineering design guidance methods for New Zealand and in April this year made a presentation on this to the UK Institution of Structural Engineers. A copy of that presentation is attached.

I have quickly reviewed the NISTAR 1A Final Report on the Collapse of World Trade Center Building 7 and compared your recommendations with my postulated details from 2004. The key points are as follows:

1. Both of us give the same initiating key cause of the final collapse as being failure of one of the key internal columns
2. Both identify the column in the same location in plan: the NIST report is much more accurate on which column initiated failure
3. Both identify a similar location in elevation for the failure of the column; once again the NIST report is more accurate
4. However we give different reasons for the failure of this key column. I tentatively put it down to long burning fuel fed fires in the electricity substation fuel storage tanks weakening the column/transfer truss system and therefore taking out support to the column at the lower

levels. You have ruled this out and instead show that loss of column support due to floor beam and girder failure over some 9 levels led to the column buckling failure

5. This indicates potential weaknesses in this type of floor system, however the NIST report does not give anything like enough details on how these floor systems failed. I would like to know a much information as possible on this in order that we can look at New Zealand practice and see if we would have potentially the same problems. In particular I would like to know:

1. details of the floor slab, steel decking, beam and girder construction including any openings in the beams or girders for services that may have contributed to the failure
2. the concrete used in the floor slabs: Normal Weight or Light Weight and what compressive strength
3. details of the slab reinforcement including any support or trimmer reinforcement
4. details of the shear studs used
5. details of the connections between the beams and girders and between the girders and the columns
6. the modes of failure assessed for all of the above that lead to the floor failures including the evidence showing how these conclusions were reached

I appreciate this is asking a lot but as a key developer of fire engineering design procedures for composite floors I want to know any examples of potential weaknesses in them in as much detail as possible. In New Zealand design for expected inelastic response in fire we put considerable emphasis on design and detailing for ductility in the beams, connections and slabs and if WTC 7 had details that would be consistent with our recommendations and which showed poor performance I want to know about them. I also want to revise the WTC presentation from 2004 to be accurate in regard to the failure mode of WTC7.

I also appreciate that you will be inundated with comments and requests for information following the publication of the report, however I hope that my request can be met through sending me some of the detailed documents you have developed that are behind the published report and or through correspondence with an investigator experienced in the structural system response to the fire.

I have copied this to a colleague in the USA, Professor Jonathan Barnett at Worcester Polytechnic, who would be able to confirm my interest in this area and the genuine nature of this request for more information.

Yours sincerely,
Charles Clifton

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[Followup note]
Dear Ben,

In my email requesting more information on the floor system failures in WTC 7 I advised that you could contact a colleague who is a USA expert on fire engineering, Dr Jonathan Barnett, to confirm the genuine nature of my request.

Unfortunately I gave an outdated contact address: he has moved from WPI to a consulting firm, Simpson, Gumpertz and Heger in Waltham, MA. His email address is jbarnett@sgh.com.

Yours sincerely,
Charles

CC IStE presentation 6 slide handout for pdf.pdf

NZIQS Dunedin Branch pdf handouts WTC 170904.pdf

From: Shyam Sunder <sunder@nist.gov>
To: Stephen Cauffman <cauffman ...snip... gov'"
<ben.strin@nist.gov>
Subject: Fw: Info on WTC7

Steve,

This needs to be logged in as a public comment so that the NIST team can include this information in NCSTAR 1-9A as appropriate. After the final report is released if there are any further information needs, this should be treated as a FOIA request. Thanks.

Shyam

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**From:** Charles Clifton
**To:** Jonathon Barnett (jbarnett@sgh.com)
**Cc:** Shyam Sunder; Benjamin Stein
**Sent:** Thu Aug 28 03:58:58 2008
**Subject:** Info on WTC7

Dear Jonathan,

Many thanks for phoning me yesterday and Iâ€™m sorry I missed you. I tried phoning back today same time but I must have got the number written down wrongly as the person who answered told me it was a cell phone number and he didnâ€™t know you or the company Simpson, Gumpertz and Heger.

However I have read through the NCSTAR 1A report in detail and thought the best thing was to email you with request for specific items of information and then follow up from there.

Hopefully these details will clarify the phone message you left me, which makes sense given the details in that NIST report. What I would like to know are the following (I am using the grid numbering in Figure 1-5 of the NIST report which gives the typical WTC7 floor layout) with regard especially to the floor which initiated failure (which I am assuming was floor 13 forming the ceiling to level 13):

1. the report states that girder 79 to 44 did not have shear studs, ie was presumably non composite. Which of girders 26 to 81, 81 to 80, 80 to 79 and 79 to 44 had shear studs
2. what was the type of connection between girder and column at each end for these 4 girders. Are you able to send me drawings or are these in the other NIST reports that I have not yet downloaded
3. were all the beams running north south between grid 1 and girder 76-79 composite
4. were all the beams running east west between girder 79-44 and girders 32-36-40-42 composite
5. what was the type of connection between beam and girder for each of the beam types in questions 3 and 4 above
6. were all the beams and girders mentioned above passive fire protected (I am presuming this was the case) and if so to what FRR and with what material
7. what type of girder was 76-79, 77-80 and 78-81 and what type of connections were used between girders and columns
8. you mentioned in the phone message of shear stud failures in beams due to flexural torsional buckling. In that regard:
    a. what type of concrete was used in the floor slab where these failures occurred, eg normal weight concrete or light weight concrete and what structural strength
    b. what number and spacing of shear studs were in the failed beams or girders
    c. were the failures in only beams or only girders or both
    d. were there examples of shear stud failures where the beams or girders did not undergo flexural torsional buckling
    e. given the collapse of the building how did you establish with physical evidence these shear stud failures

Apologies for requests for so much information, but the NIST report has given me a fairly good understanding of what I think caused the failures. I would like to get the above details to be more certain, however. Two of the recommendations from the report are for systems that exhibit greater robustness and resistance to progressive collapse. These are critical and far more important than the actual level of FRR specified especially to the beams. The Slab Panel Method we have developed (based on a UK model) includes details for robustness and I am planning on putting these into the current revision of the New Zealand Steel Structures Standard NZS 3404. I would like to discuss these with the WTC7 engineers however first want to get the above details so can finalise some of these recommendations.

Kind regards,
Charles

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From: Shyam Sunder <sunder@nist.gov>
To: "wtc@nist.gov" <wtc@nist.gov>
Subject: FW: Comments on the 7 WTC report

**From:** Carter, Charlie [carter@aisc.org]
**Sent:** Thursday, September 11, 2008 6:06 PM
**To:** Shyam Sunder
**Subject:** Comments on the 7 WTC report

**********************************
General Comments:

1. It is easy to say that engineers should design buildings to resist collapse in an "infrequent (worst-case) fire". However, I don't see any definition of what is termed the infrequent (worst-case) fire. Fires already are infrequent events in buildings, and the worst case is impossible to define. No matter what scenario is selected as a design basis, it can be exceeded. Thus, the call to action seems emotional rather than scientific; misleading; and perhaps impossible to attain.

In all aspects of design, engineers can only reduce the probability of failure to an acceptably low level--we cannot eliminate the possibility entirely. In this regard, the prevention of a fire-induced collapse is no different than design for gravity, wind and seismic loads. A design basis is selected to ensure a sufficiently low probability, but failure

can occur if the conditions are such that load exceeds strength.
2. I think it is misleading to say that fire alone caused the collapse of WTC 7. Failures involve the interaction of multiple occurrences that combine to produce the end result. In this case, there is an innovative design, structural damage, fires, the failure of the municipal water supply and the decision to abandon the building and not fight the fires. There may be have been other factors as well.

3. The NIST report actually seems to attempt to minimize the impact of the structural damage, but there is load redistribution due to that damage that has an inevitable impact on the collapse. It also seems to be a given that we should expect fire department personnel not to fight fires based upon this one case with very special circumstances.

NIST seems to seek to establish that 7 WTC is a typical office building and makes explicit comments that the oddities of the site and design did not influence the collapse. While 7 WTC had some features that are more typical, it is not what I would call a typical office building. Typical bays in office buildings are rectangular, regular and span areas from 20 x 20 ft to 40 x 40 ft.

The tributary and influence areas on the columns at which NIST contends collapse initiated are very high in comparison even to the largest bay in this typical range. Seven WTC had tributary and influence areas that are in excess of 50% larger for columns 79, 80, and 81 than for columns in a 40 x 40-ft bay arrangement. I strongly suspect that this significant difference was a very significant factor in the collapse. The report also seems far too conclusive that the other oddities (skewed framing, transfers, cantilevers and transitions) did not contribute to the collapse. The proposed scenarios for collapse progression are not certain, just plausible.

Perhaps NIST is calling this a typical office building in comparison to the systems used in the 110-story WTC twin towers, which were called unique.

While I understand that difference, it should not be said that 7 WTC was a typical office building. It is actually more unique than it is typical, given the many structural challenges that were overcome with atypical framing and configurations.

The other structures noted in the report to have survived severe fires are more typical in nature.

4. It would be attainable and productive to suggest that fire engineering should be routine in atypical projects. Much more so than saying engineers should design for an infrequent worst-case fire.

5. There can be no absolute response to a probabilistic issue. There are many probabilities that interact in the case at hand, including: the probabilistic fire load, probability of sprinkler system failure, probability of coincident structural damage and probability of fire department response.

The real question facing the engineering profession is how often building failure without loss of life is acceptable. The answer of zero is impossible and illogical.
Answers to ENR questions:

ENR: Do you agree with the key premise of NIST's recommendations?

Carter: This premise involves an undefined target - the infrequent worst-case fire. Is this a codified design-basis fire similar to the design-basis loads we use in gravity, wind, and seismic design? If so, the provisions in AISC 360-05 Appendix 4 are already a part of the AISC Specification (and the International Building Code, by reference), and can be used to design for fire conditions. However, the term "worst-case" is a misnomer since a code-level event is not necessarily the worst case.

Alternatively, is it the intent of the NIST premise that the infrequent worst-case fire should represent any fire that could ever occur in any building? This is a tall order-- I doubt that it is even realistic to think that there is a singular fire scenario that represents the worst case for every component in a building, let alone every building and every possible use.

Thanks to hindsight, the scenario chosen today can be tuned to represent the multiple facets of the 7 WTC experience, but what about the next event with different facets? Clairvoyance is elusive.

ENR: Do you think that buildings should routinely be designed to resist thermal expansion that would trigger collapse?

Carter: I can't answer this question because I don't think NIST has established conclusively that thermal expansion triggered this collapse; nor have the proposed design criterion been identified.

I think NIST likely is correct in concluding that column buckling occurred at one or more of columns 79, 80, and 81, and this led to the progression of events that ended with total collapse. I don't think there is enough evidence to support the firmness of NIST's conclusions about what preceded column buckling. As one example, do we really think that nine intermediate stories of column 79 stood unsupported prior to buckling?

That seems impossible.

To draw such firm conclusions on a hypothesis that is plausible but not proven seems unnecessary.

ENR: Do you think there is a problem with the existing building stock that has not been designed to this load?

Thermal expansion undoubtedly occurs in any structure subjected to fire.

It also has been observed in full-scale testing of structures in fire conditions. The Cardington fire tests done in the U.K. on steel and reinforced concrete structures showed similar magnitudes of expansion in both materials, but none of the tested structures collapsed due to the expansion. I don't see that NIST's work has established thermal expansion as a cause of collapse.

ENR: NIST's new recommendation B, the 13th of its WTC investigation, says:

"NIST recommends that buildings be explicitly evaluated to ensure the adequate performance of the structural system under worst-case design fires with any active fire protection system rendered ineffective...."

"...Building owners, operators, and designers are strongly urged to act upon this recommendation. Engineers should be able to design cost-effective fixes to address any areas of concern that are identified by these evaluations...." NIST then lists "possible options for developing cost-effective fixes."

Do you agree with this recommendation?

Carter: Again, it is unclear what NIST intends with use of the phrase "worst-case." The possible options for cost-effective fixes are included with very little exploration of why they would have made a difference and how they would be cost-effective. They do not appear to be cost- effective to me.

Also, shouldn't assessment of sprinkler reliability and improvements (if necessary) be something that is listed as a potential solution? NIST states in the report that sprinklers are an acceptable solution to fire when they function.

ENR: NIST says it does not have any cost data to support its contention that engineers should be able to find "cost-effective" fixes. Please react to NIST's assumption that "fixes" could be cost-effective.

The suggestions for cost-effective fixes are speculative, and should not be included in the report. Without assessment, development and study, there is no way to know what the cost-effective solutions are. Moreover, has anyone agreed as to what fixes, if any, are needed? I don't think there is agreement on this.

ENR: Please speak out for or against the conclusions and recommendations in the report.

Carter: Absent a means to characterize what the "worst-case" fire scenario is, the recommendation in this report seems to head in a direction that will simply provide a new fire design level that is just as capable of being exceeded as the current one. The impact on the cost of design and the cost of construction are both indeterminate, because the recommendations are general and without characterization.

ENR: NIST was purposely silent about narrowing the field to any specific building type, size and whether the recommended new standard (and code) should apply to new buildings or all buildings. Please react.

Carter: Were any recommendations to be implemented, they should be applicable to all buildings, regardless of construction materials, type, size, etc. The recommendations should be limited to what is necessary and appropriate for life safety.

ENR: Do you agree with NIST that "the standards for estimating load effects of potential hazards (e.g. progressive collapse, wind) and the design of structural systems to mitigate the effects of those hazards should be improved to enhance structural integrity"?

Carter: No. I don't think we have a structural integrity problem in the buildings that naturally result from the common design and construction standards and methods used today in the U.S.

From: Chris Johnson <cnjohn@sbcglobal.net>
Subject: WTC Web Site Question : General Public
To: wtc@nist.gov

I have a question for John Gross. He says in a video that there was no evidence of molten metal under the twin towers etc. This is simply untrue, there is substantial (overwhelming) evidence that this is the case.

How could a tempurature 1000 deg. F more than the aviation fuel could possibly generate under controlled conditions, let alone black, oxygen-poor fires like the slow-burning ones in the twin towers?

I am EXTREMELY skeptical of the official story and will continue to be until I see an unbiased study by reputable scientists that demonstrates (and not by black-box computer models that are selected only because they show what the committee/NIST wants to prove) what happened that day. Even now, what happened on 9/11 is unique, with buildings becoming POWDERED, molten metal pools in the basements, very rapid collapse but no debris to speak of, virtually all the steel removed from public and professional scrutiny (illegal: it was evidence at a federal crime site).

Even now there is no real explanation. NIST says, "SOMETHING" happened, this set the scene where collapse ensued automatically.

If there were a few unexplained things in a complex event, that's expected. When there are MANY HUNDREDS of VERY troubling points occurring in a complex event, with overwhelming evidence of a biased investigation, that's another matter.

The Bush administration keeps using 9/11 as the U.S.'s justification for illegal wars. Iraq had NOTHING to do with 9/11 or bin Laden (he did not confess -the 'confession' videos were of another person).

Let's have a unbiased 9/11 investigation. We need one and far over half of the US public believe it's an inside job and/or coverup.

And how does NIST explain the new digital dump of flight 77's black box, which shows the plane's trajectory was absolutely inconsistent with the destroyed light poles, etc?

With the molten metal, we see NIST's representative showing a hostile, administration-sided attitude. And his ignorance is astounding: he's either totally uninformed or lying or unqualified. Let's see NIST's response to this. Where did the energy come from to create this molten metal that DID exist in all 3 collapsed buildings?

Sincerely,

Chris Johnson

From: Christopher Bollyn <bollyn.books@yahoo.com>
Subject: Open Letter to NIST in Response to WTC 7 Investigation
To: wtc@nist.gov
Cc: bollyn.books@yahoo.com

To:

WTC Technical Information Repository
National Institute of Standards and Technology
100 Bureau Drive, Stop 8611
Gaithersburg, MD 20899-8611

Email to: wtc@nist.gov

Open Letter to NIST in Response to the
"Final Report on the Collapse of the World Trade Center Building 7"

PAPER BEATS STEEL?

An American Protests the
Criminally Fraudulent NIST Report Posing as Science

(Posted on www.bollyn.info)

September 15, 2008

To the National Construction Safety Team, namely: Messrs Silvarag Shyam Sunder, Richard G. Gann, William L. Grosshandler, H.S. Lew, Richard W. Bukowski, Fahim Sadek, Frank W. Gayle, John L. Gross, Therese P. McAllister, Jason D. Averill, J. Randall Lawson, Harold E. Nelson, and Stephen A. Cauffman

To Lead Investigator Silvarag Shyam Sunder and all other members of the NIST WTC 7 Team, named and un-named:

I am writing in response to the August 2008 publication of NIST's "Final Report on the Collapse of World Trade Center Building 7." You will forgive me for being straight forward and direct in my comments.

As an independent investigation of 9-11 who has been forced to leave my home and country after being brutally attacked by undercover police and maliciously prosecuted because of my writing, I have no patience for people who wilfully concoct "fairy tales" about what happened on 9-11 at taxpayer expense.

I don't accept publicly-paid officials betraying the public trust and lying on the record. It was criminal for the corrupt members of the Hoffman Estates Police Dept. to commit perjury and lie about their actions when they attacked me at my home and it every bit as criminal for you to present this pack of lies about what happened to WTC 7.

A PACK OF LIES

This is what I think of your "final report." Moreover, I consider it a major criminal fraud foisted on the public to conceal what really happened to WTC 7. You have all willingly participated in this criminal fraud to cover up a major crime, for which you have been well paid – at taxpayer expense. This is inexcusable.

Having carefully read the NIST report on WTC 7, I would point out the following specific points for those readers who may have not read the report:

1. The NIST report about the "collapse" of WTC 7, the first and only "collapse" of a steel-framed high-rise building in history, is a mere 77 pages long. After removing the filler and repetitions, the NIST report could be pared down to less than 20 pages.
2. The report does not mention the Windsor Tower fire of 2005, in which a similar 32-floor tower burned like a torch – and remained standing.
3. The report does not mention Larry Silverstein's public comment about "pulling" the building.
4. The final report does not contain a single photo of the building on 9-11.
5. The report omits other essential information, for example, it does not even provide the dimensions of the "particularly large" columns, the critical colums, which NIST says failed and caused the progressive collapse leading to the "global collapse."
6. The report ignores important evidence about WTC 7. For example, although Mark Loizeaux of Controlled Demolition, Inc. is listed as a NIST contractor who contributed to the investigation, his eyewitness report that molten metal was found at the base of WTC 7, which he reported to me, is not even mentioned. How can such important evidence be omitted?
7. The final report says that WTC 7 "did not collapse due to fire-induced weakening of critical columns," which it says were NOT even exposed to temperatures above 300 degrees Celsius. It blames thermal expansion of steel beams, caused by paper and "ordinary office combustibles" (ca. 75 mm, with expansion of about 5 mm/m is accepted for the 15 meter long-spans, IF uniformly heated to 300 degrees C.) for causing the collapse, which is not well explained in the report. Why would steel beams give way in New York but not in Madrid – where they were exposed to much higher temperatures for much longer?
8. According to the list of "Contributors to the Investigation," NIST did not consult the architect, the structural engineer, the mechanical engineer, or the general contractor who built WTC 7. What kind of building collapse report is this?
9. As the report points out, "the remains of all the WTC buildings were disposed of before congressional actions and funding was available for this Investigation to begin." As a result, "some facts" could not be "discerned" and the final report contains "uncertainties." How convenient. All the evidence was destroyed before you began your investigation.
10. The final report rules out demolition by explosives based solely on the fact that no loud noise was heard. The use of a quiet aluminothermic reaction, e.g. Thermite, to cut critical steel columns, beams, and trusses, which is certainly indicated by the presence of the molten metal in the basement, is not even considered by NIST.
11. Under the section titled "Aspects prior to the Global Collapse," NIST notes: "A seismic signal approximately 10 seconds prior to the onset of collapse was likely due to the falling of debris from the collapse."
12. The NIST report states: "The transfer elements (trusses, girders, and cantilever overhangs) did not play a significant role in the collapse of WTC 7." How can you possibly state that not having investigated the elements themselves?
13. The NIST report states that none of the columns that held up WTC 7 were "weakened by

elevated temperatures" and that none of the columns were subjected to temperatures above 300 degrees C. So what made them fail? How do you explain the fact that all of the 24 core columns and the 58 perimeter columns failed at the same time allowing the building to fall straight down?
The "probable collapse sequence" presented in the NIST WTC 7 report is not only improbable, it is impossible. What is even worse is that you all know this but have gone along with this ridiculous explanation in order to provide a cover for the criminal demolition of WTC 7. This is more than pathetic – it is criminal.

Sincerely,

Christopher Bollyn
www.bollyn.info
www.bollyn.com

Sources:
Bollyn, Christopher, "9/11 and the Windsor Tower Fire" February 14, 2005
http://www.thetruthseeker.co.uk/article.asp?ID=2796

*Christopher Simmler*

7005 Wheat Mill Place, Raleigh, NC 27613 ♠ Similar@Gloryroad.net ♠ Telephone: 919.939.9090

*September 4, 2008*

Mr. Shyam Sunder
Lead Investigator
National Institute of Safety and Standards
100 Bureau Drive, Stop 1070
Gaithersburg, MD 20899-1070

**REFERENCE: This 3 page document on NIST NCSTAR1A and video on "Why the Building Fell."**

Mr. Sunder:

I've recently reviewed the above referenced video and report. A document used to establish belief in post hoc reasoning is dubious from the start. The conclusion that building materials' exposure to heat caused WTC 7's inevitable demise is possibly the second to last chance to dispel the controlled demolition that everyone clearly recognized here, *if not in the other two 'because of jets and fuel.'*

The third building to fall that day, WTC 7 had no impact or jet fuel to catalyze, or explain, its annihilation. It looked like a duck, but the report professes it was really a goose: That recognized by most to be controlled demolition, with warning, is professed to be *happenstance.*

The familiar precision and complete demolishment is *absent random result* and invariably part of a greater plan that included 2 of 4 jets, if not perhaps a distinguishable fraud.

The truth of that day, with thousands dead since, is material to the course of world events. Ten percent may be an appropriate number for the third building as we look to a people that still tithe.

That tax resources are devoted to "proving" something other than what many recognize to be demolition makes this citizen curious as to whether or not insurance would have covered the third building had it been a total loss due to "demolition." Perhaps a newly obsolete building would have been covered. Either way, tax dollars should not be used to protect the potentially corrupt, even if in an effort to alleviate the government of alleged culpability.

## A. CLAIMING AN INABILITY TO DETECT EXPLOSIVES BY *SOUND* WITNESSES FAILS TO INVALIDATE THE *OBSERVATION* OF A DEMOLITION.

Perhaps the public has not witnessed suppressed explosives used in a public demolition, *or any by aircraft*. If a tree falls in the forest, and there is other substantial noise or insulation, can it be heard? Could explosions have been sufficiently muffled, although seismic? Were people forced to work with explosives in their building, or can a crew do *its* work in 7 hours and not cool the flames? "'Pull' this."

The report's reasoning that an estimated 130-decibel explosion @ 1/2 mile should have been heard overlooks the 130-decibel sirens, and other chaos, in the matter of white noise. One respectfully begs to differ that demolition can only be performed with explosives that "had to be heard," as you claim SEISMOGRAPH readings support a post hoc computer-supported theory of rushing girder and cement floor collapse, *and no audible evidence of detonation.*

The enclosed video, in conjunction with your video clip, demonstrates there was a 6 to 8 second delay between commencement of Building 7's demise (as identified by east roof collapse in your video) and the time this videographer hurriedly arrived at the window for the remainder of the fall.

Please advise which cue the video recorder followed had the demolition not been marked by discernable sound, seismograph record, or quiet quake.

## B. INCONCLUSIVE FLAMES AND DURATION OF EXPOSURE.

Furthermore, the data is materially lacking. As materials experts know, the report's basis relies on a purported intensity of, exposure to, and duration of heat. Of other significant consideration is area.

The conclusion is supported with a hypothetical computer generated simulation, figure 3.6, indicating a moving fire over time, increasing in size, sustaining temperatures @ 1000 *Centigrade* at the core; none greater than 2 hours in duration, as it was outwardly clear no one floor was engulfed in flames, especially on the east side.

There is little evidence, if any, to support whole steal beam/column immersion, or necessary exposure, that led to complete and replicable failure on sequential floors. For argument's sake, any floor subjected to enough intensity and duration of heat to collapse would have fallen in a random manner upon the stationary floor below.

That lower floor would then absorb the transfer of weight until, and if, it exceeded its maximum load; slowing the process, not facilitating it. Then the lower floor would fall in its *random and incomplete* fashion, beginning at the most compromised or weighted areas, slowed and suspended by various bolts, rivets, rebar, trusses, girders, and other available safety materials, ensuring a decreased weight for the following floor; should one have existed.

Perhaps one is to believe that these buildings were not designed in the 1980s to withstand collapse. Isn't the art of demolition precisely exploiting the regions designed to prevent or allow collapse? The report also suggests new concern for building safety. I doubt any building codes will prevent events similar to those that transpired on and after 9/11.

## CONCLUSION

Creating a computer image to prove enough floors failed in order for form/column 79 to also fail is wishful thinking. As powerful as the computers used to create this simulation may have been, such a measure fails to support the accuracy or truthfulness in their creations. Certainly, computer imaging relies on the intent and design of the programmer.

Form 79 appears to be within reach of the concealed substation, and everyone recognized the critical piece that collapsed first. The report fails to rule out demolition.

Certainly, truth and common belief in matters may vary. To ask one to believe the unmistakable appearance of a skilled demolition was simply a random, precise occurrence is an exercise in blind faith, supported with post hoc reasoning and invalid evidence.

The precision and utter annihilation that was the result of *no* jet impact carries an undeniably reasonable explanation. The matter is clear, as you and yours attempt to manufacture the preponderance of evidence, if not that which is best manufactured to be clear and convincing.

One would hate to think another could be evil enough to kill thousands for any reason, let alone ensure the plan is carried through. This apparently is the world in which we live, no matter who safely takes the credit, or actually may be to blame.

However, safely acquiring generous profits on a recently obsolete and adjacent property was a viable opportunity, even if one was not responsible for the demise of the previous two, or the loss of innocent life. Business is business at the end of the day, and deception may be profitable… for a season.

Best regards,

## Stephen Cauffman

**From:** Derek White [dwhite@haifire.com]
**Sent:** Monday, September 15, 2008 11:57 AM
**To:** Stephen Cauffman
**Cc:** 'Craig Beyler'
**Subject:** NCSTAR 1A and 1-9 Comments
**Attachments:** HAI Comments on NCSTAR 1A and 1-9_Legal.pdf; HAI Comments on NCSTAR 1A and 1-9 _Letter.pdf

Dear Mr. Stephen Cauffman,

These comments are being submitted on behalf of Craig Beyler.

Name: Craig Beyler
Affiliation: Hughes Associates, Inc.
Contact: cbeyler@haifire.com or 410-737-8677

I have included two versions of the comments: one set that prints on 8.5 x 11 inch paper and one set that prints out of 8.5 x 14 inch paper. I can reformat it in another format upon request.

Best regards,
Derek

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| Comment Number | | | | CODE COMPLIANCE ISSUES | |
|---|---|---|---|---|---|
| HAI-1 | **Comment:** | Fire resistance rating for the floor assemblies is 2 hours and the columns is 3 hours as detailed in the August 26th technical briefing, the documentation of independent inspections, and NCSTAR 1-9 Section 2.6. | | | |
| | **Reason for Comment:** | Accuracy. | | | |
| | **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| HAI-1a | 1A | xxxiii | first full par. | "The installed thickness of the thermal insulation on the floor beams was below that required for unsprinklered or sprinklered buildings, but it is unlikely that the collapse of WTC 7 could have been prevented even if the thickness had been consistent with building code requirements." | *Delete.* |
| HAI-1b | 1A | 7 | end of 2nd par. of 1.2.4 | "Private inspectors found that the applied SFRM thicknesses were consistent with these values." | *Replace with:* "Private inspectors found that the applied SFRM thicknesses were consistent with NYCBC requirements." |
| HAI-1c | 1A | 53 | 2nd bullet | "The type of building classification used to design and construct the building was not clear from the available documents. Based on the height, area, primary occupancy classification, and installation of a fire sprinkler and standpipe system, the minimum construction type (permitted by NYCBC) was type I-C (2 h protected) classification. However, some documentation, including some building drawings and specifications for bidders on the contract for applying SFRM to the structural steel, indicate a type I-B (3 h protected) classification." | *Delete first sentence and replace the next two sentences with :* "NIST found that the fire resistance rating of the columns was 3 h and the rating of the floor assemblies was 2 h consistent with a type I-B classification." |
| HAI-1d | 1-9 | 11 | last par./2nd sent. | "The SFRM thickness measurements were consistent with a Type 1-B classification, with the exception of the floor system." | *Delete* ", with the exception of the floor system" |
| HAI-1e | 1-9 | 12 | 2nd par./1st sent. | "Based on the SFRM measurements and project correspondence, the columns had SFRM thicknesses consistent with a 3 h fire resistance rating, the metal deck had SFRM thicknesses consistent with a 2 h fire resistance rating, and the floor framing (beams and girders) had SFRM thicknesses consistent with a 1 h fire resistance rating." | "Based on the SFRM measurements and project correspondence, the columns had SFRM thicknesses consistent with a 3 h fire resistance rating, and the floor system (metal deck, concrete slab and beams/girders) had SFRM thicknesses consistent with a 2 h fire resistance rating." |
| HAI-1f | 1-9 | 12 | 2nd par./last sent. | "... but the actual classification may have been type I-B." | *Replace with:* "... but subsequently NIST determined that the fire resistance ratings support the building classification of type I-B" |
| HAI-1g | 1-9 | 44 | Section 2.6 | | *Add a bullet:* "The SFRM was applied in accordance with the basis of design and thus the columns achieved a fire resistance rating of 3 hours and the beams and floor system achieved a 2 hour fire resistance rating consistent with a type I-B construction classification." |
| HAI-1h | 1-9 | 81 | 2nd bullet of 4.7.2 | "The bottom of the slab was insulated with 3/8 in. thick Monokote MK-5 to achieve a 1 h fire resistance rating. The floor beams had a 2 h fire rating specified, for which a 7/16 in. thick application of SFRM Monokote MK-5 was assumed." | *Replace with:* "The bottom of the slab was insulated with 3/8 in. thick Monokote MK-5 and the floor beam insulation was modeled as a 7/16 in. thick application of SFRM Monokote MK-5. The floor beams were later found to have been protected with 1/2 inches of SFRM Monokote MK-5, consistent with floor assembly rating of 2 hours." |
| HAI-1i | 1-9 | 85 | 3rd bullet of 4.7.3 | "... (insulated for a 1 h rating), " | *Replace with:* "... (insulated for a 2 h rating), " |
| HAI-2 | **Comment:** | The stairwell capacity was sufficient to meet the requirements of the NYCBC in effect during the design and construction period. The floor population of 348 calculated by NIST only subtracts the core area from the total floor plate area. The NYCBC provisions provide that the occupant population on a given floor is based on the net floor area. The NYCBC defines the "FLOOR AREA (NET)" as the following: "When used to determine the occupant load of a space, shall mean the horizontal occupiable area within the space, excluding the thickness of walls, and partitions, columns, furred-in spaces, fixed cabinets, equipment, and accessory spaces such as closets, machine and equipment rooms, toilets, stairs, halls, corridors, elevators and similar unoccupied spaces." (Section 27-232 NYCBC) Storage rooms, employee cafeterias/lunchrooms, lounges and other spaces that are used by the employees of that floor are also permitted to be excluded from the net floor area calculation based on the nonsimultaneous occupancy clause -- Section 27-358 (c) of the NYCBC. When the net floor area is calculated in this manner the occupant load per floor drops below 300 which can be adequately handled by two 56 inch wide stairwells. It is also suggested that the reference to the 2003 edition of NFPA 5000 be removed as this building code has not been embraced by regulatory entities - as such it has little relevance to the current standard of care. | | | |

| | Reason for Comment: | Accuracy. | | | |
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| | **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| HAI-2a | 1A | xxxiii | 2nd par./last sent. | "The stairwells were narrower than those required by the NYCBC, but, combined with the elevators, were adequate for a timely evacuation on September 11, 2001, since the number of building occupants was only about half that expected during normal business hours." | *Delete.* |
| HAI-2b | 1A | 13 | last par./last sent. | "The stairwells, although somewhat narrow for the maximum possible 14,000 occupants (estimated using the formula in the NYCBC), were more than adequate to evacuate roughly one-third of that number in the building that morning (NIST NCSTAR 1-9, Chapter 7)." | *Delete* ", although somewhat narrow for the maximum possible 14,000 occupants (estimated using the formula in the NYCBC), " |
| HAI-2c | 1A | 51 | 7th bullet | "The calculated stairwell capacity was insufficient to meet the requirements of the NYCBC in effect during the design and construction period, if the building were occupied at the calculated maximum level (~ 14,000 people)." | *Replace with:* "The calculated stairwell capacity met the requirements of the NYCBC in effect during the design and construction period, if the building were occupied at the calculated maximum level (~ 12,000 people)." |
| HAI-2d | 1A | 51 | 7th bullet | "The stairwell capacity met the requirement of the (subsequent) 2000 edition of the IBC, but not the 2003 edition of NFPA 5000." | *Delete* "but not the 2003 edition of NFPA 5000" |
| HAI-2e | 1-9 | 309 | 1st par./last sent. | "... 34,800 $ft^2$, or 3,200 $m^2$ (41,600 gross $ft^2$ less 6,800 $ft^2$ of core space)." | *Replace with:* "... 30,000 $ft^2$, or 2,787 $m^2$ (41,600 gross $ft^2$ less 11,600 $ft^2$ of core space/non-occupied space)." |
| HAI-2f | 1-9 | 309 | 2nd par./1st sent. | "... maximum occupant floor load of 348 persons ... " | *Replace with:* "... maximum occupant floor load of 300 persons ..." |
| HAI-2g | 1-9 | 309 | 1st Bullet | "Sufficient capacity for 348 persons would have required six units of exit width, or 3.35 m (132 in.)." | *Replace with:* "Sufficient capacity for 300 persons would have required five units of exit width, or 2.79 m (110 in.)." |
| HAI-2h | 1-9 | 309 | 2nd Bullet | "Two equally sized stairwells meeting the design requirements of the NYCBC would have been at least 1.68 m (66 in.) wide each. Three stairwells, each 44 in. wide, would also have provided the minimum egress capacity for business occupancy floors." | *Delete second sentence, Replace first sentence with:* "Two equally sized stairwells meeting the design requirements of the NYCBC would have been at least 1.40 m (55 in.) wide each." |
| HAI-2i | 1-9 | 309 | 4th par. | "... was not consistent with the NYCBC." | *Delete* " not" |
| HAI-2j | 1-9 | 315 | Section 7.5.2, 3rd bullet | "... 348 persons per floor. Assuming approximately 40 occupied floors (ignoring mechanical floors and lobbies), this would yield a rough occupant load of approximately 14,000 persons." | *Replace with:* "... 300 persons per floor. Assuming approximately 40 occupied floors (ignoring mechanical floors and lobbies), this would yield a rough occupant load of approximately 12,000 persons." |
| HAI-2k | 1-9 | 617 | 7th bullet | "The calculated stairwell capacity was insufficient to meet the requirements of the NYCBC in effect during the design and construction period, if the building were occupied at the calculated maximum level (~ 14,000 people)." | *Replace with:* "The calculated stairwell capacity met the requirements of the NYCBC in effect during the design and construction period, if the building were occupied at the calculated maximum level (~ 12,000 people)." |
| HAI-2l | 1-9 | 617 | 7th bullet | "The stairwell capacity met the requirement of the (subsequent) 2000 edition of the IBC, but not the 2003 edition of NFPA 5000." | *Delete* " but not the 2003 edition of NFPA 5000" |

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| HAI-3 | Comment: | The stairwell door width, stair riser dimension, and stair tread dimension were in compliance with the NYCBC. The door schedule for the base building identifies the stair doors as being 3'-8" (44 inches). With respect to the stair riser dimensions, the 20th floor, for example, shows 20 risers over a height of 12'-9" (153") which would give an average riser height of 7.65 inches and calculations for floors 21 and 22 show a 7.7 inch riser height for both floors. Base building drawings show the stair tread as 9.5 inches wide which would satisfy table 6-4 of the NYCBC. |

| | Reason for Comment: | Accuracy. | | | |
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| | **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| HAI-3a | 1-9 | 309 | 3rd bullet | "The actual doors were 0.91 m (36 in.) wide." | *Replace with:* "The actual doors were 1.12 m (44 in.) wide." |

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| HAI-3b | 1-9 | 309-310 | 4th bullet | "The sum of two risers and one tread depth was required to be not less than 0.61 m (24 in.) nor greater than 0.65 m (25.5 in.). Thus, the typical WTC 7 tread depth of 0.23 m (9 in.) and riser height of 0.20 m (8 in.) would satisfy this formula, at 25 in. However, according to Table 6-4 in the NYCBC, the stair riser may not exceed 0.20 m (7.75 in.) and the tread depth must be greater than 0.24 m (9.5 in.), each of which was slightly different from the WTC 7 design specification." | *Replace with:* "The sum of two risers and one tread depth was required to be not less than 0.61 m (24 in.) nor greater than 0.65 m (25.5 in.). Thus, the typical WTC 7 tread depth of 0.24 m (9.5 in.) and riser height of 0.20 m (7.7 in.) would satisfy this formula, at 24.9 in. According to Table 6-4 in the NYCBC, the stair riser may not exceed 0.20 m (7.75 in.) and the tread depth must be greater than 0.24 m (9.5 in.), both of which were consistent with the WTC 7 design specification." |
| HAI-4 | **Comment:** | WTC7 was code compliant. The only two areas identified by NIST as possibly non-compliant (floor fire resistance rating and stair capacity) were found to be compliant (see above). | | | |
| | **Reason for Comment:** | Accuracy. | | | |
| | **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| HAI-4a | 1A | xxxiii | first full paragraph | "The design of WTC 7 was generally consistent with the New York City Building Code of 1968 ..." | *Delete* "generally" *from text excerpt.* |
| HAI-4b | 1A | 45 | Obj 3 first bullet | "The design of WTC 7 was generally consistent with the NYCBC." | *Delete* "generally" *from text excerpt.* |
| HAI-4c | 1A | 53 | 4.5.2 first bullet | "NIST found no evidence to suggest that WTC 7 was not designed in a manner generally consistent with applicable building codes and standards." | *Delete* "generally" *from text excerpt.* |
| HAI-4d | 1-9 | 611 | Obj 3 first bullet | "The design of WTC 7 was generally consistent with the NYCBC." | *Delete* "generally" *from text excerpt.* |
| HAI-4e | 1-9 | 619 | 1st bullet of 14.5.2 | "NIST found no evidence to suggest that WTC 7 was not designed in a manner generally consistent with applicable building codes and standards." | *Delete* "generally" *from text excerpt.* |
| | | | | **EVACUATION ISSUES** | |
| HAI-5 | **Comment:** | The building was successfully evacuated under difficult conditions with no loss of life and there is no basis for conclusions concerning evacuation management. (see NCSTAR 1A, p. 52). | | | |
| | **Reason for Comment:** | Accuracy. | | | |
| | **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| HAI-5a | 1A | 52 | 1st par./1st sent. | "Evacuation management at every level did not provide timely evacuation instructions to building occupants during the event." | *Delete.* |
| | | | | **SPRINKLER ISSUES** | |
| HAI-6 | **Comment:** | There was significant sprinkler pipe breakage due to debris damage, which had a substantial effect upon the systems and upon the tank water supplies at the top of the building. Figures 5-94 to 5-101 of NCSTAR 1-9 document the loss of floor segments where sprinkler piping was lost. It is readily apparent that sprinkler systems in the lower floors suffered very significant damage that would render them ineffective. Damage to the 45th to 47th floors would have caused the tanks to have been fully emptied on the time scale of an hour (say 500 gpm pump rating with 35,000 gal -> 70 minutes). Due to the loss of water from the tanks, fires observed on upper floors in the afternoon would not have been suppressed by sprinklers. Figure 5-111 is not consistent with the operation of a sprinkler system. With an operating sprinkler system the fire would never have grown to this extent. | | | |
| | **Reason for Comment:** | Accuracy. | | | |
| | **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| HAI-6a | 1A | 17, 55 | 2nd full paragraph | "It is possible that the fires on the 22nd, 29th, and 30th floors were controlled by automatic sprinklers, whose water came from the storage tanks on the 46th floor." | *Delete.* |

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| HAI-6b | 1A | 45 | 2nd bullet of obj 3 | "Since there was no gravity-fed overhead tank supplying these floors, the sprinkler system could not function when the only source of water, which was from the street mains, was not available." | *Replace with:* "The sprinkler system could not function when the only source of water, which was from the street mains, was not available and sprinkler piping was damaged due to the collapse of WTC1." |
| HAI-6c | 1-9 | 78 | 2nd paragraph of 4.4.5 | "As seen in Section 4.4.3, the sprinkler system had the capacity to control fires on multiple floors, each involving a few cubicles, and it is possible that this is why those fires were only observed for a short time." | *Replace with:* " As seen in Section 4.4.3, if undamaged, the sprinkler system had the capacity to control fires on multiple floors, each involving a few cubicles." |
| HAI-6d | 1-9 | 80 | 5th bullet | "This might explain why the fires on the 22nd, 29th and 30th floors did not spread into the afternoon." | *Delete.* |
| HAI-6e | 1-9 | 603 | 2nd bullet | "It is possible that some of these fires could have been extinguished by the gravity-fed sprinkler system that supplied Floors 21 and higher." | *Delete.* |
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| HAI-7 | **Comment:** | Municipal water supplies are highly reliable sources. This building had supplies from the municipal water main's pressure, from a fire pump, and from FDNY via fire department connections. There were redundant, independent, and remote connections to the municipal loop. This is generally regarded as the most reliable water supply available. | | | |
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| | **Reason for Comment:** | Accuracy. | | | |
| HAI-7a | 1A | xxxiii | 2nd full paragraph | "Since the collapses of the WTC towers had damaged the water main, there was no water available (such as from the gravity-fed overhead tanks that supplied water to Floor 21 and above) to control those fires that eventually led to the building collapse." | *Replace with:* "Since the collapses of the WTC towers had damaged the water main, the water department was not available to isolate the breaks, and the FDNY was not available to provide an alternate water supply, there was no water available to control those fires that eventually led to the building collapse." |
| HAI-7b | 1A | 63 | Group 4, relevance to WTC 7 | "This lack of reliability in the source ... " | *Replace with:* "This loss of the source ..." |
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| HAI-8 | **Comment:** | The ceiling systems were not fire rated because the required fire protection was provided by the SFRM on the floor assembly, not because of the existence of sprinklers. | | | |
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| | **Reason for Comment:** | Clarification. | | | |
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| | **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| HAI-8a | 1-9 | 49 | end 3rd paragraph | "However, since the building was sprinklered, the ceilings were not fire rated, and NIST assumed that the thermal response of the ceiling systems was similar to those in the towers." | *Replace with:* "The ceiling was not a part of the passive fire protection design and as such was not fire rated. NIST assumed that the thermal response of the ceiling systems was similar to those in the towers." |
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| | | | | **FDS ISSUES** | |
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| HAI-9 | **Comment:** | Heat release rate histories shown on p 385 of vol 1-9 do not seem to comport with the reported fuel loads employed. The area under the curves for floors 7 and 8 should be equal and the area under the curve for floor 12 should be 6.4/4 times that value. The shapes of the HRR curves do not have a clear explanation in terms of expected fire behavior based upon the geometry and the fuel load. | | | |
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| | **Reason for Comment:** | Clarification. | | | |
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| HAI-10 | **Comment:** | The statements that fire ignitions were a "single point of ignition" on each floor on the southwest corner are not supported by observations or forensic evidence, particularly given the smoke obscuring the south face during the day. They also conflict with the FDS modeling which starts the fires on the southeast corner of the building on certain floors, and on floor eight relies on a second fire ignition location. Especially given the debris damage to the building, multiple points of ignition are equally likely. | | | |
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| | **Reason for Comment:** | Accuracy. | | | |

| | Report # | Page # | Para./Sent. | Original Text | Suggestion for Revision |
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| HAI-10a | 1A | 16 | 5th par. | "Fires broke out on at least 10 floors of WTC 7, all near the damaged southwest corner of the building (NIST NCSTAR 1-9, Chapter 5). They were typically observed as single floor fires, and observations supported a single point of ignition on any given floor." | *Replace with:* "Fires broke out on at least 10 floors of WTC 7 on the damaged south face." |
| HAI-10b | 1A | 47 | 2nd par. | "On each floor, ignition was likely of a single workstation component or office furnishing item; growth over the full cluster of workstations or office took several minutes." | *Replace with:* "Each fire initiation was likely a workstation component or office furnishing item." |
| HAI-10c | 1-9 | 602 | 5th par./1st sent. | "Observations support a single point of ignition on any given floor in WTC 7. In most instances, the fire on any given floor likely initiated near the damaged southwest region, though collapse initiation did not occur until nearly seven hours later in the northeast region." | *Delete.* |
| HAI-11 | **Comment:** | The problem of dust and debris entering through broken windows was widespread around the WTC site. Accumulation of largely non-combustible dust and debris would have delayed ignition or fire spread. This effect could have significantly impacted the rate of fire growth. | | | |
| | **Reason for Comment:** | Accuracy. | | | |
| | **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| HAI-11a | 1A | 11 | 2nd par./2nd sent. | "Rather, in the earlier hours of the fires, the fire would have spread from one individual workstation or office to another." | *Add:* "The ingress of dust and debris through broken windows would have slowed fire spread by making the ignition of horizontal combustibles more difficult." |
| HAI-11b | 1-9 | 130 | 1st par. | "The available imagery suggests that, while the dust cloud and light debris that reached WTC 7 from the collapse of WTC 2 was sufficient to break out windows that were directly impacted ..." | *Insert after word "impacted:"* "and to enter into WTC7" |
| HAI-12 | **Comment:** | ***Uncertainties associated with computer fire modeling:*** There are numerous aspects of the FDS fire modeling that are difficult to characterize (floor layouts, dust and debris effects, fuel loads, fuel distribution, fire start times, fire growth) and this leads to results with vary in excess of the accuracy implied by the use of Cases A, B, and C that vary by 10%. Follow-up analyses that rely upon the FDS analysis treat the thermal environment as better characterized than is appropriate. Structural heating and structural response modeling results that are dependent upon the particulars of the fire exposure must necessarily share the uncertainties of the fire modeling. As such, the structural response modeling results must be regarded as one of a class of realizable failure progressions. | | | |
| | **Reason for Comment:** | Clarification. | | | |
| HAI-13 | **Comment:** | In the analytical time line, the FDS simulations have the fires basically converging in the Northeast corner of the building in the vicinity of Column 79 at approximately the time of collapse as predicted in the combined ANSYS/LS Dyna model; however, the observations detailed in Chapter 5 of NCSTAR 1-9 do not support this representation of fires in the FDS modeling. The development of discussions and conclusions that rely on the FDS modeling should be modified to reflect the real uncertainties associated with the modeling of WTC7 fires. | | | |
| | **Reason for Comment:** | Clarification. | | | |
| HAI-14 | **Comment:** | The FDS analysis does not provide the sequence of window losses used as inputs to the model. As indicated in the WTC1/2 reports, the fire spread and fire development is strongly controlled by the sequence of window losses. The absence of this critical input makes it difficult to understand the simulation results that are presented in the report. | | | |
| | **Reason for Comment:** | Clarification. | | | |

## FIRE RESISTANCE ISSUES

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| HAI-15 | **Comment:** | Performance of unrated ceiling assemblies is highly uncertain and is unlikely to survive 15 minutes of direct fire exposure. Unrated ceiling systems are unlikely to provide any significant barrier to flames and certainly cannot be relied upon to remain in place for 15 minutes of direct flame exposure. No basis for the 15 minute duration is provided and this value is not used in the FDS model. | | | |
| | **Reason for Comment:** | Accuracy. | | | |
| | **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| HAI-15a | 1A | 17 | 1st full paragraph | "After about 15 min, the ceiling tile system would have failed from the heat, and the hot air would have flowed over the office wall." | *Delete* " After about 15 min," |
| HAI-15b | 1A | 47 | 3rd bullet | "After about 15 minutes, the ceiling tile system would likely fail and the hot gases would create a local hot upper layer." | *Delete* " After about 15 min," |
| HAI-15c | 1-9 | 613 | 4th bullet | "After about 15 minutes, the ceiling tile system would likely fail and the hot gases would create a local hot upper layer." | *Delete* " After about 15 min," |
| HAI-16 | **Comment:** | Time-temperature curves for the exposure to assemblies and the thermal response of assemblies based on the exposure used in the simulation of the building response are not provided (e.g. NCSTAR 1-9 Chapter 9). For example, there are no time-temperature curves for the exposure to columns and beams as well as the assembly response in the area of Column 79-81, in the SW corner, or other representative location(s) in the middle of the north face. | | | |
| | **Reason for Comment:** | Clarification and completeness. | | | |
| HAI-17 | **Comment:** | The analysis does not show floor failures in less than 2 hours. As NIST points out, the analysis shows shortcomings of ASTM E119 (e.g. ASTM E119 does not test the performance of connections). | | | |
| | **Reason for Comment:** | Accuracy. | | | |
| | **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| HAI-17a | 1A | 61 | Rec D, relevance to WTC 7 | "The floor systems failed in WTC 7 at shorter fire exposure times than the specified fire rating (two hours) and at lower temperatures because thermal effects within the structural system, especially thermal expansion, were not considered in setting the endpoint criteria when using the ASTM E 119 or equivalent testing standard." | *Replace with:* "The floor system connections failed in WTC 7 in part due to thermal stresses not considered in the end point criteria of ASTM E 119 or equivalent testing standards." |

## STRUCTURAL ISSUES

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| HAI-18 | **Comment:** | The NIST draft reports ascribe the "initiating event" to be the result of failure induced by thermal expansion at temperatures below 400°C (750 °F). While thermal expansion effects are present below 400 °C, actual assembly failures are not predicted below ~600 °C according to the NIST documentation.<br>• The long span beam and girder example calculation in Section 8.7.2 of NCSTART 1-9 only achieves a 4.5 inch elongation using 600°C, which is not enough to unseat the connection at column 79 given that the report identifies 5.5 inches as the failure criteria (1-9, Vol 2 p. 482) for a column walking off its seat at column 79.<br>• The analysis assumes only the girder end moves and that no buckling occurs at 600°C, note that elsewhere the temperature rise of 400°C is cited, yielding even less expansion.<br>• The LS Dyna example in Section 8.8 of NCSTAR 1-9 requires buckling of beams to "rock the girder of its seat at column 79." The buckling of beams occurs at temperatures of approximately 600°C.<br>• The damage state figures at 3.5 hours (Figures 11-31 through 11-37) and at 4 hours (Figures 11-39 through 11-45) do not show environment temperatures or steel temperatures. | | | |
| | **Reason for Comment:** | Internal consistency. | | | |
| | **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| HAI-18a | 1A | 19 | 6th par./2nd sent. | "This buckling arose from a process that occurred at temperatures ... " | *Replace* " occurred" *with* "began" |

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| HAI-18b | 1A | 49 | 2nd bullet | "The connection, beam, and girder failures in the floor systems, and the resulting structural responses, occurred at temperature ..." | *Replace* "occurred" *with* "began" |
| HAI-18c | 1A | 54 | 4th bullet | "The thermal expansion of the WTC 7 floor beams that initiated the probable collapse sequence occurred at temperature below approximately 400°C." | *Replace* "occurred" *with* "began" |
| HAI-18d | 1-9 | 615 | 2nd bullet | "The connection, beam, and girder failures in the floor systems, and the resulting structural responses, occurred at temperature ..." | *Replace* "occurred" *with* "began" |

**MODELING ISSUES**

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| HAI-19 | **Comment:** | Model validation and verification documentation/references have not been included. |
| | **Reason for Comment:** | Clarification. |

**EVIDENCE/DATA ISSUES**

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| HAI-20 | **Comment:** | Structural damage is more extensive than the seven exterior columns in the southwest corner, as the report documents. NIST 1-9 page 169 documents the structural damage between columns 19 and 21 on the 44th through 47th floors and this should be included in the description. There is also the gouge that runs from the 24th floor up to the 41st floor that is in line with the structural damage around column 20 noted at the top and bottom of the south facade. It seems unlikely that there is this type of damage over 18 floors where there is clearly damage to the floor plates and offers the ability to see into the building without compromising column 19 or 20 at some point over this 210+ foot stretch of damage. |
| | **Reason for Comment:** | Clarification. |

| | Report # | Page # | Para./Sent. | Original Text | Suggestion for Revision |
|---|---|---|---|---|---|
| HAI-20a | 1A | xxxiii | last par./2nd sent. | "The debris also caused some structural damage to the southwest perimeter of WTC 7." | *Replace with:* "The debris also caused significant structural damage to the south and west faces of WTC 7." |
| HAI-20b | 1A | xxxiii | 4th par./2nd sent. | "The building withstood debris impact damage that resulted in seven exterior columns being severed ..." | *Replace with:* "The building withstood debris impact damage that resulted in significant structural damage to the south and west faces ..." |
| HAI-20c | 1A | 14 | 5th par./3rd sent. | "Pieces of WTC 1 hit WTC 7, severing six columns on Floors 7 through 17 on the south face and one column on the west face near the southwest comer." | *Add following original text:* "Additional structural damage was sustained on floors 44 through 47 between columns 19 and 21 and a gouge extended over 18 floors (floor 24 through 41) between column 19 and 20." |
| HAI-20d | 1A | 19 | 4th par./1st sent. | "The collapse of WTC 1 damaged seven exterior columns on the lower floors of the south and west faces ... " | *Replace with:* "The collapse of WTC 1 caused significant structural damage to the south and west faces ... " |
| HAI-20e | 1A | 43 | 1st bullet on page | "WTC 7 withstood debris impact damage that resulted in seven exterior columns being severed ..." | *Replace with:* "WTC 7 withstood debris impact damage that resulted in significant structural damage to the south and west faces ..." |
| HAI-20f | 1A | 46 | Section 4.3.1, Second bullet | "Severed columns were located between Floors 7 and 17 on the south face (six columns) and the west face (one column) near the southwest corner." | *Add following original text:* "Additional structural damage was sustained on floors 44 through 47 between columns 19 and 21 and a gouge extended over 18 floors (floor 24 through 41) between column 19 and 20." |
| HAI-20g | 1-9 | 184-187 | Figs 5-94 through 5-101 | | *The 18 story gouge would have damaged floor plates in similar fashion to Bankers Trust. These floor plate damage assessments should be made and figures included in the report.* |

| | | | | | |
|---|---|---|---|---|---|
| HAI-20h | 1-9 | 301 | 2nd par. & following bullets | | *Based on eye witnesses who noted the gouge in the south face (p.301 NCSTART 1-9) the structural assessment should include the 18 story gouge between column 19 and 20 as structural damage.* |
| HAI-20i | 1-9 | 601 | 1st par./3rd sent. | "The collapse of WTC 1 damaged seven exterior columns on the lower floors of the south and west faces ... " | *Replace with:* "The collapse of WTC 1 caused significant structural damage to the south and west faces ... " |
| HAI-20j | 1-9 | 602 | 2nd par./2nd sent. | "The collapse of WTC 1 caused (1) structural damage that severed seven (out of 58) exterior columns on the lower floors of WTC 7; ..." | *Add following original text "... structural damage on floors 44 through 47 between columns 19 and 21, and an 18-floor gouge from floors 44 through 47 between column 19 and 20; ..."* |
| HAI-20k | 1-9 | 609 | Section 14.2/1st bullet | "WTC 7 withstood debris impact damage that resulted in seven exterior columns being severed and ..." | *Replace with: "WTC 7 withstood debris impact damage that resulted in significant structural damage to the south and west faces ..."* |
| HAI-20l | 1-9 | 612 | 4th par./1st sent. | "Severed columns were located between Floors 7 and 17 on the south face (six columns) and the west face (one column) near the southwest corner" | *Add following original text:* " Additional structural damage was sustained on floors 44 through 47 between columns 19 and 21 and a gouge extended over 18 floors (floor 24 through 41) between column 19 and 20." |
| HAI-21 | **Comment:** | Windows broken out by debris or fire should be described as "broken or lost" instead of "open." (NCSTAR 1-9 pp 87-292) Fires which cannot be seen may still exist in the interior and should be described as "no longer visible" rather than having died out or been extinguished (NCSTAR 1A pp. 17-18; NCSTAR 1-9 pp 87-292). This is primarily in Vol 9 Chapter 5, but is done elsewhere as well. | | | |
| | **Reason for Comment:** | Clarification. | | | |
| | | | | **COMPARISON TO OTHER BUILDING FIRES** | |
| HAI-22 | **Comment:** | The NIST draft documents repeatedly assert that "the uncontrolled Fires in WTC7 were similar to fires in other tall buildings" (e.g. One Meridian Plaza and First Interstate Bank). The fires in WTC 7 were vastly different from One Meridian Plaza or First Interstate Bank. | | | |
| | **Reason for Comment:** | Accuracy. | | | |
| | **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| HAI-22a | 1A | xxxi | 2nd par./5th sent. | "Instead, the fires in WTC 7 were similar to those that have occurred in several tall buildings where the automatic sprinklers did not function or were not present." | *Delete.* |
| HAI-22b | 1A | xxxii | 1st par/2nd sent. | "These uncontrolled fires had characteristics similar to those that have occurred previously in tall buildings." | *Delete.* |
| HAI-22c | 1A | xxxiii | 4th par./2nd sent. | "... and subsequently withstood conventional fires on several floors for almost seven hours." | *Replace with* : "... and subsequently withstood fires involving typical office combustibles on several floors for almost seven hours." |
| HAI-22d | 1A | 43 | 1st bullet on page | "... and subsequently withstood conventional fires on several floors for almost seven hours." | *Replace with:* " ... and subsequently withstood fires involving typical office combustibles on several floors for almost seven hours." |
| HAI-22e | 1A | 43 | 3rd bullet | "WTC 7 collapsed due to uncontrolled fires with characteristics similar to previous fires in tall buildings. The fires in WTC 7 were similar to those that have occurred previously in several tall buildings (One New York Plaza, 1970, First Interstate Bank, 1988, and One Meridian Plaza, 1991) where the automatic sprinklers did not function or were not present. However, because of differences between their structural designs and that of WTC 7, these three buildings did not collapse. | *Delete.* |
| HAI-22f | 1A | 57 | 2nd par./5th sent. | "Instead, the fires in WTC 7 were similar to those that have occurred previously in several tall buildings where the sprinklers did not function or were not present." | *Delete.* |
| HAI-22g | 1-9 | 341 | 1st par./last sent. | "Nist (sic) therefore concluded that the fires in First Interstate Bank and One Meridian Plaza were at least as severe, and probably more severe, than the fires in WTC7." | *Delete.* |

| | | | | | |
|---|---|---|---|---|---|
| HAI-22h | 1-9 | 609 | 1st bullet | "... and subsequently withstood conventional fires on several floors for almost seven hours." | *Replace with* : "... and subsequently withstood fires involving typical office combustibles on several floors for almost seven hours." |
| HAI-22i | 1-9 | 609 | 1st bullet | "WTC 7 collapsed due to uncontrolled fires with characteristics similar to previous fires in tall buildings. The fires in WTC 7 were similar to those that have occurred previously in several tall buildings (One New York Plaza, 1970, First Interstate Bank, 1988, and One Meridian Plaza, 1991) where the automatic sprinklers did not function or were not present." | *Delete.* |
| | | | | | |
| HAI-23 | **Comment:** | The report identifies fires on floors 7-9, 11-13, 14, 19, 22, 29, and 30. The report concludes that there were no other fires (e.g. NCSTAR 1A, p.25; NCSTAR 1-9, p.246). Evidence of fires observed on floors above the 40th floor on the south face exists. FDNY personnel and building occupants have reported witnessing fires on other, specific floors. | | | |
| | | | | | |
| | **Reason for Comment:** | Accuracy. | | | |

| Comment Number | | | | | |
|---|---|---|---|---|---|
| | **Comment:** | Editorial Error | | | |
| HAI-24 | **Reason for Comment:** | Corrections of editorial errors | | | |
| | **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| HAI-24a | 1A | 5 | Fig. 1-2 | Caption of the subsystems box in the figure is cut off. | Fix figure text. |
| HAI-24b | 1-9 | 36 | 2nd par. | "A 7/16 in. thickness was used in th e thermal analyses for the floor beams, based on correspondence from W.R. Grace that indicated this thickness was being applied by the contractor. It was later determined that the thickness that was to be applied was 1/2 in., rather than 7/16 in. This difference has little, if any, effect on the heating of the floor beams, as shown in Section 11.4.1." | *Replace with:* "A 7/16 in. thickness was used in the thermal analyses for the floor beams, based on correspondence from W.R. Grace that indicated this thickness was being applied by the contractor. It was later determined that the thickness that was to be applied was 1/2 in., rather than 7/16 in. This difference has little, if any, effect on the heating of the floor beams, as shown in Section 11.4.1." |
| HAI-24c | 1-9 | 90 | 3rd par./8th sent. | "A frame taken from the clip is shown on the right side of Figure 5-1." | *Replace* "right side" *with* "bottom" |
| HAI-24d | 1-9 | 128 | 1st par./2nd. Sent. | "Figure 5-37 shows a view looking across the four story high lobby from the northwest towards the southeast." | *Replace* "Figure 5-37" with "Figure 5-39" |
| HAI-24e | 1-9 | 151 | 1st par./last sent. | "Promenade, indicated by an arrow in the right-hand image in Figure 5-53, is difficult to identify because it is in shadow." | *Replace with:* "Promenade, indicated by an arrow in the right-hand image in Figure 5-53, is difficult to identify because it is in a shadow." |
| HAI-24f | 1-9 | 169 | 4th & 5th par. | "In a frame from a distant view of WTC 7 captured from a helicopter video (not shown) much of the south face was smoke free, and some details could be seen." | *The frame should be added from the video as a figure.* |
| HAI-24g | 1-9 | 180 | bottom of page | Figure 5-90 is missing. | *Figure 5-90 should be added.* |
| HAI-24h | 1-9 | 183 | Figure 5-92 | floor designations on the right side of the figure are distorted | *Revise figure to correct floor designations.* |
| HAI-24i | 1-9 | 225 | last par./3rd sent. | "This is the first observation of large amounts of effluent flowing from fires on the north side of the 8th floor and suggests that an internal flow pathway to the east or south faces from these windows was available." | *Replace with:* "This is the first observation of large amounts of effluent flowing from fires on the north side of the 8th floor and suggests that an internal flow pathway to the east or south faces from these windows was not available." |
| HAI-24j | 1-9 | 341 | 1st par./last sent. | "Nist therefore concluded that the fires in First Interstate Bank and One Meridian Plaza were at least as severe, and probably more severe, than the fires in WTC 7." | *Replace with:* "NIST therefore concluded that the fires in First Interstate Bank and One Meridian Plaza were at least as severe, and probably more severe, than the fires in WTC 7. " |
| HAI-25 | **Comment:** | Figures 11-51 and 52 have their captions switched, 51 labeled as 1100 C increases more slowly than 52 labeled ASTM E119 | | | |
| | **Reason for Comment:** | Editorial | | | |
| | **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| HAI-25a | 1-9 | 531 | fig 11-51 | | *use caption from p. 532* |
| HAI-25b | 1-9 | 532 | fig 11-52 | | *use caption from p. 531* |

From: Benjamin Stein <bstein@nist.gov>
To: "wtc@nist.gov" <wtc@nist.gov ...snip...
Cauffman <cauffman@nist.gov>
Subject: FW: 3: NIST WTC 7 Investigation Finds Building Fires Caused Collapse

Received: from smtp.nist.gov (129.6.16.227) by wsex01.xchange.nist.gov
(129.6.13.33) with Microsoft SMTP Server (TLS) id 8.1.291.1; Mon, 25 Aug 2008
14:13:32 -0400
Received: from postmark.nist.gov (emailha1.nist.gov [129.6.16.196]) by
smtp.nist.gov (8.13.1/8.13.1) with ESMTP id m7PIIcNS008488 for
<bstein@xchange.nist.gov>; Mon, 25 Aug 2008 14:18:39 -0400
Received: from smtp.nist.gov (rimp2.nist.gov [129.6.16.227]) by
postmark.nist.gov (8.13.1/8.13.1) with ESMTP id m7PIITDL019197; Mon, 25 Aug
2008 14:18:30 -0400
Received: from spamav2.nist.gov (spamav2.nist.gov [129.6.13.239]) by
smtp.nist.gov (8.13.1/8.13.1) with ESMTP id m7PIIHij002146; Mon, 25 Aug 2008
14:18:17 -0400
Received: from planet.dialup4less.com (planet.dialup4less.com [65.200.22.7])
by spamav2.nist.gov (8.14.1/8.14.1) with ESMTP id m7PIIFaP016258
(version=TLSv1/SSLv3 cipher=DHE-RSA-AES256-SHA bits=256 verify=NOT); Mon, 25
Aug 2008 14:18:17 -0400
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(authenticated bits=0) by planet.dialup4less.com (8.13.1/8.13.1) with ESMTP
id m7PI9ngt021920; Mon, 25 Aug 2008 11:10:22 -0700
From: Dan Baron <danbaron@dialup4less.com>
To: NIST-stein <ben.stein@nist.gov>, NIST-newman <mnewman@nist.gov>,
counterpunch <counterpunch@counterpunch.org>, garcia <mango@idiom.com>,
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Date: Mon, 25 Aug 2008 14:15:53 -0400
Subject: 3: NIST WTC 7 Investigation Finds Building Fires Caused Collapse
Thread-Topic: 3: NIST WTC 7 Investigation Finds Building Fires Caused
Collapse
Thread-Index: AckG3kjLhxTnlP3DStiGXfdnf472nw==
Message-ID: <48B2F6D9.2010700@dialup4less.com>
X-MS-Exchange-Organization-AuthAs: Anonymous
X-MS-Exchange-Organization-AuthSource: wsex01.xchange.nist.gov
X-MS-Has-Attach: yes
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user-agent: Thunderbird 2.0.0.16 (X11/20080707)
x-nist-mailscanner: Found to be clean, Found to be clean
x-nist-mailscanner-information:
x-nist-mailscanner-from: danbaron@dialup4less.com
x-proofpoint-virus-version: vendor=fsecure
engine=1.12.7160:2.4.4,1.2.40,4.0.166
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adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000

definitions=main-0808250124
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Content-Type: multipart/related;
boundary="_C09_48B2F6D92010700dialup4lesscom_"; type="multipart/alternative"
MIME-Version: 1.0

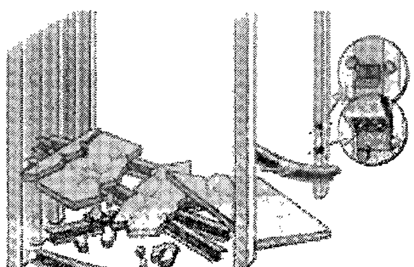
2008-08-25

Sorry for me continuing to beat on this, but I noticed one more thing about the NIST article.

*"The heat from these uncontrolled fires caused thermal expansion of the steel beams on the lower floors of the east side of WTC 7, damaging the floor framing on multiple floors. Eventually, a girder on Floor 13 lost its connection to a critical interior column that provided support for the long floor spans on the east side of the building. The displaced girder and other local fire-induced damage caused Floor 13 to collapse, beginning a cascade of floor failures down to the fifth floor."*

*"The buckling resulted from fire-induced damage to floors around Column 79, failure of the girder between Columns 44 and 79, and cascading floor failures."*

From the above quotes, Sunder is saying that on Floor 13, the floorbeam (girder) between Columns 44 and 79 expanded (became longer) and *"lost its connection"* to Column 79. I'll put two diagrams below from the article, so I can show what I want to show you.



VIDEO: The Collapse of World Trade Center 7: Why the Building Fell

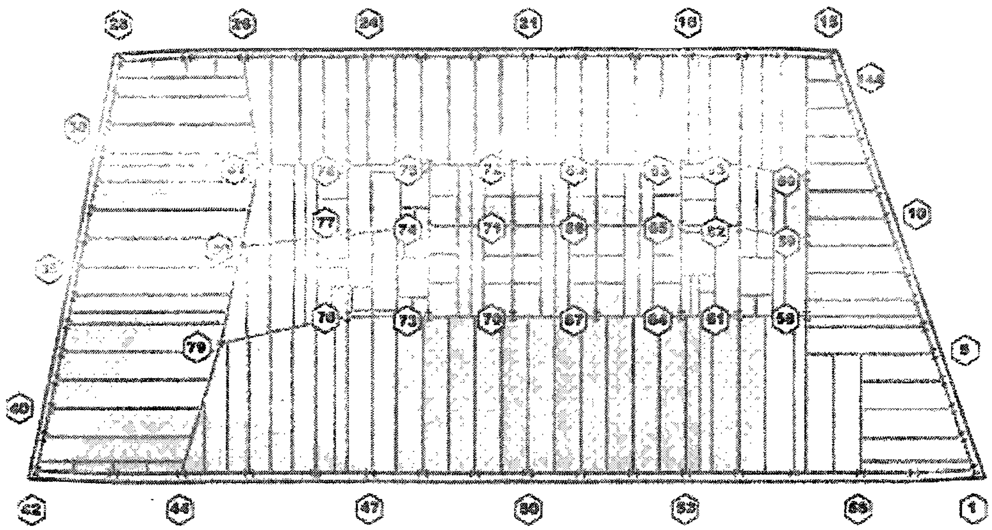


Diagram 0
Diagram 1

(In Diagram 1, the direction north is towards the right of the page, i.e., Column 28 is at the southwest corner, and Column 1 is at the northeast corner.)

To make things simple, let's call the floorbeam on Floor 13 extending between columns 44 and 79, 'Floorbeam A'.

Diagram 0 shows that Floorbeam A was constrained from below and above by two clip angles. A clip angle is a rectangular flat steel plate which is bent parallel to two of its opposite edges, into a 90 degree angle. At the end connection in question, the vertical 'legs' of each of the two clip angles were attached to Column 79, and the horizontal legs were attached to the bottom and top of Floorbeam A. You can see that the 'bend lines' of these two clip angles were oriented horizontally.

Diagram 0 shows that the heat expansion of Floorbeam A sheared (like cutting with a scissors) the bolts which fastened it to the two clip angles' horizontal legs. I agree that under certain circumstances, that could happen. In that case, as Floorbeam A expanded, there would had to have been relative movement between it and the clip angles' horizontal legs, and the bolts would be sheared. In order for this to have occurred, Column 79 had to provide resistance to Floorbeam A's expansion. In Diagram 1, this would mean that Column 79 in effect, pushed against the west end of Floorbeam A, i.e., Column 79 pushed east. But interestingly, Sunder is implying that sometime after that, Column 79 began 'pulling' in the opposite direction, west, allowing Floorbeam A to fall out of its connection with Column 79 (to slide out from between the two horizontal clip angle legs), and Floor 13 then to at least partially collapse, as shown in Diagram 0. I assume that Sunder is implying that once Floorbeam A was gone, that Column 79 buckled in the direction of where Floorbeam A had been, bowing east. I'm not saying that this sequence of events is impossible, but it sure seems unlikely to me that the two changes in directions of Column 79's horizontal forces, would be instantaneous.

(If you instead think that the bolts connecting Floorbeam A to Column 79 failed because Floorbeam A 'sagged' due to heat, then I think you are wrong. Visible vertical deflection at the center of a structural steel beam (sagging) occurs at very high temperatures; not at temperatures, *hundreds of degrees below those typically considered in current practice for fire resistance ratings.".*)

In summary, I think the article in no way makes an 'open and shut case', and is actually about as clear as mud. Maybe both volumes together of the report are clearer, and make a better case. Maybe, someone will read them in their entirety.

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2008-08-23
[
Here are some additional things I thought of, concerning this NIST report.

(Everything I put yesterday, and am putting today, came from my head alone. I haven't read any commentaries or heard any analysis. Last night, I heard on the radio that the initial report had been released, and I Googled the article shown below, and then read it. I'm not implying this makes my comments special, I'm just saying they are my own. If others come to similar conclusions, then you can judge for yourself what that might indicate.)

Comments:

This is one report that people who are knowledgeable in science and engineering, should *"pound into the pavement"*.

*"the fires burned out of control on six lower floors. The heat from these uncontrolled fires caused thermal expansion of the steel beams on the lower floors of the east side of WTC 7, damaging the floor framing on multiple floors."* Any proof of this, or is it only an assertion?

*"Eventually, a girder on Floor 13 lost its connection to a critical interior column that provided support for the long floor spans on the east side of the building. The displaced girder and other local fire-*

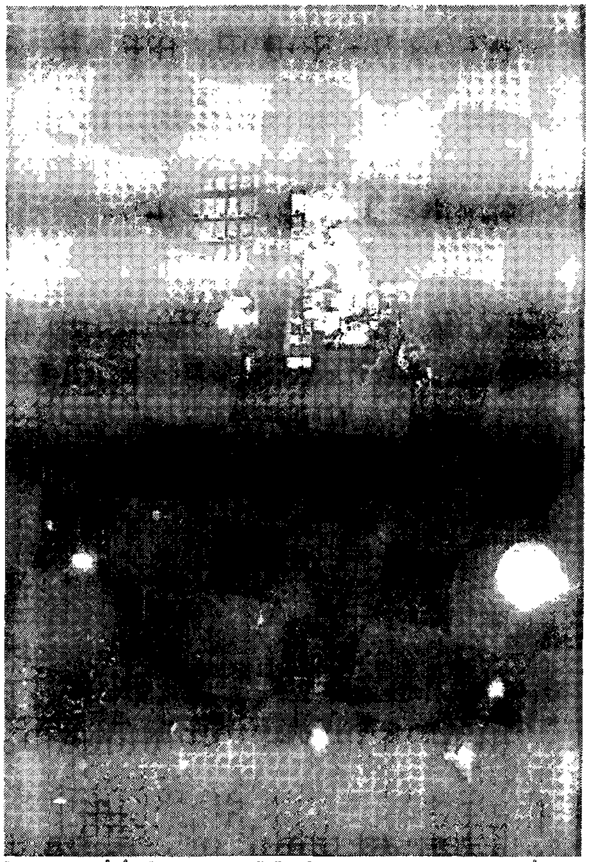
*induced damage caused Floor 13 to collapse, beginning a cascade of floor failures down to the fifth floor. Many of these floors had already been at least partially weakened by the fires in the vicinity of the critical column. This collapse of floors left the critical column unsupported over nine stories."* The assertion that *"many of these floors had already been at least partially weakened by the fires in the vicinity of the critical column"* is just NIST's opinion, as far as I can determine. In fact, the entire quotation seems to be only assertions without evidence. Anyone can construct a narrative, right?

Where did the oxygen come from for these *"out of control"* fires? As far as I am aware, most of the windows in WTC7 retained their glass until the collapse. Also, where was all of the smoke?

As far as I know, NIST made this report without any physical evidence. I think all of the structural steel from WTC7 was long gone by the time the investigation began. And yet, NIST claims to have determined the particular connection, out of thousands, which initiated the collapse. To me, this is analogous to a 757 crashing and sinking in the deepest part of the ocean, and then the NTSB saying it did a computer simulation, and knows for sure, the particular part which failed and caused the jet to fall out of the sky.

Concerning *"the most complex computer simulations ever conducted"*. Obviously, the answers which were output, depended upon the initial conditions which were input. Those initial conditions would consist of a set of events comprising causation, {A,B,C,...}. The entire set of input must be correct for the output to be correct. NIST does not enumerate what those initial conditions were. If it had, it could have assigned an estimated probability to each supposed individual causal event. The probability of the entire set occurring, could then have been calculated as the product of the individual probabilities. I bet that any honest calculation of the set probability, would have been much less than 0.1.

Big fires have burned more intensely and for longer times in other steel skyscrapers previously, and none collapsed. For instance, in 2005, the Windsor Building, in Madrid, underwent a real inferno, as shown below. It burned for 24 hours, and still stood. What was unique about WTC7, which caused it to be the one steel skyscraper in history to collapse from a fire? (Of course, if you also count WTC1 and WTC2, then there have been three steel skyscrapers in history which have collapsed from fires. And amazingly, all on the same day! What do you think the odds of that are?!)



http://whatreallyhappened.com/WRHARTICLES/spain_fire_2005.html
]

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2008-08-22
[
Just a few comments about this from me. It seems useless to me to waste much time on this. Some people are ignorant; some are dumb; some don't care about the truth; some believe only what they want to believe, in every circumstance; some lie, for what they believe is their own benefit. Do you think that taking time to dispute official government *"scientific"* reports about the causes of 9/11, could indicate masochistic tendencies?

Anyway, apparently, NIST discovered a new way that steel skyscrapers can collapse. Fortunately, it also warns structural engineers about what they should be wary of in the future. Don't you think it must have been a miracle that this is the first time this failure mode manifested in the world's over 100 year history of steel skyscrapers?!

*while the partial or total collapse of a tall building due to fires* *is a rare event"*. I agree, the only one ever, of thousands, qualifies as *"rare"*.

The NIST report must be correct, because it gives such a detailed account of how the building failed, right? And NIST used computer simulations, *"the most complex computer simulations ever conducted to model a building□s response behavior and determine its collapse sequence due to a combination of debris impact damage, fires and a progression of structural failures from local fire-induced damage to collapse initiation, and, ultimately, to global collapse"*, so who can dispute the findings? On the other hand, there is the old acronym from computer science, GIGO, *"garbage in, garbage out"*. But then again, you have to marvel at the amazing accuracy of computer simulations that, for instance, can predict the directions of hurricanes - even an hour into the future!

NIST is saying that a long steel floor beam expanded from fire heat, and broke its end connection, to column 79. The first problem I think of with that, is that the expansion would push the end of the beam against the column, making it difficult for it to detach from the clip angle it was resting on. More likely, the expansion would only cause column 79 to bow. NIST shows a picture of the detachment, but says nothing else. Secondly, NIST says this happened at temperatures □*hundreds of degrees below those typically considered in current practice for fire resistance ratings."*. The problem with that is, that skyscrapers have always been designed for the forces due to steel expansion from the thermal loads of the exact temperatures of current practice for fire resistance ratings. The possibility of fires in skyscrapers is not something that structural engineers never thought of. And you know, the last thing a structural engineer wants to happen, is to have a structure he designed fail. The smallest possibility will keep him awake at night.

Don't just the intricacy and certitude of NIST's findings, raise your mind's *"con"* flag?

□*hundreds of degrees below those typically considered in current practice for fire resistance ratings."* To me, this indicates that there was no way that NIST could make a case for the fire being hot enough to substantially soften the steel, so instead it played the only other card it thought it had, what I would call, *"the tall tale"*. Didn't Hitler say something about the willingness of people to believe really big lies? I think this is NIST whistling past the graveyard, the king walking down the street naked.

How about this problem? NIST doesn't say anything about what exactly it was that was burning. It says, it wasn't fuel oil. Then, what was it? Office furniture? How hot were the flames? It is impossible for a fire to heat an object to a temperature higher than that of itself, right? --> Heat flows from higher temperature to lower.

*"NIST found that the impact of debris from the collapse of WTC 1 ignited fires on at least 10 floors of WTC 7, and the fires burned out of control on six lower floors."* Does that make sense to you? WTC1 was 355 feet from WTC7. http://911research.wtc7.net/wtc/analysis/wtc7/index.html And anyway, how could debris falling on WTC7, ignite fires on 10 of its floors? Because NIST proclaims it could?

Do NIST's precise recommendations for preventing another occurrence of such a catastrophe, remind you of the murderer who provides the police with so many tantalizing leads for finding the killer?

***"The team said that the smallest blast event capable of crippling the critical column would have produced a 'sound level of 130 to 140 decibels at a distance of half a mile,'*** . I won't argue with that. But how about this? How many decibels do thermite and thermate produce?

The lead NIST investigator, Shyam Sunder, has a Ph.D. in structural engineering from M.I.T. But does that prove he is honest? It could be that someone told him *"how"* WTC7 fell, and it was his job to sell it, right? A guy could be the smartest human in history, but if he is bullshitting, then it's pretty easy to make him look like a monkey, if you get the chance to publicly question him. The difficulty is, getting the chance.

And Sunder's boss is the federal government, right? Could that be like the wolf hiring the dog, to determine who killed the sheep?

Never forget these timeless words of wisdom, *"If you can't convince 'em, confuse 'em!"*.

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http://www.nist.gov/public_affairs/releases/wtc082108.html

## NIST WTC 7 Investigation Finds Building Fires Caused Collapse

# Report and Recommendations for Improving Building Safety Released for Comment

August 21, 2008

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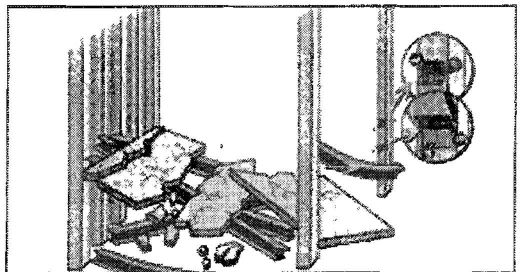
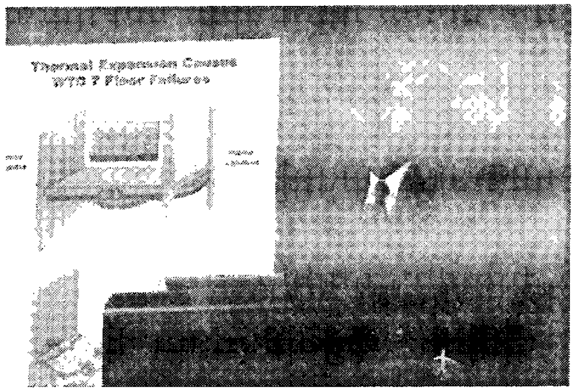
Related Documents


VIDEO: The Collapse of World Trade Center 7: Why the Building Fell

GAITHERSBURG, Md.□The fall of the 47-story World Trade Center building 7 (WTC 7) in New York City late in the afternoon of Sept. 11, 2001, was primarily due to fires, the Commerce Department□s National Institute of Standards and Technology (NIST) announced today following an extensive, three-year scientific and technical building and fire safety investigation. This was the first known instance of fire causing the total collapse of a tall building, the agency stated as it released for public comment its WTC investigation report and 13 recommendations for improving building and fire safety.

□*Our study found that the fires in WTC 7, which were uncontrolled but otherwise similar to fires experienced in other tall buildings, caused an extraordinary event,*□ said NIST WTC Lead Investigator Shyam Sunder. □*Heating of floor beams and girders caused a critical support column to fail, initiating a fire-induced progressive collapse that brought the building down.*□

□*Video and photographic evidence combined with detailed computer simulations show that neither explosives nor fuel oil fires played a role in the collapse* of *WTC* 7,□ Sunder said. The NIST investigation team also determined that other elements of the building□s construction□namely trusses, girders and cantilever overhangs that were used to transfer loads from the building superstructure to the columns of the electric substation (over which WTC 7 was constructed) and foundation below□did not play a significant role in the collapse.



Shyam Sunder, NIST lead investigator, answers questions at a news briefing on August 21 about NIST's three-year study of the collapse of World Trade Center 7.

Photo by Don Berkemeyer
View hi-resolution image

According to the report, a key factor leading to the eventual collapse of WTC 7 was thermal expansion of long-span floor systems at temperatures □*hundreds of degrees below those typically considered in current practice for fire resistance ratings."* WTC 7 used a structural system design in widespread use.

Citing its one new recommendation (the other 12 are reiterated from the previously completed investigation of the World Trade Center towers, WTC 1 and 2), the NIST investigation team said that □*while the partial or total collapse of a tall building due to fires is a rare event, we strongly urge building owners, operators and designers to evaluate buildings to ensure the adequate fire performance of the structural system. Of particular concern are the effects of thermal expansion in buildings with one or more of the following features: long-span floor systems, connections not designed for thermal effects, asymmetric floor framing and/or composite floor systems.*□ Engineers, the team said, should be able to design cost-effective fixes to address any areas of concern identified by such evaluations.

The investigators also reported that if the city water main had not been cut by the collapse of World Trade Center towers 1 and 2 (WTC 1 and WTC 2), operating sprinklers in WTC 7 would likely have prevented its collapse. Nevertheless, Sundar said, we recommend that building standards and codes be strengthened beyond their current intent to achieve life safety by preventing structural collapse even during severe fires like this one, when sprinklers do not function, do not exist or are overwhelmed by fire.

Sunder identified several existing, emerging or even anticipated capabilities that could have helped prevent WTC 7s collapse. He cautioned that the degree to which these capabilities improve performance remains to be evaluated. Possible options for developing cost-effective fixes include:

- More robust connections and framing systems to better resist effects of thermal expansion on the structural system.

- Structural systems expressly designed to prevent progressive collapse, which is the spread of local damage from a single initiating event, from element to element, eventually resulting in the collapse of an entire structure or a disproportionately large part of it. Current model building codes do not require that buildings be designed to resist progressive collapse.

- Better thermal insulation (i.e., reduced conductivity and/or increased thickness) to limit heating of structural steel and to minimize both thermal expansion and weakening effects. Insulation has been used to protect steel strength, but it could be used to maintain a lower temperature in the steel framing to limit thermal expansion.

- Improved compartmentation in tenant areas to limit the spread of fires.

- Thermally resistant window assemblies to limit breakage, reduce air supply and retard fire growth.

The 12 recommendations reiterated from the WTC towers investigation address several areas, including specific improvements to building standards, codes and practices; changes to, or the establishment of, evacuation and emergency response procedures; and research and other appropriate actions needed to help prevent future building failures.

Determining the probable collapse sequence for WTC 7, NIST found that the impact of debris from the collapse of WTC 1 ignited fires on at least 10 floors of WTC 7, and the fires burned out of control on six lower floors. The heat from these uncontrolled fires caused thermal expansion of the steel beams on the lower floors of the east side of WTC 7, damaging the floor framing on multiple floors. Eventually, a girder on Floor 13 lost its connection to a critical interior column that provided support for the long floor spans on the east side of the building. The displaced girder and other local fire-induced damage caused Floor 13 to collapse, beginning a cascade of floor failures down to the fifth floor. Many of these floors had already been at least partially weakened by the fires in the vicinity of the critical column. This collapse of floors left the critical column unsupported over nine stories.

"*When this critical column buckled due to lack of floor supports, it was the first domino in the chain,*" Sunder explained. "*What followed in rapid succession was a progression of structural failures. Failure first occurred all the way to the roof line—involving all three interior columns on the most eastern side of the building. Then, progressing from east to west across WTC 7, all of the columns in the core of the building failed. Finally, the entire fagade collapsed.*"

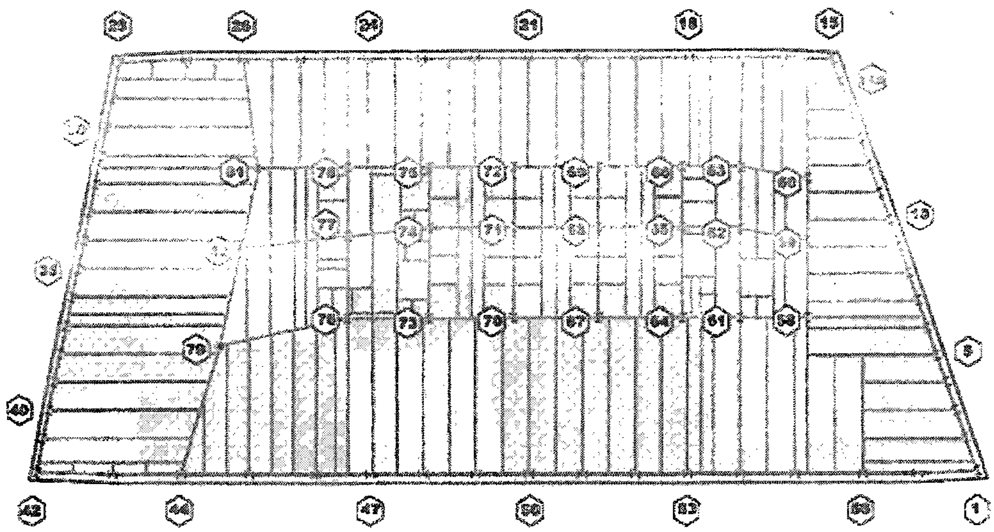


**Diagram 1—Typical WTC 7 floor showing locations of columns (numbered). The buckling of Column 79 was the initiating event that led to the collapse of WTC 7. The buckling resulted from fire-induced damage to floors around Column 79, failure of the girder between Columns 44 and 79, and cascading floor failures.**
[Download high-res version]

**The investigation team considered the possibility of other factors playing a role in the collapse of WTC 7, including the possible use of explosives, fires fed by the fuel supply tanks in and under the building, and damage from the falling debris of WTC 1.**

**The team said that the smallest blast event capable of crippling the critical column would have produced a "*sound level of 130 to 140 decibels at a distance of half a mile*," yet no noise this loud was reported by witnesses or recorded on videos.**

**As for fuel fires, the team found that they could not have been sustained long enough, could not have generated sufficient heat to fail a critical column, and/or would have produced "*large amounts of visible smoke*" from Floors 5 and 6, which was not observed.**

**Finally, the report notes that "*while debris impact from the collapse of WTC 1 initiated fires in WTC 7,***

*the resulting structural damage had little effect in causing the collapse of WTC 7.*

The investigation team found that the design of WTC 7 was generally consistent with the New York City building code in effect at the time. The estimated 4,000 occupants of WTC 7 on the morning of Sept. 11 were evacuated without any fatalities or serious injuries.

To reach the conclusions in its report, NIST complemented its in-house expertise with private-sector technical experts; accumulated an extensive collection of documents, photographs and videos related to the WTC events of 9/11; conducted first-person interviews of WTC 7 occupants and emergency responders; analyzed the evacuation and emergency response operations in and around WTC 7; and performed the most complex computer simulations ever conducted to model a building s response behavior and determine its collapse sequence due to a combination of debris impact damage, fires and a progression of structural failures from local fire-induced damage to collapse initiation, and, ultimately, to global collapse.

NIST welcomes comments on the draft report and recommendations available online at http://wtc.nist.gov received by noon Eastern Daylight Time on Sept.15, 2008. Comments (instructions for submission are available at http://wtc.nist.gov) may be submitted via:

- e-mail to wtc@nist.gov;
- fax to (301) 869-6275; or
- surface mail to WTC Technical Information Repository, Attn: Stephen Cauffman, NIST, 100 Bureau Dr., Stop 8611, Gaithersburg, Md. 20899-8610.

The NIST investigation of WTC 7 was conducted under the National Construction Safety Team (NCST) Act, as part of its overall building and fire safety investigation of the World Trade Center disaster. The act gives NIST the responsibility for conducting fact-finding investigations of building failures that resulted in substantial loss of life or that posed significant potential of substantial loss of life. NIST has no regulatory authority under the NCST Act.

As an agency of the U.S. Department of Commerce, NIST promotes U.S. innovation and industrial competitiveness by advancing measurement science, standards and technology in ways that enhance economic security and improve our quality of life.

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Related Documents

- Questions and Answers about the NIST WTC 7 Investigation
- Opening Statement Press Briefing, August 21, 2008, Report on the Collapse of World Trade Center Building 7
- NIST Response to the World Trade Center Investigation Disaster Presentation, Dr. S. Shyam Sunder, Director and Lead Investigator, Building and Fire Research Laboratory, NIST
- NIST NCSTAR 1A, Final Report on the Collapse of World Trade Center Building 7
- NIST NCSTAR 1-9, Structural Fire Response and Probable Collapse Sequence of World Trade Center Building 7
    - Volume 1: Chapters 1 through 8
    - Volume 2: Chapters 9 through 14 and Appendixes A through E
- NIST NCSTAR 1-9A, Global Structural Analysis of the Response of World Trade Center Building 7 to Fires and Debris Impact Damage
- Video: The Collapse of World Trade Center 7: Why the Building Fell
- Process for Submitting Comments on the WTC 7 Draft Reports
- Download High-Res Graphics: Typical WTC 7 Floor Diagram (2 MB) and Thermal Expansion Illustration (29 MB)
- Link to WTC 7 Report Webcast, Thursday, Aug. 21, 11 a.m. EDT

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To stop future transmissions from me,
you can reply to this e-mail. In the subject
line, before "Re:", put *"stop"*, *"desist"*, or
*"no more"*, etc. I should get the idea.
If you then still get stuff, it means I
missed your request. In that case, just do
it again. I probably won't miss it twice.
Anyway, my intention is not to send to you,
what you would prefer not to receive.

Best wishes, / Dan Baron.

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From: "Dan Goodwin" <dangoodwin@skyscraperdefense.com>
To: <wtc@nist.gov>
Cc: <dangoodwin@skyscraperdefense.com>
Subject: WTC 7 Final Report

# SKYSCRAPER DEFENSE™

THE GLOBAL LEADER IN SKYSCRAPER SAFETY & SECURITY

NIST World Trade Center Investigation Team
100 Bureau Drive, Stop 8610
Gaithersburg, MD 20899-8610
Phone: (301) 975-6051
Fax: (301) 975-6122
Email: wtc@nist.gov

Re: WTC 7 NIST Final Report

Dear NIST,

On behalf of the community devoted to the safety and the security of the world tallest skyscrapers, we were hoping you would take the time to respond to these questions.

1) In your video presentation, you state that there were no witnesses that reported hearing explosions at the time of the collapse. But yet, thanks to the New York Times who sued under the Freedom of Information Act, there were numerous fire fighters and first responders that reported hearing explosions occurring during the time of the collapse.

   How do you respond?

2) Upon reviewing the actual video of the WTC 7 collapse, then comparing it to your presentation and visualization model, it appears the two collapses are not identical. The video clearly shows the entire structure collapsing straight down into the basement at nearly free fall speed. While your presentation and visualization model shows the floors collapsing gradually, then gaining speed as the outer-walls collapse as well.

   How do you explain this?

3) It has been reported that during the removal of the debris, numerous steel beams were discovered deep in the pile, glowing red, weeks after the collapse. Did NIST examine any of these steel beams for evidence of explosive residue?

4) If the towers collapsed as your report indicates, how do you explain the rate of speed – which can only be described as a free fall…during the collapse?

5) Have you seen the video documentary by BBC – Rebuilding America that has Larry Silverstein stating the fire department had decided to "Pull" the building? - which as you know is slang for demolish! Have you questioned Mr. Silverstein regarding this comment? And do you know who the fire chief was that gave that order?

6) Considering it was common knowledge that a commercial aircraft could crash into the World Trade Centers, and that the engineers had designed the towers to withstand such impact, do you

believe the fire department could have extinguished the fires if they had been properly prepared?

7) If your report is correct, that the ensuing fires was the cause of the collapse of all three towers, and that the fire department was able to extinguish the fires, do you believe we could have shored up the damaged floors and prevented the towers from collapsing?

8) Do you believe the design of skyscrapers that are being built today are any better than they were prior to 9/11? Or do you believe we are modeling the same mistakes?

9) Based on your findings, how many skyscrapers worldwide do believe are at risk of collapsing today if faced with the same catastrophic fire?

10) Do you believe that the Skyscraper Defense Act would be a viable solution to the problems that we are facing today regarding our towering skyscrapers?

http://www.skyscraperdefense.com/skyscraper_defense_act.html

On behalf of everyone that shares our common concern, we thank you. We appreciate your answers.

Dan Goodwin
President & Founder of Skyscraper Defense™ http://www.skyscraperdefense.com/

**Stephen Cauffman**

|  |  |
|---|---|
| **From:** | wtc@nist.gov |
| **Sent:** | Wednesday, September 10, 2008 4:05 PM |
| **To:** | Stephen Cauffman |
| **Subject:** | Fwd: WTC Web Site Question : General Public |

X-Sieve: CMU Sieve 2.3
X-Authenticated: #16198971
X-Provags-ID: V01U2FsdGVkX18G1R8sepsGaYQr9GrWLbjEIs/GUi0kbF0TZnIaUR
5lnDoXjhA+aJNz
From: "Danie Kuhn" <daniel.kuhn75@gmx.net>
To: <wtc@nist.gov>
Subject: WTC Web Site Question : General Public
Date: Tue, 9 Sep 2008 23:56:20 +0200
X-Mailer: Microsoft Windows Mail 6.0.6001.18000
X-Y-GMX-Trusted: 0
X-FuHaFi: 0.57,0.57
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-09-09_14:2008-09-02,2008-09-09,2008-09-09 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0809090160
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: daniel.kuhn75@gmx.net
X-NIST-MailScanner-Information:

Dear Sir or Madam

I have a few questions about the "**Global Structural Analysis of the Responce of World Trade Center Building 7 to Fires ans Debris Impact Damage**".

http://wtc.nist.gov/media/NIST_NCSTAR_1-9A_for_public_comment.pdf

In particular about the **Ansys LS-Dyna FE Analysis**.

In Figure **4-18** to **4-35** (Page 80-90) and Figure **4-43** to **4-62** (Page 95-108).

Is there any displacement scaling in those Figures?
I assume that the Ansys setting DMULT was set to 1 (DMULT = 1) in your Analysis, so the displacement was not scaled.
Is this correct?
I also Assume the large-deflection key (NLGEOM) was set ON (NLGEOM=ON) so the large deflection effects was not ignored.
Is this correct?

Did NIST use any deflection scales without mention it and/or mention the deflection scale in the WTC7 Report(s)?

with kind regards

Daniel Kuhn
Muttenz, Switzerland

From: Dan <dtg86@yahoo.com>
Subject: Question regarding WTC7 Final Report
To: wtc@nist.gov

To NIST:

I am certain this may not be the first time this question will be asked, perhaps it can be answered in a future update public notice.

Did NIST perform any live fire test experiments to test this "Thermal Expansion" theory?

Now that the investigation is over, will NIST be releasing its supporting data on its hypothesis?

Thank You

Dan K.

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To: wtc@nist.gov
From: <Dan.Noel@ieee.org> (by way of NIST Inquiries <inquiry@nist.gov>)
Subject: World Trade Center, 3rd destruction, questions...

Hello!

Thank you for your lengthy report on the destruction of the 3rd World Trade Center building. Since the steel was shipped shortly after the event, it must have taken an extraordinary effort for NIST to reconstruct the failure mechanism.

Still, your report appears to leave several important aspects of this major structural failure enigmatic. Could you kindly clarify them?

1. The failure of the building left a high quantity of liquid iron alloy under its rubble. I don't have numbers in mind, but we are talking of several cubic meters of liquid Fe for maybe a month. Your report seems to make no allusion to this phenomenon, not even to state that NIST could not come up with a model that would account for it. Did I miss something?
2. The structural failure would have initiated at floors 7 to 9. But assuming the lower portion of the frame was intact, it would have countered the fall of the upper part of the building. Yet the videos taken of the failure show the whole building failing into the ground as a piston inside a sleeve with no resistance. These videos strongly suggest that the movement of the building was initiated at ground level, with all support columns failing simultaneously. Does NIST have an explanation for this contradiction?
3. Since the whole frame turned into rubble and almost neatly filled the basements, it is actually likelier that the failure started close to the bottom of the frame, deep in the basement. This further affects the credibility of the floor 7-9 hypothesis.
4. The language of the report is often conditional, with critical statements built around "can", "only in this particular case", or "eventually". Sadly, the alternatives to these statements are not well explored. Will NIST go back to them?
5. NIST is certainly aware of previous research that found mysterious Fe spheres in the μm range in the World Trade Center dust. NIST's report on the twin towers did not mention them. Does the report address this finding? Did NIST come up with some plausible explanation for it?
6. The Bush administration has been often accused of waging a war against science. Should a detailed reading of the report confirm the above suspicions, this considerable work by NIST will fuel this sad argument.

Love,
Dan Noël
Consultant, Engineering
1098 Glen Circle
Costa Mesa, CA 92627

From: Shyam Sunder <sunder@nist.gov>
To: "'pregrp@aol.com'" <pregrp@aol.com>
Subject: Re: Section 13.2, NIST Report WTC 7

Dave,

These were large floors and the combustibles did not ignite simultaneously. The fires spread from combustble to combustible, and from office module to office module. The floor area around column 79 was about 2000 sq. ft. Also, the combustible load on this floor was 6.4 psf about 60 percent greater than the WTC towers and the lower floors of WTC 7. Finally, floors 11 to 13 were not typical open floor plans as in the Lowe floors and the towers. They had individual offices around the perimeter providing a barrier to the rapid spread of fires.

Shyam

---

**From:** pregrp
**To:** Shyam Sunder
**Sent:** Wed Aug 27 08:40:45 2008
**Subject:** RE: Section 13.2, NIST Report WTC 7

Shyam,

In this note you indicate "ordinary combustibles and combustible load levels." Â However, in your report it shows high fire temperatures in the area of Column 79 that lasted for two hours. Â What source of combustion allowed the fire to last that long?

Dave

On Aug 26, 2008, at 5:55:46 PM, "Shyam Sunder" <sunder@nist.gov> wrote:

**From:** "Shyam Sunder" <sunder@nist.gov>
**Subject:** **RE: Section 13.2, NIST Report WTC 7**
**Date:** August 26, 2008 5:55:46 PM EDT
**To:** "'FPESCHULTE@aol.com'" <FPESCHULTE@aol.com>,Â "Nadine_Post@mcgraw-hill.com" <Nadine_Post@mcgraw-hill.com>
**Cc:** "Pregrp@aol.com" <Pregrp@aol.com>,Â "Gail Crum" <crum@nist.gov>

---

Rich,

Â

Our report states that observations support a single point of fire ignition on any given floor in WTC 7. Â We also state that there were no obvious pathways for the flames and heat to pass from one floor to another, aside from the debris damaged area in the southwest corner of the building.Â We also did not see flame spread outside the building.

Â

The fires in WTC 7 were similar to fires in the other buildings cited due to seven specific factors we identify in the report:

1. Ordinary combustibles and combustible load levels.

2. Local fire origin on any given floor.
3. No widespread use of accelerants.
4. Consecutive fire spread from combustible to combustible.
5. Fire-induced window breakage providing ventilation for continued fire spread and accelerated fire growth.
6. Concurrent fires on multiple floors.
7. Active fire protection systems rendered ineffective (sprinklers and manual suppression systems).

Â

Shyam

Â

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Dr. S. Shyam Sunder
Director
Building and Fire Research Laboratory
NationalÂ InstituteÂ ofÂ StandardsÂ and Technology
Gaithersburg,Â MDÂ 20899-8600
Tel.:Â 301-975-5900; Fax:Â 301-975-4032

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**From:**Â FPESCHULTE@aol.comÂ [mailto:FPESCHULTE@aol.com]Â
**Sent:**Â Tuesday, August 26, 2008 5:47 PM
**To:**Â Nadine_Post@mcgraw-hill.com
**Cc:**Â Shyam Sunder; Pregrp@aol.com
**Subject:**Â Section 13.2, NIST Report WTC 7

Â

Nadine-

Â

Item 9 on page 602 of the report indicates that the collapse of WTC 1 caused the ignition of fires onÂ 10 separate floors.Â These floors occurred in groups-7/8/9, 11/12/13, 19, 22, 29/30.

Â

Based upon what I have read in the report, I do not believe that this is the case.Â Â **NIST indicates that 6 separate fires must have occurred on Floors 7, 8, 9, 11, 12 and 13 because NIST did not see any indication of flame spread outside the building.**

Â

My opinion is that the collapse of WTC 1 caused fires on Floors 7 and 11 and that the fires spread to floors 8 and 9 and 12 and 13 through either improperly firestopped penetrations or through the improperly firestopped space between the edge of the floor construction and the exterior curtain wall.Â In other words, the fire spread was interior to the building.Â This would account for the fire spread on various floors lagging each other.

Â

NIST cites both fire in the First Interstate Bank Building and the One Meridian Plaza Building as examples of where fires spread between floors on the exterior of the building, however, the fire spread in the One Meridian Plaza Building was interior, not exterior.Â The fire spread through improperly firestopped penetrations.

Â

Just as an aside, fire spread between floors occurred in the fire at the Las Vegas Hilton Hotle fire in 1981.Â If I recall correctly, in this fire, the fire spread 8 floors in 25 minutes via the outside of the building-window to window above.

Â

The NIST report on WTC 7 includes no information on the firestopping detail of the space between the edge of the floor construction and the curtain wall.Â This is a glaring omission in the report.

Â

rich

---



--
David S. Collins, FAIA
**The Preview Group, Inc.Â**
*Architects providing regulatory solutions ....*
632 Race Street
513.621.2109 (o)
513.621.7297 (f)

---

From: Shyam Sunder <sunder@nist.gov>
To: "'pregrp@aol.com'" <pregrp@aol.com>
Subject: Re: Fire Progress

Dave,

Hopefully my previous response sent in a separate email addresses this question as well.

Shyam

---

**From**: pregrp
**To**: Shyam Sunder
**Sent**: Wed Aug 27 08:43:07 2008
**Subject**: RE: Fire Progress

Shyam,

On Aug 26, 2008, at 5:59:25 PM, "Shyam Sunder" <sunder@nist.gov> wrote:

> The increase in the hot area in Figure 3-6 is due to this process.Â  Hope this helps

The hot area doesn't show a process, it appears to be steady state.

Dave

--
David S. Collins, FAIA
The Preview Group, Inc.Â
*Architects providing regulatory solutions ....*
632 Race Street
513.621.2109 (o)
513.621.7297 (f)

---

From: Shyam Sunder <sunder@nist.gov>
To: "'pregrp@aol.com'" <pregrp@aol.com>
Subject: Re: Fire Progress

Dave,

The air in the upper layer on the particular floor is being heated by the fire below it. As the fire burns. the air gets hotter, while being cooled by heat loss to the ceiling. As the ceiling gets hotter, the heat loss becomes smaller. Even though the fire is moving, it is still pumping heat into that hot upper air layer. The "old" ceiling area where the fire was is still getting some heat from the area where the fire has moved.

A similar point applies to the steel and concrete. They are initially heated by the hot gases over the local fire. The steel and concrete are dissipating heat within their masses. As the fire moves, the enlarging hot upper layer continues to heat the steel and concrete. Again, the "old" ceiling area where the fire was is still getting some heat from the area where the fire has moved. The hot areas stay hot for a while due to thermal inertia, and continue to receive more heat from the nearby fire.

Shyam

---

**From:** pregrp
**To:** Shyam Sunder
**Sent:** Wed Aug 27 09:23:31 2008
**Subject:** Re: Fire Progress

Shyam,

On Aug 27, 2008, at 8:49:41 AM, "Shyam Sunder" <sunder@nist.gov> wrote:

> Hopefully my previous response sent in a separate email addresses this question as well.Â

Thanks, I am still not clear on this. Â In WTC 1 & 2 we saw the evidence in videos of the fire progressing through the building and the heat affect progressing at the same rate. Â In 7 it appears that the heat hasn't changed over a 2 hour period. Â I understand your explanation of how the fire progressed from one area to another, although there are probably more general fire areas that are burning simultaneously. Â If the fire source only lasts 20 minutes, why does the heat in the area last six times as long as the fire?

Dave

--
David S. Collins, FAIA
**The Preview Group, Inc.Â**
*Architects providing regulatory solutions ....*
632 Race Street
513.621.2109 (o)
513.621.7297 (f)

---

From: Pregrp@aol.com
Subject: Re: Fire Progress
To: sunder@nist.gov

Shyam,

In a message dated 8/28/2008 11:11:44 Eastern Daylight Time, sunder@nist.gov writes:

> As the fire moves, the enlarging hot upper layer continues to heat the steel and concrete. Again, the "old" ceiling area where the fire was is still getting some heat from the area where the fire has moved. The hot areas stay hot for a while due to thermal inertia, and continue to receive more heat from the nearby fire.

Thanks, I understand that and we saw the movement of the fire in WTC 1 and 2. In WTC 7 it appears to begin as a large fire area and stay that way for two hours. Are you saying that the fire reached those high temperatures and was fed sufficiently by the moving fires to keep the entire floor area (ceiling) at those temperatures for 2 hours?

I would have expected to see the fire start and progress ... there seems to be none of that here.

Dave

---

From: Shyam Sunder <sunder@nist.gov>
To: "'rgann@nist.gov'" <rgann ...snip... nist.gov'" <terri@nist.gov>
Subject: Fw: Fire Progress

Any reactions? How do we want to respond? Shyam

---

**From:** Pregrp@aol.com
**To:** Shyam Sunder
**Cc:** rgann@nist.gov ; terri@nist.gov ; Stephen Cauffman; wtc@nist.gov
**Sent:** Thu Aug 28 17:24:39 2008
**Subject:** Re: Fire Progress

Shyam,

In a message dated 8/28/2008 11:11:44 Eastern Daylight Time, sunder@nist.gov writes:

> As the fire moves, the enlarging hot upper layer continues to heat the steel and concrete. Again, the "old" ceiling area where the fire was is still getting some heat from the area where the fire has moved. The hot areas stay hot for a while due to thermal inertia, and continue to receive more heat from the nearby fire.

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Dave

---

From: Shyam Sunder <sunder@nist.gov>
To: "'Pregrp@aol.com'" <Pregrp@aol.com>
Subject: Re: Fire Progress

Yes, Dave. There was a lot of combustible material. The fire did move, but the combustible vapors burned where they met with air from the windows. Shyam

---

**From:** Pregrp@aol.com
**To:** Shyam Sunder
**Cc:** rgann@nist.gov ; terri@nist.gov ; Stephen Cauffman; wtc@nist.gov
**Sent:** Thu Aug 28 17:24:39 2008
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I would have expected to see the fire start and progress ... there seems to be none of that here.

Dave

---

From: Shyam Sunder <sunder@nist.gov>
To: "'wtc@nist.gov'" <wtc@nist.gov>
Subject: FW: Fire Progress

==========================================
Dr. S. Shyam Sunder
Director
Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899-8600
Tel.: 301-975-5900; Fax: 301-975-4032
==========================================

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**From:** Shyam Sunder
**Sent:** Tuesday, August 26, 2008 5:59 PM
**To:** 'Pregrp@aol.com'
**Cc:** 'rgann@nist.gov'; 'terri@nist.gov'; Stephen Cauffman; Gail Crum
**Subject:** RE: Fire Progress

Dave,

While a particular cluster of furnishings might burn out in about 20 min to 30 min, the combustibles in a whole region of a floor could (and did) burn for a much longer time. On Floor 12, the fire was spreading from office to office. To do so, the fire in the first office had to heat the ceiling tile system to the point of collapse, then form a hot gas layer over an adjacent office. When that layer was sufficiently hot, it would thermally fail the ceiling tile system over that office and then ignite the furnishings by thermal radiation (not flame contact). Thus, the spread to the adjacent office would be occurring at some time well after when the first office ignited and before it burned out. This process could accelerate when the hot upper air layer became large enough that it ignited more than one office at a time. The increase in the hot area in Figure 3-6 is due to this process. Hope this helps.

Shyam

==========================================
Dr. S. Shyam Sunder
Director
Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899-8600
Tel.: 301-975-5900; Fax: 301-975-4032
==========================================

---

**From:** Pregrp@aol.com [mailto:Pregrp@aol.com]
**Sent:** Thursday, August 21, 2008 12:17 PM
**To:** Shyam Sunder
**Subject:** Fire Progress

Shyam,

I have one question regarding the collapse of WTC 7 and its relationship to what we saw in WTC 1 and 2. In 1 and 2, there were observable fires on floors where we saw the progress of the "standard fire" moving through the building in about 20 minute segments which equated to the 10 lb fire load. In WTC 7 your diagrams indicate that the fire on the 12th floor in the vicinity of Column 79 lasted from 3 pm to 5 pm (Figure 3-6).

In WTC 1 and 2 we understand that there was some extraordinary fuel compression plus the added fuel from the aircraft and the instantaneous ignition of it all that caused significant exposure to columns in the core which led to the collapse. What was the source of fuel that fed the fire around column 79 and along that side of the WTC 7 building for two hours?

Dave

David S. Collins, FAIA
**The American Institute of Architects**
Codes Advocacy Program

The Preview Group, Inc.
*Architects providing regulatory solutions ....*
632 Race Street
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513.621.2109 (o)
513.621.7297 (f)

---

Please see the attached Comment

--David Chandler

23060 Lawson Ave
Strathmore, CA 93267
September 13, 2008

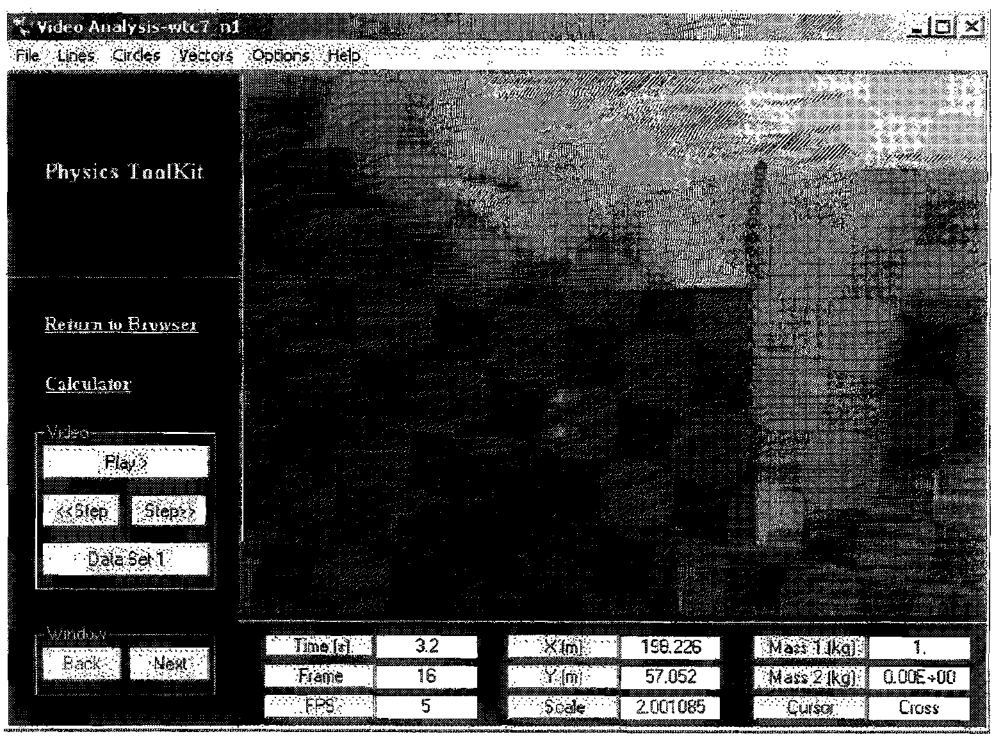
WTC Technical Information Repository
Attn: Stephen Cauffman, NIST
100 Bureau Dr., Stop 8611
Gaithersburg, Md. 20899-8610

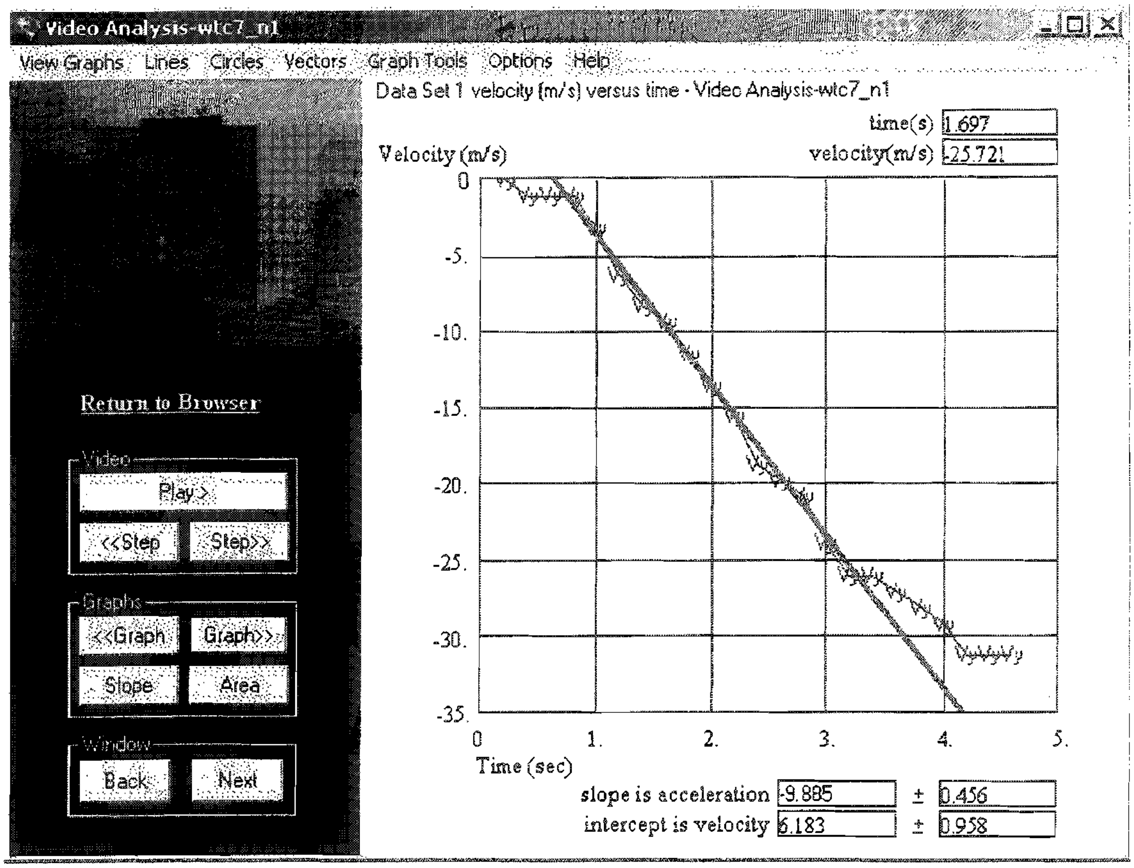
Fax to (301) 869-6275

Dear Sirs:

The WTC7 report denies that Building 7 experienced free fall based on two data points and the assumption of uniform acceleration. However, the acceleration in the measured interval was not uniform. Average acceleration is not a meaningful measurement, especially when the acceleration it describes is not uniform. It is the instantaneous acceleration that is relevant to Newton's second law and thus the forces at play.

I have measured the position as a function of time, from which velocity vs. time can be derived. It shows a period of approximately 2.5 seconds, with sudden onset, during which the acceleration was indistinguishable from free fall to the resolution of the video evidence. This corresponds to approximately eight floors that were instantly removed to the point of offering zero resistance.






A video narration showing the measurement and discussing the implications is available at http://www.ae911truth.org/+freefall. This is an easily repeatable measurement and others have, in fact, performed similar measurements. The evidence is easily measured by anyone with a background in elementary physics.

Given the easy accessibility of a velocity and acceleration measurement throughout the fall, the a priori assumption of uniformity in the NIST report is not only unnecessary, but it turns out to be false.

A question I posed at the August 26 technical briefing was asked and answered in the following way:

1. Dr Sunder acknowledged that free fall can only occur if there is no structure under the falling section of the building. In his words: "free fall time would be an object that has no structural components below it."
2. Dr Sunder acknowledges that their structural modeling predicts a fall slower than freefall. In his words: "What the analysis shows...and...uh...the structural analysis shows, the collapse analysis shows that same time that it took for the structural model to come down from the roof line all the way for those 17 floors to disappear is...um... 5.4 seconds. It's...uh..., about one point...uh...five seconds or roughly 40% more time for that free fall to happen. "

3. Dr Sunder acknowledges that there was structural resistance in this particular case. In his words, "And that is not at all unusual because there was structural resistance that was provided in this particular case. "
4. Dr Sunder acknowledges that there was a sequence of failures that had to take place and that this process was not instantaneous. In his words, "you had a sequence of structural failures that had to take place and everything was not instantaneous. "

Thus, he acknowledges that the NIST model is at variance with the observable fact that free fall actually occurred. The response appears to hold to the model and attempt to deny free fall, but the measurements offered to establish this point are irrelevant and appear to be no more than a distraction from the easily observed and measured reality.

Acknowledgment of and accounting for an extended period of free fall in the collapse of WTC7 must be a priority if the NIST is to be taken seriously.

--David Chandler

I am re-submitting my comments based on the specified format found on the NIST web site.

Please see attached.

David Chandler
American Association of Physics Teachers
Architects and Engineers for 9/11 Truth

Attention: Mr. Stephen Cauffman
National Institute of Standards and Technology
Stop 8610
Gaithersburg, MD 20899-8610

wtc@nist.gov; Fax 301-869-6275

**Name:** David Chandler
**Affiliation:**
American Association of Physics Teachers;
Architects and Engineers for 9/11 Truth
**Contact:** dchandler@ae911truth.org

**Report Number: NIST NCSTAR 1A**

**Page Number:** 40
**Paragraph/Sentence:** Last Paragraph (5th paragraph), 2nd sentence:
"Assuming that the descent speed was approximately constant,..."
**Comment:**
This is clearly a falacious statement and most likely a misstatement. I believe it was acknowledged as such in the August 26, 2008 NIST technical briefing
**Reason for Comment:**
Statement is clearly in error.
**Suggestion for Revision:**
No *a priori* assumption about velocity vs. time is warranted. It should be measured.

**Page Number:** 40
**Paragraph/Sentence:** Last Paragraph (5th paragraph), 2rd sentence:
"...the two quantities needed for the determinations were (1) a length that some feature of the building descended and (2) the time it took to fall that distance."
**Comment:**
The procedure being described gives average acceleration, which is a meaningless quantity if the acceleration is not uniform over the measured interval.
**Reason for Comment:**
Only instantaneous acceleration is relevant to the dynamics of the situation. I have measured the velocity vs. time and found that (1) the acceleration is not uniform over the period the report is considering, and (2) there is a 2.5 second interval, with sudden onset, in which the acceleration is indistinguishable from free fall to the resolution of the video data.
**Suggestion for Revision:**
Measure the velocity vs. time for the duration of the visible portion of the collapse, as I have done (see www.ae911truth.org/+freefall), and report the results of your measurements.

**Page Number:** 41
**Paragraph/Sentence:** 2[nd] paragraph/ 1[st] sentence: "The theoretical time for free fall..."
**Comment:**
The appropriate quantities to report are the velocity as a function of time and the measured acceleration over intervals where the slope of the velocity vs time graph is approximately constant.
**Reason for Comment:**
Measuring the time of fall is inappropriate. It is equivalent to a measurement of average acceleration rather than instantaneous acceleration.
**Suggestion for Revision:**
Measure the velocity vs. time and show the results as a table and a graph. Delineate the intervals during which acceleration is appropriately constant, and give the acceleration during those intervals.

**Page Number:** 41
**Paragraph/Sentence:** 3[rd] paragraph / 1[st] sentence
"Thus, the actual time for the upper 18 stories to collapse, based on video evidence, was approximately 40 percent longer than the computed free fall time"
**Comment:**
This is a highly misleading statement which should be removed and replaced with a factual, meaningful analysis of the instantaneous acceleration of the building throughout the visible portion of the collapse.
**Reason for Comment:**
This entire topic is discussed in the report in a manner which *appears* to be designed to obscure the fact that free fall for a significant time interval actually occurred. Free fall is inconsistent with NISTs modeling of the collapse of the building. Therefore the modeling of the building is flawed.
**Suggestion for Revision:**
Face the fact of free fall as evidence for explosive demolition. Reopen the investigation to include all the evidence that was categorically swept aside on the grounds that explosive demolition was ruled out. What is actually ruled out by this evidence is natural collapse.

# Comments on NIST WTC7 Report

Submitted by:

DAVID PROE, Professorial Research Fellow and
IAN THOMAS, Director
Centre for Environmental Safety & Risk Eng (CESARE),
Victoria University, Melbourne, Australia

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Email: david.proe@vu.edu.au, ian.thomas@vu.edu.au
Postal address:
PO Box 14428, Melbourne. Vic. MC8001. Australia.

Comments

1. Unless noted otherwise, all comments submitted pertain to Report NCSTAR 1-9, "Structural Fire Response and Probable Collapse Sequence of World Trade Center Building 7", 2008.
2. The assessment of WTC7 appears to conclude that composite beams are extremely susceptible to failure due to thermal expansion. This is not our experience at all.
3. We do not agree with the calculations on p. 347 indicating shear stud failure. Under the theory presented, without axial restraint at the girder end, the W24 beams try to expand, but this is entirely prevented by the slab, producing very high forces at the shear connectors. In reality, the slab is also heated and expands but more importantly the beam and slab deflect downwards due to differential thermal expansion. This relieves most of the thermal force on the studs.
4. Similarly the LS-DYNA analysis on pp. 349-354 locks in thermal stresses by imposing no translation at all slab edges and no thermal expansion or temperature rise in the slab. Both are unrealistic.
5. We conducted a series of 21 standard fire tests on simply-supported composite beams in the 1980's [1]. These were summarised and the failure times were compared with those calculated based on strength. Excellent correlation was achieved, based on full composite connection. There was no indication that shear stud failure could cause premature failure. However, the beams were 3 m in length not 16 m, but the calculations on p. 347 do not show or imply any dependence on beam length.
6. The proposed method of analysis of WTC7 does not appear to have previously been applied to any known cases, such as standard fire tests or the Cardington fire tests [2] and varies considerably from previous analyses of such tests and experiments.
7. Regarding the large-scale finite element analysis using ANSYS, it appears that the failure criteria for the slab may underestimate the true performance and be responsible for initiating the failure (although failure limits used for the studs are not clear in the report). Concrete strain limits of 0.15% in tension or 0.4% in compression are applied at the slab mid-depth, after which the slab element is completely removed from the grid (p. 487). For slab elements near beams, this removes the lateral support to the beam. When the beam subsequently

buckles, it is also removed from the analysis. Failure then progresses. This is quite unrealistic.

8. The ANSYS analysis appears to have used beam temperatures which are uniform over the beam depth, while the stud temperature is based on the average of the beam temperature and the slab temperature. A temperature gradient in the beam (which actually occurs) may be beneficial, as discussed below. The stud temperature will be affected by the beam top flange temperature but not the web and bottom flange temperatures, so may be overestimated in the analysis.

9. This analysis procedure appears to produce a gross underestimate of strength. In reality, the Cardington testing seems to show that the slab, in conjunction with its connection to the beams, greatly enhances the stability of the floor system, even when cracked and crushed locally. Tensile membrane action in the slab provides a great benefit in performance. Thermally-induced deflections of both the beam and the slab also help, as they promote catenary support mechanisms (including tensile membrane action).

10. Programs such as ABAQUS, VULCAN and ADAPTIC have been used by many researchers to model these effects in the Cardington tests [3,4,5,6]. Reasonable agreement has been obtained, supporting the validity of both the test method and the analysis procedure. We are not aware of ANSYS or LS-DYNA being used and compared with fire tests or other experimental data, although they may also be suitable if used correctly. It should be noted that the modelling of concrete in fire remains a challenging task. Each of the aforementioned programs incorporates a complex algorithm for this calculation, and considerable effort would have to be made to set up a reasonable model in a different program.

11. One factor limiting the performance of the slab in WTC7 would appear to be the very light reinforcement mesh used, being 60 $mm^2/m$ compared with 142 $mm^2/m$ in Cardington and 250 $mm^2/m$ being more typical. On the other hand, the steel deck was insulated (not usual in Australia) and would have provided considerable tensile capacity in one direction. In the direction perpendicular to the deck ribs, there was not much tensile capacity in the slab.

12. The thermal response calculations appear strange. We have used thermal properties derived from our local 3-sided Monokote tests to calculate steel temperatures [7]. We have obtained results similar to those shown in Fig 4.7 (p. 84), indicating that our material may be similar to that used in WTC7. We calculate a fire-resistance period of 67 mins for 0.5 inches and 550°C, not 120 minutes. We assume the difference may be due to the restrained fire testing used in USA, permitting higher steel temperatures. However, the results shown Fig 11.51 (p. 531) apply to the same beam and the same 1100 °C fire temperature but produce much lower temperatures. They do not mention temperature gradient in the beam, so we are not sure whether they have considered the 3-sided exposure. At 60 mins, the 4-thermocouple average temperature from Fig. 4.7 would be about 800 °C, while Fig 11.51 shows about 630°C. On the other hand, Fig 11.52 shows exposure to standard fire conditions, indicating that 0.5 inch produces 550 °C after only 23 minutes. Surely this cannot give 120 mins even when tested restrained.

13. In summary, we do not agree with the conclusions of the analysis. The accuracy of the FDS fire temperatures calculated depends entirely upon the assumptions used. Any chimney effects could have produced much hotter fire temperatures. We have not found any accurate method of predicting fire temperatures in large enclosures, but it appears that more severe

conditions are produced as the distance from the façade to the building core increases. For ventilation, a mid-range condition, with high burning rate but limited heat loss to outside, may be the most severe. In the current case, for a distance of 16 m with mid-range ventilation, very severe conditions may be expected. We therefore believe that the steel beams failed due to reaching much higher temperatures than reported. This resulted from fires which were hotter for longer than calculated and from the small insulation thickness.

14. We understand that there was little physical evidence obtained from this building. In particular, there appears to be no evidence that the composite action between the beams and the slab was detrimental.

References

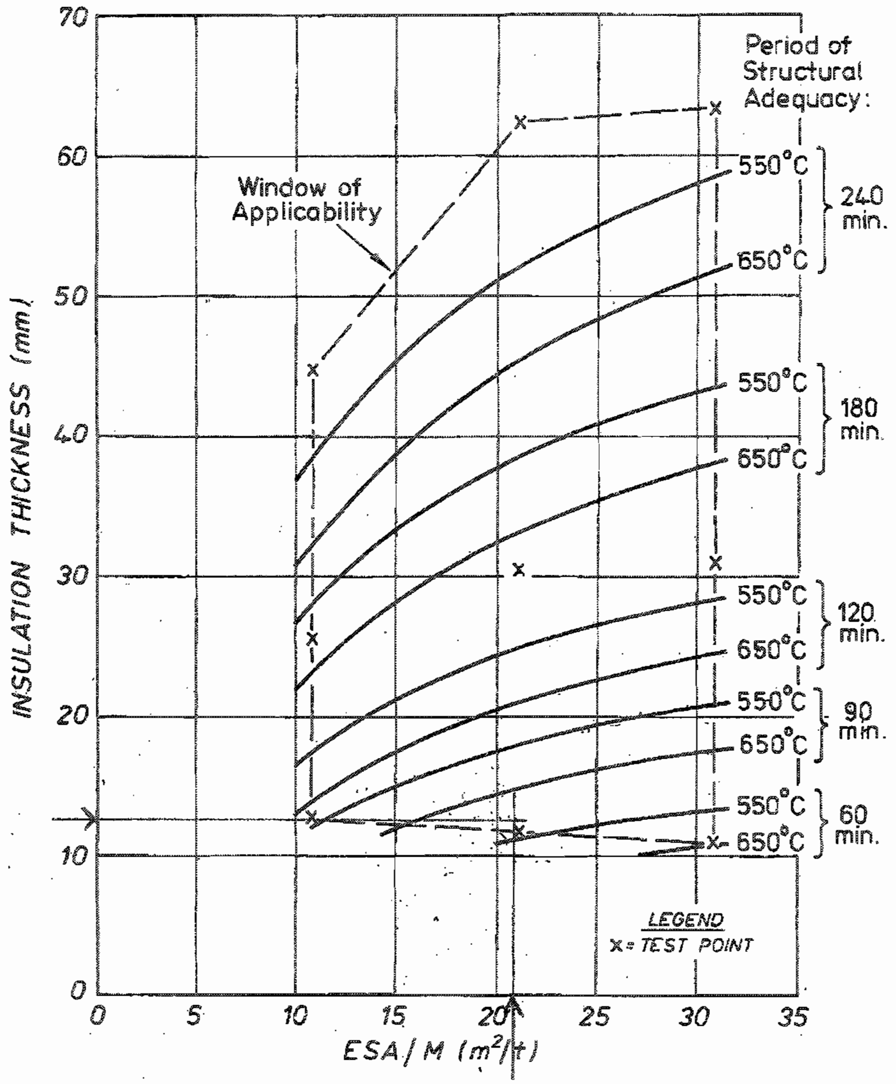
1. Proe, D J, "Ultimate Strength of Simply-Supported Composite Beams in Fire", thesis submitted for degree of Master of Engineering Science, Monash University, December 1989.
2. Kirby, B et al, "The Behaviour of Multi-Storey Steel Framed Buildings in Fire", British Steel Corporation, 1999.
3. Elghazouli, A Y, Izzuddin, B A and Richardson, A J, "Numerical Modelling of the Structural Fire Behaviour of Composite Buildings", Fire Safety Journal, Vol. 35, p. 279-297, 2000.
4. Huang, Z, Burgess, I W and Plank, R J, "Fire Resistance of Composite Floors Subject to Compartment Fires", Journal of Constructional Steel Research, 2004.
5. Bailey, C G, "Membrane Action of Slab/Beam Composite Floor Systems in Fire", Engineering Structures, Vol 26, p 1691-1703, 2004.
6. Gillie, M, Usmani, A and Rotter, M, "Bending and Membrane Action in Concrete Slabs", Fire and Materials, Vol 28, p 139-157, 2004.
7. Proe, D J, Bennetts, I D, Thomas, I R and Szeto, W T, "Handbook of Fire Protection Materials for Structural Steel", Australian Institute of Steel Construction, 1990

## Appendix A : Calculation of Thermal Response of Secondary Beam

Approximate calculations of thermal performance for the W24x55 beam were performed as follows:

- The exposed surface area to mass ratio for the W24x55 steel section was calculated to be 20.9 $m^2/t$ (equivalent to a surface area to volume ratio of 164 $m^{-1}$), based on three-sided fire exposure. See Fig. A1.
- Using the thermal response chart for Australian Monokote (three-sided fire exposure) extracted from reference 4, it was determined that this beam would reach an average steel temperature of 550°C at 66.7 mins. The average temperature is based on the 4 thermocouple locations used in the fire tests, with two thermocouples on the bottom flange, one at the mid-height of the web and one on the top flange.
- Thermal calculations were performed based on the lumped steel mass approach, ignoring the temperature gradient in the steel and ignoring heat flow into the concrete slab. Using standard fire exposure, the thermal properties of the insulation material were adjusted until an exposed surface area to mass ratio of 20.9 $m^2/t$ and a Monokote thickness of 12.7 mm produced a temperature of 550°C at 66.7 minutes. See Fig. A2.
- Using a fire which was constant at 1100°C, the thermal response was calculated. See Fig. A3.
- The response to the 1100°C fire was compared with that shown in Fig. 4.7. Reasonable agreement was obtained, indicating that the Monokote materials used in Australia and USA may be similar. The thermal response from Fig. 11.51 was added. This showed poor agreement with that from Fig. 4.7, despite being for the same beam size and fire exposure case.
- The response for standard fire exposure was taken from Fig. 11.52 and added to Fig. A2. Again, this showed poor agreement.

## MKT

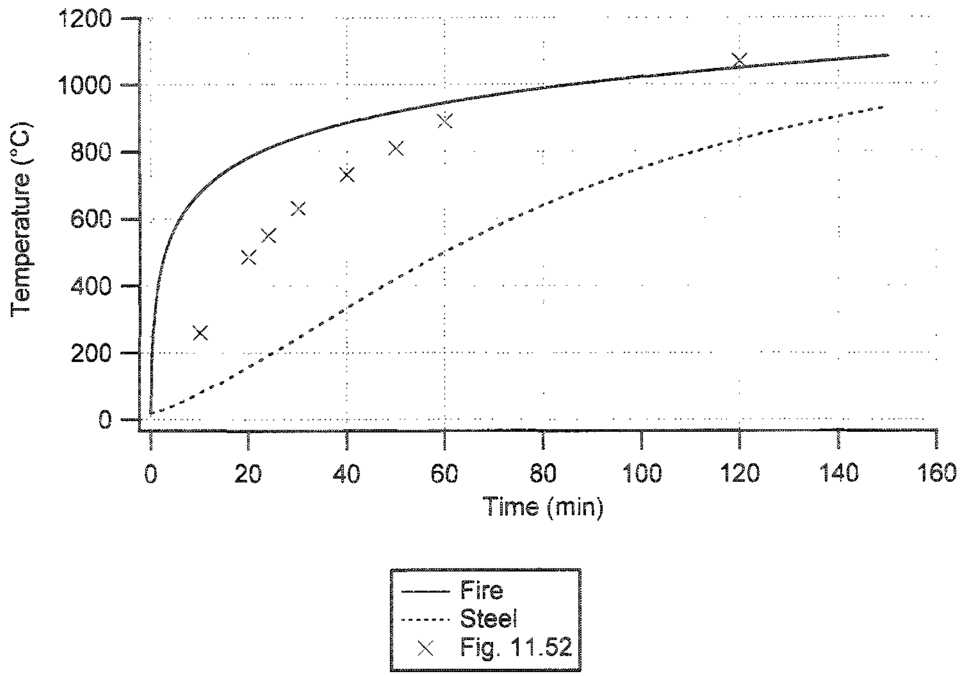



Monokote, 3-Sided Exposure

(20·9, 12·7) → 66·7, 550°C
m²/t mm mins

40 Handbook of Fire Protection Materials for Structural Steel AISC

FIGURE A1 : EXTRACT FROM HANDBOOK OF FIRE PROTECTION MATERIALS

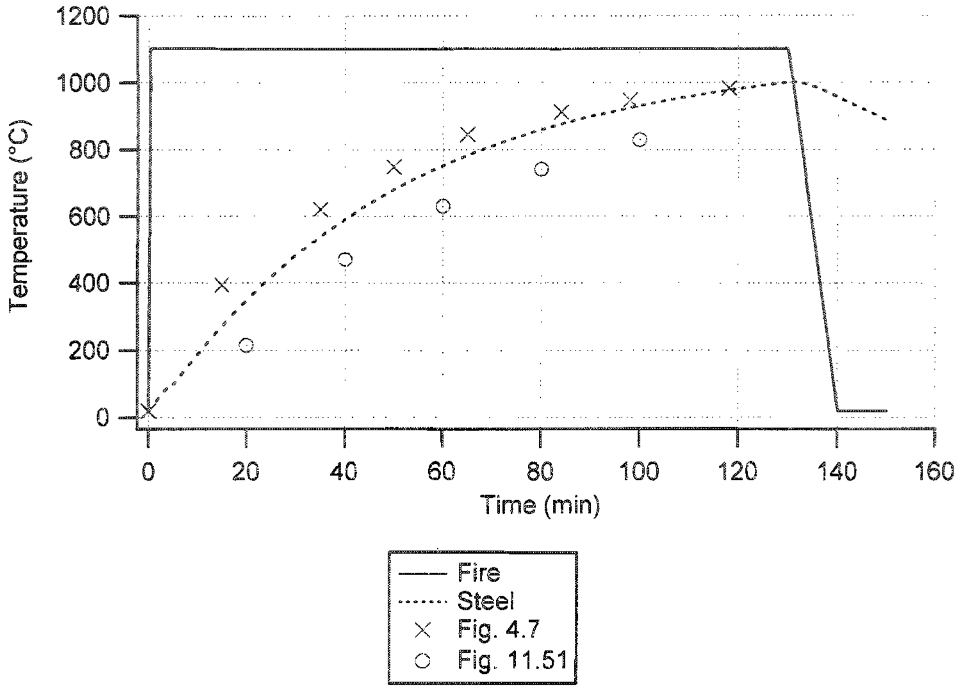



Fire : STTC

Insulation-protected section:
$k_{sm}$ = 20.9 $m^2$/t
$c_s$ = temperature-dependent
$h_i$ = 12.7 mm
$\rho_i$ = 300 kg/$m^3$
$c_i$ = 1100 J/kg-°C
$T_i = (0.5T_f + 0.5T_s)$
$k_i$ = 0.04 at 20°C, 0.079 at 500°C, 0.14 at 800°C (W/m-°C)
$p_i$ = 3% by mass
Ref: SFPE Handbook, 2nd Ed., p. 4-188

Result:
T = 550°C, t = 66.6 mins
T = 931°C, t = 150.0 mins (peak)

FIGURE A2 : STANDARD FIRE EXPOSURE




Fire : Linear

Insulation-protected section:
$k_{sm}$ = 20.9 $m^2$/t
$c_s$ = temperature-dependent
$h_i$ = 12.7 mm
$\rho_i$ = 300 kg/$m^3$
$c_i$ = 1100 J/kg-°C
$T_i = (0.5T_f + 0.5T_s)$
$k_i$ = 0.04 at 20°C, 0.079 at 500°C, 0.14 at 800°C (W/m-°C)
$p_i$ = 3% by mass
Ref: SFPE Handbook, 2nd Ed., p. 4-188

Result:
T = 550°C, t = 36.0 mins
T = 1001°C, t = 130.8 mins (peak)

FIGURE A3 : EXPOSURE TO 1100°C FIRE

To: wtc@nist.gov
From: "John L. Gross" <jgross@nist.gov>
Subject: Fwd: Question on WTC7 Physical Evidence

X-Sieve: CMU Sieve 2.3
Subject: Question on WTC7 Physical Evidence
Date: Mon, 8 Sep 2008 16:48:54 +1000
X-MS-Has-Attach:
X-MS-TNEF-Correlator:
Thread-Topic: Question on WTC7 Physical Evidence
Thread-Index: AckRfvW1cpkooRhiRf+i+zd3phoWVQ==
From: "David Proe" <David.Proe@vu.edu.au>
To: <john.gross@nist.gov>
X-OriginalArrivalTime: 08 Sep 2008 06:48:52.0329 (UTC) FILETIME=[F48E5590:01C9117E]
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-09-08_05:2008-09-02,2008-09-08,2008-09-08 signatures=0
X-PP-SpamDetails: rule=spampolicy2_notspam policy=spampolicy2 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0809070235
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: david.proe@vu.edu.au
X-NIST-MailScanner-Information:

John,
We have studied the NIST reports on the collapse of WTC7. We are particularly interested in the finding that the shear studs failed at low temperature. Having conducted numerous fire tests on composite beams, we have never observed this. Was there any physical evidence obtained of this type of failure? Chapter 5 on visual evidence does not seem to cover any information on debris obtained from the site after the collapse. Would there be any information of this type anywhere?
Thanks.

DAVID PROE, Professorial Research Fellow
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John L. Gross, Ph.D., P.E.
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Confidential and Pre-Decisional Communication

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From: "Diane Horning" <guetamina@comcast.net>
To: <wtc@nist.gov>
Subject: questions about WTC 7

"**Why didn't the investigators look at actual steel samples from WTC 7?**
Steel samples were removed from the site before the NIST investigation began. In the immediate aftermath of Sept. 11, debris was removed rapidly from the site to aid in recovery efforts and facilitate emergency responders' efforts to work around the site. Once it was removed from the scene, the steel from WTC 7 could not be clearly identified. Unlike the pieces of steel from WTC 1 and WTC 2, which were painted red and contained distinguishing markings, WTC 7 steel did not contain such identifying characteristics."
******************************************************************************************************************

How long was it before inspecters were permitted on the actual site? After about 10 days, there was no chance of rescue, so why wasn't the site then treated like any crime scene. Why was evidence removed and destroyed?

What was the significance of the comment made by Mr. Silverstein that they had decided to "pull it" in reference to WTC 7. What does the term "pull it" usually mean in relation to a building? How does this reconcile with your assessment of what happened to WTC 7?

Thank you, Diane Horning
WTCFamiliesforProperBurial@comcast.net
908-654-5244

**Stephen Cauffman**

| | |
|---|---|
| **From:** | Donald C. Meserlian, P.E. [dmeserlian@voicesofsafety.com] |
| **Sent:** | Friday, September 12, 2008 7:25 AM |
| **To:** | Stephen Cauffman |
| **Cc:** | burnardwhite@aol.com; Jonathan Mark; noflyby@yahoo.com; Richard Gage; Les Jamieson; observer; Don DeBar; wtcbill@gmail.com; Janice@911truth.org; davidraygrif@cor.net; jshelton@ae911truth.org; rgeezer@netzero.net; jfetzer@d.umn.edu; info@impeachthem.com; Susan Serpa; Steven Jones |
| **Subject:** | 2008-09-12 NIST WTC 7 Public Comment Rebuttal.doc...POGO Petition 200803 |
| **Attachments:** | header.htm |

# Comments – NIST Report on WTC 7 Collapse
# POGO Petition 200803

September 12, 2008

To: Steve Cauffman, NIST Building & Fire Research Laboratory
Ph.: (301) 975 -6051, F: (301) 869-6275, em:cauffman@nist.gov

Refs:

1. 8/28/08 Letter to New Jersey Governor Jon Corzine..."9-11 Truth Proclamation" for your signature www.voicesofsafety.com/pogonews/petitions/200802/cover-letter/
2. ***"Report of the Citizens Commission on 9/11"*** (2008 Edition), Editor, Don Harkins www.proliberty.com/observer/911report.pdf
3. "9-11 Truth Proclamation" www.voicesofsafety.com/pogonews/petitions/200802/
4. Fig. 1 "Building 7 Imploded" http://911research.wtc7.net/talks/b7/imploded.html
5. Fig. 2 Pg. 17 "Citizens 9/11 Commission Report...Seismic Record at Palisades, N.Y.
6. Fig. 3 http://media.popularmechanics.com/images/0305911-graph1-1g.jpg " " "
7. Fig. 4 http://media.popularmechanics.com/images/0305911-graph2-1g.jpg " " "
8. "FBI Refusal to Answer Petition – Revealing; the Implications – Disturbing", Ref.2, pg.27
9. "Lucky Larry's $2 billion bonus", Ref. 2 pg. 23

September 2008 is the "Month of 9-11 Truth". The **Ref. 1** sample letter is being sent to all governors for their signature on the **Ref. 3** "9-11 Truth Proclamation". Because most governors issue a Proclamation or Executive Order that has observed September 11 as a "Day of Mourning" since 9/11/01 (N.J. Governor Jon Corzine's Executive Order No. 115), there is little probability that they will sign the "9-11 Truth Proclamation" that disproves NIST's conclusions that fire was responsible for the collapse of the Twin Towers and WTC 7.

**Ref. 2,** pgs 3 and 17, prove that underground explosives were detonated in the basements of WTC 1 and 2 before the planes struck the towers. This corroborates the. Pg. 10 eyewitness testimony of William Rodriguez that was omitted by the official "Report of the 9/11 Commission".

**Ref 4** shows **Fig, 1**, that states: "The exterior walls of Building 7 were pulled toward its central axis. ....They ended *up* on top of the rubble pile." This can only occur by a controlled building demolition wherein the structure collapses into its own footprint.

**Ref. 5, Fig. 2**, "First impact" shows a 15 second expanded trace of the explosion with a maximum initial spike that decays. This trace is different from the "First collapse" trace that increases then decays in amplitude. Since the planes struck after the basement explosion the "First impact" trace should be relabeled "first basement explosion".

**Ref.6, Fig. 3** is an identical seismograph of Fig. 2 except the expanded basement explosion and collapse traces are missing.

**Ref. 7, Fig. 4** "1st impact" and "2nd impact" should be relabeled as explosions based on **Ref. 3**. The collapse times of 8 and 10 seconds for WTC 1 and 2 respectively agree with the free-fall times stated in **Ref. 3.**

**The actual collapse time of WTC 7, 6.5 seconds, closely agrees with the free-fall time of 6.2 seconds based on the 610 ft NIST stated height of WTC 7.**

**Ref. 8** explains the **refusal of the FBI to respond to POGO Petition 200701** that states the following three facts:

1. The contract termination date for WTC security Co. Stratosec was 9/10/01.
2. Seismographs detected explosions in the basements of the Twin Towers before being struck by airplanes.
3. All three WTC towers fell at free-fall speed, disproving the government's pancake collapse theory .

***The three towers could only fall at free-fall speed if a controlled demolition, using explosive devices, were used to removed the supporting structure beneath the height where each tower began to fall.***

**Ref. 9** states: "Larry Silverstein told the world what happened to Building 7 during the PBS documentary "*America Rebuilds*" in September 2002: ..."*I remember getting a call from the,er, fire department commander telling me that they were not sure they were gonna be able to contain the fire, **and I said, "We've had such a terrible loss of life, maybe the smartest thing to do is pull it"***

**The term *"pull"* ,in this case, *means to initiate a controlled demolition.*** This proves that explosives were placed in WTC 7 (and the Twin Towers) before 9/11/01. The FBI is responsible for determining the parties responsible for placing the explosives in WTC 7 and the Twin Towers.

**Conclusions:**

1. All WTC buildings collapsed because of a preplanned controlled demolition.
2. NIST should have considered the possibility of explosives instead of solely concentrating on fires as the only possible cause of failure.
3. **I am petitioning NIST to accept the above evidence and revise its erroneous WTC 7 report. Based on the 1st amendment to the U.S. Constitution, *"The right to petition the government for grievances". NIST has "an obligation to respond to POGO Petition 200803.***

Sincerely,

To: wtc@nist.gov
From: "support" <support@2extremestudios.com> (by way of NIST Inquiries <inquiry@nist.gov>)
Subject: duke

What was the extraordinary event that took down building 7?

Duke

From: "Earl Staelin" <estaelin@comcast.net>
To: <wtc@nist.gov>
Subject: Comments on Draft Report on Collapse of WTC 7

COMMENTS ON NIST DRAFT REPORT ON WTC 7
September 11, 2008

VIA EMAIL: wtc@nist.gov

WTC Technical Information Repository
Attn: Mr. Stephen Cauffman
National Institute of Standards and Technology
Stop 8610
Gaithersburg, MD 20899-8610

Dear Mr. Cauffman:

As a trial lawyer I have handled numerous cases involving scientific issues, the laws of physics and chemistry, construction, and structural failure. In the very limited time you have allowed for comments on the NIST draft report on building 7, I offer the following:

In NIST's draft report on the collapse of WTC building 7 you state:

"(T)he building and the records kept within it were destroyed and the remains of all the WTC buildings were disposed of before congressional action and funding was available for this Investigation to begin. As a result, there are some facts that could not be discerned, and thus there are uncertainties in this accounting. Nonetheless, NIST was able to gather sufficient evidence and documentation to conduct a full investigation upon which to reach firm findings and conclusions. (Report, p. 13)

However, you fail to mention that without the columns, beams, floor pans, and other structural materials from the building, the conclusion that there was widespread fire in WTC 7, especially when photos indicate the exact opposite, is highly speculative and strongly against the laws of probability, especially when the central interior of the building where the columns and elevators are located would likely contain much less flammable material than the more peripheral areas where most of the offices and their contents such as paper were. Further, the structural materials could have proven, with a high degree of probability, how hot the columns got, whether there was actually any buckling of column #79 as the report claims, whether explosives were used, and whether there was evidence that the columns were cleanly cut as would occur with explosives. Finally, the rapid and illegal destruction of the evidence should have been remarked upon in your report, as well as the fact that such conduct or spoliation may be considered as evidence of a coverup and/or complicity by the government.

In addition, the NIST report has numerous other significant shortcomings, including, but not limited to the following based upon a necessarily partial review of your report given the exceedingly short period allowed for comment:

1. The report's conclusion that there were large, long-lasting fires on several floors of the building is contrary to the photographic evidence, and is based upon very slim and questionable evidence. (NIST NCSTAR ("NN") 1A, pp. 16-17; and NN 1-9, Chapter 5). The report uses the words "would have", "could have" and similar language over and over, indicating that its conclusion about the spread of fires is not based upon facts or tests, but is based almost entirely upon speculation. On pages 18 and 19 the report describes fires moving from place to place, and dying down, e.g.: (13th floor) "at 4:38 p.m., the fires to the east had died down to the point where they could no longer be observed". (NN 1A, p. 19)

2. The report fails to mention that some (if not most) of the fires could have been caused by explosives or incendiaries. A video of the South Tower taken minutes before its collapse shows flames at the 81st floor of a white and bright yellow color indicating a much higher temperature than would be achieved by the burning of carbon-based office materials, which burn in a generally red-orange color. The video also shows white smoke rising from these flames. These facts strongly suggest the use of thermite and/or thermate as an incendiary which burns much hotter than carbon, and produces white or bright yellow flames and a rising white smoke in the form of aluminum oxide powder. This reasonable possibility or probability should have been considered and mentioned in your report.

3. The report fails to mention that the security firm for WTC 7, as for WTC 1 and 2, Securacom (later called Stratasec) had connections to George W. Bush, the Bush family, and neoconservatives, which may have made it possible for agents of our government to place explosives in the buildings and escape "detection" and reporting by security. This connection should have been thoroughly investigated.

4. The report's conclusion that the weakening of one column, #79, led to the global collapse of the building violates the laws of physics. Also, you acknowledge that the temperatures of most of the steel were not very hot. In fact, NIST's own tests of steel columns from the area of the fires in the twin towers showed that most columns did not reach above 482 degrees F, and

none reached above 1112 degrees F. Even when fires are hot enough to cause the collapse of a beam or column of a building, established fire science shows that the beam or column collapses slowly, and the collapse spreads only to other beams or columns that are equally hot. These known facts are totally at odds with the total, free fall collapse of building 7 in about 6.6 seconds, which requires all columns on a floor to collapse simultaneously, and on each floor in very rapid succession.. (NN 1A, 19-20)

5. The report's conclusion or summary fails to mention that the building came down in free fall time, a critical omission, and fails to mention that the only known cause of a free fall speed collapse of a tall steel building is controlled demolition using explosives and/or incendiaries. (NN 1A, 16-20)

6. The report fails to mention that four WTC dust samples independently collected shortly after 9/11 each contained many microscopic and tiny iron spherules that could be explained by the use of thermate, but not by much lower temperature fires such as NIST describes. Your report also fails to mention that laboratory and other tests of these dust samples show that the dust contained thousands of small pieces of unexploded thermite or thermate. (NN1A, 16-) Thermite and thermate are powerful explosives used by our military and which can be used for controlled demolition. (Cf. NIST's discussion of blast scenarios, which does not even mention thermite or thermate; NN 1A, 22-24)

7. The report ignores the evidence given by eyewitnesses that loud explosions in WTC 1, 2 and 7 occurred before any of the buildings collapsed and as they were coming down. In addition, the evidence indicates that some explosions in the towers occurred before either of the two towers was struck by a plane. (NN 1A, 22-24)

9. You fail to scientifically support your conclusion that 100 pounds of explosives would have been necessary to cut a single column of WTC 7, or that such explosives could not have been placed without detection. Therefore, you dismiss upon inadequate grounds the likely possibility that explosives were used to bring the buildings down. (NN 1A, 22-24)

The overall impression is that your report was carefully crafted to reach a foregone conclusion approved and dictated by the Bush administration, and to ignore and reject all facts and science that pointed toward a different conclusion. If this report is made final, it may eventually take its place as the most unscientific and fraudulent official report ever issued under the authority of the government of the United States. And if the collapse of building 7 was indeed caused by controlled demolition, with the approval of key officials of the U.S. government, as I believe is highly probable, then those of you who have participated in and approved the report will stand guilty of the crime of obstruction of justice and of participating in a coverup of the worst crime ever committed on American soil.

Finally, your public announcement of August 26, 2008 established an unconscionably short period for comment before the NIST report becomes final, a mere 20 days. This short period is totally inadequate to allow the full and professional evaluation and analysis that your 10,000 page report requires on a subject of great importance to the American people, and to the science of building tall steel buildings safely and economically, especially considering that NIST took three full years to produce its report on WTC 7. This is to insist that you extend the comment period to a minimum of 90 days.

Thank you for your consideration.

Sincerely yours,

Earl H. Staelin
Littleton, Colorado

(Comments also attached in rtf.)

Comments on NIST Draft Report on WTC 7 9-11-08.rtf

**Stephen Cauffman**

**From:** wtc@nist.gov
**Sent:** Monday, September 08, 2008 4:55 PM
**To:** Stephen Cauffman
**Subject:** Fw: World Trade Center Collapse - A Probable Cause

X-Sieve: CMU Sieve 2.3
From: Shyam Sunder <sunder@nist.gov>
To: "'wtc@NIST.gov'" <wtc@nist.gov>
CC: "'terri@nist.gov'" <terri@nist.gov>,
"'wgrosshandler@nist.gov'"
<wgrosshandler@nist.gov>,
"'rgann@nist.gov'" <rgann@nist.gov>,
"'jgross@nist.gov'" <jgross@nist.gov>,
"'fahim.sadek@nist.gov'"
<fahim.sadek@nist.gov>,
Stephen Cauffman <cauffman@nist.gov>
Date: Wed, 27 Aug 2008 05:22:41 -0400
Subject: Fw: World Trade Center Collapse - A Probable Cause
Thread-Topic: World Trade Center Collapse - A Probable Cause
Thread-Index: AckICoYndcJyc+rdRwydPwwRiyIVQgAG+5Nk
Accept-Language: en-US
X-MS-Has-Attach:
X-MS-TNEF-Correlator:
acceptlanguage: en-US
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: sunder@nist.gov
X-NIST-MailScanner-Information:

---

**From**: Eli rubinstein
**To**: Shyam Sunder
**Cc**: Alan Cantor
**Sent**: Wed Aug 27 02:06:33 2008
**Subject**: World Trade Center Collapse - A Probable Cause

Dr. Shyam-Sunder, Director, BFRL

Your 8-21-08 news conference on the 7 WTC final report states conclusively that neither jet-fuel fires nor explosive charges were causes of collapse. One probable cause that does not appear to have been considered in all this time is the role of concrete foundations interacting with the steel columns imbedded in them.

Consider the following:

1. The collisions interrupted power to many machines, with some conductors shorting out to the steel structural columns supporting them.

2. Emergency generators started up in response, electrifying these columns.

3. At the foundation/steel interface, the concrete (a semi-conductor) between columns would provide high resistance loads while the generators were running.

4. Concrete heating would cause the imbedded steel to melt and cause building collapse.

This scenario is supported by the following facts:

1. Diesel fuel on hand was sufficient to keep the generators running for some time.

2. Approximately 5 KW delivered to one cubic foot of concrete for 45 minutes would cause it to soften/melt/reach 2800 degrees F. (Based upon: the KW levels available; the specific heats and resistivities of concrete and steel; the melting point of steel; the density of concrete; and distances between columns.)

3. Cherry-red masses of metal seen in photographs of the rubble shortly after collapse.

4. Time intervals from airplane impact to building collapse as concrete heated. (45 and 80 minutes for first two towers; 7 hours for 7 WTC).

5. Collapse of 7 WTC starting at the bottom of the building.

I believe it would be appropriate for applicable codes to be amended to call for emergency generators to sense and shut down when their output is not being received by the loads they were provided for.

The courtesy of a reply is requested.

Eli Rubinstein, BME retired
7900 Old York Road Apt 707A
Elkins Park, PA 19027-2328

**Stephen Cauffman**

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 9:51 AM
**To:** Stephen Cauffman
**Subject:** Fwd: Comment on NIST analysis of WTC#7 collapse

>X-Sieve: CMU Sieve 2.3
>Date: Fri, 22 Aug 2008 15:20:50 -0700
>From: hawk@usdoj.gr
>To: wtc@nist.gov
>Cc: phantom421366@yahoo.com, Ronald Wieck <pomeroo@verizon.net>,
> Joseph Keith <joseph.keith@cox.net>,
> Alex LLoyd <spooked911@hotmail.com>,
>rolfusaugustusadolphus@yahoo.com,
> John Lear <johnlear@cox.net>, "'Rasga Saias'" <rasgasaias@gmail.com>,
> "'Anthony Lawson'" <lawson911@gmail.com>,
> "'Field McConnell'" <avalonbeef@msn.com>, pilotsfortruth@yahoo.com,
> jfetzer@d.umn.edu, "'Dan'" <b737dan@yahoo.com>,
> pilots@pilotsfor911truth.org, brucerideout@yahoo.com,
> "'SHURE Dj'" <shure_dj@hotmail.com>,
> "'Morgan Reynolds'" <econrn@suddenlink.net>,
> "'acebaker'" <ace@acebaker.com>, genghis@westnet.com.au,
> dylan@loosechange911.com, ben@mountain-wave.ca,
> james.t.hoffman@gmail.com, tbach65@aol.com, truthaction@hotmail.com,
> hardevidence@gmail.com,
> rgage@ae911truth.org, andrewkornkven@yahoo.com,
> webstertarpley@yahoo.com
>Subject: Comment on NIST analysis of WTC#7 collapse
>User-Agent: Internet Messaging Program (IMP) 3.2.2
>X-Originating-IP: 64.59.144.21
>X-Proofpoint-Virus-Version: vendor=fsecure
>engine=1.12.7160:2.4.4,1.2.40,4.0.166
>definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
>X-PP-SpamDetails: rule=spampolicy1_notspam
>policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0
>bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx
>engine=5.0.0-0805090000 definitions=main-0808220124
>X-PP-SpamScore: 0
>X-NIST-MailScanner: Found to be clean
>X-NIST-MailScanner-From: hawk@usdoj.gr
>X-NIST-MailScanner-Information:
>
>WTC Technical Information Repository, Attn: Stephen Cauffman, NIST, 100
>Bureau Dr., Stop 8611, Gaithersburg, Md. 20899-8610.
>
>Dear Dr. Cauffman:
>
>Re excerpts in notes below, we have comments on the NIST analysis of
>the WTC#7 collapse.
>
>Our research suggests the building was demolished at 5:20 pm on 9/11 on
>orders from the Blackstone Group (owner of the WTC#7) mortgage and KPMG
>the allegedly bogus escrow for syndicated lenders who used
>AMEC-Citigroup as prime contractor and a fake diesel-system project to
>camouflage arson and sabotage of the building and the destruction of

>evidence of ongoing securities frauds.
>
>KPMG had used its insider escrow position to double up insurance on the
>WTC#7 mortgage so that its demolition would generate an estimated $400
>million in profits shared with the demolition team and Blackstone
>private equity investors.
>
>We notice that the NIST analysis excludes what could not have explained
>anyway the observed characteristics of the demolition i.e. no
>percussive sound effects heard therefore not due to explosives, not
>enough heat from fires fed by the fuel supply tanks therefore not due
>to fires fed by the fuel supply tanks and not enough structural impact
>therefore not due to damage from the falling debris of WTC 1.
>
>What you did not address is the fact that AMEC was conducting sabotage
>vulnerability testing on 9/11 in all the WTC buildings using ultra high
>temperature accelerants developed by Molten Metal Technologies
>sponsored by Al Gore and Maurice Strong and wepaonized by Lockheed Martin.
>
>Kindly ask your NIST scientists to examine the hypothesis that the
>central columns were melted or even vaporized with UHTA reaching
>temperatures up to 5,800 degrees Fahrenheit consistent with the use of
>solid propellant rocket fuel in the elevator shafts (No percussion
>heard, pools of molten-steel found and KPMG-AMEC spoliated evidence of escrow and mortgage and insurance
fraud.
>
>Thank you
>
>Field McConnell and David Hawkins
>Forensic Economists at Hawks CAFE
>http://www.captainsherlock.com/
>
>Notes
>
>"NIST welcomes comments on the draft report and
>recommendations—available online at http://wtc.nist.gov—received by
>noon Eastern Daylight Time on Sept.15, 2008.
>Comments (instructions for submission are available at
>http://wtc.nist.gov) may be submitted via: e-mail to wtc@nist.gov; fax
>to (301) 869-6275; or surface mail to WTC Technical Information
>Repository,
>Attn: Stephen Cauffman, NIST, 100
>Bureau Dr., Stop 8611, Gaithersburg, Md. 20899-8610."
>http://www.nist.gov/public_affairs/releases/wtc082108.html
>
>"Diagram 1—Typical WTC 7 floor showing locations of columns (numbered).
>The buckling of Column 79 was the initiating event that led to the
>collapse of WTC 7. The buckling resulted from fire-induced damage to
>floors around Column 79, failure of the girder between Columns 44 and 79, and cascading floor failures.
>[Download high-res version] The investigation team considered the
>possibility of other factors playing a role in the collapse of WTC 7,
>including the possible use of explosives, fires fed by the fuel supply
>tanks in and under the building, and damage from the falling debris of
>WTC 1. The team said that the smallest blast event capable of crippling
>the critical column would have produced a "sound level of 130 to 140
>decibels at a distance of half a mile,"
>yet no noise this loud was reported by witnesses or recorded on videos.
>As for fuel fires, the team found that they could not have been

From: j c <sirisfi@hotmail.com>
To: <wtc@nist.gov>
Subject: question concerning wtc 7

I was wondering if the nist found out who was on the other end of the phone conversation when Larry Silverstein made his famous "pull it" quote. I have looked into who the fire commander was that day but have not seen anything to suggest that he talked too larry Silverstein. I have searched though many firefighter oral histories concerning 911. I have also seen quotes where the fireman do not take orders from the public in regards to pulling a firefighting operation.
So my question is, who was on the other end of that phone call and has the nist talked with that person to verify Silversteins claims??
thanks
justin

---

From: "greening" <greening@sympatico.ca>
To: <wtc@nist.gov>
Subject: WTC 7 Draft Report Comments

# Comments on the Draft Report NIST NCSTAR 1-9: "*Structural Fire Response and Probable Collapse Sequence of World Trade Center Building 7*", issued by NIST August 21st, 2008

**By**

**F. R. Greening**

## 1.0 Introduction

A preliminary (draft) version of NIST's final report on the collapse of WTC 7 was issued on August 21st 2008 together with a call by NIST's Investigation Team for the submission of comments on the Draft Report from interested parties within the general public. First I wish to thank NIST for producing such a detailed technical report on the collapse of WTC 7 and secondly, I applaud NIST for allowing researchers from around the world to offer technical feedback that hopefully will be duly considered by NIST before a final version of the report is issued.

In reading the Draft WTC 7 Report a number of issues emerge that are crucial to the credibility of NIST's proposal as to how and why building 7 collapsed on September 11th, 2001. These key issues center on the narrative surrounding the ignition of the fires in WTC 7 and the spreading of these fires within the building prior to its collapse. The accuracy of NIST's account of what transpired within the confines of building 7 during 9/11, is vital to NIST's entire WTC 7 Report because it provides the basis for the computer modeling/simulation of the heating of structural elements on the fire-affected floors, which in turn, leads to NIST's proposed collapse initiation and propagation mechanism.

In the following comments I will attempt to address each of the key topics - fire ignition and spreading, fire intensities and durations, structural heating, collapse initiation and propagation – and in so doing, highlight my concerns or objections to NIST's position on these topics as presented in its Draft WTC 7 Report.

## 2.0 The Ignition and Spreading of the Fires in WTC 7

In Chapter 9 of NIST NCSTAR 1-9 we encounter one of the most significant problems with attempts to unravel the mystery of why and how WTC 7 collapsed late in the afternoon of September 11th, 2001 – the question of where and how fires started in building 7. On page 376 of NCSTAR 1-9 we read:

"... *the ignition and early course of the fires (in WTC 7) were unknown because they were presumed to have occurred in the damaged and heavily smoke-shrouded southern portion of the building.*"

NIST's knowledge of the fires in WTC 7 is therefore based on images of the *exterior faces* of the buildings. Unfortunately however, as acknowledged by NIST, most of the burning of combustible materials at the WTC on 9/11 took place beyond the views available through exterior windows well *inside* the buildings.

NIST propose, and it appears to be a reasonable assumption, that the fires in WTC 7 started near the south face as a result of the collapse of WTC 1 at about 10:29 on the morning of 9/11. However, even this assumption is problematical because fires on the crucial 12th and 13th floors of WTC 7 were not in fact observed until after 2:00 p.m., and then only on the *east* face of the building.

Faced with the problem of modeling the spreading of the fires in WTC 7, NIST begins its computer simulation with a set of 2 MW fires, presumably one per floor, for floors 7, 8, 9, 11, 12 and 13. These hypothetical fires are stated to be "*roughly equivalent to small, single workstation fires*", but NIST is quite vague about *where* these fires were located other than "*near the southern face of the building*". What is more, for the fire to spread to NIST's satisfaction on floor 8, *two* fires were hypothesized to start at this level within the building.

Other aspects of NIST's simulation also appear to be quite arbitrary and unphysical. Thus the fire on floor 12 was prescribed to start "*near the center of the south face at an assigned time of 12:00 noon.*" This is a strange choice of ignition time given that the WTC 7 fires were supposedly started by flaming debris from the collapse of WTC 1 at 10:29 a.m. It implies that some of the flaming material in the WTC 1 debris that settled near WTC 7 remained dormant for about an hour and a half before spontaneously igniting fires that were subsequently observed on floor 12.

**1.0 Fire Intensities and Durations**

The way the fires spread in WTC 7 during 9/11 was largely determined by the distribution of combustible materials throughout the building. In NIST's fire simulations this distribution was approximated by an average fuel load for each fire-affected floor of 20 - 32 $kg/m^2$ or 4.0 and 6.4 $lb/ft^2$, (See NIST NCSTAR 1-9 pages 59 – 60). As shown in Figures 10-15 and 10-16 of NCSTAR 1-9, this fuel loading is calculated by NIST to have been sufficient to sustain temperatures above 400 °C for the floor beams and concrete slab on the east side of floors 12 and 13 for about 2 hours. According to NIST's fire simulations, floors 12 and 13 were the most severely heated floors in WTC 7; however, there are reasons to question the level of heating claimed by NIST.

NIST's fire simulation would have us believe that a very substantial heat release rate was sustained for over 2 hours over a floor area of about 500 $m^2$ in building 7. Thus Figure 9-13 of NCSTAR 1-9 shows that a heat release rate of 200 MW was attained on floor 12 at about 3:00 p.m. on September 11th and remained above 200 MW until well after 5:00 p.m. But we need to ask: Is a 200 MW fire consistent with a fuel loading of 32 $kg/m^2$ - the value used by NIST for its floor 12 fire simulations? The answer appears to be no. Thus a 200 MW heat release rate for 2 hours implies a total energy release of 1,440 GJ. If the combustible material on the 12th floor of WTC 7 is assumed to release 20 MJ/kg, we have to conclude that 72,000 kg of office material was combusted over an area of 500 $m^2$, or there was a fuel loading in WTC 7 of 144 $kg/m^2$ – a value over four times NIST's assumed fuel loading.

That there is a problem with NIST's predicted fire intensities in WTC 7 compared to the assumed fuel loading is supported by comparisons to other studies of fires in steel framed buildings. For example, the well-known Cardington tests conducted in the U.K. in 1999 measured a maximum heat flux of about 200 kW/m$^2$ over a period of about 1 hour from the combustion of 6000 kg of cellulose-based fuel inside a 144 m$^2$ steel framed structure, giving a fuel loading of 42 kg/m$^2$. Thus we see that in the Cardington tests the total energy release is predicted to be 144 x 200 kW for one hour which equals 28.8 MW for 3600 seconds or 104 GJ. The heat of combustion of the fuel was 17 MJ/kg, so for 6000 kg we would expect a heat release of 102 GJ in good agreement with the predicted energy release.

The main problem with the NIST fire simulation appears to be the calculated *duration* of the fire on the 12$^{th}$ and 13$^{th}$ floors of WTC 7. For example, if we assume a more reasonable fire duration of 30 minutes, rather than NIST's excessive 2 hours, we may revise the energy release down from 1,440 GJ to a mere 360 GJ in which case the combustion of 20 MJ/kg fuel would have consumed 18,000 kg of material and the fuel loading would have been 36 kg/m$^2$ in much better agreement with NIST's assumed fuel load. That these are more realistic figures is also supported by some of NIST's own studies of the relationship between combustible loads in buildings and classifications of fire severity. Thus M G. Goode in NIST Report No. GCR-04-872, published in July 2004, provided a table showing that fire durations of 0.5 and 0.75 hours are to be expected for fuel loads of 20 kg/m$^2$ and 30 kg/m$^2$, respectively.

4.0 Structural Heating

In view of the fact that NIST appears to have overestimated the intensity and duration of the fires in WTC 7, particularly on floors 12 and 13, it follows that the heating of the structural steel is also overestimated in the WTC 7 Draft Report. This is fatal to the overall validity of NIST's collapse initiation hypothesis because NIST's hypothesis is predicated on the thermal expansion of long span beams and girders on floors 12/13 and their eventual loss of connectivity with column 79, (See Chapter 8 of NCSTAR 1-9).

NIST's computer simulation of the thermal response of floors 12/13 is described in Chapter 10 of NCSTAR 1-9 and estimates temperatures as high as 675 °C "*on much of the east side and the east portion of the south side of* (floor 12)". NIST also concludes that the temperatures of floor beams and girders on floors 12/13 were 600 °C or higher for 1 - 2 hours.

The temperature vs. time profile of a structural steel member exposed to a fire and protected by a layer of insulation of thickness $d_i$ is given by the formula:

$$\Delta T_s / \Delta t = [ k_i / (d_i c_s \rho_s) ] (A_p / V) ( T_g - T_s )$$

where,

$\Delta T_s / \Delta t$ is the rate of change of the temperature of the steel

$k_i$ is the thermal conductivity of the insulation material

$c_s$ is the heat capacity of the steel

$\rho_s$ is the density of the steel

$A_p$ / V is the section factor of the steel member

$T_g - T_s$ is the temperature difference between the steel and the combustion gases

Values for the quantities $k_i$, $d_i$, $c_s$, $\rho_s$ and $A_p$ / V appropriate for calculations of the heating of structural members in WTC 7 are as follows:

$k_i$ = 0.12 W/m.°C (Monokote MK-5)

$d_i$ = 0.015 m

$c_s$ = 660 J/kg.°C

$\rho_s$ = 7800 kg/m$^3$

$A_p$ / V = 100 m$^{-1}$ (W33x130 girder)

As discussed in Section 3.0 above, the duration and intensity of the fires on floors 12 and 13 of WTC 7 discussed by NIST in Chapter 10 of NCSTAR 1-9, appear to be inconsistent with the fuel loads used in NIST's simulations. However, based on data from A. Jowsey's thesis: *Fire Imposed Heat Fluxes for Structural Analysis*, (Edinburgh 2006), an upper layer gas temperature of 800 °C sustained for 40 minutes would appear to provide a more realistic description of the fires at the east side of floors 12 and 13 prior to the collapse of WTC 7. This leads to a predicted heating rate of 7.46 °C/min and a maximum temperature for the floor framing beams and girders near the critical column 79 of about 300 °C, or barely *half* the temperatures estimated for these structural members in the NIST WTC 7 Draft Report.

**5.0 Collapse Initiation and Propagation**

NIST's computer simulation of the collapse of WTC 7, as presented in Chapters 8 and 12 of NCSTAR 1-9, is remarkable for the low temperatures - as low as 100 °C – at which failures of connecting elements such as bolts and studs are predicted to have first occurred in WTC 7 after about 3:00 p.m. on 9/11. These failures were caused, so NIST asserts, by the thermal expansion of asymmetrical framing beams and girders on the east side of floors 12/13. Nevertheless, in NIST's model, complete separation of column 79 from lateral restraints to buckling is predicted to occur only at temperatures well above 300 °C. Thus NIST's collapse initiation hypothesis *requires* that structural steel temperatures on floors 12/13 significantly exceeded 300 °C - a condition I believe that could never have been realized with NIST's postulated 32 kg/m$^2$ or lower fuel loading.

However, assume for a moment that collapse initiation in WTC 7 did in fact occur as NIST states: by a thermally induced buckling failure of column 79 on floors 12/13. It would then be appropriate to ask: Is the collapse propagation mechanism proposed by NIST consistent with the *observed* collapse of WTC 7? If the answer to this question is indeed "Yes", it would add credibility to NIST's account of what happened to building 7 on 9/11 even if an inappropriate fuel loading was used. However, I would suggest that NIST's account of the last ½ minute of the life of WTC 7 not only lacks crucial physical detail, but is also at odds with what was observed in the well-known collapse videos of WTC 7.

In NIST's WTC 7 collapse simulation, the fires in the lower part of the building severely heat floors 12 and 13 near column 79 causing it to lose lateral support and buckle. Then, according to NIST, the entire section of column 79 *above* floor 14 began to descend and trigger a global "disproportionate" collapse of WTC 7. In NCSTAR 1-9, Chapter 12, page 57, it is claimed that the top of column 79 was moving downward within 0.2 seconds of its buckling between floor 5 and 14.

Let's consider this alleged motion of column 79 in more detail. Figure 12-43 in Chapter 12 of NCSTAR 1-9 NIST shows column 79 buckling between floors 5 and 14 starting about 14.9 seconds into NIST's collapse initiation simulation. The lateral displacement of column 79 is shown to be about 5.5 meters to the east of its normal, fully vertical position at floors 9/10 at 15.5 seconds into the simulation. A consideration of the geometry of a column buckling over a length of about 36 meters shows that a lateral displacement of 5.5 meters should lower the top of the column by about 0.8 meters. In the same collapse simulation timeframe, (14.9 – 15.5 seconds), NIST show in Figure 12-45 that the vertical displacement of column 79 at the roof level was in fact 0.83 meters in 0.6 seconds. This implies that column 79 was moving downwards with an acceleration of 4.6 $m/s^2$ or about ½ g which is a very dramatic motion for a column that was restrained by several framing beams and girders on all the undamaged and unheated floors above floor 14 just moments before collapse initiation. I would therefore ask NIST to explain how and why all lateral supports acting on column 79, from more than 30 upper floors, were simply ripped out or otherwise detached from their very secure connections in only 0.2 seconds?

To conclude this section I would like to briefly mention NIST's simulation of the final global collapse of WTC 7. Of course we are all very familiar with what actually transpired during the final moments in the life of WTC 7 because of the numerous well-known videos of this dramatic event, as discussed in Chapter 5 of NCSTAR 1-9. These videos typically present an unobstructed view of at least the upper third of WTC 7 and permit the collapse to be followed for 4 - 5 seconds. The videos show the upper section of WTC descending very smoothly as an intact structure with the roofline remaining essentially horizontal until it passes behind buildings in the foreground. The only significant distortion of the boxed-shaped Building 7 that is noticeable after the façade begins its downward motion, is the formation of a slight kink on the eastern side of the north face.

Now consider NIST's version of the final moments of WTC 7 as exemplified by the computer-generated simulacra of Figure 12-69 of NCSTAR 1-9. These images of the final collapse of WTC 7 from the north, west and south show very extensive buckling of the exterior columns especially near the mid-height of the building. It is simply astounding that, even though these computer generated images of a crumpled and severely distorted Building 7 look nothing like the video images of the real thing, NIST nevertheless concludes: "*the global collapse analyses matched the observed behavior reasonably well.*"

**5.0 Conclusions**

I believe there are many problems with the material presented in NIST's Draft WTC 7 Report; most of these problems stem from the fuel loading assumed by NIST but I would add that NIST's collapse hypothesis is not physically realistic and is not well supported by observations of the behavior of Building 7 during its collapse. I certainly believe that an alternative collapse initiation and propagation hypothesis is called for; an hypothesis that more accurately reflects the reality of what happened to WTC 7 on September 11th 2001.

Dr. F. R. Greening
Hamilton, Ontario, Canada

From: "greening" <greening@sympatico.ca>
To: <wtc@nist.gov>
Subject: Comments on WTC 7 Report

To whom it may concern,

Please accept these further comments on the WTC 7 *Draft Report*:

**Addendum:**

**Additional Comments by F.R. Greening on NIST's Global Collapse Analysis in Chapter 12 of NCSTAR 1-9**

In Chapter 12 of NCSTAR 1-9 NIST describes the main findings of its computer modeling of the collapse of WTC 7. Some of the key results of this modeling are also presented in Figures 12-48 to 12-69 to be found on pages 571 to 595 of Chapter 12.

In Section 5.0 of the Comments I submitted to NIST September 11$^{th}$, 2008, I addressed some of my concerns with the material presented in Chapter 12 of the *Draft Report*. Here I wish to consider NIST's core collapse sequence in more detail especially the results illustrated by Figures 12-48 et seq. and Figures 12-66 et seq. in Chapter 12 of NCSTAR 1-9. These Figures show the vertical progression of core column failures on the east side of WTC 7 that, according to NIST, led to the collapse of the East Penthouse. NIST states that the WTC 7 core collapse started with the buckling of column 79 about 14 seconds into the computer simulation, and was followed by the descent of the East Penthouse below the roofline of WTC 7 at about 16.5 seconds into the simulation.

According to NIST, the global collapse of WTC 7 began 6.9 seconds after the East Penthouse collapse or about 23 seconds into the simulation. Now consider NIST's Figures 12-66, 12-67 and 12-69 and in particular the images showing the alleged state of the core 17.5, 19.5, 20.7, 21.8, 24.1, 26.8 and 28.8 seconds into the collapse simulation. These images represent NIST's view of what the core looked like at ~ 1 - 2 second intervals following the collapse of the East Penthouse. What is most significant about these images is that around the time of global collapse initiation NIST's simulation shows that the eastern half of the core had completely collapsed while the western half of the core remained standing and relatively undamaged. This is quite remarkable since videos of the collapse of WTC 7 show that up to *and well beyond* the moment that the roofline of WTC 7 exhibited its first downward movement, the exterior of the building revealed absolutely no signs of NIST's proposed partial collapse of the core even though the core was connected to the exterior walls of Building 7 by dozens of horizontal beams on every floor.

NIST's proposed collapse of the eastern half of the core would have completely removed the lateral restrains normally acting on the eastern exterior columns of WTC 7. Indeed, NIST assert that in the moments before global collapse initiation, "*the exterior façade on the east quarter of the building was just a hollow shell.*" This would have caused the eastern façade to buckle *well before* global collapse ensued. This buckling would have been visible as a bowing of the northeast corner of the building. Needless to say, such pre-collapse buckling or bowing of WTC 7 was not observed. However, the problems with NIST's simulations only get worse *after* global collapse initiation. Thus Figure 12-68 of NCSTAR 1-9 shows that the western end of the WTC 7 core only started to collapse about 25 seconds into NIST's simulation, a full 2 seconds after NIST claims that global collapse was underway.

NIST states in NCSTAR 1-9 that 24.5 seconds into its simulation, the roof of WTC 7 was falling with a velocity of approximately 10 to 15 m/s, while Figure E-4 of NCSTAR 1-9A shows that the roofline of WTC 7 had descended about 3 stories at 24.6 seconds of the simulation, or 1.6 seconds into global collapse. These Figures are in complete contradiction to Figure 12-68 of NCSTAR 1-9 which shows a computer-generated image of WTC 7 taken 24.1 seconds into NIST's collapse simulation with the eastern end of the core completely collapsed, but the western end still standing, essentially undamaged, to within 0.5 meters of its full 186 meter height.

The images 26.8 and 28.8 seconds into NIST's simulation, or 3.8 and 5.8 seconds after the initiation of global collapse, deliver a final blow to the credibility of NIST's collapse simulation. Thus the 26.8 and 28.8 second images included in Figure 12-68 reveal a collapsing core with its eastern side a full eight stories, or about 32 meters, *below* its western side. This would indicate a roofline collapse that started at the eastern end of Building 7 and progressed over a period of about 4 seconds to the western end.

Now, if NIST's collapse simulations are supposed to accurately reflect what happened to Building 7 on 9/11, one is compelled to ask:

*Why did WTC 7 undergo a strictly vertical collapse, with the roofline remaining essentially horizontal throughout the first 5 seconds of its downward motion, when NIST's simulations show the eastern side of the building starting to collapse 4 seconds before the western side*?

F.R. Greening

Sept $14^{th}$, 2008

To: wtc@nist.gov
From: james david <jimmyjamusa@yahoo.com> (by way of Jennie Covahey <jennie.covahey@nist.gov>)
Subject: question......

please answer this question.... IF building #7 did indeed collapse due to thermal expansion, why did larry silverstien say in an interview on PBS (and i paraphrase lighly) "there was such a loss of life that day, we felt the best thing was to "pull it"... so they made the decision and pulled it".

correct me if i'm wrong, but isn't "pull it" a demolition term?? why would he say "pull it" and mean ANYTHING else other than the common inferment?

i totally repect your orginazation and your staff, but something doesn't add up....is silverstien just a crackpot???

>X-Sieve: CMU Sieve 2.3
>DKIM-Signature: v=1; a=rsa-sha256; c=relaxed/relaxed;
>        d=gmail.com; s=gamma;
>        h=domainkey-signature:received:received:message-id:date:from:to
>         :subject:mime-version:content-type;
>        bh=xNW5NomLJFousiDAdwVfNyf4cJvydd2EX0FQPw/7sRI=;
>        b=kDPmq1/OcZTQUTUoO8DQUf2VdZgblexMT+hDDc85Z5j6RX9l5eauigfphLk0f81MIH
>         2QAhBbLkK46oY/3Z0TmNqgvHhm3gebNDrOEkvkPwwKuglacDeQUXmm1P7OjZawSQJkRt
>         /kqQUQsZrMOqQPMuVuKP6FMQkdSCNmywQKRuo=
>DomainKey-Signature: a=rsa-sha1; c=nofws;
>        d=gmail.com; s=gamma;
>        h=message-id:date:from:to:subject:mime-version:content-type;
>        b=NQCQNpYzSPi4tTFnCfts6rMOPTZTmCuRSO3mORjAxouH6CM23wPEEHZ12NMb7NxEeb
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>         Nm26vxbA9miUnnDdysDOD6ACldBGMdS/w8m5Y=
>Date: Mon, 15 Sep 2008 08:45:56 -0500
>From: "James Gourley" <jrpatent@gmail.com>
>To: wtc@nist.gov, "Stephen Cauffman" <cauffman@nist.gov>
>Subject: WTC 7 Public Comments
>X-Proofpoint-Virus-Version: vendor=fsecure
>engine=1.12.7160:2.4.4,1.2.40,4.0.166
>definitions=2008-09-15_09:2008-09-02,2008-09-15,2008-09-15 signatures=0
>X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0
>adultscore=0 classifier=spam adjust=0 reason=mlx
>engine=5.0.0-0805090000 definitions=main-0809150070
>X-PP-SpamScore: 0
>X-NIST-MailScanner: Found to be clean
>X-NIST-MailScanner-From: jrpatent@gmail.com
>X-NIST-MailScanner-Information:
>
>WTC Technical Information Repository
>Attention: Mr. Stephen Cauffman
>National Institute of Standards and Technology Stop 8610 Gaithersburg,
>MD 20899-8610
>
>September 15, 2008
>
>Dear Stephen,
>
>Attached to this email is a set of public comments on the NIST WTC 7
>draft report.  The names of all of the submitters, with their
>affiliations, is at the end of the document.  Please let me know if you
>have any trouble opening the attachment, which is in PDF format.  I
>will send it separately in Microsoft Word format, and in email format.
>
>Best regards,
>
>James R. Gourley, Esq.
>Content-Type: application/pdf; name="WTC 7 Public Comments.pdf"
>X-Attachment-Id: f_fl55e4300
>Content-Disposition: attachment; filename="WTC 7 Public Comments.pdf"

**via Electronic Mail: wtc@nist.gov**
WTC Technical Information Repository
Attention: Mr. Stephen Cauffman
National Institute of Standards and Technology
Stop 8610
Gaithersburg, MD 20899-8610

September 15, 2008

Re: Public Comments on WTC 7 Draft Reports

Dear Mr. Cauffman,

I am writing on behalf of a group of scientists, scholars, engineers and building professionals who are dedicated to scientific research regarding the destruction of all three high-rise buildings (WTC 1, 2 and 7) on September 11, 2001. We have examined the draft reports recently released by NIST purporting to explain the demise of WTC Building 7 (collectively referred to herein as the "Report"). We have found many areas that need to be revised and re-examined by NIST personnel before they release a final report on this matter. We have provided our names and affiliations at the end of this document, in accordance with the guidelines for submittal of comments promulgated by NIST at (http://wtc.nist.gov/media/comments2008.html).

At the outset, we would like to call attention to the fact that we requested a reasonable extension of time for the public to submit comments. Given the rate at which we were finding incorrect or contradictory statements in the Report, we would likely have found many more areas NIST needs to re-examine before issuing a final report. As we pointed out in our original correspondence with you requesting the extension, the original three week deadline was completely unreasonable. First, it took NIST more than three years to compile this 1000+ page Report. Why, then, were members of the public only given three weeks in which to comment? Moreover, NIST lists ten authors and dozens of contracted and employed staff, which over the three year investigation would yield somewhere in the neighborhood of 200,000 man-hours of labor. How did NIST expect members of the public to match or even come close to NIST's labor expenditure in three weeks? This first reason alone was enough to warrant a significant extension in the deadline for public comment.

Second, in NIST's "Questions and Answers" page (http://www.nist.gov/public_affairs/factsheet/wtc_qa_082108.html), NIST has attempted to refute many of the points that members of our group and others have made regarding the WTC 7 destruction. However, NIST did not provide any references to sections of the Report that support its alleged refutations. How is a member of the public, then, able to verify NIST's refutation without reading through the entire 1000+ page Report? Our comments are directed to many of the areas addressed in the "Questions and Answers" page, and without citations directly to the Report itself, it was extremely difficult and time consuming for us see whether our main criticisms of the NIST theory of collapse have been adequately addressed in the Report. This is especially true in light of the fact that this latest draft Report is the third different story NIST has come up with.

Your response to our request was dismissive, based primarily on your belief that a six-week comment period on the 10,000 page report NIST issued for the Twin Towers was reasonable. You also saw no problem with NIST's failure to provide any references in its Questions and Answers page to the 1000 page Report itself, apparently satisfied with NIST committing the logical fallacy of appeal to authority. As things stand right now, your position in this matter can be seen as nothing less than a deliberate attempt to hamstring the public's ability to review and comment on NIST's work in this extremely important area of research.

Nevertheless, we have been able to spend some time reading and analyzing the report, and have already found numerous problems that severely undermine its veracity and usefulness. Our comments on the Report are detailed below. Note that we declined NIST's invitation to comment only on the summary report, NCSTAR 1A. These comments are all regarding the more detailed NCSTAR 1-9 document. Of course, once NCSTAR 1-9 is revised according to these comments, the summary report NCSTAR 1A will need to be revised as well.

Based on our comments below, it is readily apparent that the NIST collapse explanation relies solely on extremely suspect computer models. Furthermore, at each juncture where NIST was given the opportunity to input data into each subsequent model, NIST has chosen to use those inputs which would cause the highest temperatures and the most amount of structural damage. Therefore, the submitters of these comments hereby call on NIST to publicly release its models and modeling data so that members of the scientific community can test whether other, more reasonable, assumptions will also result in global collapse of the structure. After all, a scientific hypothesis cannot be widely accepted unless it is repeatable by others.

## Chapter 9: Fire Simulations

*Contradictions between Floor 12 Fire Simulations and Other Evidence*

Figure 9-11 from NCSTAR 1-9 (page 383) depicts the upper layer air temperatures on the 12$^{th}$ floor fire simulation. As can be seen therein, significant fires are present across at least half of the north face of the building at 5:00pm.

This part of the fire simulation presents two problems. First, it contradicts an earlier report issued by NIST regarding the fires on floor 12. Second, it contradicts NIST's own photographic evidence of the fire activity on floor 12.

**COMMENT:** Appendix L to NIST's June 2004 "Progress Report on the Federal Building and Fire Safety Investigation of the World Trade Center" contains NIST's "Interim Report on WTC 7". (See http://wtc.nist.gov/progress_report_june04/appendixl.pdf) On page L-26 of this interim report, NIST states that "Around 4:45 p.m., a photograph showed fires on Floors 7, 8, 9, and 11 near the middle of the north face; Floor 12 was burned out by this time."

**REASON FOR COMMENT:** The contrast between NIST's prior assertion that floor 12 was "burned out" by 4:45pm, and NIST's current computer model, that shows a raging inferno at 5:00pm, could not be more apparent. This discrepancy calls into question the veracity of the Report.

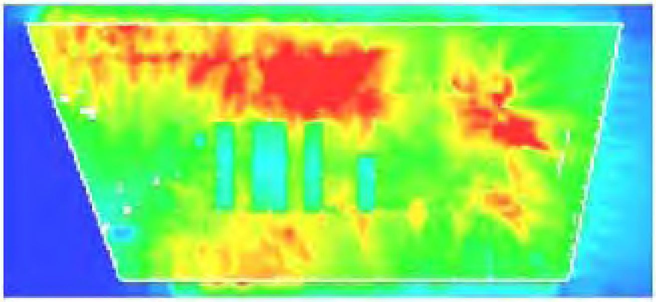
**SUGGESTED REVISION:** This discrepancy must be acknowledged and explained in the Report. Furthermore, the photographic or other visual evidence NIST relied upon for its statement in Appendix L that floor 12 was burned out by 4:45pm must be included in the final version of its report.

**COMMENT:** To support NIST's assertion that there was indeed fire present on floor 12 at 5:00pm, NIST has provided a single photograph from an "unknown source" (Figure 5-152, NCSTAR 1-9, p. 237), that was purportedly taken at around 5:00pm, and shows fire in the two windows that comprise the northwest corner. NIST contends that it has determined that this photograph was taken at approximately 5:00pm, with a margin of error of "at least 10 minutes," using shadow analysis.

**REASON FOR COMMENT:** We find it unlikely that NIST could estimate the time the "unknown source" photograph in Figure 5-152 was taken with such accuracy.

**SUGGESTED REVISION:** NIST must explain how it was able to estimate the photograph's time using shadow analysis to a margin of error even close to 10 minutes.

**COMMENT:** The following graphic is excerpted from Figure 9-11, and purports to describe the state of the fires on the 12th floor of WTC 7 at 5:00pm:



As can be seen, this graphic depicts raging fires across at least half of the north face of the building. However, when compared with Figure 5-152, which only shows a small fire in the extreme northwest corner, clearly the computer model is not representative of reality.

**REASON FOR COMMENT:** It appears that NIST's computer fire simulations are not representative at all of the fires actually occurring in WTC 7.

**SUGGESTED REVISION:** NIST needs to describe why (assuming Figure 5-152 accurately describes the floor 12 fires at about 5:00pm) the computer models show significant fires across at least half of the north side of the building at 5:00pm. NIST should clearly explain why its fire simulation models of the 12th floor should be accepted by the public as an accurate representation of the fires actually occurring in WTC 7.

Separately submitted by Chris Sarns and Richard Gage is a graphic that compares NIST's computer model fire data for floor 12 with actual pictures of the fires in WTC 7. It is attached hereto as Exhibit A. They present a more realistic depiction of what a computer model for the floor 12 fires should look like if it were to agree with the available visual evidence. NIST should take this into consideration when they are re-running their computer models based on these public comments, and revise their Report to use computer models that are more representative of reality, which would look more like the depictions contained therein.

*Combustible Fuel Loading on Floors 11 and 12*

**COMMENT:** This comment relates to NIST's assumptions regarding combustible fuel loading for the 11th and 12th floors. In NCSTAR 1-9, at p. 375 (para. 1, sent. 7-9) NIST states:

> NIST assumed that the combustible mass of furniture was about the same in an office as in a cubicle. Since the loading of other combustibles was reported to have been high on the 11th and 12th floors (Chapter 3), NIST assumed that the total combustible mass in an office was double that of a cubicle. Thus, the average combustible fuel load on the 11th and 12th floors was estimated as 32kg/m2.

However, Chapter 3 tells us that, contrary to NIST's assertions in Chapter 9, the loading of other combustibles was not reported to have been high on the 11th and 12th floors. On page 55 (para. 6, sent. 1) of NCSTAR 1-9, NIST reports that the U.S. Securities and Exchange Commission occupied the 11th and 12th floors and the north side of the 13th floor. On page 56 (para. 1, sent. 1) NIST further reports that American Express occupied the southwest sector of the 13th floor. On the same page, NIST reports that the "combustible load in the offices was described as high by interviewed American Express managers." (NCSTAR 1-9, p. 56, para. 4, sent. 3)

**REASON FOR COMMENT:** Recall that American Express occupied only the southwest sector of the 13th floor. How, then can NIST credibly claim that the combustible load on the entirety of the 11th and 12 floors, both occupied solely by the SEC, was reported to have been high? Were American Express managers given regular access to the SEC offices, such that they would be qualified to comment on the combustible fuel load there? Moreover, are American Express managers qualified to give an opinion on the quantity of combustible fuel load as compared to offices in the Twin Towers?

**SUGGESTED REVISION:** Clearly American Express personnel are competent to provide information only on the state of the American Express offices, which were confined to the southwest sector of the 13th floor. NIST must provide real support for its assertion that the combustible load on the 11th and 12th floors was high in order to merit any increase in estimated average combustible fuel load on these floors. If it cannot provide such support, it should re-run its computer models with the lower combustible fuel load on these floors and report those results to the scientific community and the American public.

*Combustible Fuel Loading on Floor 13*

**COMMENT:** This comment is regarding NIST's treatment of the combustible fuel load of the 13th floor. On page 375 of NCSTAR 1-9 (para. 1, sent. 8, 9) NIST states as follows: "The density of combustibles on the 13th floor was varied and not well known. The average value [for the 13th floor] was assumed to be the same as the 12th floor." Here again, the only reported description of the combustible load on the 13th floor was from American Express managers, who were competent to comment only on the southwest sector of the 13th floor. In Chapter 3 of NCSTAR 1-9, page 57 (para. 2, sent. 2, 3) NIST reports that in the SEC occupied sections of northern perimeter of the 13th floor were "a hearing room and multiple testimony rooms facing it. There were additional testimony rooms on the northern portion of the east and west sides of the floor, and a storage room at the northwest corner."

Importantly, NIST reports that the "testimony rooms were sparsely furnished, with just a table and a few chairs." (NCSTAR 1-9, p. 57, para. 2, sent. 4) Furthermore, an examination of the schematic diagram of floor 13 (Figure 3-8, p. 57) reveals that the hearing room appears similar to a court room. Court rooms are also sparsely furnished, with a few tables and chairs. Finally, it is doubtful that there was any appreciable level of additional combustibles present in these testimony and hearing rooms.

**REASON FOR COMMENT:** NIST has apparently greatly overestimated the fuel loading on the 13th floor.

**SUGGESTED REVISION:** NIST must justify its use of the higher combustible fuel load on the 13th floor in Chapter 9 of the Report with more than just bare assertions. NIST clearly had more information available to it regarding the layout and make up of floor 13, as reported in Chapter 3, than it lets on in Chapter 9. This discrepancy must be reconciled.

*Combustible Load Sensitivity Tests*

**COMMENT:** NIST claims that it did sensitivity tests to determine whether these exorbitant combustible fuel loads adversely affected the outcome of its simulations. However, the fact that NIST even performed the sensitivity tests brings up the question of why NIST went to the trouble of increasing the fuel load in the first place if it would have a negligible effect on the simulation. That point aside, Chapter 9 contains statements that directly contradict the results of these alleged sensitivity tests.

On page 381 of NCSTAR 1-9 (para. 3, sent. 3) NIST flatly states that, in its fire simulations for the 12th floor, "[t]he [fire] spread rate was about one-third to one-half slower than that on the lower floors due to the higher fuel load [on the 12th floor simulation]." NIST goes on to report that the burn time across the north face in the simulation was longer than observed in the visual evidence. (NCSTAR 1-9, p. 381, para. 3, sent. 4) NIST then rejects the possibility that this could have resulted from the fuel load being too high, citing the sensitivity analysis in Section 9.3.3. (para. 3, sent. 4-8)

In Section 9.3.3, we find the referenced sensitivity analysis. Here, NIST reports that doubling the fuel load on the 8th floor resulted in the fires moving distinctly more slowly than in the visual evidence. (NCSTAR 1-9, p. 382, para. 5, sent. 1-3) Confusingly, NIST also reports that decreasing the fuel load by more than one-third on floor 12 "showed little effect on the rate of fire progression." (Id., para. 6, sent. 1-3)

**REASON FOR COMMENT:** NIST's contradictory statements raise the question of why reducing the fuel load by more than one-third would show no appreciable effect on the fire rate of progression on the 12th floor, when doubling the fuel load on the 8th floor did result in an appreciable change.

**SUGGESTED REVISION:** NIST should explain here exactly what the differences in the fire progression rate were in each case and let the public judge whether the effect was "little". More important, however, is the direct contradiction between NIST's statement that the "spread rate was about one-third to one-half slower than that on lower floors due to the higher fuel load" (NCSTAR 1-9, p. 381, para. 3, sent. 3) with its statement that decreasing the fuel load to a value equal to that of the lower floors "showed little effect on the fire rate of progression." (NCSTAR 1-9, p. 382, para. 6, sent. 1-3) Surely NIST can see this direct contradiction. On page 381, it is claimed that higher fuel load slows down the fire spread rate. On page 382, it is claimed that a lower fuel load will not speed up the rate of fire progression. This contradiction must be reconciled.

*Fire Simulations for Floors 11 and 13*

NIST used the data generated by its 12th floor fire simulation for floors 11 and 13. (NCSTAR 1-9, p. 382, para. 1, 3) The 13th floor simulation used the 12th floor data delayed by one-half hour because visual evidence indicated that the 13th floor fire followed the 12th floor fire. (Id., para. 3, sent. 5) The 11th floor simulation used the 12th floor fire data delayed by 1 hour, although the visual evidence indicated that the 11th floor fire was delayed from the 12th floor fire by 1.5 hours. (NCSTAR 1-9, p. 382, para. 1, sent. 5)

**COMMENT:** Our first comment in this regard simply notes the discrepancy between the visual evidence that the 11th floor fire was delayed from the 12th floor fire by 1.5 hours, yet in its fire simulations for the 11th floor, it was only delayed from the 12th floor fire by 1.0 hour.

**REASON FOR COMMENT:** This represents yet another discrepancy in the Report that needs to be rectified.

**SUGGESTED REVISION:** NIST must explain why the visual evidence was not relied upon for inputs on the 11th floor, when it was relied upon for inputs on the 13th floor. The computer models should be re-run with the 11th floor fire delayed by 1.5 hours, not 1.0 hour, and the results reported accordingly.

**COMMENT:** Our second comment concerns both the 11th and 13th floor fires. As we demonstrated above, the 12th floor fire simulation is not representative of reality, and likely grossly overestimates the fires that were present there. By using its grossly overestimated 12th floor fire data on both the 11th and 13th floors, it has magnified this error three-fold.

**REASON FOR COMMENT:** By magnifying an obvious error by three times, the results of all of NIST's subsequent computer models are again called into question.

**SUGGESTED REVISION:** The computer models should be re-run for the 12th floor using more realistic fire scenarios, and if NIST can still justify using the 12th floor data on the 11th and 13th floors, it should use that more realistic data on both floors. The results should then be reported accordingly.

**COMMENT:** Our third comment concerns the propagation of error through NIST's approach to using a purely computer model driven approach. On page 382 of NCSTAR 1-9 (para. 1-3, sent. last) NIST acknowledges that its computer models for the fires on floors 11 and 13 "could have led to a mild overestimate of the heating on the north side of the floor."

**REASON FOR COMMENT AND SUGGESTED REVISION:** In order to assure public confidence in the document, NIST must explain how such an error in overestimating the heating would propagate itself throughout all of NIST's subsequent computer models, and how such propagation of error will affect the reliability of the ultimate results. The Report should be revised to include such a propagation of error analysis.

## Chapter 11: Structural Analysis of Initial Failure Event

*Section 11.4 – Structural Response to Case B and Case C Fires*

**COMMENT:** In Section 11.4 (NCSTAR 1-9, p. 523-532), NIST goes through a detailed comparison of the structural response of the lower floors of WTC 7 to Case B and Case C fire scenarios. Case B used gas temperatures that were 10% higher than Case A, while Case C used gas temperatures that were 10% lower than Case A. No analysis of the structural response is shown or discussed for Case A.

On page 533 of NCSTAR 1-9 (para. 1, sent. 1) NIST makes the unsupported assertion that "comparison of Case B and Case C results at 4 h (Section 11.3.3) showed that the Case C structural response would be nearly identical to the Case B structural response at a time between 4.0 h and 4.5 h." However, when we read Section 11.3.3, we see that the analysis of Case C structural response was not carried out to 4.5 hours. Instead, we see that the response of Case C at 4.0 h was somewhat similar to the response of Case B at 3.5 h. NIST must explain how it extrapolated the Case C damage to 4.5 hours, when it was using lower temperatures in Case C than in Case B.

Also, no detailed analysis is disclosed for the Case A temperatures. NIST must include this data generated by Case A temperatures in its Report so the public can independently determine whether Case A profiles should be used in the subsequent LS-DYNA model.

**REASON FOR COMMENT:** Most important is the fact that NIST's use of the structural response to only Case B temperatures in its subsequent LS-DYNA model represents yet another example of NIST choosing input data that would tend to overestimate the temperatures and structural damage caused during the WTC 7 fires. We explained above how NIST did this before with respect to gross overestimates of combustible loads on floors 11, 12 and 13. These happen to be the exact floors on which the most damage was caused in NIST's black box model. Why did NIST not use the Case A and Case C structural response in the LS-DYNA model? Or, if it did, why did it not report the results of these models?

**SUGGESTED REVISION:** The final report must be revised to correct this error. If Case A and Case C structural responses were never used with the LS-DYNA model, the models should be re-run and the results reported to the scientific community and the American people. This is especially true in light of the fact that the 3.5 h Case B structural response did not result in global building collapse in the LS-DYNA model.

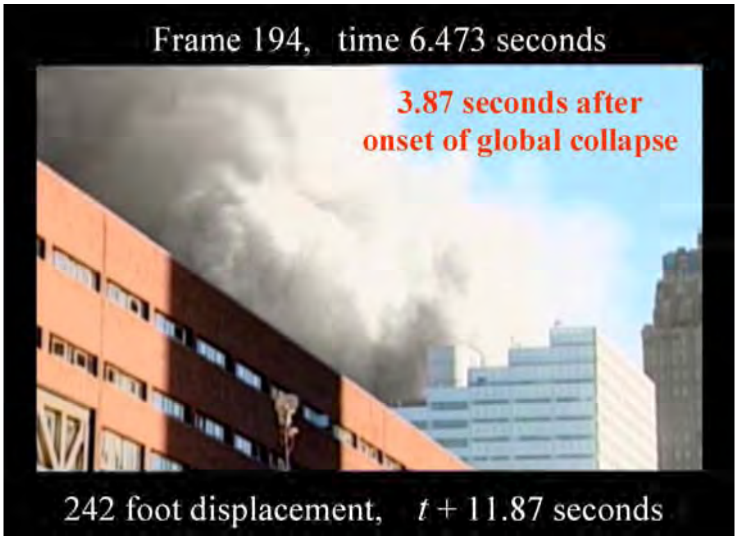
## Chapter 12: WTC Global Collapse Analysis

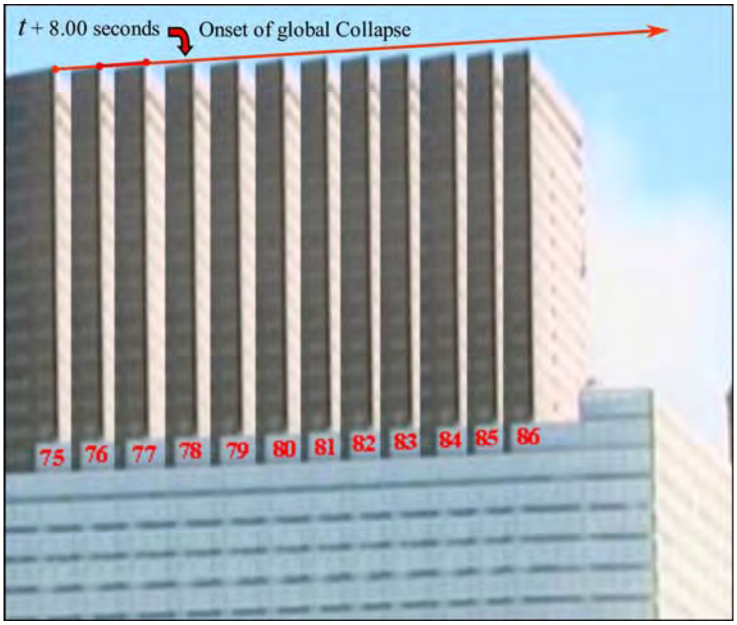
### *Section 12.5.3 – Collapse Time*

**COMMENT:** This comment concerns NIST's estimation of the time it took for the WTC 7 structure to fall. Specifically, this concerns NIST's comparison to the actual descent time with a hypothetical free-fall time. (NCSTAR 1-9, p. 595; NCSTAR 1A, p. 40-41) Basically, NIST took two data points, and assumed a constant acceleration throughout the collapse. (Id.) The first data point was allegedly taken at the time the top of the parapet wall on the roofline of the north face began descending. The second data point was allegedly taken at the time the roofline was no longer visible in Camera 3. NIST claims that the time it takes for the building to fall this distance, 242 feet, is 5.4 seconds, plus or minus 0.1 seconds. No graphical or visual support is given for this time estimate.

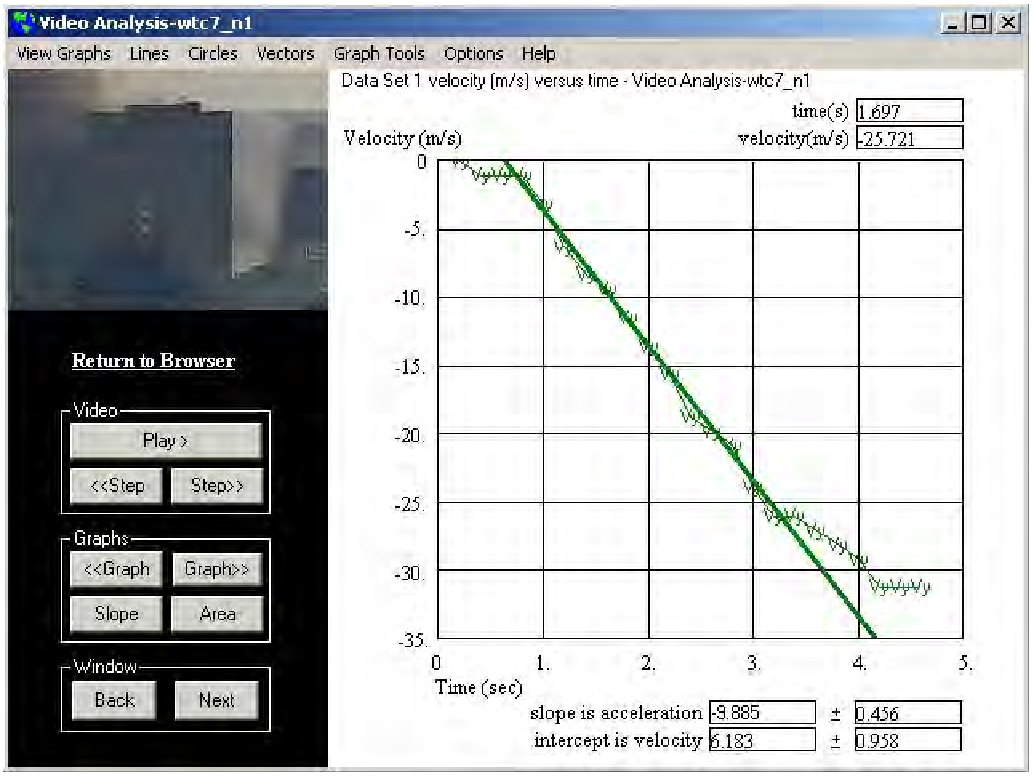
**REASON FOR COMMENT:** Members of this group have conducted an independent analysis of the Camera 3 footage and come to an entirely different conclusion regarding the collapse time. Our analysis was done on a frame-by-frame basis using a frame rate of 29.97 frames per second. As shown in the figure below, our analysis concludes that it takes 3.87 seconds for the top of the roofline to descend out of view of Camera 3. This time matches almost exactly the free-fall time.

**SUGGESTED REVISION:** NIST must revise its Report to show the exact frames it used from Camera 3 in determining the time it took for the roofline to fall out of view. 5.4 seconds appears to be a gross overestimate. The frames we used in our collapse analysis are shown below (times "t + X seconds" reference the times given in NIST's Appendix L, Table L-1) along with a graphical analysis of how we determined which frame represented the onset of global collapse:




Members of this group have used the Physics Toolkit computer software to plot Velocity vs. Collapse Time using discrete data points gathered during the entire collapse from the view NIST calls Camera 2. This plot is reproduced below and provides a much more detailed look at the dynamics of the WTC 7 collapse than is provided by NIST's two-data-point analysis. Also included in the graph is a linear regression for approximately 2.6 seconds of the collapse that appears to have a constant acceleration. As can be seen, the slope (acceleration) during this portion of the collapse was approximately constant at about 9.8 m/s/s, or acceleration due to gravity with little to no resistance below. The r-squared value for this linear regression analysis was 0.9931 – a very good fit. This clearly demonstrates that NIST is being extremely misleading in reporting to the public that the structure did not descend at free-fall speed, especially given the implications of this documented feature of WTC 7's destruction.




**Chapter 8: Initiating Event Hypothesis**

*Inconsistencies Between Report and NIST Technical Presentation Slides*

**COMMENT:** On page 353 of NCSTAR 1-9 (para. 1, sent. 9) NIST states that "Buckling of other floor beams followed as shown in Figure 8-27 (a), leading to collapse of the floor system, and rocking of the girder off its seat at Column 79 as shown in Figure 8-27(b)." Slide 33 of Dr. Sunder's August 26, 2008 technical presentation states that "Forces from thermal expansion failed the connection at Column 79, then pushed the girder off the seat." (http://wtc.nist.gov/media/WTC7_Technical_Briefing_082608.pdf)

**REASON FOR COMMENT:** There seems to be an inconsistency in what NIST is telling the public. In the Report it seems as if the floor system collapses, which drags the girder off its seat to the east. In Dr. Sunder's presentation, the floor beams appear to remain rigid and push the girder off its seat to the west. These conflicting statements make it difficult for the public to determine which story NIST actually believes.

**SUGGESTED REVISION:** NIST must reconcile the difference between its public presentation and the substance of the Report.

*"Perfectly Fixed" Exterior Columns and Rigid Floor Beams*

**COMMENT:** On page 350 of NCSTAR 1-9 (para. 2) the exterior columns and column 44 were modeled as "perfectly fixed" at a number of locations during the finite element analysis of the northeast corner of the building. This computer model was purporting to demonstrate that thermal expansion could cause the girder to disconnect from Column 79. Obviously, if the floor beams were to elongate due to thermal expansion, it would expand in both axial directions. This, in turn, would put pressure on whatever was connected to each end of the expanded beam.

**REASON FOR COMMENT:** To the extent "perfectly fixing" the exterior columns and column 44 caused the computer model to neglect the pressure put on the exterior columns due to thermal expansion, the computer model does not represent reality. The exterior columns should have been allowed to bow outward in response to this pressure. It is also unclear whether the floor beams were allowed to sag as they heated in the computer model. In NIST's report on the Twin Towers, the main reason given for global collapse initiation was sagging floor beams. If NIST did not allow the floor beams to sag in its WTC 7 model, then it did not allow any of the thermal expansion to express itself as sagging rather than pressure on the connections. Even the Cardington tests cited by NIST showed that floor beams to sag when they are heated.

**SUGGESTED REVISION:** NIST must more clearly explain how the thermal expansion of the floor beams in both axial directions was accounted for in the computer models. If "perfectly fixing" the exterior columns caused all of the thermal expansion to occur in one direction, the computer models needs to be modified to comport with reality, and allow outward bowing of the external columns. Also, if the floor beams and girders were not allowed to sag as they heated, there is a fundamental disconnect between the WTC 7 computer models and the WTC 1 and 2 computer models. The computer models should be re-run with appropriate revisions made to the floor beam properties, which allow them to sag as they heat.

*Temperatures Applied to Beams and Girders*

**COMMENT:** In Figure 8-25 on p.352 of NCSTAR 1-9, NIST applies temperatures of 600°C and 500°C to the floor beams and girders, respectively, over a period of about 2.6 seconds. Putting aside for a moment the fact that applying that much heat over a 2.6 second time interval could not possibly approximate the reality of the fires at WTC 7, other problems still remain. For example, these extreme temperatures were applied uniformly for all nodes of the beams and girders. (NCSTAR 1-9, p. 351)

**REASON FOR COMMENT:** On page 452 of NCSTAR 1-9, NIST only reports that some "sections" of the floor beams exceeded 600°C. Nowhere does NIST indicate that the computer models show ***uniform*** temperatures of 600°C for floor beams and virtually no information is given for temperatures of girders. Again, these temperatures are applied uniformly over an extremely small amount of time, which is not representative of an actual fire.

**SUGGESTED REVISION:** Run the computer models for the northeast section of floors again using realistic temperatures and realistic application times. Report the results accordingly.

*Only High Explosives Considered in Hypothetical Blast Event*

**COMMENT:** In its analysis of "hypothetical blast scenarios" that might have lead to the collapse of WTC 7, NIST only considers blast events using RDX, an extremely high explosive. (NCSTAR 1-9, p. 355, last sentence) NIST goes on to argue that because no loud sounds were heard, and because no window breakage was observed, that RDX was not used to bring down WTC 7.

**REASON FOR COMMENT AND SUGGESTED REVISION:** However, as documented by Kevin Ryan at the Journal of 9/11 Studies (http://www.journalof911studies.com/volume/2008/Ryan_NIST_and_Nano-1.pdf) many scientists working for and associated with NIST have experience with nanoenergetic compounds, or nanothermites, that have the potential to be used for building demolitions. And because nanothermites are primarily high-temperature incendiaries rather than explosives, they could cause damage to steel structures without producing the sound and destruction levels associated with RDX. Because NIST personnel have intimate experience with these materials, NIST should revise its report to specifically analyze whether such nanoenergetic materials could have been used as a component in a "hypothetical blast scenario" at WTC 7.

Furthermore, the National Fire Protection Association Manual for fire and explosion investigations, in Section 921, very clearly indicates that the possibility of explosives should have been thoroughly investigated by NIST. Specifically in NFPA 921 18.3.2 "High Order Damage" – "High-order damage is characterized by shattering of the structure, producing small, pulverized debris. Walls, roofs, and structural members are splintered or shattered, with the building completely demolished. Debris is thrown great distances, possibly hundreds of feet. High-order damage is the result of rapid rates of pressure rise." WTC 7 clearly met this definition. Therefore NIST should have investigated more thoroughly the possibility that explosive were used. Specifically, the use of "exotic accelerants" should have been investigated. In NFPA 921 19.2.4 – "Exotic Accelerants," three indicators were clearly met that should have led to a thorough investigation into the possible use of "exotic accelerants," specifically as stated in the guideline, "Thermite mixtures." NIST should comply with NFPA Section 921 and test the debris from WTC 7 for thermite residues and report the results to the scientific community.

**Omissions from the NIST Report**

*Foreknowledge of Collapse*

NIST omitted from the Report information relating to foreknowledge by several groups of people that WTC 7 was going to collapse.

What we mean by foreknowledge is a quality of detail and a strength of conviction that allow us to say, in light of the building's collapse at approximately 5:21 p.m., that they *knew* in advance that it was coming down.

Such knowledge is highly significant in light of the facts that (a) no steel framed skyscraper in history (indeed, NIST says, "no tall building" in history) had ever before collapsed from fire alone; and (b) the collapse, according to NIST, was the result of a series of accidental and unpredictable factors, which did not come together in such a way as to determine the fate of the building until minutes, or possibly even seconds, before the collapse took place.

In any situation where someone demonstrates foreknowledge of an extremely unusual event, the possibility must be considered that the knowledge derived from those who had control over the event. In other words, foreknowledge of WTC 7's collapse greatly strengthens our suspicions that the building was subjected to controlled demolition and that the knowledge of its demise derived ultimately from those who intended to bring it down.

NIST has tried to evade the issue of foreknowledge of WTC's collapse by implying:

(a) that the FDNY, on the scene, saw the damage to the building caused by the collapse of WTC 1 and rationally concluded that WTC 7 might collapse.

From NIST NCSTAR 1A, p.16:

"The emergency responders quickly recognized that WTC 7 had been damaged by the collapse of WTC 1...

As early as 11:30 a.m., FDNY recognized that there was no water coming out of the hydrant system to fight the fires that were visible. With the collapses of the towers fresh in their minds, there was concern that WTC 7 too might collapse..."

(b) that an engineer, early in the day, saw the damage to the building and concluded it might collapse, passing on this assessment to others (Lead Investigator Shyam Sunder, in a discussion with Graeme MacQueen on CKNX Radio, Wingham, Ontario, Aug. 25, 2008)

It is true that damage to WTC 7 was directly witnessed by some firefighters and led a few of them (about seven) to worry that the building might collapse, but the great majority (approximately 50) who were worried about collapse did not base this worry on what they perceived but on what they were told. (See Graeme MacQueen, "Waiting for Seven: WTC 7 Collapse Warnings in the FDNY Oral Histories", *Journal of 9/11 Studies*, June 11, 2008) Moreover, while it is apparently also true that an engineer communicated his opinion, early in the day, that the building might collapse, neither this communication nor communications from the FDNY is sufficient to explain the evidence of foreknowledge that we possess.

Below are seven reasons why the above NIST explanations of foreknowledge are inadequate. One example is given to illustrate each of the seven reasons. More details can be found in the paper by Graeme MacQueen titled “Waiting for Seven: WTC 7 Collapse Warnings in the FDNY Oral Histories” published at the Journal of 9/11 Studies (http://www.journalof911studies.com/volume/200701/MacQueenWaitingforSeven.pdf).

1. Certainty
To worry that a damaged building *might* collapse in some fashion is one thing; but to be certain that it *will* collapse is another. Detailed study of the accounts of the FDNY shows that over half of those who received warnings of WTC 7’s collapse (where degree of certainty can be determined from the reports) *were certain or were told with certainty* that it was coming down. (The figures are: 31 out of 58. See “Waiting for Seven”.)

2. Early announcement
If someone was observing the fires in WTC 7 and was able to determine, in the last few moments of the building’s existence, that a peculiar set of circumstances was beginning to threaten the building, that would be one thing; but to receive warnings of the building’s collapse well before this set of circumstances was in place raises far more suspicions. Yet a detailed study of the FDNY reports show that of the 33 cases where the time of warning can be determined, in ten cases warnings were received two or more hours in advance and in six cases warnings were apparently received four of more hours in advance. (See “Waiting for Seven.”) In other words, long, long before the unique set of circumstances had come together to cause the building’s collapse, the collapse was being spoken of widely.

3. Precision
If the collapse warnings derived from vague worries and concerns they would not have been precise. No building had come down from these causes before, and, in fact, *complete collapse* such as happened to WTC 1, WTC 2, and WTC 7 was very rare, apart from cases of controlled demolition. That is why FDNY member James McGlynn could say on 9/11, speaking of one of the Towers, "Any time I've heard of a collapse, it was never an entire building like this turned out to be." (See “Waiting for Seven.”) Yet, despite the rareness of complete collapse, many people apparently knew in advance that WTC 7 would be undergoing such a collapse. Consider the following from the FDNY oral histories:

Q. "Were you there when building 7 came down in the afternoon?"
A. "Yes."
Q. "You were still there?"
A. "Yes, so basically they measured out how far the building was going to come, so we knew exactly where we could stand."
Q. "So they just put you in a safe area, safe enough for when that building came down?"

A. "5 blocks. 5 blocks away. We still could see. Exactly right on point, the cloud stopped right there." (See “Waiting for Seven.”)

4. New information
If the collapse warnings derived from worries and concerns expressed early in the day by engineers and firefighters, why would the collapse of WTC 7 have been reported by CNN (one hour and 10 minutes in advance) and BBC (23 minutes in advance) as *breaking news* based on just received information? CNN anchor Aaron Brown said “*We are getting information now*.” CNN anchor Judy Woodruff: *“We’re hearing for the first time”* (See Appendix.) BBC anchor: *“We’ve got some news just coming in”*.

5. Premature announcement
CNN and the BBC did not merely report that the building was damaged or that it might collapse; they *prematurely announced its actual collapse*.

CNN’s Aaron Brown, one hour and ten minutes in advance of the collapse: “We are getting information now that one of the other buildings, Building 7, in the World Trade Center complex, is on fire and has either collapsed or is collapsing...”

BBC anchor, 23 minutes before the collapse: “the Salomon Brothers Building in New York, right in the heart of Manhattan, has also collapsed.”

No satisfactory explanation has been forthcoming about these premature announcements, which were obviously based on data fed to these announcers.

6. Continuity
The BBC *continued to announce* that WTC 7 had collapsed, even when the building could be seen standing directly behind reporter Jane Standley, for about 17 minutes until the story was pulled abruptly.

When CNN personnel realized they had made an error in their early announcement, they could simply have corrected it. They could, at the very least, have withdrawn their attention from WTC 7 and stopped covering it since it was obviously still standing. Instead, CNN *continued to keep WTC 7 in the forefront of its coverage* over the hour and ten minutes preceding its collapse, repeatedly warning that it was going to come down and keeping the image of the building in front of the viewer until it had actually collapsed. (See Appendix.)

7. Progression
According to NIST’s study, WTC 7’s fires had been reduced from ten floors, soon after the collapse of WTC 1, to essentially two floors as the collapse time approached. This was a building in which the fires were actually dying down. Why, then, did CNN show awareness of the building’s approaching doom, and why did it revise its captions accordingly, from “may collapse” to “poised to collapse” (approximately 15 minutes before actual collapse) and then to “on verge of collapse” (approximately 1.5 minutes before actual collapse). (Appendix)

Any one of these seven factors would be enough to make us consider the possibility of *foreknowledge* of WTC 7's collapse. Taken together, they make an unanswerable case.

As further support, below we have provided a timeline of events based on CNN's coverage of Building 7. The times in the left-hand column are within 30 seconds of actual time.

| Time | Event in progress |
|---|---|
| 4:11:16 | Anchor Aaron Brown: "We are getting information now that one of the other buildings, Building 7, in the World Trade Center complex, is on fire and has either collapsed or is collapsing and I, I...[pauses, looks at monitor, where WTC 7 stands, apparently firm and stable] you, to be honest, can see these pictures a little bit more clearly than I..."<br><br>Fixed Caption near bottom of screen: "Building 7 at World Trade Ctr. on fire, may collapse" |
| 4:13:25 | Anchor Judy Woodruff reaffirms what Aaron Brown has just announced, saying "we're hearing for the first time" that "one of the support buildings [in the World Trade Center complex] is on the verge of collapse if it has not already collapsed".<br><br>Fixed Caption near bottom of screen: "Building 7 at World Trade Ctr. on fire, may collapse" |
| 4:21:16 | Judy Woodruff : "one of the buildings may have collapsed or may be in the process of collapsing"<br><br>Fixed Caption near bottom of screen: "Building 7 at World Trade Ctr. on fire, may collapse" |
| 4:35:58 | Running Caption at very bottom of screen scrolls by, saying that WTC 7 has caught fire and may collapse |
| 4:50:33 | After many split screen shots with WTC 7 as one of two images, we now get WTC 7 filling most of the screen<br><br>Fixed Caption near bottom of screen: "Building 7 at World Trade Ctr. on fire, may collapse" |
| 5:06:15 | Running Caption at very bottom of screen scrolls by, saying: "World Trade Center Building 7 ablaze, poised to collapse" |
| 5:19:31 | Fixed Caption: "Building 7 at World Trade Ctr. on fire, on verge of collapse" |
| 5:21:12 | Shot of NY skyline with WTC 7 gone and large clouds of dust rising. Anchor Aaron Brown announces: "just in the last few seconds another building—we will speculate carefully here that it was Building Number 7...has collapsed" |

The NIST Report should be revised to include a detailed analysis of all of the reports of specific foreknowledge of the collapse of Building 7. NIST's Lead Investigator, Dr.

Sunder, when challenged with reports like this during radio interviews recently has stated that NIST's investigation was not a criminal investigation, but instead is a technical one. However, this position belies the fact that NIST did opine in the Report that the controlled demolition hypothesis was unlikely because NIST didn't believe that the explosives could be placed without being detected. Such an opinion is not a technical opinion, but an operational one that goes more to logistically how a criminal could have committed the crime than technically how it was done. Clearly NIST could consider the many reports of foreknowledge and note the impossibility of such specific and detailed foreknowledge. The Report should be revised accordingly.

*FEMA Building Performance Study – Appendix C*

The NIST WTC 7 Report does not attempt to explain the "*severe high-temperature corrosion attack*" on apparently the only piece of WTC 7 steel which was tested, as documented in Appendix C, "Limited Metallurgical Examination" of the Federal Emergency Management Agency (FEMA) Building Performance Study, which can be found at the link below on the NIST website.

http://wtc.nist.gov/media/AppendixC-fema403_apc.pdf

The detailed further study deemed necessary by FEMA was – as far as we know - never done, and the observed "*intergranular melting*" of the steel can not be explained within the framework of the present NIST hypothesis. Why would NIST ignore the recommendations made by FEMA investigators for additional research of the unexplained material behavior?

In a taped interview Worcester Polytechnic Institute Fire Engineering professor Dr. Jonathan Barnett, one of the authors of the 13 page report in Appendix C, made the comment that normal investigative protocol was not followed in the case of the WTC 7 collapse. He says that the steel from WTC 7 was not photographed, examined, and cataloged before being removed. The comments he makes are at the 3:00 minute mark in the below linked video.

http://www.911podcasts.com/display.php?cat=9998&med=0&ord=Name&strt=180&vid=58&epi=0&typ=0

It is reported that WTC 7 was fully evacuated long before its collapse and that there were no fatalities or missing persons involved with its demise. The photos in the figures below show the collapsed WTC 7 to have its debris field confined to within a short distance of its footprint.

**Figure 1. The rubble pile of WTC 7 on Sept. 15, 2001, four days after the building collapsed**


**Figure 2. NOAA aerial photo of Ground Zero on Sept. 23, 2001 showing the relative location of the WTC 7 rubble with respect to debris of the other WTC buildings and a somewhat clear line of demarcation on Vesey Street**

In addition to showing the relatively tight confinement of the debris field of WTC 7, the photo in Figure 2 also shows that debris from WTC 6 and WTC 5 was contained within their footprints or very nearby.

The FEMA report debris field map for the Twin Towers, below in Figure 3, shows that only a small percentage of the debris from WTC 1 made it the 350 feet to WTC 7's location. The lighter areas on the map represent low debris density and the darker areas high debris density.


**Figure 3. FEMA debris map for the Twin Towers**

The seeming separation of the WTC 7 debris field from those of the other buildings, and the fact there were no missing persons or fatalities involved with its collapse, make it hard to accept the History Channel program narrator's comment, in the video above, that the mingling of the steel from the different buildings, and the need for search and rescue, were the reasons for the removal of the WTC 7 steel, before it could be properly photographed, examined, and cataloged, at the collapse site.

Even if the WTC 7 steel was moved, without being examined and cataloged at the site of the collapse, an additional question arises as to why it wasn't recovered and stored for later testing, evaluation, and a systematic forensic analysis. This is especially pertinent in light of the FEMA recommendation that additional research was needed due to the strange findings in their very limited metallurgical examination.

In the August 2008 NIST draft Report on WTC 7 there is no mention of testing of any recovered steel from the collapsed remains of the building. In sections where the properties of the steel need to be discussed reference is curiously made to WTC steel samples, not specifically those of WTC 7. This can be understood if one is aware that in an earlier draft of the WTC 7 report NIST made the stark admission that “No metallography could be carried out because no steel was recovered from WTC 7. Other physical properties are the same as those estimated in Chapter 8 for the WTC steels”.

Since NIST report on the collapse of WTC 7 suffers from a lack of physical evidence to support its findings, it should go into some level of detail on: why normal investigatory protocol was not followed, why none of the steel was recovered, and whether any laws were violated in not doing so. If there are questions as to the legality of the removal and lack of recovery for investigatory purposes, NIST should recommend that an investigation be commenced to determine who was involved with the decision to remove the steel and why NIST did not receive any of it for its investigation.

There are also several seemingly contradictory issues between the FEMA Building Performance Study Appendix C and the NIST WTC 7 Report, for which no explanations have been provided, and they are:

- NIST states "No steel was recovered from WTC 7" while FEMA section C.2 shows that at least one piece of WTC 7 steel was tested, with the results being alarming, considering the highly unusual formation of a liquid eutectic, intergranular melting, and erosion. Features not seen before, by the experienced investigators, in steel subject to common office fires.

- FEMA section C.3 Summary for Sample 1 states that the steel was heated to around 1,000° C. (1,800° F.), which is much hotter than the steel temperatures NIST is claiming to have caused the collapse, and seemingly far outside the ability of office fires to heat the steel. Additionally, this section states that steel liquefied at these temperatures, due to the formation of the eutectic, which would dramatically lower the usual 2750° F melting point temperature of the steel.

- FEMA Section C.6 Suggestions for Future Research states "It is also possible that the intergranular melting, eutectic formation, and erosion phenomenon started prior to collapse and accelerated the weakening of the steel structure."

Why hasn't the "future research" been done, and the results from it published, especially when FEMA itself suggested that this melting and erosion may have started “prior to collapse”? NIST was charged with investigating the conditions that led to the collapse of WTC 7, and clearly something that possibly occurred prior to collapse and “accelerated the weakening of the steel structure” is something NIST should have investigated. NIST should revise the Report accordingly after it has performed the needed metallurgical analysis.

These public comments on the NIST WTC 7 Report are being submitted by the following individuals:

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Structural Engineer
Architects & Engineers for 9/11 Truth

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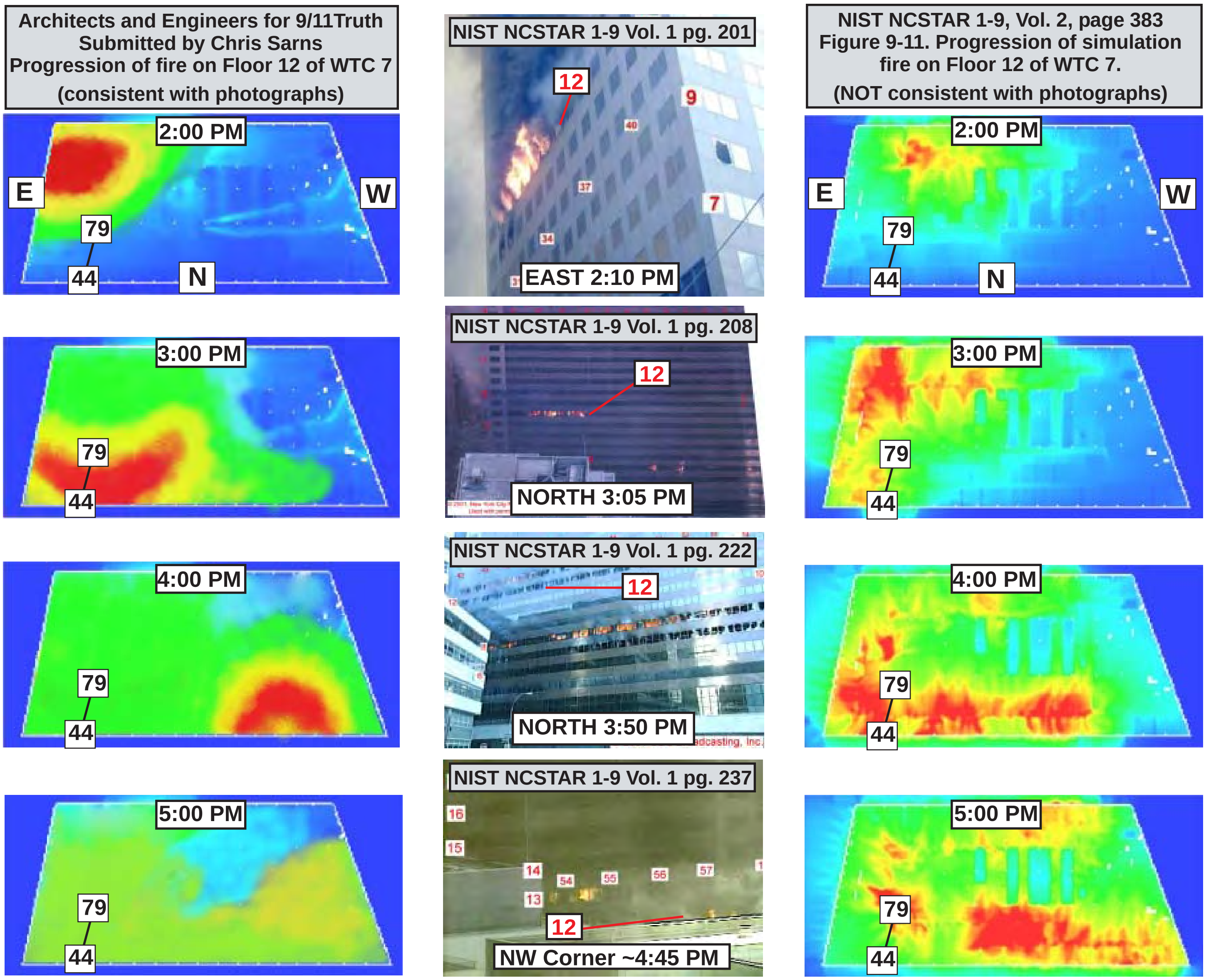
Forensic Engineer
Civil Engineer
Architects & Engineers for 9/11 Truth

# Exhibit A
# Graphical Examination of NIST WTC 7 Floor 12 Fire Analysis

ARCHITECTS & ENGINEERS for 9/11 TRUTH

*9/11: Re-examining the 3 WTC high-rise "collapses".*

# AE911Truth Challenges NIST's WTC 7 Floor 12 Fire Analysis




According to NIST, the fire on floor 12 caused the girder between columns 79 and 44 under floor 13 to fail at 5:20 PM. Theoretically, this was the beginning of the initiating event that led to the implosion of WTC 7.

On page 383 of NIST NCSTAR 1-9 Vol. 1 (2008), the fire simulations graphic of floor 12 shows the fire burning around column 79 at 4:00 and 5:00 PM. The NIST simulation is not consistent with the photographs of the fire. The photographs show, and the NIST Appendix L report (2004) states "Around 4:45 PM, a photograph showed fires Floors 7, 8, 9, and 11 near the middle of the north face; Floor 12 was burned out by this time." In fact, it had burned out in the east end before 4:00 PM.

**Therefore, the fire on floor 12 could not have caused floor 13 to collapse (at 5:20 PM) and the implosion of WTC 7 could not have occurred as NIST has proposed.**

To: WTC Technical Information Repository
Attention: Mr. Stephen Cauffman
National Institute of Standards and Technology
Stop 8610
Gaithersburg, MD 20899-8610

Sent by e-mail to: wtc@nist.gov

From: James H. Hatton, Jr., PE (Inactive)
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Phone: 301-330-8046

Date: 15 Sep 08

Subject: Drafts for Public Comment–NIST Reports NCSTAR 1A and NCSTAR 1-9

Please accept and respond to the following comments on the subject reports.

**Comment 1:**

Since there was smoke emanating from the south face of WTC 7 from the time WTC 1 collapsed it is obvious there was fire in WTC 7 from that time. Given that the water main feeding the sprinkler system on the lower floors of the building was broken, what consideration was given to pumping water from the Hudson River or tank trucks into the system. If the sprinkler feed lines were not configured to receive water from such sources or the fire department was not equipped to inject water into the system from such sources, I would suggest that one of NIST's recommendations be that, to the extent technically feasible, sprinkler systems be configured to receive water from such sources and that fire fighters be equipped and trained to follow such a procedure where it would be advantageous.

**Comment 2:**

Since NIST's accepted WTC 7 collapse hypothesis is based on fire fighters not fighting the fires in the building, recognizing that the fire fighters were faced with unprecedented difficulties when the Twin Towers collapsed and they must have been disheartened by the loss of their comrades and focused on trying to save some of them, NIST's report should contain a much more detailed account of the people involved in the decision not to fight the fires , their levels of authority, and the items considered that led to the decision. I would suggest that NIST recommend that fire departments have a protocol that calls for bring to bear all available resources to contain and, if possible, suppress any fires that have the potential of spreading, even in the face of very demanding parallel activities.

**Comment 3:**

I found many structural and construction details missing or ambiguous in the NIST reports. I would very much like to see the details listed below included or revised in the report. If this would require NIST to seek out persons who actually created or dealt with the details, such effort should be expended.

Detail 1: The sizes, splices, and connections of the members in the perimeter support system are needed to explain the buildings stability under the assumed damage to its southwest corner. These details are missing and should be added.

Detail 2: Information on the lengths of the stud shear connectors should be included, along with when and how the studs were installed. If they were installed in the steel fabrication shop the procedure would probable have been much different that used in a field installation. This would have been particularly true if the steel floor pans were continuous over their supports and the studs were installed after the pans were in place.

Detail 3: Complete details on the installation of the steel floor pans should be included in the reports. The details should include the locations and sizes of all welds, the configuration and attachment details of closure dams use at the ends and edges of the pans to prevent concrete leakage, where and how much the pans overlapped their supports, and, if any were continuous over their supports, where the were continuous.

Detail 4: (See NIST NCSTAR 1-9, p. 350.) It is indicated that welded wire fabric was used in the concrete floors. The sizes and spacings of the wires in the fabric should be reported along with the vertical location of the fabric in the concrete. In addition, if the sizes or spacings of the wires in the fabric were asymmetrical, the installed orientation of the fabric should be reported.

Detail 5: It is not clear to me what the exact cross sections of the various floors were. Are the concrete slab dimensions given from the top, mid-height, or bottom of the steel floor pan incorporated in the floor structure. Dimensioned cross sections would be helpful.

Detail 6: Steel reinforced concrete is possible because of the relative compatibility of the coefficients of thermal expansion of steel and concrete, the texts of the NIST reports not withstanding. The aggregate used in a concrete, its initial water-cement ratio, and, probably, the type of cement used and the quantity of cement per unit volume will affect its coefficient of thermal expansion. The age of a concrete and, probably, the temperature range within which it undergoes a temperature change will also influence its coefficient of thermal expansion. Since NIST's WTC 7 collapse hypothesis is dependent on an assumption of a significant difference in the coefficients of thermal expansion between steel and concrete, it is essential that the concrete used in the WTC 7 floors be accurately described and its coefficient of thermal expansion determined and reported.
Detail 7: I did not find descriptions of the floor systems in the core areas of the building.

Even if these are given in the reports it would be helpful if drawings showing the details of these floor areas, along with details of how they transition to the floors outside of the core, were included in the reports.

**Comment 4a:**

At the heart of the NIST WTC 7 collapse hypothesis are two heat induced events that must happen together. The stud shear connectors on the floor beams carrying the floor in the northeast corner of floor 13 must fail, which in turn allows the floor beams to expand unidirectionally to the west and push the girders supporting them off their seats on column 79. Thus, the floor no longer being supported at column 79, it collapsed and caused successive floors below to collapse until a sufficient length of the column was stripped of its lateral support causing it to buckle, setting in motion a progressive collapse of the building. For all of this to happen girders carrying the floor beams must be free to move relative to the floor slab. In support of this possibly being the actual condition, NIST includes in its report (1-9, p. 343) part of a structural drawing sheet that calls for stud shear connectors on the floor beams and the spandrel girders between the perimeter columns but not on the girders framing into column 79. However, this partial drawing, which is described as "Based on erection drawing of Floors 12/13," is not conclusive. It is a small portion of a single sheet that was probably taken from a set of many sheets of drawings, possibly hundreds of sheets, supplemented by associated specifications. Instructions for installing stud shear connectors on the girders might have been included in notes and tables elsewhere in the documents. There are several references to notes on the partial sheet shown in the report. However, none of the notes are presented. In addition, the partial sheet shows member designations for the columns and the perimeter spandrel girders but not for the interior floor beams or girders, suggesting that the partial sheet might have come from a set of drawings that were in an intermediate stage of development. Frequently stud shear connectors are installed in the steel fabrication shop. However, for the safety of the steel workers who must walk on the steel, studs are often installed in the field after members have been erected and the slab floor pans or floor slab forms are in place. In the absence of eye-witness testimony, ideally supported by concrete placement pictures, or complete plans and specifications explicitly indicating that stud shear connectors were not to be installed on the girders, it is entirely possible that the partial drawing shown in the report shows connectors that were to be installed in the shop and studs on the girders were to be installed in the field. Even if studs were omitted from the girders, it is possible the attachment of the floor pans and dams to the girders could have resisted lateral movement of the girders–a point rather cavalierly dismissed by NIST at the top of page 9-1, 346.

**Comment 4b:**

The assumptions used in the finite element analysis presented to support the hypothesis that stud shear connectors failed are very questionable. The assumption that there would be no change in the shape of the concrete slab because of fixed edge conditions, while the floor beams were free to expand, but only westward because they were assumed to be restrained from expanding to the east, seems quite unrealistic. The slab would have been soaking up heat for several hours and would probably have led or lagged the floor beams in temperature by only a little. Another flawed assumption, or possibly the same assumption just discussed stated in a different way, is illustrated in Figure 8-25 on page 9-1, 352, which describes input into the finite element analysis of the stud shear connectors. Here there is shown an implied nearly 600 °C temperature differential between a floor beam and the slab it supports. Presumably for computational efficiency, this temperature differential was assumed to develop in 1.25 seconds. This level of thermal shock is just not realistic. To summerize Comments 4a and 4b, NIST has not adequately supported the assumptions it has used in analyzing its WTC 7 collapse hypothesis and the hypothesis would certainly fail if stud shear connectors were actually installed on the girders framing into column 79 and would probably fail under a more nuanced and realistic set of assumptions.

**Comment 5:**

The NIST rejection of the possibility of WTC 7 having been brought down by controlled demolition can only be characterized as a strawman argument. NIST postulated a demolition procedure and then estimated that it would have produced more noise than was reported by witnesses. Later at the 21 September press conference rolling out the subject reports, when Dr. Sunder was asked about the possible use of quieter thermate-like demolition devices he speculated that too much demolition material would have been required. He estimated a hundred pounds would have been required per column. Using this estimate and assuming a belt-and-suspenders demolition crew chose to take out 15 columns they would only have needed 1500 pound of demolition material–the equivalent of about thirty boxes of printer or copier paper.

**Comment 6:**

As illustrated in my Comment 5, there is no technical basis for rejecting the possibility that WTC 7 was brought down by controlled demolition and, since its collapse looked exactly like a controlled demolition, it would seem that NIST should have devoted considerable time exploring the possibility of that having been exactly what happened. This it did not do and it should do it now.

From: James Legault <james.legault@yahoo.ca>
Subject: RE: Questions and Answers about the NIST WTC 7 Investigation
To: wtc@nist.gov

I noticed that in your "Questions and Answers about the NIST WTC 7 Investigation" you didn't mention anything about why World Trade Center 7 was reported to have collapsed 20 minutes before the actual event as reported by the BBC news and FOX news. Will you be addressing this issue?

My definition of a free society is a society where it is safe to be unpopular.
-Adlai E. Stevenson Jr.

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From: Jeffrey Hoffman <jehoffma@earthlink.net>
To: wtc@nist.gov
Subject: Response to Building Number 7 Study

Dear Sirs,
Your study on the cause of structural failure in Building number 7 does not answer my questions as to what happened that day.

For starters, how does your study explain Mr. Silverstein's explanation? See attached video:

http://www.youtube.com/watch?v=j2q2mD2HaKA

That doesn't even begin to address the physics behind the observed high velocity plumes exiting the building ahead of the crumple zone.

How about the fact that a smoldering fire will reduce the yield stress of structural steel to one half its ambient temperature strength. However, engineers will design the building with a safety factor of 100 plus.

If you are truly investigating, I would like to hear more from you regarding my questions. However, I suspect your report is bogus and in that case, there is no need to respond.

Regards,

Jeff Hoffman, Ph.D., P.E.

From: Shyam Sunder <sunder@nist.gov>
To: '"wtc@nist.gov"' <wtc@nist.gov>
Subject: FW: Questions

==========================================

Dr. S. Shyam Sunder
Director
Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899-8600
Tel.: 301-975-5900; Fax: 301-975-4032

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-----Original Message-----

>From: Jeff [mailto:dexterousdigits@yahoo.com]
>Sent: Saturday, August 23, 2008 9:47 PM
>To: Shyam Sunder
>Subject: Questions
>
>Dear Sir,
>I am a bit confused after watching your explanation of the 'collapse' of
>WT7.
>According to NISTs short video, ten floors were on fire when the video
>only shows one. I have seen video with fires on at least three floors.
>You state you would have had recorded evidence of loud explosions when
>we are well aware that thermite/ thermate would not create concussive
>sounds. These are cutting agents.
>You ignore the evidence of nano thermite particles found in the dust
>from the WTC, I have witnessed the ignition of nano particulates from
>this source myself.
>Lateral expansion in theory would push the walls outward very slowly,
>why do we witness implosion in under 7 seconds? Even at 1 sec per floor
>with resistance the collapse of this building by your institutes theory
>should be very close to 1 minute.
>As a builder I know that these buildings were fire coded and doubt the
>temperature of these fires ever reached anywhere over 500 degrees F.
>It is very hard for me to comprehend the outright fraud of this study. I
>feel a bit sorry that you people have to resort to these slight of hands
>which no one with any common sense would ever believe. I guess these are
>things you have to deal with inside your own heart and mind.
> Jeff Tanzer, Salem Ma.

September 2, 2008

WTC Technical Information Repository
Attention: Mr. Stephen Cauffman
National Institute of Standards and Technology
Stop 8610
Gaithersburg, MD 20899-8610

Dear Mr. Cauffman,

Thank you for the opportunity to comment on the draft NIST report compiled to address the unfortunate collapse of WTC Building 7 on September 11, 2001. I was intrigued by the report and I have provided some comments below to hopefully help improve the quality of the NIST report so that the general public can better understand the analysis of the situation.

Please let me know if you need any clarification of my comments. Per the instructions provided by NIST I have included my name and e-mail address below.

Comments should contain the following information:

**Name: Jim Braun**
**Affiliation: citizen**
**Contact: e-mail: jbraun9@yahoo.com**
**Report Number: NCSTAR 1A**
**Page Number: All**
**Paragraph/Sentence: All**

**1. Comment:** I searched through the document and I was not able to find where the report stated specifically how hot the open air fire was from the office material burning inside the building.

**Reason for Comment:** It is critical for the public to understand how hot an open air fire can get.

**Suggestion for Revision:** Please state specifically in the report how hot (in either degrees Celsius or degrees Fahrenheit) the open air fire was inside Building 7.

**2. Comment:** I was not able to find where the report stated specifically the temperature at which thermal expansion of fire-protected steel occurs.

**Reason for Comment:** It is important for the public to understand the temperature at which thermal expansion of fire-protected steel occurs.

**Suggestion for Revision:** Please state specifically in the report the temperature (in either degrees Celsius or degrees Fahrenheit) at which thermal expansion of fire-protected steel occurs.

**3. Comment:** I was not able to find where the report stated specifically the temperature at which thermal expansion of steel occurs.

**Reason for Comment:** It is important for the public to understand the temperature at which thermal expansion of steel occurs.

**Suggestion for Revision:** Please state specifically in the report the temperature (in either degrees Celsius or degrees Fahrenheit) at which thermal expansion of steel occurs.

**4. Comment:** I was not able to find in the report how far the steel column 79 expanded as a result of the thermal expansion due to open air fire - was it one inch or was it two feet?

**Reason for Comment:** It's important for the public to understand how far steel can expand as a result of open air fire.

**Suggestion for Revision:** Please state specifically in the report how far the steel expanded (e.g., one inch or two feet) as a result of thermal expansion caused by open air fire.

**5. Comment:** I was not able to find in the report specifically how column 79 buckled. If the attached floors broke free, there would have been less load on column 79 so the column should not have buckled.

**Reason for Comment:** It is important for the public to understand specifically how column 79 buckled.

**Suggestion for Revision:** Please state in the report specifically how column 79 buckled with less load on the column after the floors broke away.

**6. Comment:** I was not able to find in the report how NIST managed to jump from column 79 buckling to complete progressive global collapse of the entire structure. This is a huge gap in the NIST analysis since steel frame buildings are designed specifically to prevent global collapse. If a column fails in a steel frame structure then the rest of the structure is designed to pick up the load and keep the building standing. If NIST's assessment of column 79 buckling is correct then the only thing that should have occurred is a hole in the building where column 79 was standing - the rest of the structure should have remained standing.

**Reason for Comment:** It is important for the public to understand how an incredibly strong steel frame building can succumb to global collapse due to the failure of a single column when steel frame buildings are designed specifically to prevent global collapse.

**Suggestion for Revision:** Please state specifically in the report the exact reason why the other columns failed as a result of column 79 buckling.

**7. Comment:** I was not able to find in the report a clear explanation of how WTC Building 7 collapsed at free-fall speed in approximately six seconds. This implies that the top of the building collapsed through the incredibly strong lower structure without any resistance. How is this possible?

**Reason for Comment:** It is important for the public to understand how an incredibly strong steel frame building can collapse at free fall speed without incurring any resistance from the strong steel beams and columns.

**Suggestion for Revision:** Please state specifically how it is possible for an incredibly strong steel frame building to collapse at free fall speed in approximately six seconds without incurring any resistance.

**8. Comment:** I was not able to find in the report a clear explanation of how the building collapsed from the bottom when video footage shows the collapse initiating at the top at the penthouse. The video footage clearly shows the upper portion of the structure remain intact as it collapses into its own footprint. How is this possible if the collapse initiation occurred at the penthouse - the top portion should have been crumbling and falling apart as the structure collapsed.

**Reason for Comment:** It is important for the public to understand how this structure collapsed at the base rather than from the top downward.

**Suggestion for Revision:** Please state specifically in the report how it is possible that this structure collapsed at the base while the upper structure remained intact during collapse.

**9. Comment:** I was not able to find in the report a clear explanation as to how WTC Building 7 collapsed straight down in perfect symmetry when, according to the NIST report, column 79 failed on one side of the building. If failure occurs on only one side of the building then the building should have toppled over to the side of failure not straight down. The angular momentum of the massive weight should have pulled the structure over to one side.

**Reason for Comment:** It is important for the public to understand how failure on one side of a steel frame building can cause global symmetrical collapse of the entire structure.

**Suggestion for Revision:** Please state specifically in the report why failure of column 79 did not cause this structure to topple over to one side in accordance with angular momentum and instead somehow incurred global collapse.

**10. Comment:** I was not able to find in the report discussion of the fact that structural steel is ductile not brittle. Ductile steel will not snap in half easily, it will bend but not break in half. Consequently, I did not find a clear explanation of how it is possible for incredibly strong ductile steel to break in half in approximately six seconds while the building collapse at free fall speed.

**Reason for Comment:** It is important for the public to understand that structural steel is ductile not brittle and will not break in half easily.

**Suggestion for Revision:** Please state specifically in the report how it is possible for very strong ductile structural steel to break in half in six seconds during the collapse of the structure.

**11. Comment:** The NIST report claims that open air fire can cause the global progressive collapse of a steel frame building at free fall speed in perfect symmetry. If this is the case then it appears that it will no longer be necessary to hire expensive controlled demolition teams to demolish a steel frame building. Instead, it will only be necessary to light a few small fires, wait a couple of hours, and then watch the incredibly strong steel frame building collapse.

**Reason for Comment:** It is important for the public to understand that there are now opportunities to start new controlled demolition companies that only use fire to demolish incredibly strong steel frame buildings. This can mean new jobs for a lot of people.

**Suggestion for Revision:** Please state specifically in the report that controlled demolition can now be accomplished through the use of small open air fires in a steel frame building resulting in perfect symmetrical global progressive collapse of the structure at free fall speed.

**12. Comment:** I was not able to find in the report any other examples of steel frame buildings experiencing global progressive collapse as a result of open air fire. I am not aware of any other steel frame building collapsing as a result of fire. Likewise, I have never seen or heard of a steel frame cooking grill experiencing global collapse due to the open air fire.

**Reason for Comment:** The public needs to know if their steel frame cooking grill will experience global progressive collapse as a result of open air fire while cooking their favorite foods. People will be severely disappointed if their grills start to experience global progressive collapse.

**Suggestion for Revision:** Please state specifically in the report that steel frame cooking grills are now at risk of global progressive collapse due to thermal expansion caused by open air fire. Please explain how it is possible for steel frame cooking grills to collapse due to open air fire even though it has never happened previously. It's important for people to understand the risks while cooking on their grills.

**13. Comment:** I was not able to find anywhere in the report where the NIST investigators had performed actual physical tests of certified steel, both fire-protected and unprotected, placed under open air fire to verify the extent of thermal expansion that occurs under open air fire conditions. It appears that NIST has solely relied on computer modeling to support its theories.

**Reason for Comment:** It is important for the public to understand that the NIST report is not supported by actual physical tests of certified steel that has been exposed to open air fire. These tests would have been very easy for NIST to perform to determine the amount of thermal expansion that occurs as a result of exposure to open air fire.

**Suggestion for Revision:** Please state specifically in the report that the NIST investigators did not perform any actual physical tests of certified steel to determine the amount of thermal expansion when exposed to open air fire. Alternatively, please take the time to perform as many actual physical tests as are needed to accurately determine the amount of thermal expansion of steel when exposed to open air fire. Please include the results of these physical tests in the final report.

**14. Comment:** I was not able to find anywhere in the report where the NIST investigators had performed actual physical tests of certified steel columns and beams, both fire-protected and unprotected, that have been bolted together in the same manner as an actual building and placed under open air fire to verify that it is possible for a column to buckle as a result of open air fire and then have instantaneous progressive global collapse of the entire structure in perfect symmetry in six seconds or less. It appears that NIST has solely relied on computer modeling to support its theories.

**Reason for Comment:** It is important for the public to understand that the NIST report is not supported by actual physical tests of certified steel that has been exposed to open air fire. These tests would have been very easy for NIST to perform to determine if it is possible for a steel column to buckle as a result of open air fire and then to have progressive global collapse of the entire structure in perfect symmetry in six seconds or less.

**Suggestion for Revision:** Please state specifically in the report that the NIST investigators did not perform any actual physical tests of certified steel to determine if it is possible for a steel column to buckle as a result of open air fire and then to have progressive global collapse of the entire structure in perfect symmetry in six seconds or less. Alternatively, please take the time to perform as many actual physical tests as are needed to accurately determine if it is possible for a steel column to buckle as a result of open air fire and then to have progressive global collapse of the entire structure in perfect symmetry in six seconds or less. Please include the results of these actual physical tests in the final report.

From: "John Brown" <jbrown@forrestpaint.com>
To: <wtc@nist.gov>
Subject: Thank you for your service!

Sir or Mam,

Just a note about steel expanding and contracting in minor temperature changes.

The company I work for, Forrest Paint Co. specializes in temperature resistant coatings, Paint.
We also make a product called Fire Snake. This is used on railroads when they freeze and separate. It is a alcohol filled plastic tube that is laid down parallel the tracks and lit on fire. It burns at roughly 350F.
This is sufficient to bring the steel back together and then they tack weld the railroad back in place.

My point is to conspiracy theorists, if cold weather can pull steel railroads apart, and an alcohol based gel inside a plastic tube can expand it back together, why wouldn't a raging fire be able to expand a steel truss enough to create a building collapse?

Also, it would be good to mention that the top 11 floors of the Windsor Tower fire in Spain collapsed from fire alone. The top 11 floors steel was not incased in concrete just as the WTC's were not. (The Windsor tower wasn't hit by debris or planes either)

Thank you for your service to our great nation and on this very important project.

Respectfully submitted,

John J Brown
Forrest Paint Co.
International Sales Rep.
541 342 1821 Office
541 285 7689 Cell

36 Union Street
Peterborough, NH 03458
September 7, 2008

WTC Technical Information Repository
Attn: Stephen Cauffman,
NIST, 100 Bureau Dr., Stop 8611,
Gaithersburg, Md. 20899-8610.

Dear Sirs:

I have examined the documents[1] you provided on your theory of the collapse of WTC 7 due to fires by way of thermal expansion. It is apparent that you have spent a great deal of time, effort, money and thought on this project.

However, like Ptolemy's Theory of Epicycles, you begin with a faulty and unproven assumption. It is also the least likely assumption based on the evidence. Therefore, although your computer modeling may be intricate, your results are completely speculative and have no connection with the reality of what happened to that building. You are simply "adding epicycles" to a theory based on a false premise.

Your theory essentially rests on two physical observations:

1. There were office fires in WTC 7 that burned for some hours.

2. The building completely collapsed.

Observation 1 is not in dispute, except as to the location, extent, and effect of the fires. You never observed these fires from inside the building, and you have no actual measurements of the thermal expansion and deformation of the structural steel beams whatever. You never examined any of the steel.

Observation 2 runs contrary to 100 years of experience with the behavior of steel-framed buildings that have caught on fire. Every one of them was subjected to thermal expansion, but never before has there been such a collapse. To now postulate that a collapse did occur due to office fires is the height of scientific recklessness.

Your consideration of hypothetical blast scenarios (Appendix D) is disingenuous, to say the least. You rule out a possible blast on the basis that it would have been audible, but was not reported. You consider only RDX and C4, which is RDX-based and known to be noisy. RDX has been in use since WWII and C4 reportedly has been used by terrorists. It is simply not believable that foreign terrorists could have gained unobserved access to WTC 7 before 9/11 (scenario 1) or during the 6 hour interval prior to its collapse (scenario 2). Why did you not consider the use of thermite, thermate, nano-thermites, and other state of the art materials? As shown by Kevin Ryan, NIST has extensive knowledge of and experience with the latter materials[2].

In contrast to the non-existent observational basis for your theory, there exists a large and growing body of evidence, physical, eye-witness, anecdotal, and circumstantial, that points to controlled demolition as the reason for the building's collapse.

Millions of people worldwide are in ready possession of this evidence. Allow me to briefly review this evidence for you.

Physical Evidence for the Controlled Demolition of WTC 7

1. The rapid onset of collapse indicates controlled demolition. Natural collapses begin slowly as the steel deforms (but this has never before led to collapse from office fires).

2. The symmetrical, straight-down nature of the collapse. In a natural collapse, the building would tend to topple or show asymmetries.

3. The time taken by the collapse, approximately 6.5 seconds. This is almost free-fall speed and indicates little resistance, which is incomprehensible if natural. Your theory of a slower collapse within the outer frame of the building is outrageous speculation.

4. The neat, tidy debris pile, a few stories high, with adjoining buildings essentially untouched. Such a pile is the main objective and hallmark of controlled demolition.

5. The molten metal and high temperatures observed for weeks afterwards in the debris pile. Only incendiary and explosive materials, such as thermite, thermate, and nano-thermites could produce these temperatures. Particles in the dust indicate these materials.

6. The evidence of corroded steel with sulfur found by FEMA. Again, sulfur is a product of a thermate reaction.

Eye-witness Evidence for the Controlled Demolition of WTC 7

1. The testimony of Barry Jennings. Mr. Jennings timeline is crucial and unassailable. The essentials of his story were told to Eye-Witness Channel 7 News shortly after 1 pm on 9/11/01, and later elaborated on in taped interviews. BEFORE either tower fell, he was blown back, by an explosion, from the sixth floor to the eighth floor in a stairwell in WTC 7. The sixth floor landing was destroyed. Help came twice and ran away when each tower collapsed. He was in the dark for several hours. He heard explosions from that time (before 9:58 am) until he was found and led to safety around 1 pm. At that time the lobby of WTC 7 was completely destroyed. None of this could have happened because of the tower collapses. All his eye-witness evidence points to pre-demolition blasts in WTC 7.

2. The video-taped statements of various firemen and policemen before 5:20 pm on 9/11/01 to the effect that WTC 7 was "coming down" or "about to blow up." This pre-knowledge indicates controlled demolition.

3. The video-taped statement of a witness who overheard a "count-down" for WTC 7 on a worker's radio.

4. The many videos showing the actual collapse of WTC 7, with various evidences of controlled demolition such as a kink in the roof, exploding charges at upper stories, and so on.

5. Audible explosions heard by eye-witnesses just before and during the collapse of WTC 7.

Anecdotal Evidence for the Controlled Demolition of WTC 7

1. Larry Silverstein's remarks about the decision to "pull" are clear enough. The arguments about the meaning of "pull" are beside the point. There is a causal relationship between "and they made that decision to pull" and "then we watched the building collapse." The latter follows the former. The decision to "pull" resulted in the fall of WTC 7. This could only take place with controlled demolition.

2. When Barry Jennings and Hess arrived at the OEM, Floor 23, in WTC 7 around 9 am, they found it empty. Why? $13 million dollars was expended to create this impregnable floor, and the towers had not yet fallen! The food and coffee showed the occupants had left in a hurry. Then Jennings made a phone call and was told he must "get out of there." Why? The only plausible answer is that the pre-demolition blasts were about to begin.

3. The BBC and CNN early announcements of the complete collapse of WTC 7 have never been satisfactorily explained. Obviously, the pre-knowledge of the demolition was handled badly by these news outlets.

Circumstantial Evidence for the Controlled Demolition of WTC 7

1. Removal and destruction of WTC 7 steel before examination is the most compelling evidence of fraud. It is inconceivable that, if WTC 7 fell as the result of office fires, the steel would be quickly removed and shipped away to be destroyed before examination. This fact alone is enough to convince anyone that there was something to hide. The action of the government in this respect defies all the norms of civilization itself, were the collapse to be a truly natural and unexpected event.

2. Real examination of the steel was denied to all. Instead, it was shipped away like garbage. But, with GPS tracking, no truck was allowed to lose its way to the dump or the dock. No independent party was to have access to the steel. Again, this suggests fraud.

3. Omission from the 9/11 Commission Report of any mention of WTC 7 also points to fraud. The complete collapse of a 47-story building is not trivial.

4. NIST's failure to seriously consider other causes besides fire for the building collapses strongly suggests government interference in a scientific process, and points to a selective and thereby fraudulent investigation. The standards for fire investigations call for tests for explosives. No such tests were made.

5. The entire 9/11 "official" story appears to be a litany of impossible and improbable events, accompanied by a brazen suppression of evidence. Your investigation of WTC 7's collapse must be seen within this context. In this respect, your selective approach to the collapse of WTC 7 continues the pattern of obfuscation.

In any criminal investigation, the behavior of witnesses and possible suspects is of vital interest, especially where it concerns the removal, destruction, and suppression of evidence. Many of the circumstances surrounding WTC 7's collapse suggest fraud.

Every scientific theory, to be valid, must give results that are repeatable. What does your theory predict?

Firstly, it predicts that other steel-framed buildings that have office fires may also completely collapse after a few hours. Will firemen attend to such fires? What will be the result in loss of life and property if they decline to fight these fires? What will be your liability for these losses, if they act on the basis of your theory?

Secondly, fire insurance rates for steel-framed buildings should now jump astronomically. What will be the effect on building owners, and society in general?

Thirdly, will controlled demolition companies now attempt a cheap way to bring down a building by setting a few fires? What mischief will this cause to surrounding properties and all concerned?

Your theory, if believed, has extremely serious consequences for the steel building construction industry and society in general. For this reason, it is doubtful whether anyone will embrace it. On the contrary, there is likely to be a public reaction that will expose its falsity. In addition, a vast and growing number of citizens of this and other countries are now on the march toward a truthful and independent accounting of 9/11. Your theory lacks scientific credibility. It is certain to be repudiated by future generations if not this one.

Sincerely yours,

John D. Wyndham

John D. Wyndham, PhD (Physics)

## References

1. http://wtc.nist.gov/
2. http://www.journalof911studies.com/

### Physical Evidence for the Controlled Demolition of WTC 7

1. http://911research.wtc7.net/wtc/evidence/videos/index.html#building7

2. http://911research.wtc7.net/wtc/evidence/videos/index.html#building7

3. http://www.saunalahti.fi/wtc2001/WTC7_collapse_examination.pdf

4. http://physics911.net/stevenjones

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6. http://wtc.nist.gov/media/AppendixC-fema403_apc.pdf

### Eye-witness Evidence for the Controlled Demolition of WTC 7

1. http://www.911blogger.com/node/16573

2. http://www.youtube.com/watch?v=z9CXQY-bZn4

3.
http://www.infowars.com/articles/sept11/first_responders_heard_wtc_7_demo_countdown.htm

4. http://911research.wtc7.net/wtc/evidence/videos/index.html

5. http://www.youtube.com/watch?v=58h0LjdMry0
http://www.infowars.com/articles/sept11/first_responders_heard_wtc_7_demo_countdown.htm

### Anecdotal Evidence for the Controlled Demolition of WTC 7

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Circumstantial Evidence for the Controlled Demolition of WTC 7

1. http://911review.com/coverup/groundzero.html

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http://911research.syes-dog-training.com/sept11/analysis/evidence.html

2. http://www.sf911truth.org/flyer2.pdf
http://911research.wtc7.net/wtc/groundzero/cleanup.html

3. http://www.gpoaccess.gov/911/pdf/fullreport.pdf

4. http://www.freerepublic.com/focus/f-news/1697907/posts

5. Books by David Ray Griffin and others: For example,
The New Pearl Harbor, Olive Branch Press, 2004.
The 9/11 Commission Report: Omissions and Distortions, Olive Branch Press, 2004.

From: "John Wyndham" <jcwyndham@verizon.net>
Subject: Comments on Your Latest Theory of WTC 7 's Collapse
To: <wtc@nist.gov>

WTC Technical Information Repository
Attn: Stephen Cauffman,
NIST, 100 Bureau Dr., Stop 8611,
Gaithersburg, Md. 20899-8610.

Dear Sirs:

I have examined the documents[1] you provided on your theory of the collapse of WTC 7 due to fires by way of thermal expansion. It is apparent that you have spent a great deal of time, effort, money and thought on this project.

However, like Ptolemy's Theory of Epicycles, you begin with a faulty and unproven assumption. It is also the least likely assumption based on the evidence. Therefore, although your computer modeling may be intricate, your results are completely speculative and have no connection with the reality of what happened to that building. You are simply "adding epicycles" to a theory based on a false premise.

Your theory essentially rests on two physical observations:

1. There were office fires in WTC 7 that burned for some hours.

2. The building completely collapsed.

Observation 1 is not in dispute, except as to the location, extent, and effect of the fires. You never observed these fires from inside the building, and you have no actual measurements of the thermal expansion and deformation of the structural steel beams whatever. You never examined any of the steel.

Observation 2 runs contrary to 100 years of experience with the behavior of steel-framed buildings that have caught on fire. Every one of them was subjected to thermal expansion, but never before has there been such a collapse. To now postulate that a collapse did occur due to office fires is the height of scientific recklessness.

Your consideration of hypothetical blast scenarios (Appendix D) is disingenuous, to say the least. You rule out a possible blast on the basis that it would have been audible, but was not reported. You consider only RDX and C4, which is RDX-based and known to be noisy. RDX has been in use since WWII and C4 reportedly has been used by terrorists. It is simply not believable that foreign terrorists could have gained unobserved access to WTC 7 before 9/11 (scenario 1) or during the 6 hour interval prior to its collapse (scenario 2). Why did you not consider the use of thermite, thermate, nano-thermites, and other state of the art materials? As shown by

Kevin Ryan, NIST has extensive knowledge of and experience with the latter materials[2].

In contrast to the non-existent observational basis for your theory, there exists a large and growing body of evidence, physical, eye-witness, anecdotal, and circumstantial, that points to controlled demolition as the reason for the building's collapse.

Millions of people worldwide are in ready possession of this evidence. Allow me to briefly review this evidence for you.

Physical Evidence for the Controlled Demolition of WTC 7

1. The rapid onset of collapse indicates controlled demolition. Natural collapses begin slowly as the steel deforms (but this has never before led to collapse from office fires).

2. The symmetrical, straight-down nature of the collapse. In a natural collapse, the building would tend to topple or show asymmetries.

3. The time taken by the collapse, approximately 6.5 seconds. This is almost free-fall speed and indicates little resistance, which is incomprehensible if natural. Your theory of a slower collapse within the outer frame of the building is outrageous speculation.

4. The neat, tidy debris pile, a few stories high, with adjoining buildings essentially untouched. Such a pile is the main objective and hallmark of controlled demolition.

5. The molten metal and high temperatures observed for weeks afterwards in the debris pile. Only incendiary and explosive materials, such as thermite, thermate, and nano-thermites could produce these temperatures. Particles in the dust indicate these materials.

6. The evidence of corroded steel with sulfur found by FEMA. Again, sulfur is a product of a thermate reaction.

Eye-witness Evidence for the Controlled Demolition of WTC 7

1. The testimony of Barry Jennings. Mr. Jennings timeline is crucial and unassailable. The essentials of his story were told to Eye-Witness Channel 7 News shortly after 1 pm on 9/11/01, and later elaborated on in taped interviews. BEFORE either tower fell, he was blown back, by an explosion, from the sixth floor to the eighth floor in a stairwell in WTC 7. The sixth floor landing was destroyed. Help came twice and ran away when each tower collapsed. He was in the dark for several hours. He heard explosions from that time (before 9:58 am) until he was found and led to safety around 1 pm. At that time the lobby of WTC 7 was completely destroyed. None of this could

have happened because of the tower collapses. All his eye-witness evidence points to pre-demolition blasts in WTC 7.

2. The video-taped statements of various firemen and policemen before 5:20 pm on 9/11/01 to the effect that WTC 7 was "coming down" or "about to blow up." This pre-knowledge indicates controlled demolition.

3. The video-taped statement of a witness who overheard a "count-down" for WTC 7 on a worker's radio.

4. The many videos showing the actual collapse of WTC 7, with various evidences of controlled demolition such as a kink in the roof, exploding charges at upper stories, and so on.

5. Audible explosions heard by eye-witnesses just before and during the collapse of WTC 7.

Anecdotal Evidence for the Controlled Demolition of WTC 7

1. Larry Silverstein's remarks about the decision to "pull" are clear enough. The arguments about the meaning of "pull" are beside the point. There is a causal relationship between "and they made that decision to pull" and "then we watched the building collapse." The latter follows the former. The decision to "pull" resulted in the fall of WTC 7. This could only take place with controlled demolition.

2. When Barry Jennings and Hess arrived at the OEM, Floor 23, in WTC 7 around 9 am, they found it empty. Why? $13 million dollars was expended to create this impregnable floor, and the towers had not yet fallen! The food and coffee showed the occupants had left in a hurry. Then Jennings made a phone call and was told he must "get out of there." Why? The only plausible answer is that the pre-demolition blasts were about to begin.

3. The BBC and CNN early announcements of the complete collapse of WTC 7 have never been satisfactorily explained. Obviously, the pre-knowledge of the demolition was handled badly by these news outlets.

Circumstantial Evidence for the Controlled Demolition of WTC 7

In any criminal investigation, the behavior of witnesses and possible suspects is of vital interest, especially where it concerns the removal, destruction, and suppression of evidence. Many of the circumstances surrounding WTC 7's collapse suggest fraud.

1. Removal and destruction of WTC 7 steel before examination is the most compelling evidence of fraud. It is inconceivable that, if WTC 7 fell as the result of office fires, the steel would be quickly removed and shipped away to be destroyed before examination. This fact alone is enough to convince

anyone that there was something to hide. The action of the government in this respect defies all the norms of civilization itself, were the collapse to be a truly natural and unexpected event.

2. Real examination of the steel was denied to all. Instead, it was shipped away like garbage. But, with GPS tracking, no truck was allowed to lose its way to the dump or the dock. No independent party was to have access to the steel. Again, this suggests fraud.

3. Omission from the 9/11 Commission Report of any mention of WTC 7 also points to fraud. The complete collapse of a 47-story building is not trivial.

4. NIST's failure to seriously consider other causes besides fire for the building collapses strongly suggests government interference in a scientific process, and points to a selective and thereby fraudulent investigation. The standards for fire investigations call for tests for explosives. No such tests were made.

5. The entire 9/11 "official" story appears to be a litany of impossible and improbable events, accompanied by a brazen suppression of evidence. Your investigation of WTC 7's collapse must be seen within this context. In this respect, your selective approach to the collapse of WTC 7 continues the pattern of obfuscation.

Every scientific theory, to be valid, must give results that are repeatable. What does your theory predict?

Firstly, it predicts that other steel-framed buildings that have office fires may also completely collapse after a few hours. Will firemen attend to such fires? What will be the result in loss of life and property if they decline to fight these fires? What will be your liability for these losses, if they act on the basis of your theory?

Secondly, fire insurance rates for steel-framed buildings should now jump astronomically. What will be the effect on building owners, and society in general?

Thirdly, will controlled demolition companies now attempt a cheap way to bring down a building by setting a few fires? What mischief will this cause to surrounding properties and all concerned?

Your theory, if believed, has extremely serious consequences for the steel building construction industry and society in general. For this reason, it is doubtful whether anyone will embrace it. On the contrary, there is likely to be a public reaction that will expose its falsity. In addition, a vast and growing number of citizens of this and other countries are now on the march toward a truthful and independent accounting of 9/11. Your theory lacks scientific credibility. It is certain to be repudiated by future generations if not this one.

Sincerely yours,

John D. Wyndham, PhD (Physics)

36 Union Street
Peterborough
NH 03458
September 5, 2008

References

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Physical Evidence for the Controlled Demolition of WTC 7

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4. http://www.freerepublic.com/focus/f-news/1697907/posts

5. Books by David Ray Griffin and others: For example,
The New Pearl Harbor, Olive Branch Press, 2004.
The 9/11 Commission Report: Omissions and Distortions, Olive Branch Press, 2004.

*JONATHAN H. COLE, P.E.*
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Englewood, FL 34223

September 11, 2008

Sent Via E-Mail To: wtc@nist.gov
And Via Fax to: 301-869-6275

WTC Technical Information Repository
Attention: Mr. Stephen Cauffman
National Institute of Standards and Technology
Stop 8610
Gaithersburg, MD 20866-8610

**Re: Public Comments of NIST Reports NCSTAR 1A – "Final Report on the Collapse of World Trade Center Building 7", and NCSTAR 1-9 Volume One and Two, "Structural Fire Response and Probable Collapse Sequence of World Trade Center 7"**

Dear Mr. Cauffman:

Pursuant to the instructions contained on the NIST website, I offer the attached public comments relating the referenced documents.

Please recognize that due to the limited three week time-frame for public review of the reports, it's entirely possible that some of my concerns may be readily answered in the documents. However, even if some can be reasonably answered, I believe all comments must be adequately resolved in order to put this issue to rest, as it has far reaching implications for the future of structural design.

Thank you for allowing the public to offer this input.

Very truly yours,

Jonathan H Cole

Jonathan H. Cole, P.E.

JHC:pec

Attachment

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# PUBLIC COMMENTS
# For
# THREE DRAFT REPORTS – WTC 7

NIST NCSTAR 1A: "Final Report on the Collapse of World Trade Center Building 7"

NIST NCSTAR 1-9: "Structural Fire Response and Probable Collapse Sequence of World Trade Center Building 7" - Volume 1

NIST NCSTAR 1-9: "Structural Fire Response and Probable Collapse Sequence of World Trade Center Building 7" - Volume 2

Prepared and Submitted
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September 11, 2008

WTC Technical Information Repository
Attention: Mr. Stephen Cauffman
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Name: Jonathan Cole, P.E.
Affiliation: N/A
Contact: JC@jonsbarn.com

**Report Number: NCSTAR 1A, NCSTAR 1-9 Volume One and Volume Two.**

**Comment 1:**
**Report Number:** NCSTAR 1-9 Volume 2, Chapter 10
**Page Number:** Graphics of floor temperatures on Pages 400 through Page 410
**Paragraph/Sentence:** N/A Graphics only.

**Comment:** The building collapsed just before 5:21 P.M. (NCSTAR 1A page xxxi, first paragraph), yet all these graphics indicate floor temperatures at 5:30 p.m. and 6:00 p.m., or well after the structure collapsed.

**Reason for Comment:** Since the floors as a whole didn't even exist after 5:21 P.M., it's unusual that the graphics would indicate predictions of floor and beam temperatures well *after* the collapse event.

Recognizing that the temperatures are only estimates based on a computer model simulation extrapolated beyond the collapse, it is misleading to show graphics with the hotter floor temperatures that we know are impossible because the floors themselves simply did not exist as a unit after the global collapse.

**Suggestion for Revision:** If the above assessment is true, suggest the graphics indicating predicted fire spread and temperatures of the floors *after* the global collapse of the structure, be deleted on these pages and other pages.

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**Comment 2:**
**Report Number:** NCSTAR 1A
**Page Number:** 10
**Paragraph/Sentence:** Last paragraph; the following sentence: . . . *"On the 11th and 12th floors, which will be seen later to have been the sites of significant and sustained fires, the mass of additional paper materials was described as very high."*

**Comment:** It is unclear how the mass of paper loading of these floors was ascertained and additional information as to the type and volume of material stored on these particular floors would be helpful, because the material loading of these floors was used as a basis for causing bigger and hotter fires. This appears to conflict with the prior Page 9 last sentence which states: . . . *"Presumably there were a variety of amounts and locations of paper, both exposed on the work surfaces and contained within the file cabinets."*

And the unknowns by NIST about the details of these floors such as NCSTAR 1-9 Page 48: . . . *"However, despite the quality of the drawings and verbal descriptions obtained by NIST, there was some uncertainty regarding the nature of some spaces. Notably, the US Securities and Exchange Commission and American Express occupied all but the east side of the 13th floor, and NIST was unable to find people who recalled the nature of the unoccupied space."*

And NCSTAR 1-9 Page 60 (for floors 11 and 12): . . . *"The mass of the furnishings per office was not known; the mass of additional paper materials was described as very high. As indicated in Section 9.3.1, the Investigation Team began with an initial estimation of the combusted fuel load of approximately 32 kg/m (cubed). Simulations of the fires with a lower combusted fuel load (Chapter 9) resulted in poor agreement with the observed spread of rates."* And (same page) for floor 13: *"There was little information regarding the combustibles on this floor, and there was little visual evidence for estimating the effect of different combustible mass loadings on agreement with the observed fire growth patterns. NIST assumed a combusted mass similar to that on the 11th and 12th floor."*

**Reason for Comment:** "Very high" appears to be subjective and difficult to quantify. In addition NIST uses the word "presumably" as if it's just a rough estimate at best, since there is no way of knowing the true volume of combustibles. And if people didn't even know what occupied some of the spaces, then how could NIST assume that the "very high" estimation of material creating the larger fire that caused the eventual collapse (based on the NIST simulations) is even reasonable? Moreover, it appears that NIST is not even very certain of the fire intensities. (NISTNC STAR 1A, Page 28 states: *"There were far fewer photographs and videos of WTC 7 than the towers; and, thus, the details of the WTC 7 were not as precise as for the fires in the towers."*

Because the simulation did not match observed fires and associated heat needed for "thermal expansion", it appears that NIST used a predetermined conclusion to arrive at the necessary initial assumption. In other words, since NIST needed hotter fires to later cause the simulated first ever "thermal expansion" type of global collapse, and also assumed the fires were only from burning office material, then NIST assumed that there must have been more combustible mass then normal for an office to create the fire.

But what if the fires that were observed were from some other fuel source? Is it possible that an incendiary such as thermite was used to weaken the heavier core columns so they would be easier to blast later with a smaller shape charge, and could that be the source of the observed hotter fires? Or what if smaller explosions witnessed earlier that day (refer to eyewitness testimony by Mr. Barry Jennings and Mr. Michael Hess, who were inside WTC 7), weakening the internal network of columns and beams before the global collapse at 5:21 P.M. were the cause of the observed fires?

Regardless, it would be helpful to know why NIST believed these particular floors contained a very high paper mass to reinforce the assumption that these floors burned more intensely causing thermal expansion and the ultimate global failure of the entire structure.

**Suggestion for Revision:** *"On the 11th and 12th floors, which will be seen later to have been the sites of significant and sustained fires, the mass of additional paper materials was described as very high, however this was just an assumption made on the part of NIST to produce the fires observed that was eventually used in the NIST model simulation.*

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**Comment 3:**
**Report Number:** NCSTAR 1A
**Page Number:** 16
**Paragraph/Sentence:** Section 2.2.3, second paragraph, second sentence: *"With the collapses of the towers fresh in their minds, there was concern that WTC 7 too might collapse, risking the lives of additional firefighters."*

**Comment:** Prior to this particular day, no steel structure ever globally collapsed due to fire, and firefighters know this, which is why they rush in to burning skyscrapers without concern. If there was no historical precedent, how would the firefighters at the time have known this? Moreover, according to NCSTAR 1-9 Section 6.6 Page 299 *"Between 11:00 a.m. and 12:00 noon approximately 40 FDNY members arrived at WTC 7 with orders to put the fires out. Inside they reported seeing small fires in debris in the core area and on the west side of the same floor of the building. A chief officer inside the building ran into other firefighters who had searched the upper floors and they reported that no one was inside the building. When the chief officer reached approximately the 9th or 10th floor, he had been inside the building about 20 minutes to 25 minutes. He received a radio call from another Chief Officer outside the building ordering him out of WTC 7. The Chief Officer was ordering everyone out of the building. The Chief Officer left the building and went to the FDNY Command Post and reported to the Command Post Chief that he believed the fires inside WTC 7 could be extinguished. Thus the Chief assigned to the firefighting tasks was sent back to extinguish the fires."*

**Reason for Comment:** Typically, scientific research papers rely on the known facts and not assumptions of what individuals might have been thinking.

**Suggestion for Revision:** Suggest NIST deletes the sentence in its entirety as it could be construed by some as being unscientific.

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Comment 4:
**Report Number:** NCSTAR 1A
**Page Number:** 16 Section 2.3 "General"
**Paragraph/Sentence:** Second paragraph: *"Most likely, the WTC 7 fires began as a result of the impact from the collapse of WTC 1 at about 10:29 a.m."*

**Comment:** It appears that in addition to not really knowing the mass of combustibles on the floors, NIST is also uncertain of how the fires even started. For example, NIST NCSTAR 1-9 Page 194 states: . . . *"Since fires were observed on the ground surrounding WTC 7, it is possible that potential ignition sources might have entered WTC 7 through openings created in the south and west face of the building during the collapses of the towers. NIST found no evidence to confirm this possibility, but the available data suggest that this was highly likely."*

And NCSTAR 1-9 Chapter 9, Section 9.1.1: . . . *"Chapter 3 showed that there were no pathways for the flames and heat to pass from one floor to another, aside from the debris damaged area in the southwest of the building."* Because of the tremendous uncertainty, other fire initiation scenarios should be investigated. For example, the intentional setting of independent fires is possible or setting of fires due to incendiaries weakening critical columns in the hours before the global collapse, particularly since the fires appear to jump from location to location on certain floors.

It is also very possible that fires were started by explosions inside the structures well before collapse, and is consistent with the eyewitness accounts of people inside hours before the collapse. Moreover, an explanation of exactly how steel beams and columns thrown from the exploding WTC 1 could start a fire would be a benefit, since we know of several other adjacent structures at about the same radius as WTC 7 with steel impacts from the towers did not start any fires.

**Reason for Comment:** All possible explanations and reasons as to how the fires actually started should be addressed.

**Suggestion for Revision:** *The exact source for the ignition of the fires is unknown, and it is unclear if it was from the impact from WTC 1 or possibly from some other ignition sources inside the structure.*

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Comment 5:
**Report Number:** NCSTAR 1-9 Vol 1.
**Page Number:** 245 last paragraph and 246 first paragraphs
**Paragraph/Sentence:** . . . *"The next time that flames were observed on the 13th floor was around 5:00 p.m., when intense burning was observed between windows 13-53D*

*and 13-54D, to the west of the center of the north face. A couple of minutes prior to the collapse of the building at 5:20:52 p.m., a jet of flames was pushed from windows in the same area. NIST found no evidence regarding the cause of this unusual behavior, but the behavior is similar to smoke and flame expulsions in the WTC towers prior to their collapses that were attributed to pressure pulses associated with structural changes (e.g. a partial floor collapse) occurring within the tower."*

**Comment:** There is a very good explanation for this unusual behavior that NIST should investigate; and that is, the pulses were caused by blasts of exploding charges, cutting the internal core columns just prior to the global collapse. This is far more logical and fits precisely with all the other evidence of a controlled demolition, than a "partially collapsed floor" pushing the flames out.

**Reason for Comment:** Although technically outside the scope of this report, the comparison by NIST to the twin towers for similar pulses of flames can also be explained with the following hypothesis that matches all known evidence for WTC 1 and WTC 2: The expulsions of flame and concrete dust in the WTC towers just prior to collapse were not at every floor but rather from about each third floor. Because of this, the expulsions could not be from a "pancake" or "piston" effect of collapsing floors, but rather were very likely the result of high explosives placed in the core columns at the weld points.

The tremendous energy from the blasts from the core columns not only pulverized the concrete floors (a gravitational collapse in the initial stage simply does not have the necessary energy to pulverize the floors), but also pushed out flames in the initial seconds.

In addition, those high explosives placed in the core of the towers threw out huge segments of steel hundreds of feet away into the adjacent structures, including WTC 7; something an "office fire" has never done.

And because the pulses of concrete dust from the explosive charges in the towers were at roughly 30 foot intervals, one would expect that the resulting debris at ground zero would indicate similar lengths of cut core columns. This is precisely what was found at ground zero (not "pancaked" floors at all) further confirming this scenario.

The fact that the destruction of the corners of the towers lagged significantly behind the center portion of the floors as the structure exploded also proves that the pancake or piston type of collapse was impossible.

In addition, no block of upper floors could be seen "sledge hammering" down on the structure, as they too were vaporized on the way down to ground zero.

Moreover, the initial collapse of the 353 ton antennae in WTC 1 that was supported with a hat truss on the core columns fell several feet first, *before* the perimeter walls collapsed, confirming that the core columns *had* to have been cut first, all at the same time. The fact that the antenna accelerated into the path of most resistance (the core columns), rather then slow down, indicates that the core columns were being cut at a rapid rate, generating the necessary energy to pulverize the concrete and allowing the towers to fall very close to free fall speed.

Finally, the fact that some of the inner core was seen momentarily standing after the floors fell, cut at about the 60th floor level (well below the airplane strike), indicated that the tower collapse simply could not have been from a "pancake or piston type" crushing effect. NIST did not investigate any of this evidence, stopping their investigation of the towers at "collapse initiation", rather than having the burden of explaining all the above phenomena.

Only pre-planted, rapidly timed explosives can explain all the known events of the collapses that day, and those same explosives also easily explain the unusual behavior of the flames and pressure pulses just prior to the global collapse of WTC 7.

**Suggestion for Revision:** *"NIST will look into the possibility that internal explosives detonating just before collapse could be the source of the observed unusual behavior."*

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Comment 6:
**Report Number:** NCSTAR 1-9 Vol. 1
**Page Number:** Section 5.7.3 Distortion of North Façade Page 271
**Paragraph/Sentence:** *"Since the majority of the window glass in the area of the movement was still intact, it is probable that the lighter area was the result of changing light reflections due to distortions of the façade, similar to those discussed earlier. Such distortions could be due to physical movement of the face or perhaps to pressure changes within the building. Whatever the cause, it seems clear that some type of disturbance began to move downward in the building at the same time as the east penthouse started descending."*

**Comment:** NIST should investigate another very likely cause of the distortions noticed. A controlled demolition with internal explosions can create pressure waves distorting the facade of glass. The disturbance moving downward could have been created by well timed explosions, severing the columns and bringing the building down.

**Reason for Comment:** Only a controlled demolition easily explains all the evidence and events of the day. This shock wave is one more piece of evidence that is explained by a controlled demolition.

**Suggestion for Revision:** *"This downward moving distortion may be the result of a controlled demolition. NIST will investigate this scenario further."*

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**<u>Comment 7</u>:**
**Report Number:** NCSTAR 1A
**Page Number:** 19 Section 2.4
**Paragraph/Sentence:** Second paragraph: The phrase: *". . . because water was not available."*

**Comment:** Better corroboration is needed for this statement, because it appears that there is some evidence that water was available in the NIST Report.

**Reason for Comment:** Almost immediately after the total collapse virtually into its own footprint, there is a picture of several fire hoses spraying water on the cut up wall segments. If fire trucks are in the photo it is difficult to determine and yet, there appears to be a full stream of water spraying the debris pile. If there was no water in the mains, where did the firefighters get the water to spray the pile shortly after collapse? In addition there is a photo of a fire stream hosing down the area in front of WTC 7 before the collapse on Page 141 NCSTAR 1-9 Chapter 5 with what appears to be ample water pressure, at 1:30 p.m.

**Suggestion for Revision:** *" . . because of reports that water may not have been available, however, photographic evidence does not corroborate the report."*

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**<u>Comment 8</u>:**
**Report Number:** NCSTAR 1A
**Page Number:** 19
**Paragraph/Sentence:** Sixth paragraph: *"This buckling process that occurred at temperatures at or below approximately 400° C (750 °F), which are well below the temperatures considered in current practice for determining fire resistance ratings associated with significant loss of steel strength."*

**AND**

Fifth paragraph: *"The heat from these uncontrolled fires caused thermal expansion of the steel beams on the lower floors of the east side of WTC 7, damaging the floor framing on multiple floors."*

**Comment:** While heat does indeed expand steel and concrete, the primary method for deducing that the heat generated in WTC 7 was enough to *"damage the floor framing on multiple floors"* was based on model simulations where inputs could be easily "tweaked" to produce the desired results. Is there any physical evidence of the steel from WTC 7 to corroborate this model? Equally important, did NIST conduct any laboratory analysis, with a full scale beam–column set up in a furnace in an effort to replicate the simulation results? Since the model input can significantly affect the output and the conclusions are so remarkable; and since it the first time in history that a building globally collapsed allegedly due to "thermal expansion", a full scale fire test simulation is definitely in order.

**Reason for Comment:** Was there any specific physical evidence of distorted beam-column connections? Was there any physical evidence of damaged floor framing due to heat found?

It appears that this was a result based on a model simulation only, but not based on any physical evidence or testing whatsoever.

**Suggestion for Revision:** *"One hypothesis is that the heat from these uncontrolled fires caused thermal expansion of the steel beams on the lower floors of the east side of WTC 7, damaging the floor framing on multiple floors. However, because the temperatures did not last for the minimum time necessary to generate the heat on the beam–column system for the model to predict that thermal expansion could have occurred, no physical evidence was found indicating beam joint failures; no testing was done to confirm the simulation; and the fact that thermal expansion never caused a global collapse on any steel structure, it is very highly unlikely that thermal expansion could possibly be the real cause of the structures global collapse."*

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**Comment 9:**
**Report Number:** NCSTAR 1A
**Page Number:** 19
**Paragraph/Sentence:** Last paragraph: *"This movement (from thermal expansion) was enough to lose its connection to Column 79."*

**Comment:** Thermal expansion of floor beams breaking its beam seat connection and then causing a global collapse has never happened before, and very highly unlikely. Structural engineers do not design connections for lateral forces from thermal expansion because it is so rare. No structure before or after 9/11 has ever globally failed due to "thermal expansion" and it's very doubtful if it was the cause of the collapse of WTC 7.

**Reason for Comment:** Structural engineers do not design connections for lateral forces for thermal expansion because it is so rare. Thermal expansion for a 53 foot beam with a delta "T" of 654 F (752 – body temp) is less then 2.7 inches.

Other pages in NCSTAR 1-9 indicate sag in the floor system due to the heat. (NCSTAR 1-9 Vol. 1 Chapter 8, Page 323: *"Elevated temperatures in the floor elements led to thermal expansion, with or without thermal weakening and sagging, . . ."*)

The sagging effect is also indicated graphically in NCSTAR 1-9 Vol. 2 Page 56. Any sag effects need to be subtracted from the lengthening effects of thermal expansion. In addition any warping of the flange or web will also consume some distance and must be subtracted from any elongation and assumed forces of the thermal expansion. NIST is claiming that girders "walked off" their beam seats at the major connections with Column 79 (and others). But the elongation from thermal expansion, even if the sagging effects are ignored, is only a couple of inches at most; yet the beam seats are longer. How can the girders "walk off" their beam seats if the seats are longer then the possible expansion?

Finally, any residual expansion distance, once the sag, warping, and torsion effects are subtracted is shared between each end of a beam and any lengthening or sagging is incrementally re-distributed throughout the network of adjacent beams and columns rendering elongations at any one particular location to be almost negligible; or well within the elastic limits of the connections.

Steel structure beam to beam, or beam to column connections have been riveted, bolted, welded or a combination thereof for over a hundred years, with no significant "thermal expansion" sheering problems during much hotter fires, which is one reason it's simply not necessary to include in any structural design analysis.

Because no steel structure has ever failed globally due to fire, and this fire was a cool office fire when compared to historical fires, the suggestion that thermal expansion of the floor beam system was the trigger for global collapse is highly suspect and definitely should not be considered the leading hypothesis; given the overwhelming evidence for a hypothetical blast scenario.

**Suggestion for Revision:** Delete sentence and all related (thermal expansion causing global collapse) conclusions in its entirety and dismiss this cause of failure, due to the fact that it is so highly improbable as to render it not credible to scientific scrutiny.

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**Comment 10:**
**Report Number:** NCSTAR 1-9 Chapter 13 13.3 (16)
**Page Numbers:** *606*
**Paragraph/Sentence:** *Section 13.3*, Paragraph (16) - "*Hypothetical blast events did not cause the collapse of WTC 7. NIST concluded that blast events could not have occurred and found no evidence of any blast events.*"

**Comment:** Contrary to the above opening statement, it is apparent that adequate effort was not expended or was intentionally overlooked when compiling the evidence for a blast scenario. There are many layers of evidence for a controlled demolition and some of the issues that were overlooked include:

- No mention of eye witness accounts of personnel that were inside the structure reporting both hearing and feeling the effects of explosions, including a very credible witness, Mr. Barry Jennings, (along with Mr. Hess), who were trapped inside. (However NCSTAR 1A Section 3.4.1, Page 24 - third line and in other areas of the study, NIST does allow eyewitness accounts and personal interviews for other evidence; but not for the numerous accounts of blasts by eyewitnesses.)

- No discussion of eyewitness, Michael Hess, NYC Corporation Council (actually INSIDE the building) stating: *"Another gentleman and I walked down to the 8th floor, where there was an explosion, and we've been trapped with all smoke around us for an hour and a half."*

- No mention of all the explosions reported that day by the firefighters and contained in the City of N.Y. Oral Histories.

- No mention of the many many explosions reported by news anchors at the scene that day. Recommend NIST reviews the following video on "youtube": http://www.youtube.com/watch?v=ylgoXQWiSIM

- Reports from emergency workers need to be addressed including: *"We were watching the building actually 'cause is was on fire' . . . and . . . we heard this sound that sounded like a clap of thunder . . . turned around -- we were shocked to see that the building was ah well it looked like there was a shockwave ripping through the building and the windows all busted out . . . about a second later the bottom floor caved out and the building followed after that."*

- And from Peter DeMarco, a New York Daily News Reporter: *"At 5:30 p.m. there was a rumble. The buildings top row of windows popped out. Then all the windows on the thirty ninth floor popped out. Then the thirty eighth floor. Pop! Pop! Pop! was all you heard until the building sunk into a rising cloud of grey."*

- No mention of the eutectic steel found on the site, FEMA reported: *"The severe corrosion of and subsequent erosion of (steel) samples 1 and 2 are a very unusual event. A detailed study of the mechanism of this phenomenon is needed."* And the "deep mystery" of sulfur found on the steel quoted from WPI -- Transformations Spring 2002: *"The New York Times called these findings "perhaps the deepest mystery uncovered in the investigation." The significance of the work on a sample from Building 7 and a structural column from one of the twin towers becomes apparent only when one sees these heavy chunks of damaged metal. A one-inch column has been reduced to half-inch thickness. Its edges--which are curled like a paper scroll--have been thinned to almost razor sharpness. Gaping holes--some larger than a silver dollar--let light shine through a formerly solid steel flange. This Swiss cheese appearance shocked all of the fire-wise professors, who expected to see distortion and bending--but not holes. A eutectic compound is a mixture of two or more substances that melts at the lowest temperature of any mixture of its components. Blacksmiths took advantage of this property by welding over fires of sulfur-rich charcoal, which lowers the melting point of iron. In the World Trade Center fire, the presence of oxygen, sulfur and heat caused iron oxide and iron sulfide to form at the surface of structural steel members. This liquid slag corroded through intergranular channels into the body of the metal, causing severe erosion and a loss of structural integrity."*

Note: an office fire will not cause a eutectic state for the steel found by FEMA. Sulfur, from a thermite reaction, could very well cause this eutectic state.

- The peer reviewed air quality analysis that found at that the air in the area indicated the use of explosives, found at this site: http://www.springerlink.com/content/f67q6272583h86n4/fulltext.pdf

- The dust samples with molten spheroids indicating the use of explosives, along with the dull grey/red chips of thermite found in the dust samples which can be reviewed at this site: http://www.911research.com/wtc/evidence/residues.html

- The symmetrical collapse pattern of WTC 7 indicating the use of explosives, and the fact that is very difficult to make a building fall in such a way using explosives, but has never fallen in such a way by gravity or fire induced forces alone: FEMA WTC Performance Study reports: *"Demolishing the building so that it collapses straight down into its own footprint requires such a skill that only a handful of demolition companies will attempt it."* If it's that difficult to create a perfectly symmetrical collapse with pre-planted charges, then its virtually impossible to make a structure fall this way due to an office fire and gravity alone; especially one that was partially weakened on its south west face due to impacts.

- The straight down, parallel fall of the roof line, indicating simultaneous dissociation of all 58 perimeter columns at virtually the same time. The NIST buckling simulation on one side would make the roof line tip, yet the roof fell parallel to the horizon.

- The analysis by Dutch demolition expert Danny Jowenko, indicates that it was clearly a controlled demolition.

- The small debris field that did little damage to the adjacent structures, indicative of a controlled demolition.

- The many reports of red hot or molten steel in the debris; that simply cannot be made molten by an office fire.

- No mention of FEMA Report 403, Appendix C that recommends further study of evidence of liquid steel that could be related to the cause of the collapse and should be studied further.

- No explanation what caused the pyroclastic flow of pulverized dust, indicative of a controlled demolition, and the energy it took to create that flow of dust. (NCSTAR 1-9 Vol 1 Page 286 states: *"When WTC 7 collapsed, the dust that was generated mixed with air to create a dense mixture that flowed away from the site. The* *resulting dust and debris-laden flow spread over many blocks of lower Manhattan.")*

- No mention of the "count down" by officials heard over the radio of the demolition reported by eye witnesses.

- No mention as to why Mayor Giuliani decided not to use his state-of-the-art reinforced command center that day inside WTC 7 specifically designed for such an event.

- No mention of how Captain Michael Currid, President of the Uniformed Fire Officers Association, knew ahead of time that the building was a lost cause. *"Someone from the city's Office of Emergency Management told him that WTC 7 was basically a lost cause and we should not loose anyone else trying to save it."* And Firefighter Vincent Massa said: *"We hung out for hours waiting for 7 to come down."*

- No mention of how the Mayor knew of impending building collapses when he said: *"I went down to the scene and we set up headquarters at 75 Barkley Street, which was right there with the Police Commissioner, the Fire Commissioner, the Head of Emergency Management, and we were operating out of there when we were told that the World Trade Center was going to collapse. And it did collapse before we could actually get out of the building, so we were trapped in the building for 10, 15 minutes, and finally found an exit and got out, walked north, and took a lot of people with us."*

- No mention of the BBC footage with Jane Stanley, a BBC Reporter, "live on the scene" at around 5:00 p.m. announcing the collapse of the Solomon Brothers Building over 20 minutes before it actually collapsed.

- No mention of the CNN foreknowledge and premature announcement of the collapse of WTC 7. *"We are getting information now that one of other buildings, building 7, in the world trade center complex is on fire and has either collapsed or is collapsing. I . You to be honest can see these pictures just a little bit more clearly than I, but Building number 7 one of the other buildings in this very large complex of buildings that is the Trade Center . . . there were -- there were -- and that is the right way to put it -- there were the two towers, but then there are a number of support buildings around it -- retail spaces, restaurants, office space, garages, the trains come in from New Jersey bringing commuters taking commuters back, come into the complex that is the World Trade Center, and now we are told there is a fire there and that building may collapse as well, as you can see."*

- Accordingly, if no steel structure has ever collapsed due to fire and the fires inside WTC 7 were really not that extensive or hot, and firemen routinely enter and extinguish fires such as those experienced in WTC 7, then how did "they" *know* that the building(s) would come down? On the other hand, if someone knew that the building was rigged with explosives, and/or the final stages were being rigged in those hours, it would explain *all known evidence very easily*.

**Reason for Comment:** All of the above evidence linking explosives appears to have been grossly overlooked or intentionally ignored.

Without discussion of the above items, all of Section 2.3 as well as the entire NIST report, analysis and conclusions are incomplete and simply not credible to scientific scrutiny.

**Suggestion for Revision:** *"Hypothetical Blast Events are the primary cause the collapse of WTC 7. NIST concluded that blast events must have occurred because no other hypothesis can explain all the known events, all the known evidence and all the testimony from eye witness accounts. Only a blast scenario addresses 100% of all known evidence, and therefore is our leading hypothesis."*

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**Comment 11:**
**Report Number:** NCSTAR 1A
**Page Number:** 32
**Paragraph/Sentence:** Section 3.4.5 Second to last paragraph. *"Figure 3-9 shows an example of the extent of structural damage from the fires, in this case for the 13th floor. At both 3.5 h and 4.0 h, connections, floor beams, and girders were damaged or had failed at steel temperatures that were approximately 400° C or less, primarily due to the effects of thermal expansion. After 4 h of heating, there was substantially more damage and failures in the WTC 7 structural system than at 3.5 h of heating."* And in the next paragraph: *"However, it appeared likely the critical damage state occurred between 3.5 h and 4 h."*

**Comment:** Exact input details of the NIST model were not provided for review. However, based on the above, it appears the modeling effort to reach failure mode of the connections required was at least a time of 3.5 hours at a temperature of approximately 400° C., or to put it another way, any time less then 3.5 hours or 4 hours would not cause a failure.

**Reason for Comment:** Based on Figure 3.6, Page 30 (NCSTAR 1A) temperatures near the floor system of Column 79 did not sustain temperatures of 400° C for a time in excess of 3.5 hours. Rather, this indicated a time of perhaps 2 hours.

In addition, according to Page 330 Section 8.4.1 (NCSTAR 1-9 Vol. 1): *"Prediction and growth of building contents fires (Chapter 9) indicated that such fires did not persist at* *any one location for more then about 20 min to 30 min., which is consistent with observations of fires in the windows (Chapter 5)."*

Finally, Floors 12 and 13 (the SEC floors) were determined to be the hottest, yet: *"Fire was first observed on the 12th floor, on the south side of the east face, at about 2:10 p.m."* (Page 381 NCSTAR 1-9 Vol 2), and didn't even begin to heat up the areas near Column 79 until around 3:00 p.m.

NCSTAR 1-9 Page 243 for the 8th floor: *"As late as 3:22 p.m., there was no indication of fire in this area but about 17 min later a substantial fire spreading to the east was visible between windows 8-47C and 8-53C."*

NCSTAR 1-9 Pages 244 and 245 state: 11th floor: *"A fire was first observed at 2:08 p.m. on the east face."*, and for the 12th floor, a similar time.

For the 13th floor: *"The first visual evidence for burning on the 13th floor was seen on the east face around 2:30 p.m"*; less then 3 hours before the collapse.

And even more importantly, the floor temperatures predicted (Figure 3-8 Page 31 NCSTA 1A) indicate temperatures colder then 200° C as late as 4:00 p.m in the area of Column 79, and not until about 5:00 p.m. (20 minutes before collapse) does only a small portion of the floor area theoretically approach temperatures of 400 C. But the building collapsed at about 5:21 p.m. in the afternoon, about a half hour later, far less time than the critical 3.5 hour time used in the model.

If the entire analysis of the initial failure event is dependent on temperatures approaching 400° C that must exist over 3.5 hour period, and/or the fires did not last that long in the critical Column 79 area, then the entire foundation of the simulation appears flawed. And if the input of the model is flawed, the output results and conclusions are also flawed.

**Suggestion for Revision:** Add the sentence: *"Because the time of heating was not sufficient or near the necessary time of 4.0 h to cause sufficient thermal expansion in the connections, this hypothesis for global collapse was abandoned."*

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**<u>Comment 12</u>:**
**Report Number:** NCSTAR 1A
**Page Number:** 34 NCSTAR 1A Section 3.4.6 Global Analysis using LS-DYNA - third to last paragraph: *"The first was based on NIST's best estimate of both debris impact damage form"* (sic from) *"WTC 1 and the fire-induced damage as developed using the ANSYS modeling. This occurred at 4 h in the ANSYS computation."*

**AND**

**Paragraph/Sentence:**
Page 35 NCATAR 1A - Paragraph 2: *"The global analysis with fire-induced damage at 4.0 h most closely matched the observed collapse events, and the following discussion begins with the results from this analysis."*

**Comment:** The heat applied for four hours to the floor system and floor beams did not last that long in the critical area.

**Reason for Comment:** If the heat did not last four hours in the area of Column 79, then there is no collapse initiation by "thermal expansion" and no trigger to start the global collapse due to fire.

If the above is true, the entire model, analysis summary and conclusions are wrong.

**Suggestion for Revision:** *"The global analysis with fire induced damage at 4 h most closely matched the observed events and the following discussion begins with the results of the analysis. However, since the office fires in WTC 7 did not have duration of 4 hours in any one area, although the model results may have matched the observed events, the model input was not valid and therefore the entire model results were dismissed."*

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**Comment 13:**
**Report Number:** NCSTAR 1A
**Page Number:** Page 35
**Paragraph/Sentence:** Last paragraph: *"With no fires on the west side of Floors 10 through 14, the intact floor framing pulled the exterior columns inward and the interior columns fell downward. Loads from the buckled interior columns were redistributed to the exterior columns, which, in turn, buckled the exterior columns between Floors 7 and 14 within approximately 2 s. At that point the entire building above the buckled-column region moved downward as a single unit, resulting in the global collapse of WTC 7."*

**Comment:** There are several problems with this hypothetical collapse sequence.

**Reason for Comment:** First, if the interior floors under the penthouse and surrounding Column 79 collapsed first, there is very little floor load to be redistributed to the exterior walls, particularly on the northwest, southwest and west side. If anything, the loads would become significantly reduced on the perimeter walls as there is no dead loading from the internal floors, nor of course any live loads imposed by occupants, wind or snow loads. The steel structures, in addition to being able to carry full loadings, are also designed with a factor of safety of at least double the maximum rated loadings, acting simultaneously. Probably this particular structure has a higher factor of safety since it was a reinforced emergency command center.

Secondly, Figure 3-14, indicates the most buckling on the westerly face with a severe kink between Floors 7 -14. Any buckling of the perimeter wall columns by increased loading above, must by definition, shorten the distance between the top of the roof and the ground along the westerly wall, compared to the easterly wall. If the "top block of floors" remains fixed and level, then there can be no increase in vertical loading and no buckling of the lower walls. This shortening due to the buckling would be reflected in a roofline that would not be parallel to the horizon as it fell, but rather a tilted roof line relative to the horizon. We know from video that the roof fell parallel to the horizon and was definitely not tilted or at an angle.

In addition the twist of the entire easterly portion of the structure, indicated in Figure 3-14 as representative of the model, is not supported by the videos or photographic evidence of the collapse.

NIST then claims that: *"At that point the entire building above the buckled-column region moved downward as a single unit, resulting in the global collapse of WTC 7."* But to remain as a unit, one would expect to see a stack of pancaked floors in the final debris pile; with concrete floors stacked on each other crushed but intact, and furniture crushed between the floors. But that was not observed at the debris pile. Rather, steel wall W sections were cut up (not bent, but cut), and there were no stacks of floors as predicted by the NIST account of events, with the upper floors falling as a single unit. The concrete floors were pulverized and the debris pile looked exactly like that of a controlled demolition, and definitely not a collapse of a single block of upper floors. And to fall vertically as a single unit, the underlying perimeter supports would all have to fail at the same time. But the NIST analysis indicates the bucking of the walls on the south westerly side first, followed later by failure on the north and easterly sides.

The evidence simply does not match the conclusion presented in the global collapse analysis presented, and is, therefore, fatally flawed.

**Suggestion for Revision:** Delete *"thermal expansion leading to global collapse"* as your leading hypothesis. It is fatally flawed. Re-focus on the blast scenario which addresses all known evidence.

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**Comment 14:**
**Document:** NCSTAR 1-9 WTC 13.3(16)
**Page Number:** 606
**Paragraph/Sentence:** *"The minimum explosive charge (lower bound) required to fail a critical column (i.e. Column 79) would have produced a pressure wave that would have broken windows on the north and east faces of the building near Column 79."*

**AND**

**NCSTAR 1A Pages 22-23**
**Paragraph/Sentence:** *"Nearly all the windows on the northeast section of the blast floor would have been broken, even by the smaller charge. Simulations for open landscaped floors led to more extensive window breakage."*

*The actual window breakage pattern on the visible floors on September 11, 2001 (NIST NCSTAR 1-9 Chapter 5) was not at all like that expected from a blast that was even 20 percent of that needed to damage a critical column in WTC 7. The visual evidence did not show showing such a breakage pattern on any floor of WTC 7 as late as about 4:00 p.m. or above the 25th floor at the time of the building collapse initiation. Views of the northeast corner at the time of the collapse were obstructed by other building."*

**Comment:** I believe the inference from NIST can be summarized as follows: Since the windows would have been broken with a blast event, and we didn't notice any broken windows, we conclude that there was no blast event. This logic is flawed for many reasons:

1. The entire window analysis in NIST NCSTAR 1-9 Chapter 5 are primarily from photographic evidence many hours before collapse at about 5:21 P.M. And from the above quote, that last photographic evidence was around 4:00 p.m., or over an hour and twenty minutes before collapse. So, the fact that "*visual evidence did not show . . . breakage pattern on any floor of WTC 7 as late as 4:00 p.m. . .*" is meaningless, since the final blast events would not have been initiated until about 5:20 p.m. And by saying ." . . *or above the 25th floor at the time of building collapse . . .*" can be inferred that below the 25th floor up to collapse initiation there <u>WAS</u> evidence of window breakage.

2. *"Views of the northeast corner at the time of collapse were obstructed by other buildings."* In other words, since the northeast corner - the area predicted by NIST simulations to have been broken (indicated on Page 23 - NCSTAR 1A), could not even be seen because they were obstructed.

3. The conclusion that *windows must break by the blast event for it to be a controlled demolition* is simply false and not supported by many videos of structures that have been taken down by a controlled demolition; indicating that the blast event *did not* break windows, but rather the subsequent collapse did.

4. The assumption that a certain amount of an explosive shape charge to sever the heavy boxed in Column 79 assumes that all cutting action is only from the shaped charge. However, if the column was initially weakened by an incendiary such as thermite, the size of the shaped charge necessary to sever the weakened column would be significantly less, indicating that the glass breakage and sound volume would be far less.

**Reason for Comment:** Window breakage is a very poor method to conclude that explosives were not used, especially since there is overwhelming evidence that explosives were used to bring the building down.

By NIST's own admission, there is not sufficient evidence to support this rationale whatsoever.

**Suggestion for Revision:** *"Unfortunately the visual evidence did not show showing such a breakage pattern on any floor of WTC 7 as late as about 4:00 p.m. (which was well over an hour before the building collapsed), or above the 25th floor at the time of the building collapse initiation. Views of the northeast corner at the time of the collapse were obstructed by other buildings. Accordingly, we cannot rule out a blast scenario based on available window data, since we do not have data at the time a blast would have occurred, or within seconds of the collapse at about 5:20 P.M."*

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**Comment 15:**
**Report Number:** NCSTAR 1A
**Page Number:** 23
**Paragraph/Sentence:** *"The calculations showed that all the hypothetical blast scenarios and charge sizes would have broadcast significant sound levels from all of the building faces."* AND *". . . the sound level . . . would have been approximately 130 dB to 140 dB at a distance of 1 km . . ."* AND (Page 24 NCSTAR 1A): *"However, the soundtracks from videos being recorded at the time of the collapse did not contain any sound as intense as would have accompanied such a blast event. Therefore, the Investigation Team concluded that there was no demolition-type blast that would have been enough to lead to the collapse of WTC 7 . . ."*

**Comment:** I believe the NIST position can be summarized as follows: *Since our model predicted explosive sounds in excess to what we have known recordings of the event, we conclude that explosives were not used.* This logic is flawed for many reasons:

1. If the heavy columns were weakened with an incendiary first, smaller shaped charges with less sound would be needed.

2. Soundtracks of videos do indicate a rather loud collapse, however, the placement of the video microphones are haphazard, and not necessarily focused on the source of the sound propagation. Just like any sound heard is dependent on how your head is turned, one simply cannot rely on video sound tracks as firm evidence of sound propagation or intensity.

3. There are many controlled demolitions very similar to the WTC 7 collapse that has very similar sound volumes. One recent one is in Glasgow and can be heard and viewed at:

   http://news.bbc.co.uk/2/hi/uk_news/scotland/glasgow_and_west/7516267.stm

4. There are many examples of explosions. Please review all the evidence at the following link: http://www.youtube.com/watch?v=ylgoXQWiSIM

5. There are many eyewitness accounts of explosions. Please refer to Comments 6 and 10 for examples.

**Reason for Comment:** To conclude that explosives were not used based only on sound is not realistic, in light of all the other evidence that the use of explosives were used to take the building down, that has not been addressed in this report.

All the known evidence of explosions need to be addressed in order to be valid. Relying on video sound tracks and a simulation model is simply not appropriate or sufficient to dismiss the use of explosives in light of the overwhelming unaddressed evidence for the use of explosives.

**Suggestion for Revision:** *"However, the soundtracks from videos being recorded at the time of the collapse did not contain any sound as intense as would have accompanied such a blast event. NIST recognizes that video sound tracks are not accurate enough to dismiss the use of explosives, and given all the other evidence (time of fall, symmetry of fall, eyewitness accounts, cut up wall segments contained debris field, evidence of thermite, evidence of molten metal, pyroclastic flow of dust, etc), NIST recognizes that dismissing the blast hypothesis based on only one method (model predicted sound levels) is inappropriate, and not accordance with the scientific method.*

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**Comment 16:**
**Report Number:** NCSTAR 1A
**Page Number:** 22
**Paragraph/Sentence:** Section 3.3 Paragraph 4: *"The other scenarios would have required more explosives or were considered infeasible to carry out without detection."*

**Comment:** To dismiss a very high probability of global collapse due to explosives, which easily explains all known evidence and eyewitness accounts because NIST examiners didn't "think" that planting of explosives could be carried out without detection, is totally unscientific. Rather, it's very plausible that explosives could have been planted since many of the floors were controlled by governmental entities and much of the prep work could have been placed on the core columns accessed undetected inside the elevators shafts, similar to the twin towers. Moreover night work and the fact that the owner of the structure gained financially by the collapses that day would point to access issues not being problematic at all.

**Reason for Comment:** To dismiss placement of explosives because those placing it "might be detected" is not a good scientific reason to dismiss the likelihood and only increases the potential ridicule of the official investigation.

**Suggestion for Revision:** *"The other scenarios would have required more explosives, which is entirely within the realm of possibility. Moreover, NIST bases the conclusions solely on scientific evidence and research, and leaves how the potential explosives could have been placed to other agencies having jurisdiction."*

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**Comment 17:**
**Report Number:** NCSTAR 1A
**Page Number:** xxxi Executive Summary
**Paragraph/Sentence:** *"This was the first known instance of the total collapse of a tall building due to fires."*

**Comment:** This very conclusion, regardless of how extensive the modeling simulations were, is cause for deep concern and is highly suspect. Since there have been thousands of fires, several of which were discussed in the "Lessons Learned" Chapter (NCSTAR 1-9 Chapter 8.5 pages 331 – 336), that burned hotter and longer and never globally collapsed; it is very improbable that this is the first and only structure to-date that experienced global collapse in all of world history.

**Reason for Comment:** A far more likely rationale is that the structure was taken down by a *controlled demolition*. It has all the attributes of a controlled demolition, and the evidence collected all point to a controlled demolition. And almost anyone who watches the collapse and compares it to other controlled demolitions concludes the same thing. However, NIST ignored all the evidence and dismissed this cause on very questionable model results and video noise levels; the determination that in NISTS opinion, *anyone planting explosives would have been detected,* and a flawed window analysis.

**Suggestion for Revision:** *"Since no structure has ever experienced a global collapse due to a simple office fire, before or after 9/11, any conclusion that suggests "thermal expansion" as the cause of the collapse of WTC 7 would be remarkable and highly suspect. Accordingly, the finding of NIST does not support the following explanations for the global collapse: diesel fire, damage due to impact from WTC 1, column heating beyond its strength carrying capability, "thermal expansion" of beams breaking their connections, or global collapse due to the relatively cool and short duration of office fires. Rather, the only explanation for the global collapse that matches all known evidence is that WTC 7 collapse is due to a controlled demolition. Who placed the explosives and when they were placed, is outside the jurisdiction of this agency, and scope of this report.*

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**Comment 18:**
**Report Number:** NCSTAR 1-9 Chapter 11
**Page Number:** 534 and 535

**Paragraph/Sentence:** The entire summary of findings, including *bolt failures, weld failures, beams buckling, girders "walking off" beam seats, sheer studs breaking, at relatively low temperatures ultimately leading of loss of lateral support of Column 79; and then to a global collapse needs to be confirmed by something besides a computer "simulation."*

**Comment:** Not having the computer inputs, the models or the necessary time to evaluate, due to the deadline for public input, there was no way to verify the simulations that NIST performed. Therefore, one must rely on logical deductions as to the validity and probability of the results.

The entire analysis of the global collapse in Chapter 12 is based upon the collapse initiation simulation of Chapter 11, which is based on the assumptions of temperatures models in prior chapters, which is based on the fuel loading of a prior chapter, and based on fire initiation of an even prior chapter. Each module is dependent on the results of a prior simulation. Yet, all of it is just a computer simulation that has not been verified in a laboratory and the end results are so fantastic as to be totally unbelievable. Never in all history has a building collapsed this way, and there have been hundreds of if not thousands of fires in steel framed structures with hotter temperatures and with no global collapse at almost free fall speed.

**Reason for Comment:** Having worked with many computer simulation models, the output results can be very sensitive to the input assumptions, and those results can be dramatically different based on the input. Results from model simulations, for example, the weather service predicting "*projected*" hurricane paths can be very *questionable*. In this particular case, any errors or wrong assumptions are compounded because each subsequent simulation is dependent on the cumulative assumptions and results from prior simulations. Recognizing this reliance of assumptions and the multiplying effect of incorrect assumptions, resulting in a conclusion that has never happened in the real world, places the entire modeling simulations into the realm of the unbelievable without corroborating evidence. The results from the NIST simulation would be like NOAA predicting an Atlantic hurricane travelling from the Caribbean to Africa, spinning clockwise, opposite to all historical precedence.

**Suggestion for Revision**: *"Because the simulation results are so astonishing, only thermal expansion leading to global collapse based only on computer simulations simply cannot be believed unless it is confirmed with actual historical examples of structures that acted in a similar way."*

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**Comment 19:**
**Report Number:** NCSTAR 1A
**Page Number:** 41
**Paragraph/Sentence:** Second Paragraph, First Sentence: *"The elevation of the top of the parapet wall was +925 ft. 4 in."*

**Comment:** This elevation needs to be clarified. Was this NGVD or AGL? In other words, is the top of the parapet wall 925 feet above mean sea level or above the ground level?

**Reason for Comment:** The datum should be clarified because according to Page 5 NCSTAR 1A, the height of the building was 610 feet tall.

**Suggestion for Revision:** *"The elevation of the parapet wall was [+925feet 4 inches above the ground] OR [+925.33' NGVD.]*

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**Comment 20:**
**Report Number:** NCSTAR 1A
**Page Number:** 38
**Paragraph/Sentence:** *"Figure 3-14 Buckling of the lower exterior columns within 1 s of Figure 3-13."*

**Comment:** This graphics indicates the buckling anticipated from the NIST model simulation on the westerly side of WTC 7, and a predicted twist on the easterly side. The top of the graphic is truncated horizontally, almost inferring that it is the roof top. Recognizing that this is a section cut through at a lower level, a continuation of the graphic up to the parapet walls on the roof would indicate that the roof could not be parallel to the horizon because of the predicted buckling and twisting action. This can be seen viewing the yellow horizontal (yet uneven) floor lines of Figure 3- 14.

**Reason for Comment:** Since we know the roof of the actual collapse event did remain virtually horizontal or parallel with the horizon and the graphic on Figure 3-14 would indicate a roof line that is NOT parallel with the horizon; the predicted global collapse from the model is false, and the model must be discarded. In addition, the graphic indicates that the sides of the structure would be twisted and not vertical. Yet, we know that the sides fundamentally remained vertical. According to NIST NCSTAR 1-9 Page 277: *"Thus, well into the building collapse, the northeast corner of the building fell either straight down; directly toward, or directly away from the video camera."*

**AND**

Near the end of the next paragraph, same page: *"The northwest edge initially tilted in a similar manner, but then settled back to its original line and fell nearly vertically, (or directly toward or away from the camera)."* Other videos from differing perspectives indicate the same thing, eliminating the "directly toward or away" from the camera comment. The building fell straight down, and to fall straight down without the roof line tilting, all 58 perimeter 14" W shape columns had to be cut at the same time.

**Suggestion for Revision:** Show the entire structure all the way to the top to indicate the roof and wall lines of position that the NIST model predicts just before collapse and it will indicate how the simulation simply does not follow the observed collapse geometry.

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**Comment 21:**
**Report Number:** NCSTAR 1A
**Page Number:** 40
**Paragraph/Sentence:** 3.6 Last paragraph, about halfway through it: *"Assuming that the descent speed was approximately constant, the two quantities needed for the determinations were (1) a length of some feature of the building descended and (2) the time it took to fall that distance."*

**Comment:** The first phrase of the sentence *"Assuming that the descent speed was approximately constant..."* is a poor assumption. The speed of a falling body is not constant. It's accelerating at a rate of 9.8 m/s (squared). The rate of acceleration is constant...not the speed.

**Reason for Comment:** The assumption by NIST is incorrect, or rather defies all known Newtonian physical laws of free falling bodies.

**Suggestion for Revision:** *"Assuming that the descent speed was accelerating at the rate of gravitational attraction . . ."*

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**Comment 22:**
**Report Number:** NCSTAR 1A
**Page Number:** 40
**Paragraph/Sentence:** 3.6 Last Paragraph, first sentence: *"NIST was interested in estimating how closely the time for WTC 7 took to fall compared with the descent time if the building were falling freely under the force of gravity (NOIST NCSTAR 1-9 Chapter 12).*

**Comment:** The time that the structure fell may not have been precisely at free fall speed in a vacuum, but was certainly close to free fall speed which is remarkable given the fact that it was supported by 24 core and 58 perimeter columns. Saying that the actual rate of fall for the selected feature was 1.5 seconds longer (5.4 seconds vs. a fall in a vacuum of 3.9 seconds), or *"40 percent longer"*, is misleading and not significant. Regardless, all 58 exterior supporting columns had to be severed at virtually the exact same time in several places at various levels, in order for the roof to fall parallel to the horizon at *almost* free fall speed.

**Reason for Comment:** What would be far more significant is to compare the actual time of collapse vs. the NIST simulation that was done, including the time delay for the natural inertial effects of impact and acceleration of each internal floor. In addition the time to buckle the interior and exterior southwest columns and the twist of the faces predicted by the NIST model graphically indicated on Page 38 needs to be calculated.

If all the inertial effects are summed, the time for each floor to cascade and the time to bend and buckle all the columns as predicted in the NIST model was determined vs. the actual the time to fall, it would be far more beneficial to determine if the NIST simulation is even valid. If the model time does is not corroborated by the actual time, then the model is fatally flawed.

**Suggestion for Revision:** "*NIST compared the time predicted in the model that accounted for all buckling time and the inertial effects of accelerating each floor and compared it to the measured time of the event.*" (Then expand on the results.) The "*40% greater*" comment is of little value.

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**<u>Comment 23</u>:**
**Report Number:** NCSTAR 1A
**Page Number:** 58 through 66
**Paragraph/Sentence:** All the recommendation for stricter design codes including recommendations such as (Page 55-4.6) "*Structural systems expressly designed to prevent progressive collapse. The current model building codes do not require that buildings be designed to resists progressive collapse.*"

**Comment:** A global collapse has never happened with any steel structures in the way that WTC 7 fell, *unless* it was a controlled demolition. Like tornadoes, designing for the loadings imposed by a controlled demolition is simply out of the question due to cost. The conclusion of NIST that this building fell due to thermal expansion does not fit the evidence, and *even if it somehow did (which defies all probability and does not pass the straight face test)*; if it only has happened once in the last 100 years, and never since that day, then a recommendation of an overhaul in fire and structural design codes is irresponsible. At a minimum, a cost/benefit study should be conducted prior to making such recommendations based on a singular event in the last 100 years.

**Reason for Comment:** The reason that engineers and codes do not require thermal expansion analysis of structures globally failing due to fires, is because it never happens, and any small thermal expansion that does happen is negligible or local relative to the entire structure. NCSTAR 1A Executive Summary Page xxxi states: "*This was the first known instance of the total collapse of a tall building primarily due to fire.*"

NCSTAR 1A Section 4.5.2 states: *"The structural design did not explicitly evaluate fire effects, which was typical for engineering practice at that time and continues to remain so today."*

NCSTAR 1A Page 44 states: *"This is the first known instance where fire-induced local damage (i.e. buckling failure of Column 79; one of 82 columns in WTC 7) led to the collapse of an entire tall building.";*

*AND*

NCSTAR 1A Section 5.1 Page 57 states: *"The partial or total collapse of a building due to fires is an infrequent event."* By the many admissions of NCSTAR 1A, it is such a highly improbable event (in fact *NEVER* has a steel structure collapsed globally due to thermal expansion) as to render the entire NIST simulation process, its conclusions and the recommendations for even more stringent codes based on a flawed analysis of a singular event, totally unacceptable.

**Suggestion for Revision:** *"Since the global collapse of a steel structure never occurred before or after the collapse of WTC 7, without the use of explosives, code changes based on one single event is not prudent, and no code changes whatsoever are recommended."*

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**Comment 24:**
**Report Number:** NCSTAR 1A
**Page Number:** Cover Page of Report
**Paragraph/Sentence:** N/A

**Comment:** This report and analysis has far reaching implications, since it is a structural analysis with associated conclusions and recommendations. Accordingly due to its importance, Professional Engineer(s) in responsible charge should sign, date and seal all documents in accordance with ASCE and State Statutes. As such, that engineer is responsible for its content, and any falsification of content would be subject to disciplinary action if it was found that facts were intentionally overlooked, or conclusions intentionally skewed, in accordance with the Code of Ethics for Engineers.

**Reason for Comment:** All engineering documents, studies and analysis should be signed and sealed by the professional engineer(s) in responsible charge, to lend credibility to the entire report.

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**Comment 25:**
**Report Number:** NCSTAR 1A
**Page Number:** Page xxxi of the Executive Summary
**Paragraph/Sentence:** Paragraph 3 states: *"However, the reader should keep in mind that the building and the records kept within it were destroyed, and the remains of all the WTC buildings were disposed of before congressional action and funding was available for this Investigation to begin."*

**Comment:** Due to the problem of having key evidence destroyed, which puts a real burden on the analysis team at NIST, and realizing that the computer models could not be verified by field evidence, places the entire modeling process, calibration and conclusions of that model into serious question.

**Reason for Comment:** To protect NIST staff, you may wish to put a bold disclaimer on the cover of the entire report. As mentioned several times (NCSTAR 1A Page 38): *"Independent assessment of the validity of the key steps in the collapse of WTC 7 was a challenging task."*

**Suggestion for Revision:** *"KEY EVIDENCE RELATING TO THE COLLAPSE OF WTC 7 WAS IMMEDIATELY AND SYSTEMATICALLY DESTROYED BEFORE THE INVESTIGATION INTO THE CAUSE OF THE COLLAPSE COMMENCED. THE NIST COLLAPSE SCENARIO HEREIN IS BASED IN PART ON A COMPUTER MODEL UTILIZING NUMEROUS ASSUMPTIONS THAT COULD NOT BE FIELD VERIFIED. INPUTS, EQUATIONS AND ASSUMPTIONS USED IN THE COMPUTER SIMULATIONS AND THE TECHNICAL ANALYSIS HAVE NOT BEEN PEER REVIEWED. NIST RESERVES THE RIGHT TO MODIFY THE CONCLUSIONS OF THIS REPORT IF ADDITIONAL INFORMATION AND EVIDENCE IS FOUND WHICH MAY DRAMATICALLY ALTER THE RECOMENDATIONS."*

From: "Joseph Ciolino" <aciolino@nyc.rr.com>
To: <wtc@nist.gov>
Subject: query

Mr. Cauffman,

Did I hear correctly? I believe I heard Mr. Sunder say, in a response to a question, that, "Obviously, buildings are not designed to withstand airplane impacts."

How can it be possible for him to say that?

Thank you.

Joseph Ciolino
NYC

From: Joseph Nobles <bolo.boffin@gmail.com>
To: wtc@nist.gov
Subject: CBS Footage of Complete Collapse

My name is Joseph Nobles, and I'm the administrator of a website that is working to counter the lies and distortions of Richard Gage and the Architects and Engineers for 9/11 Truth. You can find my website at http://ae911truth.info .

I am writing to ask your assistance in a single matter. Your presentation of the NIST report on Building 7 included a particular piece of footage that I have been anxious to see be more fully available to the public. It is the first shot of the collapse that you use in your video presentation on this page:

http://www.nist.gov/public_affairs/releases/wtc_videos/wtc_videos.html

A section of this footage is in wide circulation on the Internet, and is used by alternate theorists to pretend that the collapse of WTC 7 took only 7 seconds. However, they only show the last 7 seconds where the exterior followed the rest of the interior columns.

This video is so iconic among alternate theorists that the wider availability of the full collapse video from CBS would help demonstrate their fantasies perhaps even to themselves. The sight of the east penthouse collapsing into the building, the building's shudder, the breaking windows as the debris falls inside, and the clear east-west collapse of the screen wall and west penthouse is a clear visual antidote to the poison created in the truncated footage out there.

I am aware that you operate under strict guidelines for the reproduction of another company's product. It is not up to you to release this footage to the public. This is clearly evident from your posted intent to

However, you have contacts at CBS that have cooperated in this study so far. I am asking you to petition CBS for the release of this complete footage. The damage being caused by the partial footage is evident. The full footage is the only remedy for this particular piece of misinformation.

I thank you for this consideration, and I congratulate you on the release of the draft report.

Joseph Nobles

**DR. JUDY WOOD**
202 Mulberry Ave.
Clemson, SC 29631
864-654-8271

lisajudy@nctv.com

September 14, 2008

WTC Technical Information Repository
Attention: Mr. Stephen Cauffman
National Institute of Standards and Technology
Stop 8610
Gaithersburg, MD 20899-8610
Email: wtc@nist.gov

Re: Comments

Dear Mr. Stephen Cauffman:

Set forth below are comments on the "Final Report on the Collapse of World Trade Center Building 7 Draft for Public Comment" dated August 21, 2008 (NCSTAR 1A). The source of the said NCSTAR 1, meaning the point at which it can be and has been accessed, is: http://wtc.nist.gov/

First, the comment period provides insufficient time for comprehensive comment. That period should be extended for a minimum of ninety (90) additional days. Further, and as seen below, several of the comments that are made herein indicate that NCSTAR 1-A is misleading to the point of being fraudulent.

NIST should also publish all comments received in their entirety. If NIST does not do so, then NIST should at least acknowledge that one commentator, Dr. Judy Wood, requested that NIST do so and NIST should then explain that such comments can be obtained by the public upon request and should further indicate the reason for not publishing all comments it received.

I am represented in connection with these comments by Attorney Jerry V. Leaphart whose contact information is set out at the end of the comments. If you have any questions, please contact either me or my counsel.

## Comment 1

**Issue:** Listing of Contributors

**Location:** page 8-10 of 115 of pdf, (labeled page vi-viii of report)
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**NIST CONTRACTORS**

**Siemens**

Steven Shamash
John Farrington
Robert Salamone

**U.S. Securities and Exchange Commission**

Al Basile
Robert DeLeonardus
Ray Ferrari
Richard Lee

**COOPERATING ORGANIZATIONS**

**Siemens Corporation**

Steven R. Shamash
Bob Salamone

**U.S. Securities and Exchange Commission**

Richard D. Lee
Robert DeLeonardis

**Figure 1.**
page 9-10 of 115 of pdf, (labeled page vii-viii of report)http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**General Services Administration**
Mary Guida

**GSA**
Maria Guida

**Figure 2.**
page 10 of 115 of pdf, http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf
(labeled page viii of report)

**Reason for Comment:** The listings are inconsistent with individuals being listed as paid contractors and cooperating organizations. This should be clarified. Mary Guida is listed twice (GSA is listed twice).

**Suggestion for Revision:** Delete or modify as necessary.

## Comment 2

Issue: Reference to weather

**Location**: Beginning of Section 2.1 pg. 51, paragraph 1.



### 2.1 INTRODUCTION

Shortly before 9:00 a.m. on Tuesday, September 11, 2001, about 4,000 people were at work in WTC 7. This was about half of the roughly 8,000 people who worked there. It was the first day of school for many local children, and it also was a primary election day in New York. The weather was clear and comfortable, so some had taken time to do early morning errands.

**Figure 3.**
page 51 of 115 of pdf (labeled page of report), http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**Reason for Comment:** The reference is casual and is based on commonly held assumptions, but is not sufficient for a comprehensive and detailed report. Because of the magnitude of the destruction that NIST itself describes as "disproportionate" it is necessary to have a proper understanding of the precise weather mechanism that may have impacted upon the unprecedented destructive events that occurred.

**Suggestion for Revision:** It is not commonly known or appreciated that a massive Category 3 hurricane was located offshore New York on 9/11/01. That was Hurricane Erin, as seen here:

**Hurricane Erin on 9/11/01**

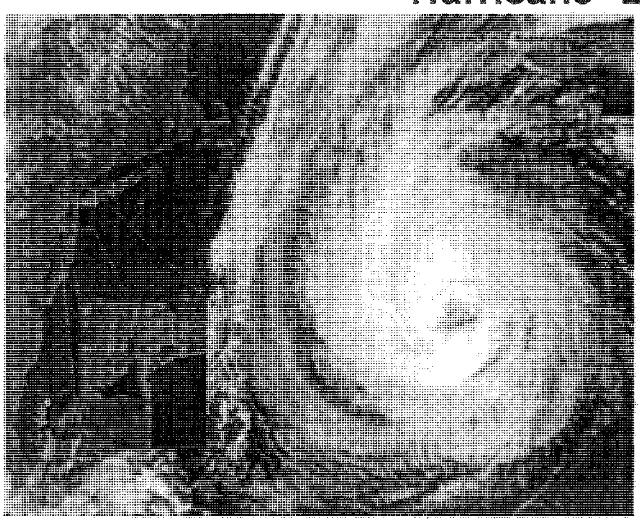


**Figure 4.** http://911digitalarchive.org/REPOSITORY/IMAGES/PHOTOS/1867.pjpeg, http://drjudywood.com/articles/erin/hpics/010911_1867.jpeg

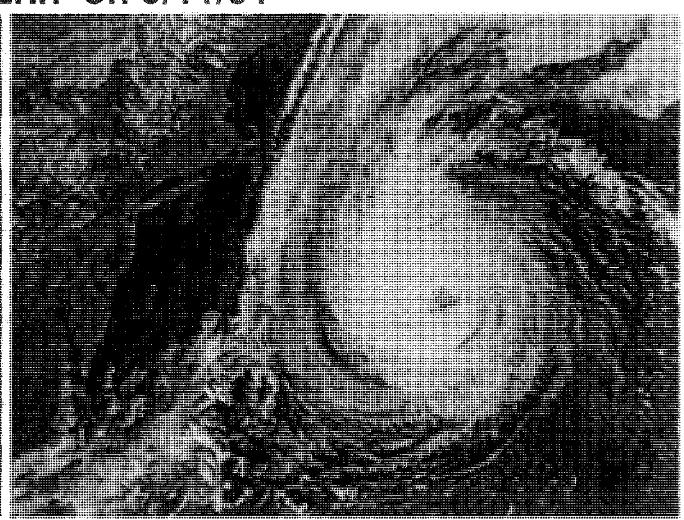


**Figure 5.** http://svs.gsfc.nasa.gov/vis/a000000/a002500/a002521/wtc_terra1.tif, http://drjudywood.com/articles/erin/nonapics/010911_wtc_terra1_s.jpg

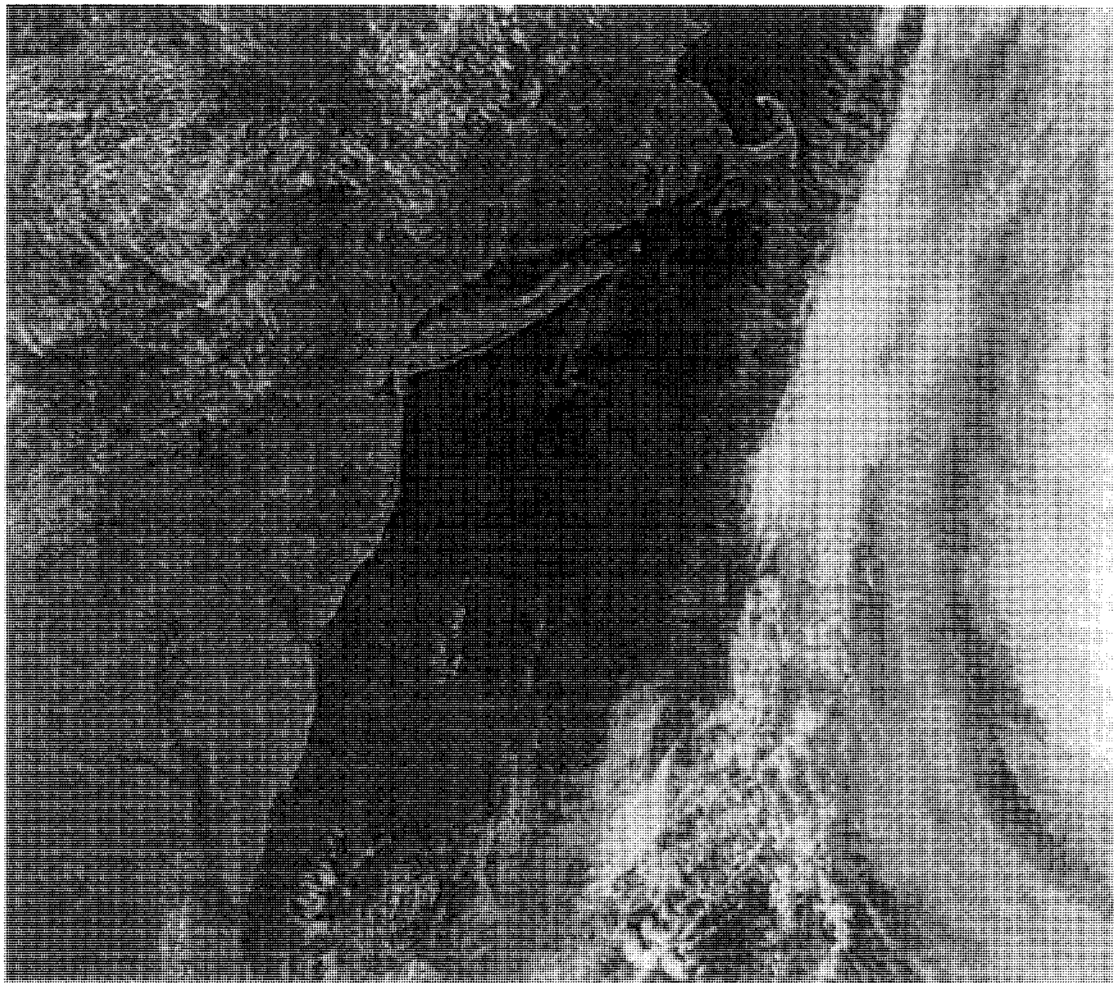


**Figure 6.** http://svs.gsfc.nasa.gov/vis/a000000/a002500/a002521/wtc_terra1.tif, http://drjudywood.com/articles/erin/noaapics/010911_wtc_terra1_cbc.jpg

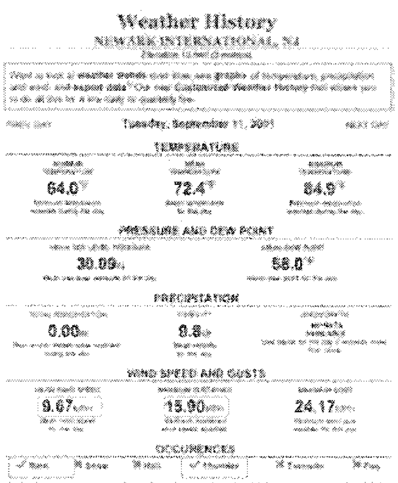



**Figure 7**. Weather at Newark International Airport, Newark, NJ, on 9/11/01.

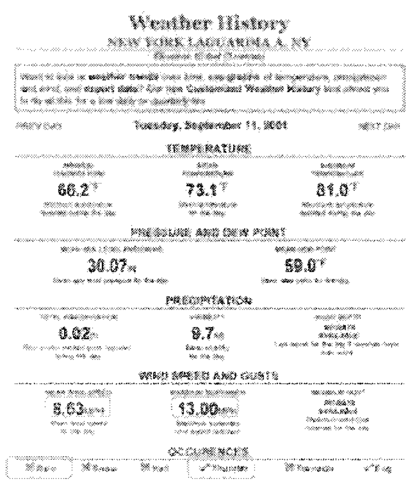



**Figure 8**. Weather at Laguardia International Airport, New York, on 9/11/01.

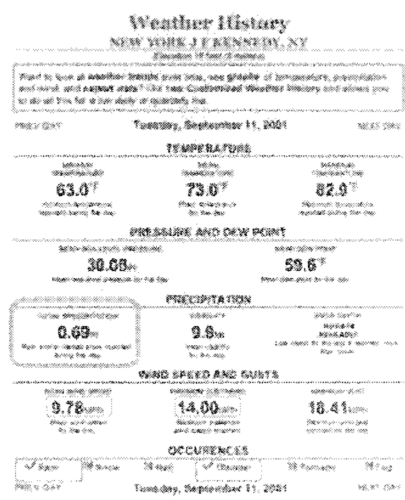



**Figure 9**. Weather at J.F. Kennedy International Airport, New York, on 9/11/01.

Locations where rain and thunder were recorded.

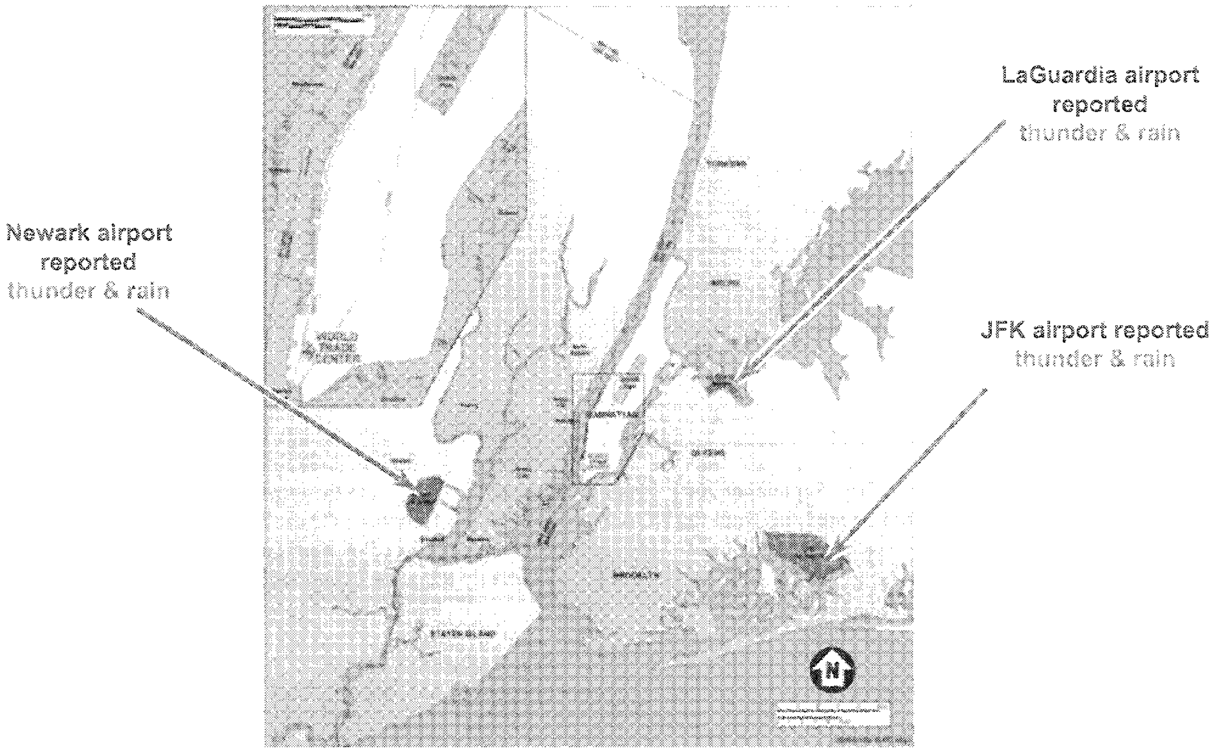



**Figure 5–3. Map of the lower portion of Manhattan showing the location of the WTC complex relative to the island.**

**Figure 10**. Page 138 of 404 of pdf (labeled page 94 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9_Vol1_for_public_comment.pdf

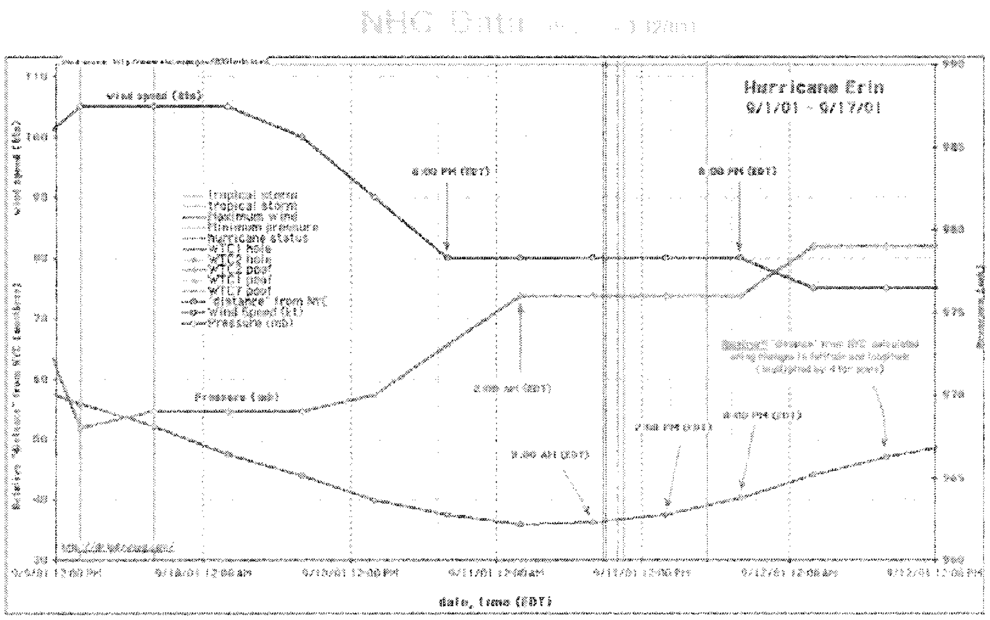



**Figure 11**. nhc http://www.nhc.noaa.gov/2001erin.html 2001_erin_close.jpg

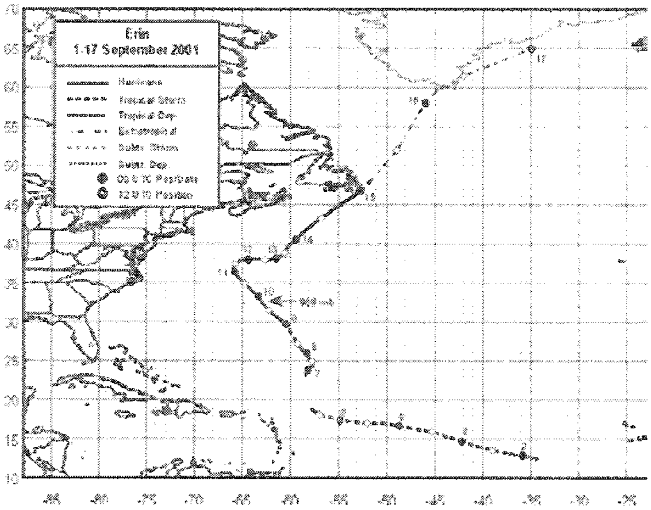



Figure 12. Best track for Hurricane Erin, September 2001. Track during the extratropical stage is based on analyses from the NOAA Marine Prediction Center.

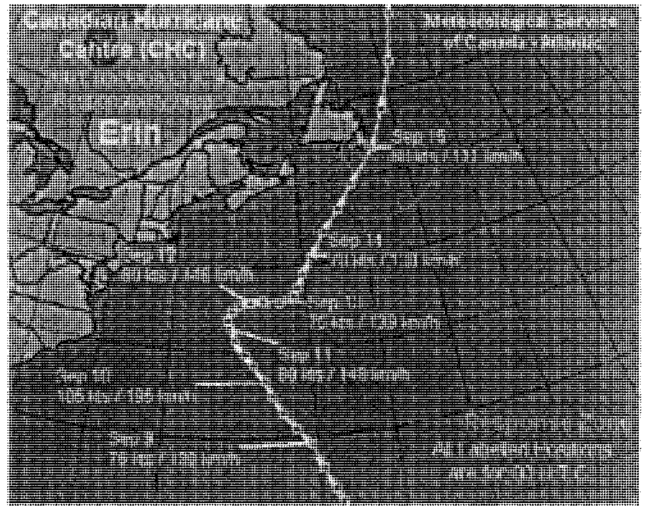



Figure 13. Hurricane Erin track (atl.ec.gc.ca). According to the Canadian Hurricane Centre (CHC), Hurricane Erin entered the "Response Zone." A hurricane in this zone should presumably trigger a "response."

Eye of Hurricane Erin at approximately 8 AM, 9/11/01

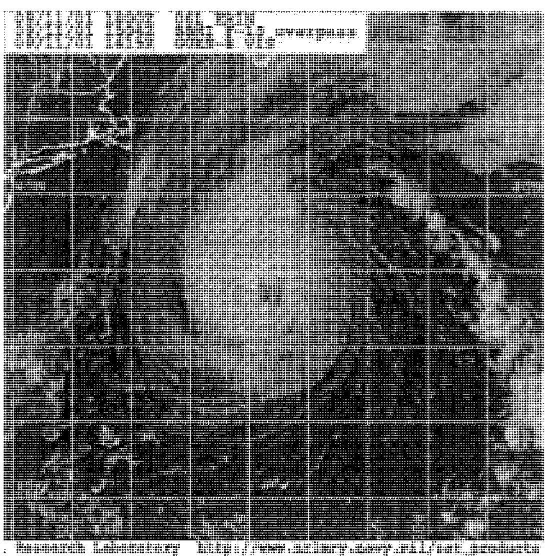


**Figure 14.** Hurricane Erin, September 11, 2001, at about 37.4°N, 65.6°W, which corresponds to abut 10:15AM (EDT).
Source:

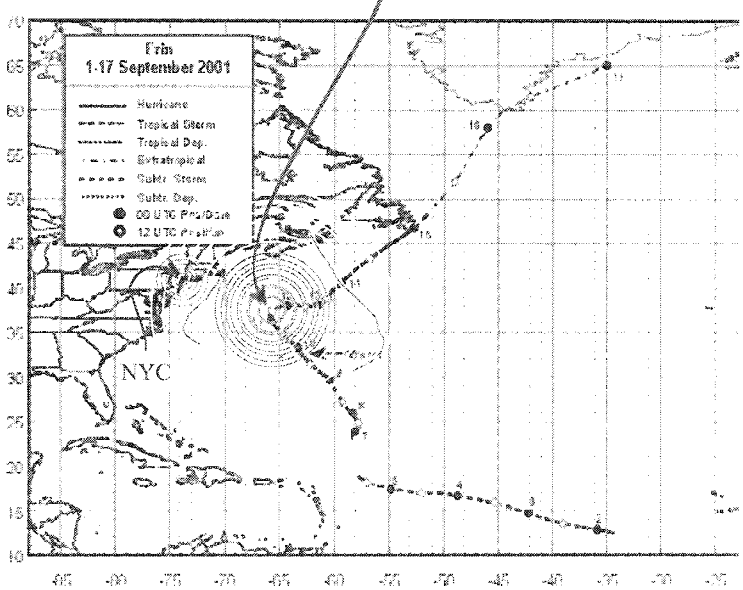



**Figure 15.** . Best track of Hurricane Erin, September 1-17, 2001
Source:

Comment: 2 with 4 pages 6

## Comment 3

**Issue:** Analysis of the buckling is substantially incomplete.

**Location:** page 34 of 115 of pdf, (labeled page xxxii of report), paragraph 2
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

> **PRINCIPAL FINDINGS OF THE INVESTIGATION**
>
> Eventually, the fires reached the northeast of the building. The probable collapse sequence that caused the global collapse of WTC 7 was initiated by the buckling of a critical interior column in that vicinity. This column had become unsupported over nine stories after initial local fire-induced damage led to a cascade of local floor failures. The buckling of this column led to a vertical progression of floor failures up to the roof and to the buckling of adjacent interior columns to the south of the critical column. An east-to-west horizontal progression of interior column buckling followed, due to loss of lateral support to adjacent columns, forces exerted by falling debris, and load redistribution from other buckled columns. The exterior columns then buckled as the failed building core moved downward, redistributing its loads to the exterior columns. Global collapse occurred as the entire building above the buckled region moved downward as a single unit. This was a fire-induced progressive collapse, also known as disproportionate collapse, which is defined as the spread of local damage, from an initiating event, from element to element, eventually resulting in the collapse of an entire structure or a disproportionately large part of it.
>
> **Figure 16.** [emphasis added]
> page 34 of 115 of pdf, (labeled page xxxii of report)
> http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**Reason for Comment:** Analysis explaining exactly how an interior progressive collapse and complete unit global collapse occurred. The likelihood of asymmetry converting to symmetry is highly unlikely and without detailed engineering descriptions, borders on incredible.

**Suggestion for Revision:** Crucial to the viability of the probable collapse sequence articulated in this report is that the [dimensions] column would have had to become unsupported over nine stories. We also note that we relied on the soundtracks of available video to refute hypothetical blast events as a causal factor. We did not engage in an analysis of the soundtracks to determine whether the audible sounds could be deemed to be consistent with a [dimension] column becoming unsupported. We have no explanation for why we did not engage in that analysis.

## Comment 4

**Issue:** Failure due to thermal expansion in buildings does not happen at low temperatures. To suggest this disregards the known properties of materials.

**Location:** First use at Pg. 34 (pdf) Executive Summary, plus, comment pertains to all 37 uses of that term throughout NCSTAR 1-A, paragraph 3

> **PRINCIPAL FINDINGS OF THE INVESTIGATION**
>
> Factors contributing to the building failure were: thermal expansion occurring at temperatures hundreds of degrees below those typically considered in design practice for establishing structural fire resistance ratings; significant magnification of thermal expansion effects due to the long-span floors, which are common in office buildings in widespread use; connections that were designed to resist gravity loads, but not thermally induced lateral loads; and a structural system that was not designed to prevent fire-induced progressive collapse.
>
> **Figure 17.**
> page 34-5 of 115 of pdf, (labeled page xxxii - xxxii of report)
> http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**Reason for Comment:**

The term "thermal expansion" does not appear to have any clearly articulated scientific basis in reality; nor does NCSTAR 1-A adequately explain how the concept of thermal expansion, as articulated, could have arisen in connection with steel columns, girders, and beams that were fire proofed.

## December 18, 2007 NCST meeting

**Charlie Thornton:** Let me ask another question. How long does a 4 pound per square foot combustible office building fire generally last?

**Shyam Sunder:** The rule of thumb for 10 pounds per square feet is one hour. Four pounds is 20 minutes.

**Charlie Thornton:** So again, why would these fires have burned for as long as they did in order to take out this rather well fireproofed heavy robust structure?

**Shyam Sunder:** Charlie, what I'm saying – I guess I'm not communicating well what I'm saying, which is that the fire at any one location is consumed in 20 minutes where the fire front is, but then it moves to the next place where there's more combustibles.

**Charlie Thornton:** But if you're saying that beams sagged and buckled and pulled,
O K, that had to be exposed to the fire for more than 20 minutes.

**Shyam Sunder:** Well, the temperatures at which the beams are exposed, that is the critical issue here, not how long they were exposed to that temperature, and of course beams and slabs and any fireproofing – concrete slab - the metal deck may have some. The beams are much more slender elements in terms of thermal mass and of course the fireproofing on the beams, the floor beams, are much less than the fireproofing on the girders and of course the columns. And so when you go through the analysis for these fires which are moving around from location to location, on those particular floor beams, you see a considerable amount of temperature increases. In fact, you'll see temperatures getting up in to ...in certain regions to 5 600 degrees. Now what also compounds this is you have these heating elements in very large spans in the northeast side of the building. As we said before, there were 2000 square feet large spans, floor areas ... for those columns. So those spans were in fact sagging and we're seeing evidence through our analysis of these very large magnitude of sag.

[There is a loud hammering/knocking sound at this part of the recording as though carpenters were hammering on something in the room. This made Charlie's next remark difficult to hear.]

**Charlie Thornton:** I mean it sounds to me, it sounds to me like between the words here you're questioning the use of _?_ fireproofing for a two-hour rating on a W 21 wide flange beam as an effective fireproofing in the absence of sprinkler systems.

**Bill Gross:** Can I add two things to Shyam's [remarks]. Charlie, you can have an ignition event quite early in the process in which the fire does not burn robustly but smolders and, you know, is barely maintained. And unlike the Towers where you had so much fuel distributed in which the fires spread very quickly, you could have a fire ignited and not grow very fast. It reaches then a certain critical size and then it begins moving as Shyam described. That's one thing.

The second, this would have to be literally a matter of an hour or two where it could be burning at a very slow rate and then burst out in to a full fledged floor fire.

The second thing is don't forget that once the fire front passes, you still a lot of amount of heat there, so the cool-down period following the consumption of most of the fuel – it's still very very hot and will last for a couple of hours, so that adds to the heating of the structure.

**Shyam Sunder:** Yes, that's a very good point, Bill. The fire front moves but the heated elements don't cool down.

**Bob ____:** Shyam, this is Bob. I ran down the same question that Charlie did some time ago

**Shyam: O K**

**Bob:** The same concern. The basic point is that this was a bank fire, and we did the temperature study by using the model, the fire dynamic simulator model, and the temperature... it was more like a series of burners coming on at 20-minute intervals, and as you said, pumping heat into the building, losing some through the vents, having other sink into the material, and the model gave us the fire that they are using. We transferred all of the temperatures on the back side of the fireproofing and then compared those to the properties of the steel or the concrete as the case may be and fed in to the structural model these changes in qualities.

**Shyam Sunder:** Yes, I think that that is an important point that, Charlie, we aren't making any assumptions in this thing. The models are very detailed, so the fire dynamics model gives us the information on the gas temperatures. The thermal model, which is using also LS-DYNA, which is not the structural model, the model, the fireproofing and the structural elements, the seal (?) elements there. So basically, the gas temperatures actually predicting the rise of the temperature in the steel through the fireproofing, and that is done with considerable detail, and then at that point, the structural model comes in to play.

**Charlie Thornton:** I'm not questioning what you're doing. I'm questioning the way that American architects and structural engineers design buildings with spray-on fireproofing. I think you're basically coming out with a conclusion that maybe it doesn't work.

**Shyam Sunder:** I think I will hold off on making a recommendation at this point. Your input is certainly very meaningful to us and as we go forward here, you know, at the end of the day when all of this analysis is finished and we can conclude definitively what we have actually accomplished. At that point I think we will in a position to make a statement about design practices."

The foregoing exchange clearly questions the efficacy of reliance on an unexplained concept of "thermal expansion" as a causal factor in the destruction of WTC 7.

**Figure 18.** from Transcript of NCST December 18, 2007 meeting.

NIST's use of a thermal expansion, occurring at "low temperature" is insufficiently elaborated. Clearly, NIST is trying to navigate a very narrow factor of plausibility here, and that is the most that can be said about it. On the one hand, thermal expansion might, in very generous theoretical terms be said to result in certain effects. However, if the temperature is too high, then a softening of material occurs, which would negate the necessary strength needed to cause expansion. Accordingly, absent a detailed indication of what temperature is low enough to cause expansion, while simultaneously not causing loss of strength is crucial. It may well be that there is no such temperature. In any event, NIST must, at a minimum specify what temperature it has reason to believe was achieved and how the conditions known could have resulted in that temperature. We understand, as well, that there are some who will question the validity of the use of this concept and who may claim that NCSTAR 1-A is fraudulent.

### Suggestion for Revision:

NIST data show htat X termperature was achieved and documents that following conditions occurred at that temperature [details]

NIST also acknowledges, in this respect that there are some who will question the validity of the use of this concept and who may claim that NCSTAR 1-A is fraudulent.

## Comment 5

**Issue**: Limiting the analysis to properties of the soundtracks to hypothetical blast events is fraudulent

**Location**: page 34 of 115 of pdf, (labeled page xxxii of report), paragraph 5
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**PRINCIPAL FINDINGS OF THE INVESTIGATION**

Hypothetical blast events did not play a role in the collapse of WTC 7. NIST concluded that blast events did not occur, and found no evidence whose explanation required invocation of a blast event. Blast from the smallest charge capable of failing the critical column would have resulted in a sound level of 130 dB to 140 dB at a distance of at least half a mile. There were no witness reports of such a loud noise, nor was such a noise heard on the audio tracks of video recordings of the WTC 7 collapse.

**Figure 19.** [emphasis added]
page 34 of 115 of pdf, (labeled page xxxii of report)
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**Reason for Comment:** NIST's acknowledgment that the soundtracks from available videos were used in connection with the analysis of hypothetical blast events requires, for sake of consistency of analysis, that such soundtracks also be used to substantiate (or refute) the findings that NIST made in connection with its other findings. The failure to do so is consistent with fraud.

**Suggestion for Revision:** We understand, as well, that there are some who will question the validity of limiting our analysis of the properties of the soundtracks to hypothetical blast events. We have no explanation for doing so and if there are those who wish to assert that our failure in this respect is fraudulent, then they may do so. We acknowledge being placed on notice of this claim of fraud in comments received from Dr. Judy Wood.

## Comment 6

**Issue:** Building structure as given in the document(s) is incomplete – therefore the analysis is incomplete.

**Location:** page 43 of 115 of pdf, (labeled page 5 of report), 2nd paragraph from bottom
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf



From the 7th floor to the 47th floor, WTC 7 was supported by 24 interior columns and 58 perimeter columns (numbered 1 through 57, plus 14A, which was located near the south end of the west face) (Figure 1 5). Twenty one of the interior columns (numbered 58 through 78) formed a rectangular building core, which was offset toward the west of the building. The remaining three interior columns (79, 80, and 81) were particularly large, as they provided support for the long floor spans on the east side of the building.

**Figure 20.** [emphasis added]
page 43 of 115 of pdf, (labeled page 5 of report) http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**Reason for Comment:**

Use of generic, non-specific language -- "three interior columns (79, 80, and 81) were particularly large" is unsatisfactory for a report that must comply with the standards of the Information Quality Act. The dimensions of those columns must be specific. Full drawings and material specifications related to the building must be available in the report.

**Suggestion for Revision:**

The three interior columns (79, 80, and 81) were of the following dimensions: [provide length, width, breadth and weight]. NIST could not confirm via the available soundtracks that columns of that dimension could be heard crashing down. [Or, in the alternative}: NIST correlated the sound of crashing of columns in the soundtracks for videos taken at sites __, __.

## Comment 7

**Issue:** Dimensions and weights of beams must be provided.

**Location:** page 44 of 115 of pdf, (labeled page 6 of report), paragraph 1
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf



The floor slabs were reinforced concrete of varying thickness. The 1st floor slab was 14 in. thick. The concrete on almost all of the other floors was poured on top of 3 in. deep corrugated metal decking. Floors 2, 3, 4, and 6 had a 6 in. total slab thickness; on Floor 5, the concrete was 14 in. thick; and on Floors 8 through 47, the concrete was 5.5 in. thick. On Floor 7, the south half of the floor had a poured 8 in. slab, and the north half had an 8 in. total slab thickness on a 3 in. deep metal deck. The floor slabs were supported by the structural floor framing shown in Figure 1-5. The floor beams were connected to the concrete deck by shear studs, which caused the floor beams and concrete slab to act together, or compositely. This type of floor system is thus referred to as a composite floor. The floor beams were framed into (connected to) girders with a variety of types of shear connectors2, through which the floor beams transferred gravity loads from the floors to the girders. The girders also framed into the columns with a variety of types of shear connectors and transferred the gravity loads to the columns. Interior columns were connected with splice plates, welds and bolts. The exterior frame had moment connections in each face of the building.

**Figure 21.** [emphasis added]
page 44 of 115 of pdf, (labeled page 6 of report) http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**Reason for Comment:** Building structure as given in the document(s) is incomplete – therefore the analysis is incomplete. Location of beams alone is insufficient to make a valid assessment. Much more structural information needs to be included, with more specific details of dimensions, weights and materials involved for anything which fell to the ground.

**Suggestion for Revision:** NIST has determined that the dimensions of the beams referenced here are as follows: [provide dimensions]

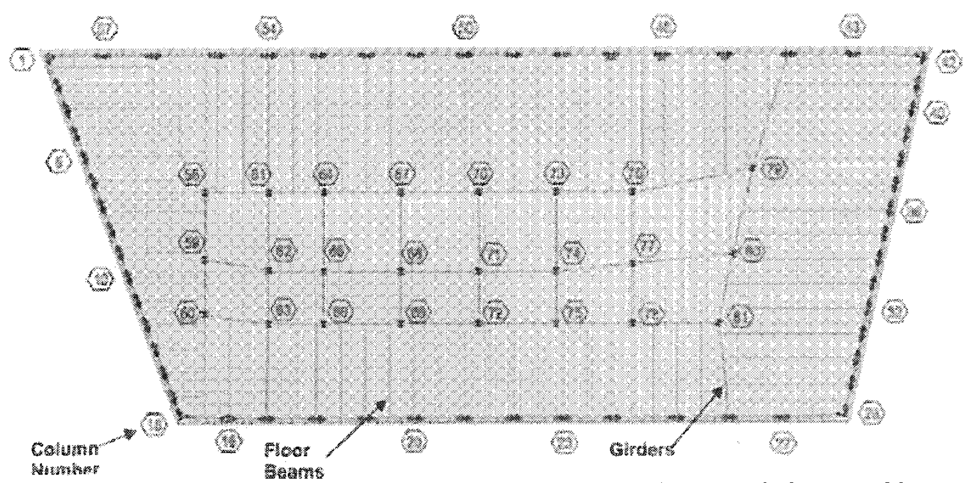



**Figure 1–5. Typical WTC 7 floor showing locations of the columns, girders, and beams..**
**Figure 22.** page 44 of 115 of pdf (labeled page 6 of report),
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

## Comment 8

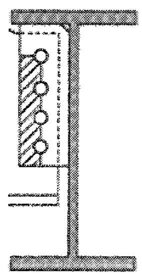
**Issue**: Aspect ratio of beams

**Location**: Page 346 of 382 of pdf (labeled page 684 of report), page 127 of 382 of pdf (labeled page 465 of report)
http://wtc.nist.gov/media/NIST_NCSTAR_1-9_vol2_for_public_comment.pdf

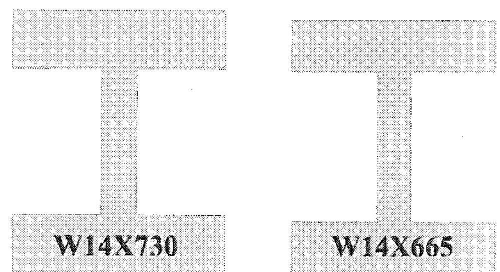
**Table D1. Basic wide flange column parameters. (Dimensions in in.)**

| Section | Web Height | Flange Width | Flange Thickness | Web Thickness |
|---|---|---|---|---|
| W14X730 | 22.4 | 17.9 | 4.91 | 3.07 |
| W14X665 | 21.6 | 17.7 | 4.52 | 2.83 |

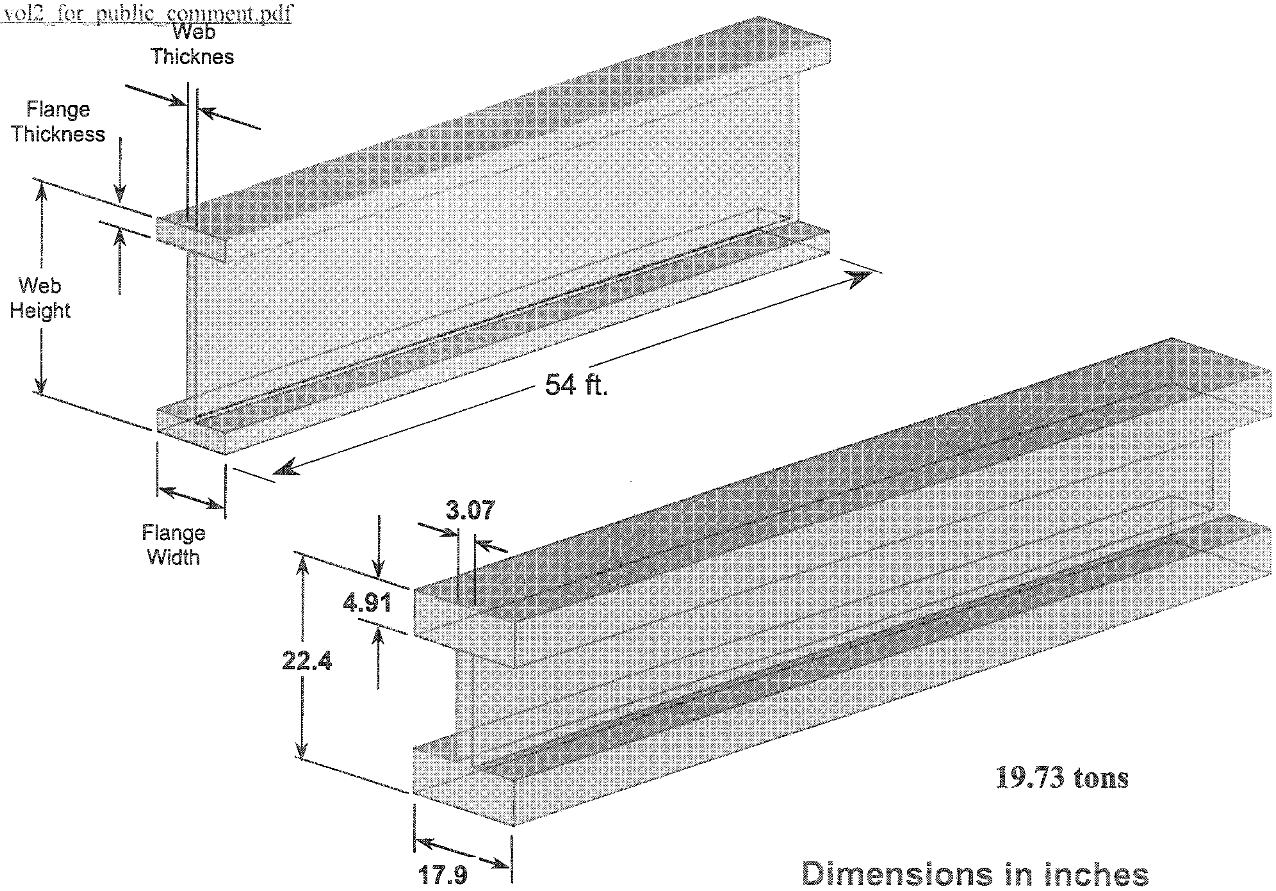
**Figure 23.**
Page 346 of 382 of pdf (labeled page 684 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9_vol2_for_public_comment.pdf



page 127 of 382 of pdf (labeled page 465 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9_vol2_for_public_comment.pdf




The aspect ratio of the dimensions provided in Table D1 are shown above.



**Reason for Comment:** The aspect ratio of beam cross sections shown in the report do not have dimensions. The dimensions provided in the report describe beams with a very different aspect ratio. Dimensions and weights of beams used in this analysis must be provided so that the plausibility of NIST's theory can be properly assessed, among other things. Basically, we are led to believe that very large columns, beams and girders were all sufficiently heated by ordinary office fires that burned for no more than 20 minutes in any one area resulted in multiple, nearly simultaneous failure. That explanation is, of course, implausible, but, at a very minimum, accurate dimensions of what failed must be both provided in detail and properly diagrammed.

Because NCSTAR 1-A refers to collapsing beams, it is essential that the correct aspect ratio is depicted. Otherwise, a highly misleading report would be foisted on the public. We are already required to accept that a 47-story building could collapse in a matter of seconds. At a minimum, correct diagrams of what is said to have collapsed are required. If not, then the appearance of fraud is overwhelmingly confirmed.

**Suggestion for Revision:**
This revision requires re-do of diagrams as exemplified above to show correct aspect ratios.

## Comment 9

**Issue:** Causes for the destruction other than fire and thermal expansion must be properly considered, using all available data.

**Location:** page 47-8 of 115 of pdf, (labeled page 9-10 of report)
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf



**1.2.6 The Combustible Contents**
The layout of most of the floors featured clusters of workstations, or cubicles, throughout the space surrounding the building core (NIST NCSTAR 1-9, Chapter 3). Often, there were walled offices at the perimeter. The layout in Figure 1 8 is indicative of these floors. While there were almost certainly different types of workstations in the building, they were all fundamentally similar. Each cubicle typically was bounded on four sides by privacy panels, with a single entrance opening. Within the area defined by the panels was a self-contained workspace: desktop (almost always a wood product, generally with a laminated finish), file storage, bookshelves, carpeting, chair, etc. Presumably there were a variety of amounts and locations of paper, both exposed on the work surfaces and contained within the file cabinets and bookshelves.

The **combustible fuel load**[3] for these open landscaped floors was dominated by the workstations. The architectural drawings showed densities of workstations similar to those on most of the fire floors in the WTC towers. The estimated combustible fuel load for these floors was about 20 kg/m2 (4 lb/ft2). **Simulations of the fires with a higher combusted fuel load (NIST NCSTAR 19, Chapter 9) resulted in poor agreement with the observed fire spread rates.**

**Figure 24.** [emphasis added]
page 47-8 of 115 of pdf, (labeled page 9-10 of report)
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

[3] In the fire simulations, the entire combustible fuel load can be burned. In actuality, not all of, e.g., a wood desk is consumed. Thus, the combusted fuel loads estimated for these simulations are somewhat lower than the actual fuel loads in prior surveys of office buildings. (See NIST NCSTAR 15.)

**Figure 25.** [emphasis added] Footnote 3, page 48 of 115 of pdf, (labeled page 10 of report),
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**Reason for Comment:**
If it was the case that: "Simulations of the fires with a higher combusted fuel load (NIST NCSTAR 1-9, Chapter 9) resulted in poor agreement with the observed fire spread rates" this means the analysis is incomplete or incorrect. Full detailed resulting data from testing of combustible fuel load should be included in the report. If data from these repeatable tests does not match up well with observed fire spread rates, then further testing is necessary.

**Suggestion for Revision:**
Data: [Fully described, repeatable tests of combustibles within the building should be available which describe temperatures achieved (compared with materials fully documented in architectural documentation) as well as fire spread rates. These must be compared to expected heating and material failure specs of the actual materials in the building according to official architectural documents.]

## Comment 10

**Issue**: Analysis for the fate of the fuel is incomplete.

**Location**: page 49 of 115 of pdf, (labeled page 11 of report),
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

> The base building tanks were full on September 11, 2001. Several months following the attacks on the WTC, a contractor recovered an estimated 23,000 gal of fuel from these tanks. NIST estimated that approximately 1000 gal ± 1000 gal was unaccounted. The fate of the fuel in the three day tanks is unknown, so NIST assumed they were full on September 11, 2001.
>
> The fate of the fuel in the two tanks for the SSB system was also unknown. Thus, NIST assumed that all of the fuel would have been available to feed fires either at ground level or on the 5th floor.

**Figure 26.** [emphasis added]
page 49 of 115 of pdf, (labeled page 11 of report),
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**Reason for Comment:** Incomplete audit of fuel from internal WTC7 fuel tanks and how it did or did not contribute to heating of the materials within the building prior to global symmetric collapse.

**Suggestion for Revision:**
DATA: [Provide audit of fuel available in the tanks pre-9/11 with fuel accounted for during cleanup.]

## Comment 11

**Issue**: Incomplete analysis of what was heard.

**Location**: page 51 of 115 of pdf, (labeled page 13 of report)
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

> **2.2 ACTIVITY AT THE WTC 7 SITE**
>
> **2.2.1 8:46 a.m. to 9:59 a.m. EDT**
>
> **People throughout WTC 7 heard the boom of the aircraft hitting WTC 1**, which was only about 110 m (350 ft) to the south. Lights flickered, the building shook, and some windows on the south side of WTC 7 were broken. However, few, if any, of the workers felt their lives were in immediate danger. This perception changed as the occupants became aware of the subsequent attacks on WTC 2 and the Pentagon, and people began using the elevators and stairs to leave the building. The elevators alone could have evacuated the building in about 20 min. The stairwells, although somewhat narrow for the maximum possible 14,000 occupants (estimated using the formula in the NYCBC), were more than adequate to evacuate roughly one third of that number in the building that morning (NIST NCSTAR 19, Chapter 7).

**Figure 27.** [emphasis added]
page 51 of 115 of pdf, (labeled page 13 of report) http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**Reason for Comment:**
Use of language is not specific enough "People throughout the building…" The description of the sound is also vague. Determine and include how many people heard the "boom". The description of the sound needs to be clearer – did it sound more like a crash, or an explosion? All subjective comments must be supported by actual statements that will verify what exactly individuals heard and how they corroborate to each other. Statistical analyses should be conducted of witness statements to ensure consistency of said statements to insure that readers of this report only hear objective data. This could then be compared with public domain analyses of eyewitness statements to ensure consistency.

**Suggestion for Revision:**
NIST has determined with reasonable certainty the assertions concerning what was heard based on the following accounts and soundtracks [provide data]

## Comment 12

### Issue: It would be like raining dump trucks.

**Location**: page 58 of 115 of pdf, (labeled page 20 of report),
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

> The upper section of Column 79 began to descend. The cascading failures of the lower floors surrounding Column 79 led to increased unsupported length in, falling debris impact on, and loads being redistributed to adjacent columns; and Column 80 and then Column 81 buckled as well. All the floor connections to these three columns, as well as to the exterior columns, failed, and the floors fell on the east side of the building. The exterior façade on the east quarter of the building was just a hollow shell.
>
> The failure then proceeded toward the west. Truss 2 (Figure 1-6) failed, hit by the debris from the falling floors. This caused Column 77 and Column 78 to fail, followed shortly by Column 76. Each north-south line of three core columns then buckled in succession from east to west, due to loss of lateral support from floor system failures, to the forces exerted by falling debris, which tended to push the columns westward, and to the loads redistributed to them from the buckled columns. Within seconds, the entire building core was failing.
>
> The global collapse of WTC 7 was underway. The shell of exterior columns buckled between the 7th and 14th floors, as loads were redistributed to these columns due to the downward movement of the building core and the floors. The entire building above the buckled-column region then moved downward as a single unit, completing the global collapse sequence.

**Figure 28.**
page 58 of 115 of pdf, (labeled page 20 of report) http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**Reason for Comment:**
Analysis of columns 79, 80, 81, is incomplete. Much more structural information needs to be included, with more specific details of dimensions, weights and materials involved. Comprehensive re-analysis of the sound of the destruction is required – and considered in the light of the seismic readings. I.e. there was a great volume of heavy material coming down to the ground, which would have made very loud noise, but this was not observed. This must be addressed. This section describes the gravitational failure of several columns during the initiation of internal progressive collapse without including sound analysis of falling debris based on architectural documentation and material specs. Analysis of the audible recordings and sound properties of materials specified in the building should be included in the report to understand comparisons with similar weight objects as they are affected by gravity and collide with materials below.

**Suggestion for Revision:**
NIST realizes that the sound properties associated with the progressive collapse hypothesized in this report would have been quite pronounced. Detailed confirmation of the sound can be found in [provide data]

Or in the alternative

NIST has not been able to find any soundtrack containing crashing sounds that would corroborate the theory of collapse articulated in this report. However, NIST still maintains its belief in the plausibility of its explanation even though no audible confirmation could be found.

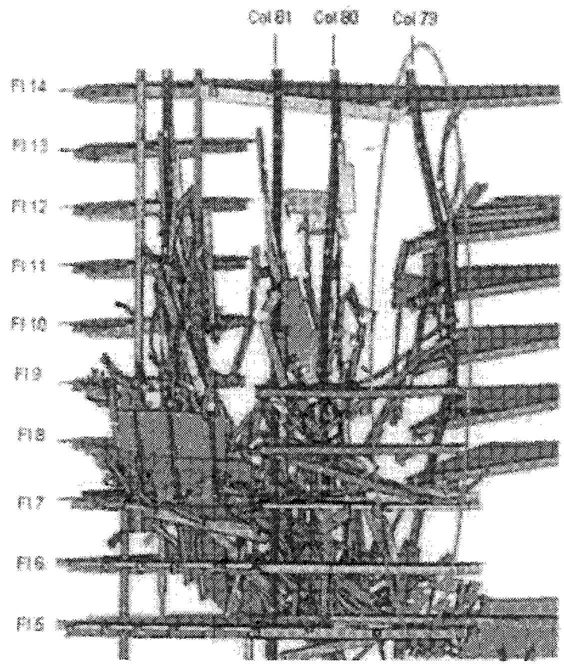



**Figure 2–2. Eastward buckling of Column 79, viewed from the** southeast.
**Figure 29.** page 58 of 115 of pdf, (labeled page 20 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

## Comment 13

**Issue:** No mention of fire, heat or smoke on floors 4,5,6 casts doubt on NIST's analysis of fire immediately above those floors.

**Location:**

> Based on these analyses and review of the numerous interview transcripts[5], NIST concluded that it was highly unlikely that any fires on the $5^{th}$ or $6^{th}$ floors contributed significantly to the collapse of WTC 7. NIST concluded that the only fires that could have led to structural weakening of WTC 7 were those on the $7^{th}$ through $9^{th}$ and $11^{th}$ through $13^{th}$ floors.
>
> [5] For instance, sometime after 1:00 p.m., OEM and FDNY staff climbed the east stairway of WTC 7 and did not see much damage on the $4^{th}$, $5^{th}$, or $6^{th}$ floors from their viewing location. They made **no mention of fire, heat or smoke.**
>
> **Figure 30.** [emphasis added]
> page 64 of 115 of pdf, (labeled page 26 of report) http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**Reason for Comment:**

No mention of fire, heat or smoke on floors 4,5,6 casts doubt on NIST's analysis of fire immediately above those floors. Careful consideration of actual damage to floors 4, 5 and 6 needs to be made. Their structure (and those of other floors) cannot have been completely destroyed by the "thermal expansion" can "collapse" of the upper floors. Documentation of eyewitnesses indicates little or no damage on various indicated floors, including fire, heat or smoke. A more realistic analysis of the destruction of all floors not affected by fire needs to be included.

**Suggestion for Revision:**

NIST recognizes that the hypothesis of the effect of fires on floors above 6 is inconsistent with what was seen to have occurred on floors 4,5 and 6. We assert that the following specific evidence was used to account for that difference [provide data]

Or, in the alternative.

NIST recognizes that the hypothesis of the effect of fires on floors above 6 is inconsistent with what was seen to have occurred on floors 4,5 and 6. NIST has no data to account for the difference, but nonetheless maintains that it can make the claims made for fires above floor 6.

## Comment 14

**Issue:** Spontaneous disintegration

**Location:** page 58 of 115 of pdf, (labeled page 20 of report)
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

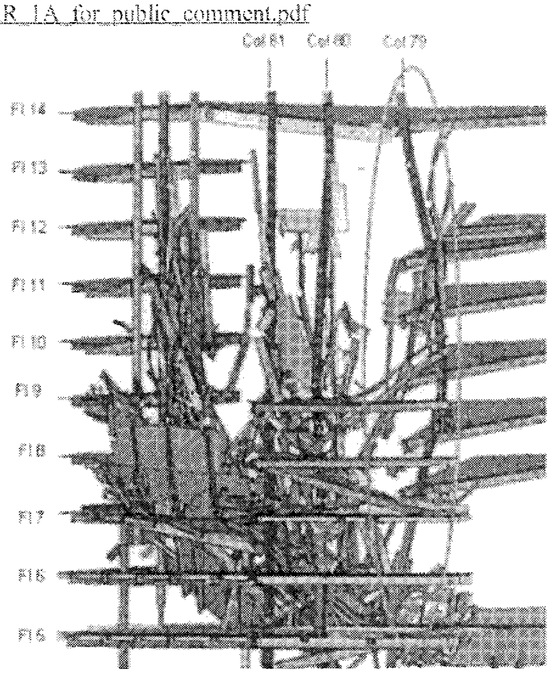



**Figure 2–2. Eastward buckling of Column 79, viewed from the** southeast.
**Figure 31.**
page 58 of 115 of pdf, (labeled page 20 of report),
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**Reason for Comment:**
Unless the building structure spontaneously disintegrated, when horizontal beams are removed from one side of a column, there should still be beams connected to the other side of the column. So, the column will not be unsupported. With less loading on the columns, they are less likely to fail. If a beam connected to one side had been removed, the beam on the other side is less constrained which would reduce the stress.

**Suggestion for Revision:**
NIST nevertheless acknowledges that unless the building structure spontaneously disintegrated, when horizontal beams are removed from one side of a column, there should still be beams connected to the other side of the column. So, the column will not be unsupported. With less loading on the columns, they are less likely to fail. If a beam connected to one side had been removed, the beam on the other side is less constrained which would reduce the stress.

## Comment 15

**Issue**: Failure to include magnetometer and failure to properly use seismic data

**Location**: page 315 of 382 of pdf, (labeled page 653 of report) http://wtc.nist.gov/media/NIST_NCSTAR_1-9_vol2_for_public_comment.pdf

> **B.3 PREVIOUSLY IDENTIFIED SEISMIC EVENTS AT WTC**
>
> In September 2001, researchers at LDEO analyzed seismic records from the WTC disaster and reported their findings for five major events at the WTC site (Kim et al., 2001); the event time, equivalent magnitude on the Richter scale, the dominant period of ground vibration, and the duration of the signal are shown in Table B2 for the major events. The origin times listed in column 3 of Table B2 are taken Table 53 from Kim, et al. (2001), and were also used in the FEMA report (McAllister 2002). These
>
> **Figure 32.** [emphasis added]
> page 315 of 382 of pdf, (labeled page 653 of report) http://wtc.nist.gov/media/NIST_NCSTAR_1-9_vol2_for_public_comment.pdf

**Reason for Comment:**

Seismic data makes no comparisons to other comparable seismic events such as blasts related to TNT (in tons) relating to building size. Full comparisons of expected seismic activity should be made with other structures based on mass and substructure composition compared with seismic expectations of certain volumes of TNT. Any anomalies should be evaluated and determinations of these variations should be explained. If additional data, such as magnetometer data that corresponds to the onset of the events at the WTC as well as the final failure at WTC7 is available and suggests a correlation, this correlation should be included in the report and analyses conducted and findings documented.

The impact of the debris from WTC7 registered an equivalent to 0.6 on the Richter Scale. This is the magnitude of a signal that might be expected if WTC7 had lost at least 99% of its mass, evenly, over the height of the building.

Significant and important magnetometer data exists and must be included. That data consists in the following.

Analysis of that data, in conjunction with seismic data results in important information that will cast doubt on the probable collapse scenario in NCSTAR 1-A. We anticipate that NIST may not use this data and that, instead, the failure to do so will have to await further proceedings, such as a Request for Correction. NIST is hereby placed on notice that the failure to include the data is inexcusable.

**Suggestion for Revision:**

# Magnetometer + seismic + "Our seismic "

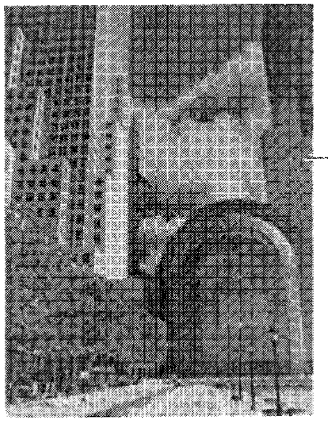


**Figure 33.** . North face of WFC2 shows an unusual distortion in the image.
(9/11/01) Source:

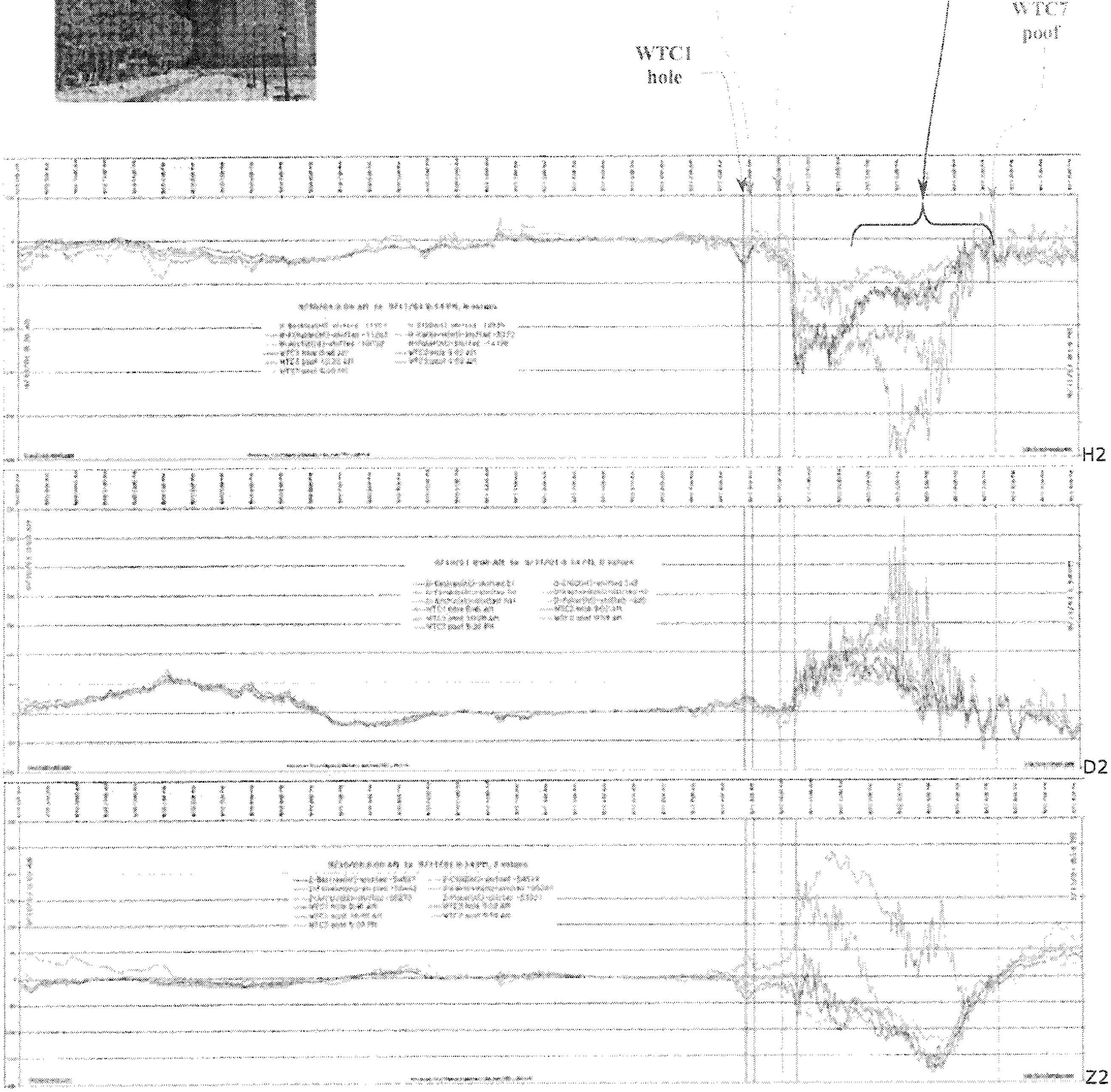



**Figure 34.** *Magnetometer Readings (normalized), 9/10/01-8:00 AM (EDT) - 9/12/01-8:14 PM (EDT)*
(data posted at one-minute intervals)
Source: http://magnet.gi.alaska.edu/table_index/2001_table.html

Issue: 15 with 2 pages 19

## Comment 16

**Issue: Analysis is incomplete; sound analysis omitted.**

**Location**: page 78 of 115 of pdf, (labeled page 40 of report)
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

> **3.5.2 Aspects following the Collapse Initiation**
> Once simulation of the global collapse of WTC 7 was underway, there was a great increase in the uncertainty in the progression of the collapse sequence, due to the random nature of the interaction, break up, disintegration, and falling of the debris. The uncertainties deriving from these random processes increasingly influenced the deterministic physics-based collapse process, and the details of the progression of the horizontal failure and final global collapse were increasingly less precise.
>
> Thus, while the two predictions of the time of descent of the west penthouse also straddled the observed time, the mechanisms of building collapse were quite different. In the analysis without debris impact damage, the exterior columns buckled near mid-height of the building, approximately between Floors 17 and 29. In the analysis with debris impact damage, the exterior columns buckled between Floors 7 to 14, due to the influence of the exterior damage near the southwest corner. In both analyses, the eastern exterior wall deflected inward at the roof level as the structure became unsupported after the vertical collapse event. The western wall also deflected inward in the analysis without debris impact damage, as it was pulled inward as the last line of core columns failed.
>
> There was another observable feature that occurred after the global collapse was underway and **no Science-based simulation capability** exists to capture it. After the exterior facade began to fall downward at 6.9 s, the north face developed a line or kink near the end of the core at Column 76. As shown in Figure 5205, the northeast corner then began to displace to the north at about 8.8 s, and the kink was visible at 9.3 s. The kink and rotation of the northeast façade occurred 2 s to 3 s after the exterior façade had begun to move downward, as a result of the global collapse. The simulations do show the formation of the kink, but any subsequent movement of the building is beyond the reliability of the physics in the model.
>
> **3.5.3 Accuracy Appraisal**
> Given the complexity of the modeled behavior, the global collapse analyses matched the observed behavior reasonably well. The close similarity of the timing and the nature of the events up to the initiation of global collapse is strong confirmation of the extent and nature of the structural failures in the interior of the building and the accuracy of the four-step simulation process. The overall simulation of the collapsing building with damage better matched the video observations of the global collapse. The global collapse analysis confirmed the leading collapse hypothesis, which was based on the available evidence.
>
> **Figure 35.** [emphasis added]
> page 78 of 115 of pdf, (labeled page 40 of report) http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**Reason for Comment:**
Very subjective descriptions of matched observed behavior with the complex nature of the modeled behavior.
Any sound simulations compared to observed data as noted in Comment 5.
Analysis incomplete – sound analysis omitted.
Precise measurements should be provided from modeling to compare with actual observations. Sound simulation findings and comparisons to expectations and observable data should be included.
Re-analysis, including sound, needs to be added.

**Suggestion for Revision:**
NIST has found [insert analysis of soundtrack and other data of audible phenomena].
[It is known that soundtracks show a lack of loud audible booms or crashes, something that makes NIST's probable collapse sequence highly doubtful.]

## Comment 17

Issue: 242-foot drop?!

**Location**: page 79 of 115 of pdf, (labeled page 41 of report)
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

> The elevation of the top of the parapet wall was +925 ft 4 in. The lowest point on the north face of WTC 7 visible on the Camera 3 video (Section 5.7.1) prior to any downward movement was the top of the windows on Floor 29, which had an approximate elevation of +683 ft 6 in. Thus, the distance that the roof-line moved downward before it disappeared from view was 242 ft. The relative time at which the roofline began to descend was 20.60 s, and the relative time when the **roofline dropped from view** behind the buildings was 25.97 s. The time the roofline took to fall 18 stories was 5.4 s, with an uncertainty of no more than 0.1 s.
>
> **Figure 36.** [emphasis added]
> page 79 of 115 of pdf, (labeled page 41 of report) http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**Reason for Comment:**
Descent of Roofline by 242 feet should have made a noise.
242 feet of drop noted in evaluation of Camera 3 with no notation of sound-- a very loud noise. Re-analysis, including sound, needs to be added. Analysis of sound as it compares to the visible data in the camera view should be included and compared with expected results.

**Suggestion for Revision:**
NIST has analyzed all available soundtracks and could not find sound consistent with the 242 drop referenced here.

Or, in the alternative,

The sound of the 242' drop was confirmed by [insert confirming data]

## Comment 18

Issue: Incongruence in **Collapse time calculation.**

**Location**: page 79 of 115 of pdf, (labeled page 41 of report),
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

> **3.6 Collapse Time**........................................................................................................ 40

> The theoretical time for free fall (i.e., neglecting air friction), was computed from,
>
> $$t = \sqrt{\frac{2h}{g}}$$
>
> where $t$ is the descent time (s), $h$ is the distance fallen (ft), and g is the gravitational acceleration constant, 32.2 ft/s$^2$ (9.81 m/s$^2$). **Upon substitution of h = 242 ft.** in the above equation, the estimated free fall time for the top of the north face to fall 18 stories was approximately 3.9 s. The uncertainty in this value was also less than 0.1 s.
>
> Thus, the actual time for the upper 18 stories to collapse, based on video evidence, was approximately 40 percent longer than the computed free fall time and was consistent with physical principles.
>
> **Figure 37.** [emphasis added]
> page 79 of 115 of pdf, (labeled page 41 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**Reason for Comment:** NIST arbitrarily limited its collapse time analysis to the 242-foot drop. However, even in doing that, NIST did not correlate its collapse time calculation with either an explanation of what materials dropped [columns, beams, and girders, and their dimensions] and the known audible data and seismic data. The data presented by NIST in Table B-2 shows a dominant period lasting 0.8 seconds.

Collapse time
Duration of signal

# Did the ground shake like raining dump trucks?

**Table B-2. Major seismic events previously reported.**

| Event Source | ID | Event Time (EDT) Kim et al., 2001 | Event Time (EDT) LEDO current Estimate[a] | Table 5-1 of Chapter 5 of This Report (± 1 s)[b] | Equivalent earthquake Magnitude (Richter Scale, ± 0.1) | Dominant Period (s) | Sustained Signal Duration (s) |
|---|---|---|---|---|---|---|---|
| WTC 1 impact | 1 | 8:46:26 | 08:46:29±2 | 8:46:30 | 0.9 | 0.8 | 14 ±2 |
| WTC2 impact | 2 | 9:02:54 | 09:02:57±4 | 9:02:59 | 0.7 | 0.6 | 6 ±2 |
| WTC 2 collapse | 3 | 9:59:04 | 09:59:07±2 | 9:58:59 | 2.1 | 0.8 | 10 ±1 |
| WTC 1 collapse | 4 | 10:28:31 | 10:28:34±2 | 10:28:22 | 2.3 | 0.9 | 9 ±1 |
| WTC 7 collapse | 5 | 17:20:33 | 17:20:42±4 | 17:20:52[c] | 0.6 | 0.8 | 17 ±2[d] |

a derived from signal arrival and estimated travel times from WTC site to PAL.
b based upon events observed in videos and photographs; collapse times were based on collapse initiation, not time of ground impact
c NCSTAR 1-5A timing was based on downward movement of the WTC 7 roofline and not the downward movement of the east penthouse that occurred earlier.
d Total duration of BHE PAL signal in Fig. A-6, including a possible second arrival

**Figure 38.**
page 316 of 382 of pdf, (labeled page 654 of report) http://wtc.nist.gov/media/NIST_NCSTAR_1-9_vol2_for_public_comment.pdf

NIST does not correlate with the seismic data noted . That data shows a seismic event lasting less than 6.4 seconds.

$t = \sqrt{\frac{2h}{g}}$, *where h = 650 ft(198 m),* 32.2 ft/s$^2$ (9.81 m/s$^2$),

$t = 6.355$ seconds, or $t = 6.4$ s.

The collapse time for the building is not addressed. Analysis is incomplete and inconsistent with time the ground shook. Add: the sound heard should have been comparable with a fleet of dump trucks crashing to the ground (one only has to consider the noise and vibration of one that is loaded when it passes by a pedestrian on the sidewalk). In complete and should be addressed.

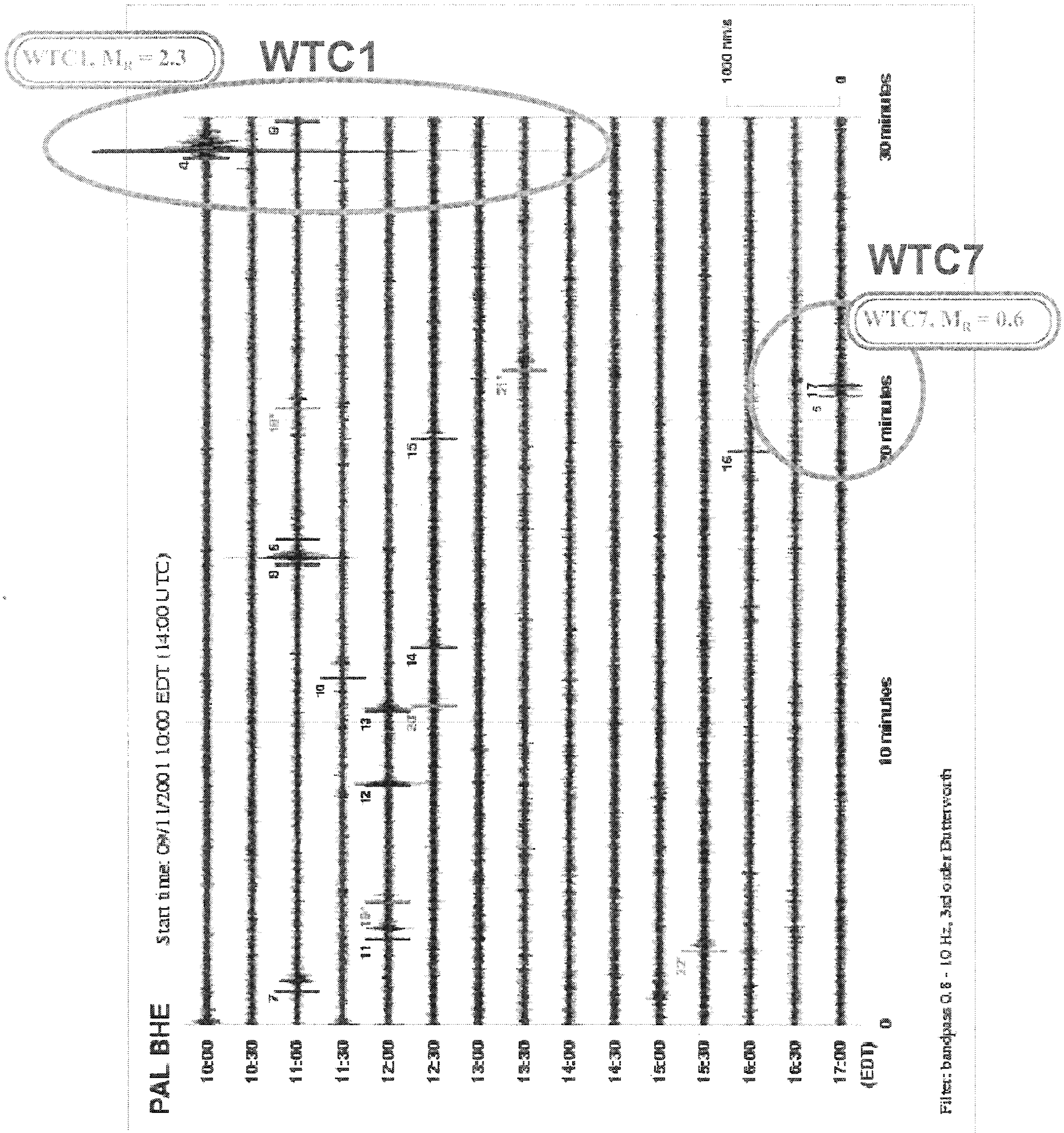



**Figure B-9. Events identified on PAL seismogram.**
Refer to Table B-4 for location, strength and description of event type.

**Figure 39.**
329 of 382 of pdf, (labeled page 667 of report) http://wtc.nist.gov/media/NIST_NCSTAR_1-9_vol2_for_public_comment.pdf

T = sqrt ((2*h)/g) = sqrt ((2*650)/32.2) = 6.3539 seconds = ~6.4 seconds.

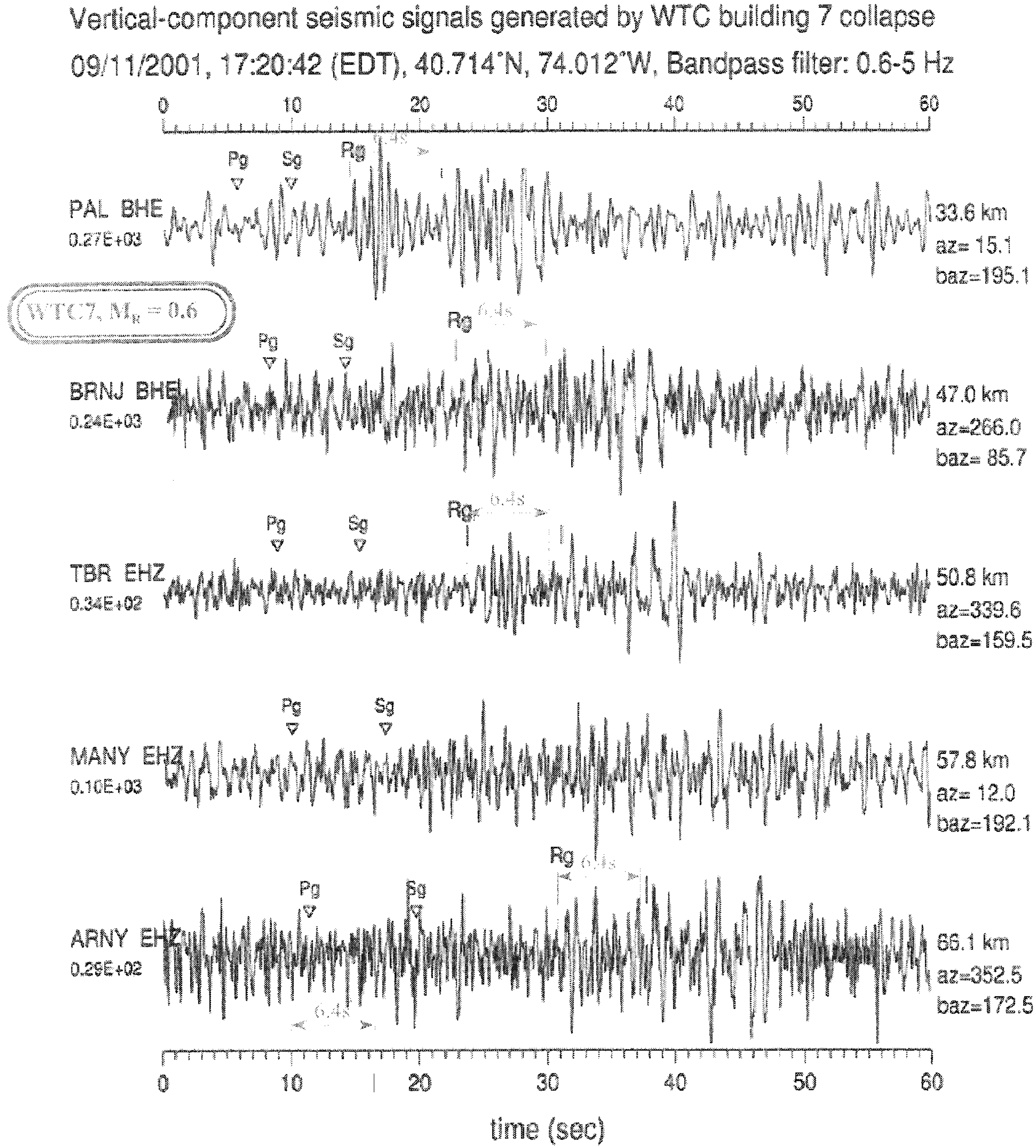



**Figure B-5. East-west (BHE) and vertical (EHZ) component seismic records, 0.6 Hz Hz filtered, at PAL, BRNJ, TBR, MANY and ARNY from collapse of WTC 7.**

**Figure 40.**
page 320 of 382 of pdf, http://wtc.nist.gov/media/NIST_NCSTAR_1-9_vol2_for_public_comment.pdf
(labeled page 658 of report)

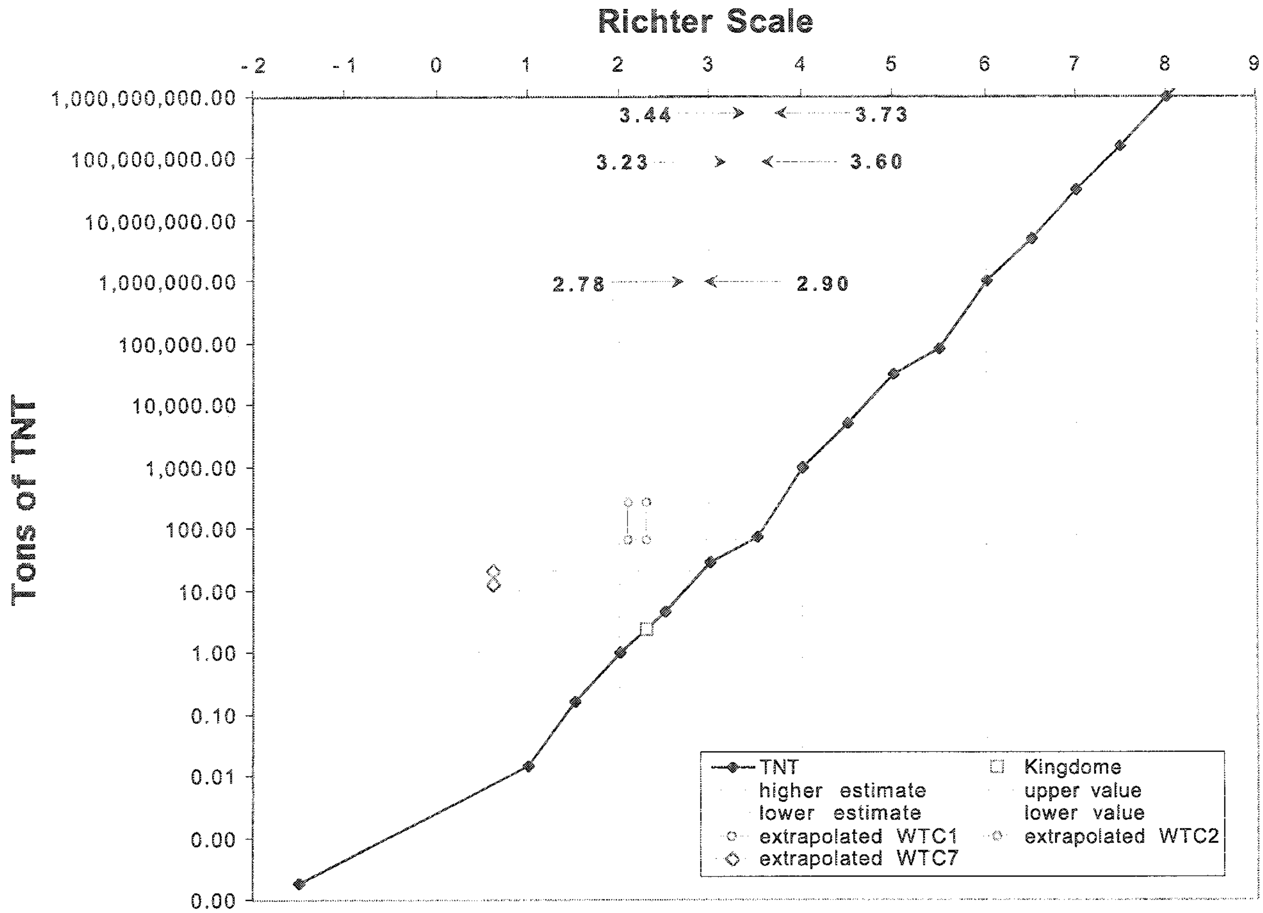



**Figure 41.**

**Suggestion for Revision:**

Comment 19 **The analysis of sound is incomplete.**
Issue: Selective use of audible data

**Location:** page 87 of 115 of pdf, (labeled page 49 of report),
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

> Hypothetical blast events did not play a role in the collapse of WTC 7. NIST concluded that blast events could not have occurred, and found no evidence whose explanation required invocation of a blast event. Blast from the smallest charge capable of failing a critical column (i.e., Column 79) would have resulted in a sound level of 130 dB to 140 dB at a distance of at least half a mile if unobstructed by surrounding buildings (such as along Greenwich Street and West Broadway). This sound level is comparable to a gunshot blast, standing next to a jet plane engine, and more than 10 times louder than being in front of the speakers at a rock concert. The sound from such a blast in an urban setting would have been reflected and channeled down streets with minimum attenuation. However, the soundtracks from videos being recorded at the time of the collapse did not contain any sound as intense as would

have accompanied such a blast.

**Figure 42.** [emphasis added]
page 87 of 115 of pdf, (labeled page 49 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**5.7.5 Audio Characteristics Based on Video Soundtracks**

Three videos in the database included soundtracks that were used to investigate the audio signature associated with the period immediately prior to and during the collapse of WTC 7. All of these cameras were located at street level at least 640 m (2100 ft) from the building. Also, there were numerous other buildings between the cameras and WTC 7.

The most usable soundtrack was recorded by Camera 3, with its West Street location. This video ran for many minutes prior to and during the collapse. Even though sound was recorded by the camera, no interviews or commentary were recorded, and the microphone tended to pick up low level street sounds, such as sirens, traffic, and distant conversations. Occasionally, the camera operators located nearby were recorded at a much louder level. Since the collapse was recorded on the video, it was possible to coordinate the sound recording with the actual WTC 7 collapse.

A careful review of the audio clip did not reveal any sounds that could be associated with WTC 7 until the global collapse began. A low level waveform for the audio signal using Aftereffects software. This video also did not reveal any features that could be associated with the collapse until after the global collapse began. In the analysis, the roughly 2 s delay in sound transmission between WTC 7 and the camera was accounted for. The amplitude of the sound signal increased while the global collapse was taking place, but there were no loud, explosive sounds when the collapse began.

The response of the camera operators provides another indication of the audio environment. Even though the east penthouse began to descend into the building 6.9 s prior to initiation of global collapse, there was no verbal response from the camera operators until 2.5 s after the global collapse began, when a loud shout of whoa, whoa, whoa, whoa was heard. There is no evidence that the operators heard something that attracted their attention prior to this time.

**At the same time the Camera 3 video was being shot, a recorded street interview was being conducted a short distance away on West Street. In this video clip of the interview, WTC 7 is visible in the upper left hand corner of the frame. Even though** the east penthouse can be seen disappearing into the building, neither the camera operator, interviewer, nor interviewee responded in any way until just over 3 s after the global collapse began. **Again, there was no indication that sounds loud enough to attract attention or cause alarm were heard by people at the interview location prior to global collapse initiation.**

**Figure 43.** [emphasis added]
Page 333-334 of 404 of pdf, (labeled page 289-290 of report) http://wtc.nist.gov/media/NIST_NCSTAR_1-9_Vol1_for_public_comment.pdf

**Reason for Comment:** The sound analysis is incomplete. It is stated that the soundtracks from the videos recording the event did not contain any sound as intense as would have accompanied such a blast, yet there is no analysis for what sound levels should accompany the sudden gravity collapse proposed. Sound is used as one of the criteria to eliminate the consideration of a blast event as causing the destruction of WTC7. But the proposed causal theory with a gravity collapse has not been tested by the same criteria.

**10 - 20 tons** (including some cargo)

WTC7 is approximately 200,000 tons. That's equivalent in mass to about 10,000 - 20,000 dump trucks, distributed in space over the height of the building. If those suddenly collapsed to the ground, the sound should be audible, should register seismically and must be included in NIST's analysis.

NIST acknowledges that it did not do an analysis of the soundtracks in order to verify its collapse hypothesis and, instead, only used soundtrack analysis to confirm there was no loud sound that would have been expected from a hypothetical blast event. NIST is aware that its work in this respect may be challenged as being fraudulent.

**Suggestion for Revision:**
Soundtrack analysis data show [add data] and add conclusions that follow from that data.

## Comment 20

**Issue: Eliminating Controlled Demolition through false choice.**

**Location:** Page 345-6 of 382 of pdf, (labeled page 683-4 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9_vol2_for_public_comment.pdf

**D.2 PHASE I: EXPERT RECOMMENDED PREPARATIONS FOR EXPLOSIVELY CONTROLLED DEMOLITION**
Phase I identified a single minimum plausible scenario for the explosive demolition of a selected column or truss. This included columns that supported large tributary areas and a critical truss cross-member. The analysis assumed that severance of one of these members could initiate building collapse. For successful demolition of a column, failure was defined as complete severance of the column section, or complete severance of sufficient sections of the flange, web, and cover plates, such that the remaining column section was insufficient to carry the column service loads, or that a lateral deflection of the column section would exceed its section width.

The hypothetical blast scenarios that were addressed fell into two categories:
**Those in which there was sufficient time to prepare the structures for an optimum setup prior to demolition.** The objective would have been to use the minimum possible amount of explosives in the demolition process. Preliminary cutting of structural members could have been performed.

18. **Those in which the demolition was to be performed in the shortest possible time.** The objective would have been to set up for demolition during approximately a 6 h time frame, i.e., between the time WTC 7 had been evacuated and the time at which collapse occurred.

For each of the scenario categories, the type and quantity of explosive material (e.g., shaped charges, C4 or other nondirectional explosive materials) required to fail each of the selected column sections was identified. In addition, any special equipment or supplies, and the time required to prepare the column, were identified. For each scenario, expected secondary effects fireballs, noise level, extent of window breakage, and dust expulsion were estimated. Two

approaches were considered, in which the column was or was not prepared with preliminary cutting..
**Figure 44.** [emphasis added]
Page 345-6 of 382 of pdf, (labeled page 683-4 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9_vol2_for_public_comment.pdf

**Reason for Comment**: False choice. Only a particular type of "controlled demolition" was ruled out, which is **conventional-controlled demolition** with **bombs in the building** (CCD-BiB). This is a false choice …

All that was considered is the following two categories:
a) Those in which there was sufficient time to prepare the structures for an optimum setup prior to demolition.
b) Those in which the demolition was to be performed in the shortest possible time.

Other evidence now available suggests some sort of high-tech weaponry was used.

# Erin, field effects

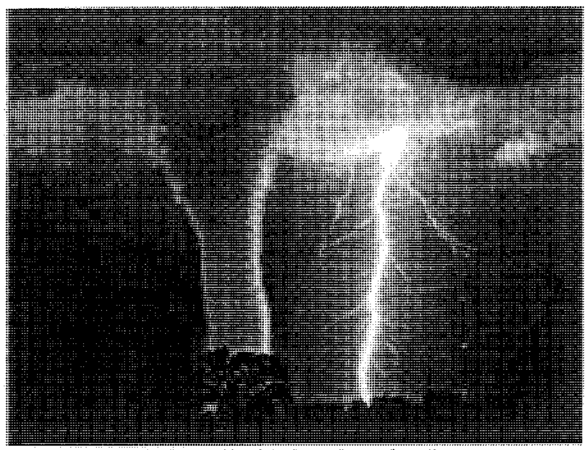


Figure 45. This is called "dry thunder."

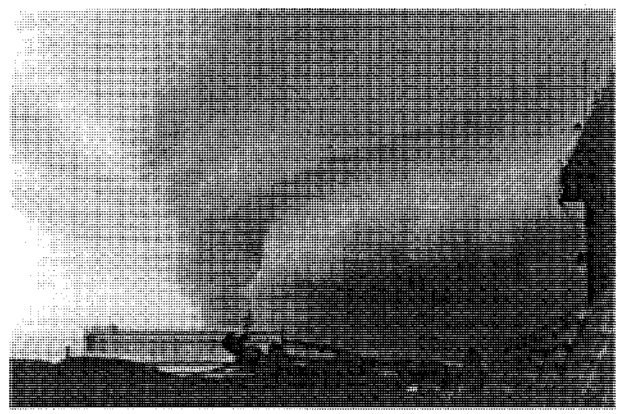


Figure 46. Hurricane in Toronto, Canada, October 9-12, 2007. *(10/9-12/07)*

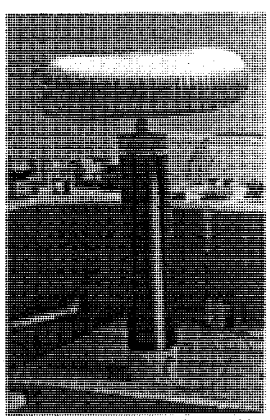


Figure 47. A Tesla coil

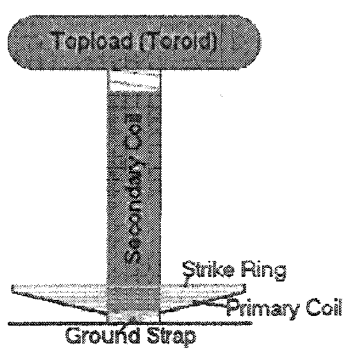



Figure 48. Diagram of a Tesla coil

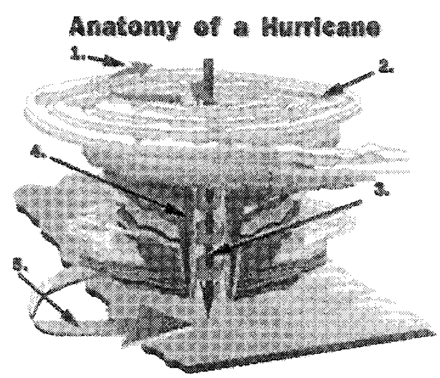



Figure 49.

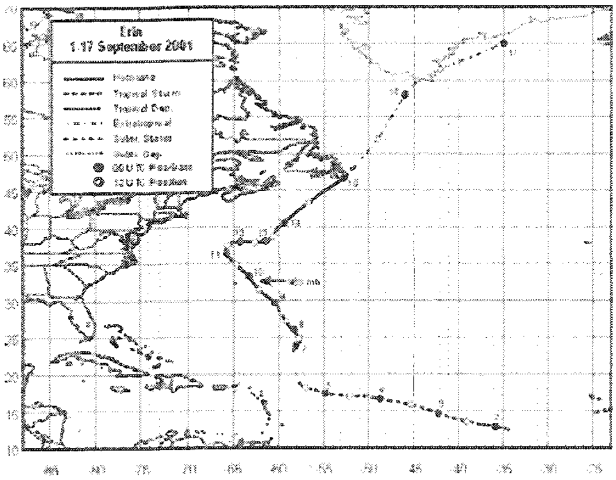


Figure 50. Best track for Hurricane Erin, September 2001. Track during the extratropical stage is based on analyses from the NOAA Marine Prediction Center. (Original figure from source.)

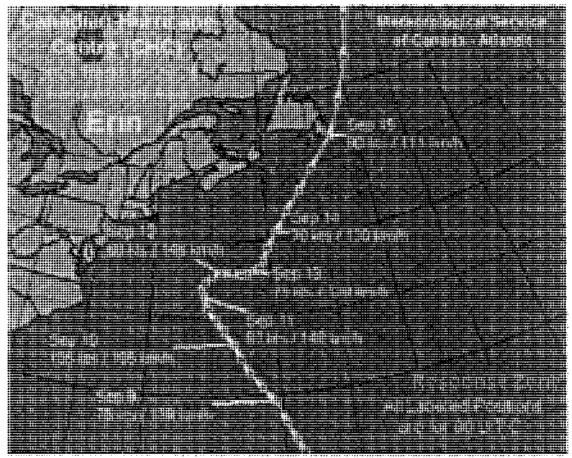


Figure 51. Hurricane Erin track (atl.ec.gc.ca). According to the Canadian Hurricane Centre (CHC), Hurricane Erin entered the "Response Zone." A hurricane in this zone should presumably trigger a "response."

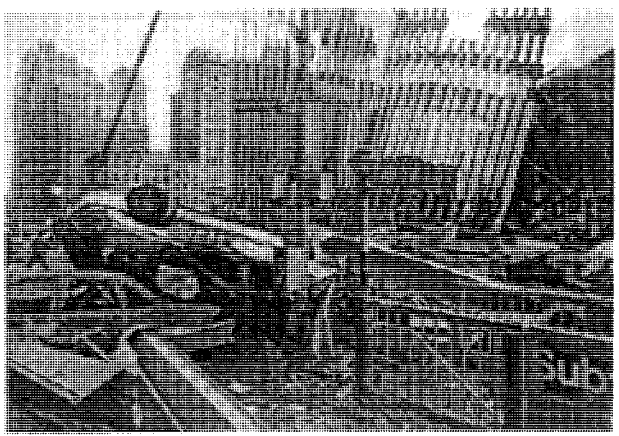


Figure 52.

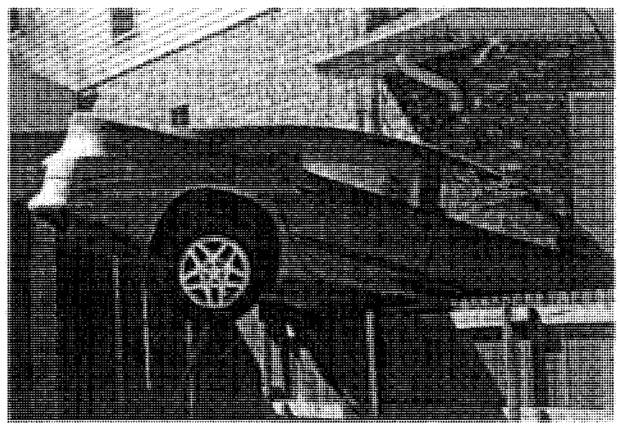


Figure 53. Note, the fence still stands.

# Weather and Magnetometer Data

## Space Weather

The following four charts (Figures 54 to 57) show that there were no solar storms or other significant space-weather events.

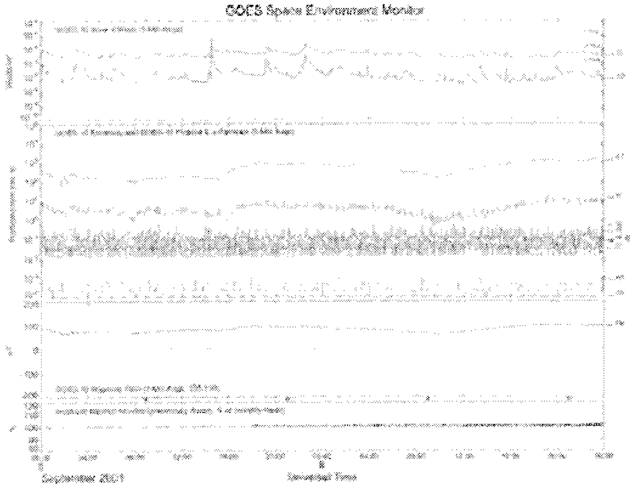



**Figure 54**. Space weather, 9/5/01-9/6/01

[illegible] GOES-20010904_150.jpg

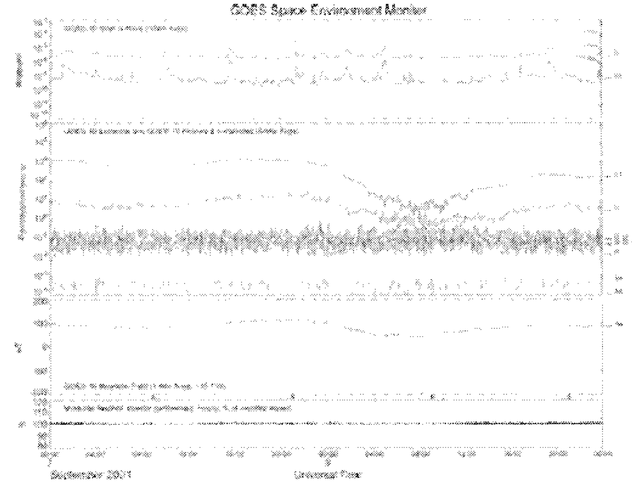



**Figure 55**. Space weather, 9/7/01-9/8/01

[illegible] GOES-20010905_150.jpg

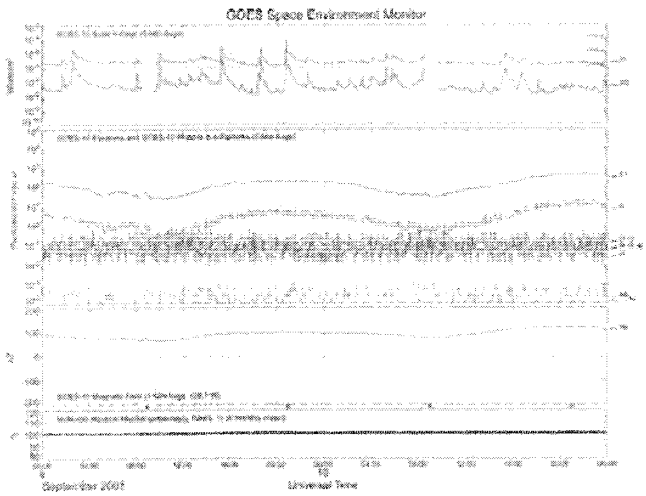



**Figure 56**. Space weather, 9/9/01-9/10/01

[illegible] GOES-20010906_150.jpg

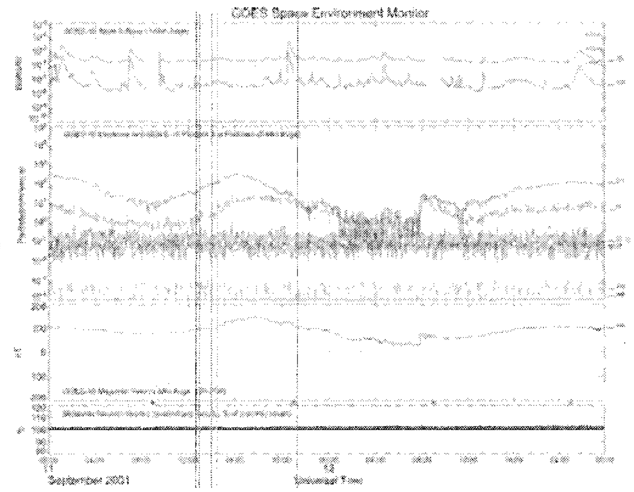



**Figure 57**. Space weather, 9/11/01-9/12/01

[illegible] GOES-20010907_150.jpg

NHC Data

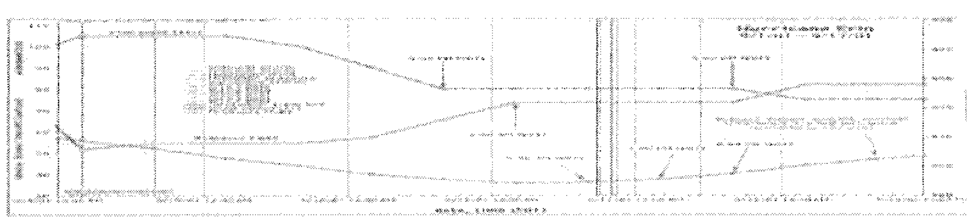


**Figure 58**. nhc [illegible], http://drjudywood.com/articles/erin/epics/2001_erin_close.jpg

Comment: 20 with 6 pages 30

# Magnetometer Data (9/8/01 - 9/12/01)

*Magnetometer Readings (normalized), 6 stations (96 hours), 9/8/01-8:00 PM (EDT) - 9/12/01-8:00 PM (EDT)*
(data posted at one-minute intervals)

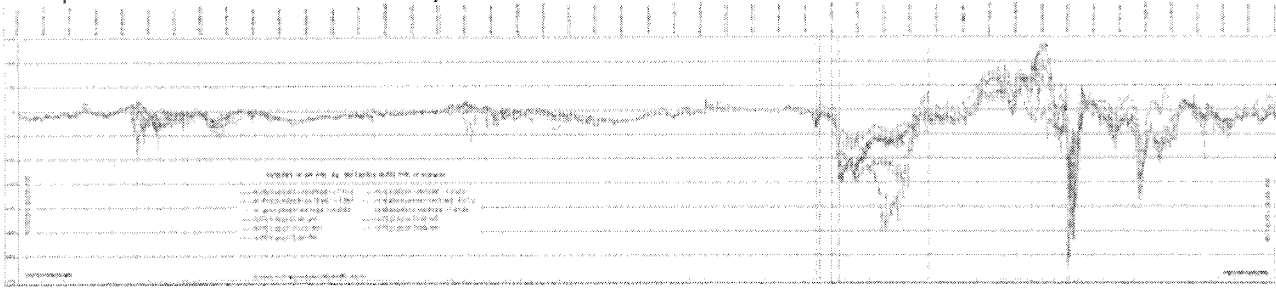


**Figure 59**. H1

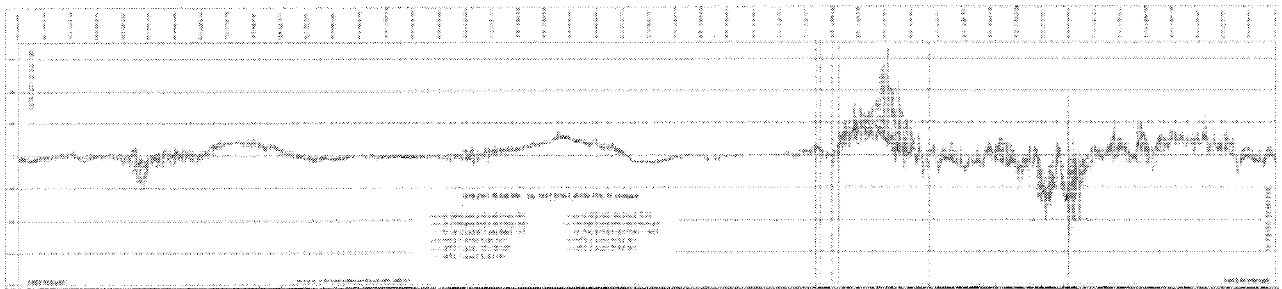


**Figure 60**. D1

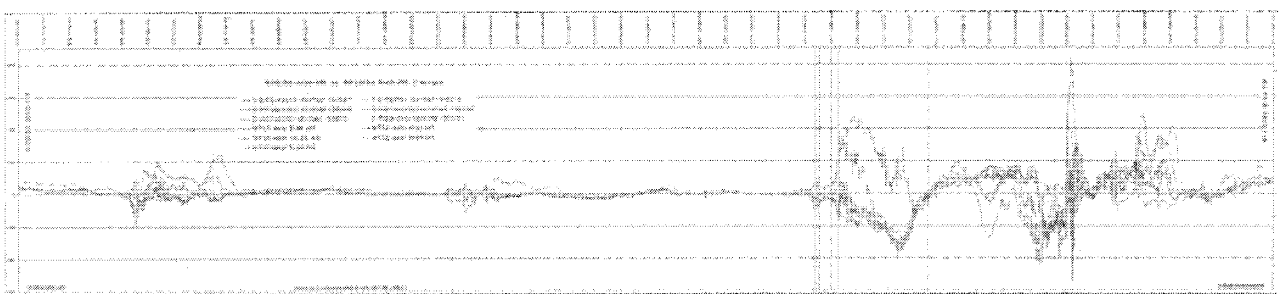


**Figure 61**. Z1

WTC1
hole
WTC2 hole
WTC2 poof
WTC7 poof

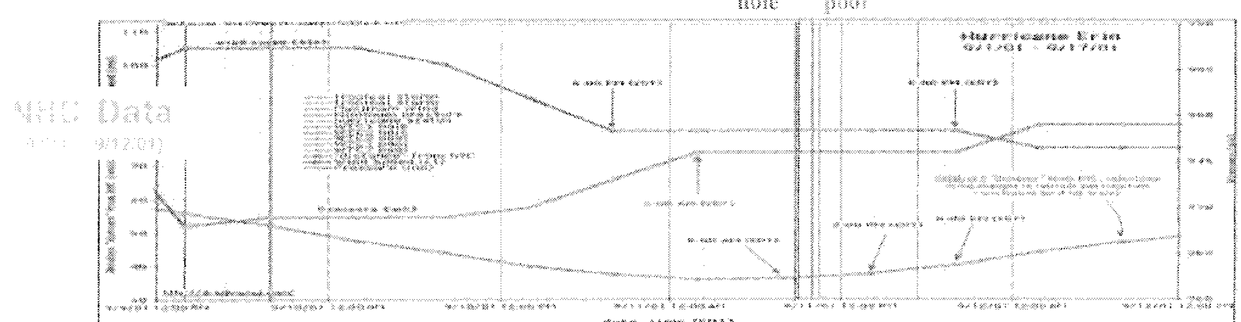



**Figure 62**. nhc, http://drjudywood.com/articles/erin/cpics/2001_erin_close.jpg

**Suggestion for Revision:**
Inclusion of additional data and analysis which illustrates use of high tech weaponry.

## Comment 21
**Issue: Need to explain "disintegration."**

**Location:**

> The uncertainties in predicting the precise progression of the collapse sequence increased as the analysis proceeded due to the random nature of the interaction, break up, **disintegration**, and falling of the debris. The uncertainties deriving from these random processes increasingly influence the deterministic physics-based collapse process. Thus, the details of the progression of horizontal failure and final global collapse were sensitive to the uncertainties in how the building materials (steel, concrete) and building systems and contents interacted, broke up, and **disintegrated**
>
> **Figure 63.** [emphasis added]
> page 89 of 115 of pdf, (labeled page 51 of report) http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

**Reason for Comment:**
The use of the word *disintegration* of building materials in the text should be described. Material volumes of the debris pile would indicated that much of the building mass was in fact disintegrated to the point that it blew away in the form of dust.
By NIST's own admission, the modeling is an approximation only. While it may simulate some observed features of the destruction, it does not explain the resulting status of Building 7. NIST limited its analysis of hypothetical blast events that are not only nonexhaustive, they are, indeed, extremely limited. NIST is informed that its work in this respect will be challenged as being fraudulent.

Full analyses of the mass remaining in the debris pile should be compared with expected mass and corresponding volume considering the amount of steel and concrete. That very little intact concrete existed in the debris pile and the unusual organization of the steel that remained in the pile should be documented and modeled. That the word *disintegration* was used in this context, full descriptions should be made and any variances from expected mass and volume of debris remaining should be explained. The report should explain how it is that surrounding buildings were not damaged or the fact that debris in the pile did not even cross the streets, fully remaining with a few feet of the footprint of the building itself. New analyses are required which explain resulting debris pile as well as speed and nature of destruction. Also, sound analysis required.
NIST's acknowledgment of disentegration of steel columns, beams and girders that are as massive as those contained in WTC 7 is both accurate, as to what actually happened, and simultaneously, a description of an event that is inconsistent with office fires. Hence, a more complete explanation of how disentegration of so much massive material could have occurred is mandatory.

**Suggestion for Revision:**
NIST has no current explanation for the disentegration it acknowledges occurred. NIST understands that its failure to do so may be a part of the basis for a claim of fraud that will be filed by Dr. Judy Wood.

## Comment 22
**Issue:** Effects on WTC7 compared with effects on Bankers Trust

**Location:** Page 82-4 of 404 of pdf (labeled page 38-40 of report),
http://wtc.nist.gov/media/NIST_NCSTAR_1-9_Vol1_for_public_comment.pdf

> **After Debris Impact**
> After the dust and smoke cleared following the collapse of WTC 1, damage to WTC 7 was observed primarily on the south face near the southwest corner, between Floors 5 to 17 (Section 5.5). Seven

exterior columns were severed (six columns on the south face and one column on the west face). The interior damage was not visible but, based on engineering judgment and interview accounts by individuals that were in or around WTC 7, estimates of interior structural damage between the exterior walls and the core were made. Chapter 5 describes the damage observed from photos and videos, and the structural damage in the southwest region is summarized in Section 5.5.3.

**The WTC 7 structural damage resulted from debris falling from WTC 1. In a similar fashion, the building located at 130 Liberty Street (referred to as Deutsche Bank or the Bankers Trust building), was damaged by falling exterior panels from WTC 2 as it collapsed.** NIST was granted access to inspect floors where damage occurred in the building on 130 Liberty Street on August 21 and 22, 2006. The debris from WTC 2 had penetrated the north face of the 130 Liberty Street building and caused damage to Floors 9 through 22, as shown in Figure 2-30 and Figure 2-31. The north face had severed spandrel beams between exterior columns, with the damage extending into the interior that grew in magnitude as the debris fell. Figure 2-31 shows that the floor beams framing into intact exterior columns remained in place, but the SFRM in the immediate vicinity of the damage was knocked off.

Figure 2-32 shows the extent of the damage that was documented by the FEMA WTC Building Performance Study (McAllister 2002). Immediately after the damage was incurred, the ceilings and column enclosures were still in place, so possible SFRM damage in other parts of the building could not be observed.

**Figure 64.** [emphasis added]
Page 82 of 404 of pdf (labeled page 38 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9_Vol1_for_public_comment.pdf

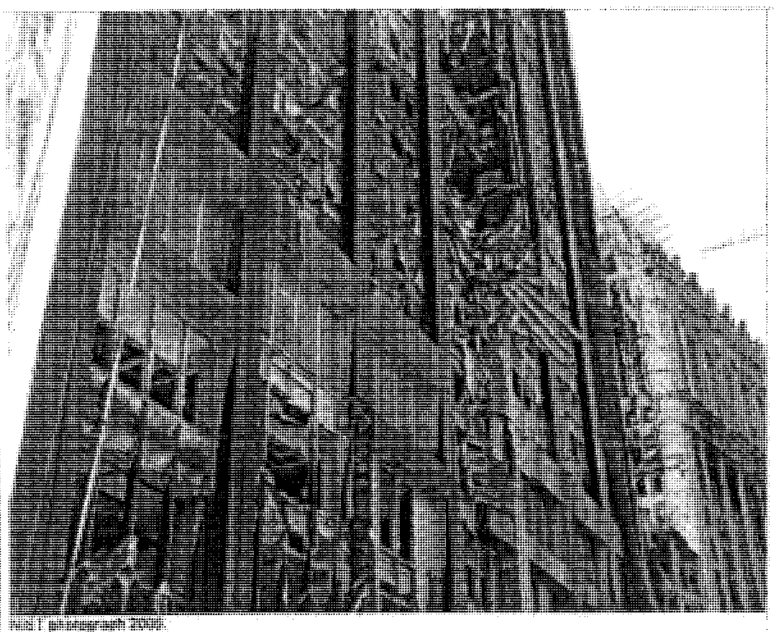


**Figure 2–30. Exterior view of damage to the north face of 130 Liberty Street by debris falling from WTC 2.**

**Figure 65.** Page 83 of 404 of pdf (labeled page 39 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9_Vol1_for_public_comment.pdf

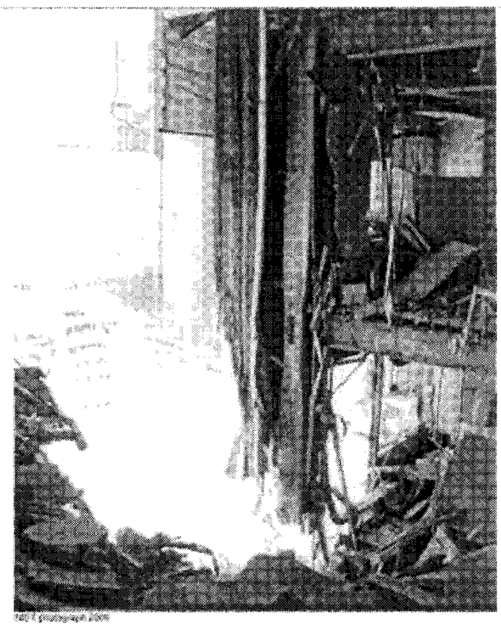


**Figure 2–31. Interior view of damage to the north face of 130 Liberty Street by debris** falling from WTC 2.

**Figure 66.** Page 84 of 404 of pdf (labeled page 40 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9_Vol1_for_public_comment.pdf

**Reason for Comment:**

It was assumed that falling debris caused the damage in Bankers Trust, but the evidence is not consistent with this conclusion. There has not been a full investigation of the damage to Bankers Trust. There is little debris visible in the open "gash." There is a recognizable "wheatchex" (a unit of three outer columns, three stories tall) presumably from WTC2. This "wheatchex" does not exhibit the level of damage even tool steel might have if grinding out the amount of material that is missing. The damage in Bankers Trust is consistent with molecular dissociation resulting from the use of an energy weapon. This information has been presented to NIST (2/29/08), previously, including the continuing reaction implies that this effect is non-self-quenching, exposing the public to continuing danger. In that correspondence, I noted that "[t]he destruction of WTC7 exhibited nearly all of the same characteristics as the destruction of WTC1&2. Noting that many of the contractors are the same, so it is likely that NIST's ongoing investigation of WTC7 may be dangerously and fraudulently flawed to such a degree that if it is not halted and if the current contractors are not removed, then the problems associated with the cover-up of the fact that the World Trade Center was destroyed by directed energy weapons may continue to multiply." The original correspondence is attached here. **[FletcherMcAllister.pdf] [080229_AFFIDAVITtight.pdf]**

According to FEMA, there were no fires in this building.

# *6 Bankers Trust Building*

**6.1 Introduction**

The Bankers Trust building at 130 Liberty Street, also referred to as the Deutsche Bank building, withstood die impact of one or more pieces of column-tree debris raining down from the collapsing south tower (WTC 2). Although the debris sliced through the exterior façade, fracturing spandrel beam connections and exterior columns for a height of approximately 15 stories, the building sustained only localized damage in the immediate path ofthe debris from WTC 2 (hereafter referred to as the impact debris) (Figures 6-1 and 6-2). There were no fires in this building. [emphasis added] The ability of this building to sustain significant structural damage yet arrest the progression of collapse is worthy of thorough study. Unlike WTC 1, 2, and 7, which collapsed completely, the Bankers Trust building provided an opportunity to analyze a structure that suffered a moderate level of damage, to explain the structural behavior, and to verify the analytical methods used. The following sections describe the building structure, the extent of damage, and the computational methods that were used to analyze the structure.

**6.2 Building Description**

The Bankers Trust building is a steel-frame commercial office structure, designed and constructed circa 1971. Bankers Trust was designed by Shreve, Lamb & Harmon Associates P. C. Architects; Peterson and Brickbauer Associated Architects; the Office of James Rudderman Structural Engineers, and Jaros Baum and Bolles Mechanical and Electrical Engineers. The building measures 560 feet in height with 40 stories above grade and 2 below. It is located directly across Liberty Street from the former site of WTC 2, about 600 feet due south of the southeast corner of WTC 2.

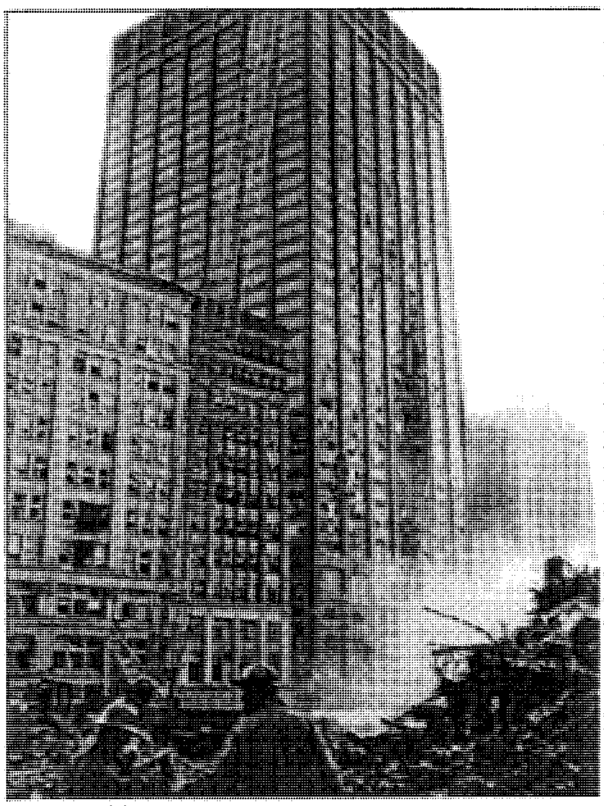


*Figure 6-1*
***North face of Bankers Trust building with Impact damage between floors 8 and 23.***

Photo credit: FEDERAL EMERGENCY MANAGEMENT AGENCY

**Figure 67**. Page 1 of 16 of pdf (labeled page 6-1 of FEMA report), http://www.fema.gov/pdf/library/fema403_ch6.pdf

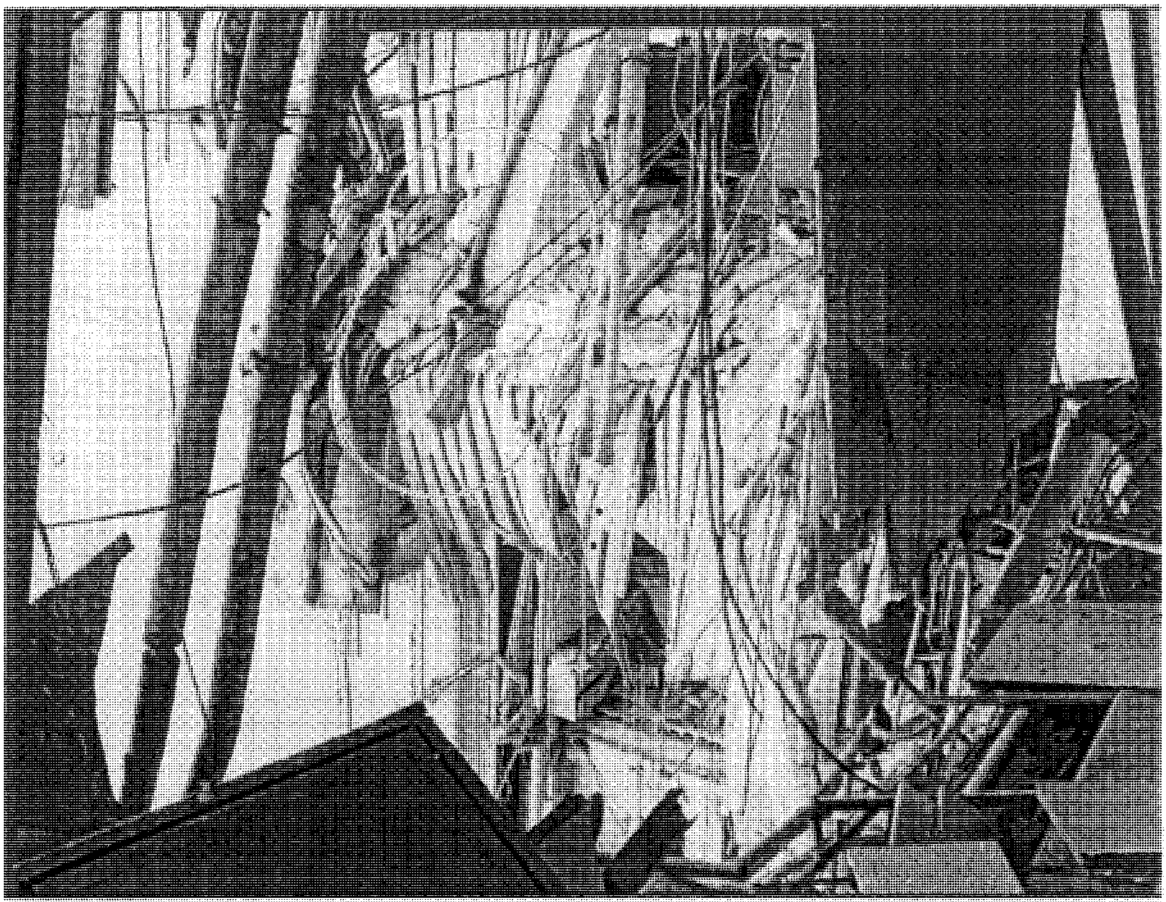


*Figure 6-10 Area of collapsed floor slab in bays between C-8, E-8, C-7, and E-7, from the 15th floor.*

**Figure 68.** (Fig6-10.) from the FEMA report . This beam shriveled up and has see-through holes in it, hanging in the gash/opening of Bankers Trust. Source: http://www.fema.gov/pdf/library/fema403_ch6.pdf, Image187fema.gif

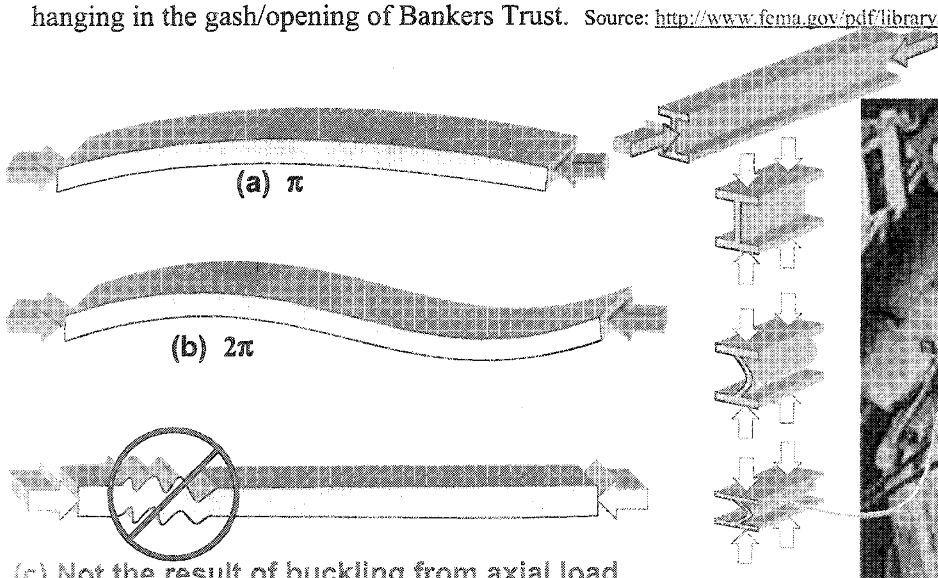



**Figure 69.** In buckling a beam deforms into (a) a half sine wave, $\pi$, or (b) a full sine wave, or 2 $\pi$. The random deformation in (c) is not associated with buckling.

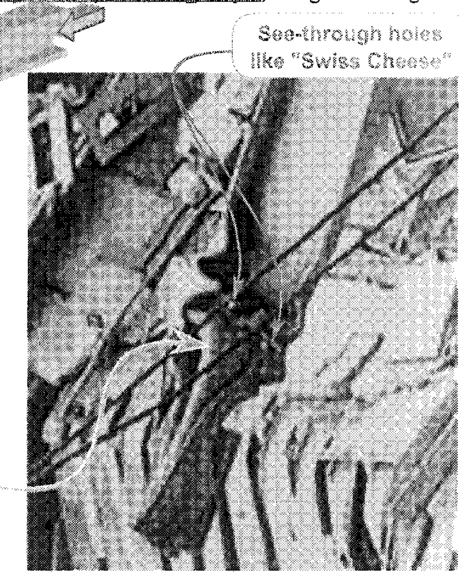



**Figure 70.** A close-up view of an I-beam in Figure **68**.
*Source:* http://www.fema.gov/pdf/library/fema403_ch6.pdf, FEMA6-10_[illegible]

Comment: 22 with 6 pages 35

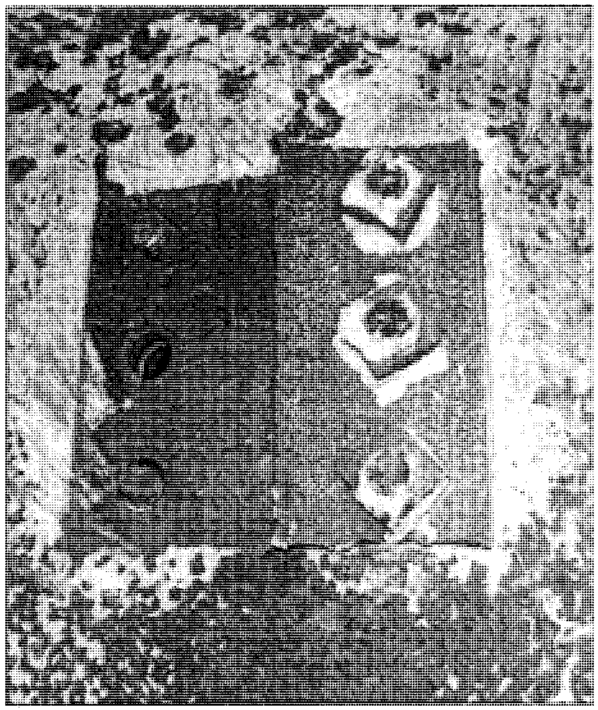


**Figure 71**. Figure 6-8, Failed shear connection of beam web to column web.
Page 8 of 16 of pdf (labeled page 6-8 of FEMA report),
http://www.fema.gov/pdf/library/fema403_ch6.pdf
fema403_ch608p6a.jpg

This steel connection from Banker's Trust is very deteriorated.

**Suggestion for Revision:**
NIST acknowledges that its comparison of effects on WTC 7 with those occurring to the Bankers Trust building may be challenged as being fraudulent by Dr. Judy Wood.

## Comment 23

**Issue**: Modeling a disintegrating structure

**Location**: page 108 of 170 of pdf (labeled page 56 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9A_for_public_comment.pdf

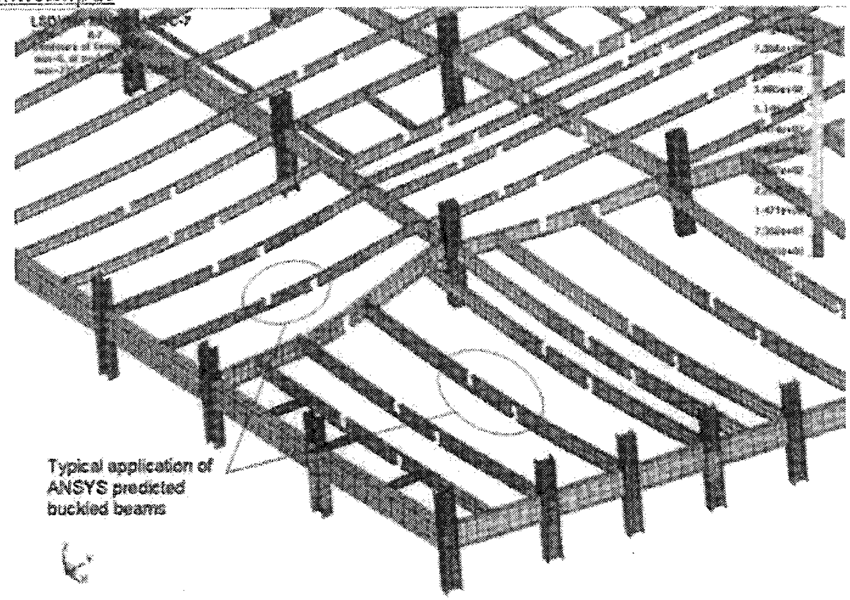



**Figure 72.**
page 108 of 170 of pdf (labeled page 56 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9A_for_public_comment.pdf

The uncertainties in predicting the precise progression of the collapse sequence increased as the analysis proceeded due to the random nature of the interaction, break up, **disintegration**, and falling of the debris. The uncertainties deriving from these random processes increasingly influence the deterministic physics-based collapse process. Thus, the details of the progression of horizontal failure and final global collapse were sensitive to the uncertainties in how the building materials (steel, concrete) and building systems and contents interacted, broke up, and **disintegrated**

**Figure 73.** [emphasis added]
page 89 of 115 of pdf, (labeled page 51 of report) http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

### Reason for Comment:

Thermal expansion does not cause tensile failure of beams that are expanding with end constraints. This drawing above does not show buckled beams. It shows beams with gaps in them. Apparently this is how ANSYS illustrates buckled beams, representing a reduced stiffness. If the stiffness is reduced, then the force this beam is able to apply on the end connections due to "thermal expansion" is also reduced. That is, if a beam has buckled, the amount of axial force it will apply is greatly reduced. If one beam buckles, it reduces the constraint on neighboring beams, reducing their stress. So, it is difficult to imagine how every beam on one floor could have buckled, as is shown in the diagram above.

If the beams were actually disintegrating, as stated elsewhere in the NIST report, the disintegrating structure could be modeled using "buckled beams." If this is what was done, this should be clearly stated in the report.

Samples of steel apparently recovered from WTC7 show evidence of molecular dissociation from partial disintegration. Some of these are shown in the figures below. The FEMA report implied these came from WTC7.

"Materials science professors Ronald R. Biederman and Richard D. Sisson Jr. confirmed the presence of eutectic formations by examining steel samples under optical and scanning electron microscopes. A preliminary report was published in JOM, the journal of the Minerals, Metals & Materials Society. A more detailed analysis comprises Appendix C of the FEMA report. The New York Times called these findings 'perhaps the deepest mystery uncovered in the investigation.' The significance of the work on a sample from Building 7 and a structural column from one of the twin towers becomes apparent only when one sees these heavy chunks of damaged metal."

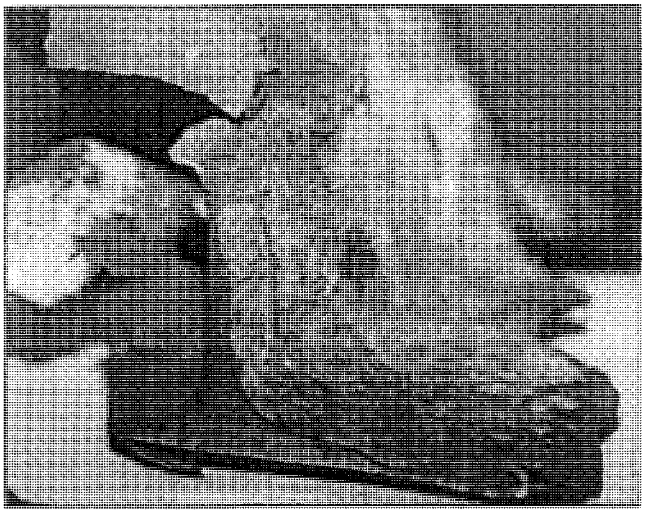


**Figure 74.** This piece of steel thought to be from WTC7 appears partially disintegrated. (Figure C-2. Closeup view of eroded wide-flange beam section.) (2002) Source: http://www.fema.gov/pdf/library/fema403_apc.pdf

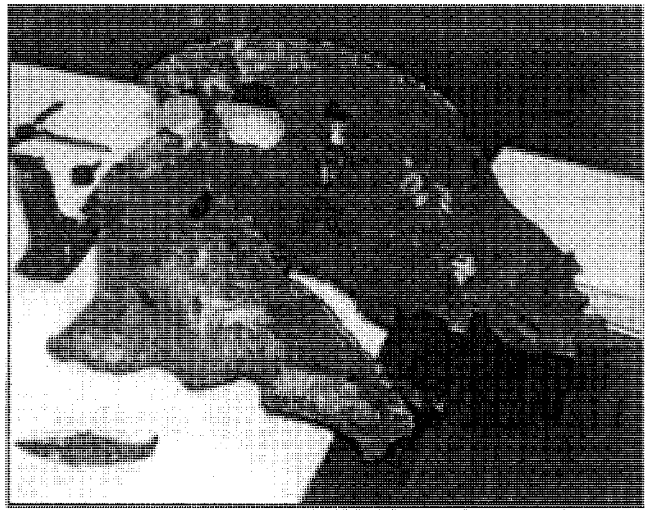


**Figure 75.** This piece of steel thought to be from WTC7 appears partially disintegrated. (Figure C-1. Eroded A36 wide-flange beam.) (2002) Source: http://www.fema.gov/pdf/library/fema403_apc.pdf

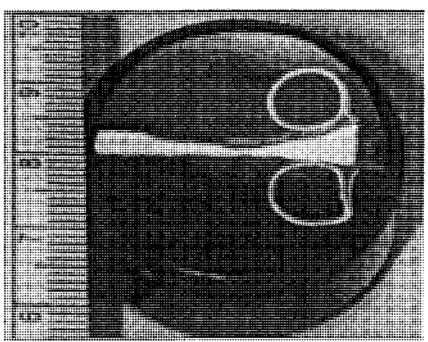


**Figure 76.** This piece of steel thought to be from WTC7 appears partially disintegrated. (Figure C-3. Mounted and polished severely thinned section removed from the wide-flange beam shown in Figure C-1.) (2002) Source: http://www.fema.gov/pdf/library/fema403_apc.pdf

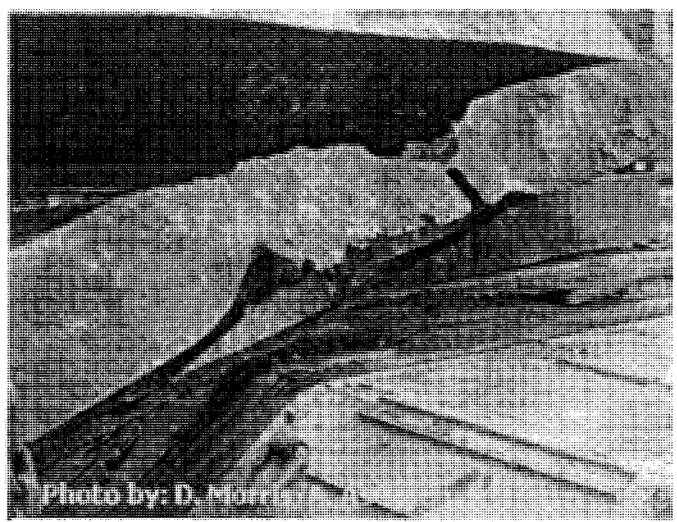


**Figure 77.** "A Beam Removed From the World Trade Centerthe Site Most Probably From Building 7" (Ref: Astaneh-Asl, 2002b) Source: http://www.nistreview.org/WTC-ASTANEH.pdf

**Suggestion for Revision:**

Comment: 23 with 4 pages 38

Our model of the collapse of the building predicted all the horizontal beams to buckle at the same time, or buckle individually without relieving constraints on the other beams.

OR

We modeled the disintegrating structure using buckled beams..

Comment: 23 with 4 pages 39

## Comment 24

### Issue: How was this possible?

Location: page 43 of 115 of pdf, (labeled page 5 of report)
http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

> **1.2.3 The Structure**
> WTC 7 was an irregular trapezoid, approximately 100 m (329 ft) long on the north face and 75 m (247 ft) long on the south face, 44 m (144 ft) wide, and 186 m (610 ft) tall. The 47 story building contained approximately 200,000 $m^2$ (2 million $ft^2$) of floor area. A typical floor was similar in size to a football field. The gross floor area was about 75 percent of that contained in the Empire State Building. As shown in Figure 1 3, about half of WTC 7 rose outside the footprint of the Con Edison substation.
>
> **Figure 78.** [emphasis added]
> page 43 of 115 of pdf, (labeled page 5 of report) http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

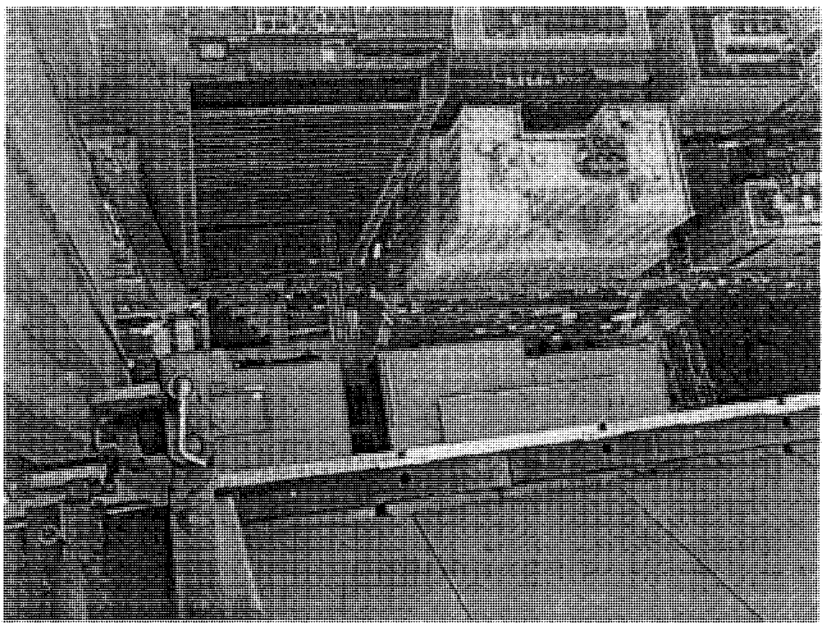


**Figure 79.**
*(pre 9/11/01) Source:* [illegible] Image217a.jpg

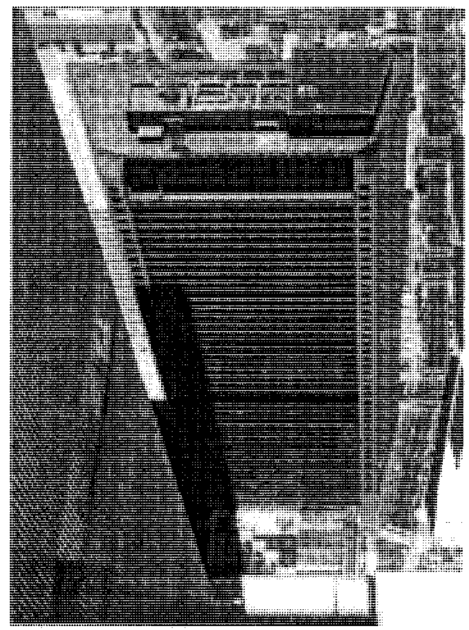


**Figure 80.** WTC7 before
Source: *(pre 9/11/01)* [illegible]

**Figure 81.** A view south on West Broadway shows that the

debris from WTC7 didn't even reach across the street to the Postal Building. *(9/12-13/01)*
http://www.hybrideb.com/source/eyewitness/complex/081.jpg

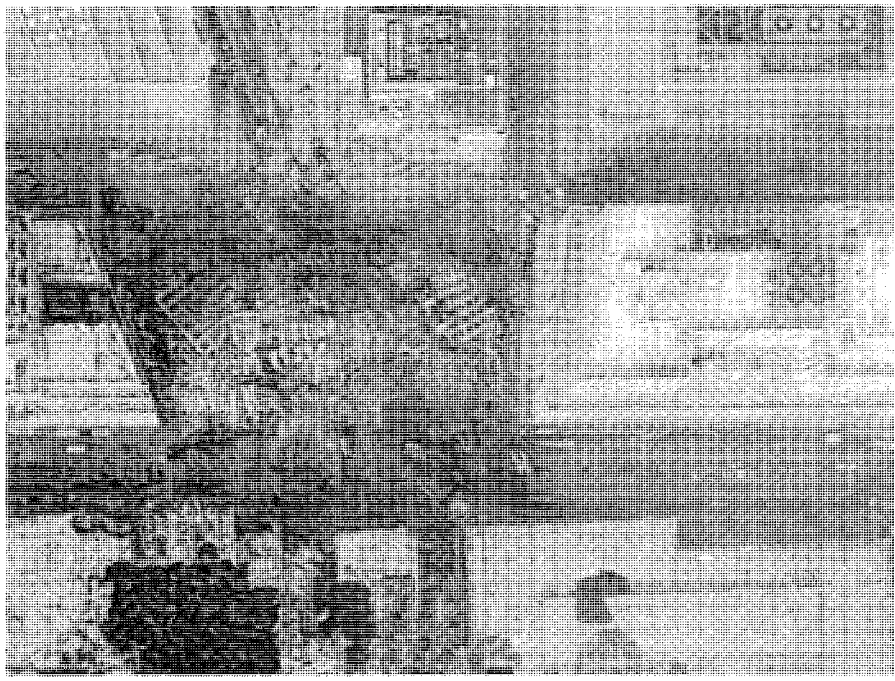


**Figure 82.** Debris from WTC7 did not reach the sidewalk adjacent to the Postal Building. *(post 9/11/01)* *__Source__*:

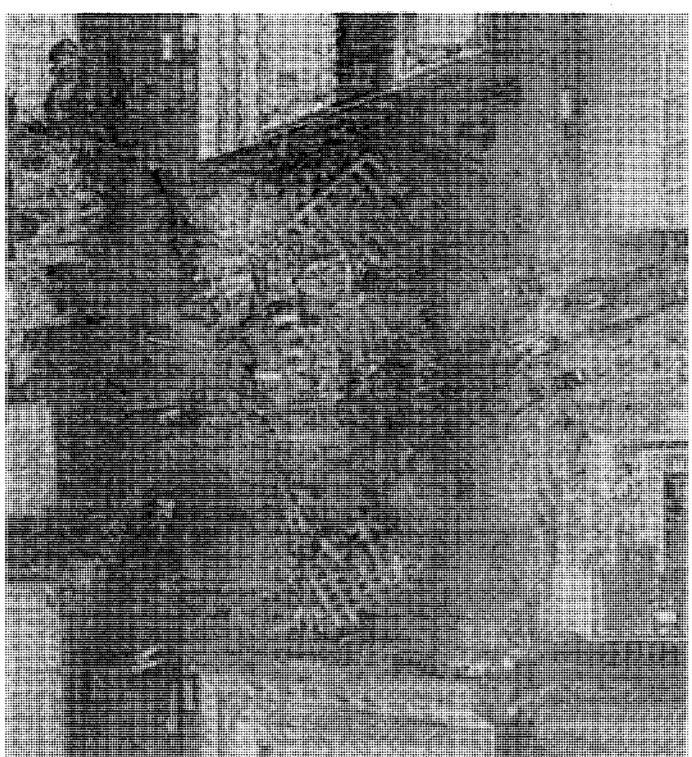


**Figure 83.**

Source: http://wtc7.net/docs/gz_aerial_wtc7.jpg

**Reason for Comment:** Nature of debris is inconsistent with a gravity-driven collapse.
A full analysis is necessary of expected debris pile volume and mass. This analysis should then compare with the slumped pile that is noted in pictorial evidence. Comparisons should also be made of composition and organization of the debris field as compared with modeled expectations. It is expected that structural steel debris will fall in a random order, not the organized layout seen within the pile. Further, concrete debris should exist in large chunks, medium size pieces, small pieces, and smaller rubble. This is inconsistent with the nearly uniform dirt/mud consistency seen in the pile

**Suggestion for Revision:**
The answer to the question, "Where did the debris go?" is [provide answer].

## Comment 25

Issue: A building turns to mud.

**Location**: page 304 of 382 of pdf, (labeled page 642 of report) http://wtc.nist.gov/media/NIST_NCSTAR_1-9_vol2_for_public_comment.pdf

**Source:** G&S Technologies, reproduced with permission

**Figure 84. Figure A9. Con Edison transformer #7 (or #5) uncovered from debris pile of WTC 7; photo taken midOctober, 2001.**
page 304 of 382 of pdf, (labeled page 642 of report) http://wtc.nist.gov/media/NIST_NCSTAR_1-9_vol2_for_public_comment.pdf

**Reason for Comment:**
Dirt/Mud shown in Figure 84 is not properly explained. A gravity driven collapse alone would not produce this type of result, or this pile of material. A closer and more detailed analysis of evidence is needed including neatness, composition (e.g. mud and dirt observed in some pictures), fuming, rusting, etc.

**Figure 85.** A view of the WTC7 dirt pile from Barclay Street.
*(9/20/01)*

**Suggestion for Revision:**
NIST has no current explanation for the dirt/mud that encasing transformers in the remains of the WTC which it documented had occurred. NIST understands that its failure to do so may be a part of the basis for a claim of fraud that will be filed by Dr. Judy Wood.

## Comment 26
Issue: Incorrect description of Bar/Beam shape

**Location**: page 56 of 170 of pdf (labeled page 4 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9A_for_public_comment.pdf

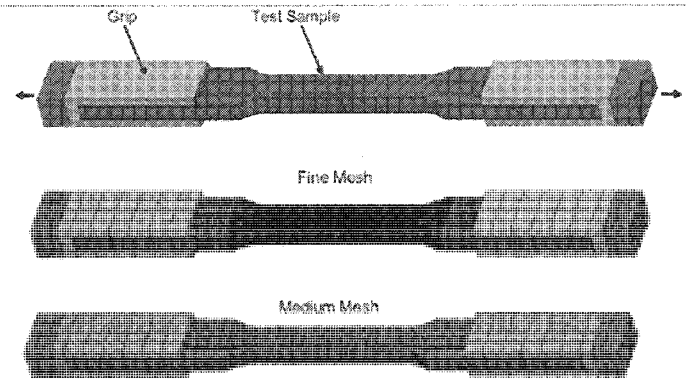



**Figure 2-1. Example finite element models of the ASTM 370 round bar tensile specimen.**

**Figure 86.**
page 56 of 170 of pdf (labeled page 4 of report),
http://wtc.nist.gov/media/NIST_NCSTAR_1-9A_for_public_comment.pdf

**Reason for Comment:** Figure caption is not consistent with the image shown. Figure 85 and the commentary describing it should be corrected to accurately describe the image shown.

Shown below are two diagrams found in the technical literature that are described as "round-bar" specimens. The second one is a finite element model of such a specimen.

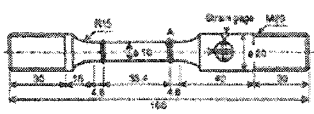
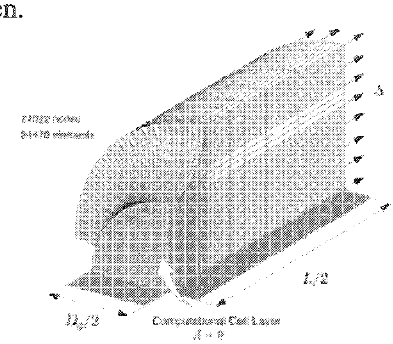


Figure 1: Geometry of round-bar specimen used for dynamic tension tests.

**Figure 87. FRACTURE PROPERTIES OF HIGH STRENGTH LOW ALLOY STEELS UNDER DYNAMIC LOADING**
Zdravko Praunseis1*, Masao Toyoda2
Page 4 of 7,
http://www.umt.fme.vutbr.cz/osem/pdf/can2001/praunseis.pdf




(b)

Figure 6. Finite element 3-D models for the tensile specimens employed in the analyses: (a) round bar specimen; (b) circumferentially notched specimen).

**Figure 88.**
**J. Braz. Soc. Mech. Sci. & Eng. vol.26 no.2**
**Rio de Janeiro Apr./June 2004**
**Numerical investigation of constraint effects on ductile fracture in tensile specimens**
**C. Ruggieri**
http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1678-58782004000200011&nrm=iso&tlng=pt
http://www.scielo.br/img/revistas/jbsmse/v26n2/21054f06b.gif

**Suggestion for Revision:**
[describe properly]

## Comment 27

**Issue:** Stress-strain curves are shown for tension, but according to the text, the beams were loaded in compression.

**Location**: 58 of 170 of pdf (labeled page 6 of report), page 61 of 170 of pdf (labeled page 9 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9A_for_public_comment.pdf

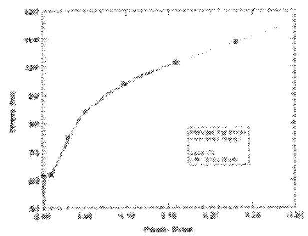


**Figure 89.**
page 58 of 170 of pdf (labeled page 6 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9A_for_public_comment.pdf

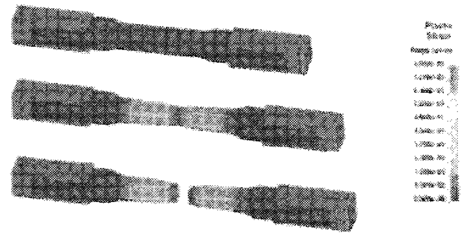



**Figure 90.**
page 58 of 170 of pdf (labeled page 6 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9A_for_public_comment.pdf

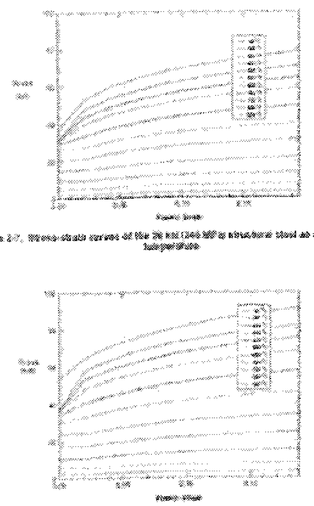


**Figure 91.** page 61 of 170 of pdf (labeled page 9 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9A_for_public_comment.pdf

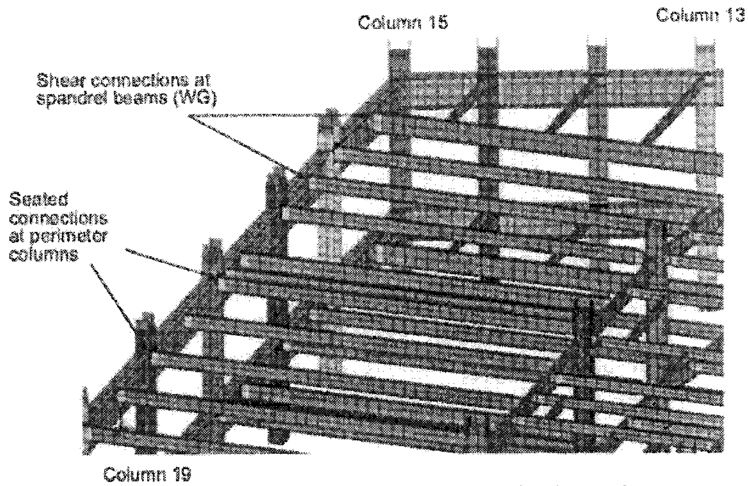



**Figure 310.** STP connection in global model, view of southwest corner above Floor 9.

**Figure 92.** floor connections
page 78 of 170 of pdf (labeled page 26 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9A_for_public_comment.pdf

**Reason for Comment:** NIST has focused on tensile tests and tensile data for material that is claimed to have failed in compression in a not-clearly-defined environmental.

**Suggestion for Revision:** Tension diagrams are shown because.

## Comment 28

**Issue**: Observed fuming pattern not properly defined or explained

**Location**: Page 271 of 404 of pdf (labeled page 227 of report),
Page 158 of 404 of pdf (labeled page 114 of report),
Page 161 of 404 of pdf (labeled page 117 of report),
http://wtc.nist.gov/media/NIST_NCSTAR_1-9_Vol1_for_public_comment.pdf

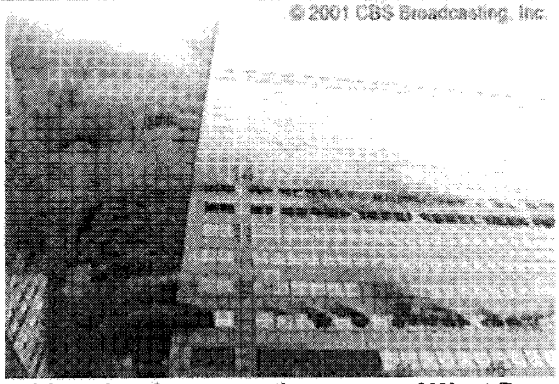



**Figure 5–141. Frame from a video shot from near the corner of West Broadway and Barclay Street showing the eastern side of the north face of WTC 7 between 3:53 p.m. and 4:02 p.m.**
The intensities have been adjusted, and column and floor numbers have been added.

**Figure 93**. Page 271 of 404 of pdf (labeled page 227 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9_Vol1_for_public_comment.pdf

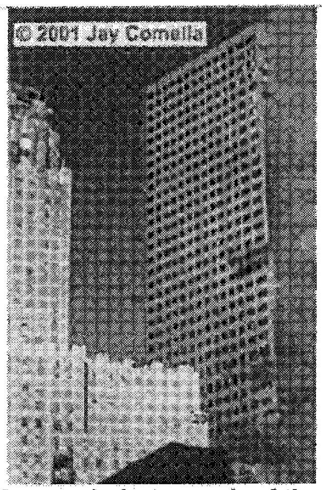



**Figure 5–24. Cropped photograph of the west face of WTC 7 shot from West Street between 3:30 p.m. and 4:30 p.m. on September 11.**
The structure on the left is the Verizon Building, and the building just visible at the bottom is WTC 6. The intensity levels have been adjusted.

**Figure 94**. Page 158 of 404 of pdf (labeled page 114 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9_Vol1_for_public_comment.pdf

**Figure 5–27. Cropped photograph showing the dust cloud created by the collapse of WTC 2.**
The image was shot from the west at 10:03:56 a.m. WTC 7 can barely be seen above the cloud. The intensity levels of the photograph have been adjusted.

**Figure 95**. Page 161 of 404 of pdf (labeled page 117 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9_Vol1_for_public_comment.pdf

The theoretical time for free fall (i.e., neglecting air friction), was computed from,

$$t = \sqrt{\frac{2h}{g}}$$

where $t$ is the descent time (s), $h$ is the distance fallen (ft), and g is the gravitational acceleration constant, 32.2 ft/s$^2$ (9.81 m/s$^2$). **Upon substitution of h = 242 ft.** in the above equation, the estimated free fall time for the top of the north face to fall 18 stories was approximately 3.9 s. The uncertainty in this value was also less than 0.1 s.

Thus, the actual time for the upper 18 stories to collapse, based on video evidence, was approximately 40 percent longer than the computed free fall time and was consistent with physical principles.

**Figure 96.** [emphasis added]
page 79 of 115 of pdf, (labeled page 41 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1A_for_public_comment.pdf

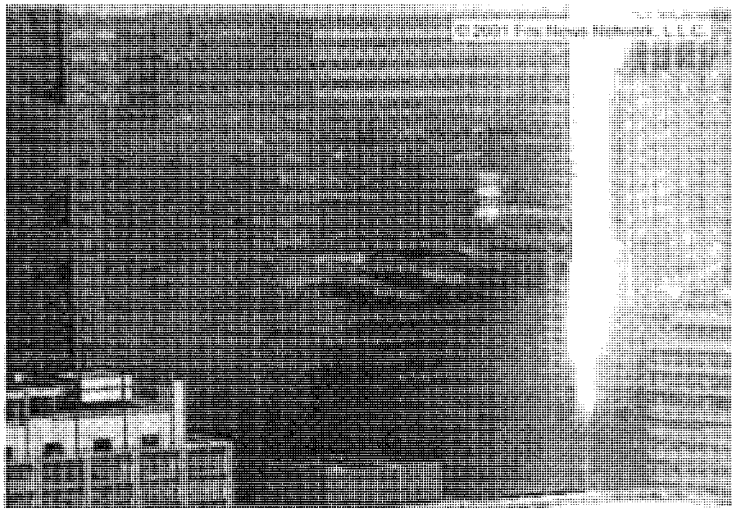


**Figure 5–157. Frame taken from a video clip shot from the northeast, showing the north face of WTC 7 within a few minutes of the WTC 7 collapse at 5:20:52 p.m.**
The intensity levels were adjusted.

**Figure 97**. Page 285 of 404 of pdf (labeled page 241 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9_Vol1_for_public_comment.pdf


**Figure 5–209. Frame from the Camera 6 video clip in Figure 5–189, showing the north face of WTC 7 10.0 s ± 0.2 s after the east penthouse began to descend.**
The intensities have been adjusted.

**Figure 98**. Page 327 of 404 of pdf (labeled page 283 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9_Vol1_for_public_comment.pdf

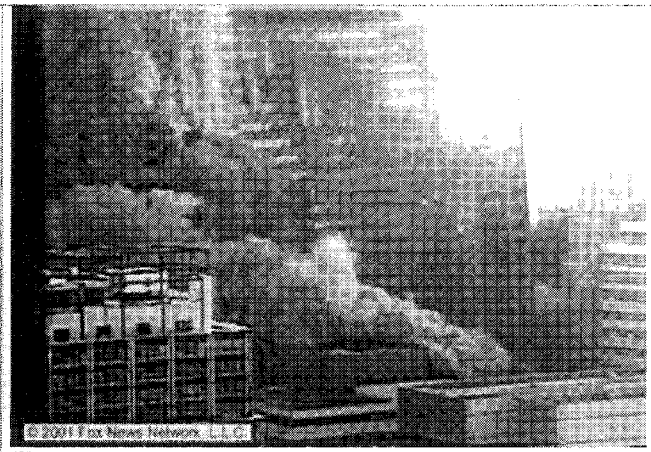



**Figure 5–212. Frame from the Camera 6 video clip in Figure 5–189, showing the north face of WTC 7 11.0 s ± 0.2 s after the east penthouse began to move downward.**
The intensities have been adjusted.

**Figure 99**. Page 328 of 404 of pdf (labeled page 284 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9_Vol1_for_public_comment.pdf

**Reason for Comment:** Analysis is incomplete and does not address the disintegration of the building. If the top portion of the building "fell" at near free-fall speed, it would have encountered no more resistance from the lower portions than from air. But, the building disintegrated while falling as if it encountered very high resistance. Here we have conditions which contradict each other and which NIST fails to address, much less explain. In fact, the observed conditions are consistent with unusual energy effects that are obvious and that mandate explanation. The failure to address the observed conditions may be evidence of fraud and/or criminal wrongdoing.

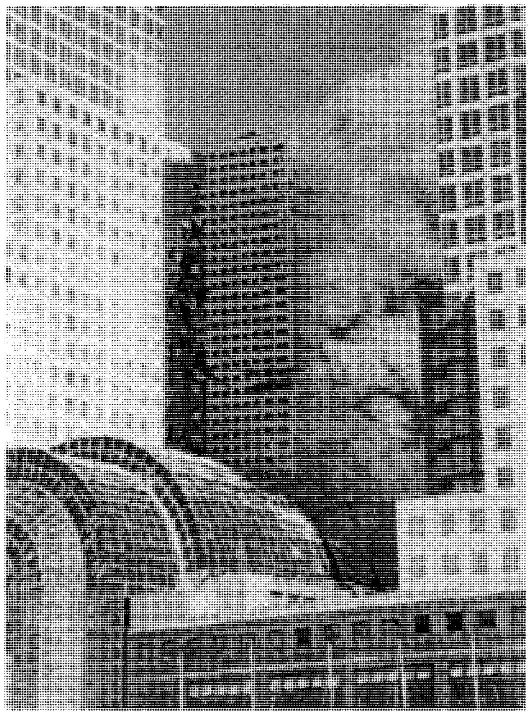


**Figure 100.** WTC7 appears to be dissolving.
Source: [illegible]

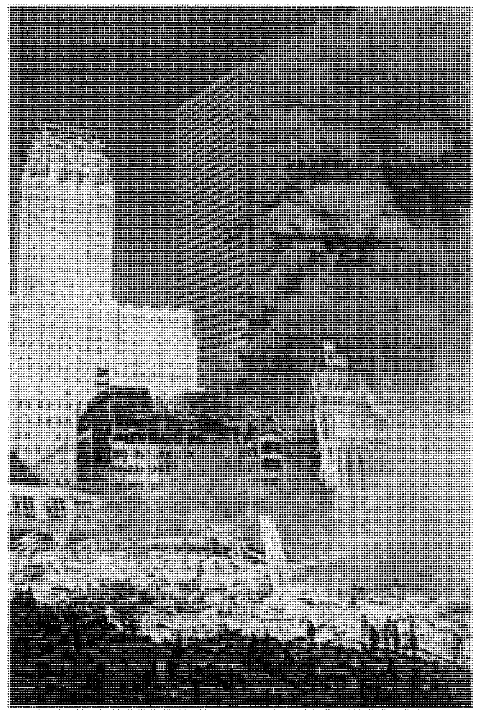


**Figure 101.** WTC7 appears to be dissolving.
Source: [illegible]

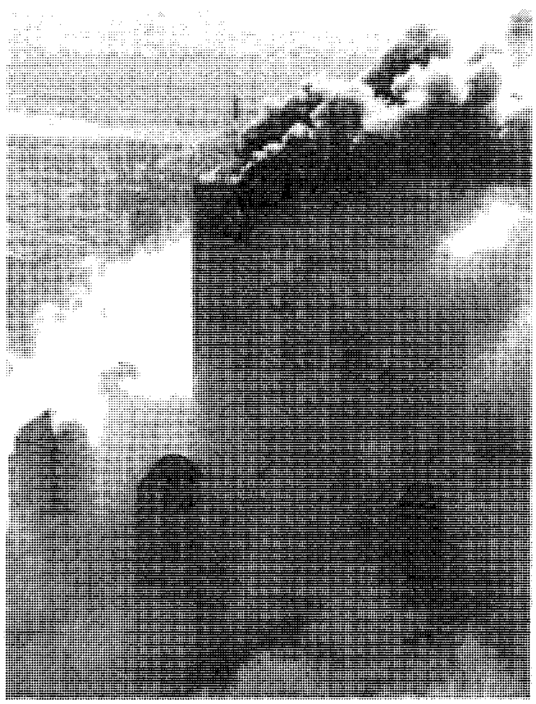


**Figure 102.**
WTC1 lathering up shortly after the destruction of WTC2. This is a distinctive phenomenon. This occurred prior to the "initiation of collapse" of WTC1.

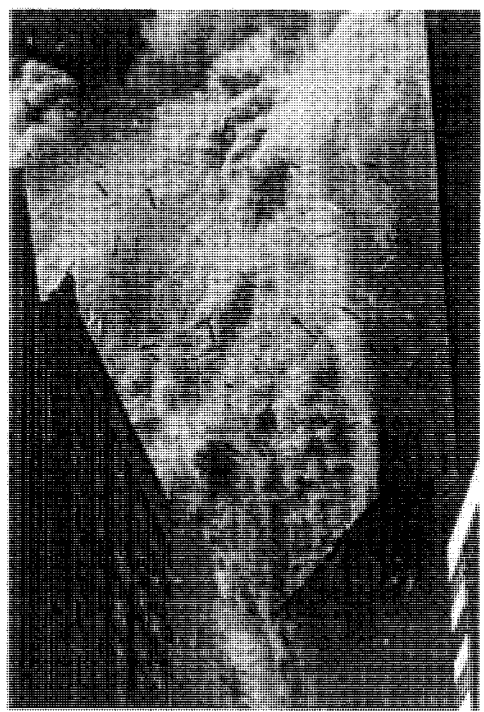


**Figure 103.** WTC1 disintegrated while falling.

**Suggestion for Revision:**
We have no explanation for for what caused WTC7 to dissolve and if there are those who wish to assert that our failure to address this is fraudulent, then they may do so. We acknowledge being placed on notice of this claim of fraud in comments received from Dr. Judy Wood.

## Comment 29

Issue: Models given do not match enough of observed phenomena, nor to they explain resulting state of WTC 7

**Location**: slide 11 of 17 of News Briefing slide,, page 160 of 170 of pdf (labeled page 108 of report), http://wtc.nist.gov/media/NIST_NCSTAR_1-9A_for_public_comment.pdf

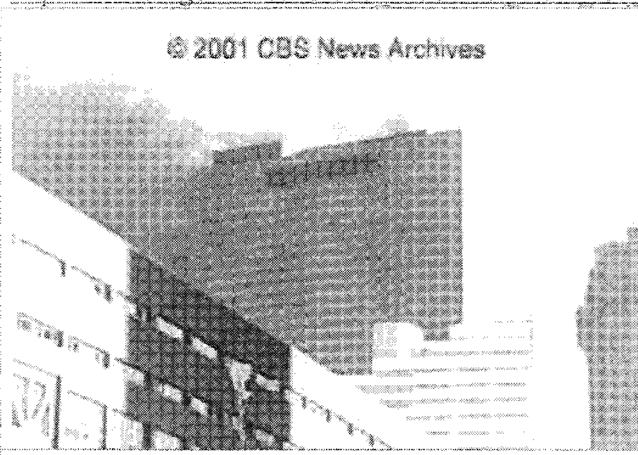



**Figure 104.**
slide 11 of 17 of News Briefing slide,
http://wtc.nist.gov/media/WTC7_News_Briefing_082008.pdf

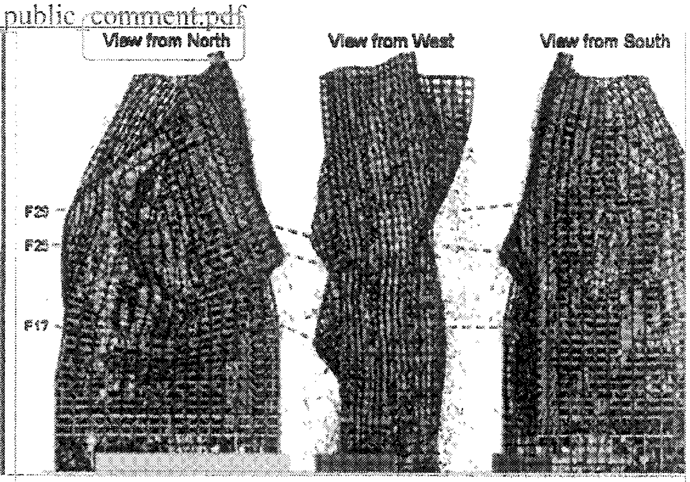



**Figure 105.**
page 160 of 170 of pdf (labeled page 108 of report),
http://wtc.nist.gov/media/NIST_NCSTAR_1-9A_for_public_comment.pdf

**Reason for Comment:**
Modeling of the progressive/global collapse shows the building contorting, flexing and losing its shape. This is inconsistent with pictorial and video evidence. Observed evidence is the truth theory must mimic. The diagrams in Figure 105 do not mimic the real event, shown in Figure 104. The models presented are inadequate as explanations for the data/phenomena briefly outlined in parts of this document.

**Suggestion for Revision:**
We are unable to explain the observed phenomena, so have ignored them. We acknowledge being placed on notice of this claim of fraud in comments received from Dr. Judy Wood.

Once again, the comment period is woefully insufficient for full and fair public comment. Additional time should be provided. If more time is provided, then I will offer additional comments.

In addition, on February --, 2008, I submitted a detailed report calling attention to ongoing clear and present danger arising from nonself-quenching toxicity arising from the evidence of use of exotic weaponry to destroy the WTC complex. NIST did not ever indicate acknowledgment of those concerns. The draft WTC 7 report continues the ongoing process of deception and of disregard of the public's right to know why and how the WTC complex was destroyed. That situation is a travesty.

If there are any questions concerning these submitted comments, please contact either me or my below-listed counsel.

Respectfully,

Dr Judy Wood

cc
Jerry V. Leaphart, Attorney
8 West Street
Suite 203
Danbury, CT 06810
p-203-825-6265
f-203-825-6256
e-jsleaphart@cs.com

To: Therese McAllister <Therese.McAllister@nist.gov>, Catherine Fletcher <catherine.fletcher@nist.gov>
From: Judy Wood <lisajudy@nctv.com>
Subject: Evidence of Non-self-quenching toxicity at World Trade Center Site
Cc: Jsleaphart@cs.com
Bcc: lisajudy@nctv.com
X-Attachments: :Harvey:584882:080229_AFFIDAVITtight.pdf:

Dear Catherine Fletcher and Theresa McAllister,

As you know, I have previously engaged in an RFC process that is now completed and concluded. As you may know, I have also initiated a lawsuit under the False Claims Act against many of the contractors NIST hired for professional services on the investigation of what caused the destruction of the Twin Towers. I have also voiced objection to the way in which the Building 7 (WTC7) investigation is proceeding.

In NIST's July 27, 2007, Response to my RFC, it was stated "[A]s you know, NIST did not investigate the actual collapses" of the Twin Towers. Actually, I suspected that, so I greatly appreciated your confirmation of that, which was stated in your letter. The statement that NIST did not investigate the destruction of the Twin Towers was not explicitly stated in NCSTAR 1, but Footnotes 2 and 13 vaguely hinted at the possibility that no investigation was done. But, those footnotes mainly implied that a choice to limit what was being reported on was for sake of "brevity" and not because no part of the phase of actual destruction of the WTC had been investigated.

That stunning admission of fraudulent omission has consequences.

I have attached to this email an affidavit that has been submitted in connection with my lawsuit against NIST's contractors. The affidavit documents the existence of ongoing cleanup problems that are highly consistent with a continuing reaction and continuing molecular dissociation at GZ. A continuing reaction implies that this effect is non-self-quenching, so the public may be exposed to continuing danger. The destruction of WTC7 exhibited nearly all of the same characteristics as the destruction of WTC1&2. Noting that many of the contractors are the same, so it is likely that NIST's ongoing investigation of WTC7 may be dangerously and fraudulently flawed to such a degree that if it is not halted and if the current contractors are not removed, then the problems associated with the cover-up of the fact that the World Trade Center was destroyed by directed energy weapons may continue to multiply.

After you review the attached affidavit, please feel free to contact either me or my counsel, Jerry Leaphart, if you have questions. I am advised that a copy of this correspondence will be sent by Mr. Leaphart to the U.S. Attorney's Office in New York City, care of Benjamin Torrance.

In conclusion, I strongly urge NIST to suspend its investigation of WTC 7.

In December, 2007, the public was told that:

"At this point, the analysis of the initiating event we expect will be completed in January of 2008, which is about a month, a month and a half from now. We expect to finish the global analysis of the initiating event by March and at that stage, we will then identify a leading collapse hypothesis, which will then lead to the drafting of our reports for internal review by the tactical team followed by a revised draft that is shared with the advisory committee - that's you folks -- as well as reviewed at NIST. We have a normal NIST quality control for all publications released by NIST. It's called the Editorial Review Board at NIST and all publications before they are released by NIST are reviewed by that independent body, and that will be done concurrently with the Advisory Committee review some time in June and we expect to release the report for public comment soon after that in July, and there will be a period of public comment similar to what we had for the Towers at the end of which we will then release the final reports. So that is really the overall schedule. If you have any questions, I'd be happy to answer. If there are none, we'll just move to Terri's presentation."

Because of the way NIST has conducted its WTC investigation, namely, by ignoring the actual events of destruction, and thus engaging in a fraudulent investigation, assisted by companies that are also engaging in fraud, there is no viable way for NIST to be anywhere near reaching a "leading hypothesis." Rather NIST can only be reaching a stage where a fraudulent hypothesis may be on the verge of being put forth.

The consequences of this fraudulent process are ongoing and are manifested in the ongoing remediation using dirt and hazmat procedures in NYC, up to and including the present. The fuming, which many assumed was 'smoke' that lingered at GZ for months is, in fact, still taking place there. I, myself, have provided photographic evidence of this and have set it out in the attached affidavit.

Thank you for your attention to this matter.

Respectfully,

Dr. Judy Wood

cc
Jerry Leaphart
Attorney
8 West Street
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---------------------

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**UNITED STATES DISTRICT COURT**
**FOR THE SOUTHERN DISTRICT OF NEW YORK**

| | |
|---|---|
| DR. JUDY WOOD on behalf of the UNITED STATES OF AMERICA, | EFC Case |
| Plaintiff/Relator, | |
| vs. | February 29, 2008 |
| APPLIED RESEARCH ASSOCIATES, INC. et al | DOCKET NO. 07 CV 3314 (GBD) |
| Defendants. | |

# AFFIDAVIT

STATE OF SOUTH CAROLINA )
ss:
COUNTY OF PICKINS )

DR. JUDY WOOD, being duly sworn, deposes and says:

1. I am of full age and legal capacity and make this affidavit in support of my opposition to defendants' motions to dismiss in the above-captioned matter.

2. I hereby reaffirm the state of facts and of affairs articulated in paragraphs 1 through and including 70 of my amended complaint in this action that sets forth the factual claims that confirm:

A. That per 31 U.S.C. § 3730(e)(4)(b), I am the original source of information confirming fraud by the defendants in this matter.

B. My direct and independent knowledge of the information upon which my claims are made will be articulated in some detail in this affidavit.

3. I am a former professor of mechanical engineering with research interests in experimental stress analysis, structural mechanics, optical methods, deformation analysis, and the materials characterization of biomaterials and composite materials. I am a member of the Society for Experimental Mechanics (SEM), co-founded SEM's Biological Systems and Materials Division, and I serve on the SEM Composite Materials Technical Division.

4. I received my

* B.S. Civil Engineering, 1981 (Structural Engineering), Virginia Polytechnic Institute and State University in Blacksburg, Virginia.

* M.S. Engineering Mechanics (Applied Physics), 1983, Virginia Polytechnic Institute and State University in Blacksburg, Virginia.

* Ph.D. Materials Engineering Science, 1992, from the Department of Engineering Science and Mechanics at Virginia Polytechnic Institute and State University in Blacksburg, Virginia.

My dissertation involved the development of an experimental method to measure thermal stresses in bimaterial joints. I have taught courses including

- Experimental Stress Analysis,
- Engineering Mechanics,
- Mechanics of Materials (Strength of Materials)
- Strength of Materials Testing

5. From 1999 to 2006 I was an assistant professor in the Mechanical Engineering Department at Clemson University in Clemson, South Carolina. Before moving to Clemson I spent three years as a postdoctoral research associate in the Department of Engineering Science and Mechanics at Virginia Tech. I am currently writing a book with Morgan Reynolds based on the physical evidence for understanding and explaining the events on 9/11.

6. One of my research interests is biomimicry, or applying the mechanical structures of biological materials to engineering design using engineering materials. Other recent research has investigated the

deformation behavior of materials and structures with complex geometries and complex material properties, such as fiber-reinforced composite materials and biological materials. I am an expert in the use of moiré interferometry, a full-field optical method that is used in stress analysis, as well as materials characterization and other types of interference. In recent years, I along with students have developed optical systems with various wavelengths and waveguides. I have over 60 technical publications in refereed journals, conference proceedings, and edited monographs and special technical reports.

7. I started to question the events of 9/11 on that same day when what I saw and heard on television was contradictory and appeared to violate the laws of physics. Since that day I have used my knowledge of engineering mechanics to demonstrate that the collapse of the World Trade Center twin towers could not have happened as the American public was lead to believe.

8. I provided clear and unequivocal notice of the fraudulent nature of the NCSTAR report to the National Institute of Standards and Technology (NIST) on March 16, 2007, March 29, 2007 (supplement#1), April 20, 2007 (supplement#2 ), and on August 22-3, 2007 (Appeal), in writing, and these writings are annexed hereto as Exhibits A, B, C, and E respectively.[1]

9. I have direct and independent knowledge and have informed a government agency that its contractors intentionally participated in a blatantly false and misleading project that was to have determined why and how the Twin Towers of the World Trade Center were destroyed. In this project, the defendants herein each had contracts that required them to provide various professional services in furtherance of determining what caused the destruction of the WTC. The importance of that work--to have determined why and how the

[1] Ocio links: http://www.ocio.os.doc.gov/ITPolicyandPrograms/Information_Quality/PROD01_002619
Request for Correction from Dr. Judy Wood dated March 16, 2007
http://www.ocio.os.doc.gov/ITPolicyandPrograms/Information_Quality/ssLINK/PROD01_004678
Supplement #1 to Request for Correction dated March 29, 2007
http://www.ocio.os.doc.gov/ITPolicyandPrograms/Information_Quality/ssLINK/PROD01_004117
Supplement #2 to Request for Correction dated April 20, 2007
http://www.ocio.os.doc.gov/ITPolicyandPrograms/Information_Quality/ssLINK/PROD01_004156
Appeal by Dr. Wood of NIST Initial Denial dated August 22, 2007
http://www.ocio.os.doc.gov/ITPolicyandPrograms/Information_Quality/ssLINK/PROD01_004155
Amendment (replacement pages) to Appeal dated August 23, 2007
http://www.ocio.os.doc.gov/ITPolicyandPrograms/Information_Quality/ssLINK/PROD01_004157

Twin Towers of the World Trade Center were destroyed--and the importance of doing it, absent fraud, cannot be overstated. The evidence I have gathered indicates that exotic weapons systems involving directed energy were used to destroy the WTC on 9/11. I refer to these weapons generically as "DIRECTED ENERGY WEAPONS" (DEW), meaning it involves energy that is directed and is used as a weapon. I also consider "energetics" to be part of this definition.

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**Beam Weapons, High Energy Weapons, and Directed Energy Weapons (DEW):**[2]

10. **--ENERGETICS AND DIRECTED ENERGY WEAPONS (DEW'S)**[3]**--**

The ordinary Soviet name for this type of weapons science is energetics. In the west that term is believed to be associated with conventional directed energy weapons (DEWs) such as particle beam weapons, lasers, radio-frequency (RF) directed energy devices, etc. The Soviets do not limit the term in this way.

Western scientists are familiar only with directed energy weapons where fragments, masses, photons, or particles travel through space and contact the target to deliver their effects. Hence in their thinking they limit the Soviet term "energetics" to the type of weapons they themselves understand -- exotic but normal weapons using energy or mass traveling through space to impact a target.

However, it is possible to focus the potential for the effects of a weapon through spacetime itself, in a manner so that mass and energy do not "travel through space" from the transmitter to the target at all. Instead, ripples and patterns in the fabric of spacetime itself are manipulated to meet and interfere in and at the local spacetime of some distant target. There interference of these ripple patterns creates the desired energetic effect (hence the term energetics) directly in and through the target itself, emerging from the very spacetime (vacuum) in which the target is imbedded at its distant location. As used by the Soviets, energetics refers to these eerie new superweapons, as well as to the more mundane DEWs known to the west.

As a consequence of the Soviet breakthrough and decades of feverish development, monstrous strategic weapons undreamed of in the West are already in Soviet hands. A noose is slowly and steadily being tightened about our throats, and it is already the 11th hour.

11. I have used the terms "beam weapons" and "directed energy weapons" (DEW) to refer to unconventional weapons (exotic weapons) that are energy weapons. The full range of these weapons is classified information, so I make no limits or distinction of categories within the realm of energy weapons. Doing so would imply specific knowledge of all that is available. I have discussed some of the possibilities I am aware of. In their motion to dismiss my case, one of the defendants stated that DEW is only science fiction. However, at a news conference in 2003, Defense Secretary Donald Rumsfeld publicly

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[2] *http://drjudywood.com/articles/DEW/StarWarsBeam7.html#DEW*

acknowledged that the US has developed DEW technology. For more information, please see my RFC Appeal as well as the additional links. [4]

12. Some critics have accused me of insisting that beam weapons did their damage from outer space, yet I make no claim about whether the directed energy weapon operated from a space-, air-, or ground-based platform. Nor do I make any claim about what wavelength(s) was/were used, what the source(s) of energy was/were, whether it involved interference of multiple beams, whether it involved sound waves, whether it involved sonoluminescence, whether it involved antimatter weapons, whether it involved scalar weapons, whether it was HAARP, whether it involved a nuclear process (e.g. NDEW), whether it involved conventional directed energy weapons (cDEW), whether it involved improvised directed energy weapons (iDEW), nor what kind of accelerator was used, nor do I claim to know what the serial numbers of the parts that were in the weapon(s).

13. What I do claim is that the evidence is consistent with the use of energy weapons that go well beyond the capabilities of conventional explosives and can be directed, as demonstrated below. [5] The defendants had the necessary expertise and experience to recognize this fact.

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[3] http://www.freedomdomain.com/weathercontrol/scalarweapon01.html

[4] Request for Correction from Dr. Judy Wood dated March 16, 2007
http://www.ocio.os.doc.gov/ITPolicyandPrograms/Information_Quality/ssLINK/PROD01_004678
http://drjudywood.com/articles/DEW/StarWarsBeam7.html
http://drjudywood.com/articles/DEW/StarWarsBeamAppendix1.html
http://drjudywood.com/articles/DEW/StarWarsBeamAppendix2.html
http://drjudywood.com/articles/DEW/StarWarsBeamAppendix3.html

[5] sonoluminescence, http://en.wikipedia.org/wiki/Sonoluminescence
antimatter weapons, http://cui.unige.ch/isi/sscr/phys/antim-BPP.html
scalar weapons, http://www.freedomdomain.com/weathercontrol/scalarweapon01.html
HAARP http://www.darpa.mil/tto/programs/haarp.htm
HAARP http://www.viewzone.com/haarp11.html
HAARP http://www-star.stanford.edu/%7evlf/HAARP/index.html
Nuclear DEW (NDEW), http://www.fas.org/irp/doddir/doe/pubgd.html
Nuclear DEW (NDEW), http://drjudywood.com/articles/DEW/StarWarsAppendix1.html#nuke_1F
improvised DEW (iDEW) http://www.engadget.com/2006/10/23/inventors-claim-to-turn-300-microwaves-into-megawatt-energy-weap/
improvised DEW (iDEW) http://appft1.uspto.gov/netacgi/nph-Parser?Sect1=PTO1&Sect2=HITOFF&d=PG01&p=1&u=%2Fnetahtml%2FPTO%2Fsrchnum.html&r=1&f=G&l=50&s1=%2220060208672%22.PGNR.&OS=DN/20060208672&RS=DN/20060208672

14. As a result of the fraud committed by the defendants herein, the fact that the WTC was destroyed by use of exotic weapons systems, known generically as "DIRECTED ENERGY WEAPONS" (DEW) has been withheld and hidden, such that, to this day, meaning the day and time this affidavit is submitted and filed, there exists, at the site of the WTC, in New York, NY, a clear and present danger to the public in that the after-effects of the use of DEW has not been rectified and is still ongoing, as demonstrated below.

15. The type of DEW used to destroy the WTC had certain characteristics and properties that mandate a certain kind of cleanup process as demonstrated below. In the case of the DEW used to destroy the WTC, the evidence indicates that the cleanup necessitates the use of enormous quantities of dirt over an extended period of time, measured in years, rather than days, weeks or months.

16. Dirt is being trucked into and out of the WTC site to this day, as demonstrated below.

17. The aftereffects of the use of DEW, including, by way of example, the periodic and unpredictable release of "fumes" that appear, on casual observation, to be smoke. In the initial months after the events of 9/11/01, the "smoke," we were told, was due to lingering "fires." Until I had more information, I referred to this phenomenon as "fuming," a non-specific term, in order to keep my observations unbiased. The evidence indicates that this ongoing fuming happens as a result of DEW used on 9/11.

18. In recognition of the fact that the aftereffects of the use of DEW are ongoing and have not been controlled or contained, let alone fully remedied, I have caused a copy of this affidavit to be served on the NIST, care of Catherine Fletcher and Therese McAllister, who had been handling this case as and for notification that a clear and present danger continues to exist at the WTC site as a result of and by virtue of the non-disclosure and the continuing fraud of not acknowledging that the WTC was destroyed by DEW.

19. Put it this way: I hereby assert that a 1776 ft structure should not be placed atop or near a location that is still fuming some six-plus (6+) years after the DEW-destructive event was initiated on September 11, 2001.

20. False and fraudulent assertions were made in officially-disseminated information to the public. That officially-disseminated information was a report entitled and designated NCSTAR 1 ("Final Report on the

Collapse of the World Trade Center Towers") issued on or about the month of September 2005, which report helped to further the false, deceptive and highly misleading claim, without proof and in the face of overwhelming proof to the contrary and/or gaping inconsistencies, that held out as true, the following fallacious proposition:

NCSTAR 1 states the specific objective of the investigation was to

> "1. Determine why and how WTC 1 and WTC 2 collapsed following the initial impacts of the aircraft and why and how WTC 7 collapsed."[6]

Yet two pages later, in a footnote, NIST states,

> "The focus of the investigation was on the sequence of events from the instance of aircraft impact to the initiation of collapse for each tower. For brevity in this report, this sequence is referred to as the "probable collapse sequence," although it does not actually include the structural behavior of the tower after the conditions for collapse initiation were reached and collapse became inevitable."[7]

21. The title of NCSTAR 1, "Final Report on the Collapse of the World Trade Center Towers," is flawed in that the visual evidence demonstrates that the nomenclature "collapse" as contained in the title and throughout NCSTAR 1 is false, deceptive and misleading. The use of the word "collapse" does not comport with the full range of the evidence from the WTC. The Twin Towers did not collapse.

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[6] E.1 Genesis of this investigation, p. xxxv (p. 37) The source of the said NCSTAR 1, meaning the point at which it can be and has been accessed, is: *http://wtc.nist.gov/reports_october05.htm*

[7] E.2 Approach, p. xxxvii (p. 39) footnote (!) *http://wtc.nist.gov/reports_october05.htm*

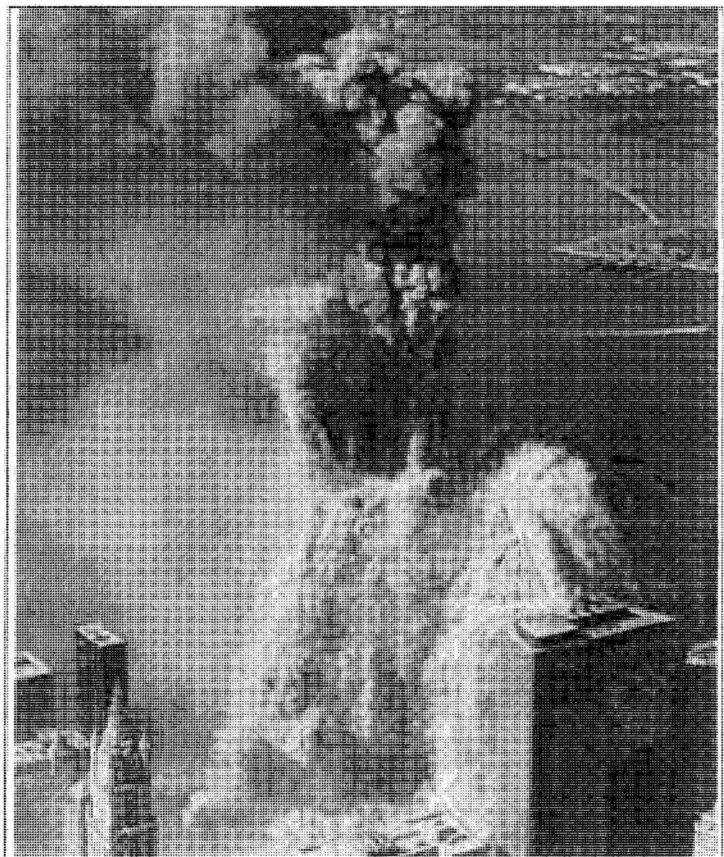

**Figure 1.** This does not look like a collapse to me.
*(9/11/01)*

Instead, they were quite obviously pulverized from top to bottom. I have coined the term the term "dustification" to describe the extraordinary destruction of the Twin Towers. While NCSTAR 1 acknowledges that "…the stories below the level of 'collapse' initiation provided little resistance to the tremendous energy released by the falling building mass, the building section above came down essentially in free fall, as seen in videos."

22. NIST cannot make a statement that the World Trade Center towers came down in "free fall" on one hand, and then indicate, on the other, that doing so is a form of collapse. The conditions there involved are not a collapse; and, in any event, NIST acknowledges that it does not analyze that part of the sequence of events; thus, it is utterly incongruent for NIST to describe that which it acknowledges went without analysis on its part.

23. My RFC, Exhibit A, directly challenged the assertion above as fraudulent. In its response to my RFC dated July 27, 2007, annexed hereto as Exhibit D, NIST openly acknowledged that it had not determined what caused the destruction of the WTC. Instead, NIST basically admitted that fraud had taken place in that respect by stating:

> "As stated in NCSTAR 1, NIST only investigated the factors leading to the initiation of the collapses of the WTC towers, not the collapses themselves."

24. The defendants that NIST relied on for professional expertise either knew or should have known that the NIST request and the work they were participating in was a fraud. I know that military personnel are prosecuted for following orders which are illegal. Therefore, the fact that these contractors knowingly supported and contributed to this fraudulent report with their professional prestige and credibility amounts to willful blindness. By limiting the investigation of the destruction of the WTC to the time frame before dustification, NIST provided no explanation of the event itself, but instead, produced a cover-up and a fraudulent scheme to disguise the abundant evidence that readily confirms the WTC towers were destroyed by DEW. That is, the contractors willfully partook in the cover up of the biggest crime in history.

25. Not only did they disguise the true nature of the destruction, those who participated in that fraud include those who are most directly involved in the development and manufacture of such weapons, and I was the one who clearly and directly disclosed that information to NIST, to which NIST replied, in substance, that it did not know that, for instance, ARA (and also SAIC) are involved in the manufacture and development of DEW. In its response to my RFC dated July 27, 2007, annexed hereto as Exhibit D, NIST states:

> Prior to award, each NIST WTC Investigation Contractor underwent a rigorous organizational conflict of interest analysis. As a result of the analysis, ARA was determined not to have an organizational conflict of interest. In addition, each contract contained a provision requiring the contractor to notify NIST immediately should any organizational conflict of interest arise during the course of the contract, and no such conflicts of interest were reported. You further claim that ARA is a significant manufacturer of directed energy weapons and/or components thereof. Since there is no factual evidence to support this claim, NIST has no basis for accepting your proposed corrections to NCSTAR 1.

26. In the appeal stage with NIST, I fully developed the information necessary to inform NIST about the activities and weapons expertise of SAIC and ARA. These two defendants are the most involved of the defendants in the development and manufacture of DEW. I further developed and provided NIST with ample information on the Directed Energy Professional Society (DEPS) and I also sought answers on the use of DEW at the WTC from the U.S. Directed Energy Directorate, annexed hereto as Exhibit G, which did not deny the relevance of my question, annexed hereto as Exhibit H. Juveisttino "Rich" Garcia states:

> While on a personal level I may find Dr Wood's investigation interesting and worthy of further consideration, on a professional level we are unable to devote our limited resources to activities outside of our charter, I wish you success in your endeavor and am available to answer whatever directed energy questions may arise.

27. My appeal, Exhibit E, dated August 22-3, 2007, I provided the information necessary to inform NIST about the activities and weapons expertise of SAIC and ARA. In its response to my appeal dated January 10, 2008, annexed hereto as Exhibit F, NIST openly acknowledged that it had **explicitly stated in their contract with ARA that they were not to report findings of what caused the destruction of the WTC.** NIST basically admitted that fraud had taken place in that respect by stating:

> Regarding your assertion that ARA is a significant manufacturer of directed energy weapons and/or components thereof, NIST's original response noted that "each NIST WTC Investigation Contractor underwent a rigorous organizational conflict of interest analysis." ARA was not requested to provide evidence or hypotheses as to what caused the collapses of the WTC towers. The reported findings and conclusions in the NCSTAR reports are NIST's alone; indeed, the contract for ARA working in support of the investigation **explicitly states that "Deliverables shall not include findings, conclusions, and recommendations." (Contract SB1341-03-Z-0022)** [emphasis added]. Because the performance work statement of the contract did not provide an opportunity for ARA to advise NIST on the cause of the failure of the WTC buildings, any expertise in demolitions was not, and is not, relevant.

This statement by NIST indicates the contract with ARA essentially contained a gag order, explicitly requiring ARA to not report what happened to the WTC. The defendants knew or should have known that they were participating in fraud by adhering to a fraudulent contract.

28. By the fact that the defendants willfully and purposefully avoided any investigation at all of the actual event of the destruction at the WTC occurring on 9/11, which NIST accomplished by curtailing, narrowing and limiting its investigation to a fraudulently selected point in time that it called "initiation of collapse,"

NIST and the defendants have participated in and contributed to a fraud that continues to pose a clear and present danger the public.[8] Instead of an investigation that was "thorough and based on all available evidence" by NIST personnel and the defendants, in fact, it was the opposite of an investigation since it was a "scientific" cover up, as demonstrated below.[9] During the course of this lawsuit, the exact details of the willful blindness and indifference to facts and to fact finding will be proven through the discovery process and subsequent trial.

29. Rarely has such an abuse of public trust been so devastating as that which NIST and the defendants perpetrated. That fraud has consequences. Ground Zero, for example, is still contaminated and the effects of DEW continue and are still being hidden. None of us liked what happened on 9/11 and we do not want it to ever happen again -- yet it is still happening! The defendants, by their participation in the cover up, are liable for the ongoing molecular dissociation and the consequent damage to people and property.

30. I present evidence in support of the claim that DEW destroyed the WTC and that the effects are still ongoing, as given below.

31. In this affidavit, I articulate the proof that DEW destroyed the WTC and that the contractors relied on by NIST included companies whose primary products and services include either the production of DEW, lethality effects testing of such weapons, and/or other scientific disciplines that could have and should have resulted in the clear and unmistakable recognition that the WTC was destroyed by such weapons. The defendants know that the WTC towers could not have been destroyed by aircraft impact damage, kerosene fires, and/or a gravity-driven collapse. Steel, concrete and rebar were instantaneously pulverized along with two 110-story towers dustified in about 10 seconds each.

32. The defendants cannot plead ignorance of fraud in the NIST project because among the professional disciplines that the list of defendants entails here are listed here, annexed hereto as Exhibit J.

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[8] See NIST claims of "thorough, open, independent" here:
http://wtc.nist.gov/pubs/semerjian_remarks_62305.htm

[9] January 10, 2008, denial of the appeal of Dr. Judy Wood available at
http://www.ocio.os.doc.gov/ITPolicyandPrograms/Information_Quality/ssLINK/PROD01_005026

33. How the defendants herein participated in the fraud of withholding from the public the fact that the WTC was destroyed by DEW

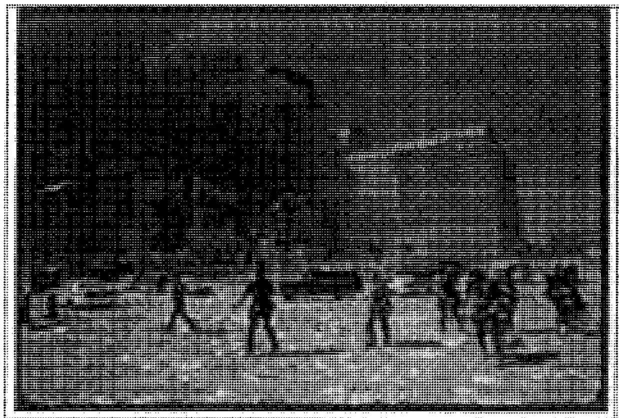

**Figure 2.** Coarse dust quickly settles to the ground. But fine dust can be seen around the feet. This indicates the dust is continuing to break down.

**Figure 3.** Soon, finer and finer dust begins rising from the ground. Dust this fine could not have settled out of the air this quickly. Coarse dust settled to the ground, but continued to break down.

34. How the ongoing effects of DEW pose a clear and present danger to the public I visited the WTC site on October 9, 2007, October 12, 2007, and January 17, 2008 and witnessed the ongoing effects and cleanup.


**Figure 4.** Looking west across the fresh dirtpile near Church and Vesey Streets. On Tuesday, there was a fresh new pile of dirt. It could have been potting soil or topsoil. Dirt is not used to make a new building foundation. *(10/09/07)*

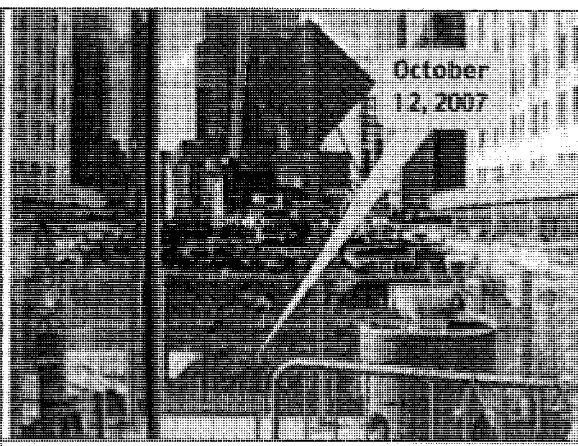


**Figure 5.** By three days later (Friday), most of that dirt pile is gone. *(10/12/07)*

I photographed cleanup operations on the site of WTC on each of these visits. Trucks were transporting dirt in and out of the site.

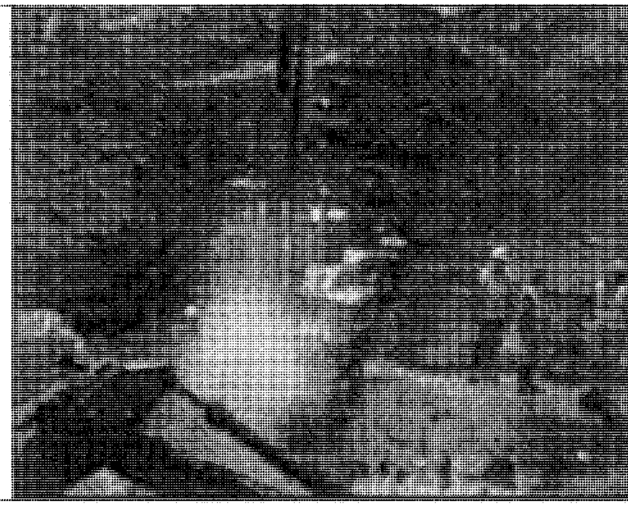

**Figure 6.** fuming0.jpg
*(1/17/08)*

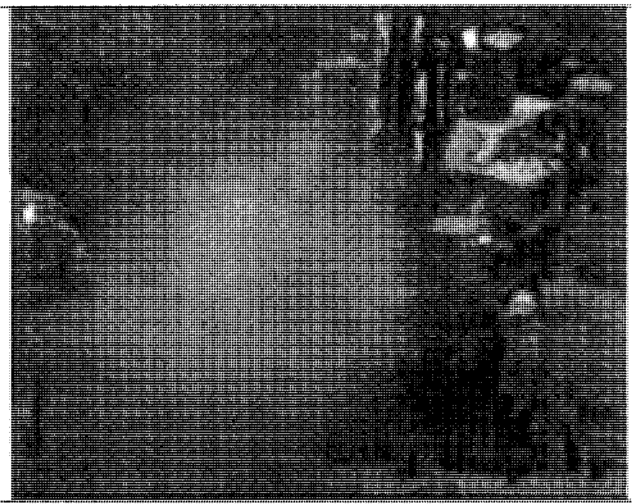

**Figure 7.** Fuming1.jpg
*(1/17/08)*

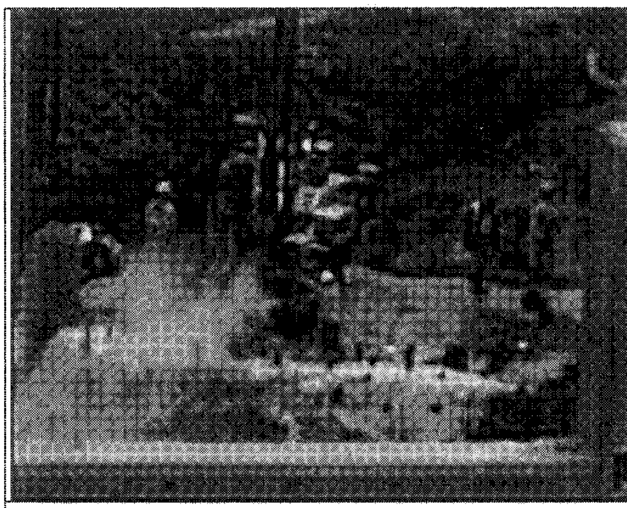

**Figure 8.** Fuming2.jpg
*(1/17/08)*

**Figure 9.** Steel turns to dust in mid-air. "Alkaseltzer"
*(9/11/01) Source: Shannon Stapleton, Reuters*

35. Yet NIST reasserts "…the NIST WTC investigation as described in NCSTAR 1 and the supporting reports was thorough and based on all available evidence…" in its January 10, 2008, denial of the appeal by

Dr. Judy Wood,[10] annexed hereto as Exhibit **F**. Also see more self-praise by NIST of its investigation as open, thorough and independent here.[11]

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## Weird Fires

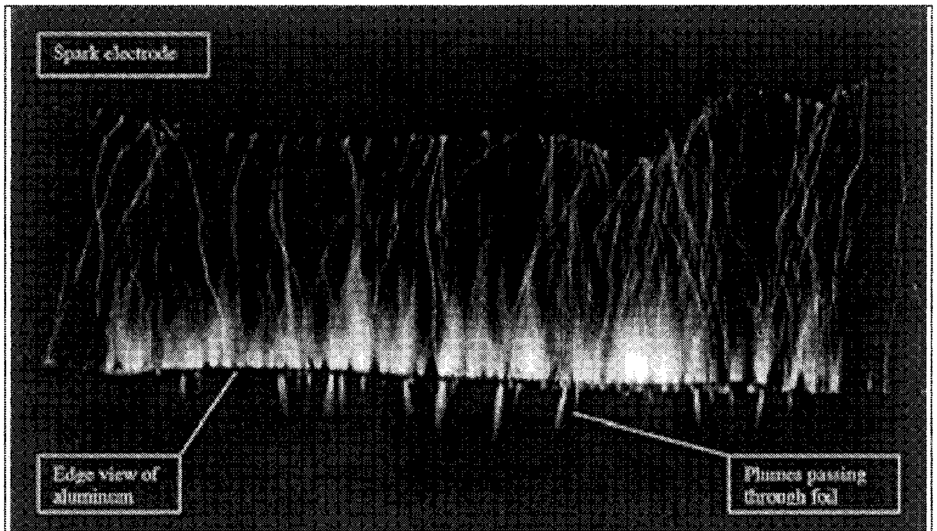


**Figure 10.** EVO.jpg
*(11/29/07?) Source*: pdf[12][13]

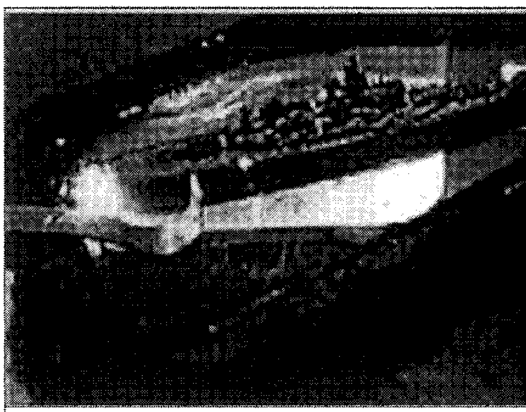

**Figure 11.** *Source*: Smokeless fires. mpg. (4.7 MB) *(11/29/07?)*

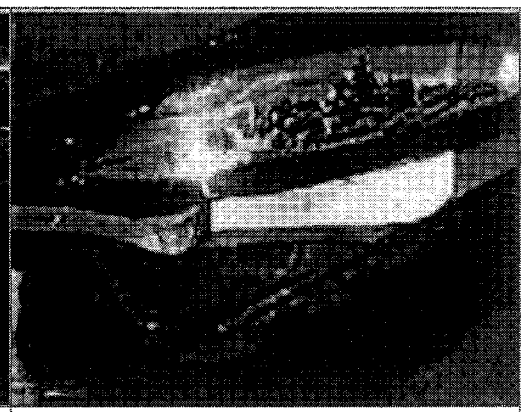

**Figure 12.** *Source*: Smokes fire moved. mpg. (4.7 MB) *(11/29/07?)*

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[10] *http://www.ocio.os.doc.gov/ITPolicyandPrograms/Information_Quality/ssLINK/PROD01_005026*

[11] *http://wtc.nist.gov/pubs/semerjian_remarks_62305.htm*

[12] http://blog.hasslberger.com/img/EVO.jpg

[13] http://www.svn.net/krscfs/EVOs%20and%20Hutchison%20Effect.pdf


Figure 13. Smokeless Car fire near Liberty St. and West Street. (9/11/01) Source:


Figure 14. Smokes car fire moved. These anomalous fires occurred before either tower was destroyed. (9/11/01) Source:

Figure 15. Anomalous smokeless fire on Church Street. This firefighter is unafraid of being burned. These fires do not appear to be hot. [5139~0.jpg] (9/11/01) Source:

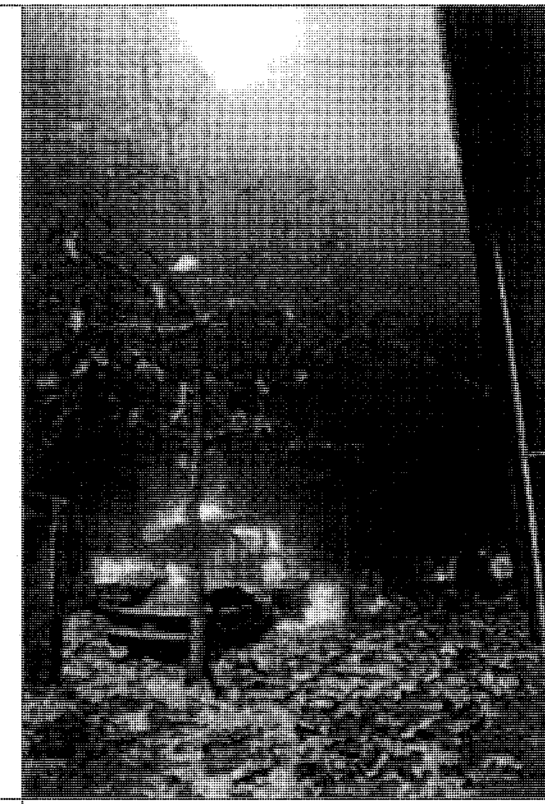

Figure 16. Vehicles burn the paper does not. (9/11/01) Source:

15

## Flipped cars

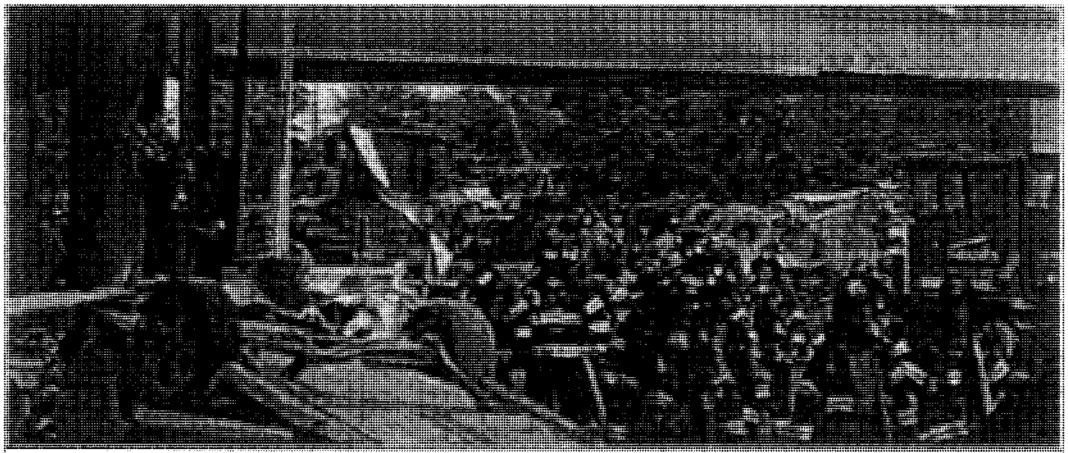

**Figure 17.**
*(9/12?/01) Source:*

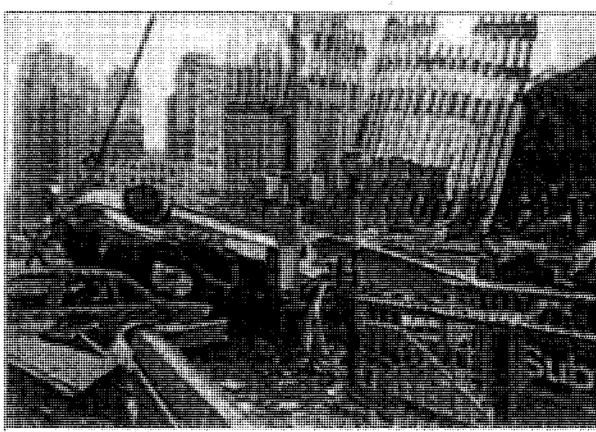

**Figure 18. 02102v_c.jpg** (trimmed)
(9/12?/01) Source: 02102v.jpg *(original)*

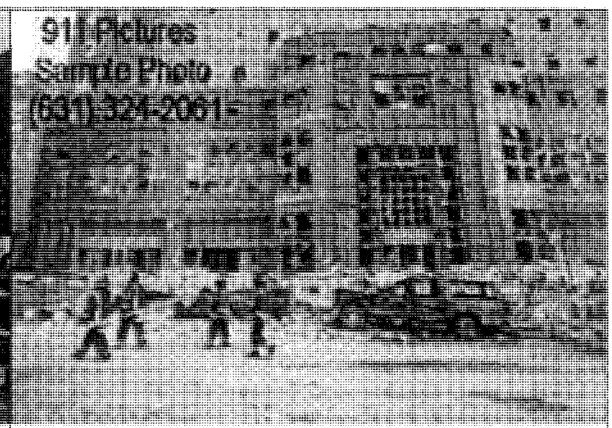


**Figure 19. Flipped car in front of a damaged SUV, in front of WFC1.** (9/12?/01) Source:

ARA is contracted to have comprehensive understanding of all weapons of mass destruction (WMD), including DEW.

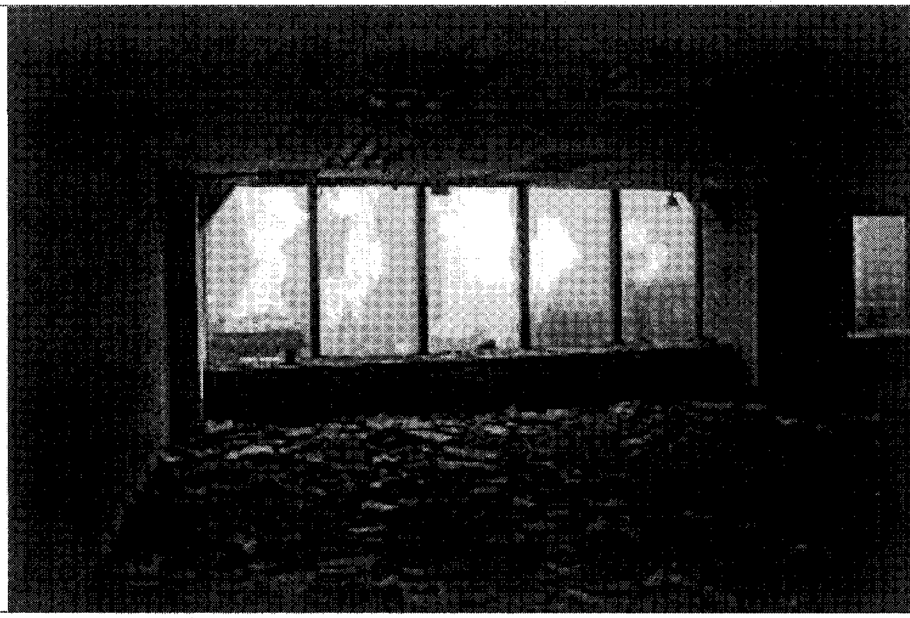

**Figure 20.** Round holes through glass, looking out of the One Liberty Plaza Bldg., over the remains of WTC4 and WTC5, with WFC2 in the distance, viewed through the far-left window. There are no large pieces of broken glass visible on the floor.
*(?/?/02) Source*

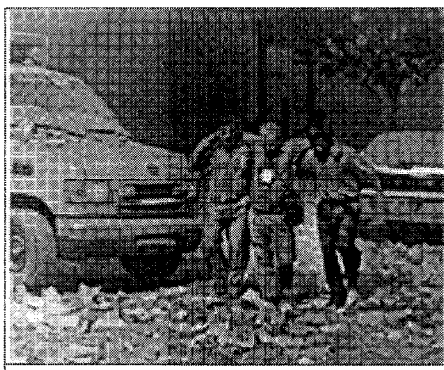

**Figure 21.** This is the front of the Millenium Hotel. Full foliage on the tree. (9/11/01)

**Figure 22.** Few windows look damage on the front face of the Millenium Hotel one week after 9/11.
(9/18/01)

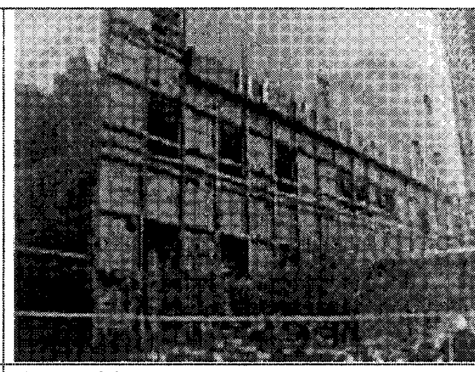

**Figure 23.**

*(9/21/01)*

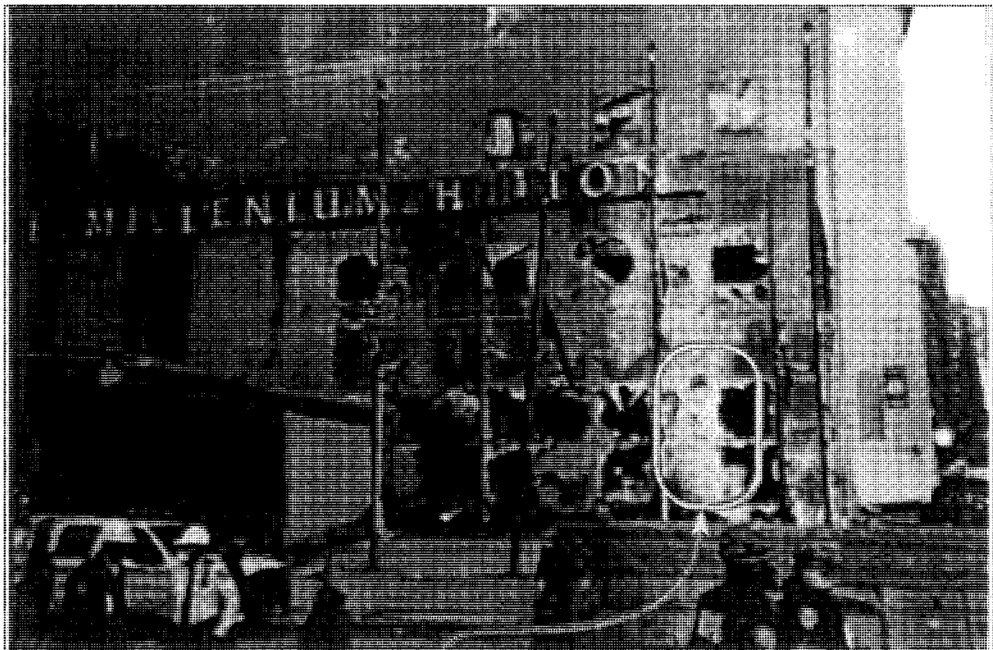

**Figure 24.** Round holes with no evidence they were caused by a projectile. To the contrary, the region noted above is unscarred behind the damaged glass façade. It is as if a big soldering iron made these holes and penetrated no further.
*(9/11/01) < ? < (9/21/01)*

Rene Daliva took cover in the Millenium Hotel during the destruction of WTC2.

**First Responder Statement: RENE DAVILA**

**File 1. No. 9110075**
WORLD TRADE CENTER TASK FORCE INTERVIEW
LIEUTENANT RENE DAVILA
Interview Date: October 12, 2001
[Emphasis added.]

A. ...I remember one guy was laying down. He had an open chest wound about the size of my fist in his right chest. I kept on looking. I knew what was coming. I knew he was going to go downhill. He had that look in his eye like -- he wasn't even talking. He was going into shock.

All of a sudden you heard the rumble and people yelling and screaming. You look andyou see -- I didn't see the top of the building. I didn't see the top of tower two. The collapse started. You felt like the ground -- it was like a deep sound, rumble; like you're laying on the platform and the D train is coming. You look and you see what -- I best describe it as a wave coming.

I started running in my direction. I started running into the hotel. Somethingknocked me. I don't know whether it was --

Q. The Millennium?
A. We were in front of the Millennium. I'm talking going in through the lobby.
Q. Okay.

**A. Something knocked me down. I don't know if something hit my helmet or whether it was a force.** I got down, and I thought I've got to get up. By the time I got up, it was like [sound] I'm overcome by black and I'm running in the building in this black, and I'm running and I'm running and I'm running.

The next thing I know, I see a little light, and I follow that light. I run in there,and I find I'm in an office, and I close the door. I close the door and then I start walking, and I'm panicked, I'm panicked. I lost it. I lost it for a few minutes in here.

In this room there's nothing but computers, maybe five, six computers, and phones. **As I'm in there, this force is still coming through the cracks of the door.** [illegible] a water fountain, and I [illegible] them, and I wet them and I stuff them under. I'm like walking back and forth, "I'm a medic. I'm a medic. I'm not a fucking firefighter. What do you do? What do you do? What do you do?"

WORLD TRADE CENTER TASK FORCE
http://graphics8.nytimes.com/packages/html/nyregion/20050812_WTC_GRAPHIC/met
RENE DAVILA INTERVIEW, pp. 21-22

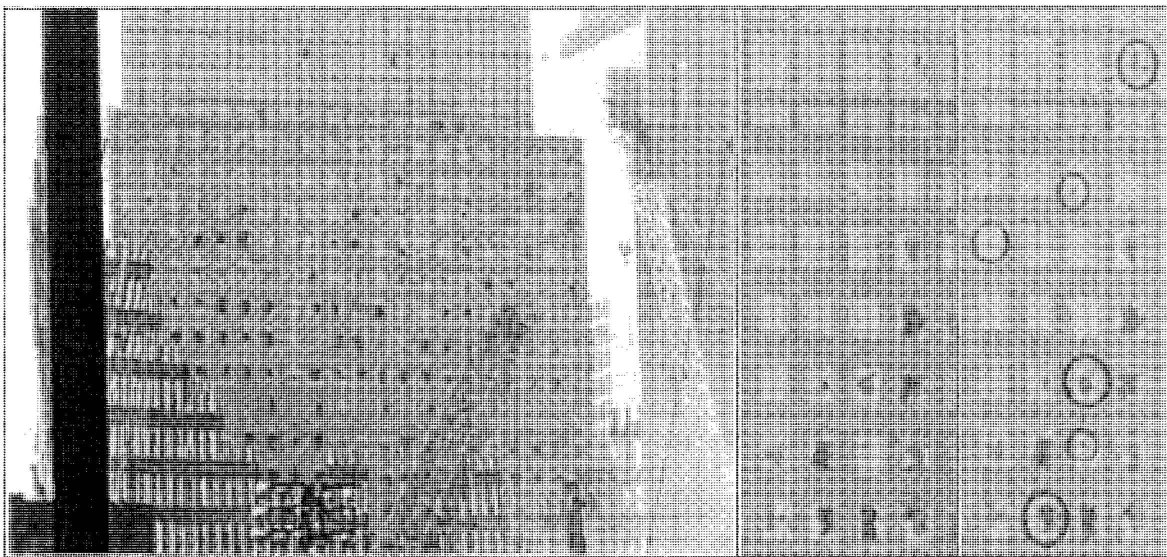

**Figure 25.** Round holes in WFC2 *(9/?/01)*
**Figure 26.** *(9/?/01)*
**Figure 27.** *(9/?/01)*

Round holes in windows with no damage to the rest of the façade were common on buildings facing Ground Zero (GZ) on 9/11/01.

## Reaction might not be self-quenching

"15. Serious considerations should be given to the idea that exceeding a certain critical mass of any relatively pure material may result in a reaction that is not self-quenching."

**Figure 28.** by Richard Sparks, Scientific and Technical Intelligence/SBIR, Ottawa. I think I see where this one applies. As of December 2007, they were still changing dirt in New York.
*(1996) Source*: The Hutchison File, *page 69 of 87.*
http://drjudywood.com/pdf/HutchisonEffectReport_txt.pdf

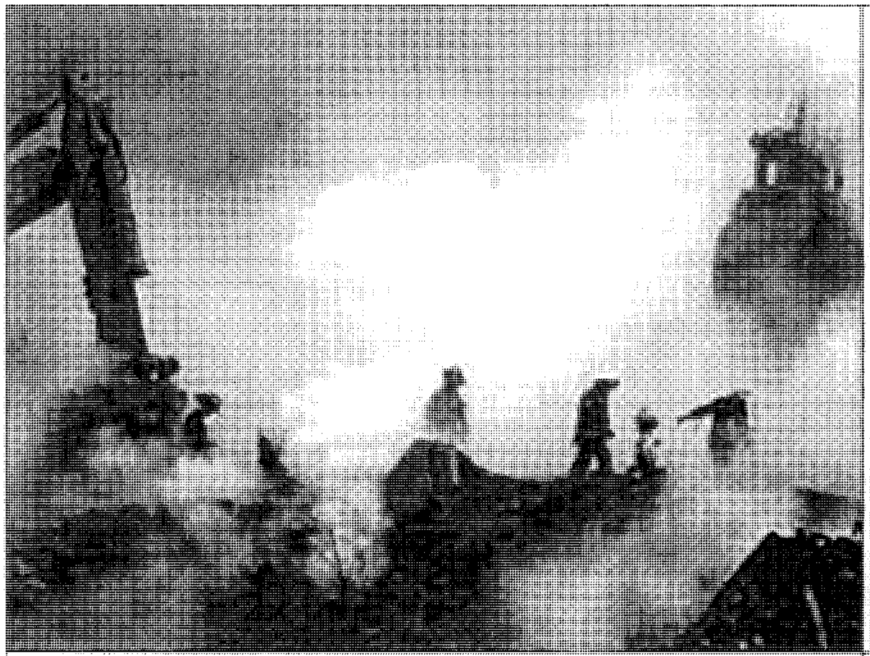

Figure 29. The white clouds cannot be steam or smoke because these GZ workers are not cooked and have not been asphyxiated. *(10/31/01)* 011011_zero04.jpg

Figure 30. This fuming looks like cotton candy, but it is deadly. *(11?/?/01)* 5159_moldy.jpg

**Figure 31.** Steam? If this were steam, these workers would have been cooked. If this were as hot as a grill, these people would become something that looked more like a grilled-cheese sandwich. *(9/12/01)*

**Figure 32.** Near the bottom of GZ, it's a swamp, but it is still fuming.

20

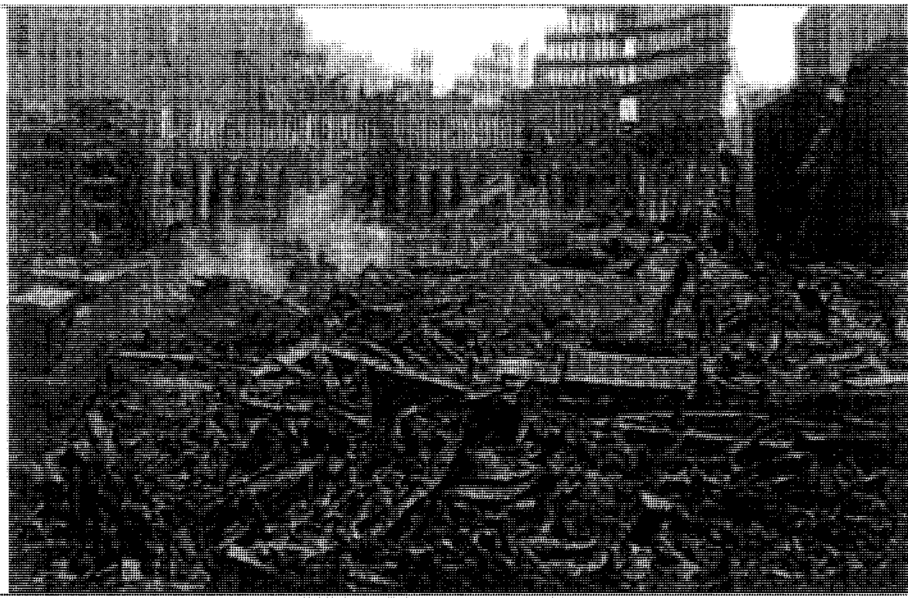

**Figure 33.** This "pile" cannot be very hot, because grapplers and people cannot work under such conditions.
*(10/13/01)*

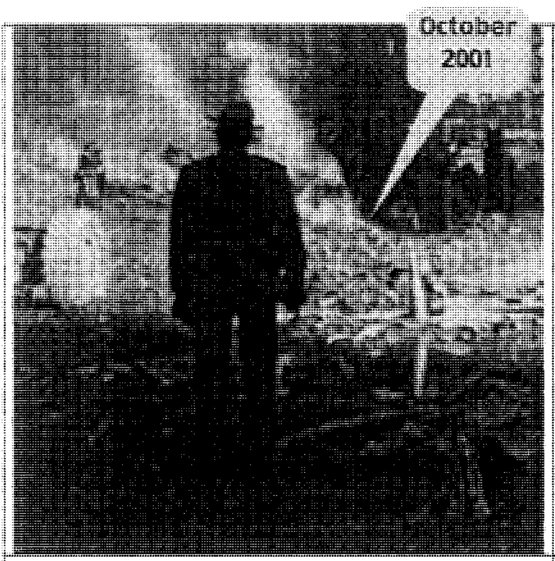


**Figure 34.** Smoke does not rise from saturated (wet) dirt. This is the "basement" of WTC1.
*(10/28/01) Source:*


**Figure 35.** These fumes are coming out of wet soil.
*(10/28/01) entered Source:*

21

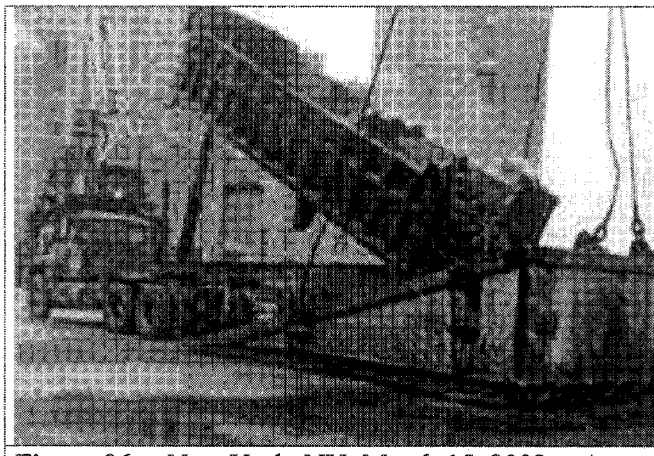

**Figure 36.** New York, NY, March 15, 2002 -- A truck dumps debris into the bucket of a 500-ton floating crane located at FEMA's Pier 25 Loading Site, a few blocks north of Ground Zero.
*(3/15/02) Source: FEMA*

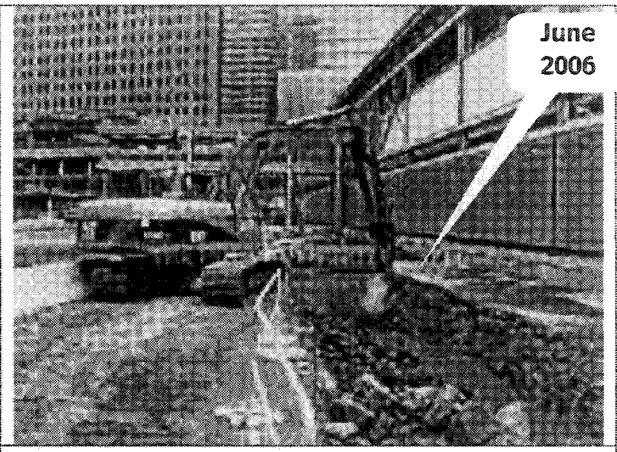


**Figure 37.** June 2006, looking north in the big bathtub. The new WTC7 is in the distance, on the right. Here's why the dirt is needed. This is the same "puff-ball poofing" we saw in October!
*(6/06) Source:*

They officially said all fires were out at the 99-day mark. Figure 36 is at the 6-month mark, yet the truckbed and tailgate are fuming. The stuff is covered with wet dirt. They are hosing it down as they dump it -- and it is still fuming. The tailgate of the truckbed is swung open and is fuming with no water on it. The water appears to cut down on the fuming. If this were steam, we would see the opposite of this.

Also, if it were hot, why didn't they hose it down and cool it off *BEFORE* they operated the hydraulics?
* If it's hot enough to require hosing down, it's too hot for hydraulics.
* If it's hot enough to require hosing down, why didn't they cool it off before operating the hydraulics?

The front tires of the truck appear dry as well as the cab. The upper-front of the truckbed appears dry. The lower-right end of the truckbed appears wet. The hose-down appears to be just in one place (note the water path in front of the building on the right, and note the water pattern on the pavement).

In Figure 37 the power shovel is stirring up the fuming in a mud puddle nearly five years after 9/11. This is not "smoke." The process that began on 9/11 still continues.

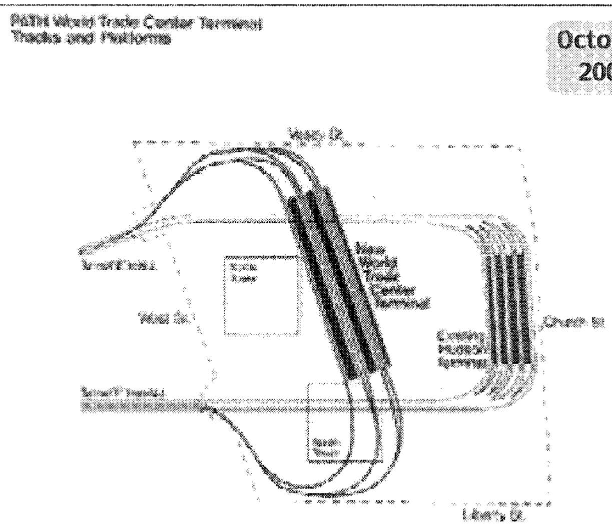

**Figure 38.** Prior to building the WTC, the PATH trains used to go through the big bathtub into the small (east) bathtub. The figure below comes from a document where they were planning to build the WTC and locate the PATH train stating in the big (west) bathtub. They left the old terminal.
*(?/?/?) Source:*

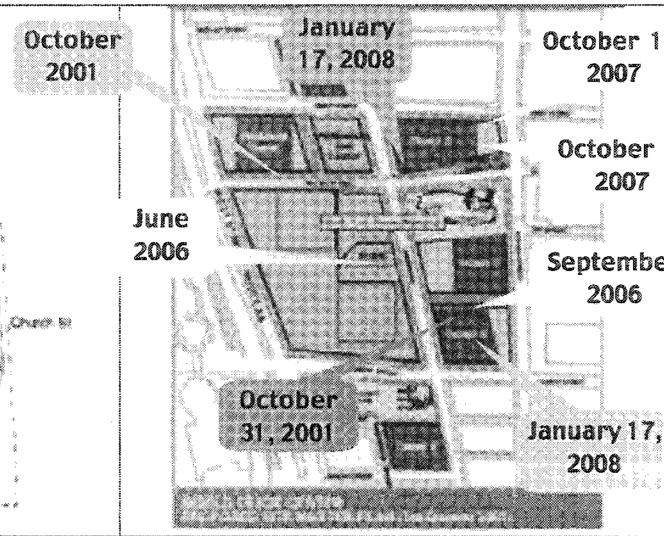


**Figure 39.** The "bubble dates" locate fuming by date for the photos shown in this affidavit. The old PATH train station was located below the original WTC 4 & 5 and where the new Tower 3 is planned.
*(?/?/?) Source:*

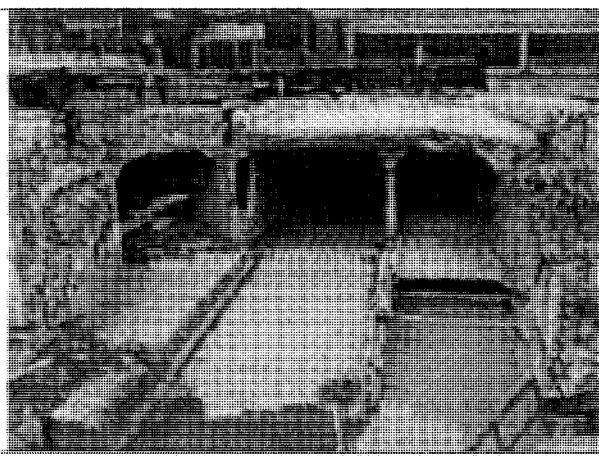

**Figure 40.** A view east where the PATH tracks were. Note, this area was not filled with dirt. The water here looks like what is seen in a typical rock quarry, not a muddy construction site.
*(4/06)*

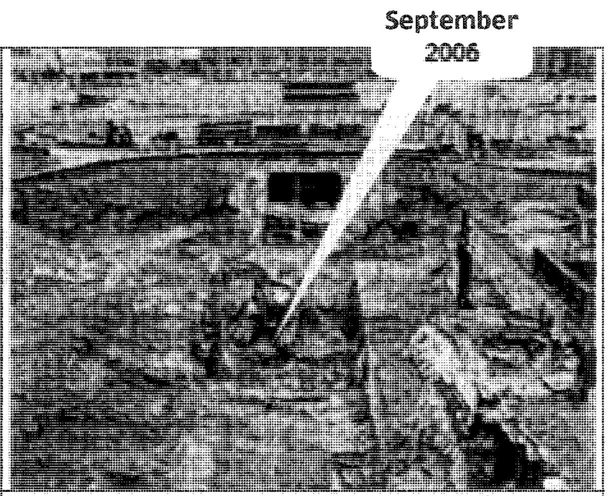


**Figure 41.** A view west along where the PATH train tracks were. Stirring the mud triggers fuming, five years after 9/11.
*(9/06)*

23


Figure 42. Fuming emerges from the wet dirt in the area between where WTC2 and WTC4 once stood. *(10/31/01) Source:*

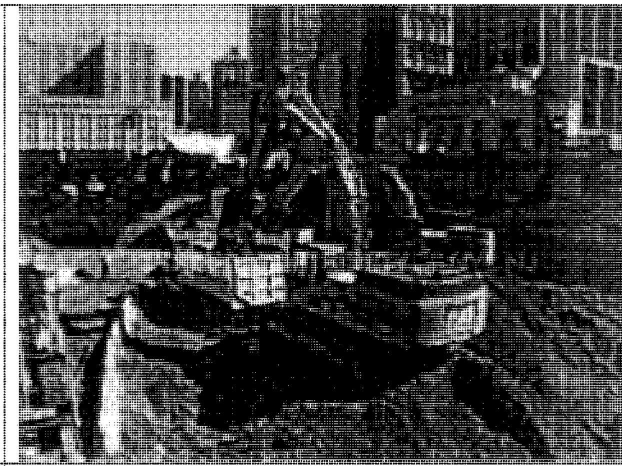

Figure 43. In September 2007, they are taking dirt out from the eastern bathtub. Where did the dirt come from? It was trucked in from outside Manhattan. *(9/07)*

**Port Authority Could Owe Larry Silverstein $12 M.-Plus for Delays**[14]
by Eliot Brown | December 31, 2007 Quoted from article: *(12/31/07):*
"'**As we got deeper and deeper there was a lot more rock that had to be blasted and broken up,**" he said. Officials said that the work on the 1,700-foot Freedom Tower is not affected by the problems at the Silverstein tower sites."

They are not blasting rocks in Figure **43**. They are trucking dirt in and out.

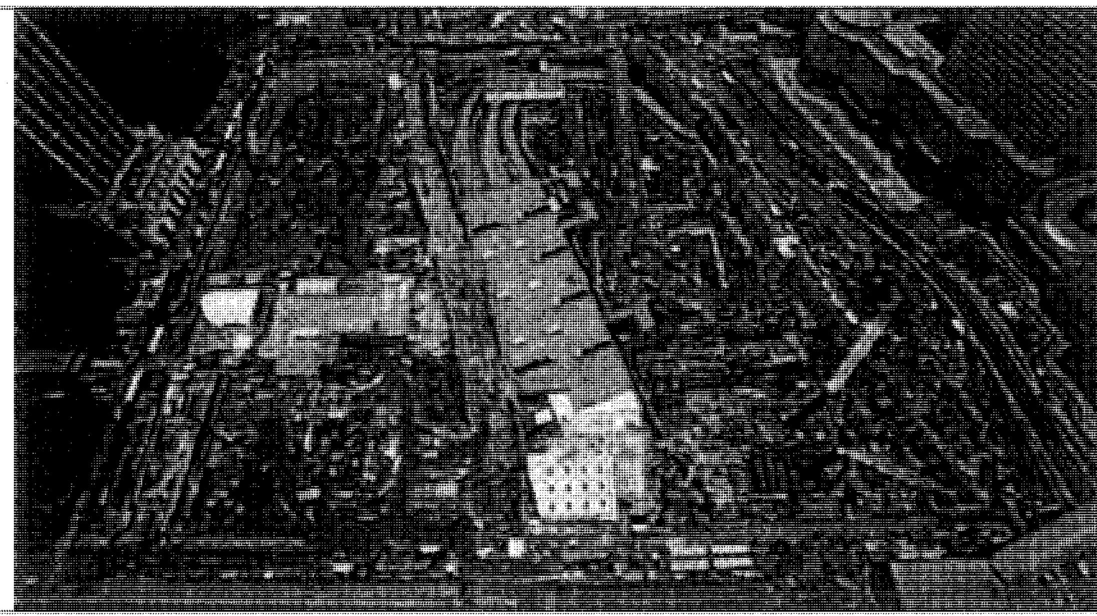

Figure 44. Looking south across Ground Zero in October 2007. None of the rrich-brown dirt came from the WTC nor was it dug up out of the bedrock. *(10/20/07) Source:*

[14] http://www.observer.com/2007/port-authority-could-owe-larry-silverstein-12m-plus-delays

24

The WTC buildings were built on bedrock, so any soft material between the surface and the bedrock was removed when the WTC foundations were built. So, the dirt seen in the above photograph must have been trucked in since 9/11. Dirt is used in chemical spills and in the cleanup of toxic sites.

**Figure 45.** This man is wearing a rubber hazmat suit. It was 75°F that day, October 12, 2007. *(10/12/07)*

**Figure 46.** Dump truck being hosed down before leaving the site through the Liberty Street gate. *(10/12/07) Source*

**Figure 47.** Yellow rubber hazmat suit? It's about 75°F, clear blue sky. Observe the mutual hose-down job? *(10/12/07) Source*

*Defendant SAIC was hired to secure the WTC cleanup.*

**New York picks SAIC to secure WTC site**

New York Gov. George Pataki's office said yesterday that San Diego's SAIC has been hired to help authorities create a master security plan for the World Trade Center site while it is being rebuilt. The comprehensive planning effort will coordinate all aspects of security for redevelopment of the World

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Trade Center site, from security design through construction, occupancy and operations. *(11/11/05)* http://wwww.signonsandiego.com/uniontrib/20051111/news_1b11saic.html

36. Here, I also confirm that the effects of DEW are still ongoing by presenting evidence associated with the current cleanup and the effects of DEW on the Bankers Trust building.

## Fixing BT before taking it apart, *Bankers Trust (Deutsche Bank)*

**Figure 48.** From FEMA report: [Link(pdf)] (archived) http://www.fema.gov/pdf/library/fema403_ch6.pdf http://drjudywood.com/pdf/fema403_ch6.pdf

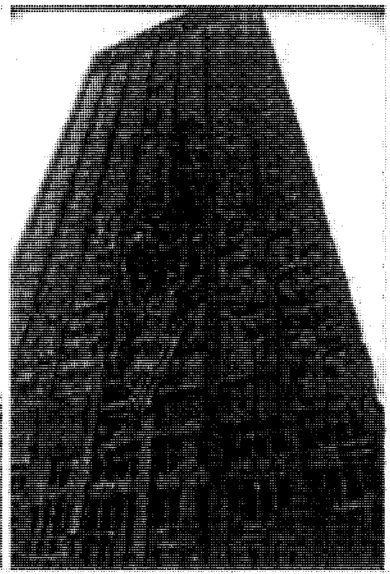


**Figure 49.** ***attachment6.php*** *(?/?/0?) Source:* http://wirednewyork.com/forum/attachment.php?attachmentid=3458&d=1170269946

**Figure 50.** **attachment7.php** *(?/?/0?) Source:* http://wirednewyork.com/forum/attachment.php?attachmentid=3459&d=1170269967

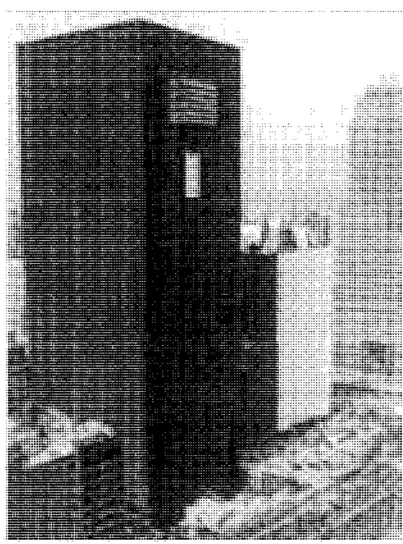


**Figure 51.** **020530_1020252_IMG.jpg** http://k43.pbase.com/u15/apmillard/upload/4818455.1020252_IMG.JPG **(30-May-2002 09:28:54)**

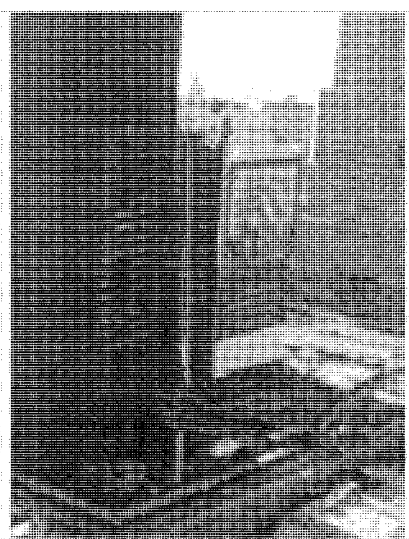


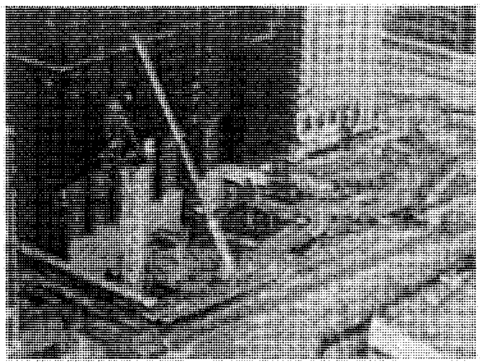
**Figure 52.** *Two years after 9/11 the missing floors are being replace.* **031103_06AbandonedDeutscheB.jpg**

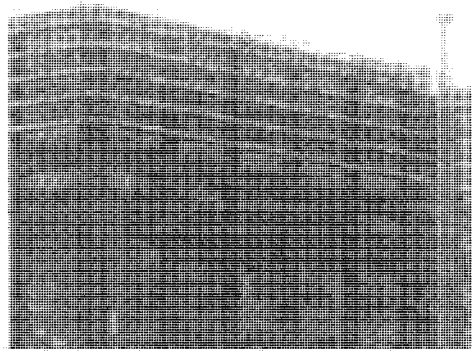
**Figure 53.** The structural and cosmetic damage to the building has been

26

http://i.pbase.com/u35/apmillard/upload/23202568.06AbandonedDeutscheBankbuilding.jpg
**03-Nov-2003 13:23:39**

rehabilitated.
060728_IMG_1701_edit.jpg
*(07/28/06) Source*





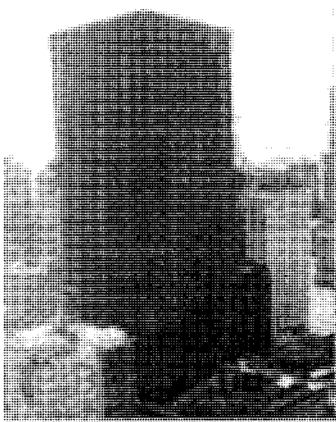


**Figure 54.**
**060301_IMG_1517.jpg**
http://i.pbase.com/o6/51/57151/1/80214221.EdF0aqzP.IMG_1517.jpg
**01-Mar-2006 13:31:47**

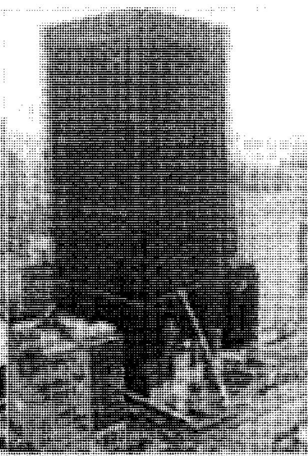


**Figure 55.**
**060728_IMG_1701_edit.jpg**
http://i.pbase.com/o6/51/57151/1/80214224.iJeOlpzP.IMG_1701_edited.jpg
**28-Jul-2006 08:09:43**

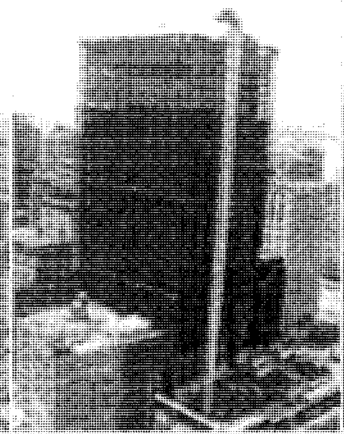


**Figure 56. 2007 June - Dismantling has started:** *It is being dismantled piece by piece.*
**070607_IMG_0594.jpg**
http://i.pbase.com/o6/51/57151/1/80214407.Vs1YYSCi.IMG_0594.jpg
**07-Jun-2007 12:43:43**

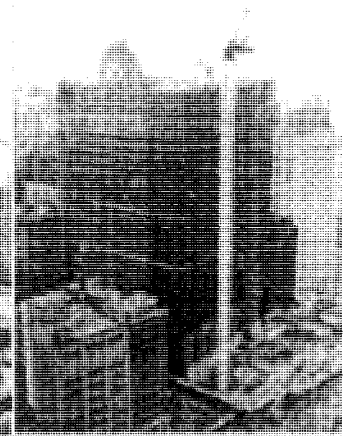


**Figure 57. 2007 September:** *This was taken a couple of weeks after the fire that killed three firefighters.*
**070907_IMG_1074.jpg**
http://i.pbase.com/o6/51/57151/1/85323874.YJ6gSStT.IMG_1074.jpg
**07-Sep-2007 08:30:01**

**Figure 58.** 1164155146_675bf025e7_b.jpg
*(?/?/0?) Source:*
http://farm2.static.flickr.com/1156/1164155146_675bf025e7_b.jpg

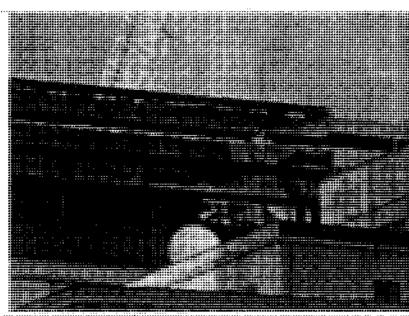


**Figure 59.** ire1163301181_358bb9202b_b.jpg
*(?/?/0?) Source:*
http://farm2.static.flickr.com/1146/1163301181_358bb9202b_b.jpg

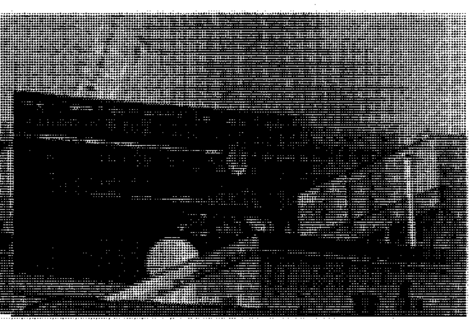
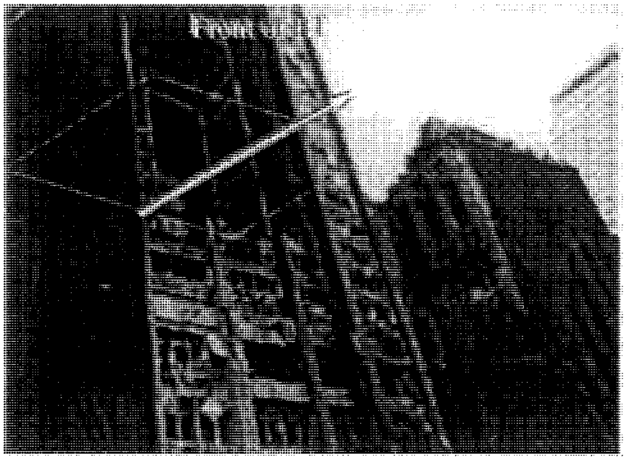


**Figure 60.** fire1164155736_e0b7316104_b.jpg
*(?/?/0?) Source:*
http://farm2.static.flickr.com/1225/1164155736_e0b7316104_b.jpg



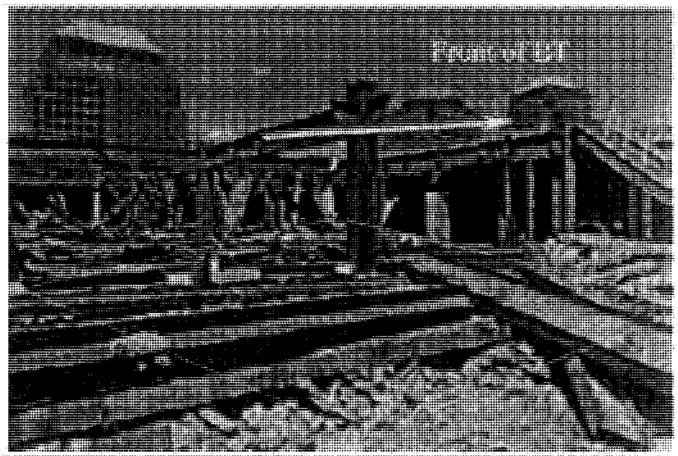



**Figure 61.** Photo from soon after 9/11. *(09/?/01) Source*:

**Figure 62.** This is Bankers Trust being taken apart. Recognize any "rustification" out there? There seems to be a trend for where the really furry-looking rust is. (WTC2 was across the street, to the right of where the first photo was taken.) That red furry-looking beam in the senter of the photo is incredible! How many years at the bottom of the ocean would be required to to that? 17bank_CA07.jpg *(01/?/07) Source*:

http://graphics8.nytimes.com/images/2007/08/16/nyregion/17bank_CA07.jpg
http://www.nytimes.com/slideshow/2007/08/16/nyregion/20070817_BANK_SLIDESHOW_6.html

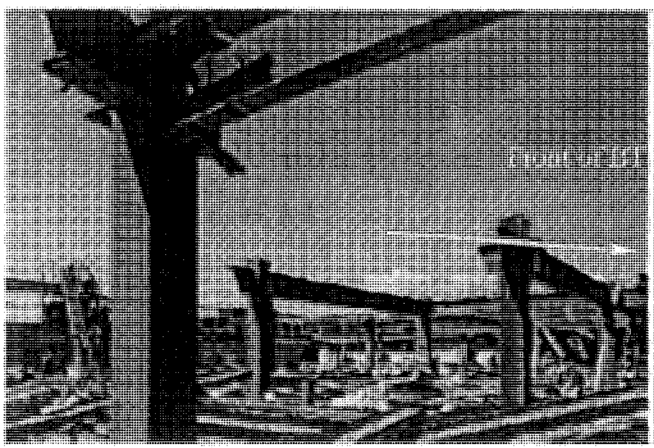



**Figure 63.** As more and more beams and columns are removed, what was once an enclosed building opens up to the sky.
17bank_CA08.jpg
*(?/?/07) Photo: David W. Dunlap/The New York Times*
http://graphics8.nytimes.com/images/2007/08/16/nyregion/17bank_CA08.jpg
http://www.nytimes.com/slideshow/2007/08/16/nyregion/20070817_BANK_SLIDESHOW_7.html


**Figure 64.** Once the concrete slab and metal decking are removed, what remains is a steel skeleton of each floor. There is little rust in the southwest corner of the building, even though it is open during the deconstruction from the top down.
17bank_CA06.jpg
http://graphics8.nytimes.com/images/2007/08/16/nyregion/17bank_CA06.jpg
http://www.nytimes.com/slideshow/2007/08/16/nyregion/20070817_BANK_SLIDESHOW_5.html
*(?/?/07) Photo: David W. Dunlap/The New York Times*

It appears that the folks in charge of Bankers Trust were unaware of the non-self-quenching nature of the process of molecular dissociation that was initiated on 9/11/01.

*Disintegrating Beams?*

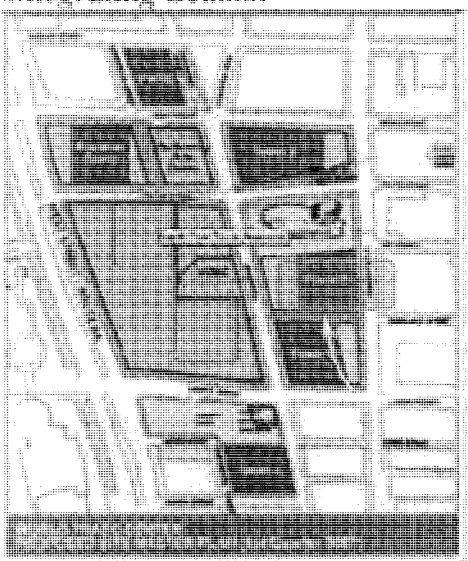


**Figure 65.** The old PATH train station used to be below the area between the original WTC 4 & 5 and where the new Tower 3 is, including adjacent areas.. wtc_new_map.jpg
*(01/?/07) Source*:

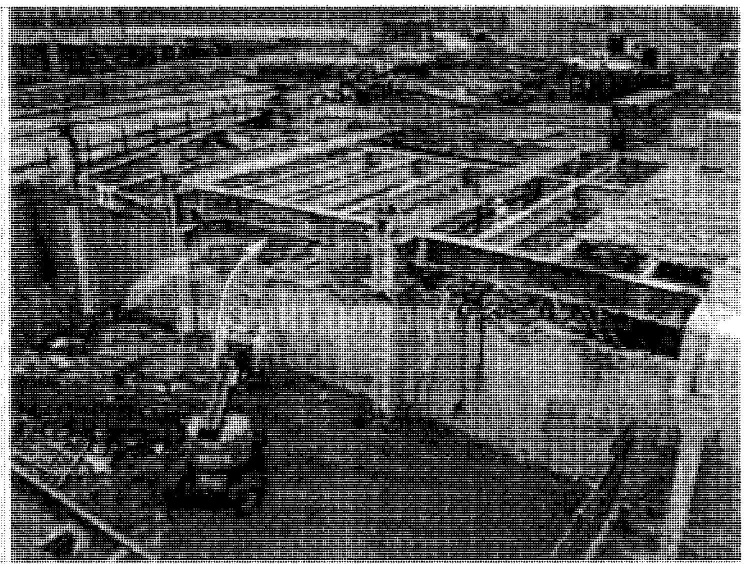


**Figure 66.** Why is this inspection being done with white hazmat suits? This is the area where the old PATH terminal was.
061200_HMdemo03.jpg
*(01/?/07) Source*:

*Ongoing Rapid Rusting*

Across from WTC7, they are building the **forth temporary PATH train** station since 9/11.

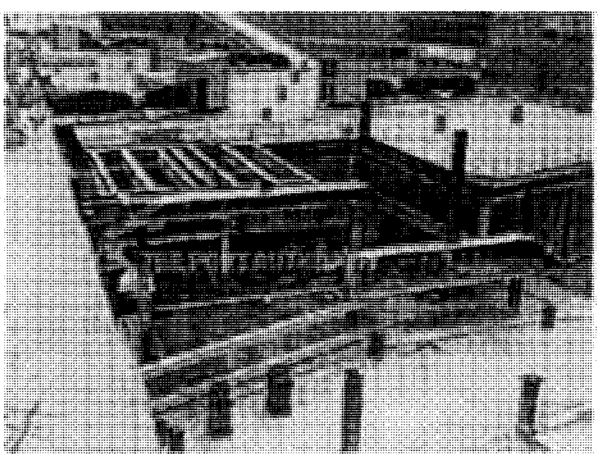


**Figure 67.** New beams rusted. June 2006
*(6/?/06) Sourc:e* 060600_RampJ02.jpg

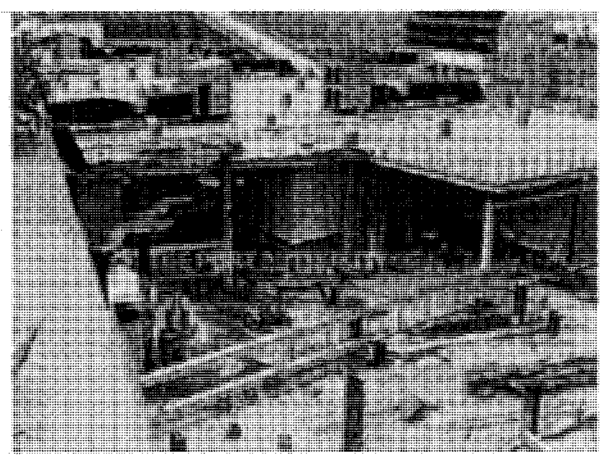


**Figure 68.** Infected beams removed, probably within days. *(6/?/06) Source*:

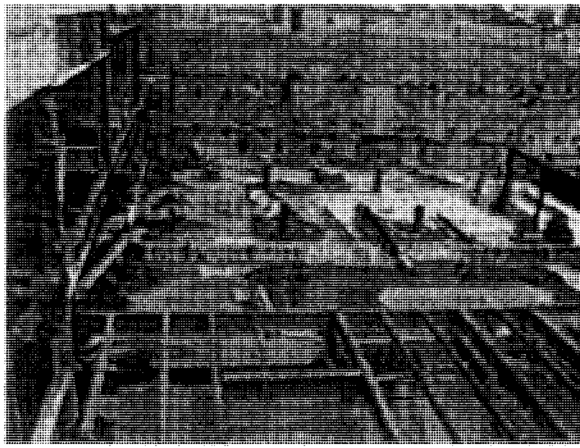


**Figure 69.** *(06/?/07)*: 070600_Npathstrstmp01.jpg

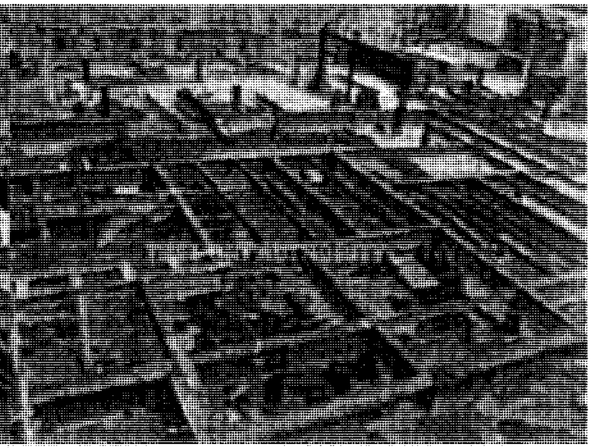


**Figure 70.** *(06/?/07)*: 070600_Npathstrstmp02.jpg

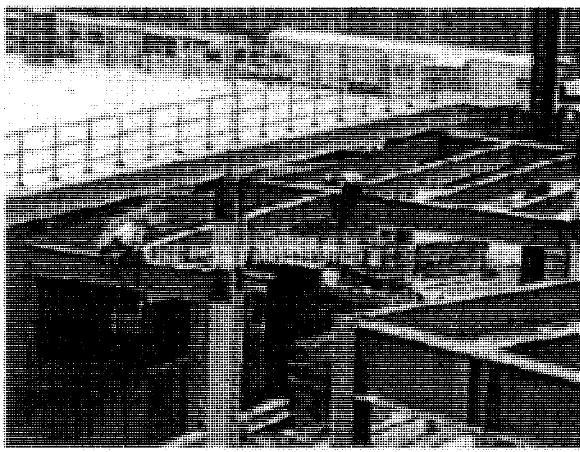


**Figure 71.** *(06/?/07)*: 070600_Npathstrstmp03.jpg

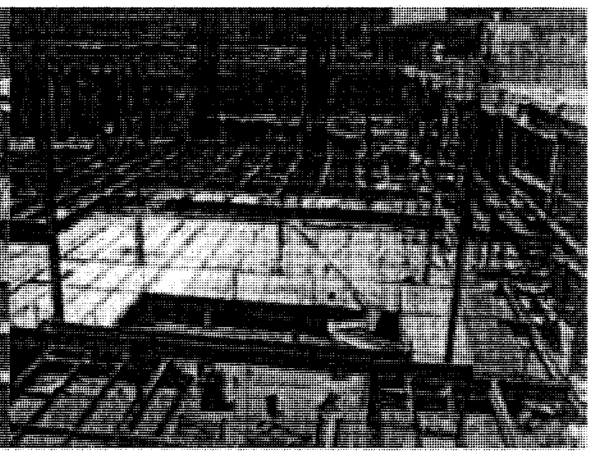


**Figure 72.** *(06/?/07)*: 070600_Npathstrstmp04.jpg

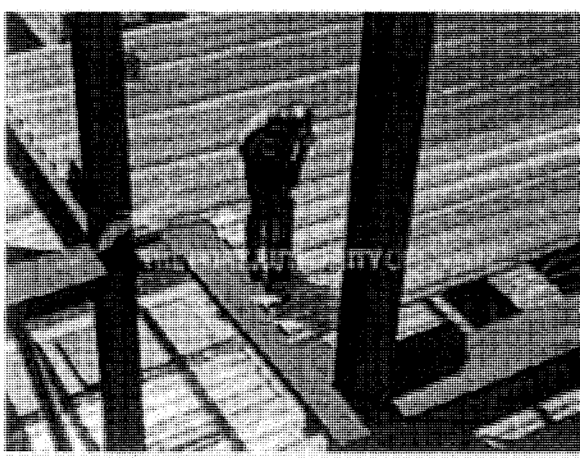


**Figure 73.** *(07/?/07) Source*: 070700_Npathstrstmp02.jpg

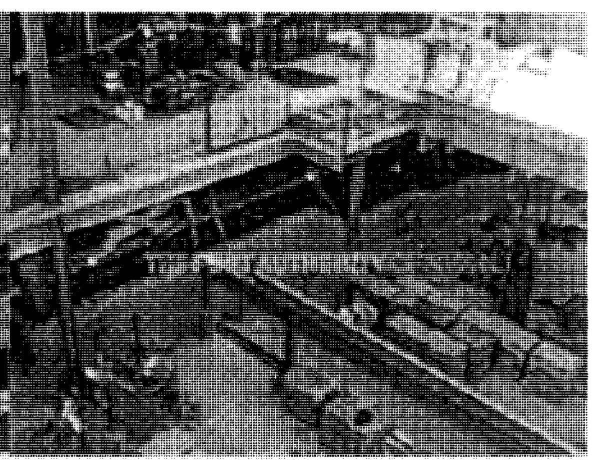


**Figure 74.** *(09/?/07)*: 070900_Npathstrstmp02.jpg

New beams. Nearly instantaneous rust. This is not normal, especially for treated and painted beams of structural steel. This is the kind of rust you might expect to see in an iron skillet left in standing water.

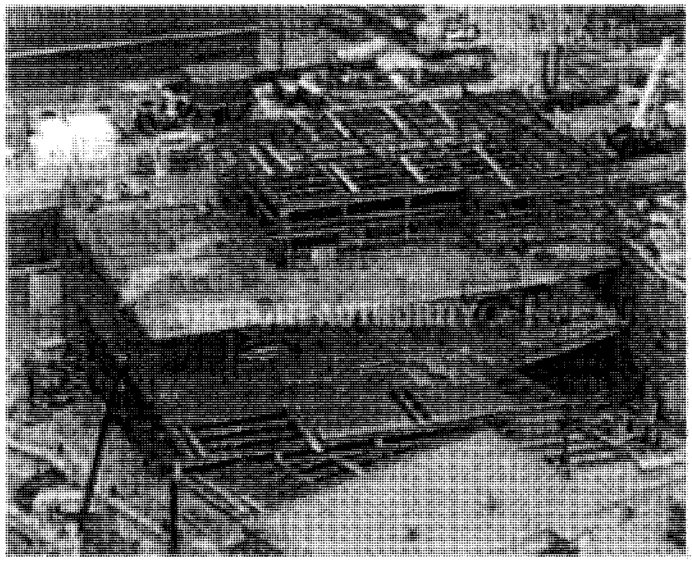


**Figure 75.** 070800_Npathstrstmp01.jpg
*(08/?/07) Source:*

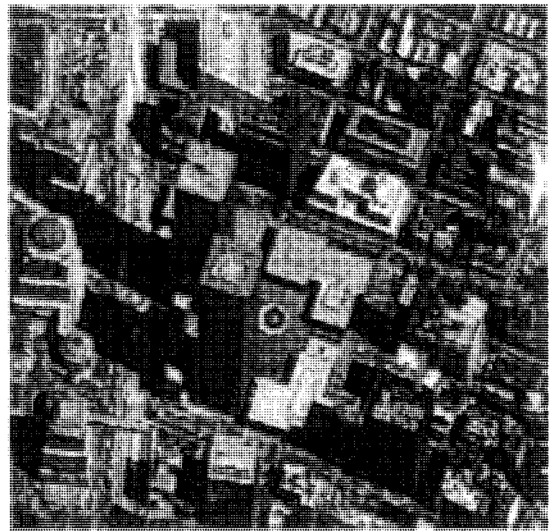


**Figure 76.** skyview.jpg
*(before to 9/11/01?) Source*

**Applied Research Associates, Inc. (ARA)**
**Knows the effects of DEW**

This is the **second temporary PATH train** station since 9/11.

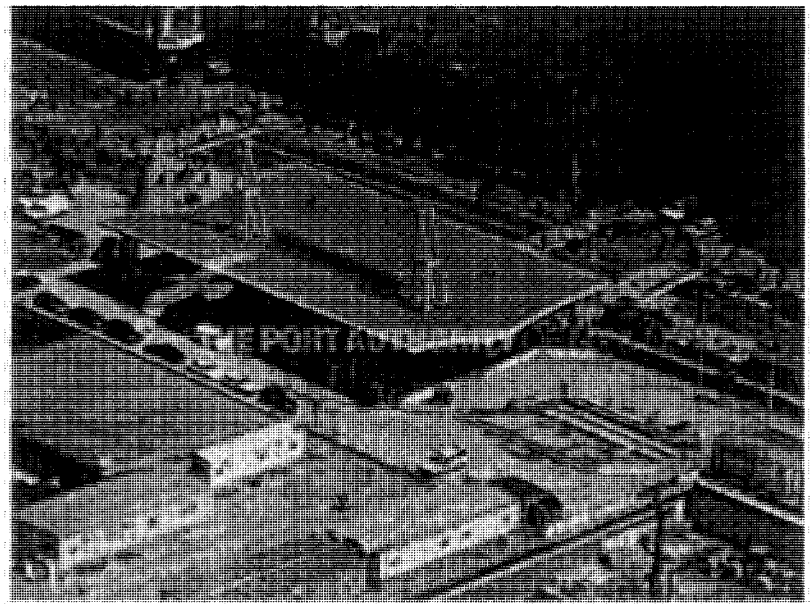


**Figure 77.**
070400_pathentmove01.jpg
*(04/?/07) Source*:

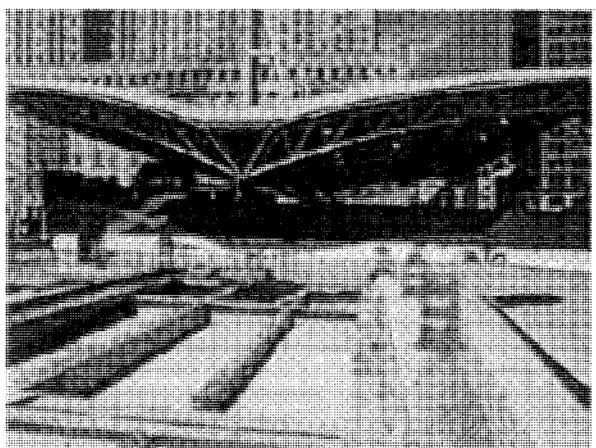


**Figure 78.**
070400_pathentmove02.jpg
*(04/?/07) Source*:

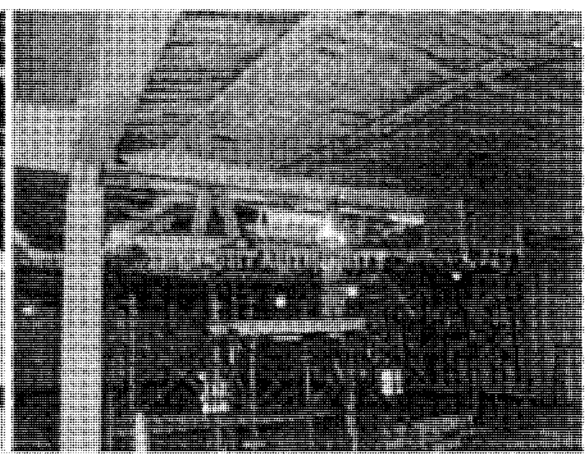


**Figure 79.**
070400_pathentmove03.jpg
*(04/?/07) Source*:

This is the third temporary PATH train station since 9/11.

**Figure 80.** 070500_pathstrstmp01.jpg
*(05/07) Source:*

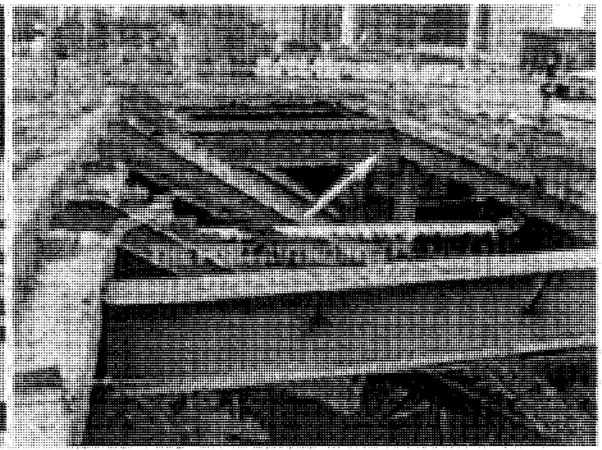


**Figure 81.** 070500_pathstrstmp03.jpg
*(05/07) Source:*

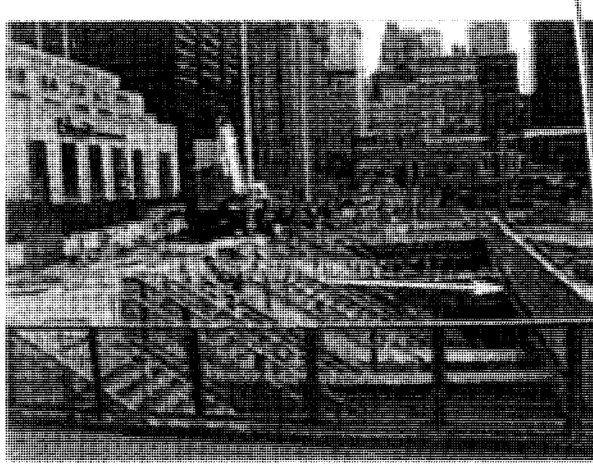


**Figure 82.**
070600_pathstrstmp02.jpg
*(06/?/07) Source:*

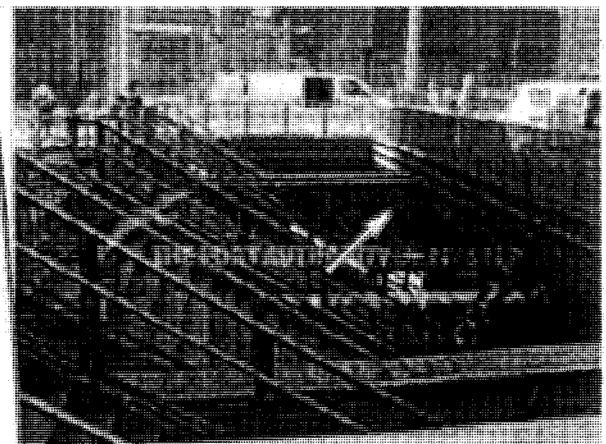


**Figure 83.**
070500_pathstrstmp04.jpg
*(05/?/07) Source*

Extraordinary rusting in only a few months.

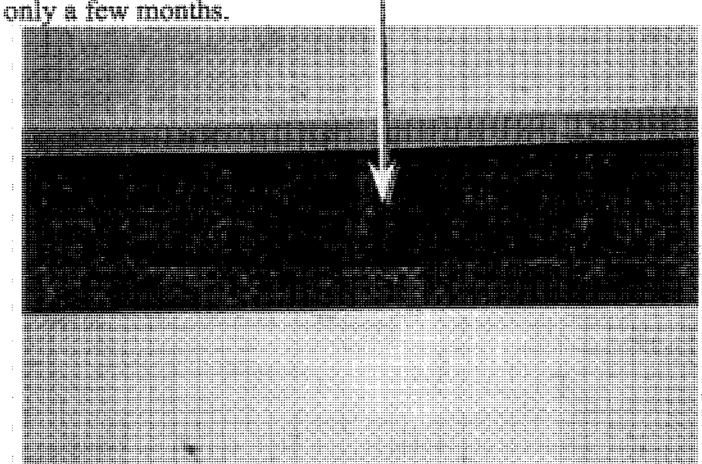


**Figure 84.**
*(10/09/07) Source*

33

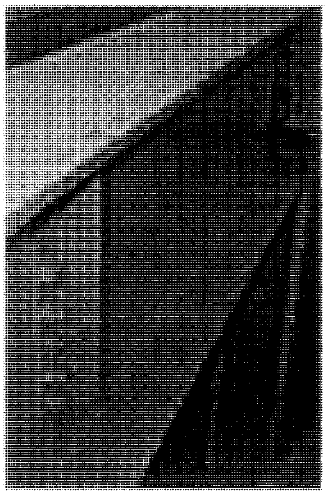


**Figure 85.**
*(10/09/07) Source*

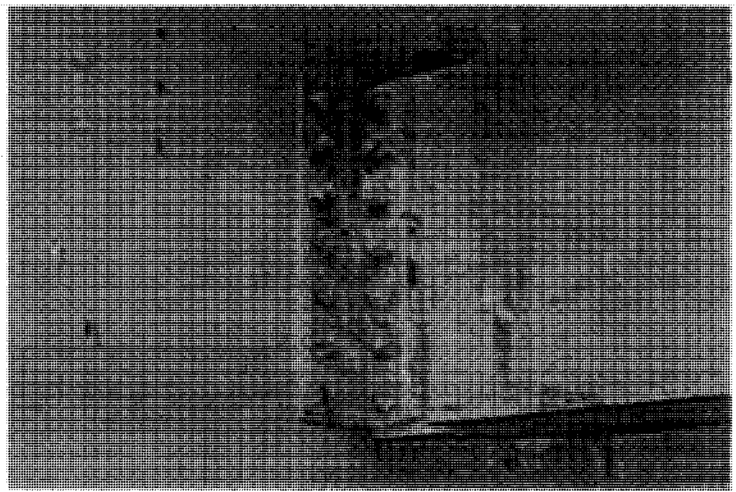


**Figure 86. This beam was painted in June 2007.**
*(10/09/07) Source*

**Wiss, Janney, Elstner Associates, Inc.**
Document and Evaluate the Steel Recovered from the WTC Towers

ARA is contracted to have comprehensive understanding of all weapons of mass destruction (WMD), including DEW.

## ARA - Federal Contract Vehicles

http://www.ara.com/about/contracts.htm

*Quoting ARA:*

| **Weapons of Mass Destruction-Defeat Technology (WMD-DT IDIQ)** |
|---|
| **Contract:** DTRA01-03-D-0014<br>**Scope:** Purpose is to support all present and future DTRA Counter WMD Technologies Directorate (CX) activities. These activities include supporting other DTRA directorates and providing operational support to the Combatant Commanders and their staffs. Additionally, the scope also includes supporting other federal, state and local government activities. Orders issued pursuant to this contract may be placed by Federal Agencies other than DTRA. Federal Agencies other than DTRA desiring to place orders under this contract shall contact the DTRA Contracting Officer, Ms. Kathryn Cooper,(703) 767-3503, for prior approval. This approval shall be obtained for each order.<br>**Period of Performance:** Active thru May 2008 + 5 year option |
| **Contact:** Rob Sues (703) 329-0200 |

To repeat, "**Weapons of Mass Destruction-Defeat Technology (WMD-DT IDIQ)**" and "Purpose is to support all present and future DTRA Counter WMD Technologies Directorate (CX) activities." Presumably ARA was chosen for this contract because it is a leading firm in WMD technologies. Obviously ARA has expertise is all WMD technologies.

ARA supports DTRA research and development. The Defense Threat Reduction Agency (DTRA)

## Fuming Rust and Rapid Rust

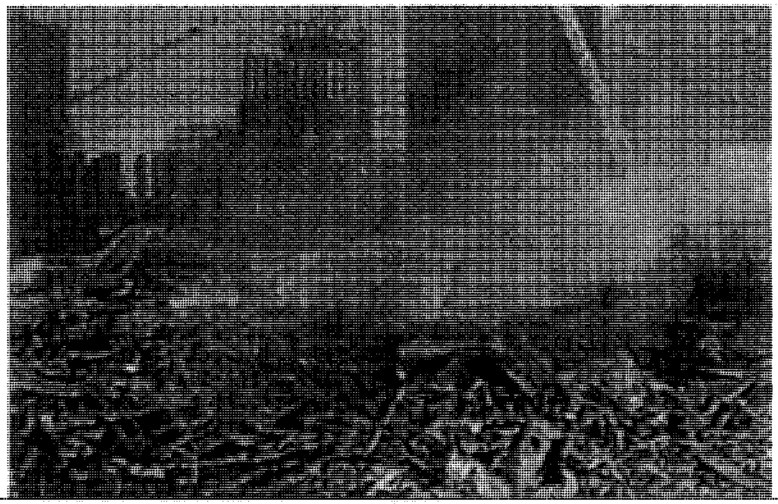


**Figure 87.** Instant rusting into the air? Does fire cause instant dust? I don't think so.
*(10/13/01)*

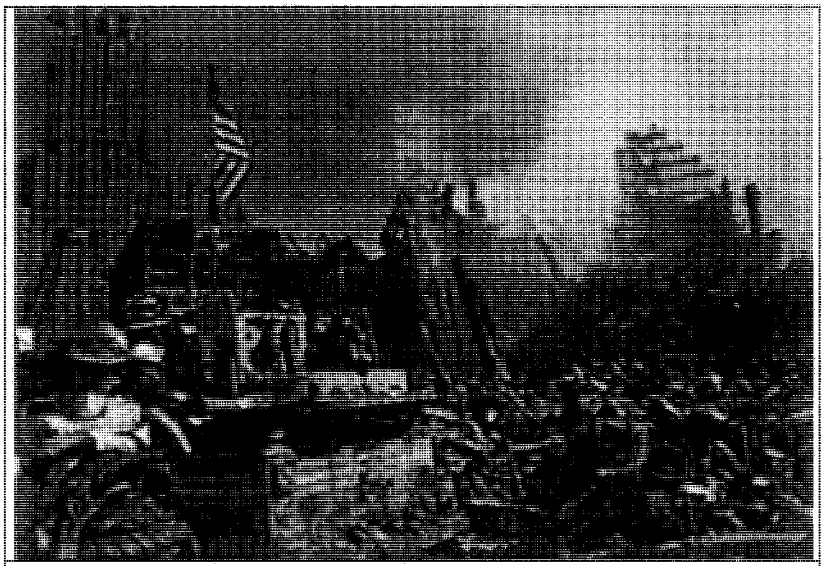


**Figure 88.** Why did so much of this "steel" rust in less than two days? Why did some of the more-exposed pieces not rust much?
*(9/13/01 entered) Source*

The following two photos are a view east, from West street, and both are probably early afternoon. The two images appear to be taken on days not too far apart, if not back-to-back days, because the "stuff" on the truck is in a similar place. (Note the white buckets as well as the metal "coil" on top.) perhaps 9/12-13/01? The fire truck has dust on it more than dirt. I don't see WTC7, so I don't think it's 9/11. In the first photo, the white fluff is on the wheatchex in the foreground. So, it hasn't rained, yet. (First big rain I noted was on 9/14/01.) Road graders have gone through. They've only taken the first pass with the road-grader/street-cleaner, so that also supports it being early. Maybe they aren't on back-to-back days. That's a lot of stuff they'd need to cart away. But, they wouldn't be directing the search dogs for too long.

The flag is not in the above and there are the "day after" flowers on the truck. I've noticed flowers on vehicles that were affected. Perhaps they're for those who died in the vehicle? The rusty coils of stuff looks very rusty in the second photo below.


**Figure 89.** Rust *(9/12-13?/01) Source*

**Figure 90.** More rust *(9/13?/01) Source:*


**Figure 91.** Instant rust? But, not all of the exposed steel was rusted. *(9/12?/01)*

**Figure 92.** Presumably these cars are finally being towed away from that lot. Those wheels look fairly good which means they probably aren't steel.
*(9/7/01) Source:*

**Figure 93.** Why is this one car rusted and the other is not?
*(9/7/01) Source:*

### *Rusty Beams and Pipes*

**Figure 94.** Original photo. It appears that pipes either rusted a lot or not at all.
*(9/16/01) Source*

**Figure 95.** This is the upper-left quadrant of the previous photo.
*(9/16/01) Source*

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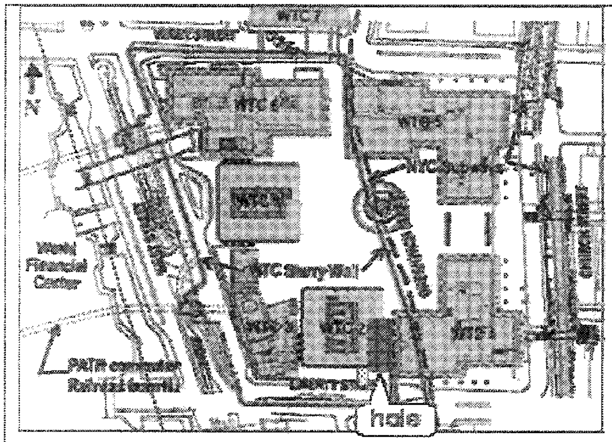


**Figure 96.** Solid red box locates the location in the figure to the left. This is the same location shown in the figure below.

**Figure 97.** The basement: of WTC2 *(9/18/01)*:

**Figure 98.** Outer columns with spandrel plates wrapped around them. Also, fresh dirt has arrived. *(9/16/01)*: *010916_5320_carpet.jpg*

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# Fire, UL testing

**Table 5–5. Times to reach ASTM E 119 end-point criteria and ASTM E 119 hourly ratings.**

| Test | Description | Times to Reach End-Point Criteria (min) | | | | | Test Terminated (min) | Standard Fire Test Rating (hr) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Temperature on Unexposed Surface | | Steel Temperatures | | Failure to Support Load | | ASTM E 119-61 | ASTM E 119-00 | |
| | | Average (Ambient +250°F) | Maximum (Ambient +325°F) | Average (1100°F) | Maximum (1300°F) | | | Rating | Restrained Rating | Unrestrained Rating |
| 1 | 35 ft restrained ¾ in SFRM | — | 111 (see Fig. 5-6) | 66 (see Fig. 5-1) | 62 (see Fig. 5-1) | (3) | 110(1) | 1½ | 1½ | 1 |
| 2 | 35 ft unrestrained ¾ in SFRM | — | — | 76 (Fig. 5-20) | 62 (Fig. 5-20) | (3) | 140(2) | 2 | — | 2 |
| 3 | 17 ft restrained ¾ in SFRM | 180 (see Fig. 5-41) | 157 (Fig. 5-41) | 66 (Fig. 5-35) | 76 (Fig. 5-36) | (3) | 210(1) | 2 | 2 | 1 |
| 4 | 17 ft restrained ½ in SFRM | — | 58 (Fig. 5-57) | 66 (Fig. 5-52) | 58 (Fig. 5-52) | (3) | 120(1) | ¾ | ¾ | ¾ |

Notes: (1) Test terminated due to imminent collapse
(2) Test terminated when vertical displacement exceeded capability to measure accurately
(3) Did not occur

**Figure 99.** The fire testing done by Underwriters Laboratory (UL) did not demonstrate failure of the structure.
UL Fire Tests
*(9/05)*: NISTNCSTAR 1-6? UL-Table5-5-No failur.jpg

**Rolf Jensen & Associates, Inc. (RJA) (fire alarm)**
(R-- Analysis of Active Fire Alarm Systems, WTC 1, 2, and 7)

**Underwriters Laboratory, Inc.**
(R -- Fire Endurance Testing of the World Trade Center Floor System (contract modification) *Also relates to* *SB1341-03-Q-0281 - 7/10/2003*
**Fire models, ASTM E119)**

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http://www.cooperativeresearch.org/context.jsp?item=a111099wtcfire#a111099wtcfire
Context of 'November 10, 1999: North WTC Tower Suffers Last 'Significant' Fire Prior to 9/11; Bigger Fire Occurred in 1975'

## Context of 'November 10, 1999: North WTC Tower Suffers Last 'Significant' Fire Prior to 9/11; Bigger Fire Occurred in 1975'

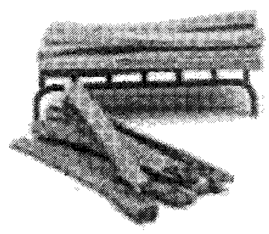
This is a scalable context timeline. It contains events related to the event
http://www.cooperativeresearch.org/context.jsp?item=a111099wtcfire&scale=0#a111099wtcfire
**November 10, 1999: North WTC Tower Suffers Last 'Significant' Fire Prior to 9/11; Bigger Fire Occurred in 1975**. You can narrow or broaden the context of this timeline by adjusting the zoom level. The lower the scale, the more relevant the items on average will be, while the higher the scale, the less relevant the items, on average, will be.

http://www.cooperativeresearch.org/context.jsp?item=a111099wtcfire#a111099wtcfire
**November 10, 1999: North WTC Tower Suffers Last 'Significant' Fire Prior to 9/11; Bigger Fire Occurred in 1975**
http://www.cooperativeresearch.org/eventedit.jsp?oid=1626004942-17511

The North Tower of the WTC suffers a fire on its 104th floor. This is the 15th and last of what the National Institute of Standards and Technology later describes as "significant fires," which occurred in the Twin Towers from 1975 onwards, and prior to 9/11. These fires each activate up to three sprinklers but are confined to just one floor.
http://wtc.nist.gov/oct05NCSTAR1-4index.htm
Kuligowski, Evans, and Peacock, 9/2005, pp. 7-11] Additionally, on **February 14, 1975** a major fire occurred, the result of arson, which began on the 11th floor of the North Tower during the middle of the night. Spreading through floor openings in the utility closets, it caused damage from the **10th to 19th floors**, though this was generally confined to the utility closets. However, on the **11th floor about 9,000 square feet was damaged**. This was about **21 percent of the floor's total area** (43,200 square feet) and took weeks to repair. Some parts of the steel trusses (floor supports) buckled due to the heat. **132 firefighters** were called to the tower in response, and because the fire was so hot, many got their necks and ears burned. Fire Department Captain Harold Kull described the three-hour effort to extinguish it as "like fighting a blowtorch."

http://www.epa.gov/wtc/panel/ATSDRFinal-report-lowermanhattan-02.pdf
WTC Environmental Assessment Working Group, 9/2002, pp. 10 ;
http://www.mishalov.com/wtc_firetest.html
New York Times, 5/8/2003;
http://www.amazon.com/exec/obidos/ASIN/0805074287/centerforcoop-20
Glanz and Lipton, 2004, pp. 213, 214, 324;
http://wtc.nist.gov/oct05NCSTAR1-4index.htm
Kuligowski, Evans, and Peacock, 9/2005, pp. 1] An article in Fire Engineering magazine will later summarize, "[A]lmost all large buildings will be the location for a major fire in their useful life. No major high-rise building has ever collapsed from fire. The WTC was the location for such a fire in **1975**; however, the building survived with minor damage and was repaired and returned to service."
http://fe.pennnet.com/Articles/Article_Display.cfm?Section=Archi&Subsection=Display&P=25&ARTICLE_ID=163411
Fire Engineering, 10/2002. Building 7 of the WTC, which completely collapses late in the afternoon on 9/11, has also suffered a 'significant' fire in 1988, occurring on its third floor, with multiple sprinklers being activated.
http://wtc.nist.gov/oct05NCSTAR1-4index.htm
Kuligowski, Evans, and Peacock, 9/2005, pp. 12

# Fixing BT before taking apart



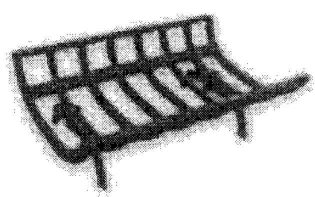


**Figure 100.** Wood panelling and paper don't burn hot enough to melt steel.
Source: *northlineexpress.com*

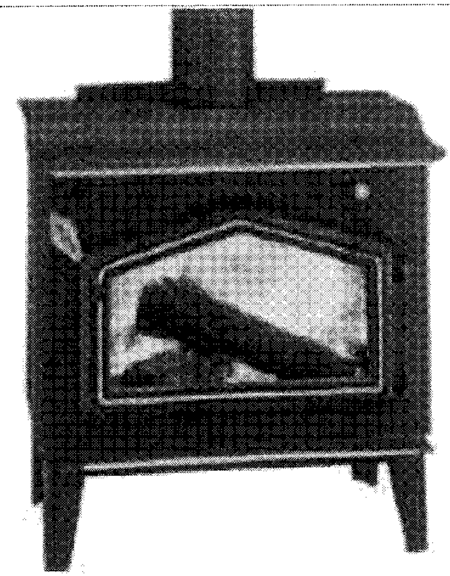


**Figure 101.** These fires do not melt or significantly weaken steel.
Source: *Century wood stoves*

**File 2. No. 9110019, 10**
WORLD TRADE CENTER TASK FORCE INTERVIEW
LIEUTENANT BRIAN BECKER
Interview Date: October 9, 2001
**So I think that the building was really kind of starting to melt. We were -- like, the melt down was beginning. The collapse hadn't begun, but it was not a fire any more up there. It was like -- it was like that -- like smoke explosion on a tremendous scale going on up there.**

**Figure 102.** This first responder indicates he thought it was not a "collapse" due to fire but a disintegration of the building.
*(10/9/01) Source* http://graphics8.nytimes.com/packages/html/nyregion/20050812_WTC_GRAPHIC/met

**File 3. No. 9110041, 32** **DEW**
WORLD TRADE CENTER TASK FORCE INTERVIEW
EMT JARJEAN FELTON
Interview Date: October 10, 2001
"...about that. I wasn't worried about the time. I looked for my partner, they was like "Make sure you have your partner, you two stay together." Cause they was stressing that. "Make sure your partner is with you at all times." So, we were together. After that I don't know what happened. I really don't know what's going on. Really, I'm not really sure what's going on. By that time it was, one was still on fire, that was the last one hit, but that was the first one to come down. I would say like, right when I got back to Vesey and North, that's when one came down. At that time, I just left my vehicle and everybody's just running up North End Avenue. Whatever avenue it is, everyone is running up. I remember seeing we're all running, running like There's a little park here, we're running alongside there. I seen firemen, I seen everybody. I seen all types of equipment laying down on the ground, I seen Scott Packs making that noise.
Q: The alarm?
A: Yeah, the alarm for like say, somebody got knocked out and they're laying motionless. That alarm is going off. I just heard that, you just seen a whole bunch of equipment all over the place."

**Figure 103.** What happened to the firemen whose Scott Packs had alarms going?
*(10/10/01) Source* http://graphics8.nytimes.com/packages/html/nyregion/20050812_WTC_GRAPHIC/met

**File 4. No. 9110506** **DEW-levitation**
WORLD TRADE CENTER TASK FORCE INTERVIEW
FIREFIGHTER MICHAEL MACKO
Interview Date: January 25, 2002

"We were making our way down West Street. We got just about south of the north overpass, about 50 feet past that, when the first collapse occurred. I looked up. I was awed by -- I thought it exploded at the top. Everybody I guess at that point started running, and I luckily ran north where I came from to try to run out from under this -- which happened to be a collapse, realized I couldn't. I was going to stay under the overpass.

I realized I couldn't get out from under the collapse. I dove under an ESU truck that was facing north on the west side of West Street. I dove under that and waited for the building to come down.
When the building did come down, I actually thought I was trapped, and the truck was blown off me, pushed off me, I guess. It was not there. At that point I was just really shocked and didn't know what was going on at that point. I didn't know -- I was really, really shocked."

**Figure 104.** Truck blown off = levitation?
*(1/25/02) Source* http://graphics8.nytimes.com/packages/html/nyregion/20050812_WTC_GRAPHIC/met

**File 5. File No. 9110145,** **DEW**
WORLD TRADE CENTER TASK FORCE INTERVIEW

EMS CHIEF ZACHARY GOLDFARB
Interview Date: October 23, 2001

"So then she tells me or we discover that one of the buildings we think had collapsed. You really couldn't tell because there was just clouds and smoke, but it was like it wasn't there. I can't begin to tell you how weird this thing was and what a strange feeling this was."

...

"So the second tower comes down. Huge clouds, huge -- the same thing. It's like, hey, I've been here already, you know? Just horrible. The strangest thing is I don't remember noise associated with it. You would think that would be a very noisy kind of thing, and I just remember quiet. I don't know if like your ears disconnect or something? I don't know. I don't remember ground shaking, noise, any of that stuff, and I was right there. Much too close."

**Figure 105.** Quiet
*(10/9/01) Source* http://graphics8.nytimes.com/packages/html/nyregion/20050812_WTC_GRAPHIC/met

**File 6. No. 9110192,** **disappear** **Can't breath** **DEW**
WORLD TRADE CENTER TASK FORCE INTERVIEW
CAPTAIN KARIN DESHORE
Interview Date: November 7, 2001

"As they are walking now they are tripping on the straps, so I told them -- again, I told them this is not right. You are going to fall and hurt yourself. You won't be able to help anybody and they took the long board and put it on top. My last recollection was of them going towards the building.

I asked at that time -- everybody else was with me still and I kept pushing them back and back and back, because I said what is this, a subway at the end of the overpass, because there is fire coming out of the ground. I didn't realize that that was a car already on fire over there."

...

" I had no clue what was going on. I never turned around because a sound came from somewhere that I never heard before. Some people compared it with an airplane. It was the worst sound of a rolling sound, not a thunder. I can't explain it, what it was. All I know is -- and a force started to come hit me in my back. I can't explain it. You had to be there. All I know is I had to run because I thought there was an explosion.
I ran about 10, 12 feet up this little grassy hill and by then this force and this sound caught up with me already. I threw myself behind the last support column of the pedestrian overpass. It became pitch dark. The sound got worse, the force just kept passing me. At times I thought it was like an orange light maybe, coming past me.

I was unaware what was happening. I thought it was just a major explosion. I didn't know the building was collapsing. I was sitting with my left side towards the support beam, total darkness, total noise. I felt beyond alone. I felt desolated. I felt like, all I could say was people think about their families and whatever. All I kept saying to myself within me I don't want to die, I don't want to die, I don't want to die.

I can't tell you how long it was before it died down. I just felt like the darkness the loneliness and being alone was the worst thing I ever experienced in my life and not being able to breathe. There was no air. Whatever this explosion was simply sucked all the oxygen out of the air. You couldn't breathe and the feeling of suffocation, I can't explain no further on that.

I don't know how long it took. All of a sudden it was all over and the silence set in. Nobody cried, nobody talked, nobody made a sound. There was nothing. Absolutely nothing. You could open your eyes, it was pitch black. Breathing became a little bit easier but I just sat there. I didn't know what was happening and I just sat there. Again, I can't give you time periods, 5 minutes, 5 seconds or however long it might have been. Somehow over my right shoulder I hear this male voice, "is there anybody out there." I didn't know at first should I answer, should I not answer. Then I just said I'm over here, please don't leave me. The man said I'm over here, I can't see. That's when I opened my eyes. I said I can't see either. He said okay I'm going to talk. I said I'm going to talk and we will find each other. That's exactly what we did. We found each other. We kept talking to each other. We found each other. Nobody else answered, nobody else said a word. I was unaware that there were people from my unit laying all around me. They described it later on where they were.

I had a police van in front of me, about 6 feet that I remember being there. I saw a picture later on, it was totally destroyed. Two feet to my right there was an overturned car, which I saw later on the pictures also. I had steel beams all around me.

Like I said I found this gentleman and we held onto each other like little kids. By then we were coughing, vomiting, spitting. It was just -- we were trying to breathe. It was total darkness. We couldn't see anything behind us at all. We found about 5 or 6 more people and we held onto each other. Like little kids, we walked, as I found out later on, towards the water. Since I didn't know any of the location I didn't know there was a marina. We just walked in a direction where we could walk. We held onto each other. We were all coughing, vomiting. Some of us fell down. We would pick each other up. There might have been 6, 7, 8 of us by now. There were dead bodies laying everywhere, obvious signs of death."

...

"Again, I didn't see what was happening behind me, but knowing of all the explosions I thought here was another explosion coming and this sound again and this wave of this force again. I just jumped on the boat, closed the door with my left hand and just sank down to my knees. Here whatever it was just came right at us again. The sergeant is yelling at the one officer. The second officer was in the back with some of the people that had been in the back of the boat. I had no clue what was going on back there. The sergeant is yelling at the second officer, get the fuck out of here, get the fuck out of here. I'm sorry for using that word repeatedly. The poor guy behind the steering wheel is saying I can't go any place, we are tied on. That is about what saved our lives, because this force came at us and hit us with everything. The boat was attempting to overturn and it kept hitting in the back against the pier. Again, I was just -- by then I was resigned to die. I didn't mind dying because I was with other people, you know, and the guy behind the steering wheel just sank to his knee and the sergeant just stood at the other door. I have no clue how long that lasted. I was -- my back was towards it and as I'm sitting in this corner there I was just resigned, this is it, it can't happen to me a second time. We were -- this time was a difference. We were capable of breathing and I was with somebody."

**Figure 106.** This first responder indicates he thought it was not a "collapse" due to fire but a disintegration of the building.

*(11/7/01) Source* http://graphics8.nytimes.com/packages/html/nyregion/20050812_WTC_GRAPHIC/met

**File 7. No. 9110225,** **disappear**

WORLD TRADE CENTER TASK FORCE INTERVIEW
FIREFIGHTER BERTRAM SPRINGSTEAD
Interview Date: December 4, 2001

I remember somebody said, "You think you're having a bad day? Take a look out this window." We looked

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out the Trade Center window, and there was the Vista Hotel, I guess it was there. I'm not really sure what building I was looking at, but I'm pretty sure it was the roof of the Vista. There had to be 30, 40 jumpers sprayed out all over the roof. I went, "Oh, Jesus, what the hell is going on here?"

As I was looking out the window, which is a total of five seconds, another jumper comes by, kind of like **clipped the edge of the roof and just vaporized. The guy just disappeared. There was no longer a body, just a big cloud of red.**

Q. Wow.
A. I was like, "I didn't need to see that." A total of five seconds I was looking out that window, total.

**Figure 107.** This first responder indicates he thought it was not a "collapse" due to fire but a disintegration of the building.
*(12/4/01) Source* http://graphics8.nytimes.com/packages/html/nyregion/20050812_WTC_GRAPHIC/met

**File 8. No. 9110150,** **disappear** **DEW**
WORLD TRADE CENTER TASK FORCE INTERVIEW
CAPTAIN RAY GOLDBACH Interview
Date: October 24, 2001

Before we got back to the command post, somebody told us that the Mayor's group had now gone to 7 World Trade Center to the OEM command post. We went from where we were at that point, it was somewhere around Vesey or Vesey or something like that. We got into 7 World Trade Center, we took the escalator up to the second floor, then we were going to take the elevator. I think it was John Peruggia from operations, but I'm not sure, at that point told us we had to get out of that building. Everybody was evacuated in that buildingl. We walked out of 7 World Trade Center, now following the whole group of people from City Hall who were somewhere ahead of us. I think we were on Washington Street near Greenwich Street, when the north tower started to collapse. I remember running and I think it was down Greenwich Street with John McLaughlin. We lost the Commissioner and the guy that he was with, the marshall. We got caught like in a white out, like a blizzard, and like dust, felt like insulation. Myself and John stayed together. We were trying to get down next to - we got down on the street and on our hands and knees crawled to the curb. I remember thinking to myself I thought we were going to get run over by a car. We didn't know whether - I thought I saw the building collapsing, but I didn't believe it. I saw it disappearing into a cloud, but I thought maybe a couple of floors had fallen off.

At that point we made our way about half a block up till we could eventually see. We got ourselves together. I said to him we got to make sure we find the boss. We went back into the cloud again, myself and John, and we walked around in this dust cloud. You couldn't see your hand in front of your face. Probably a couple of minutes, just calling the Commissioner. Eventually he and the marshall he was with called us. They had got across the street from where we were and into a doorway.

At that point I think we walked further up Greenwich Street and somebody brought us into another building where the Mayor's whole staff was. Everybody was tremendously in panic at that point. They decided that they were going to try to stabilize the situation in some way. They had to get away from this. We started working our way, I think it was up Broadway, I believe. Stopping at several places where the Mayor was looking for a place where we might be able to set up some type of - I don't know whether it was a command post or a place just to talk, and he was giving news reports as we were walking on the street. Every couple of minutes he would stop and give an update on whatever he had. Just what was going on as we were walking uptown.

We walked all the way up to 5 truck in a panic and haste situation. We just about forced our way into the fire house and we set up the - I guess the initial operations point from the Mayor's office at 5 truck. We were

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there for -- prior to getting to 5 truck, the other tower fell down. I remember telling Tom the other tower fell down. I saw it disappear into a cloud again and he didn't believe me, because he was continuing to walk, but I remember telling him that, at some point during the walk while we were going uptown.

Q. You were referring to Commissioner Von Essen?
A. Yes, Commissioner Von Essen. We were in 5 truck for what seemed like a long time.
Q. Where is 5 truck?

**Figure 108.** This first responder indicates he thought it was not a "collapse" due to fire but a disintegration of the building.
*(10/24/01) Source* http://graphics8.nytimes.com/packages/html/nyregion/20050812_WTC_GRAPHIC/met

**File 9. No. 9110318,** **disappear** **Can't breath** **DEW**

WORLD TRADE CENTER TASK FORCE INTERVIEW
FIREFIGHTER FERNANDO CAMACHO
Interview Date: December 12, 2001

We went across the lobby of the hotel, going north, and we exited and made a right going towards the second tower, the south tower. We must have walked about 100-200 feet to revolving doors, which led into a hallway to where the mall was. I could see maybe 20, 25 civilians and I believe Ladder 25, which was about another 100 to 150 feet ahead of us.

As we came in through the revolving doors, the lights went out. A second or two later everything started to shake. You could hear explosions. We didn't know what it was. We thought it was just a small collapse.

As I looked straight ahead of me, I saw total darkness. Everything was coming our way like a wave. The firefighters that were ahead of us and the civilians that were ahead of us totally disappeared.

We turned around. We were all pretty much within ten feet of each other: lieutenant, chauffeur, roof, OV, can. As we turned around, I ran probably maybe ten feet and that's when the body of the building or body of the collapse hit, and we were flying through the air basically. I must have flown 30, 40 feet through the air.

Then total quiet. You couldn't breathe. You couldn't see anything. None of the equipment worked. My face piece was gone, flashlight, helmet. There were about maybe five or six civilians around us. We tried to get them out, as we tried to make our way out.

We did a perimeter search. Everything behind us was blocked and to our sides. We came back out basically through the same way we came into the building. We were facing the West Side Highway now, but there was a hole in the side of the building. So that's how we found our way out.

**Figure 109.** This first responder indicates he thought it was not a "collapse" due to fire but a disintegration of the building. *(12/12/01) Source*
http://graphics8.nytimes.com/packages/html/nyregion/20050812_WTC_GRAPHIC/met

**File 10. No.** We're going to cut across and go to 2." With that we both got blown in. That was it. It was pitch black and we were being thrown back down, 50 feet down a hallway.

But I recall it was right wall out for me. I tried to go back left for my members and it was not possible. We were now getting groups of civilians coming to the lights and the people were just coming to our light. Which saved the last people that we visually seen.

**They observed the explosion and the hallway disappeared.** They thought the hallway blew up where I had

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|---|
| come from. They thought they seen debris coming down and said, "The Lieutenant's dead." My senior guy regroups the company. He yells out, "Regroup." They're under light debris also. |
| **Figure 110.** This first responder indicates he thought it was not a "collapse" due to fire but a disintegration of the building. *(10/9/01) Source* http://graphics8.nytimes.com/packages/html/nyregion/20050812_WTC_GRAPHIC/met |

37. How the use of DEW to destroy the WTC is proven:

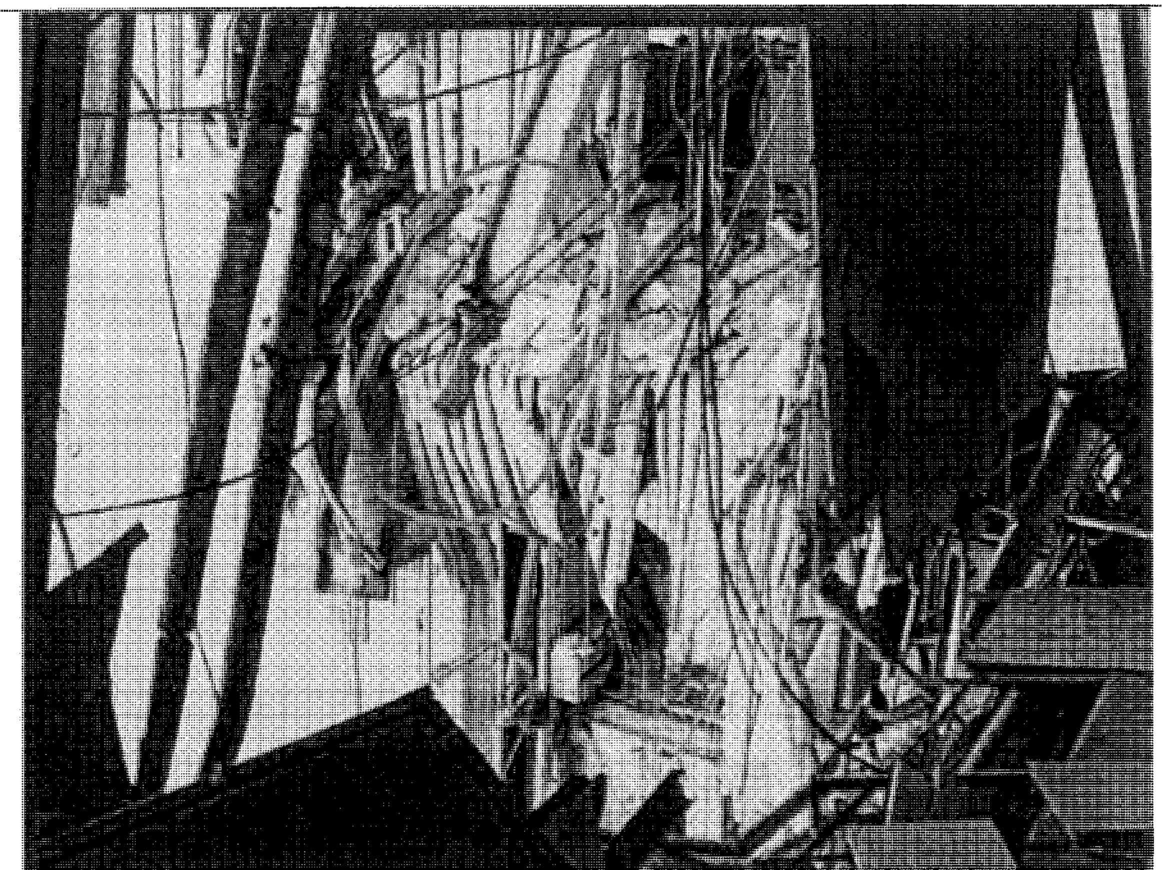

*Figure 6-10 Area of collapsed floor slab in bays between C-8, E-8, C-7, and E-7, from the 15th floor*

**Figure 111.** From FEMA report: (Fig6-10.) Why is this beam shriveled up? This seems to be a common theme. http://www.fema.gov/pdf/library/fema403_ch6.pdf

**Area 4: Teng & Associates, Inc.**

R-Outside Experts for Baseline Structural Performance, Impact Analysis, Structural Response to Fire, Collapse

**Area 1: Skidmore, Owings & Merrill LLP**

R-Outside Experts for Baseline Structural Performance, Impact Analysis, Structural Response to Fire, Collapse

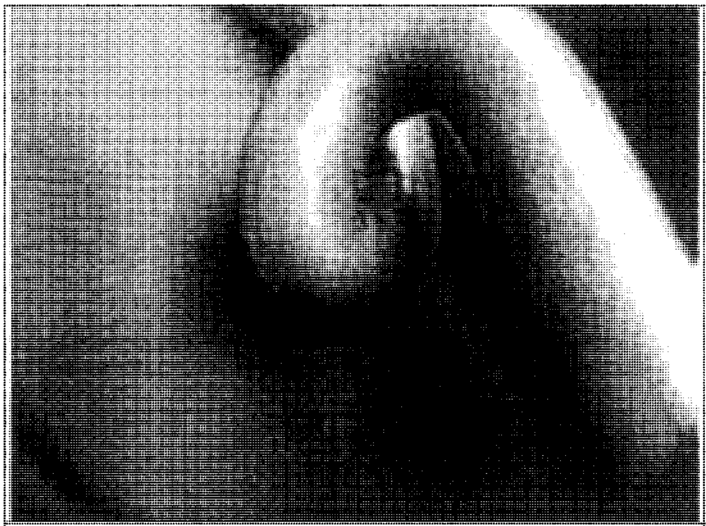

**Figure 112.** Hutchison-Effect beam
*(?/?/?) Source: blog*

38. How the use of DEW to destroy the WTC is proven:

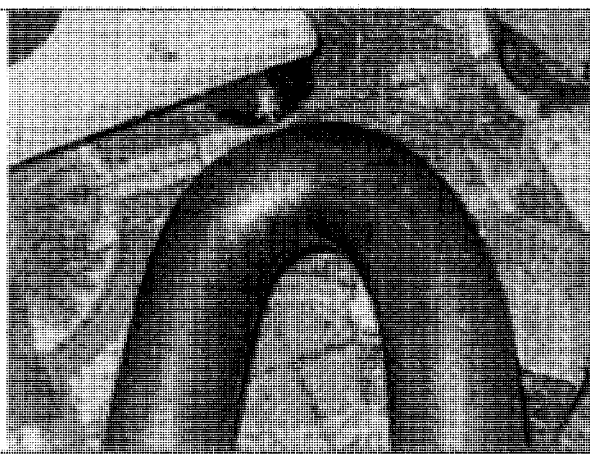

**Figure 113.** Hutchison beam. (3" diameter?)

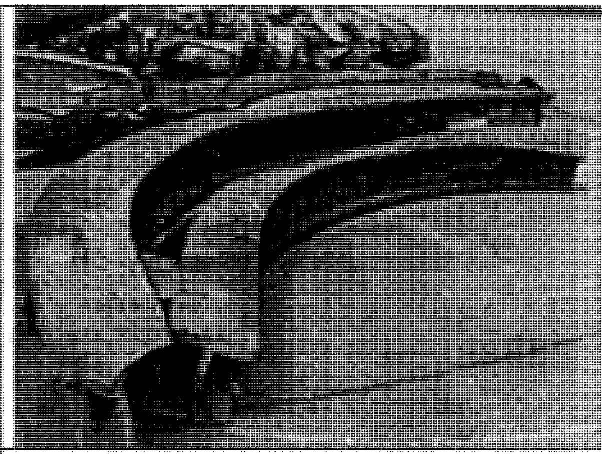

**Figure 114.** WTC beams
*(?/?/02) Source:* DSCN0941_hires.jpg

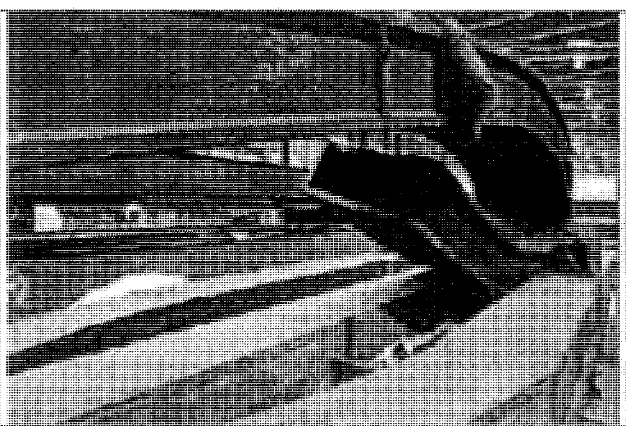

**Figure 115.** WTC beams
*(?/?/02) Source* core1.jpg

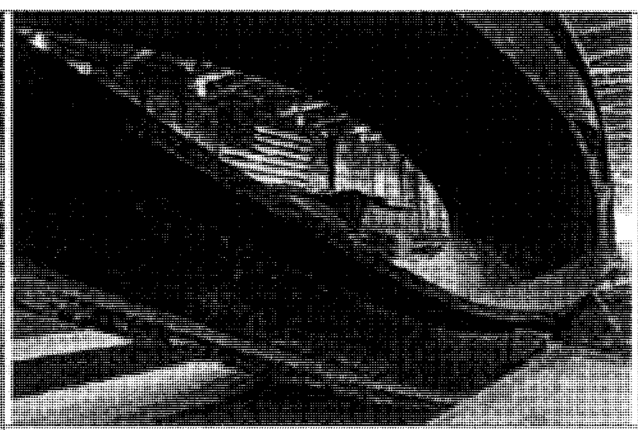

**Figure 116.** WTC beams.
*(?/?/02) Source* core4.jpg

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The contractors conducting structural analysis know the above deformation cannot be the result of a collapse.

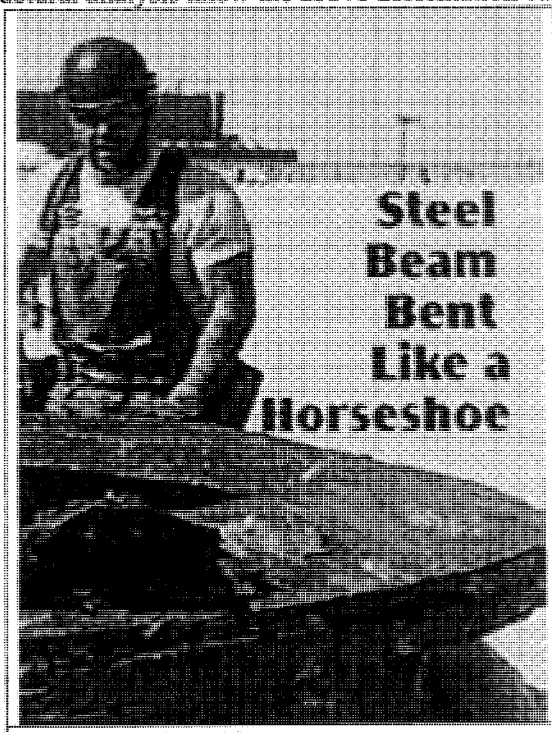


**Figure 117.** WTC beams
*(?/?/02) Source:* horseshoe_r1_c2_a_a.jpg

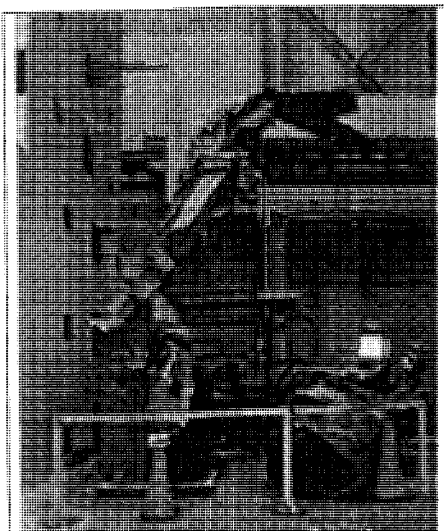

**Figure 118.** WTC beams
*(?/?/02) Source*

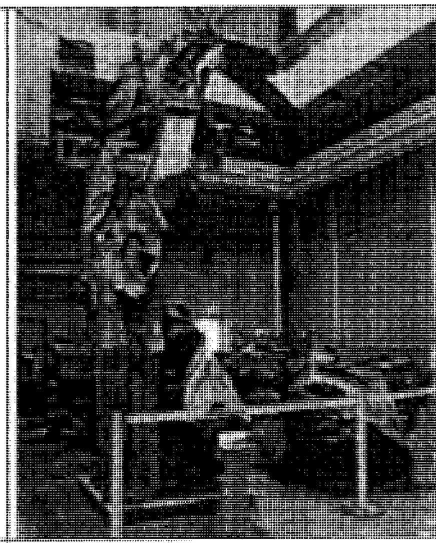

**Figure 119.** WTC beams
*(?/?/02) Source*

**Figure 120.** WTC beams
*(?/?/02) Source*

On the floor is a, cluster of beams wrapped with spandrel plates. This looks more like a rolled-up carpet than it does the vertical outer columns of the WTC (wheatchex).

*If the WTC was destroyed by a gravity collapse, what would engineers expect to see?*

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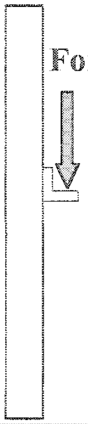


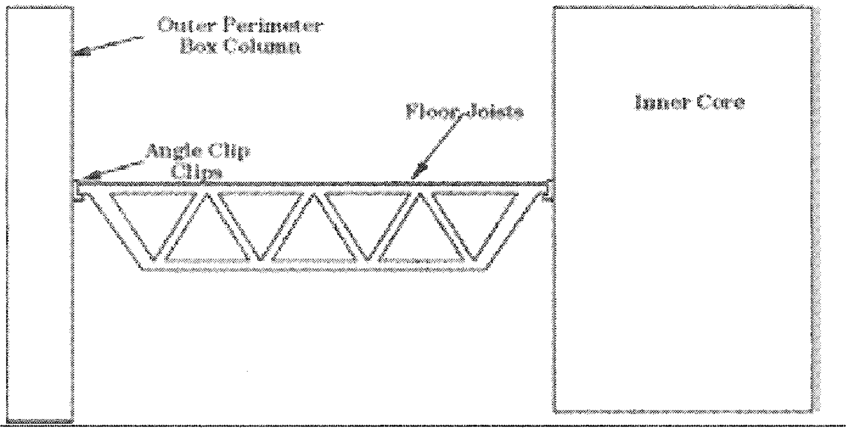




**Figure 121.** **Figure 122.** http://www.tms.org/pubs/journals/JOM/0112/Eagar/fig5.gif

Either the floors hold or they don't. If there is pancaking, there will not be column failure. If the floors pancake down, the columns will no longer be carrying a significant load.

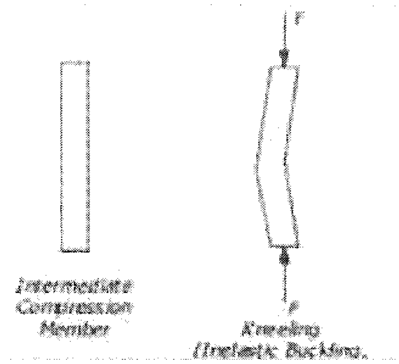



**Figure 123.** http://www.efunda.com/formulae/solid_mechanics/columns/images/CompressionMember_Intermediate.gif

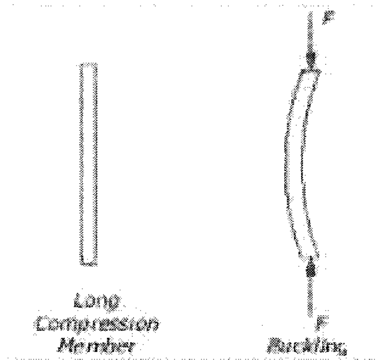



**Figure 124.** http://www.efunda.com/formulae/solid_mechanics/columns/images/CompressionMember_Long.gif

$$F_{cr} = \frac{EI\pi^2}{L^2}$$

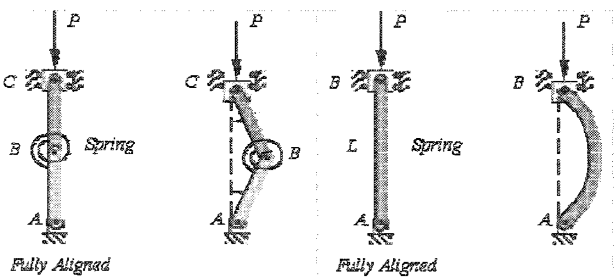



**Figure 125.** http://em-ntserver.unl.edu/NEGAHBAN/Em325/21-Buckling%20of%20columns/Buckling%20of%20columns.htm

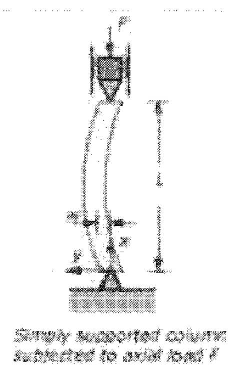
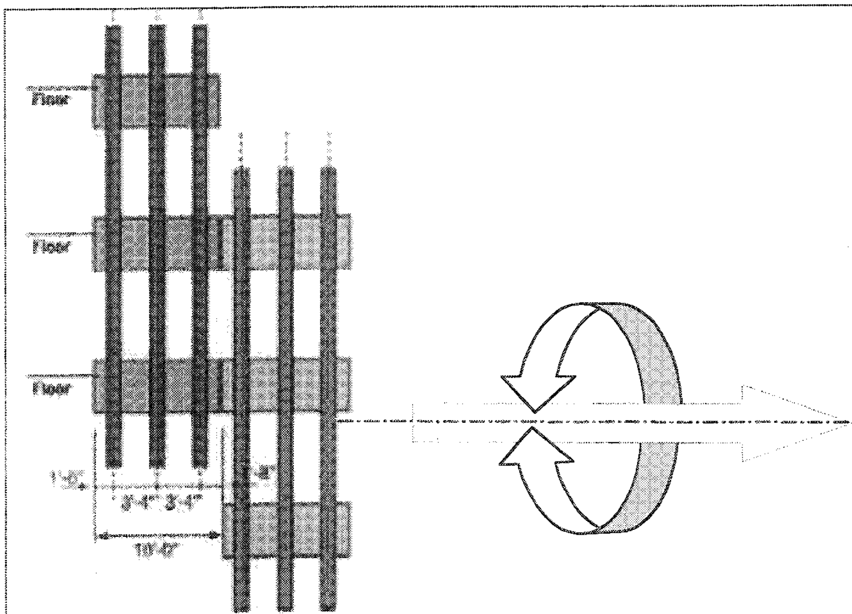
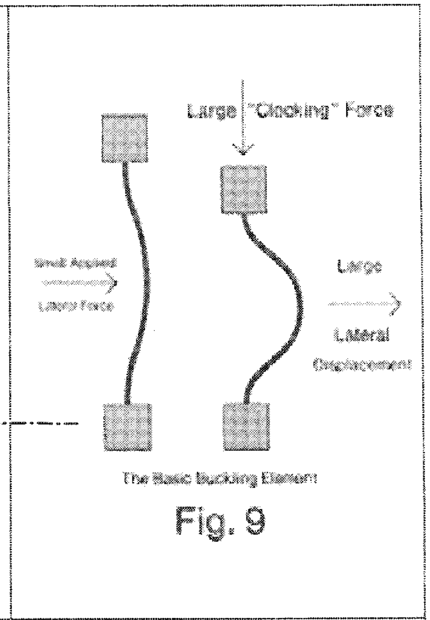



**Figure 126.** http://www.efunda.com/formulae/solid_mechanics/columns/images/Column_SS.gif


**Figure 127.** http://www.efunda.com/formulae/solid_mechanics/columns/images/Column_SS_FBD.gif

If there is more force (overload and/or high temperature) than the column can carry, it will bow outward or inward.




| | |
|---|---|
| **Figure 128.** Bending about a horizontal axis (which would be expected for a "collapse" from overload and/or weakening) | **Figure 129.** http://www.zyvex.com/nanotech/images/mechano/fig9.jpg |

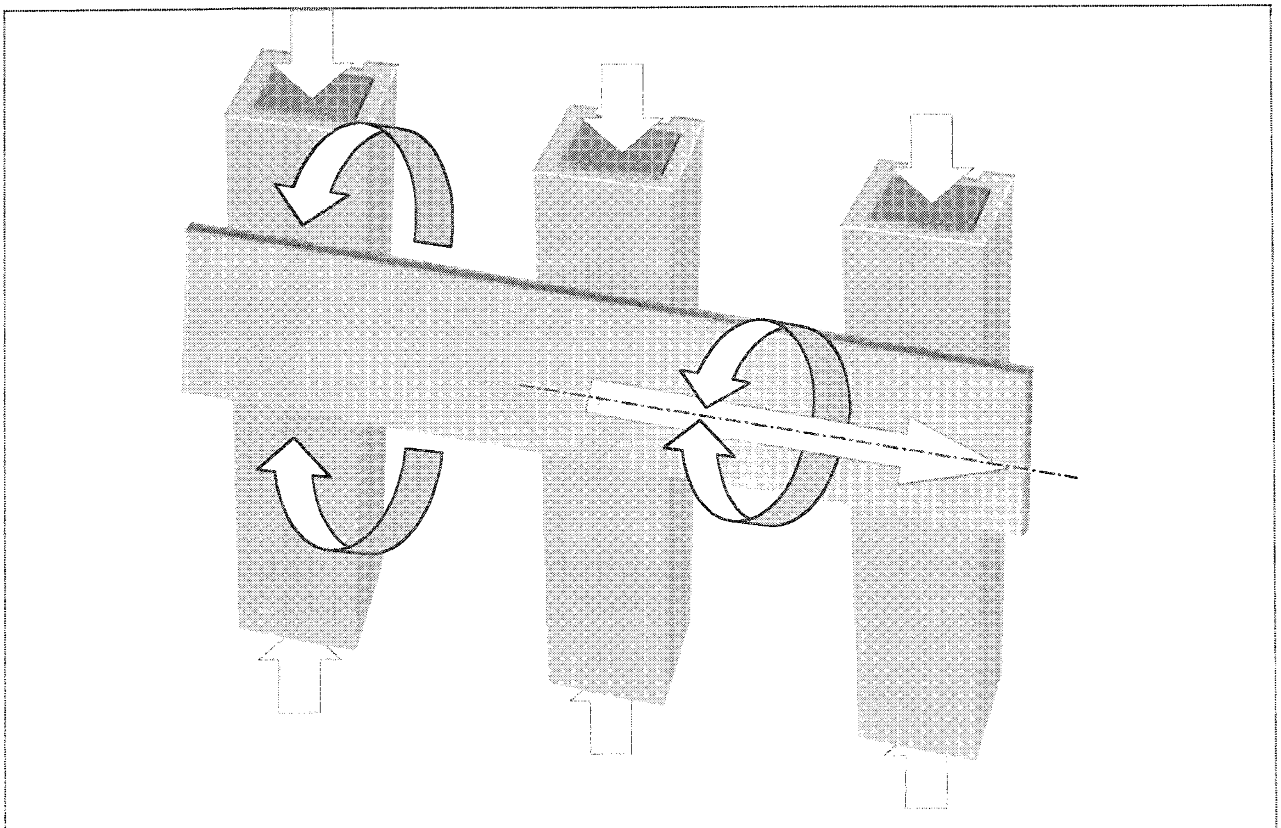


**Figure 130.** The outer columns are subjected to a vertical axial load. If overloaded, bending in this direction is likely.

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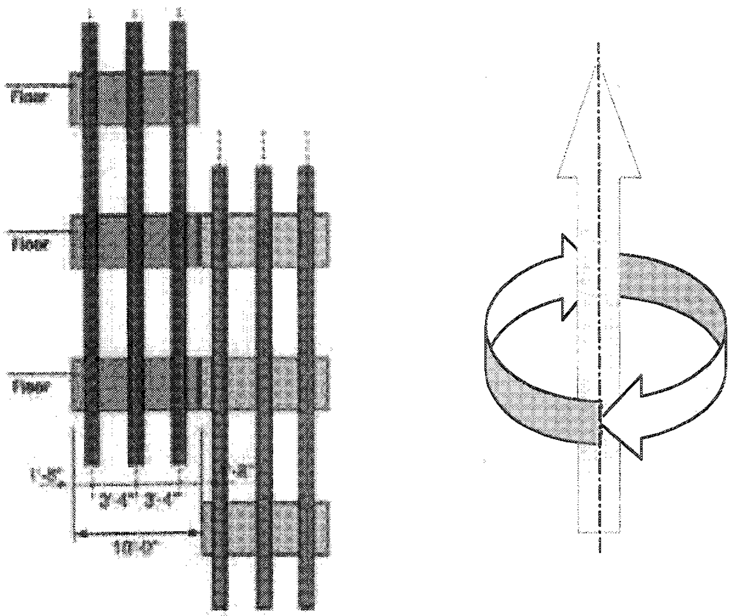

**Figure 131.** Bending about a vertical axis makes no sense. The building is not loaded in that way.

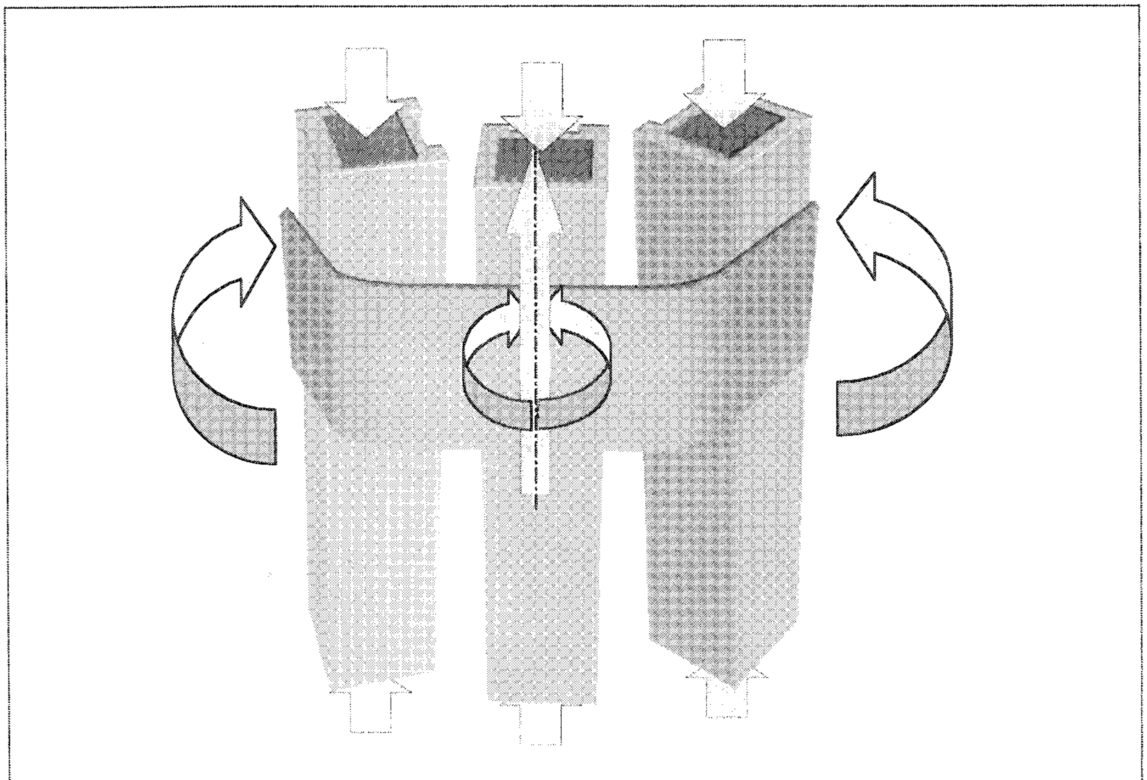

**Figure 132.** The outer columns are subjected to essentially no loading in this direction.

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**Figure 133.** WTC beams. But, here is phenomenon that needs to be explained. This is not consistent with a gravity collapse or conventional explosion.
*(?/?/02) Source*

WJE | ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

In Support of Task 2 under Project 3 of the NIST WTC1
Visual Observations of the Steel Recovered From the World Trade Center Site

| | | | |
|---|---|---|---|
| **Piece ID Mark:** K-1 or K-13 | | **By & Date:** CP / JH 31 July 2003 | |
| **Bldg:** WTC 1 | **Column:** 209 | **Floors:** 97 - 100 | Fire effects |

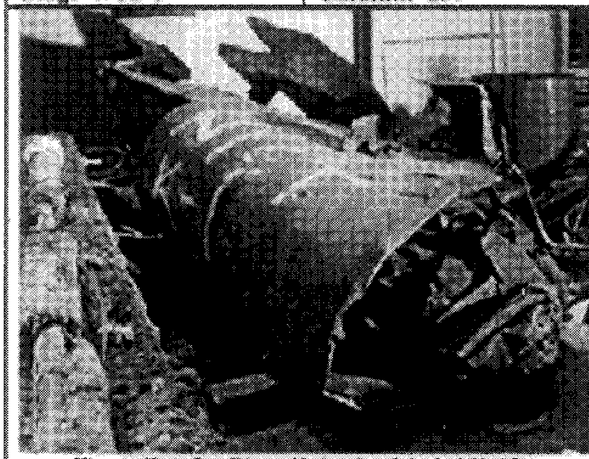

Figure F-A-2a: Piece K-1 (also labeled K-13).

Figure F-A-2b: Piece K-1 (also labeled K-13(.

Figure F-A-2c: Collapsed part of Column 210.

The piece is unique among the recovered steel in that Column 210 (the right-most of the three column, as viewed from inside looking out) has collapsed in compression in an accordion-like manner. No other similarly-collapsed piece is found among the recovered steel that was surveyed. The corresponding upper portions of Columns 208 and 209 are not attached to the recovered piece.

While this piece is from floors in WTC 1 that were impacted by the aircraft, this piece is from the east building face (aircraft impact was on the north face). It is therefore unlikely that this piece has been directly impacted by aircraft.

The accordion-like collapsed part of Column 210 remains in general concentric axial alignment with the lower portion of the same column, which is relatively undistorted even after salvage and recovery operations.

It cannot be readily distinguished whether this failure took place at a high or low rate of loading, whether or not this failure occurred at about the time of collapse initiation; or if the observed condition is a result of impact as the piece fell to the ground. Further study of this piece in detail is needed in order to better understand how this type of collapse occurred.

The lower portion of this piece is somewhat intact below the distorted portions of the columns. There are no significant visual indications of fire effects on the lower portion of this piece. However, given the sharp curvature of much of the bent steel in the collapsed portion of Column 3, there is the chance that that portion of Column 3 has been fire affected. Metallurgical examination can be used to determine whether or not the collapsed portion of Column 210 has been fire affected.

**Wiss, Janney, Elstner Associates, Inc.**

Document and Evaluate the Steel Recovered from the WTC Towers

**Figure 134. NISTNCSTAR1-3C Appxs.pdf, Attachment A, WJE No. 2003.0323.0, Page A-497,**

54

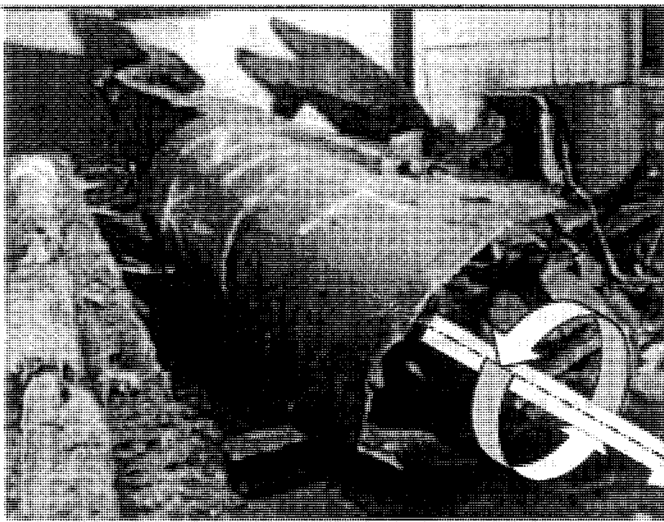

Figure F-A-2a: Piece K-1 (also labeled K-13).

**Figure 135.** WTC beams . **NISTNCSTAR1-3C Appxs.pdf, Attachment A, WJE No. 2003.0323.0,** Page A-497, NISTNCSTAR 1-3C Appxs.pdf, File page (211 of 258), http://wtc.nist.gov/WTCfinal1-3.zip

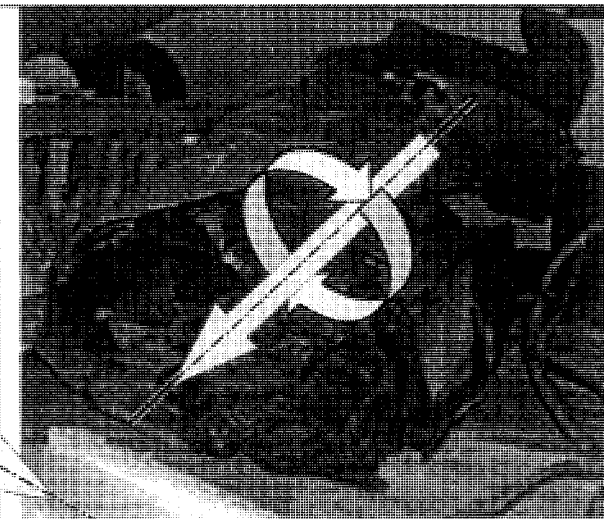

Figure F-A-2b: Piece K-1 (also labeled K-13).

**Figure 136.** WTC beams . **NISTNCSTAR1-3C Appxs.pdf, Attachment A, WJE No. 2003.0323.0, Page A-497,** NISTNCSTAR 1-3C Appxs.pdf, File page (211 of 258), http://wtc.nist.gov/WTCfinal1-3.zip

Figure F-A-2c: Collapsed part of Column 210.

**Figure 137.** WTC beams . **NISTNCSTAR1-3C Appxs.pdf, Attachment A, WJE No. 2003.0323.0, ,** NISTNCSTAR 1-3C Appxs.pdf, File page (211 of 258), http://wtc.nist.gov/WTCfinal1-3.zip

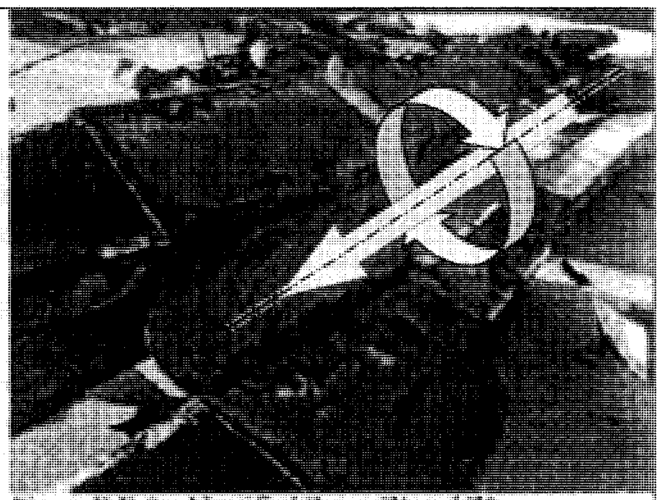

Figure F-B-9c: Identified Zones Z1 and Z6.

**Figure 138.** WTC beams . **NISTNCSTAR1-3C Appxs.pdf, Attachment B, WJE No. 2003.0323.0, ,** NISTNCSTAR 1-3C Appxs.pdf, File page (234 of 258), http://wtc.nist.gov/WTCfinal1-3.zip

*If the WTC was destroyed by a gravity collapse, what would engineers expect to see?*

**Wiss, Janney, Elstner Associates, Inc.**

(Document and Evaluate the Steel Recovered from the WTC Towers)

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| | | | |
|---|---|---|---|
| **Piece ID Mark:** M-4 | | **By & Date:** CP & JH / 25 June 2003 | |
| **Bldg:** WTC 1 or WTC 2 | **Column:** unknown | **Floors:** unknown | Fire effects |

Figure F-B-9a: Overall view of piece M-4.

Figure F-B-9b: Identified Zone Z2. Possible fire effects on inside faces of column elements at window location.

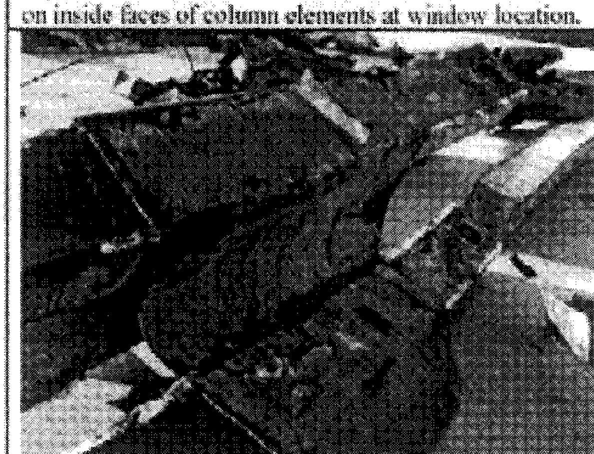

Figure F-B-9c: Identified Zones Z1 and Z0.

This is an unidentified exterior column panel from WTC 1 or WTC 2. The recovered piece is a partial panel, consisting of approximately the upper one-half to two-thirds of the panel.

This panel exhibits possible fire effects on the inside faces of all three columns at some window locations, as exhibited by loss of most paint and the presence of local buckling or "dishing" of the inside faces of the columns. The side faces and outside face of the columns exhibit little or none of these fire effects.

Zones of interest were identified on the inside faces of two of the columns as follows:

Z4: At window location just below the middle spandrel element. Loss of paint and severe distortions suggest possible fire effects.
Z3: At spandrel section at middle of panel. Little or no visible indication of fire effects.
Z2: At window location between middle and upper spandrel elements. Inside face of columns exhibit loss of paint and inward local buckling or dishing, both indicative of possible fire effects.
Z1: At upper spandrel section. Little or no visible indication of fire effects.
Z0: At window location above upper spandrel element. Little or no indication of fire effects.

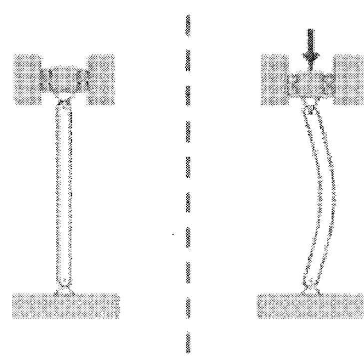

**Figure 139.** WTC beams. **NISTNCSTAR1-3C Appxs.pdf, Attachment B, WJE No. 2003.0323.0, Page B-520,**
NISTNCSTAR 1-3C Appxs.pdf, File page (234 of 258), http://wtc.nist.gov/WTCfinal1-3.zip

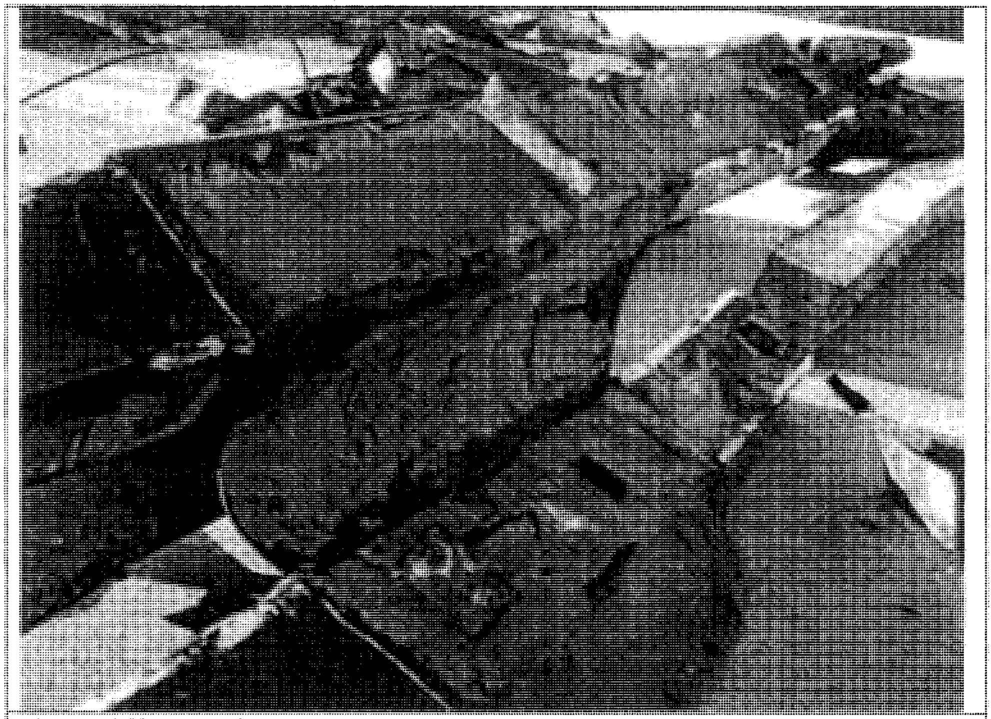

**Figure 140.** UL Fire Tests
*(9/05)*: F-B-9e_ec.jpg
NCSTAR1-3c-P234.jpg

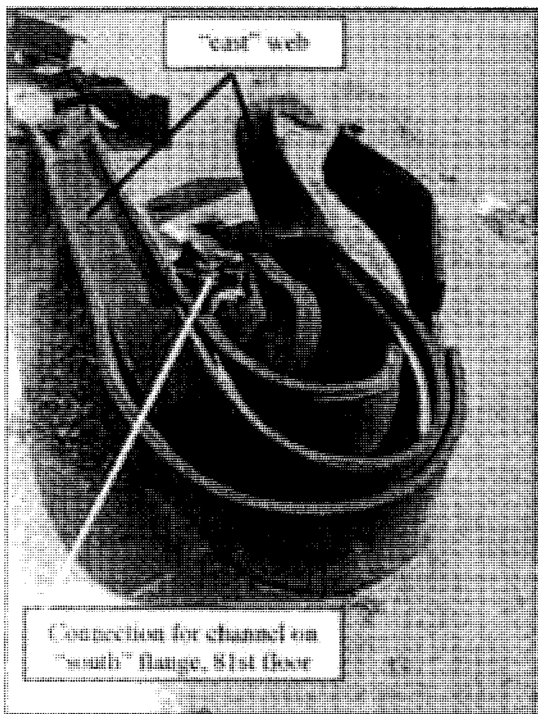


**Figure 141.** NISTNCSTAR1-3C-chaps P253_c.jpg
*(9/05)*:

**Figure 142.** UL Fire Tests
*(9/05)*: NIST-NCSTAR1-3C-P128_b.jpg
NIST-NCSTAR1-3C-P128.jpg

**Figure 143.** UL Fire Tests
*(9/05)*: S14-C1M (WTC2 Col.219).jpg
NIST-NCSTAR1-3C-P128.jpg

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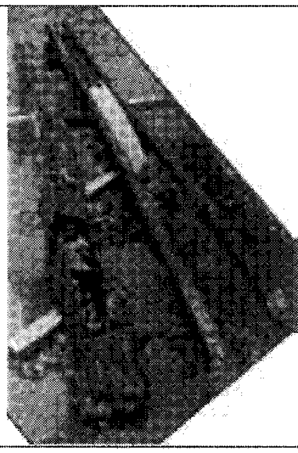

**Figure 144.** UL Fire Tests
*(9/05)*: 312a.jpg

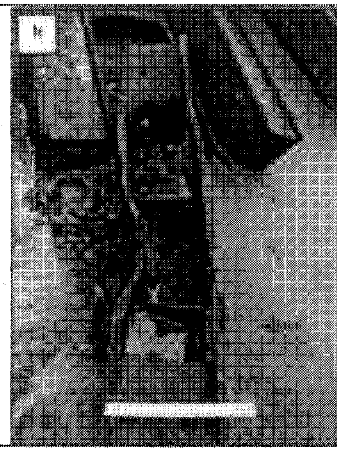

**Figure 145.** UL Fire Tests
*(9/05)*: 312b.jpg

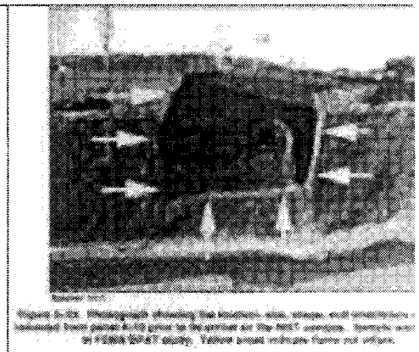

**Figure 146.** UL Fire Tests
*(9/05)*: NIST-NCSTAR1-3C-chaps P317c.jpg

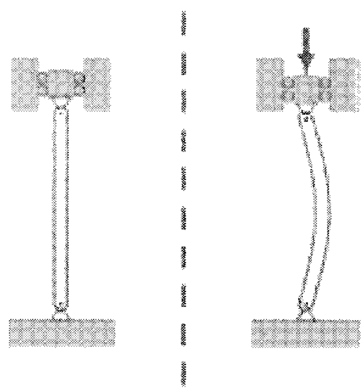

**Figure 147.** http://en.wikipedia.org/wiki/Buckling

**What possible explanation is there for this evidence, no matter what hypothetical fire event is posited?**

**A gravity collapse (with or without heat) won't cause this type of failure.**
**Bombs won't cause this type of failure.**
**Nukes won't cause this type of failure.**
**Cutting torches won't cause this type of failure.**

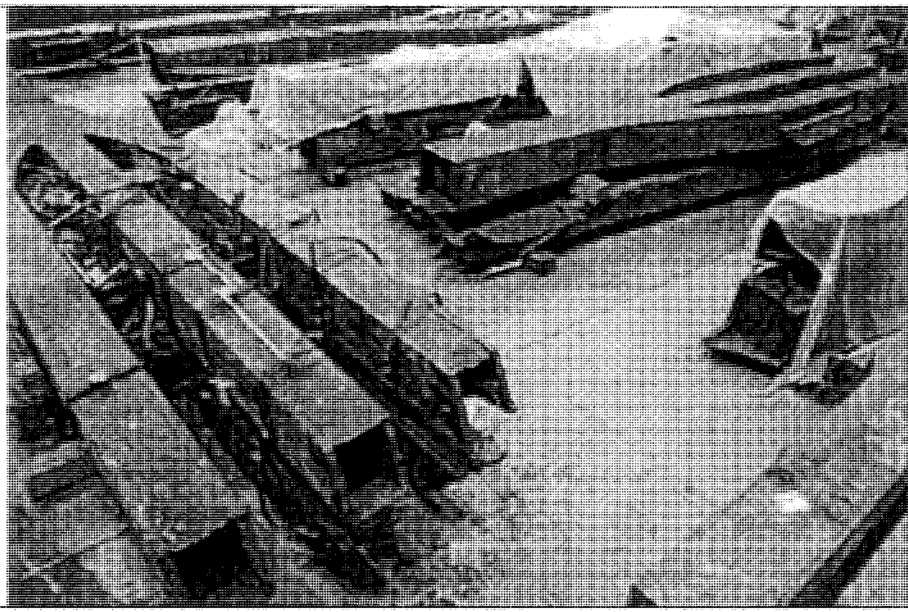

**Figure 148.** These columns don't look like 500,000 tons landed on them.
UL Fire trees2.jpg

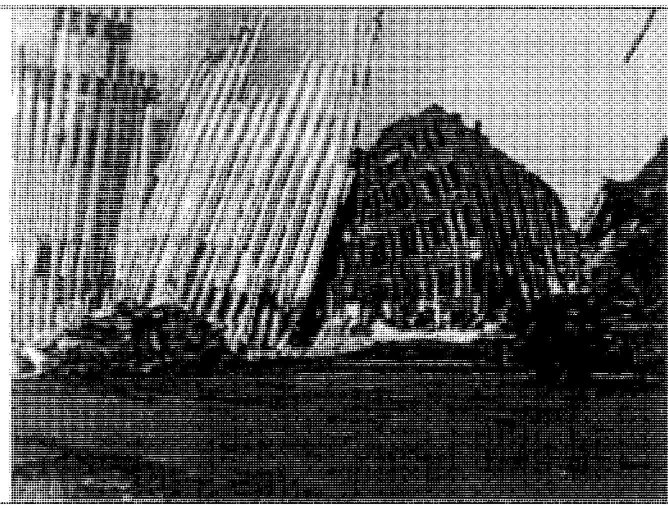

**Figure 149.** The beams stabbed into the street without buckling. WTC beams .
http://www.sharpprintinginc.com/911_math/mush_room_perimeter.jpg

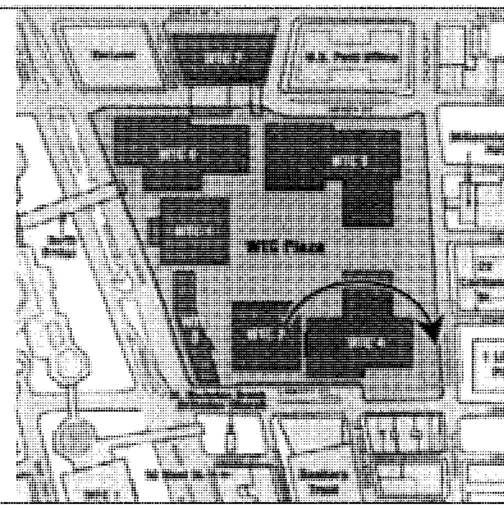


**Figure 150.** Those wheatchext flew far.
http://www.sharpprintinginc.com/911_math/wtc_map.jpg

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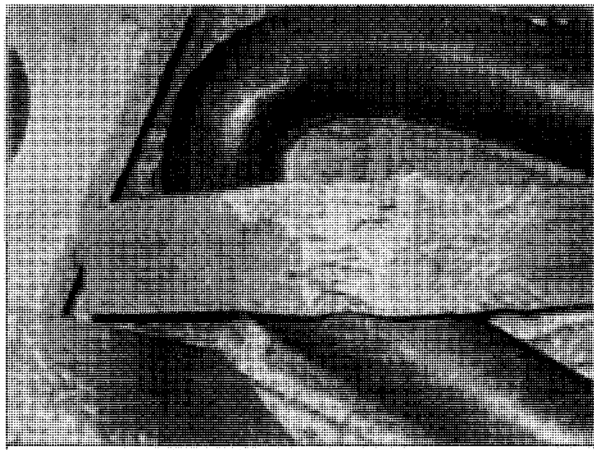

**Figure 151.** WTC beams
*(9/12?/01) Source: blog*. Picture+319.jpg

**Figure 152.** WTC beams.
*(?/?/?) Source:* OcIx3iXItlvZiWjRFZPTR.jpg

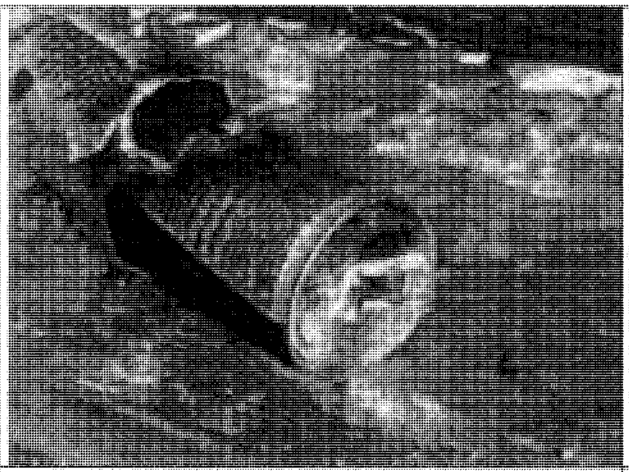

**Figure 153.** A Red Bull can, victimized by Hutchison Effects.
*(06/06):* Picture+625.jpg



**Figure 154.** Hazmat vehicle on West Street, in front of WTC6, victimized by DEW on 9/11/01. Note similarities to Figure 153.
*(9/11/01) Source:* 010911_WTC6_911_1328.jpg.

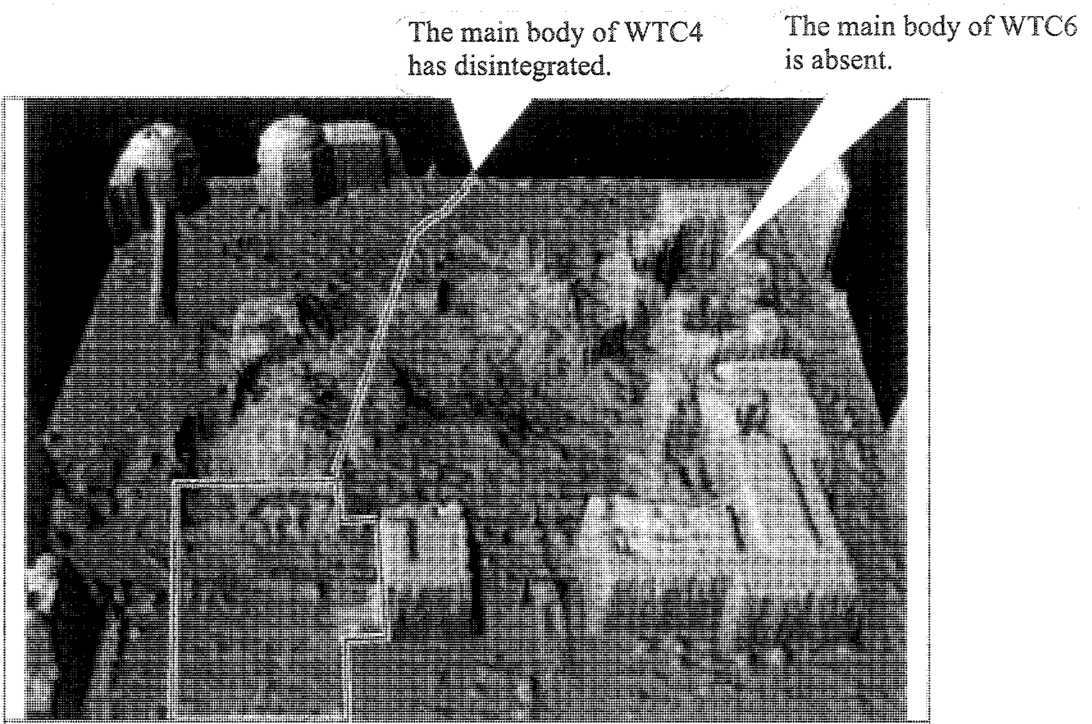


**Figure 155.** wtc-lidar092701-site.jpg.
*(9/23-26/01) Source: more*

**Figure 156.** WTC4 footprint at the bottom, the remaining WTC4 north wing on the right, and the WTC2 footprint above.
*(9/23/01) Source: USGS/NOAA*

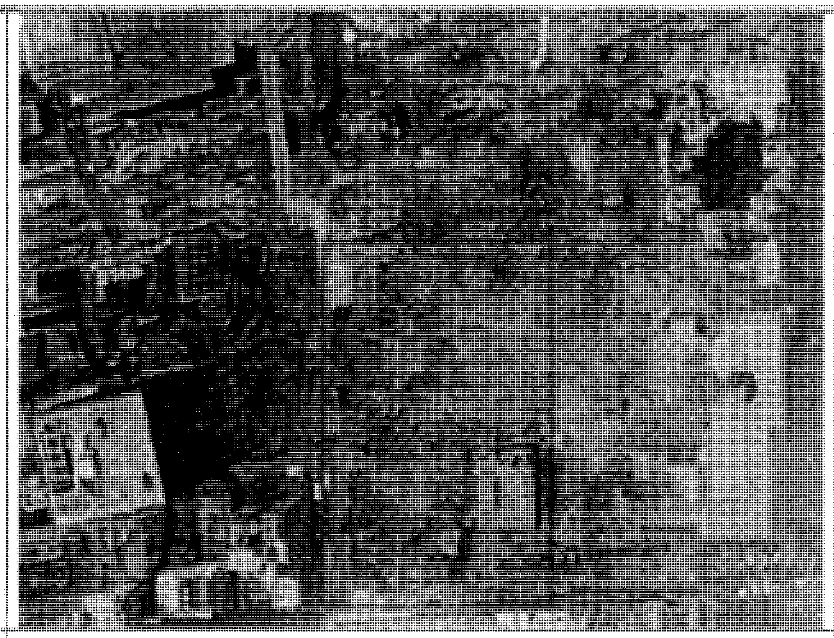

**Figure 157.** Red box outlines the region of Figure 60.

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**Figure 158.** wtc6aerial.jpg
(9/23/01) Source: USGS/NOAA

**Figure 159. UL Fire Tests**
(9/05): NCSTAR1-3c-P197_cc.jpg

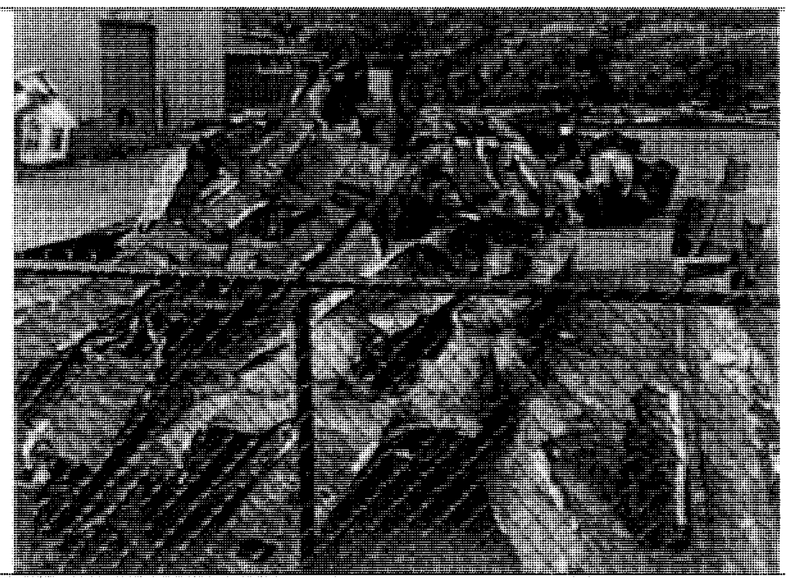

**Figure 160. UL Fire Tests**
(9/05): NCSTAR1-3c-P187_carpet_c.jpg

*If the WTC was destroyed by a gravity collapse, what would engineers expect to see?*

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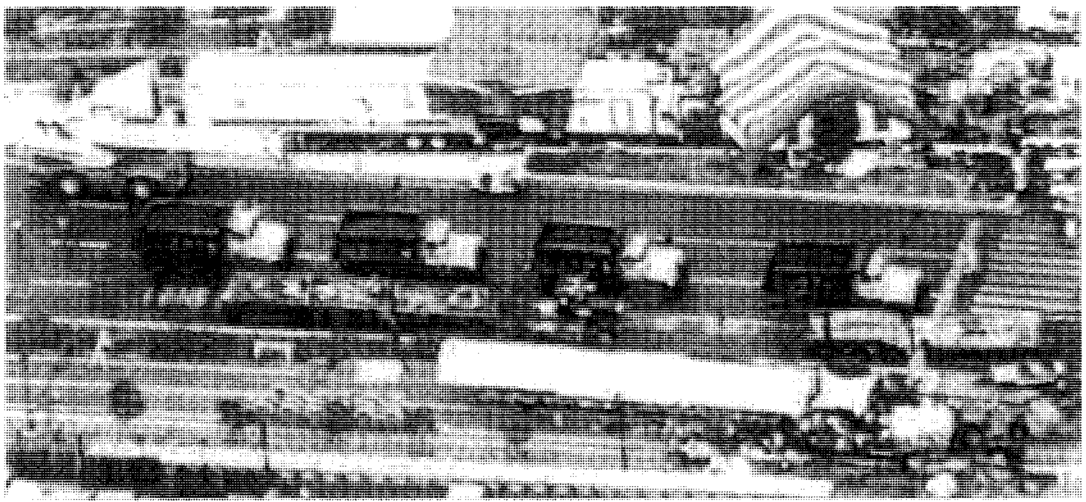


**Figure 102(a).** The four yellow dump trucks are heading south on West Street, toward the WTC complex. Each of the dump trucks carries a uniform load of what appears to be dirt.
*(9/27/01)*:

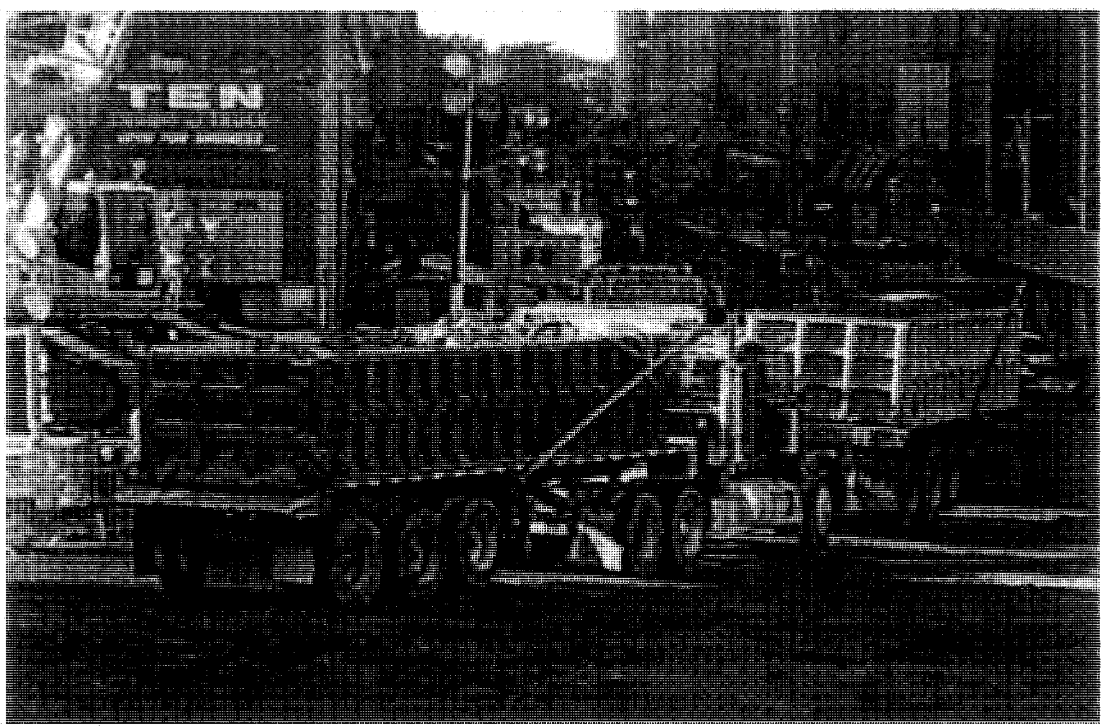


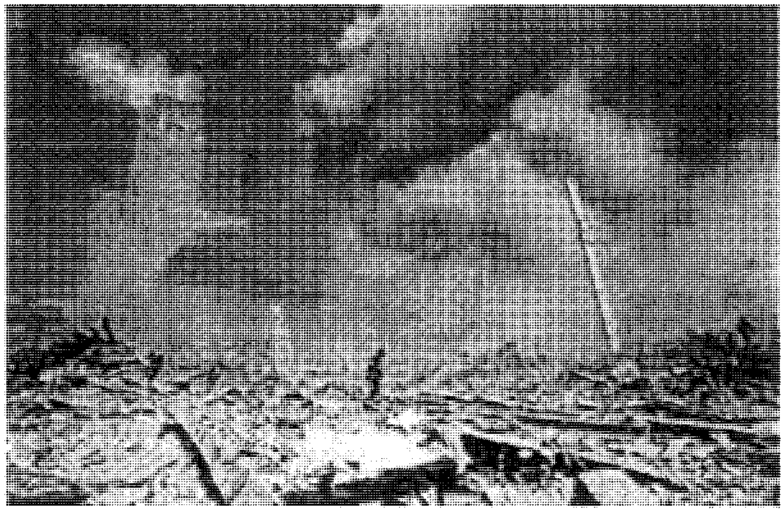

**Figure 103(a).** This appears to be dirt being trucked away from the WTC complex. Why is so much dirt coming and going? The four trucks ahead of the green one carry a uniform load of what appears to be dirt.
*(photo filed 10/13/01)* Source

In fighting fires, they may drop loads of dirt on the fire from a chopper. In any case, this will be their cover story. But... we never saw any flames to put out. So, they still have some explaining to do.

**Figure 89.** Why would there be dirt sprinkled on top of the rubble pile? The dirt arrived quickly. Is this from a landfill?
*(9/13/01 entered) Source*

**Figure 161.** Bringing in dirt.
*(10/9/01) Source 5320.jpg*

Experimental evidence is the truth theory must mimic.



Where did the buildings go? Where is all the material for 110 floors of steel and concrete? Poof!

Photo: http://www.september11news.com/JamesNachtweyTime_search2.jpg

/s/ DR. JUDY WOOD
DR. JUDY WOOD

Subscribed and Sworn to before
me this 29th day of February 2008.

/s/ Jerry V. Leaphart
Jerry V. Leaphart #JL4468
Jerry V. Leaphart & Assoc., P.C.
8 West Street, Suite 203
Danbury, CT 06810
(203) 825-6265 – phone
(203) 825-6256 – fax
jsleaphart@cs.com

## EXHIBIT LIST

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| A | RFC | March 16, 2007 | 070316_PROD01_002667.pdf | 43 |
| B | Supplement#1 | March 29, 2007 | 070329_PROD01_002722.pdf | 2 |
| C | Supplement#2 | April 20, 2007 | 070420_PROD01_002899.pdf | 28 |
| | | | | |
| D | NIST Response to RFC | July 27, 2007 | 070727_PROD01_003222.pdf | 3 |
| E | Appeal by Wood | August 23, 2007 | | 54 |
| F | NIST Response to appeal | January 10, 2008 | 070727_PROD01_003222.pdf | 3 |
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| G | Phone call follow-up | May 3, 2007 | 070503_lettertoGarcia.pdf | 18 |
| H | Garcia fax response | May 4, 2007 | 070504_GarciaFaxMESSAGE.pdf | 3 |
| I | NIST Contracts Review (all) | February 28, 2008 | NISTContractsReview-JudyCa.pdf | 58 |
| J | NIST Contract Participants | February 28, 2008 | Participants_NIST_cont.pdf | 9 |
| | | | | (221) |
| | | | | |
| | Judy Wood Affirmation | February 29, 2008 | | ~64 |
| | John Hutchison Affirmation | February 27, 2008 | AffJHutchison3.pdf | 30 |
| | Andrew Johnson Affirmation | February 25, 2008 | ADJ JW AFFIDAVIT-Updated.pdf | 6 |
| | | | | |

Ocio links: *http://www.ocio.os.doc.gov/ITPolicyandPrograms/Information_Quality/PROD01_002619*

A Request for Correction from Dr. Judy Wood dated March 16, 2007
*http://www.ocio.os.doc.gov/ITPolicyandPrograms/Information_Quality/ssLINK/PROD01_004678*

B Supplement #1 to Request for Correction dated March 29, 2007
*http://www.ocio.os.doc.gov/ITPolicyandPrograms/Information_Quality/ssLINK/PROD01_004117*

C Supplement #2 to Request for Correction dated April 20, 2007
*http://www.ocio.os.doc.gov/ITPolicyandPrograms/Information_Quality/ssLINK/PROD01_004156*

D Response to Wood Request for Correction July 27, 2007.
*http://www.ocio.os.doc.gov/ITPolicyandPrograms/Information_Quality/ssLINK/PROD01_004161*

E Appeal by Dr. Wood of NIST Initial Denial dated August 22, 2007
*http://www.ocio.os.doc.gov/ITPolicyandPrograms/Information_Quality/ssLINK/PROD01_004155*

Amendment (replacement pages) to Appeal dated August 23, 2007
*http://www.ocio.os.doc.gov/ITPolicyandPrograms/Information_Quality/ssLINK/PROD01_004157*

F Response to Wood Amendment to Appeal, January 10, 2008.

*http://www.ocio.os.doc.gov/ITPolicyandPrograms/Information_Quality/ssLINK/PROD01_005026*

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*http://www.ocio.os.doc.gov/ITPolicyandPrograms/Information_Quality/ssLINK/PROD01_005026*
*http://wtc.nist.gov/pubs/semerjian_remarks_62305.htm*

G. Phone call follow-up, May 3, 2007, 070503_lettertoGarcia.pdf

H. Garcia fax response, May 4, 2007, 070504_GarciaFaxMESSAGE.pdf

I. NIST Contracts Review (all), February 28, 2008, NISTContractsReview-JudyCa.pdf

J. NIST Contract Participants, February 28, 2008, Participants_NIST_cont.pdf

EVO
http://blog.hasslberger.com/img/EVO.jpg
http://www.svn.net/krscfs/EVOs%20and%20Hutchison%20Effect.pdf

Silverstein
http://www.observer.com/2007/port-authority-could-owe-larry-silverstein-12m-plus-delays
**Port Authority Could Owe Larry Silverstein $12 M.-Plus for Delays**
by Eliot Brown | December 31, 2007
http://www.observer.com/2007/author/eliot-brown

From: "Justin Keogh" <justin.keogh@gmail.com>
To: wtc@nist.gov
Subject: WTC7 Public Comment

Name: Justin Keogh
Affiliation:
Contact: Phone number or e-mail address where you can be contacted in case of questions.
520-265-0034
Report Number: NCSTAR 1-9
Page Number: 595
Paragraph/Sentence: Paragraph 3

Comment: The draft states: "Given the complexity of the modeled behavior, the global collapse analyses matched the observed behavior reasonably well. The global collapse analysis confirmed the leading collapse hypothesis, which was based on the available evidence."

Reason for Comment: The global collapse models to not resemble the video evidence "reasonably well".

Suggestion for Revision: The global collapse analysis shows large deformations in the building superstructure which were not observed in the video evidence. All videos of WTC7 collapsing show the curtain wall stays generally flat during the collapse. Since the window frames were attached to the trusses, interior deformations of the building's load bearing elements would be visible as deflections in the curtain wall.

From: j c <sirisfi@hotmail.com>
To: <wtc@nist.gov>
Subject: question concerning wtc 7

I was wondering if the nist found out who was on the other end of the phone conversation when Larry Silverstein made his famous "pull it" quote. I have looked into who the fire commander was that day but have not seen anything to suggest that he talked too larry Silverstein. I have searched though many firefighter oral histories concerning 911. I have also seen quotes where the fireman do not take orders from the public in regards to pulling a firefighting operation.
So my question is, who was on the other end of that phone call and has the nist talked with that person to verify Silversteins claims??
thanks
justin

---

From: j c <sirisfi@hotmail.com>
To: <wtc@nist.gov>
Subject: questions concering wtc 7 report

1. Deputy Fire Chief Hayden, said "one particular engineer" advised that collapse of WTC7 was a possibility. And gave them about 5 hours, and "he was pretty much right on the money, that he said in its current state, you have about 5 hours."
Does the nist know this "engineers" name? Did the nist interview this engineer. Considering that it must have been around 12pm and the nist computer simulation didnt need the damage to make the building fall, how was it that this engineer called it "right on the money". No steel building has fallen due to fire. This was from this bbc conspiracy files concerning wtc 7.
http://www.indymedia.org.uk/en/2008/07/404876.html

2. We also have an eyewitness claiming there was a countdown to wtc 7. There are other stories out there that deal with the "countdown".
Does the nist know of a countdown. Will the nist investigate since eyewittness are coming out stating there was a countdown before the building fell.
http://www.youtube.com/watch?v=STbD9XMCOho

3. Then we have Dr. Astaneh-Asl that states this piece of steel "vaporized". From the context, it seems that he thinks it "burned" first then buckled. He is linking "burn" with "vaporize". So that would mean the nist would need to look into molten metel before the collape instead of just writing it off. Dr Barnett said that piece of steel that he said looked "evaporated" was the sample 1 from the fema bpat report. So im guessing that the piece of steel Dr. Astaneh-Asl saw was also similar to the pieces dr barnett saw.

One piece Dr. Astaneh-Asl saw was a charred horizontal I-beam from 7 World Trade Center, a 47-story skyscraper that collapsed from fire eight hours after the attacks. The beam, so named because its cross-section looks like a capital I, had clearly endured searing temperatures. Parts of the flat top of the I, once five-eighths of an inch thick, had vaporized. Less clear was whether the beam had been charred after the collapse, as it lay in the pile of burning rubble, or whether it had been engulfed in the fire that led to the building's collapse, which would provide a more telling clue. The answer lay in the beam's twisted shape. As weight pushed down, the center portion had buckled outward.
"This tells me it buckled while it was attached to the column," not as it fell, Dr. Astaneh-Asl said, adding, "It had burned first, then buckled."
http://www.historycommons.org/context.jsp?item=a091901astanehfinds#a091901astanehfinds

4. Dr. Astaneh-Asl got to the site 8 days after sept 11. The steel he saw looked "vaporized". Since he got there only 8 days after sept 11, then i would assume that the steel he saw was from the top of the debris pile. Does Dr. Sisson's explanation (slag consisting of iron, oxygen, and sulfur attacked the steel) account for this beam. Or could the fema bpat report summary that suggests "It is also possible that the phenomenon started prior to collapse and accelerated the weakening of the steel structure" be correct?

5. I am wondering how much steel was at the wtc 7 site that had the appearance of being "evaporated" as Dr barnett stated or "vaporized" as Dr. Astaneh-Asl stated. Note that when Dr Barnett speaks, he says "steel members". That is pleural.

Acombination of an uncontrolled fire and the structural damage might have been able to bring the building down, some engineers said. But that would not explain steel members in the debris pile that appear to have

been partly evaporated in extraordinarily high temperatures, Dr. Barnett said.
http://query.nytimes.com/gst/fullpage.html?res=9E02E3DE143DF93AA15752C1A9679C8B63&sec=&spon=&pagewanted=all

6. Has steel from an office fire at first glance ever looked "evaporated" or "vaporized" before. Or showed the same characteristics of the wtc 7 sample from the fema bpat report?

7. Check out the nasa Images of the World Trade Center Site that Show Thermal Hot Spots on September 16 and 23, 2001. At the very end of the page, check out the pic where it shows "A" as a "HOT SPOT". Notice "A" looks like where column 79 is. Nist hypothesis revolves around column 79. Dr Sisson says that "slag" that consisted of iron, sulfur, and oxygen attacked the steel seen in the fema wtc 7 sample 1. Now, if column 79 got pulled out of the rubble and had signs of severe corrosion that looked "evaporated" or "vaporized", would the nist pursue what exactly caused this. From what ive read, the wtc fires were oxygen poor but very hot. And there is still no deffinate source for the sulfur except its maybe from diesel fuel or the wallboard.
http://pubs.usgs.gov/of/2001/ofr-01-0429/thermal.r09.html

8. Has the nist tested wallboard (sheetrock) to determine that that is the definate source for the elemental sulfur found in high concentrations that lead to the severe corrosion in the wtc 7 sample?

9. Molten metal came flowing out of the wtc. Look at the hole it leaves towards the end of the video. Looks bright yellow too me. Some think it is iron. Has the nist tried to recreate alluminum that looks like this? Check out how Dr Astaneh links yellow hot or white hot to melted steel. Again note that Dr. Astaneh-Asl got to the wtc site 8 days after it happened. This steel was probably on top of the debris pile.
Dr. Astaneh-Asl notes that steel has bent at several connection points that had joined the floors of the WTC to the vertical columns. He describes the connections as being smoothly warped, saying, "If you remember the Salvador Dali paintings with the clocks that are kind of melted--it's kind of like that." He adds, "That could only happen if you get steel yellow hot or white hot--perhaps around 2,000 degrees."
http://video.google.com/videoplay?docid=-8548302528330664o&ei=CnfBSL7ZCY7wqgKa89CjCQ&q=molten+metal+wtc+compilation&vt=lf&hl=en

10. Dr Jones has found what he believes to be thermite that appear as "red chips". Has the nist found or tested any "red chips" that he describes?
http://video.google.com/videoplay?docid=-4186920967571123147

11. Last, there is an article 'The Top Ten Connections Between NIST and Nano-Thermites' -- by Kevin Ryan. Has anyone that has experience with nano-thermite looked at and tested the sample 1 from the wtc 7?
http://www.indymedia.org.uk/en/2008/07/402772.html

thanks
a concerned citizen

From: Shyam Sunder <sunder@nist.gov>
To: "'wtc@nist.gov'" <wtc@nist.gov>
Subject: FW: Dr Sunder

Dr. S. Shyam Sunder
Director
Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899-8600
Tel.: 301-975-5900; Fax: 301-975-4032

**From:** Betty Crawford [mailto:BettyCrawford1@sbcglobal.net]
**Sent:** Monday, August 25, 2008 1:07 PM
**To:** Shyam Sunder
**Subject:** Dr Sunder

I'm praying that you take the peer revued research from Dr Steven Jones/ Kevin Ryan concerning the collapse of WTC Building 7 and complete your WTC research. What your proposing is ridiculous. Your saying fire and expansion of load bearing beams brought down WTC 7 symetrically. You say that load bearing column 79 (on the wide side of a trapezoidal
shaped building) was the initiate to collapse. If that were the case then how did the building fall symetrically as this column
was on the wide(heavier) part of this structure. Common sense/physics dictates that if this were the case the building should have fallen over toward the collapsed beam side..common senseical. Further FEMA admitted years ago that even if the diesel had exploded in the storage tanks in the basement it had a low probability of causing catastrophic collapse. Now your saying that fire was the culprit????????? Your reasoning that molten metal in the basements of WTC 1, 2 and 7 from dieselcarbon fuel based fire (buried in a basement by tons of debis) is ridiculous. Where is this superheated fire supposed to get its oxygen from?????? Open air foundries have to have a tremendous air/oygen source or the fire will never get hot enough to create molten metal to pour. Of couse your an expert and already know this I assume. From this I can only conclude that you know better...Please explain?

Sincerely
Dr Keith Crawford
ae911truth.org

**Stephen Cauffman**

| | |
|---|---|
| **From:** | wtc@nist.gov |
| **Sent:** | Tuesday, September 09, 2008 2:51 PM |
| **To:** | Stephen Cauffman |
| **Subject:** | Fwd: Is NIST is following the same pathway as US economy? |


>X-Sieve: CMU Sieve 2.3
>DKIM-Signature: v=1; a=rsa-sha256; c=relaxed/relaxed;
> d=gmail.com; s=gamma;
> h=domainkey-signature:received:received:message-id:date:user-agent
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> :content-transfer-encoding:from;
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> d=gmail.com; s=gamma;
> h=message-id:date:user-agent:mime-version:to:subject
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>Date: Fri, 29 Aug 2008 11:40:42 +0800
>User-Agent: Thunderbird 2.0.0.16 (Windows/20080708)
>To: wtc@nist.gov
>Subject: Is NIST is following the same pathway as US economy?
>X-Enigmail-Version: 0.95.6
>From: Kevin Jaeger <jetechwa@gmail.com>
>X-Proofpoint-Virus-Version: vendor=fsecure
>engine=1.12.7160:2.4.4,1.2.40,4.0.166
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>X-PP-SpamScore: 0
>X-NIST-MailScanner: Found to be clean
>X-NIST-MailScanner-From: jetechwa@gmail.com
>X-NIST-MailScanner-Information:

>
> From the desk of Kevin Jaeger [engineering] :-) Western Australia.
>
>
>Hello NIST,
>
>
>I am writing at your request for comments. The immediate questions that
>come to mind are:
>1. Is NIST following the same pathway as US economy and US banks?
>2. Has NIST become the technical propaganda arm and distribution
>center for those who were really guilty for executing 911?
>
>There is no time/space here to prove your conclusions are incorrect and
>your method of analysis was inappropriate, so it was quite impossible

>for you to arrive at correct conclusions. I rarely if ever come out and
>directly state that any individual or group of individuals is plain
>wrong, but in this case NIST is plain wrong.
>
>Within my profession up until this point, I have regularly quoted NIST
>standards along with our own local standards when writing a
>specification. I was proud of the technical excellence associated with
>NIST and the fact that we could meet these high standards.
>
>The practice of quoting NIST has ended, I don't need to quote NIST and
>in any case NIST is no longer trustworthy and has changed its direction
>and its purpose of being, NIST has been caught up in politics which
>have directed analysis methodologies rather than use the best
>technology and science available.
>
>Please allow me to demonstrate a horizontal version of the Twin Towers
>collapse and if you don't want to watch the whole video, please scroll
>along to the 3 minute mark where the action starts.
>The video is taken in outback Western Australia.
>http://www.youtube.com/watch?v=nR1W0OEo7ig
>
>I realize the Twin Towers are not building #7, but please humor me just
>for a few lines.
>
>As soon as I saw the Twin Towers collapse, I knew immediately that the
>official spin was a concocted lie. I was viewing a vertical version of
>an horizontal experience that I have witnessed 100s of times.
>
>The Twin Towers collapsed UP and OUT, now that defies the laws of
>physics and of nature. Most all of the concrete within these buildings
>was pulverized into particle sizes that resemble powder.
>How many PSI is required to powder the concrete from its reinforcing,
>before being deposited in the river and surrounding streets? The world
>is not stupid.
>
>As these towers fell I could see the charges going off and the
>individual jets within the smoky crown, just like I can see the charges
>going off in the above video. Huge pieces of outer skin and columns
>were ripped to shreds, then blown up and out through the atmosphere
>over great distances. There is a case where a huge piece of column
>traveled a great distance like a huge spear and was embedded in a
>surrounding building. This was not an action cause by gravity.
>
>A slightly different approach was used to bring down building #7.
>Work by professor Steven Jones best describes how building #7 was
>brought down and I am not even going to go into that as this venue is
>just for comments.
>
>If I were running NIST would I have buckled under the pressure to
>invent new science that reverses well known and understood principals
>that are governed by the Laws of Nature? I don't think so.
>
>We are really scraping the bottom of the barrel now, when NIST starts
>with a political conclusion and then makes the science fit. I did not
>think that I would ever see the day that NIST would throw its own
>principals out the door.
>
>Kind Regards,

>Kevin

## Stephen Cauffman

**From:** Michael E. Newman [michael.newman@nist.gov]
**Sent:** Monday, September 15, 2008 11:33 AM
**To:** Stephen Cauffman
**Subject:** Fwd: Final comment

X-Sieve: CMU Sieve 2.3
X-Originating-IP: [167.83.101.22]
From: Kevin Ryan <kncryan@msn.com>
To: <wtc@nist.gov>, <frank.gayle@nist.gov>, <mnewman@nist.gov>
Subject: Final comment
Date: Mon, 15 Sep 2008 11:24:33 -0400
X-OriginalArrivalTime: 15 Sep 2008 15:24:32.0932 (UTC) FILETIME=[277BEE40:01C91747]
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X-PP-SpamDetails: rule=spampolicy2_notspam policy=spampolicy2 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0809150090
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: kncryan@msn.com
X-NIST-MailScanner-Information:

Name: Kevin R. Ryan

Affiliation: An American citizen

Contact: kncryan@msn.com

Report Number: NCSTAR 1-A and supporting documents

Page Number: All

Paragraph/Sentence: All

<?xml:namespace prefix = o ns = "urn:schemas-microsoft-com:office:office" />

Comment: You have disgraced my country and the human race. Additionally, you are now personally responsible for the ongoing death and destruction resulting from the 9/11 Wars. The story of your dishonor will be repeated endlessly.

Reason for comment: Your deceptive reports are malevolent and revolting.

Suggestion for revision: I tried to help you four years ago, but you would not listen or even respond. I realize now that suggestions do not help you, because your only intention is to deceive.

*****************************************************************

Michael E. Newman
Senior Communications Officer
Public Affairs Office
National Institute of Standards and Technology
100 Bureau Drive, Stop 1070
Gaithersburg, MD 20899-1070

Phone: (301) 975-3025
FAX: (301) 926-1630
E-mail: michael.newman@nist.gov

NIST info at http://www.nist.gov
NIST news and Tech Beat newsletter at http://www.nist.gov/news
NIST WTC investigation info at http://wtc.nist.gov

*****************************************************************

X-Sieve: CMU Sieve 2.3
X-BigFish: VP
Subject: NFPA comments on WTC 7
Date: Tue, 23 Sep 2008 14:35:39 -0400
X-MS-Has-Attach: yes
X-MS-TNEF-Correlator:
Thread-Topic: NFPA comments on WTC 7
Thread-Index: Ackdqy1TSsDUXLLFT7ORn/srY3l7Uw==
From: "Collette, Kristin" <kcollette@NFPA.org>
To: <wtc@nist.gov>
X-OriginalArrivalTime: 23 Sep 2008 18:35:59.0500 (UTC)
FILETIME=[39511CC0:01C91DAB]
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166
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classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0809230107
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: kcollette@nfpa.org
X-NIST-MailScanner-Information:

Attached are NFPA comments to WTC 7.  Please let us know if they are unable to be opened again.

Thank you.

Kristin Collette
Fire Protection Engineer
National Fire Protection Association
Quincy, MA

**Important Notice:** This correspondence is not a Formal Interpretation issued pursuant to NFPA Regulations. Any opinion expressed is the personal opinion of the author and does not necessarily represent the official position of the NFPA or its Technical Committees. In addition, this correspondence is neither intended, nor should it be relied upon, to provide professional consultation or services.



Content-Type: application/octet-stream; name="NFPA COMMENTS TO NIST ON THE"
 TECHNICAL INVESTIGATION OF THE WTC BLDG 7 SEPT 08.pdf"

Content-Description: NFPA COMMENTS TO NIST ON THE TECHNICAL INVESTIGATION OF THE WTC BLDG 7 SEPT 08.pdf
Content-Disposition: attachment; filename="NFPA COMMENTS TO NIST ON THE" TECHNICAL INVESTIGATION OF THE WTC BLDG 7 SEPT 08.pdf"

# NFPA COMMENTS TO NIST ON THE FEDERAL BUILDING AND FIRE SAFETY INVESTIGATION OF THE WORLD TRADE CENTER BUILDING 7 INVESTIGATION
# SEPTEMBER 15, 2008

## INTRODUCTION

NFPA is pleased to present comments to NIST on their comprehensive study of the World Trade Center (WTC) Building 7 collapse. The level of effort, study, analysis and examination of the Building 7 collapse was an apparent and obviously complex endeavor due to the myriad and complex circumstances involved. NIST is commended for also taking the time to consider, and ultimately discount alternative and unconventional scenarios such as the controlled demolition theories. The members of the National Construction Safety Team (NCST), the contributing NIST staff, as well as the private contractors and consultants are to be applauded for their commitment to this project as well as the public members of the NCST Federal Advisory Committee for their oversight of the project.

The previously released NCST reports issued on WTC 1 and 2 in 2005 have served as an important framework for discussion and change in many of the NFPA codes and standards in the last 3 years. NFPA was already implementing and considering revisions to NFPA codes, standards, programs and policies prior to release of the 2005 studies.

In our 2005 comments, we stated that *It should be noted, however, that it is not only possible, but likely, that after a thorough and detailed analysis of some of the NCST recommendations, there simply may not be enough sufficient detail or compelling evidence to promulgate a change to a particular code or standard* and that statement is equally applicable to the WTC 7 study. Moving forward, NFPA is making a commitment to NIST to continue to study, review and evaluate the new recommendations in this latest study and we continue to evaluate the status of the 30 recommendations from the 2005 study.

The overlap recommendations from the WTC 1 and 2 studies as well as the new recommendation in the WTC 7 study, while clearly written, still leave open the question as to what design hazards and scenarios are realistic for building performance. While the WTC 1 and WTC 2 studies considered a clear combination of severely compromised structural integrity coupled with a severe fire, the WTC 7 outcome appears to focus on an atypical and not considered fire event.

The debate about whether building regulations should address events associated with normal building hazards (single ignition point assumptions for fire) or more extreme events such multiple and near simultaneous ignition points will be a main focus before consensus is reached on the new/primary recommendation and finding addressed in the WTC 7 study.

The comments contained within this document have been prepared by the staff of NFPA and have not been reviewed or endorsed by any of the NFPA Technical Committees or relevant NFPA advisory committees. That process is ongoing and will continue into the future once the final report is issued.

Our comments have been arranged so as to generally follow the major NCSTAR section and chapter headings of the report. When possible, our comments will refer to specific sections of the NIST study to make sure we have correlated our responses to the recommendations, findings or supplemental information contained within the report. In most cases, NFPA's comments may be as simple as agreeing with the recommendation or finding, agreeing with the recommendation or finding in principle or in some cases, disagreeing with the recommendation or finding. Regardless of our comments on the report, NFPA plans to fully consider the depth and breadth of the recommendations in future revision cycles of the relevant NFPA codes and standards, research programs or public education programs and instruction efforts.

# SUMMARY

## NFPA's Initial Reactions and Comments

The draft report by NIST on August 18, 2008 is what NFPA believes to be a very thorough, technical, scientific study of a building loss investigation that is only rivaled by the WTC 1 and WTC 2 study released in 2005. Additionally, NFPA is pleased to see the work effort of NIST resulting in positions on many controversial and sometimes, unpopular subjects. The need to conduct more research in numerous areas is quite clear. In addition, the need to parse the recommendations that may only be appropriate for a September 11, 2001 attack (or similar extreme event) versus lower magnitude events that may have severe consequences is an important distinction.

While NFPA documents –primarily NFPA 101®, *Life Safety Code*® and NFPA 5000®, *Building Construction and Safety Code*® have implemented changes in response to several of the 30 recommendation from the 2005 study, the new and unique recommendation for the WTC 7 study is unlikely to be a quick fix or rapid change. In fact, it is entirely unclear at this point in time if the fire protection engineering and structural engineering community will be quick to embrace the recommendation to the extent that NIST may desire. As noted by several comments in the 2005 study, a number of the recommendations from NIST were qualitative, somewhat undefined and left open to interpretation.

How codes and standards organizations, building owners, engineers or architects will *"…evaluate buildings to ensure the adequate fire performance of the structural system*." will have as many responses as there are buildings. More troubling however, is the implication that this is not being done now. While the entities that deal with these issues day in and day out know that this type of evaluation is considered-either through prescriptive requirements or performance based design analysis- the public at large is sure to have their confidence in the design community somewhat taken aback by such a statement-especially when it appears in at least one of the NIST news releases on the study.

NFPA will, nonetheless, take full advantage of the effort by NIST with the primary recommendation and subject it to our codes and standards development process as well as the related program activities that we have at our disposal such as the NFPA Technical Committee process, the High Rise Building Safety Advisory Committee (HRBSAC) and The Fire Protection Research Foundation (FPRF) among others. NFPA has committed its own resources to look at these complex and highly specialized issues over the years and has had much success in implementing meaningful change.

Following the release of the final WTC 7 report, NFPA staff will:

a. Review the report recommendations to determine the best course of action for each, within the NFPA codes and standards process or in other research, advisory committee or education areas within NFPA
b. Determine the status of each recommendation within NFPA's activities (Some have already been acted on; some are in process; some are not yet developed where NFPA has a clear position.)
c. Develop a schedule, specifying priorities, for actions on the recommendations

Once the final report is released, the aforementioned and continuing review of the 30 recommendations from the 2005 study and the new recommendation included in the WTC 7 study will continue to be a focus of NFPA committees and projects. As before, the practicality or impracticality of the new recommendations and the extent to which the recommendation is justified or defined, and the best approach to integrate the recommendation, if feasible, will be considered for inclusion into appropriate design practice in the coming years.

# NFPA COMMENTS ON THE RECOMMENDATIONS

NFPA has addressed the substance of the NIST report in two ways. First, we have laid out a broad reaction and response to the new recommendation. This section provides input and response to NIST and also notes what NFPA committee projects or programs are likely to be asked to look at the details of the related recommendations.

The second part of our response provides comments directly on several of the NCSTAR documents. This portion identifies changes that we believe need to be made to clarify, revise or correct in the final report from NIST. We have elected to not address the other 12 recommendations as our comments from 2005 would be largely unchanged. For convenience purposes, we have appended our comments from 2005 at the end of our comments section in Annex A.

## NFPA'S INITIAL COMMENTS AND REACTIONS

**5.1.2** **Recommendation B.** NFPA agrees that some, but not necessarily all buildings should be evaluated to consider failure of one or more built in features or systems under varying fire conditions. In addition, the effect of certain long term heating/cooling cycles on structural connections with long span members is an area requiring further investigation. Fire test protocols are not necessary inadequate as they stand today, but certainly consideration can be given to allow them to expand into other areas, to provide other information and to be reconfigured to look at newly introduced pass/fail criteria. See related comment on Recommendation D.

The reference to *worst-case design fires* is a wide open suggestion that is very difficult to define or refine. A conventional structural fire that has simultaneous ignition points on at least 10 floors is not close to realistic. If that becomes defined as the worst-case fire, and if you somehow can design for that event, then why not consider simultaneous ignition on 12 or 15 or 20 stories? If anything, the recommendation needs to consider the expected or most likely ignition scenario that morphs into a worst case (i.e. uncontrolled) design fire. That translates to a single ignition point that grows to uncontrolled fire conditions on a floor with subsequent fire spread to other floors. This is a worst-case and is the exception to fire performance and outcomes.

A principal finding for Objective 1 says WTC 7 had characteristics that were similar to other high rise fires. A significant and major difference once again relates back to the multiple ignitions on multiple floors of the WTC 7 scenario. This was not a circumstance or characteristic of any of the fires noted and is a very important distinction. First Interstate (Los Angeles-1988), Meridian Plaza (Philadelphia-1991), Parque Central (Caracus-2004) and Windsor Tower (Madrid-2005) would be typically classified as a worst-case. These fires all involved complete burnout with either no local collapse or limited local collapse. None of the events resulted in catastrophic global collapse.

If the Building 7 study had shown that a single ignition point coupled with uncontrolled fire growth, automatic sprinklers not available and subsequent fire spread to upper, multiple floors would have resulted in local collapse and ultimately catastrophic progressive or disproportionate collapse-that perhaps would have been a more realistic concept to consider. It does not appear that this type of analysis was done. This scenario is an example of a realistic fire that is worst-case. This does appear to match closely to the NIST description of *Characteristics of Infrequent (Worst-Case) Fire Events*.

This approach (also discussed in Recommendation C) allows a situation to be considered in the context of a single ignition point fire. In fact, Fire Design Scenario No. 8 from NFPA 5000 considers this exact circumstance:

> **5.5.2.8* Design Fire Scenario 8.** Design Fire Scenario 8, which is a fire originating in ordinary combustibles in a room or area with each passive or active fire protection system or fire protection feature independently rendered ineffective, shall address the concern regarding each fire protection system or fire protection feature, considered individually, being unreliable or becoming unavailable. This scenario shall not be required to be applied to fire protection systems or fire protection features for which both the level of reliability and the design performance in the absence of the system or feature are acceptable to the authority having jurisdiction.

The five bullet points that appear as sub-items as a part of the recommendation could then be considered in a more realistic manner. In the scenario noted above, related goals and objectives could be considered and might include:

-Are all occupants able to evacuate safely prior to onset of a local collapse?

-Are all occupants able to evacuate safely prior to onset of a disproportionate collapse?

-What are the property conservation and loss of mission consequences resulting from a local or disproportionate collapse?

- What are the property conservation and loss of mission consequences resulting from a local or disproportionate collapse on neighboring structures?

- What are the hazard consequences resulting from a local or disproportionate collapse on first responders?

This level of flexibility would then allow a designer to select a set of performance goals and objectives that are typically in excess of what current era codes and standards require and permit an analysis to be done on the various outcomes. In some cases, an acceptable solution and outcome may be to provide defensive fire suppression actions only provided the occupants are all able to evacuate.

While the NIST report accurately notes that the temperature that Column 79 may have been exposed to what was below the temperature that a thermal failure would have been expected-as were the structural members for the floor assembly, it should not be inferred that the fire played no role in the failure of the column. It is conclusive that the fires caused failure of the floor assemblies –and that the initial failure (local collapse) of floor 13 triggered the collapse of additional weakened floors thus leading to global collapse of the entire structure. Loss of the floor assemblies due to fire did however have an obvious impact on the load redistribution of the column-to the point that buckling failure occurred.

**5.1.2** **Recommendation D.** NFPA continues to largely be in agreement with this provision as presented and has initiated and completed a specific action on this recommendation. The Fire Protection Research Foundation has completed a report in June 2007 on improving the fire resistance testing of the ASTM E119 test. The report, *Fire Resistance Testing for Performance-based Fire Design of Buildings*, presents a study undertaken by the Foundation to develop the technical basis for changes and additions to ASTM E119 so that measurements and results can be used in performance-based design, without compromising the traditional use of the test standard for prescriptive building code compliance.

The goal of this project was to identify the needed capabilities of a standard fire resistance test to support Performance-Based Structural Fire Engineering (PBSFE). The goal of the work was not to alter this prescriptive-based system. Rather, the goal of this work is to provide a partial basis for a complementary performance-based system for the provision of structural fire protection. The report provides recommendations to the test methods of the standard fire resistance test in three different areas: thermal/heat transfer, structural performance, and test documentation.

Most directly related to the work of the NIST WTC 7 study were the recommendations for structural performance. The report recommends the following changes to the standard fire resistance test in regards to structural performance:

- **Assembly End Restraint**
  Place load cells at the assembly end boundaries to record magnitude of thermal restraining forces throughout test duration: minimum of three cells at one edge of furnace for the top, center, and bottom of a middle beam or stud of assembly.

- **Deflections**
  Record, as a minimum, the time-history of transverse deflections at mid-span in all primary structural members (beams, joists, columns, and wall studs) of the assembly, together with axial shortening of loaded columns and wall studs.

- **Strain Gauges**
  Require high-temperature strain gauges at critical sections (typically ends and/or mid-span) of main structural members (beams, joists, columns, wall studs) and of other important load transfer elements (shear studs, metal deck, floor slabs and reinforcement, and connections).

- **Standardized Assembly Load Application**
  Superimposed loading on all assemblies should only be applied through mechanical or hydraulically-controlled apparatus.

- **Specification of Maximum Superimposed Design Load**
  The standard should require the maximum assembly design load to be based on the greater of the design load computed from either allowable stress design or

limit states-LRFD and the controlling strength failure mode to be used for each type of assembly construction.

- **Minimum Assembly Size**
  Specified minimum sizes of construction assemblies should be as follows: walls and paritions-100 sq ft with neither dimension less than 9 ft, columns –not less than 9 ft length, floors/roofs – 180 sq ft, with neither dimension less than 12 ft, beams – not less than 12 ft-span length. Standards-making bodies should consider the formation of furnace classes to recognize furnace capabilities larger than the minimum size.

- **Size Effects and Experimental Scaling**
  Employ dimensional scaling principles in the design of the test assembly to represent the actual construction applications.

- **Mandatory Fire Testing Under Design Load to Structural Failure**
  All assembly fire tests should be conducted under maximum design load until an imminent or actual structural failure limit state is attained, or until an major integrity breach occurs, irrespective of the assembly's other thermal conditions.

- **Actual Strength of Assembly Structural Materials at Ambient Temperature**
  Material strength tests should be performed on samples extracted from the primary structural assembly members to determine their actual mechanical properties at ambient (including yield and ultimate strength, and elastic modulus).

- **Determination of Structural Properties at Elevated Temperatures**
  Material strength tests should be performed on materials used in the primary structural assembly members to determine their actual mechanical properties at high temperatures (including yield and ultimate strength, and elastic modulus).

- **Inclusion of Load Eccentricity for Walls and Columns**
  Require column and wall tests to be conducted with a minimum d/6 eccentricity of axial compression load from centerline, where d is the depth of column or wall.

- **No Hose Stream Test Requirement for Walls and Partitions**
  Hose stream test procedure and its acceptance criteria for walls and partitions are no longer required.

- **Structural Instrumentation Check/Calibration**
  Prior to initiation of fire test, check/calibrate all of assembly's structural instrumentation (transducers, strain gauges, load cells) under superimposed load.

Fire Protection Research Foundation has taken the initiative to recognize where improvements and additions are needed in the standard fire resistance test. NFPA strongly agrees that current practice does not fully address all of the issues that are present in structural fire performance today and fully supports continued research as recommended by the report.

This report addresses the recommendations set forth by the NIST WTC 7 report. Please see Annex B for a copy of the full report (also available for download at www.nfpa.org).

# ANNEX A

## NFPA COMMENTS TO NIST

## AUGUST 2005

The following are the basic recommendations from NIST and NFPA's initial comment and reaction to the 8 subject groups and 30 recommendations.

### Group 1. Increased Structural Integrity

**The standards for estimating the load effects of potential hazards (e.g., progressive collapse, wind) and the design of structural systems to mitigate the effects of those hazards should be improved to enhance structural integrity.**

**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.**

NFPA Comment: This recommendation will need further discussion and debate as it does not stipulate the extent of the multiple hazards to be considered, what load conditions should be assumed, what percentage of load path members would be assumed to be unavailable, and on how many floors those members would be missing.

NFPA believes that progressive collapse should be prevented and that it ultimately should be addressed by building regulations and design methods. However, the concept deserves further study. A clear delineation between what is defined as progressive collapse versus disproportionate collapse must be established and plainly defined.

The degree to which progressive collapse can be addressed is dependent upon the threat/hazard to be considered. Most scenarios would dictate that a progressive collapse of a building would be initiated by a substantial event such as an explosion rather than the type of events considered by current codes. The techniques used to protect against progressive collapse also need to be further analyzed. Mitigation techniques may need to consider more than just the loss of a single column or load path. Additionally, the impact of any potential solutions on other design objectives also needs to be thoroughly considered. This recommendation is of the type that may only be needed to be considered for select icon or symbolic buildings. Any such collapse scenarios, and their associated designs would require a comprehensive risk analysis to better identify the threat/hazard to be protected against. NFPA further believes that the collection of existing data on the hazard level with respect to progressive collapse is needed, and that other kinds of data such as that which shows how many deaths have resulted from disproportionate collapse also needs to be collected. Policy wise, organizations such as the Structural Engineering Institute of ASCE and the National Council of Structural Engineering Associations (NCSEA) should be tasked with development of key guidelines or manuals to address this concept.

NFPA PROJECTS: Technical Committee on Fundamentals (BLD-FUN); Technical Committee on Structures and Construction (BLD-STR); Technical Committee on Building Construction (BLD-BLC).

**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.**

NFPA Comment: Comparing state of the practice from 1964 to the tools available in 2002 does not seem to be a fair judgment. Such tools are available and have been in use for decades. This recommendation would seem to be asking for refinement of these tools, but not a mandate to use them. Policy wise, organizations such as the Structural Engineering Institute of ASCE and the National Council of Structural Engineering Associations (NCSEA) should be tasked with development of key guidelines or manuals to address this concept.

NFPA PROJECTS: Technical Committee on Structures and Construction (BLD-STR);

**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).**

NFPA Comment: It would appear that the drift limit criteria associated with seismic design already exists to address this recommendation. Serviceability criteria also would seem to drive this limitation more than wind or seismic design. There is no immediate evidence that something is amiss within this area of tall building design. Policy wise, organizations such as the Structural Engineering Institute of ASCE and the National Council of Structural Engineering Associations (NCSEA) should be tasked with development of key guidelines or manuals to address this concept.

NFPA PROJECTS: Technical Committee on Structures and Construction (BLD-STR)

## Group 2. Enhanced Fire Resistance of Structures

**The procedures and practices used to ensure the fire resistance of structures should be enhanced by improving the technical basis for construction classifications and fire resistance ratings, improving the technical basis for standard fire resistance testing methods, use of the "structural frame" approach to fire resistance ratings, and developing in-service performance requirements and conformance criteria for spray-applied fire resistive materials.**

**<u>Recommendation 4.</u> NIST recommends evaluating, and where needed improving, the technical basis for determining appropriate construction classification and fire rating requirements (especially for tall buildings greater than 20 stories in height)—and making related code changes now as much as possible—by explicitly considering factors including:**
**• timely access by emergency responders and full evacuation of occupants, or the time required for burnout without local collapse;**
**• the extent to which redundancy in active fire protection (sprinkler and standpipe, fire alarm, and smoke management) systems should be credited for occupant life safety;**
**• the need for redundancy in fire protection systems that are critical to structural integrity;**
**• the ability of the structure and local floor systems to withstand a maximum credible fire scenario without collapse, recognizing that sprinklers could be compromised, not operational, or non-existent;**
**• compartmentation requirements (e.g., 12,000 $ft^2$) to protect the structure, including fire rated doors and automatic enclosures, and limiting air supply (e.g., thermally resistant window assemblies) to retard fire spread in buildings with large, open floor plans;**
**• the impact of spaces containing unusually large fuel concentrations for the expected occupancy of the building; and**
**• the extent to which fire control systems, including suppression by automatic or manual means, should be credited as part of the prevention of fire spread.**

NFPA Comment: Ideas in this recommendation are continuously under review, scrutiny and debate-and not just for tall buildings. The fact is, we have had excellent performance in high-rise building fires when the combination of passive and active features was present. The recent history of high-rise building fire that included total or near total burnout of significant parts the structure, including Meridian Plaza (1991); Parque Central (2004) Windsor Towers (2005) would suggest that we are doing much of this at present. These buildings sustained long duration fires (18 plus hours) without suffering global collapse. This recommendation can, and should, be used to determine if such sustained burnouts are acceptable, and if demolition of the structure after the event is an acceptable property, financial and economic loss.

NFPA is in general agreement with the recommendation that a more technical basis for the determination and use of construction classifications be pursued, and notes that NFPA has and continues to pursue this overall objective through its codes and standards development process. NFPA understands this comment to mean that NIST has not indicated that there is a problem with the current system of construction classification but that the current system should be based on a more technical and scientific basis.

More specifically, NFPA believes that the ultimate successful implementation of this recommendation is largely dependent upon how some of the other recommendations are addressed. For example, re-considering the determination of construction type, which is dependent upon the test method utilized to arrive at a fire resistance rating, cannot be pursued until the test protocols are evaluated, as suggested by NIST Recommendation #5. With regard to considering specific factors as identified in the bulleted items of Recommendation #4, these also cannot be properly addressed until other recommendations are considered. For instance, the timely evacuation of occupants in bullet item one would be a function of the potential use of new evacuation means such as the use of elevators as noted in recommendation #20. The very complex and interconnected issues raised by Recommendation #4 are in need of further study. Performance and reliability of automatic sprinkler systems in Recommendation #12 seems to be called into question, which will impact any changes derived from Recommendation # 4. Automatic sprinkler performance has been , and continues to be excellent. A more specific research agenda and procedure in addressing this very comprehensive recommendation needs to be developed.

With regard to further categorizing tall buildings based upon height, NFPA believes that this subject deserves more immediate attention and should be specifically addressed based upon the current construction classification system, and then re-evaluated if a new approach for construction classification is developed. One suggestion that NFPA will pursue is to look at a segmentation of high rise building levels and determine if a risk indexing system may be implemented based upon a certain height category. All NFPA technical committees responsible for NFPA 101 and NFPA 5000 should provide further input as any such categorization may be occupancy dependent.

NFPA also notes that the basis for requiring a certain type of construction classification is a function of the threats/hazards to be protected against. The types of threats/hazards to be considered by building regulations and building designs need to be better quantified. NFPA‘s Technical Committee on Fundamentals (BLD-FUN) and NFPA‘s occupancy committees could provide further input in this regard.

A small, but important point (the sixth bullet) in this recommendation is crucial and will require attention as it relates to location and placement of day tanks and routing of the fuel lines to emergency generators and fire pumps in all structures. NFPA agrees that consideration must be given to the impact on a building structure due to the presence of unusually large amounts of hydrocarbon fuel, such as was stored in WTC 7 for the numerous emergency generators located in WTC 7. Continuous discharge of fuel for these generator sets may have contributed to the collapse of WTC 7 once one or more of the fuel lines failed allowing the fuel to be ignited and burn unimpeded.

NFPA requirements for storage of liquid fuel inside a building for the operation of stationary engine-driven or stationary turbine-driven equipment ( e.g., fire pumps, electric generators) are contained in Chapters 6, Fuel Supply – Liquid, of NFPA 37-2002, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*. The requirements are similar but not identical to the requirements in the Building Code of the City of New York (BCNYC).

Several issues identified in Chapter 12 of NCSTAR 1-1 need to be considered and studied by NFPA‘s Technical Committee on Internal Combustion Engines, including but not limited to the following:

- Maximum fuel storage capacity allowed unenclosed, i.e., not in a dedicated enclosure. This includes so-called base tanks and day tanks.

- Maximum fuel storage capacity allowed in dedicated fire-rated enclosures and the required fire resistance of the enclosure walls, floor, and ceiling.

- Need for active fire suppression systems designed for the quantity of fuel present.

- Need for specific protection requirements for fuel piping leading from lower floor storage tanks to upper floor stationary engines. (NOTE: NFPA 37 simply refers to NFPA 30-2003, *Flammable and Combustible Liquids Code*, for piping design and installation. NFPA 30 does not contain specific requirements that fuel piping in a building be contained within a dedicated shaft.)

- Need for specific piping system components to shut down fuel supply pumps if a break in the piping occurs.

NFPA 37 is currently being revised and the next edition is scheduled for publication in the first Quarter, 2006. The Technical Committee on Internal Combustion Engines will address these issues during the next document revision cycle.

As with other recommendations, NFPA notes that this recommendation and its associated bulleted items calls for the greater use and application of risk and hazard analyses for building design, and that the factors identified by NIST in the recommendation be considered in these analyses. Many of the tools and data needed to properly conduct this risk evaluation might not be available at present thus presenting some unique challenges as this effort moves forward.

NFPA understands that the bulleted items are intended to serve as factors which might or should be considered in the determination and use of construction types, and that the bulleted items are not intended to serve as standalone recommendations.

NFPA views these recommendations as long term objectives which will result in a more technical and scientific basis for building regulations.

NFPA PROJECTS: All Technical Committees responsible for NFPA 101 and NFPA 5000 (BLD-AAC, SAF-AAC) ;Technical Committee on Flammable and Combustible Liquids (FLC-AAC); Technical Committee on Emergency Power Supplies (EPS-AAA); Technical Committee on Internal Combustion Engines (INT-AAA).

**<u>Recommendation 5.</u> NIST recommends that the technical basis for the century-old standard for fire resistance testing of components, assemblies, and systems should be improved through a national effort. Necessary guidance also should be developed for extrapolating the results of tested assemblies to prototypical building systems.**

NFPA Comment: While the test protocols have been used for a very long time, there is nothing striking or remarkably wrong with the tests. The third bullet item under Part a. has been a focal point of the AISC Fire Engineering Committee since May of 2001. In other cases, the need to evaluate construction assemblies under simulated load conditions has also been in discussion. A review of the NFPA 251/ASTM E119/ UL 263 time-temperature curve in comparison to the data that has been collected in real world laboratory fires is reasonable to determine if these test protocols should be modified.

NFPA is in agreement with this recommendation for improving the technical basis for determining fire resistance ratings. NFPA notes that pursuing this recommendation might result in less fireproofing in some instances and more fireproofing in other cases as the current test procedure (NFPA 251/ ASTM E119/UL 263) is considered by many to be conservative on a macro scale even though it does not completely address details such as connection methods. The implementation of this recommendation will require further study and additional research. As a part of the evaluation of these test procedures, a joint effort by NFPA, ASTM and UL will be proposed by the Fire Protection Research Foundation (FPRF) to study the issues, the similarities and the differences between the test protocols versus actual fires and relevant ISO standards to determine if the test protocols need to be or should be changed.

NFPA PROJECTS: Technical Committee on Fire Protection Features (BLD-FIR); Technical Committee on Fire Tests (FIZ-AAA); Fire Protection Research Foundation.

**Recommendation 6.** **NIST recommends the development of criteria, test methods, and standards: (1) for the in-service performance of spray-applied fire resistive materials (SFRM, also commonly referred to as fireproofing or insulation) used to protect structural components; and (2) to ensure that these materials, as-installed, conform to conditions in tests used to establish the fire resistance rating of components, assemblies, and systems.**

NFPA Comment: Quality control associated with field preparation and application of SFRM is a legitimate concern. Firestop Contractors International Association (FCIA) has initiated work on standards and procedures to address this particular need. These standards, once completed, should be recognized and adopted by models codes and standards. The life of use issue associated with SFRM is also critical. Inspection procedures, on site repair and environmental exposure are all key factors in determining the effectiveness of the material.

NFPA is in agreement with this recommendation to improve the overall performance of SFRM. Further, it is noted that in addition to the specific items listed in the recommendation, particular attention should be given to the application of fireproofing on all structural shapes and sizes. Fire service representatives on NFPA‘s HRBSAC expressed specific concern with regard to small diameter structural elements such as bar joists. SFRM standards from organization such as FCIA and AWCI should be reviewed for reference by NFPA 5000 and NFPA 101. A need to address the appropriate criteria for abrasion, vibration, shock and impact of SFRM under expected service conditions also exists. Enforcement of the integrity of SFRM throughout the life of the building also needs to be addressed by this recommendation.

NFPA PROJECTS: Technical Committee on Fire Protection Features (BLD-FIR); Technical Committee on Fire Tests (FIZ-AAA); Technical Committee on Structures and

Construction (BLD-STR); Technical Committee on Building Construction (BLD-BLC); Technical Committee on Fire Prevention Code (UFC-AAA).

**Recommendation 7. NIST recommends the nationwide adoption and use of the "structural frame" approach to fire resistance ratings.**

NFPA Comment: This approach, now recognized in both model building codes, simply addresses the potential for a ―weakest link". While the basis of the recommendation is now addressed in the 2006 edition of NFPA 5000, the term ―structural frame" should be better defined for future editions of the model codes. For example, is the term to include the full load path of all structural members? Thermal failure of a beam or girder connected to a main support column carrying a gravity load-and that is essential to the stability of the structure-can impact the load path. This recommendation only addresses that particular scenario.

NFPA PROJECTS: Technical Committee on Structures and Construction (BLD-STR); Technical Committee on Building Construction (BLD-BLC); Technical Committee on Fire Tests (FIR-AAA).

### Group 3. New Methods for Fire Resistance Design of Structures

**The procedures and practices used in the fire resistance design of structures should be enhanced by requiring an objective that uncontrolled fires result in burnout without local or global collapse. Performance-based methods are an alternative to prescriptive design methods. This effort should include the development and evaluation of new fire resistive coating materials and technologies and evaluation of the fire performance of conventional and high-performance structural materials. Technical and standards barriers to the introduction of new materials and technologies should be eliminated.**

**Recommendation 8. NIST recommends that the fire resistance of structures should be enhanced by requiring a performance objective that uncontrolled building fires result in burnout without local or global collapse.**

NFPA Comment: This recommendation lumps two very different outcomes together-that being total burnout without local or global collapse. The fire events noted in Recommendation 4 did result in local, but not global collapse. The design level of preventing local collapse during a total burnout does not appear to be realistic unless the current cadre of expected fire scenarios are enhanced and made substantially more conservative. This would result in system redundancies and robustness that will LIKELY be difficult to justify from an economic and experiential point of view. Global collapse from a typical or anticipated fire event is certainly an unwanted outcome-but such cases simply do not exist for the high-rise building environment. NFPA suggests that this recommendation be parsed to separately address local collapse (which seems more acceptable) from global collapse (which seems wholly unacceptable)

A need exists to better define what is meant by ―uncontrolled building fires". Is it intended that this term include only those types of fires already addressed by building and fire regulations, or is it to include other threats/hazards such as hostile acts and explosions? NFPA notes that where building collapses have occurred as a result of fire, the failures were primarily a result of the inadequate application of code mandated provisions and maintenance of fire protection features rather than from any shortcoming associated with building regulations or design methods.

NFPA PROJECTS: Technical Committees on Structures and Construction (BLD-STR), Technical Committees on Building Construction (BLD-BLC); Technical Committee on Fundamentals (BLD-FUN); Technical Committee on Fire Risk Assessment Methods (FIR-AAA)

**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.**

NFPA Comment: Performance Based Design (PBD) methods already exist in NFPA 1, NFPA 101 and NFPA 5000. These can be applied equally to new construction or existing buildings. The same discussion with respect to local and global collapse (Recommendation 8) also applies here. PBD will also have to be measured against prescriptive design to assure it is not providing a lower level of performance in any manner.

NFPA believes that ongoing efforts are needed in the development of tools, data and training for the better implementation of performance-based design methods.

NFPA PROJECTS: Technical Committee on Fundamentals (BLD-FUN).

**Recommendation 10. NIST recommends the development and evaluation of new fire resistive coating materials, systems, and technologies with significantly enhanced performance and durability to provide protection following major events.**

NFPA Comment: This recommendation should not be de-coupled from recommendation No. 6. There are no technical barriers that NFPA is aware of to such systems or materials and NFPA agrees with this recommendation that new building materials be evaluated for their fire resistant characteristics. The testing and listing laboratories such as UL, FM Global, Omega Point and Southwest have the ability to test innovative materials.

NFPA PROJECTS: Technical Committee on Fire Tests (FIZ-AAA); Technical Committee on Building Construction (BLD-BLC).

**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.**

NFPA Comment: Use of material such as fire resistive steel (FRS), concrete filled tube (CFT) and use of similar existing innovations (water filled tube WFT) have the potential to become more mainstream. Provided any of the materials or composites provides the same or higher level of protection than the current offering of construction materials, such options should be considered and more fully developed. NFPA comments on Recommendation #10 also apply here.

NFPA PROJECTS: Technical Committee on Fire Tests (FIZ-AAA); Technical Committee on Building Construction (BLD-BLC); Fire Protection Research Foundation

## Group 4. Improved Active Fire Protection

**Active fire protection systems (i.e., sprinklers, standpipes/hoses, fire alarms, and smoke management systems) should be enhanced through improvements to design, performance, reliability, and redundancy of such systems.**

**<u>Recommendation 12.</u> NIST recommends that the performance and redundancy of active fire protection systems (sprinklers, standpipes/hoses, fire alarms, and smoke management systems) in buildings should be enhanced to accommodate the greater risks associated with increasing building height and population, increased use of open spaces, available compartmentation, high-risk building activities, fire department response limits, transient fuel loads, and higher threat profile.**

NFPA Comment: This recommendation should be broken down into a broader category- namely to look at various risks associated with various segments of tall buildings. While the recommendations are appropriate to look at, other parts of the report only seem to focus on a 20 story differentiation. Consideration of a schedule for high rise buildings (perhaps 4 or 5 categories-see NFPA comments on related subject in Recommendation #4) would be more appropriate. The taller the building, i.e. the greater the perceived risk , construction features and systems with added redundancies or robustness of systems could be increased in some manner.

A means for better understanding and quantifying the impact, performance and reliability of fire protection systems should be pursued. A distinction should also be emphasized between enhancing the effectiveness of such systems and evaluating their appropriateness with respect to specific hazards/threats.

One starting point to consider, revolves around the CTBUH *Building Enhancement Guidelines*. These guidelines, released in May of 2002 provide potential augmentation features that could be applied to increase the reliability of certain building systems and features. In this realm, the systems would be enhanced or hardened to be able to manage certain design hazards that are normally not contemplated in codes. The NFPA HRBSAC is considering a concept (modeled on the LEEDS system) that would provide a point score system for certain system features or enhancements that are best described as “code-plus” designs. Work in this area will likely be in collaboration with NIST and CIB.

It should be noted that the Technical Correlating Committee for the National Electrical Code (NEC) has established a task group to specifically look at the hazard scenarios identified by DHS and to determine what (and where) enhancements to building electrical services could be made to increase the reliability/robustness of such systems.

NFPA PROJECTS: Technical Correlating Committee on Automatic Sprinklers (AUT-AAC); Technical Committee on Fire Pumps (FIM-AAA); Technical Committee on Standpipes (SPI-AAA); Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Correlating Committee on National Electrical Code (NEC-AAC); Technical Committee on Emergency Power Supplies (EPS-AAA); Technical Committee on Smoke Management Systems (SMO-AAA).

**Recommendation 13. NIST recommends that fire alarm and communications systems in buildings should be developed to provide continuous, reliable, and accurate information on the status of life safety conditions at a level of detail sufficient to manage the evacuation process in building fire emergencies, and that standards for their performance be developed.**

NFPA Comment: Timeliness of accurate information for the occupants during large scale building emergencies is of crucial importance. The hardware and software necessary to achieve this is available. Knowing when to give direction, and what direction to give is of paramount importance. This recommendation is closely aligned with Recommendation 16 and 19.

NFPA PROJECTS: Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC).

**Recommendation 14. NIST recommends that control panels at fire/emergency command stations in buildings should be adapted to accept and interpret a larger quantity of more reliable information from the active fire protection systems that provide tactical decision aids to fireground commanders, including water flow rates from pressure and flow measurement devices, and that standards for their performance be developed.**

NFPA Comment: The benefit of having flow rate data available at the command center is not obvious. What other information was being considered when this recommendation was being drafted?

NFPA PROJECTS: Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Correlating Committee on Automatic Sprinklers (AUT-AAC); Technical Committee on Fire Service Occupational Safety (FIX-AAA).

**Recommendation 15. NIST recommends that systems should be developed and implemented for: (1) real-time off-site secure transmission of valuable information from fire alarm and other monitored building systems for use by emergency responders, at any location, to enhance situational awareness and response decisions and maintain safe and efficient operations[32]; and (2) preservation of that information either off-site or in a black**

**box that will survive a fire or other building failure for purposes of subsequent investigations and analysis. Standards for the performance of such systems should be developed, and their use should be required.**

NFPA Comment: Alarm transmission information is routinely backed up and available at central station monitoring facilities. If the only purpose for having this is for event reconstruction, such data already exists in most cases. If it is for use during an event, a point of information overload may be reached. Under some circumstances, too much information becomes less than useful. NIST should particularly pay attention to comments from fire department personnel and OEM managers on this recommendation.

NFPA PROJECTS: Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Committee on Fire Service Occupational Safety (FIX-AAA).

## Group 5. Improved Building Evacuation

**Building evacuation should be improved to include system designs that facilitate safe and rapid egress, methods for ensuring clear and timely emergency communications to occupants, better occupant preparedness for evacuation during emergencies, and incorporation of appropriate egress technologies.**

**Recommendation 16. NIST recommends that public agencies, non-profit organizations concerned with building and fire safety, and building owners and managers should develop and carry out public education campaigns, jointly and on a nationwide scale, to improve building occupants' preparedness for evacuation in case of building emergencies.**

NFPA Comment: This type of action should have been standard protocol pre September 11. High rise building evacuation is a complex subject and while partial relocation of occupants is still the preferred method, we now know that:
A. It may not always be the preference of the occupant;
B. Some building events-fire, power failure, bomb threat-require special approaches, and a full building evacuation may be needed.

At present, NFPA does offer guidelines, both in pamphlet form and on the NFPA website concerning evacuation protocols from high rise buildings. NFPA will pursue the development of additional education programs in this regard and establish cooperative agreements with other organization that have similar interests (BOMA, CTBUH, GSA, ULI). In all cases, any such programs or educational initiatives must be inclusive of persons with all manner of disabilities. See related item in Recommendation #20.

NFPA PROJECTS: Technical Correlating Committee on Safety to Life (SAF-AAC); Technical Committee on Fire Prevention Code (UFC-AAA); Public Education Section; DARAC.

**Recommendation 17. NIST recommends that tall buildings should be designed to accommodate timely full building evacuation of occupants due to building-specific or large-scale emergencies such as widespread power outages, major earthquakes, tornadoes, hurricanes without sufficient advanced warning, fires, accidental explosions, and terrorist**

**attack. Building size, population, function, and iconic status should be taken into account in designing the egress system. Stairwell and exit capacity should be adequate to accommodate counter flow due to emergency access by responders.**

NFPA Comment: Full building evacuation concepts are an important consideration, but should not be viewed as the preferred or optimum choice for a tall building. Width of stairs in high rise buildings has been a discussion topic for decades, not years. While the concept of sizing the stairs for the largest floor population is workable for typical or expected scenarios, there are definitive concerns for mass evacuation of the building coupled with issues of counter-flow by first responders. The 2006 editions of NFPA 101 and NFPA 5000 include a new stair width design concept that incorporates cumulative population use of the stairs. An aggregate of the floor populations will trigger an increase in stair width (from 44 inches to 56 inches) where 2000 or more occupants are expected to use a given stair.

NFPA does believe that a better understanding of the evacuation and egress of building occupants is necessary. Data and methods need to be further developed to help understand occupant behavior and to determine the length of time needed to evacuate building occupants. Scenarios should include various types of evacuation such as partial evacuation or relocation concepts, full evacuation, defend in place concepts, use of elevators, escape devices, and other alternate means of escape. Availability and reduction of egress routes should be also considered. NFPA notes that the term ―timely” is largely a function of the threat/hazard to be considered and is likely to require risk analysis. Building-specific and large-scale emergencies need to be quantified. It should also be recognized that rapid evacuation of all building occupants could place them in greater danger. The effect of evacuation planning and drills should be quantified, and efforts in limiting the number of trips and falls should also be pursued.

NFPA PROJECTS: Technical Committee on Means of Egress (BLD/SAF-MEA); Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Committee on Fire Service Occupational Safety (FIX-AAA); Research Section; Fire Service Section, Public Education Section.

**<u>Recommendation 18.</u> 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.**

NFPA Comment: This recommendation is disconcerting in that it introduces a major assumption of a ‗large scale‘ emergency, yet states in item b. this is not an aircraft impact. What event(s) would fit into this category? The recommendation also attempts to sweep into it design of other systems and features such as elevators. NFPA recommends that the subject in Recommendation #18 regarding ―large scale” emergency be removed from the list and described as a separate point of philosophical discussion. The on-going debate about whether building regulations should address events associated with normal building hazards, or more extreme events such as hostile acts and explosions will have to be settled first before consensus is reached on this subject.

NFPA agrees with that part of the recommendation regarding consistent layout and signage and the use of features that will make the egress system more intuitive. NFPA 72, *National Fire Alarm Code*, has accepted a series of proposals for the 2007 edition that will introduce the concept of *Exit Marking Audible Notification Appliances*. Such components have the ability to direct occupants by sound to the exit locations.

NFPA also agree that remoteness of exits should be studied, as current remoteness provisions might not be adequate for other than fire events. Areas that NFPA Technical Committees will study include concepts of a more robust building core, or more robust stair construction and the reduction of remoteness of exits in sprinklered buildings.

NFPA PROJECTS: Technical Committee on Means of Egress (BLD/SAF-MEA); Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC).

**Recommendation 19. NIST recommends that building owners, managers, and emergency responders develop a joint plan and take steps to ensure that accurate emergency information is communicated in a timely manner to enhance the situational awareness of building occupants and emergency responders affected by an event. This should be accomplished through better coordination of information among different emergency responder groups, efficient sharing of that information among building occupants and emergency responders, more robust design of emergency public address systems, improved emergency responder communication systems, and use of the Emergency Broadcast System (now known as the Integrated Public Alert and Warning System) and Community Emergency Alert Networks.**

NFPA Comment: This subject closely aligns with Recommendation #13. Similar technologies are deployed at the US Capitol complex to provide an alert status to the approximately 30,000 staff, occupants and visitors who may be present on a given day. Recent work underway at NFPA, and that was initiated at the request of the US Air Force on Mass Notification systems will help to codify and standardize some of these protocols.

NFPA PROJECTS: Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Committee on Building Systems (BLD-SYS); Fire Service Section; Public Education Section; Metro Chiefs.

**Recommendation 20. NIST recommends that the full range of current and next generation evacuation technologies should be evaluated for future use, including protected/hardened elevators, exterior escape devices, and stairwell navigation devices, which may allow all occupants an equal opportunity for evacuation and facilitate emergency response access.**

NFPA Comment: This subject was part of the theme at a NIST sponsored workshop in 2004. Recommendation #21 on elevator use is going to happen sooner rather than later. Last resort escape devices are gaining some recognition and use, but integration of such devices into the built environment must be carefully managed. And there can be no expectation, however, that current technologies will have an impact on September 11 type events.

The term —stairway descent devices” has been used in NFPA 101 and NFPA 5000, and it is recommended that NIST use the same terminology in lieu of stairwell navigation devices.

NFPA PROJECTS: Technical Committee on Means of Egress (BLD/SAF-MEA); Technical Committee on Building Systems (BLD-SYS); DARAC; Public Education Section.

## Group 6. Improved Emergency Response

**Technologies and procedures for emergency response should be improved to enable better access to buildings, response operations, emergency communications, and command and control in large scale emergencies.**

**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.**

NFPA Comment: Broad use of elevators well into a building fire or other emergency event will offer a means of attaining a more timely evacuation of very tall buildings as noted in Recommendation #17. Work in this particular area is likely within three years of completion and implementation. If possible, NIST and ASME should fast track this particular project so as to allow the hardened elevator concept to be realized sooner if possible.

The effort being organized by NIST and ASME is of crucial importance to ensure that current technology (both hardware and software) can adequately address the associated safety, functional and operational concerns with using the elevators as described. In particular, concerns with elevator shunt trips, the filling of shafts with smoke, the operation of equipment under adverse conditions such as when wet from fire suppression operations or systems and the need to provide direction to the occupants must be addressed.

A dedicated use elevator as described only for the exclusive use of emergency responders, i.e. fire fighters is open to discussion. In some cases, on site fire ground operations in a high-rise building may take 15 to 20 minutes to commence from time of the first alarm. If a goal truly is to strive for timely evacuation, this is a significant portion of time where the elevators may be in recall mode and are not being utilized. Keeping elevators available for use by building occupants, or at least building occupants with mobility impairments, during this time period, vastly improves the chances of meeting Recommendations #17 and #21.

NFPA suggests that the use elevators should be as a minimum, under exclusive authority of the fire service and other first responders such as fire wardens, security personnel and other authorized on site personnel who may be adequately trained to use the elevator. Ideally, use of the elevators by the occupants should be a longer term goal to strive for. In particular, anything that can be done allow mobility impaired occupants access and use of the elevators under emergency conditions should be pursued as quickly as possible.

Structurally hardened (properly protected) elevators also need to be further defined as well as the threats/hazards to be considered. The CTBUH *Emergency Evacuation Elevator Systems Guideline* (September 2004) provides a definitive starting point for elevator evacuation concepts.

NFPA PROJECTS: Technical Committee on Means of Egress (BLD/SAF-MEA); Technical Committee on Building Systems (BLD-SYS); Technical Committee on Uniform Fire Code (UFC-AAA); Technical Committee on Fire Service Occupational Safety (FIX-AAA); DARAC; Public Education Section; Fire Service Section; Metro Chiefs.

**<u>Recommendation 22.</u> NIST recommends the installation, inspection, and testing of emergency communications systems, radio communications, and associated operating protocols to ensure that the systems and protocols: (1) are effective for large-scale emergencies in buildings with challenging radio frequency propagation environments; and (2) can be used to identify, locate, and track emergency responders within indoor building environments and in the field.**

NFPA Comment: First responder communication systems must be robust enough to allow uninterrupted, reliable communication between fire, police and OEM officials for all building emergencies and not just the large scale event mentioned. The particular problem of needing reliable and dependable communication systems that work from inside of any building environment to both internal and external locations is crucial.

NFPA PROJECTS: Technical Committee on Fire and Emergency Service Organization and Deployment — Career (FAC-AAA); Technical Committee on Fire and Emergency Service Organization and Deployment — Volunteer (FAD-AAA) ;Technical Committee on Fire Service Occupational Safety (FIX-AAA) ; Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Committee on Public Emergency Service Communication (PUF-AAA); National Electrical Code Committee (NEC-AAC);Fire Service Section; Metro Chiefs.

**<u>Recommendation 23</u>. NIST recommends the establishment and implementation of detailed procedures and methods for gathering, processing, and delivering critical information through integration of relevant voice, video, graphical, and written data to enhance the situational awareness of all emergency responders. An information intelligence sector should be established to coordinate the effort for each incident.**

NFPA Comment: Related to Recommendation #15, this concept must remain manageable by that individual or sector. One concern may be too much information.

NFPA PROJECTS: Technical Committee on Fire and Emergency Service Organization and Deployment — Career (FAC-AAA); Technical Committee on Fire and Emergency Service Organization and Deployment — Volunteer (FAD-AAA); Technical Committee on Fire Service Occupational Safety (FIX-AAA) ; Technical Correlating Committee on Signaling Systems for the Protection of Life and Property (SIG-AAC); Technical Committee on Public Emergency Service Communication (PUF-AAA); Technical Committee on Pre-Incident Planning (PIP-AAA);Fire Service Section; Metro Chiefs.

**<u>Recommendation 24.</u> NIST recommends the establishment and implementation of codes and protocols for ensuring effective and uninterrupted operation of the command and control system for large-scale building emergencies.**

NFPA Comment: Circumstances by which a governmental entity establishes a command authority that is event dependent is critical. Smaller jurisdictions may have a one stop procedure-regardless of the event. Larger jurisdictions may have a complex system that has different lead agencies for different events. Such protocols should consider the event, mutual aid from surrounding jurisdictions, and thresholds for assistance from state and federal government agencies.

Jurisdictions at all levels need to develop and implement protocols that clear lines of authority are established in advance of major emergencies. The recommendations made in the report very clearly outline the steps that jurisdictions should take to improve their command and control of large-scale incidents.

NFPA PROJECTS: Technical Committee on Fire and Emergency Service Organization and Deployment — Career (FAC-AAA); Technical Committee on Fire and Emergency Service Organization and Deployment — Volunteer (FAD-AAA); Technical Committee on Fire Service Occupational Safety (FIX-AAA); Technical Committee on Public Emergency Service Communication (PUF-AAA); Technical Committee on Pre-Incident Planning (PIP-AAA); Fire Service Section; Metro Chiefs.

## Group 7. Improved Procedures and Practices

**The procedures and practices used in the design, construction, maintenance, and operation of buildings should be improved to include encouraging code compliance by nongovernmental and quasi-governmental entities, adoption and application of egress and sprinkler requirements in codes for existing buildings, and retention and availability of building documents over the life of a building.**

**<u>Recommendation 25.</u> 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.**

NFPA Comment: The recommendation should also extend to federal agencies as well. This recommendation is simply good practice-both business and neighbor. The terms ―non-governmental and quasi-governmental" should be deleted. Additionally it should address those situations where no Authority Having Jurisdiction exists, where the local governing building regulations do not need to be adhered to by the party constructing the building, and where self-certification in the private sector occurs.

NFPA PROJECTS: Technical Committee on Fundamentals (BLD/SAF-FUN); Technical Committee on Uniform Fire Code (UFC-AAA); IFMA; AEBO Section

<u>**Recommendation 26.**</u> **NIST recommends that state and local jurisdictions should adopt and aggressively enforce available provisions in building codes to ensure that egress and sprinkler requirements are met by existing buildings. Further, occupancy requirements should be modified where needed (such as when there are assembly use spaces within an office building) to meet the requirements in model building codes.**

NFPA Comment: While retroactive imposition of building safety standards can be intrusive, it is none-the-less good practice. Grandfathering concepts that allow other than imminent hazards to remain in place have proven to be problematic. At first pass, this recommendation needs to be modified somewhat to distinguish between removal of grandfathering clauses and complying with requirements for new construction during renovation type projects. The thresholds' for change is quite different in these two concepts.

Certain requirements for existing buildings such as those pertaining to sprinkler protection and fire resistance should meet the same level of safety required for new construction when a renovation in contemplated. Additional regulations for existing buildings, such as those currently found in NFPA 101, should be developed and adopted. NFPA 101 does not recognize the ―grandfathering concept"-instead, it mandates a minimum level of safety and performance that applies retroactively to a building. NFPA is strongly in support of the recommendation that high rise buildings be retrofitted with automatic sprinkler systems. This provision is currently a requirement of NFPA 1 and NFPA 101.

NFPA PROJECTS: Technical Committees for the Life Safety Code (SAF-AAC) and Building Code (BLD-AAC); Technical Committee on Uniform Fire Code (UFC-AAA); IFMA; AEBO Section.

**<u>Recommendation 27.</u> 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[45]. 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.**

NFPA Comment: The retention of documents- including as built drawings, relevant calculations and O&M manuals is important for future modifications or work on the building. What type, and how much information should be available to first responders will be a function of the extent to which government entities adapt to items in Recommendations 15 and 23. Local issues with regard to information required by first responders, the format of the information, and how much information is necessary must also need to be addressed.

NFPA PROJECTS: Technical Committee on Fire and Emergency Service Organization and Deployment — Career (FAC-AAA); Technical Committee on Fire and Emergency Service Organization and Deployment — Volunteer (FAD-AAA); Technical Committee on Fire Service Occupational Safety (FIX-AAA); Technical Committee on Pre-Incident Planning (PIP-AAA); Fire Service Section; Metro Chiefs.

**<u>Recommendation 28.</u> 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 systems, 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.**

NFPA Comment: Use of all appropriate design professionals should be integrated into this recommendation. Unusual structural design applications must be over seen by a structural engineer; unusual mechanical design applications must be overseen by a mechanical engineer. Codes should continue to advance the concept of *Design Professional in Responsible Charge*, or *Registered Design Professional*, but state licensing boards should be responsible for establishing the areas of practice for a given project.

**<u>Recommendation 29.</u> 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.**

NFPA Comment: This recommendation embraces a concept that is long overdue. In some case, fire safety needs and concerns are addressed almost as an afterthought. Fire protection engineers want to offer solutions to everyday prescriptive-based designs but also to innovative architectural designs. Likewise, it is important for the architectural community to be aware of the limits in fire protection engineering. Work among affiliated groups such as NFPA, SFPE, AIA, NCSEA and ASCE among others would help with the cross knowledge application desired by this recommendation.

NFPA PROJECTS: Professional Development Division.

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

NFPA Comment: Such course offering currently exist and broader availability of these programs will help everyone to perform more concise analyses of buildings designs with respect to fire events. Work among affiliated groups such as NFPA, SFPE, AIA, NCSEA and ASCE among others would help with the cross knowledge application desired by this recommendation.

NFPA PROJECTS: Fire Science and Technology Educators Section

# ANNEX B

## FPRF Report

## June 2007

# Fire Resistance Testing
# For Performance-based Fire Design of Buildings

*Final report*

Prepared by:

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# FOREWORD

The ASTM E119 test procedure (or equivalent) is used to determine whether a construction assembly or structural element meets the fire resistance rating requirements specified in prescriptive building codes. Fire statistics indicate that these requirements appear to be adequate in meeting the intended fire safety objectives of the prescriptive codes. In recent years it has become more common to design buildings for fire safety on a performance basis. The standard fire resistance test in its present form is not designed to provide discrete information that can be used in support of performance-based structural fire design. The technology of the test standard could be improved to make the measurements and results more useful for performance-based fire design.

This report presents the results of a study undertaken by the Foundation to develop the technical basis for changes and additions to ASTM E119 so that measurements and results can be used in performance-based design, without compromising the traditional use of the test standard for prescriptive building code compliance.

The Research Foundation expresses gratitude to the report authors Craig Beyler, Jesse Beitel, Nestor Iwankiw, and Brian Lattimer of Hughes Associates, Inc.; and the Project Technical Panelists and Principal Sponsors listed on the following page.

The content, opinions and conclusions contained in this report are solely those of the authors.

# Fire Resistance Testing
# For Performance-based Fire Design of Buildings

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HAI Project # 2843-000

# FIRE RESISTANCE TESTING
# FOR PERFORMANCE-BASED FIRE DESIGN OF BUILDINGS

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June 18, 2007

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**The Technical Basis of a Fire Resistance Test for Performance-Based Fire Design of Buildings**

## 1.0 INTRODUCTION

There is an ongoing trend in Fire Protection Engineering toward Performance-Based Design (PBD) and toward rational engineering of fire protection in lieu of prescriptive requirements. This approach requires engineering data that existing test methods, like ASTM E 119 (American Society for Testing and Materials), are not currently configured to provide (Grosshandler, 2002). The lack of engineering data from standard fire resistance test methods requires that performance-based design utilize data obtained from ad hoc test methods performed outside of the scope of standard test methodologies. This process is lacking in both standardization and efficiency.

In addition to other limitations with respect to test procedures, measurements, and reporting, reproducibility of standard furnace testing has always been a serious issue. Fire resistance tests are unique within the fire test world in that the apparatus is only generally specified in the test standard. Fuels, burners, furnace linings, furnace dimensions, loading levels, and loading mechanisms are either unspecified or only generally specified. This has led to the situation that test results cannot be reproduced from laboratory to laboratory. This situation causes significant problems in a performance-based design environment.

The goal of this project is to identify the needed capabilities of a standard fire resistance test to support Performance-Based Structural Fire Engineering (PBSFE). A test plan outline to develop and validate the proposed capabilities, procedures, and instrumentation has been developed and is included in this report. The test plan outline provides an approach to evaluate the ability of the recommendations to be implemented, and to evaluate the value added by the recommendations. The recommendations developed in this report are intended to apply to the entire range of fire resistive assemblies. However, the accompanying test plan outline utilizes two common building elements; composite concrete slab/steel beam floor assemblies and gypsum-protected load bearing steel-stud walls as test beds for the evaluation of the recommendations. It is intended that such testing will provide a partial basis for the inclusion of the recommendations into a test standard. It is envisioned that the work will support the ongoing development of fire resistance test methods in ASTM E 5.

While there is emerging interest in Performance-Based Structural Fire Engineering, it is understood that the existing test methods that support prescriptive requirements will be needed for the foreseeable future. It is recognized that some of the recommendations in this report may be applicable to existing test methods that support current prescriptive design approaches. Recommendations that may be applicable to existing test methods are summarized in Section 6.4.

The existing test methods and the listings that have resulted from application of these test methods are a significant legacy that has served the fire community since the 1920s. The combination of the test methods, the listings, and prescriptive fire resistance requirements of the building codes have resulted in very satisfactory overall fire performance of buildings. The goal of this work is not to alter this prescriptive-based system. Rather, the goal of this work is to provide a partial basis for a complementary performance-based system for the provision of structural fire protection. Given the long history of the prescriptive-based system, discussions of the provisions of a new performance-based system will inevitably include a juxtaposition of the properties of the new performance-based system relative to the existing prescriptive-based system. These juxtapositions inevitably focus on the shortcomings of the prescriptive system with respect to performance-based design. The simple fact is that the design approaches are different and have different requirements. It is appropriate for the development of performance-based methods to grow out of our extensive experience with the prescriptive system. When elements of the prescriptive system are highlighted as not appropriate for performance-based design, these are simply expressions of the differences in the requirements of the two systems and are not appropriately regarded as failures of the prescriptive system. The prescriptive approach has provided very satisfactory results in application. It is simply hoped that the performance-based system can provide similarly satisfactory or better results in a more cost-effective manner.

### 1.1 Ongoing Developments in Structural Fire Protection Design Methods

In the area of engineered structural fire protection, there are many ongoing organizational efforts to develop the required design method infrastructure. The Society of Fire Protection Engineers (SFPE) has a committee working on a standard for determination of the design fire exposure. SFPE is also in the process of constituting a committee to develop a standard on the thermal/heat-transfer portion of the design process. The National Fire Protection Association (NFPA), meanwhile, is developing a standard for fire loads for structural fire protection design. These committees are coordinating their efforts to produce a suite of documents that collectively support PBSFE.

While the American Society of Civil Engineers (ASCE) had announced some time ago its intention to produce a document in the structural portion of the design process, it seems that this process has not yet materialized (ASCE Committee for Structural Design for Fire Conditions is charged with development of a Performance-Based Fire Design Standard). There is no doubt that the SFPE efforts on the heat-transfer portion and ASCE's efforts on the structural portion will require data that cannot be obtained using current test methods.

In that vein, there is a task group working within ASTM E 05.11 (Fire Resistance) that is developing a guidance document for conducting nonstandard furnace tests. All these activities have European counterparts generally encompassed by the Eurocode suite of documents. Based upon the various ongoing related activities, there is a genuine need to develop means for integrating standardized fire resistance test results into the performance-based structural fire engineering process.

### 1.2 Outline of the Analysis Approach

The approach to analyzing the recommendations for fire resistance testing in support of PBSFE begins by reviewing the PBSFE design process. Based upon the needs of PBSFE and the research literature, recommendations are developed in the areas of heat-transfer/thermal response, structural performance, and test documentation. The recommendations are first stated, and then the basis for the recommendation is developed from the research literature. Appendix A includes a bibliography of research in structural fire engineering.

## 2.0 PERFORMANCE-BASED STRUCTURAL FIRE ENGINEERING (PBSFE)

While the field of Performance-Based Structural Fire Engineering is in the developmental stage, the overall structure of the process has been well defined for some time. Grosshandler (2002) outlined the process in summarizing a recent fire resistance workshop. The process includes both design and analysis components. The analysis components involve the definition of the design fire exposure, the thermal/mechanical response of the structural assembly (including any fireproofing materials), and structural response of the structural system. The broader design processes are shown in Figure 1, including inputs from building code requirements and inputs from assembly listings. Here we take a broad view of assembly listings to include any engineering data that can be deduced from the testing involved in the development of the listing (despite the fact that such test data is not made public by the listing organization or test sponsors at the current time) or fire resistance testing not associated directly with the listing process. The recommendations developed in this report are intended to provide additional engineering information and data from the activity noted in Figure 1 as "Assembly Listing and Data." These infrastructure components are shown above the dashed line, while the actual design portion of the process is shown below the dashed line. The design components include the architectural and structural designs of the building, which form the basis for the fire engineering design.

The fire engineering begins with the development of a design fire exposure to the structure. This normally takes the form of a time-temperature curve based upon the fire load, ventilation, and thermal properties of the bounding surfaces (walls, floor, and ceiling). Design fire loads are dependent upon the occupancy and other fire protection features of the building. Significantly, with respect to furnace testing, the performance of the boundaries to limit fire spread is the primary component of defining the design fire area. Often the exposed fire area is defined by boundaries with sufficient fire resistance to prevent fire spread under the design fire load density. It is significant to note that the time-temperature curves developed in compartment fires most often exceed the time-temperature curves used in the test methods like ASTM E 119. As noted by Drysdale (1999), this has been recognized but tacitly accepted since the 1920s in the setting of prescriptive fire resistance requirements for buildings.

Based upon the architectural and structural designs, the design fire is used to develop the passive fire protection design. This involves the selection of fire resistive assembly constructions for use as walls, columns, and floor/ceiling assemblies. The assemblies are selected to survive the design fire exposure, to be consistent with the architectural/structural design, and to provide cost-effective protection. It would be normal to develop more than one set of conceptual designs for further evaluation.

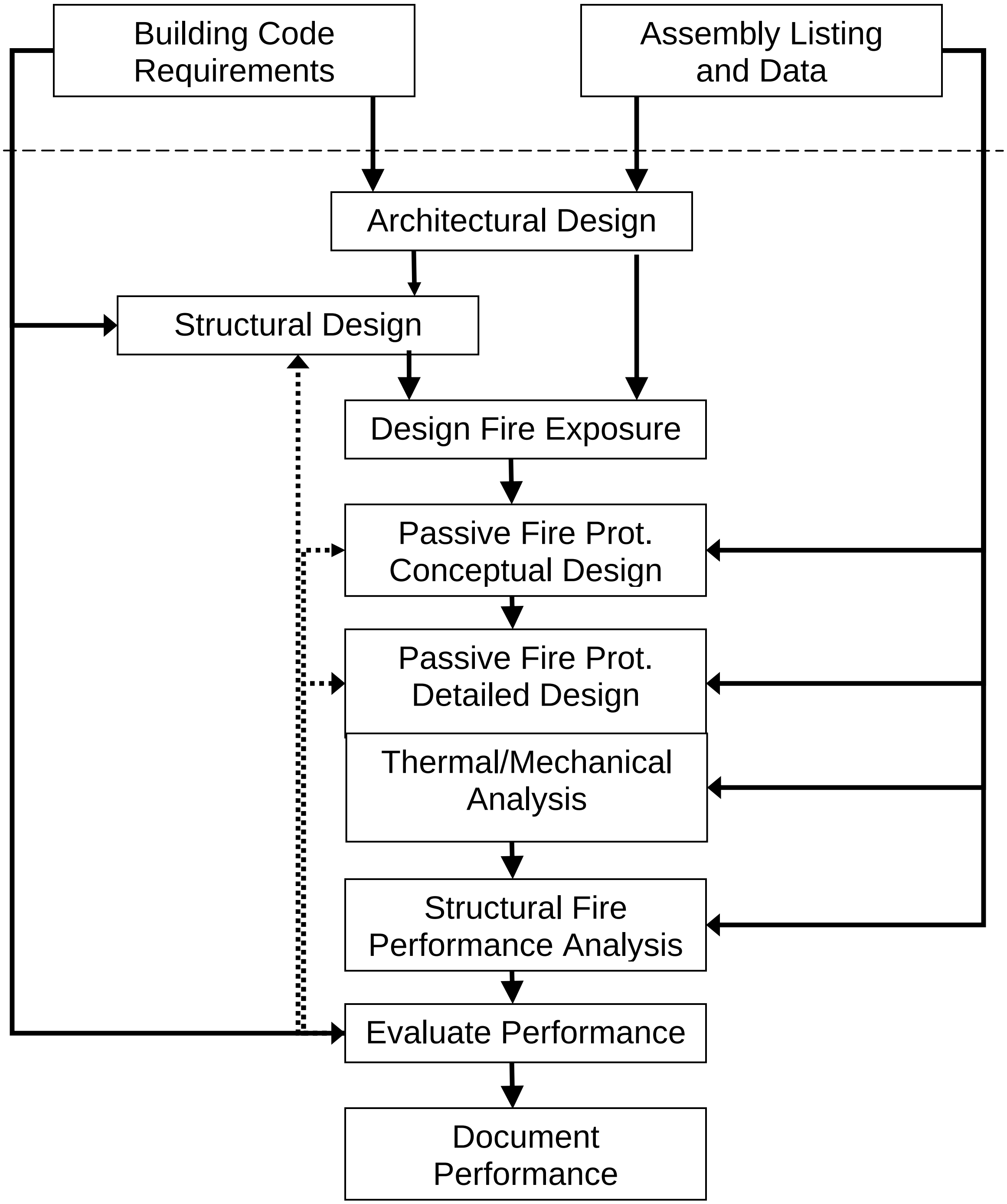



Figure 1. Performance-based structural fire engineering (PBSFE) design process.

Detailed design involves the use of thermal/mechanical models to assess the performance of each conceptual design, resulting in trial protection thicknesses based upon tentative thermal failure criteria. It is typical to perform two-dimensional heat-transfer analyses, but three-dimensional analyses are sometimes required. It is significant that existing models cannot deal with the mechanical performance of the assembly in any substantive manner. Loss of physical integrity of a material or the assembly cannot be modeled at this time. The designer relies entirely upon the results of testing to assure that physical integrity is maintained over the design exposure period. In most cases, the engineer will seek to use materials and assemblies that can be relied upon to maintain integrity, or alternatively simple, and somewhat ad hoc, assumptions about material loss are made in the design calculations.

The final analysis process is the prediction of structural performance of the structure under design loads with the structural elements heated according to the heat-transfer analysis. This analysis can be performed for individual elements, for the substructure in the fire area, or for the complete structural system. Typically, multiple analyses are performed with more detailed analysis at the element level and more basic analysis at the structural system level.

Based upon the performance of the system, redesign may be indicated. This could include changes to the structural design (especially if changes here could allow removal of fireproofing altogether), changes in the passive design concept (e.g., change insulating material), or alterations in the detailed design of the passive fire protection (modify the thicknesses of the insulation). Other redesign aspects are possible, but these are the most common.

As indicated in Figure 1, the assembly listing and data that is, or could be, included in the listing documentation can contribute to the passive fire protection design, the thermal/mechanical analysis, and the structural fire performance analysis. It is important to note that the listing documentation (e.g., the test report) is not a public document under the current system so that these can only be used with the assistance of the owner of the listing. In addition, the current listing may not be directly supported by reported tests. Testing may have been performed with an old version of the protective material and the current material may be accepted under the listing based upon the listing agency's engineering judgment. While this may be satisfactory for prescriptive use of the product, it has serious limitations with respect to PBSFE.

Other data sources, not shown in Figure 1, also contribute to these design and analysis processes. These include other published data concerning temperature dependent structural properties of materials and thermal properties of insulating materials. While some of this data is produced using standard methods, other data is obtained via ad hoc testing methods.

The analysis methods employed in the design process may vary from special purpose software to general heat-transfer or structural analysis software. Some software is developed by the designer, some is developed by government laboratories, and some is commercial software. There is a specific need to address applicability, validation, and verification of these methods for use in specific Performance-Based Structural Fire Engineering (PBSFE) designs.

It is the vision of this report that a fire resistance test in support of PBSFE should be a part of the validation and verification (V&V) basis for the application of analysis tools to specific fire resistance designs. All needed data to support the analysis should be developed through tests designed for that purpose (e.g., thermal properties and structural properties). The furnace test should be conducted and instrumented to provide high quality data and boundary conditions to form a data set that can be predicted using the analysis tools. The successful prediction of the test would form a partial basis for demonstrating the applicability of the models to the particular fire resistance design. The test would further identify any mechanical behaviors such as erosion, cracking, spalling, shrinkage, fastener failures, warpage, and other behaviors that need to be mitigated in the design or accommodated in the design calculations.

There is a wide range of testing and reporting aspects of standard fire test methods that are required to support PBSFE. These include simple characterization of the test article and the properties of the component materials, as well as substantive measurements made and the conduct of the test itself. It has been recognized for many decades that realistic fire exposures can exceed the exposure in ASTM E 119 and that the exposure conditions to the assembly vary among furnaces operated in a manner consistent with existing test methods. There is also a need to develop and validate thermal properties of insulating materials and the methods and instrumentation of standard test methods to support PBSFE. There are definite unresolved issues concerning the structural conduct of the test to assure that the results are applicable to longer spans and connections found in actual construction. This brings to the fore issues of structural scaling laws, and the use of structural rather than thermal endpoints for the test. Issues also exist with the conduct of the test with respect to failure criteria. Valuable failure mode data can be provided by the practice of "testing to failure." These and other issues have received varying levels of attention in the testing and research literature. There is no doubt that a new fire resistance test method can become a valuable tool in PBSFE design. The recommendations included in the following sections are in support of this objective.

## 3.0 TEST METHOD RECOMMENDATIONS – THERMAL/HEAT-TRANSFER

The test requirements with respect to the thermal aspects of the test method involve measurements/instrumentation, furnace-operating conditions, and test documentation. These requirements relate to the representation of realistic fire exposures and production of data that can directly support PBSFE. The recommendations are followed by a discussion of the issue and the basis for the recommendation.

Heat-transfer analysis through an assembly exposed to fire conditions must be conducted using models that have been verified and validated (V&V) with data that is representative of the expected fire conditions. Guidance is provided in this section of the report to develop a furnace test that generates thermal response data that can be used to V&V heat-transfer models. Data collected will provide a means for engineers to V&V models for predicting the variables of potential concern in a fire resistance simulation including temperature profiles through the assembly, temperature rise of an item placed against the unexposed side of the assembly, and total heat flux off the unexposed side and/or through transparent portions of the assembly.

Furnace construction and control are detailed to provide a consistent, repeatable exposure that minimizes the effects of test article construction on the exposure conditions. A furnace calibration test is recommended to quantify the thermal exposure onto a test article. This should be done through the measurement of total heat fluxes from the furnace onto the test article as well as the thermal response of noncombustible boards with known thermal properties. With this data, heat-transfer models can be used to predict temperature profiles through the noncombustible boards, demonstrating the capability of the model to predict heat transmission due to a furnace exposure. These procedures minimize furnace-to-furnace differences and provide a basis for validating the model performance with the furnace to be used to test the assembly to be used in PBFPE. This procedure will directly support round-robin comparisons of furnaces to insure the consistent application of the test method among laboratories.

The recommended furnace exposure conditions are based on an upper bound of conditions that have been measured in compartment fire testing, including temperature, pressure, and oxygen levels. By conducting tests at the upper bound of possible conditions, the performance of the assembly has been evaluated over the range of potential fire exposures. The use of an upper-bound exposure condition to evaluate materials or assemblies will provide some assurance that for most materials, performance under a less severe exposure will not result in a degradation of performance. When extrapolating performance from one fire exposure to a more severe fire exposure, there are no assurances that the performance of materials or assemblies will be predictable. Some materials may perform well at elevated temperatures, while other materials may expand, contract, warp, spall, change phase, debond, or crack, and fasteners may fail. Materials may lose integrity and fall off from the surface. Many of these phenomena and failure modes cannot be predicted using the current state-of-the-art models. Therefore, testing products at the upper bound of temperature level expected is currently the only way to demonstrate the overall performance of a material.

A model that is validated against this upper-bound exposure data will also be demonstrated to be appropriate for predicting the thermal response of the assembly over the range of exposures. Temperature data can be used to demonstrate that the thermal properties being used in the heat-transfer analysis are appropriate. In cases where material failures occur (i.e., fall off the exposed side), the through-thickness temperature data can be used to understand when such failures may occur and data could be used to assist in developing/validating constitutive models to predict these failures. Through model validation with the calibration test, as well as the test on the actual assembly, the heat-transfer model could be used with confidence to predict thermal response of the assembly during compartment fire exposures.

## 3.1 Instrumentation

### 3.1.1 Furnace Temperature Control

*Recommendation T-1: Plate thermometers should be used to measure furnace temperature and control the furnace exposure. There should be nine plate thermometers equally distributed across the test specimen surface. Plate thermometers are typically placed 0.10 m (4 in.) away from the sample; however, a larger spacing is desired to prevent them from potentially being damaged by failing test articles. Testing needs to be performed to demonstrate that a larger spacing does not affect the thermometer measurement.*

Engineers need a repeatable furnace exposure that is as independent as possible from the test article construction and the furnace details. This will allow modelers to use the thermal exposure calibration test described in Section 3.2 as a basis for the thermal exposure in all tests. In order to provide a repeatable furnace exposure, the furnace temperature measurement used to control the furnace should not be sensitive to test article construction and furnace details.

Plate thermometers have been documented to provide a more repeatable exposure furnace-to-furnace and within the same furnace with different types of test articles. Based on analysis by Babrauskas and Williamson (1978), Wickstrom (1989, 1997) developed the plate thermometer to provide a temperature measurement that had no radiative view of the test article, to remove the variation due to thermocouple design and bead size, to reduce the effects of variations in furnace construction, and to result in a heat-transfer coefficient similar to a test specimen.

Plate thermometers have been shown to minimize the variation in exposure measured within different furnaces. Testing with different furnaces has demonstrated that using plate thermometers to control furnace temperature reduces the effects of different furnace linings (van der Luer and Twilt, 1999, Harada et al., 1997, Davies and Dewhurst, 1996, Cooke, 1994), furnace depths (Harada et al., 1997, Fromy and Curtat, 1999, Cooke, 1994), and furnace gas emissivity through burning different fuels (Cooke, 1994, Harada et al., 1997, Fromy and Curtat, 1999). Testing has also demonstrated that plate thermometers provide a more consistent thermal exposure, independent of the thermal properties of the test specimen (van de Leur and Twilt, 1999).

The thermal exposure produced when the furnace exposure is controlled using plate thermometers has been shown to be less severe than furnaces controlled using shielded thermocouples in the early portions of the test (up to about 10 minutes), but more severe than furnaces controlled with bare thermocouples throughout the test. Compared with shielded thermocouples, Sultan (2006) determined that controlling the furnace with plate thermometers produced a less severe exposure during the initial 10 minutes of the test, but thereafter the exposures were similar. Compared with furnaces controlled with bare thermocouples, van der Leur and Twilt (1999) measured that furnaces controlled by plate thermometers resulted in higher temperatures (as measured using 1-mm diameter sheathed thermocouples) during the entire test, compared with temperatures measured when the furnace was controlled with 1-mm sheathed thermocouples.

Plate thermometers are typically placed 0.10 m (4 in.) from the specimen surface. This is done to keep the thermometer as close as possible to the test article so that the thermometer is measuring the exposure seen by the test article. In performing tests to failure, test articles may deflect more than 0.10 m (4 in.) into the furnace, which could potentially damage plate thermometers. As a result, plate thermometers need to be located as much as 0.30 m (12 in.) from the test article to allow room for it to deflect and fail. Wickstrom (1998) states that the location of the plate thermometer away from the test article is not expected to influence the plate thermometer furnace temperature measurement. Testing is recommended to verify that the plate thermometer measurement is not significantly influenced by the increased offset from the test article.

<u>Furnace Differential Pressure</u>

*Recommendation T-2: Tests should be performed with a positive furnace pressure (relative to laboratory conditions) across the entire test article. All furnace pressures* *should be measured using the tube sensor provided in ISO 834 and EN1363-1. In a vertical furnace, pressure should be measured at the bottom and top of the test specimen. The neutral plane in the furnace should be maintained at the bottom of the test specimen with no limit on the pressure at the top of the specimen. In a horizontal furnace, the furnace pressure should be measured at one location and maintained at a minimum of 20 Pa. Pressure tube sensors should be located at the same distance away from test articles as the plate thermometers.*

Fully-developed fires will always produce a positive pressure gradient across ceilings and a majority of the boundary height relative to ambient conditions. In these areas of positive pressure, hot gases are driven through small openings that develop in the assembly causing damage to the internal portions of the assembly. Hot gas migration through the assembly may also give rise to ignition on the unexposed side of the assembly in these local areas of weakness. As a result, it is recommended that furnace tests be performed with a positive furnace pressure so that the effects of hot gas transmission through the assembly can be observed.

The differential pressure between ambient and a compartment containing a hot gas layer will vary due to hydrostatics through the following relation,

$$\Delta P = g\left(\rho_f - \rho_a\right)h \qquad (1)$$

where $g$ is the gravitational constant (9.81 m/s$^2$), $\rho_f$ is the gas density inside the fire compartment, $\rho_a$ is the ambient gas density at the same elevation, $h$ is the elevation above a datum where the pressure between ambient and the compartment is equal (i.e., neutral plane) (m). Applying the ideal gas law to Equation (1), the differential pressure can be transformed into a function of temperature,

$$\Delta P = 352.8g\left(\frac{1}{T_f} - \frac{1}{T_a}\right)h \qquad (2)$$

with $T_f$ being the gas temperature inside the fire compartment (K), $T_a$ being the ambient gas temperature (293 K), and the coefficient 352.8 kg/m$^3$-K being the reference density multiplied by the reference temperature.

In a compartment fire, the differential pressure per unit height above the neutral plane will be 7.5-9.0 Pa/m with a temperature of 800–1200$^{o}$C, respectively. From ISO 834 and EN1363-1, furnaces have a similar increase in differential pressure with height (8–8.5 Pa/m); though this will obviously be a function of temperature inside the furnace. In vertical furnace tests, there will be a pressure distribution along the height of the test article. As a result, it is recommended that pressure be measured at two elevations within the furnace to quantify the pressure gradient within the furnace during the test.

At an elevation 2.4 m (8 ft) above the neutral plane of a compartment fire, the pressure will be approximately 18–22 Pa for gas temperatures in the range of 800–1200$^{o}$C. These pressures are similar to the 20 Pa pressure recommended in ISO 834 and EN 1363-1 for horizontal furnaces. In vertical furnace tests, ISO 834 and EN 1363-1 stipulate that the neutral plane inside the furnace should be located 0.50 m above the bottom test article but the pressures at the top of the test article should not be greater than 20 Pa. When necessary, the neutral plane inside the furnace will be moved upward to ensure that the pressure at the top of the test article does not exceed 20 Pa. In real fires, elevations along a wall greater than 2.4 (8 ft) above the neutral plane can have pressures in excess of 20 Pa when gas temperatures range from 800–1200$^{o}$C. Therefore, in wall tests it is recommended that the entire wall be kept at positive pressure (i.e., neutral plane at the bottom of the test article) with no limit on the pressure at the top of the test article.

In furnace tests, it is recommended that the differential furnace pressure be positive across the entire test article. The furnace differential pressure should be measured through a furnace pressure measurement and a laboratory pressure measurement at the same elevation. The furnace pressure should be measured using the tube sensor provided in ISO 834 and EN1363-1. The tube sensor should be located inside the furnace where it will not be subject to direct impingement of the convection currents from flames or in the path of the exhaust gases directly out of the burners. Pressure tubes should be horizontal both in the furnace and as they exit through the furnace wall, making the tubing elevation the same both on the inside and outside of the furnace. Any vertical section of tube should be at room temperature. In a vertical furnace, pressure should be measured at the bottom of the test specimen and the top of the test specimen. The neutral plane in the furnace should be maintained at the bottom of the test specimen with no limit on the pressure at the top of the specimen. In a horizontal furnace, the furnace pressure should be measured at one location immediately below the test assembly and maintained at a minimum of 20 Pa. Pressure tube sensors should be located at the same distance away from test articles as the plate thermometers.

Furnace Oxygen Concentration

*Recommendation T-3: Furnace oxygen concentration should be measured in the furnace stack and maintained at greater than 6% during the test. Gas samples should be continuously drawn out of the duct through a sampling line and measured using a paramagnetic type oxygen analyzer. The recommended sampling probe should be similar to the sampling probe used in duct measurements of hood calorimeters*.

A range of oxygen levels may exist during the course of a compartment fire. This may vary from zero to several percent in the upper portions of a compartment during fully-developed fires (Gross and Robertson, 1965). From a fire resistance perspective, one of the implications of the presence of oxygen is that it allows char oxidation to occur which results in faster degradation of material. This has been noted in furnace testing to result in marked differences in fire resistance performance of wood stud assemblies. In furnace testing, it is also desirable to have excess oxygen within the furnace to allow combustible test articles to burn as they could in compartment fires.

It is recommended that the oxygen concentration during the test be above 6% during the furnace test. This was developed based on oxygen concentration requirements in other fire resistance test standards as well as oxygen concentrations measured in the upper-layer of fully-developed fires. The fire resistance standard EN 1363-1 requires that a minimum oxygen concentration of 4% be maintained within the test furnace during the course of the fire test.

Gross and Robertson (1965) measured oxygen concentrations ranging from 0–11% in fully-developed compartment fires. Based on these results, and taking into account that a combustible assembly may deplete some oxygen in the furnace, furnace oxygen concentrations should be maintained at or above 6% during the test.

Unexposed Side Temperatures

> *Recommendation T-4: The unexposed side temperatures should be measured with a thermocouple placed between the specimen and a noncombustible, insulating pad. The insulating pad should be a low density, low thermal conductivity material with known thermal properties. The pads should be approximately 0.15 m (6 in.) square and 25 mm (1-in.) thick and placed in at least three locations that provide a range of heat-transfer performance.*

The ignition of combustible materials on the unexposed side of an assembly is one of the standard measures of fire resistance performance. In performance-based design, items may be in contact with the assembly or may always be offset from the assembly. To support calculations where items may be in contact with the assembly, the unexposed side temperature should be measured with a noncombustible, insulating pad mounted onto the unexposed side. This data can be used by engineers to demonstrate that their models are capable of predicting the heat-transfer through the assembly with a material on the unexposed side blocking heat and mass transfer losses.

Ignition of materials due to hot surfaces has been reviewed by Schwartz and Lie (1985) and Babrauskas (2007). Ignition was characterized as either visible glowing or flaming. The temperatures range from 300°C to as high as 950°C. The materials that ignited close to 300°C were cotton waste at 298°C and a roof assembly (five layers of roofing felt, bitumen, and 2-in. polystyrene foam) at 325°C.

The difference in temperatures of materials when ignited by hot surfaces, and those measured by ASTM E 119 insulation pads, was reviewed by Schwartz and Lie (1985). This included testing conducted at UL and NRC-Canada. In all tests, the materials were placed on the unexposed side of concrete and were exposed to an ASTM E 119 fire exposure. The effects of drafts on ignition temperatures were not explored. Results from the two series of tests are provided in Figures 2 and 3. Most of the tests at UL were glowing ignition, while all the tests at NRC-Canada were flaming ignition. Ignition times in most tests were after 1–2 hours of exposure. As seen in these figures, the material temperature was higher than the temperature measured using the ASTM E 119 pad. The exceptions to this were the tests with wooden strips and the roofing assembly test. In the tests with the wooden sticks, the sticks bowed away from the concrete, resulting in a lower material temperature.

There was no apparent physical explanation for the magnitude of the deviation between the material ignition temperature and the ASTM pad temperature. Considering all of the data, the material ignition temperature was on average 61°C higher than temperatures measured using the ASTM E 119 pad with a standard error of ±64°C. This makes the potential disagreement between the pad temperature and the material temperature at ignition as much as 125°C.

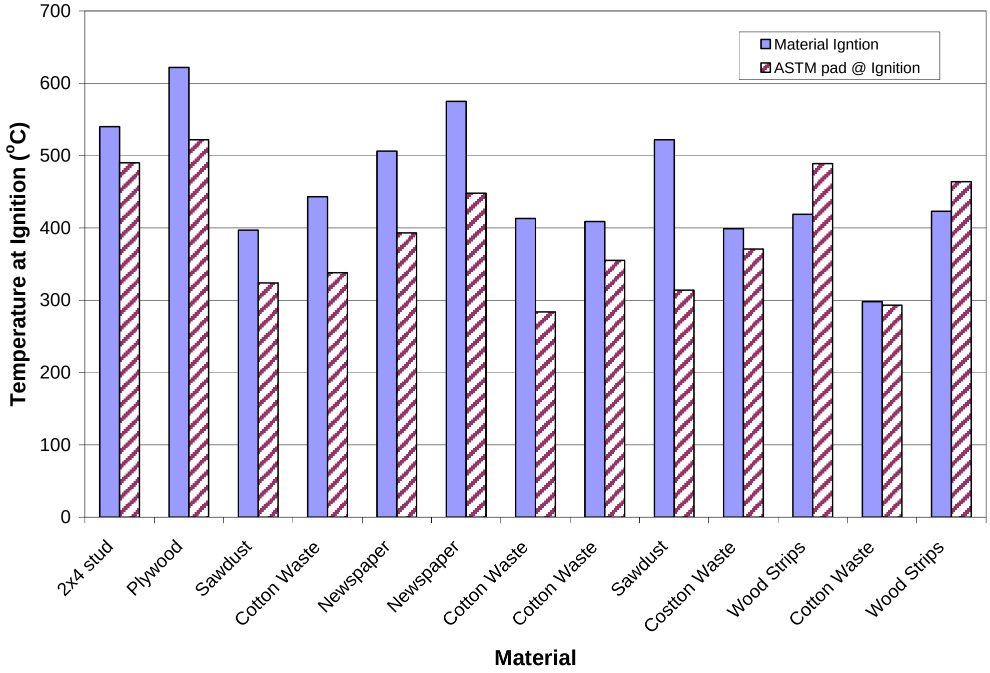



Figure 2. UL tests measuring temperature of material ignition and ASTM E 119 temperature.

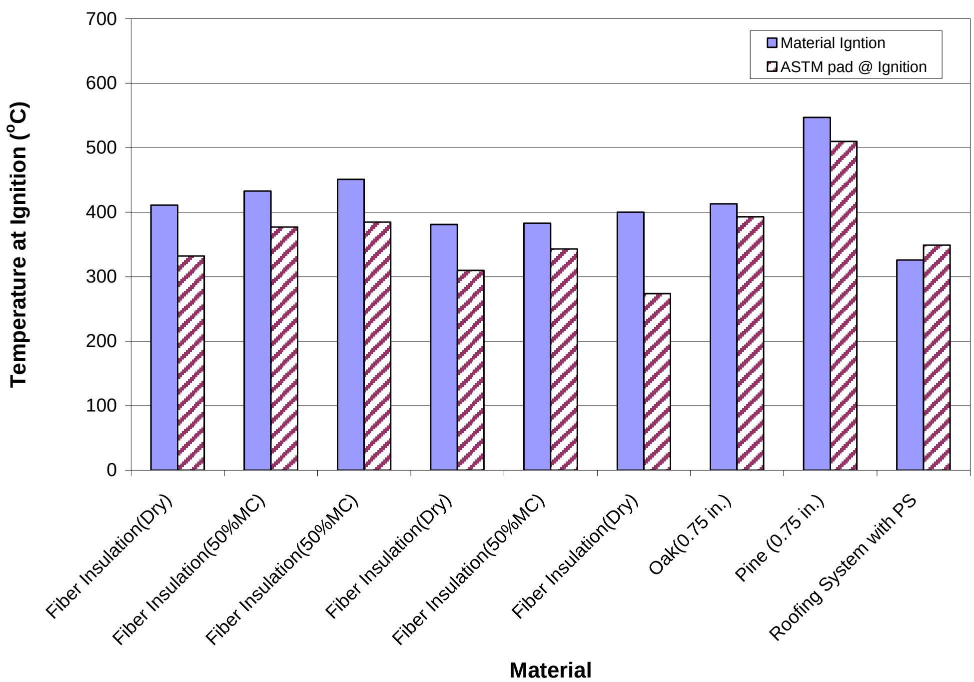



Figure 3. NRC-Canada tests on material ignition in contact with concrete along with ASTM E 119 pad temperatures.

The recommended unexposed side temperatures should be measured using a noncombustible, insulating pad. The pad should be 0.15 m (6 in.) square, which is similar in size to the ASTM pad. However, the thickness should be increased to about 25 mm (1.0-in.) so that temperatures are closer to those measured for actual materials in contact with the unexposed side of the assembly. The board should be a low density, low conductivity ceramic fiber board with known thermal properties. Some recommended boards include UNIFRAX Duraboard LD and FireMaster board made by Thermal Ceramics. The board should be mechanically attached to the unexposed side of the assembly with a bare bead, glass braid, 24-gauge, Type K thermocouple sandwich between the assembly and the board. If significant moisture is expected on the unexposed side, the bare bead thermocouple can be replace with a 1.0 mm diameter, Type K Inconel-sheathed thermocouple.

Total Heat Flux off the Unexposed Side

*Recommendation T-5: The total heat flux from the unexposed side of the assembly should be measured using a Schmidt-Boelter type water-cooled total heat flux gauge. At a minimum, a heat flux gauge should be placed near the center of the test article and as close as possible to the unexposed side. In cases where the assembly contains a transparent section, a heat flux gauge should also be placed at the center of the transparent section as close as possible to the unexposed surface.*

Heat transmitted off the unexposed side of the assembly may pre-heat and ignite materials located close to the assembly or may impede the movement of people by the assembly. This will be particularly important in assemblies, which contain sections that are transparent (e.g., glazing). This data can be used by engineers to demonstrate that their models are capable of predicting the heat-transfer off the unexposed side of the assembly and through transparent areas of the assembly.

The total heat flux gauge should be a Schmidt-Boelter water-cooled total heat flux gauge, with a 0-25 $kW/m^2$ range. A range of 0–100 $kW/m^2$ should be used for assemblies that include glazing. To ensure a high view factor between the gauge and the unexposed side of the test article, the gauge should be located as close as possible to (within 0.15 to 0.3 m) and near the center of the assembly. With radiation calculations being sensitive to the offset between the surface and heat flux gauge, the distance the heat flux gauge is located from the unexposed side surface should be recorded so that the data can be used for model validation.

Furnace Velocity

*Recommendation T-6: Velocity measurements inside the furnace should not be made.*

While it is important to create a realistic convective environment in the furnace, it is difficult to conduct meaningful velocity measurements in the furnace where the flow is expected to be complex. As a result, no velocity measurements are recommended inside the furnace. (See furnace burner recommendations below for additional information).

Temperature Profile through Test Specimen

Recommendation T-7: Temperatures should be measured through the thickness of the test assembly at locations that are representative of the different heat-transfer paths within the assembly. Repeat temperature profiles are recommended in case some thermocouples fail during the test.

Predicting the correct temperature profile is a critical aspect of predicting heat transmission through the assembly as well as the structural response. Temperature data can be used to demonstrate that the thermal properties being used in the heat-transfer analysis are appropriate. In cases where materials may lose integrity (i.e., fall off the exposed side), the through-thickness temperature data can be used to understand when such failures may occur and could be used to assist in developing/validating constitutive models to predict these failures. The strength of materials is also strongly influenced by temperature; therefore, predicting the correct temperatures will affect the predicted structural response.

The temperature through the depth of the test article should be measured at a minimum of two locations. Temperatures should be measured at locations that will provide a method for validating the heat-transfer through the assembly. Test articles that have a relatively uniform composition (e.g., concrete) will likely require two temperature profiles, while assemblies with studs will require at least four temperature (i.e., one at the stud, one between studs, and repeat measurements at a similar location). Internal temperatures should be measured at no less than three locations along the specimen thickness. For a specimen that consists of layers of materials, the temperature should be measured at each material interface. More complicated structural members (e.g., I-beams) will likely need thermocouples at several locations to provide sufficient data to validate the heat-transfer model. At each location, thermocouples in a profile should be within 0.075 m (3 in.) of the profile location.

The surface temperature on the exposed side of the specimen should be measured with a ceramic braid, 24-gauge, and Type K bare bead thermocouple. The thermocouple bead as well as the lead wire inside the furnace should be placed in contact with exposed surface of the test surface of the test article.

The surface temperature on the unexposed side of the specimen should be measured using an optical pyrometer with a wavelength range suitable for accurately measuring the surface temperature on the unexposed side.

Internal temperatures should be measured using Inconel-sheathed Type K thermocouple, with a sheath diameter of 1.0 mm. Inconel-sheathed thermocouples are required to prevent thermocouples from shorting out due to moisture in specimen materials. Thermocouples must remain in the plane of measurement for at least 50 mm (2 in.). If possible, thermocouples should be applied during construction and should be extended out of the side of the specimen. When thermocouples must be fed out of the unexposed side of the test article, the area around the thermocouple must be sealed to prevent premature hot gas transmission through the assembly at this location.

Gas Temperature Measurement

*Recommendation T-8: Gas temperatures on the exposed and unexposed side of the test specimen should be measured using aspirated thermocouples. Gas temperatures should be measured at each location where a temperature profile is being measured. Aspirated thermocouples should be placed as close as possible to the test article surface.*

Heat-transfer analysis of the assemblies may require the use of the gas temperature on both sides of the test article. Depending on the analysis, gas temperature may be needed to calculate the appropriate heat-transfer coefficient and may be used in defining the boundary condition. Gas temperatures should be measured as close as possible to the boundary surface to obtain a measure of the temperature affecting the convective heat-transfer at the surface. Using aspirated thermocouples with a high aspiration velocity provides a measure of the actual gas temperature without the effects of radiation from the surroundings. This gas temperature measurement will be used to support heat-transfer calculations but will not be used to control furnace conditions.

## 3.2 Furnace Construction and Operation

Furnace Time-Temperature Exposure Curve

*Recommendation T-9: The furnace time-temperature exposure should linearly increase to 1200$^{o}$C in six minutes and remain constant at 1200$^{o}$C for the remainder of the test.*

Performance-based design analysis should be performed using models that have been shown to predict product performance over the expected temperature range. At high temperatures, material behavior can become unpredictable and material failures may occur that were not expected based on data trends at lower temperatures. As a result, using models to predict material behavior outside their validation temperature range is not acceptable engineering practice. Fully-developed compartment fires may produce gas temperatures that range from 500$^{o}$C to in excess of 1200$^{o}$C. The gas temperature reached inside a compartment will depend on compartment geometry as well as its contents. To perform analysis on an assembly that may be exposed to compartment fire conditions, the model should be validated to gas temperatures that represent an upper-bound to those expected in a compartment fires. Historically, furnace fire exposures inside buildings have not been representative of the rate of rise and magnitude of temperatures in compartment fires. However, furnace fire exposure curves for products used in off-shore platforms as well as tunnel applications, are more consistent with the rise time and temperature levels measured in these environments. The proposed curve provides an upper-bound time-temperature curve that is consistent with the rise time and levels of temperatures possible in compartment fires. This curve can be used to evaluate the performance of products under higher temperatures that these products may be exposed to during compartment fires and can serve to validate model predictive capability for this product over the expected temperature range.

Furnace Exposures

There are several furnace fire exposures used throughout the world to evaluate the fire resistance of products. These fire exposures have peak temperatures ranging from 1050$^{o}$C to

1350$^{o}$C after a three-hour exposure, see Figure 4. The type of exposure used depends on the end-use application of the product. Tunnel and off-shore oil rig applications have the highest temperature, most severe fire exposures, while less severe exposures are used for different building applications.

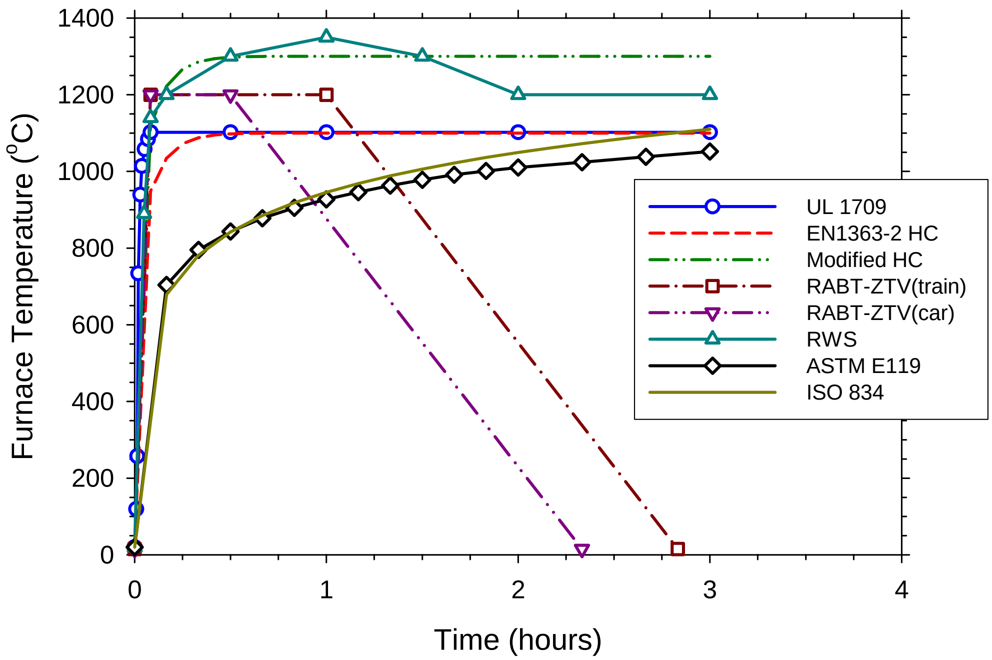



Figure 4. Furnace time-temperature exposure curves.

The ASTM E 119 and ISO 834 time-temperature curves are perhaps the most common furnace exposures used in fire resistance testing. These furnace exposures are used to evaluate the fire resistance of structural elements on buildings, ships, and in some transportation applications (e.g., railcars). ASTM E 119 is primarily used in North America, while ISO 834 is used more internationally (e.g., Europe and Australia). As seen in Figure 4, the two time-temperature curves are similar with the ISO 834 temperatures being slightly higher at times greater than one hour. The ASTM E 119 furnace exposure is measured using shielded thermocouples, while the ISO 834 furnace exposure is measured using sheathed thermocouples.

Though the time-temperature curves in these tests are similar, the actual heat flux exposure early in the ASTM E 119 fire exposure is more severe due to the type of thermocouples used to control the furnace (Harmathy et al., 1987, Babrauskas and Williamson, 1978). The European standard EN1363-1 uses the ISO 834 time-temperature curve, but the furnace is controlled using plate thermometers. Plate thermometers provide a more severe exposure compared with ISO 834 thermocouples for the test duration (Fromy and Curtat, 1999, van der Luer and Twilt, 1999). Sultan (2006) found that plate thermometers resulted in a slightly less severe exposure during the first 10 minutes of the test, compared with ASTM E 119 shielded thermocouples. Thereafter, the thermal exposures were the same for the plate thermometer and the E 119 thermocouples.

The total heat flux measured in an ASTM E 119 furnace test is provided in Figure 5 for a wall and floor furnace. Total heat fluxes were measured using a water-cooled Gardon gauge. In this test, gaseous fuel was used and the temperature was controlled with ASTM E 119 shielded thermocouples (Sultan, 2004). The wall furnace was lined with ceramic fiber while the floor furnace was lined with brick. The same furnace controlled with a plate thermometer provided similar heat flux levels at times after 10 minutes. Also provided in the plot is the blackbody heat flux based on the furnace temperatures specified in ASTM E 119. As seen in the **figure**, the blackbody heat flux is similar to heat fluxes measured in the furnace except during the initial 10 minutes.

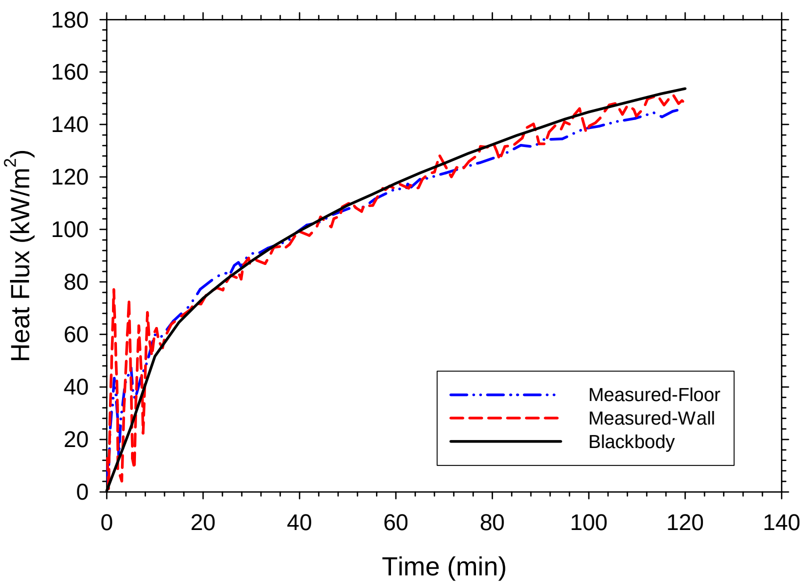



Figure 5. Heat flux measured during ASTM E 119 furnace exposure in floor and wall furnaces Blackbody heat flux was calculated from ASTM E 119 furnace temperature curve.

The higher temperature fire exposure curves in Figure 4 are used to evaluate products used in petrochemical, off-shore oil platform, and some tunnel applications. The UL 1709 hydrocarbon pool fire exposure and the EN 1363-2 hydrocarbon curve (HC), are typically used for off-shore oil platform applications, while the other higher temperature curves are used to represent a large fire inside a tunnel.

The UL 1709 and EN 1363-2 both have a maximum gas temperature of 1100°C; however, the UL 1709 exposure reaches 1100°C faster than the EN 1363-2 exposure. The UL 1709 reaches a peak temperature of 1100°C in 5 minutes, while the EN 1363-2 is approximately 1100°C after 25 minutes. Unique among the fire resistance standards, UL 1709 also has a heat flux requirement. During a calibration test with a UL 1709 exposure, the heat flux as measured from a water-cooled heat flux gauge mounted to a calibration specimen, must be 204±16 $kW/m^2$ while the furnace temperature is 1093±111°C. This heat flux is approximately equal to the blackbody heat flux at the furnace temperature (i.e., 1093°C results in a blackbody flux of 197 $kW/m^2$).

The curves for tunnel applications have peak temperatures that range from 1200–1350°C. The RABT-ZTV curves were developed in Germany to represent different vehicle fires in tunnels. These curves reach a peak temperature of 1200°C in 5 minutes and remain at 1200°C for 30–60 minutes. Thereafter, the temperatures decrease linearly with time to ambient conditions after 2.5–3.0 hours. Estimated peak heat fluxes, as the blackbody flux using the peak furnace temperature, in these tests are 267 kW/m$^2$. A modified version of the EN1363-2 HC curve has been used in France to represent fires in tunnels. The Modified HC curve peaks at 1300°C instead of 1100°C. Estimated peak heat flux in this test, based on the blackbody flux using the peak furnace temperature, is 347 kW/m$^2$. The RWS fire curve was developed by the Rijkswaterstaat, Ministry of Transport in Netherlands based on results from testing conducted by TNO in the Netherlands. The RWS curve peaks at a temperature 1350°C, which is the highest of all time-temperature curves. Estimated peak heat flux in this test, based on the blackbody flux using the peak furnace temperature, is 393 kW/m$^2$. The potential for these temperatures in tunnel fires was verified through vehicle testing in the Runehamar test series, where temperatures ranging from 1280–1365°C were measured (Lonnermark and Ingason, 2005).

Compartment Fires

Gas temperatures in compartment fires will be dependent on a number of variables including fuel type, compartment size, compartment boundary thermal properties, ventilation (i.e., door size), and fire stoichiometry.

Thomas and Heselden (1972) evaluated the effect compartment geometry (compartment and door size) on the gas temperature. Figure 6 contains the results of tests on wood cribs (Thomas and Heselden, 1972) as well as non-cellulosic materials (Bullen and Thomas, 1978). Through these tests, the gas temperature was determined to be a function of the opening factor,

$$O = \frac{A_T}{A\sqrt{H}} \tag{3}$$

where $A_T$ is the internal surface area of the walls and ceiling excluding the door area (m$^2$), $A$ is the area of the door (m$^2$), and $H$ is the door height (m). The highest gas temperatures were measured at an opening factor in the 10–20 range. At lower opening factors, larger door sizes prevented the development of high gas temperatures due to higher air flow into the compartment and more heat loss through the door. At opening factors greater than 10, limiting the ventilation reduced the fire size that could be supported inside the compartment, thus reducing the maximum gas temperature that could be produced.

The impact of fire stoichiometry and fuel type can be seen in Figure 6 through the tests on the plastics and alcohol (Bullen and Thomas, 1978). In these tests, the opening factor is constant but the fuel type and stoichiometry of the fire is being varied. As seen in the figure, gas temperatures can vary by 200°C by changing these variables. The highest gas temperatures will be produced by fuels that require less energy to volatilize and when the compartment fire has an equivalence ratio equal to one (i.e., stoichiometric burning).

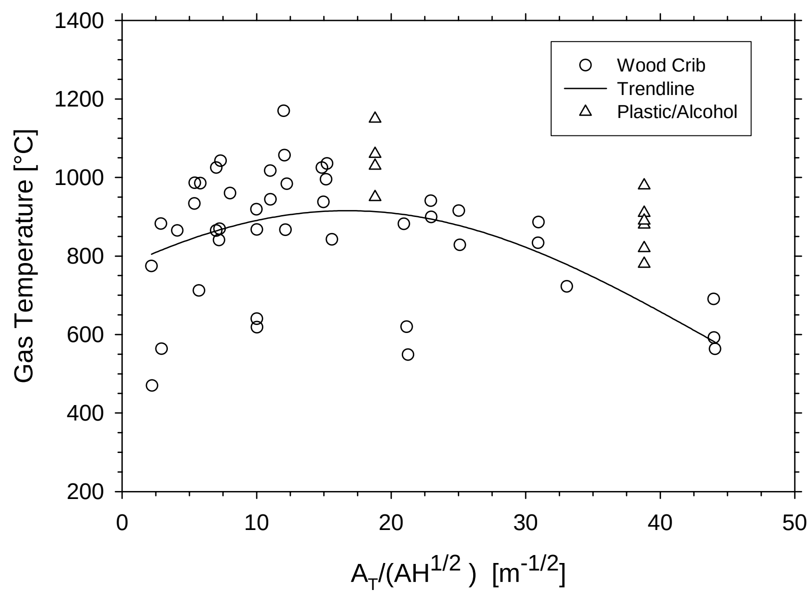



Figure 6. Compartment fire gas temperatures as a function of opening factor.

The SFPE committee on Standard on Calculating Fire Exposures to Structures has compiled a database of 139 compartment fire tests. This database was used to evaluate the appropriate furnace exposure. As seen in Figure 7, the fuels in these tests ranged from wood cribs, to furniture, to plastics. Compartments included in this database were mostly large-scale as shown in Figure 8.

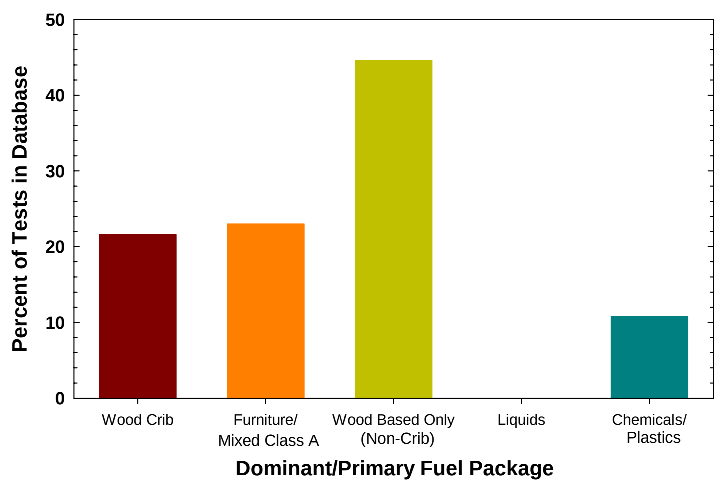
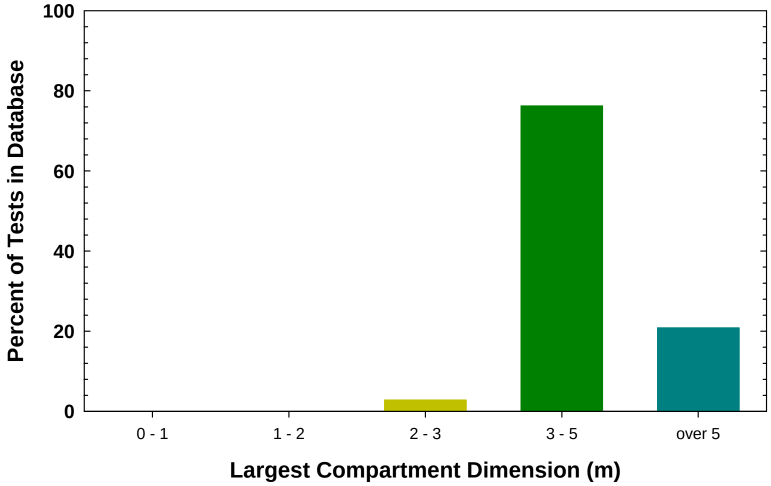
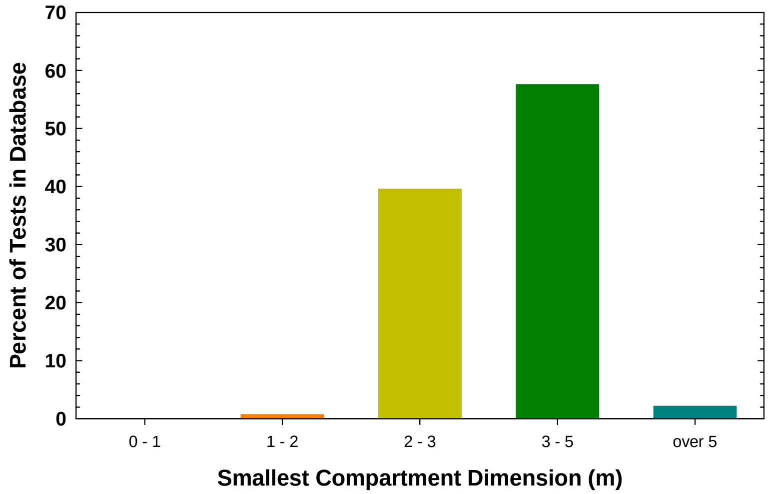



Figure 7. Fuels burned in compartment fire tests.




(a)

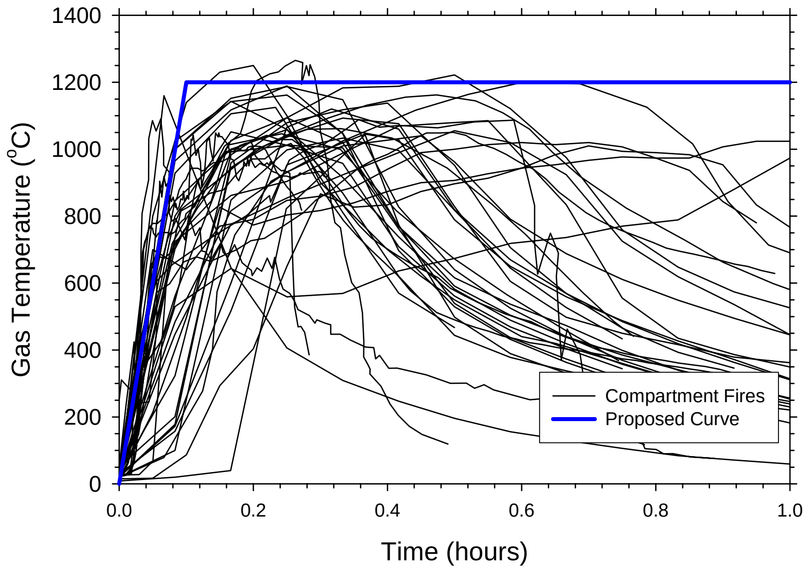



(b)

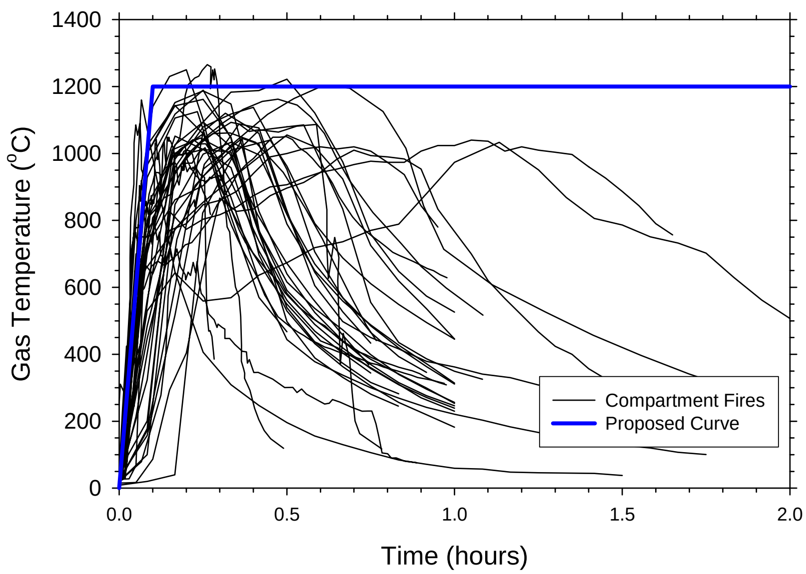
Figure 8. Compartment dimensions in compartment fire tests.

A plot of the average gas temperature as a function of time for tests with average temperatures exceeding 1000$^o$C is provided in Figure 9. Figure 10 is a plot of the peak gas temperatures measured in these same tests. As shown in these figures, in many tests there is a rapid rise in gas temperature during the initial five minutes of the fire with temperatures in several tests exceeding 1000$^o$C at this time. Post-flashover gas temperatures exist in many tests for 1–2 hours before decaying. Figures 9 and 10 also contain the proposed furnace time-temperature exposure, which increases linearly to 1200°C in six minutes and remains constant at 1200°C for the remainder of the test.

As seen in Figures 9 and 10, the proposed time-temperature curve provides a reasonable upper-bound to the test data.

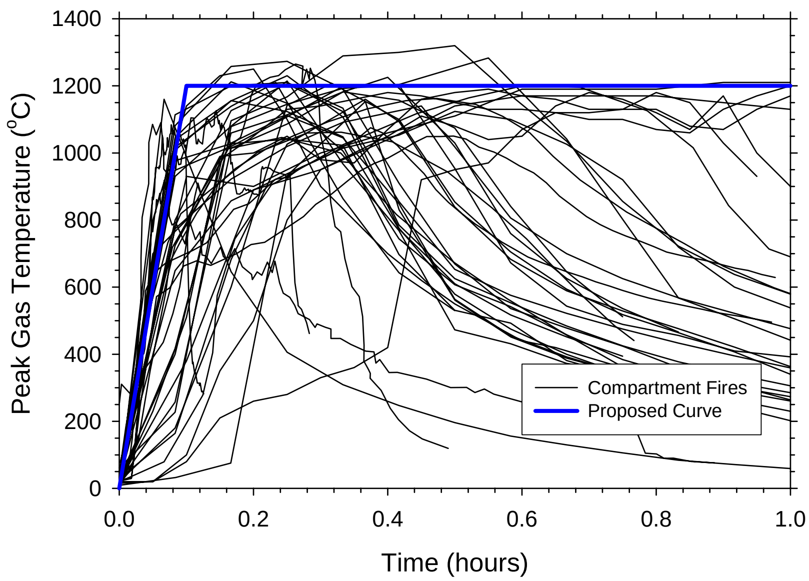



(a)

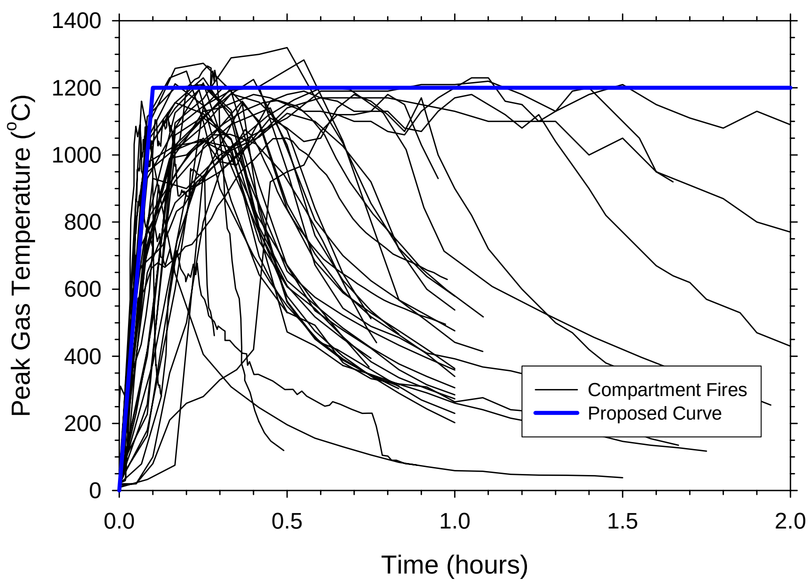



(b)

Figure 9. Average gas temperature in compartment fires as a function of time compared with the proposed time-temperature curve (a) after 1 hour and (b) after 2 hours.




(a)




(b)

Figure 10. Peak gas temperature in compartment fires as a function of time compared with the proposed time-temperature curve (a) after 1 hour and (b) after 2 hours.

Heat flux levels to the walls and ceiling of a compartment containing a fully-developed fire were measured by Tanaka et al. (1985). Tests were performed using a propane gas burner in a full-scale compartment (2.4 m high, 2.4 m wide and 3.66 m deep) with different door sizes. Heat fluxes were measured using Schmidt-Boelter type, water-cooled, total heat flux gauges. Gas temperatures in tests where heat flux was measured, ranged from 150°C–1100°C. Through these data, the heat flux at the top of the walls and ceiling in the compartment is reasonably estimated by the blackbody heat flux using the gas layer temperature. As a result, heat fluxes inside a compartment with a gas temperature of 1200°C would be expected to be 267 kW/m$^2$.

Effect of Exposure on Product Performance

The use of a severe exposure condition to evaluate materials or assemblies will provide some assurance that for most materials, performance under a less severe exposure will not result in a degradation of performance. When extrapolating performance from one fire exposure to a more severe fire exposure, there are no assurances that the performance of materials or assemblies will be predictable. Some materials may perform well at elevated temperatures, while other materials may expand, contract, warp, spall, go through phase changes, debond, or crack; fasteners may fail, and lose integrity and fall off from the surface. Many of these types of phenomena and failure cannot be predicted using the current state-of-the-art models. Therefore, testing products at the highest temperature level expected is currently the only way to demonstrate the performance of a material.

Materials that perform well at elevated temperature may just need to be thicker to obtain the desired level of performance at higher temperature. The UL Fire Resistance Directory provides design listings (i.e., minimum product thicknesses) which will provide a specific fire resistance rating when tested in accordance with various standard fire test methods, such as ASTM E 119 and UL 1709. Some products have been tested against these two standards, specifically for structural steel column protection. Broad product categories of materials include sprayed fire-resistive materials, intumescent coatings, intumescent mat products, and high-temperature board products. In all design listings reviewed, it becomes apparent that as the exposure severity increases (from ASTM E 119 to UL 1709), the minimum material thickness required to achieve the same hourly fire resistance rating must also increase.

An example of this is demonstrated in Table 1 by the increase in thickness of the amount of fireproofing required to protect a steel member when exposed to a UL 1709-type exposure versus an ASTM E 119-type exposure condition. For the same material, the thickness required to protect a W10 x 49 steel column increases as the fire exposure becomes more severe.

Table 1. Fireproofing Thickness for Steel Member

| **Rating Time (hrs.)** | **E 119 Thickness (in.) [UL, 2006a]** | **UL 1709 Thickness (in.) [UL, 2006b]** |
|---|---|---|
| 1 | 0.69 | 1.0 |
| 2 | 1.13 | 1.38 |
| 3 | 1.56 | 1.75 |
| 4 | 1.94 | 2.13 |

Other materials may only provide adequate performance over a specific temperature. At higher temperatures, the material may behave unexpectedly. One example of this was the use of mineral fiber insulation used on fire zone boundaries of U.S. Navy ships. A 1-in. thickness of mineral wool insulation provided a 30-minute fire-resistance rated bulkhead/deck when tested per the ASTM E 119 fire exposure (Scheffey et al., 1991). In the early 1990s, the U.S. Navy reevaluated the fire exposure potential for bulkheads and decks based on lessons learned from the USS Stark incident. This work effort lead the U.S. Navy to require a UL 1709 fire exposure to evaluate insulation materials. In 1993, additional test work showed that 1 in. of mineral wool insulation, when exposed to the UL 1709 fire exposure, provided a fire resistance rating of approximately 9.5 minutes and a 2-in. thickness of mineral wool provided a fire-resistance rating of approximately 11 minutes (Beitel et al., 1993). This significant reduction in performance was a result of the mineral wool exhibiting a phase change at the higher UL 1709 temperatures and melting/vaporizing off the steel base assembly. Thus, it is very clear that materials and their performance can change when the fire exposure conditions change.

Another example of differing material performance at elevated temperatures is the study performed by Nyman (2002) on the fire performance of several gypsum wallboard assemblies when exposed to compartment fires. The failure times and mode in the furnace tests were compared with those measured and observed in the compartment fire tests. Furnace tests were conducted at the Building and Research Association of New Zealand (BRANZ) using the AS 1530 Part 4 fire resistance test procedure, which is similar to the ISO 834 test method. The compartment fire testing was also conducted at BRANZ. In these tests, the compartments had dimensions of 2.4 m x 3.6 m x 2.4 m high, and a single doorway (size varied), provided ventilation of the compartment. The various walls and ceilings in each compartment were constructed using different assemblies such that several different constructions could be tested in a single compartment test. The fire sources consisted of a combination of textile-covered, polyurethane foam and wood cribs.

Table 2 provides a summary of several of these assemblies and the test results. The failure time in the compartment fire tests was shorter in the three assemblies shown in Table 2. In addition, the failure mode was different in the compartment fire tests compared with the furnace test. Assembly #1 failed due to unexposed surface temperature rise in both the furnace test and in the compartment tests. Assemblies #3 and #7 failed due to unexposed surface temperature rise in the furnace test, but in the compartment tests failure was judged to have occurred due to integrity failure. In these cases, it was determined that the steel studs experienced rapid and sizable deflections causing the gypsum plasterboard to fail. Figures 11–13 contain plots of compartment fire gas temperatures in the center of the room in the three tests where these assemblies were included. The plots show the gas temperatures in the upper part of the room are generally higher that than the ISO 834 fire exposure curve. The higher gas temperatures in the compartment fire tests had an impact not only on the time to failure but also on the mode of failure.

Table 2. Fire Performance of Gypsum Board in Standard Tests and Compartment Fire Tests

| Assembly No. | Description | Failure Time (min) and Mode | |
|---|---|---|---|
| | | **Furnace Test** | **Compartment Fire*** |
| 1 | 1 layer of 10-mm "Fyreline" plasterboard on each side of 90 x 45-mm timber studs at 600 mm OC – load bearing | 42 (heat transmission) | 21/18 (heat transmission) |
| 3 | 1 layer of 13-mm Standard plasterboard on each side of 63 x 34-mm steel studs at 600 mm OC – non-load bearing | 34 (heat transmission) | 19/17 (integrity**) |
| 7 | 1 layer of 13-mm "Fyreline" plasterboard on each side of 63 x 34 mm steel studs at 600-mm OC – non-load bearing | 63 (heat transmission) | 35 (integrity**) |

*Failure time room test – Assemblies 1 and 3 – First time is from Compartment Test #1 and second time is from Compartment Test #3. Failure time for Assembly 7 is from Compartment Test #2.
**Integrity failure due to steel studs deflecting causing plasterboard to fall off on exposed surface.

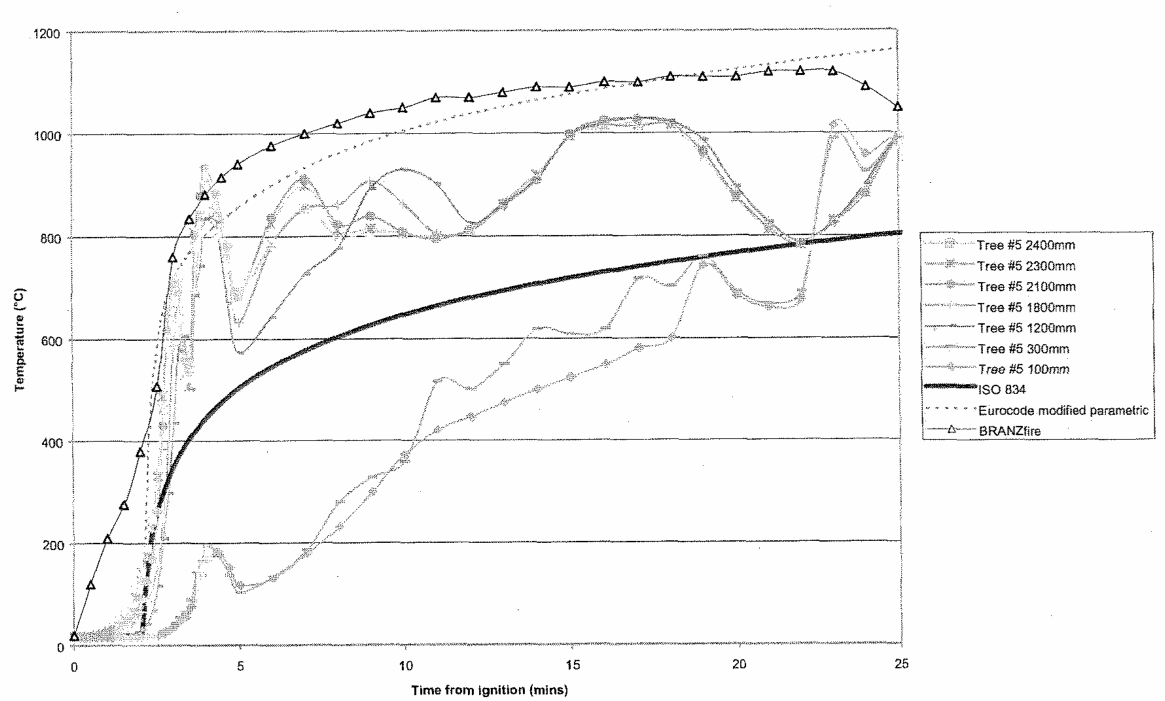



Figure 11. Compartment Test #1 exposure at tree 5.

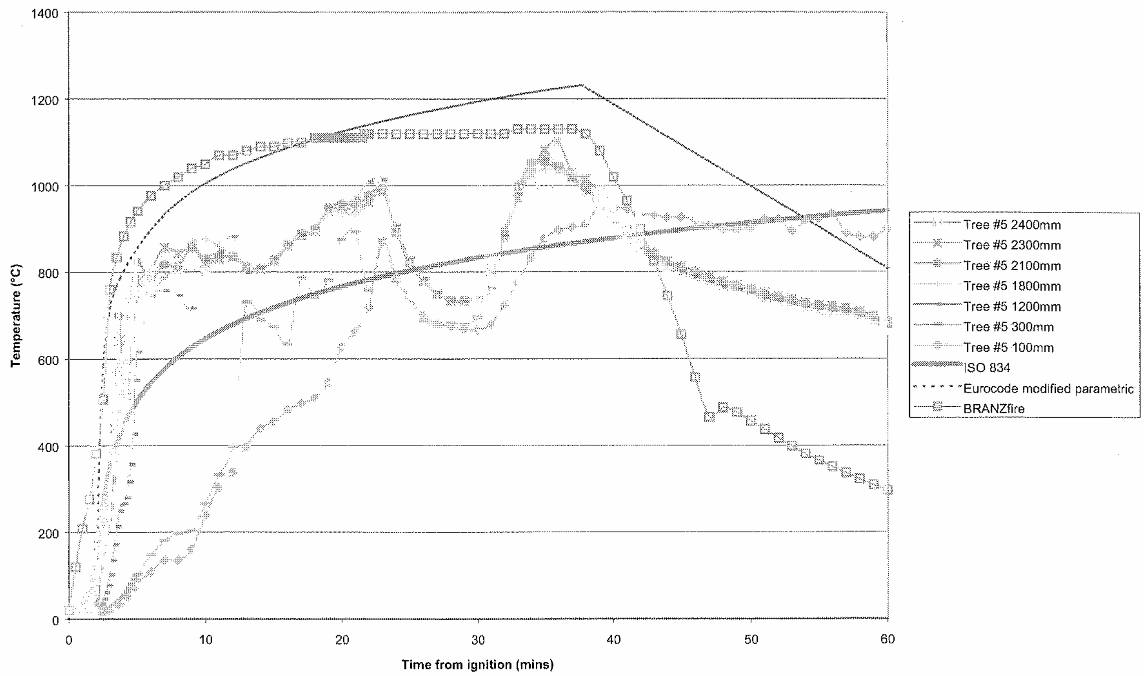



Figure 12. Compartment Test #2 exposure at tree 5.

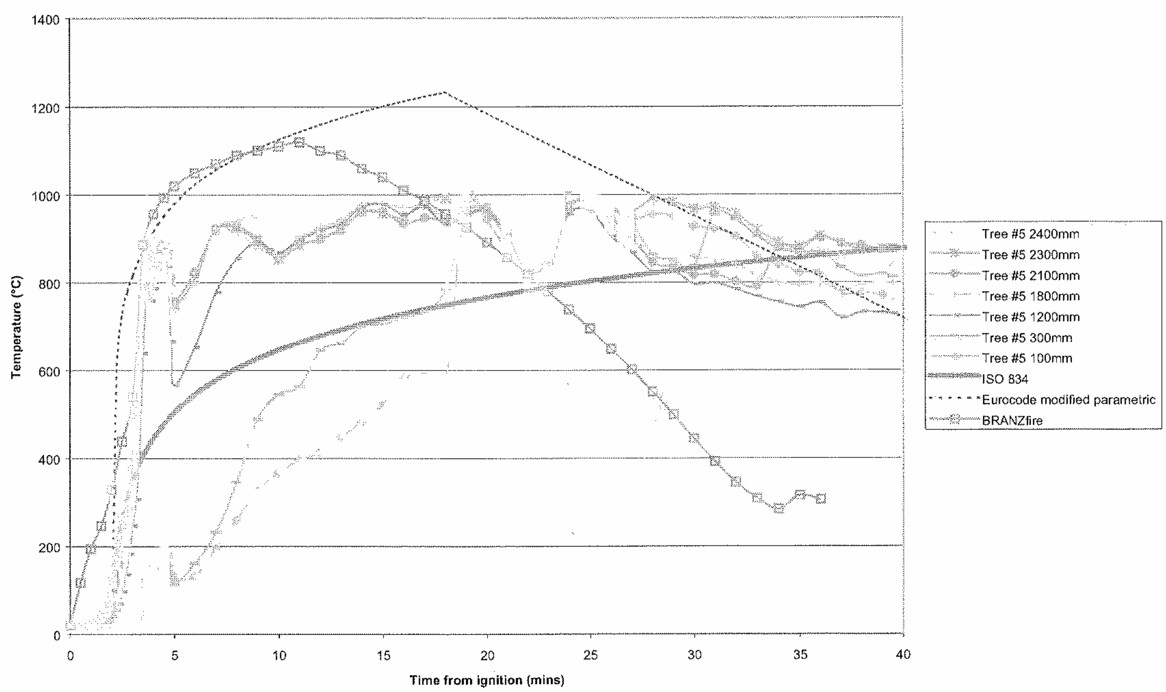



Figure 13. Compartment Test #3 exposure at tree 5.

Intumescent materials are another type of material used to provide acceptable fire resistance performance for structural elements; however, the performance of these materials may be highly variable from product to product. Two broad classes of intumescent materials have been specifically developed for distinctly different markets. Both are used for the protection of structural steel, however, the exposure conditions for which they have been designed are significantly different. Thin-film intumescent materials have been specifically designed for use in the less-severe ASTM E 119 fire exposure conditions. Epoxy-based intumescents were designed to withstand the more severe UL 1709 fire exposure. Many epoxy-based intumescents that are listed under UL 1709 ,also have ASTM E 119 listings. However, there are numerous other intumescent coatings that have ASTM E 119 listings but do not have UL 1709 ratings. Though some of these coatings may not be capable of achieving a UL 1709 rating due to the environmental exposure requirements, many ASTM E 119 listed intumescents (not listed in UL 1709) may not produce durable chars or have adhesion properties sufficient to survive the UL 1709 fire exposure. The formation and degradation of these chars as well as the adhesion of the intumescent are not readily modeled and predicted performance is only recommended over the range of conditions at which it has been tested.

Calibration Test

*Recommendation T-10: A calibration test should be conducted with a noncombustible boundary containing instrumentation to quantify the thermal exposure. Instrumentation installed in the boundary should include total heat flux gauges and calibration boards instrumented with thermocouples. Instrumentation should be installed in at least five locations (center of each quadrant and center of the boundary) to quantify the furnace exposure. The calibration test should be performed for one–hour using the required furnace exposure and instrumentation.*

Modeling the heat-transfer through a test article exposed to furnace conditions requires an understanding of the exposure provided by the furnace to the test article. Despite all efforts to construct furnaces similarly, each furnace will likely produce different exposure environments. As a result, a calibration test is required on each furnace to quantify the exposure level produced by the furnace. The calibration test is instrumented to provide heat flux levels and gas temperatures produced by the furnace. In addition, temperatures will be measured through the thickness of noncombustible board with known properties to provide model validation data. Instrumentation will be placed at five locations over the sample surface to provide information on the uniformity of the environment produced by the furnace.

The noncombustible boundary with instrumentation is shown in Figure 14. The noncombustible boundary should be constructed of steel studs covered with two layers of 15.9-mm (0.625-in.) thick Type X drywall and 50.8-mm (2-in.) thick ceramic fiber insulation on the exposed surface. Instrumentation will be installed in the noncombustible boundary in at least five locations including the center of each quadrant and the center of the entire boundary. Instrumentation will include total heat flux gauge, an aspirated thermocouple on the exposed and unexposed side of the boundary, and a calibration board installed with thermocouples.

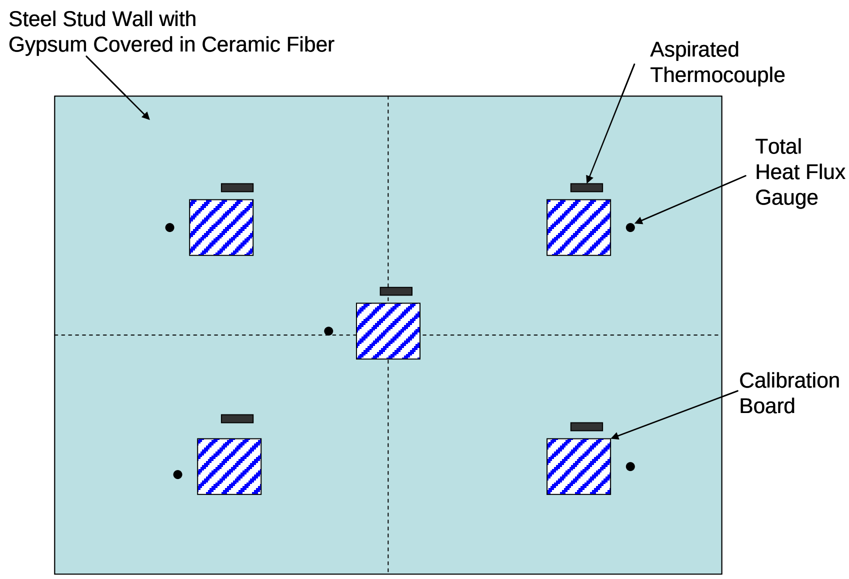



Figure 14. Calibration test noncombustible boundary with instrumentation.

Calibration boards should be located in the center of each quadrant of the noncombustible boundary and the center of the entire boundary. Total heat flux gauges should be installed in the noncombustible boundary at the mid-height and approximately 0.10 m (4 in.) from the side of each calibration board. Total heat flux gauges should be water-cooled Schmidt-Boelter type heat flux gauges with an upper range of 300 $kW/m^2$. Aspirated thermocouples should be located just below the top of the calibration board, within 25 mm (1 in.), with the thermocouple as close as possible to the calibration board to measure the gas temperature governing the convection across the sample. The location of the gas temperature measurement should be consistent with what will be used in the furnace testing on actual test articles.

Calibration boards should be 0.46-m (18-in.) by 0.46-m (18-in.) by 50.8-mm (2-in.) thick ceramic board. Examples of some acceptable boards include UNIFRAX Duraboard LD and FireMaster board made by Thermal Ceramics. The calibration boards should be installed in the noncombustible boundary so that the surface of the calibration board is flush with the surface of the ceramic fiber insulation on the exposed surface. Calibration boards should have a thermocouple installed at the exposed surface and internally at depths of 6.4 mm (0.25 in.), 12.7 mm (0.5 in.), 19.0 mm (0.75 in.), 25.4 mm (1.0 in.), and 38.1 mm (1.5 in.). The exposed surface thermocouple should be a 24-gauge bare bead thermocouple with at least 50.8 mm (2 in.) of thermocouple wire in the plane of measurement. The leads of the wire should be pushed through board for attachment to the data acquisition. Internal thermocouples should be 1.0-mm diameter Inconel-sheathed thermocouples. The unexposed side temperature should be measured using an optical pyrometer. All temperature measurements should be within 0.075 m (3 in.) of the center of the calibration board. After thermocouples are installed, the boards should be oven dried and then placed in a desicator until testing.

Furnace Lining Material

*Recommendation T-11: All interior furnace surfaces should be lined with a ceramic fiber material.*

Fire resistance furnaces have traditionally been lined with high temperature refractory brick materials commonly used in commercial furnaces. These refractory bricks are a low-density material (approximately 50 lbs/ft$^3$ (775 kg/m$^3$) and have a maximum operating temperature of approximately 2600°F (1425°C). When used in a fire resistance furnace, the refractory brick has a high thermal inertia, relative to the fire exposure period (typically 1 to 2 hours). This thermal inertia results in the refractory brick absorbing significant amounts of heat during the initial portions of the test (first 15 minutes), producing a dominantly convective heat environment within the test furnace. The furnace environment within the furnace transitions to a highly radiative environment once the brick temperature equalizes with the furnace air temperature.

To minimize the heating time of the furnace apparatus, thus resulting in less heat loss/absorption to the furnace walls, lining the inside surfaces of the furnace with a ceramic fiber insulating material is recommended. Experimental studies reported by Harada et al. (1997) demonstrated that a key aspect of the furnace environment was the absorption coefficient of the furnace gas, k, which is a function of gas temperature and the composition of the furnace gas. Tests conducted in a furnace lined with a ceramic fiber insulation material demonstrated small variation in measured test specimen temperatures as a function of furnace depth, with variations decreasing as the furnace depth increases. A similar trend was observed in furnaces lined with refractory brick, however, the temperature measurement variations increased for the similar exposure conditions. These tests demonstrate the ability of the ceramic fiber to heat up faster, resulting in a more uniform exposure temperature, and the development of a radiation dominant furnace environment. Analysis conducted by Babrauskas and Williamson (1978) support the use of ceramic fiber insulation materials used as the lining materials on developing a more uniform heat flux within the test furnace which results in improved furnace control.

The major conclusion from the work reported by Harada et al.(1997), indicated that the wall lining material was the dominant factor that influenced the heat impact on the exposed surface of the test specimen. Wall lining materials with a low thermal inertia, such as ceramic fiber insulating material, will result in improved furnace environment uniformity.

Minimum Furnace Depth

*Recommendation T-12: The minimum furnace depth should be 4 ft (1.2 m).*

Studies conducted by Harada et al. (1997) and Fromy and Curtat (1999) investigated the effect of furnace depth on the furnace environment. The work by Harada et al. (1997) evaluated furnace depths of 0.6 ft,(0.17 m), 1.6 ft (0.5 m), 3 ft (0.95 m), and 9.8 ft (3.0 m). The results of the tests indicated that as the furnace depth increased, the radiative heat increased proportionally. Furnace depths slightly greater than 4 ft (1.2 m) showed a convergence in the predicted specimen surface temperatures. The non-dimensional furnace depth parameter, kD, relates the furnace environment with the furnace depth. As kD increases, the exposed face specimen temperature uniformity converges.

Fromy and Curat ( 1999) reported the results of testing conducted in furnaces having depths of 2 ft (0.6 m), 4 ft (1.2 m), and 5 ft (1.5 m). As the depth of the furnace increased, variations in the exposed surface temperature decreased. These results indicated that as the depth of the furnace increased, the furnace environment volume became more uniform, and local effect from burners and re-radiation from the furnace walls decreased.

By increasing the non-dimensional furnace depth factor, kD, a more uniform furnace environment can be produced. The studies reported above indicate that a minimum furnace depth of 4 ft (1.2 m) would be expected to produce a uniform furnace environment which will reduce uncertainties and variability in the test conduct related to furnace construction.

Burner Fuel

*Recommendation T-13: Propane gas should be used as the furnace fuel in all fire resistance furnaces.*

Furnaces in the U.S. and in Europe use a variety of fuels to provide the heat input into the test furnace. In the U.S. gaseous fuel, either natural gas or propane, is used as the burner fuel. In some overseas furnaces, liquid fuels (heavy oil or kerosene) are used. Testing conducted by Cooke (1994) evaluated the thermal environment impact on a calibration sample in a number of furnaces located overseas. Two of the furnaces used natural gas as the burner fuel and one furnace used oil. The results of the testing did not specifically focus on the impact of the burner fuel on the furnace environment and performance of the calibration specimen, however, it was noted that the oil-fired furnace produced a more thermally-severe furnace environment compared to the natural gas fired environment. Numerical studies conducted by Sultan and Denham (1997), Sultan, Harmathy, and Mehaffey (1986), and Sultan (1996) all recognize that the absorption coefficient for the furnace hot gasses will vary with the type of burner fuel. Typically, the absorption coefficient is lower for gaseous fuels and higher for liquid fuels. As the furnace gas absorption coefficient increases, the severity of the exposure increases correspondingly. Systematic studies of propane versus natural gas do not appear to be available in the literature. Such a study would be of value to the fire resistance testing community.

Recognizing that liquid fuels will produce a more severe fire exposure, there exist practical operational and safety issues related to using liquid fuels sprayed into a closed environment. The spraying of a liquid fuel into a furnace may result in the build-up of residue on the furnace walls as a function of time, which may lead to increased maintenance costs. Safety systems would need to be implemented to insure the spraying system can be adequately secured upon termination of a fire test. Commercial gas-fueled burners are readily available with appropriate safeguards for ensuring gas flow is secured upon termination of a test. The burning of liquid fuels may not be as clean as gaseous fuels, therefore, requiring additional environmental considerations for the utilization. Many municipalities already contain the infrastructure to provide natural gas via underground supply lines or liquid propane via truck. Of the two, storage of liquid propane, used with an appropriate vaporization system, can maximize the on-site storage capability for conducting large-scale furnace testing.

Type of Burner

*Recommendation T-14: Pre-mixed burners should be used in all fire resistance furnaces.*

Two basic types of burners are currently used in existing fire resistance test furnaces; pre-mixed burners and diffusion burners. Control of the furnace temperature using diffusion burners typically involves adjusting the raw gas flow into the furnace to maintain the required temperature level. With this type of burner set-up, openings into the test specimen may require flowing additional raw gas into the furnace to maintain the furnace temperature. This can result in incomplete combustion within the test furnace. The installation of the "burners" in the test furnace requires careful placement as these burners typically produce a large flame plume, which depending on the relative location of the test sample to the burners, may result in undesirable localized heating effects.

Pre-mixed burners carefully control the amount of fuel and combustion air injected into the burner and into the test furnace resulting in a very uniform flame shape and heating capability. This results in a burner flame, which is easily controllable, and with combustion that is more complete. The air-gas mixture can be adjusted to suit a range of furnace conditions, providing operational flexibility not available with diffusion burners. These burners also produce high gas velocities inside the furnace, which is desired to produce an environment similar to that of a fully-developed compartment fires.

Secondary Air Capability

*Recommendation T-15: When necessary, a means for providing secondary air should be provided such that the minimum oxygen content within a furnace is not less than 6%.*

Maintaining a minimum oxygen concentration within the test furnace is desired to produce conditions that could be obtained in compartment fires and to support the combustion and char oxidation of combustible test samples such as wood. See Section 3.1.1 for a detailed discussion. A minimum oxygen concentration of 6% was determined to be reasonable. A secondary airflow path into the furnace may be required to maintain this oxygen level, especially in cases where the test article is combustible. Sufficient oxygen make-up air should be available to maintain oxygen levels with oxygen depletion due to burning test articles.

Exhaust Control

*Recommendation T-16: A means for controlling the internal furnace pressure (e.g., damper in exhaust stack) should be provided.*

Fully-developed fires will always produce a positive pressure gradient across ceilings and a majority of the boundary height relative to ambient conditions. In these areas of positive pressure, hot gases are driven through small openings that develop in the assembly causing damage to the internal portions of the assembly. Hot gas migration through the assembly may also give rise to ignition on the unexposed side of the assembly in these local areas of weakness. As a result, it is recommended that furnace tests be performed with a positive furnace pressure so that the effects of hot gas transmission through the assembly can be observed.

Furnaces should contain a means for controlling the pressure inside the furnace during the test. As described in Section 3.1.1, a positive furnace pressure (relative to the laboratory) will be maintained across the entire test article in both vertical and horizontal tests. In vertical tests, the neutral plane in the furnace needs to be maintained at the bottom of the test article to have the entire test article at positive pressure. There should be no limit on the pressure at the top of the test article; for a 2.4-m (8-ft) high-test article the pressure at the top will be approximately 18–22 Pa depending on the gas temperature. In horizontal tests, the furnace should be maintained at 20 Pa during the entire test. The damper system should be designed and demonstrated to be capable of meeting these requirements, with some lead way to account for leakage through the assembly.

### 3.3 Thermal Properties of Materials

*Recommendation T-17: The thermal and physical properties of materials in the test article assembly should be measured. Thermal properties (conductivity, specific heat capacity, heat of decomposition) should be measured at temperatures as close to the highest temperature the material is expected to reach during the test. Physical properties (density, moisture content, expansion/contraction, decomposition kinetics) should also be measured as a function of temperature up to temperatures the material is expected to reach during the test. Thermal property test should be performed on materials taken from the same lot of materials used to construct the test article.*

The accuracy in predicting the heat-transfer through the test article assembly during the test, as well as other exposure conditions will be dependent on knowledge of thermal properties of materials in the assembly. Thermal properties should be known over the temperature range at which the materials are expected to be exposed.

Thermal properties for noncombustible materials can be obtained as a function of temperature. However, thermal properties are more difficult to obtain for materials that lose mass through either moisture-loss or degradation or materials that are deformable or not dimensionally stable. Several methods have been developed to determine thermal properties of materials at elevated temperatures with limited success on thermal properties in excess of 800$^{o}$C (Henderson et al., 1981, 1982, 1983, Kokkala and Baroudi, 1993, Lundkvist et al., 1991, Jansson, 2004, Lattimer and Ouellette, 2004, 2006, Mehaffey et al., 1994, Sheppard and Gandhi, 1993). All of these methods are inverse heat-transfer methods where a model is used along with material temperatures measured under controlled conditions to determine the thermal properties required to obtain the measured response. Particular problems have been cited when attempting to measure properties of materials that degrade at particular temperatures. To overcome this difficulty, Henderson et al. (1982, 1983) and Lattimer and Ouellette (2004, 2006) conducted thermal property measurements on undegraded samples up to temperatures where degradation was expected. Thermal properties were determined for a degraded sample over the entire temperature range, and the thermal properties during degradation were calculated based on the fraction of degradation.

## 4.0 TEST METHOD RECOMMENDATIONS – STRUCTURAL PERFORMANCE

The test requirements, with respect to the structural aspects of the test method, involve measurements/instrumentation, test procedures, and test documentation. These requirements relate to the production of data that can directly support PBSFE. The recommendations are followed by a discussion of the issue and the basis for the recommendation. The test procedures are subdivided into instrumentation, general, and load/scale issues.

### 4.1 Instrumentation

Assembly End Restraint

> *Recommendation S-1: Place load cells at the assembly end boundaries to record magnitude of thermal restraining forces throughout test duration: minimum of three cells at one edge of furnace for the top, center, and bottom of a middle beam or stud of assembly.*

Structural modeling of the test results requires the inclusion of boundary conditions. Without these, no meaningful predictions of the test can be performed and as such, validation of the model through comparison with the results of furnace fire testing is not possible.

The fire test results recently reported in NIST NCSTAR 1-6B, as well as those from some non-standard fire tests, such as Cardington (University of Edinburgh, 2000 and Bailey, 2004) bring close scrutiny to issues of end conditions. A fully unrestrained end condition clearly represents a unique boundary condition of free expansion without any thermally-induced reactions, but the restrained condition includes a wide range of potential thermal restraints, from moderately stiff to fully rigid (Lim, Buchanan, and Moss (2004).

Another common source of confusion, particularly to structural engineers and architects, is that thermal restraint is not necessarily synonymous with structural end restraint: simple and modest steel shear connections for beam framing, which are considered to be rotationally unrestrained with negligible moment-resisting strength, have been shown to represent adequate thermally restrained conditions for most cases of both composite and non-composite steel-concrete floor systems (Gewain and Troup, 2001).

The default assembly support condition is just simple bearing on the furnace boundary. For the default bearing or end-connected assembly support condition, a complete description and quantitative characterization of the actual physical restraint provided during the fire test is very pertinent to the fire response of the assembly. Use of load cells at the restrained assembly boundaries to measure the thermally-induced forces that develop during the test would be quite illuminating in recording the assembly-to-frame interface conditions. A minimum of three load cells at a beam or stud end location within the assembly interior is recommended to measure both the total axial thrust and bending moments that occur from the thermal restraint. Additional such instrumentation for other beam or stud ends would serve to confirm similar restraint in other parts of the assembly or to demonstrate its variability. This information will provide quantitative structural data that can be converted for use in PBSFE relative to actual connections and assembly support stiffness.

Deflections

*Recommendation S-2: Record, as a minimum, the time-history of transverse deflections at mid-span in all primary structural members (beams, joists, columns, and wall studs) of the assembly, together with axial shortening of loaded columns and wall studs.*

Besides strength, the stiffness of a fire-resistive assembly is an important performance factor. Assembly deflections are not only a lead indicator of structural distress in the element tested, but large deflections also can lead to damage of its fire protection materials as well as damage to adjacent construction. Even without failure of the tested assembly, large fire-induced deflections can cause breaches of adjacent horizontal and/or vertical fire barriers, thereby leading to fire propagation into additional compartments. Therefore, transverse (out of plane) deflections of the structural members (beams, joists, wall studs, or columns) should be recorded by transducers, at least at their mid-spans, to provide the time-history of the deflection profile. For multiple beams, joists, or studs within an assembly, each member should be so instrumented, or at least those within the central, more flexible, region of the assembly. For axially loaded walls and columns in compression, the time-history of axial shortening at the load points should also be required.

Digital photo or video has additional value, especially in recording lateral or torsional deflections. Subsequent image analysis can provide quantitative deflection data.

Strain Gauges

*Recommendation S-3: Require high-temperature strain gauges at critical sections (typically ends and/or mid-span) of main structural members (beams, joists, columns, wall studs) and of other important load transfer elements (shear studs, metal deck, floor slabs and reinforcement, and connections).*

Strains in the primary structural member section (beam/joist, wall stud, or column) should be monitored with high-temperature strain gauges, at least at both of the outside section edges and at its mid-depth, at the end supports and mid-span. Strains in the metal deck, concrete slab, any shear studs (for composite steel beams) and/or steel reinforcement in the concrete slab or wall should also be instrumented at supports and mid-span, as a minimum. Such strain data provides key information on load paths, identifies the local member areas where inelastic (yielding) material response is occurring and whether it is tensile or compressive, thereby revealing the critical structural locations for force redistribution and resistance mechanisms with time. Measured strains can also be related by compatibility to thermally-induced elongations and assembly restraint to better quantify these test assembly variables. Such localized and detailed structural response information cannot be deduced solely from measured deflections that are more representative of the overall gross response.

Non-standard fire tests, such as the Cardington building tests conducted in the UK over the last 10 years (University of Edinburgh, 2000 and BRE 215-741), usually supplement thermocouple and deflection results with strain readings for such purposes. Special high-temperature strain gauges are available for applications up to about 500–600ºC. Beams and columns, concrete slabs and its reinforcing mesh or rebar, and any connection elements can be instrumented for strain. Figure 15 shows strain data for bolts in steel connection at elevated temperatures from BRE 215-741.

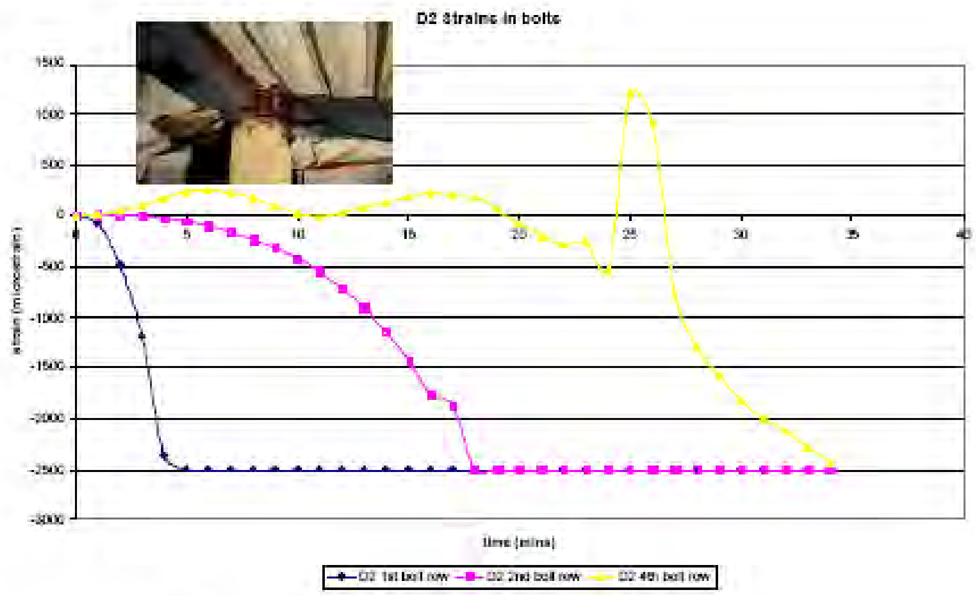



Figure 15. Bolt strain data from BRE 215-741.

This level of test data acquisition and documentation, as summarized in Table 3 and Figure 16, should be provided.

Table 3. Test Instrumentation Recommended for Acquisition of Structural Performance Data (see Figure 16)

| **Measurement** | **Instrumentation** |
|---|---|
| *Time-history of transverse (out-of-plane) deflections for all structural members* | *Transducers at assembly mid-span (minimum) for each member* |
| *Time-history of axial shortening for axially loaded walls and columns* | *Transducers at assembly load point (min)* |
| *Measure thermal restraint forces and bending moments at structural member end* | *Minimum of three load cells at beam or wall stud end, located at center of section and at both outside edges.* |
| *Time-history of strains in primary member section (beam, column or wall stud), metal deck, shear studs, steel rebar in concrete* | *High-temperature strain gages at outside edges and mid-depth of main structural section, centrally located in deck and rebar, base of shear studs - at end supports and mid-span (min) – see Figure 3* |

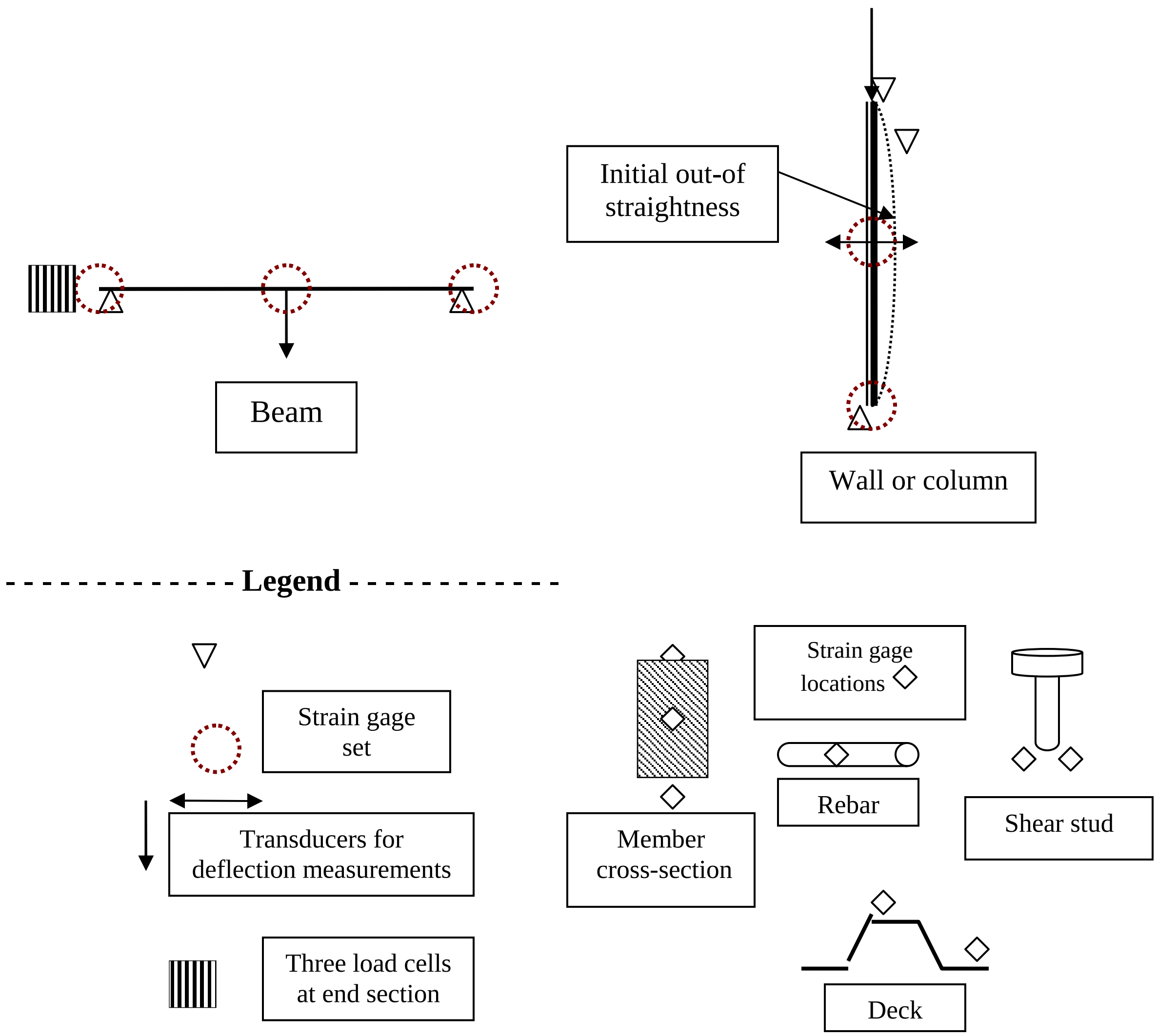



Figure 16. Illustration of recommended additional instrumentation for structural fire performance.

## 4.2 Furnace Operation and Load/Scale

Standardized Assembly Load Application

*Recommendation S-4: Superimposed loading on all assemblies should only be applied through mechanical or hydraulically-controlled apparatus.*

In addition to hydraulic/mechanical equipment, current testing practices often include use of other types of floor or beam load application, such as water-filled tanks, concrete blocks, or sand bags. While there may be some merit or convenience in using the latter for lightly loaded specimens not tested to their maximum design limit, use of such constant weights is inherently less accurate and consistent than load control equipment that has been properly calibrated and serviced. Inconsistencies and differences in the load application methodology alone may lead to discrepancies between tests and/or laboratories. The bulky natural weights can obscure needed detailed observations of the assembly's unexposed side condition relative to any openings, cracks, spalling, or fire penetration. At larger floor/beam deflections during the fire exposure, lateral contact among the stacked weights can be induced which would alter the actual gravity load distribution on the assembly. Moreover, in fire tests that reach actual structural failure, the danger to personnel and damage potential to the laboratory furnace is less with controlled loads than with stacked tank, block, and bag weights, whose support and stability cannot be readily maintained after floor/roof collapse.

For all these reasons of control, accuracy, and safety, it is recommended that loading be standardized and restricted to only hydraulic/mechanical means. It is recognized that to attain the desired pattern of uniformly distributed floor design loading in this manner, it will necessitate a series of multiple jacks, with corresponding spreader and reaction beam configurations. Appropriate guidance in this regard must still be developed to avoid assembly overload from too few or inadequately positioned concentrated loads that do not reproduce the intended characteristic response of uniformly distributed design loads.

Specification of Maximum Superimposed Design Load

> *Recommendation S-5: The standard should require the maximum assembly design load to be based on the greater of the design load computed from either allowable stress design or limit states-LRFD and the controlling strength failure mode to be used for each type of assembly construction.*

As with the thermal aspects of the test, it is necessary to provide loads that create the maximum allowable structural conditions so that potential serious failure modes can be realized in the test. Lesser loading would not provide full expression of assembly response potentials, leading to the potential for unanticipated failure modes in the field.

Over the last couple of decades, the alternative ultimate strength, limit states, or LRFD approach has evolved into an equally acceptable methodology that can result in different design solutions from working stress. In particular, it is possible to realize large maximum design load increases with the newer limit states/LRFD of up to 33–50% for some situations, such as composite steel-concrete beams. With this development and the broad acceptance in U.S. building codes of both design methods, there is no longer a unique maximum design load for a given assembly that is independent of the selected design method (ultimate strength or working stress). In some cases, it is also not clear which strength failure mode is to be considered for the assembly design.

Canada currently only allows use of limit states design, and has accordingly revised its CAN/ULC-S101-04 standard to specify how maximum assembly loads for standard fire tests are to be determined. It also addresses the typical strength limit states (bending, shear, compression, or tension) for which maximum design strength of the different assembly elements are to be computed. The latter guidance would be particularly helpful in the structural loading and analysis of multiple-part members, such as open-web joists, trusses, and non-standard girders. Additional provisions in this regard are needed in any test method in support of PBSFE. The conservative resolution of this issue in the presence of two structural design alternatives in the U.S. is to specify the maximum assembly design load as the highest load produced by working stress or limit states/LRFD, based on actual tested ambient material strength. In most typical cases, this maximum design load would be based on the ultimate strength/limit states/LRFD methods. Since testing to structural failure is the objective, restricted load tests at substantially less than the full design level may not reach this endpoint, or do so at significantly prolonged fire exposure times.

As a minimum, for purposes of PBSFE development, the applied load magnitude, type, and its design basis, as employed in the test, would add much needed clarity to the experimental results.

Minimum Assembly Size

*Recommendation S-6: Specified minimum sizes of construction assemblies should be as follows: walls and paritions-100 sq ft with neither dimension less than 9 ft, columns – not less than 9 ft length, floors/roofs – 180 sq ft, with neither dimension less than 12 ft, beams – not less than 12 ft-span length. Standards-making bodies should consider the formation of furnace classes to recognize furnace capabilities larger than the minimum size.*

While ever-larger furnaces and test assemblies are desirable to limit the extent of the scaling extrapolation required, the realities are that existing laboratory facilities were built for the current E 119, and similar ISO 834, minimum assembly size requirements (Beitel and Iwankiw, 2002). Marginal size changes from the nominal 10 x 12 ft vertical furnaces for wall and columns tests and 14 x 17-ft horizontal furnaces for floor/roof tests would be substantially meaningless toward enhancing the fidelity of test results. Only rather large increases of at least 2–3 times the current limits would enable more fully capturing the nature of continuous building construction. However, these greatly-increased assembly sizes would necessitate major new capital expenditures on bigger furnaces and ancillary test equipment, with the recurring expense of fire testing accordingly escalating. These major budget and cost factors are likely to constrain the demand and short-term availability of necessary facilities for large tests.

At this time, while fire testing development of larger assemblies is certainly encouraged, it is felt that this goal can best be accomplished in the near future within the context of special purpose projects, and not on a regular recurring basis. It is concluded that sufficient benefits for PBSFE can be more practically achieved in the shorter term through the other recommendations and without any change in the minimum assembly size.

Given the clear value of larger test specimens, it is desirable to create a number of furnace size classes so that the construction and use of larger furnaces can be recognized and the enhanced value of larger-scale testing can be reflected in the V&V requirements for models to be employed in PBSFE.

Size Effects and Experimental Scaling

> *Recommendation S-7: Employ dimensional scaling principles in the design of the test assembly to represent the actual construction applications.*

Laboratory furnaces are limited in size and depth, and this necessarily constrains the dimensions of assemblies that can be tested (Beitel and Iwankiw, 2002). Consequently, to date, most tests have been conducted full-scale on relatively small, shallow (not more than about 18 inches depth) and shorter span assemblies (less than about 17 ft) Restrictions have been imposed on the minimum structural sizes for which the rated assembly is applicable. However, it is known that long and short span floors/beams and walls/columns (often expressed in terms of a slenderness ratio of unbraced length divided by section depth or by its radius of gyration) can exhibit different structural behavior and have different strength limit states. The assembly depth can thereby be related to its span length as a contributing factor to the structural behavior. Bending and stability are the primary response modes for longer members, while shorter members are controlled by shear and axial section capacity.

In order to observe the full possible range of structural fire behavior, effects of longer spans and/or the larger assembly depths, which are actually used in construction, should be evaluated, since these could be more critical than shorter assembly spans and smaller depths. This approach would involve fire testing scaled specimens under load, which better represent reality. These geometric variables can be tested in practical furnace size and laboratory facility constraints using reduced-scale loaded assemblies and scaling laws to represent deeper trusses, bigger or taller columns and walls.

Dimensional analysis and structural similitude techniques to enable experimental test result correlations between full-size prototypes and scaled physical models have existed since the early-mid 20th century (Handbook on Experimental Mechanics, 1987, Bazant et al., 1996, Simitses and Rezaeepazhand, 1992) Preservation of key non-dimensional parameter(s) in the governing response equation(s) controls the experimental set-up and correlation of results. The fundamental differential equation for equilibrium of an elastic beam-column is given in Eq. 4, without regard to sign convention of the individual terms, and subject to material first yielding limits for axial and bending stresses:

$$\begin{gathered} EI\frac{d^2y}{dx^2} = Py(x) + M(x) \\ \text{subject to} \\ P \le F_yA \ \text{ and} \\ M(x) \le F_yS \end{gathered} \tag{4}$$

where

E I = elastic bending stiffness of the structural member, assumed as constant for prismatic section (force*lengths$^2$)

$\frac{d^2y}{dx^2}$ = second derivative of transverse member deflection relative to length, (length$^{-1}$) also known as curvature of neutral surface

P = centrally applied axial load, (force)

y(x) = transverse member deflection, function of length, x, along member, (length)|

M(x) = bending moment from continuity, axial load eccentricity and/or transverse member loads, function of length, x, along member, (force*length)

$F_y$ = material yield stress, (force/length$^2$)

A = member cross-section area, (length$^2$)

S = member section modulus, (length$^3$)

Elastic column stability for compressive axial loads is influenced by the secondary bending term, P y(x), which disappears for a pure beam with no axial force (P=0). For assessment of ultimate member structural strength and failure, utilization, or demand-to-capacity, ratio is the key invariant. If the model and prototype are built from the same materials, this ratio can be simply replaced by stress level. For these conditions and if structural member dimension of the model relative to prototype, $0<s<1.0$, is the primary scaling variable for its cross section and span length, the following scaling is necessary for complete test similitude and dimensional consistency of Eq. 4:

- Member span, length: s
- Member section area (A), length$^2$: $s^2$
- Moment of inertia (I) of member, length$^4$: $s^4$
- Concentrated load (P), force: $s^2$
- Line load, force/length: s
- Bending moment (M), force*length, and section modulus (S), length$^3$: $s^3$
- Uniformly distributed load, stress, and E (Young's Modulus), force/length$^2$: 1.0

Scaling (½-size floor truss depth and span, with doubling of applied load to produce equivalent steel stresses) was successfully employed in the recent NIST WTC floor truss fire resistance testing. (NIST NCSTAR 1-6B) Appropriate test provisions for furnace-scaled assembly testing should be developed, along with guidelines for application of results. Criteria for how and when large geometric changes in assembly span and depth can affect their fire resistance should be formulated, along with requirements for when assemblies must undergo additional scaled tests to account for these possible size effects in their fire resistance rating in lieu of extrapolation. Floor systems and columns appear to be the most likely candidates for such reduced scale testing. However, it is recognized that consistent scaling of concrete floor slabs may be problematic due to lack of sufficient control over aggregate size and internal moisture/humidity content. Furnace-scaled specimens can be considered to be about approximately ½ to ¼ size of the real prototype.

Some adaptation of full-scale to reduced, furnace-scaled fire testing of assemblies (in particular for beams, roofs, and composite steel-concrete floors) should be accomplished in the relative short-term. It would provide much needed supporting data to supplement or replace the current extrapolation of results of larger and heavier construction.

General guidance on the design of scaled furnace assemblies is needed by the fire resistance testing community and this is included as a general recommendation in Section 6.2.

## 4.3 General

Mandatory Fire Testing Under Design Load to Structural Failure

> *Recommendation S-8: All assembly fire tests should be conducted under maximum design load until an imminent or actual structural failure limit state is attained, or until an major integrity breach occurs, irrespective of the assembly's other thermal conditions.*

Oftentimes, the limiting criterion for a fire resistance rating time is either thermal or the test is simply terminated because a desired rating time target had been achieved. Under these circumstances, structural failure of the fire test assembly is never reached. The importance of continuing fire tests to structural failure, despite any rating time considerations, lies in gaining a fuller understanding of the actual structural limit states that can be encountered as the assembly reaches its failure time. These ultimate fire performance facts are not at all evident when the test is prematurely stopped, sometimes well in advance of even any visible structural distress. All loaded fire tests should continue until an imminent or actual structural limit state (failure condition) is reached.

In the recent NIST WTC collapses investigation (NIST NCSTAR 1-6B), four standard fire resistance tests were conducted on the floor truss system with different protection thicknesses and test conditions. While the E 119-based rating time was determined to be between ¾–2 hrs., the floors continued to support load without collapse for over 2 hours.

This observation, among others, reinforces the need to test to failure and to clearly identify the structural failure time and failure mode. The type of actual or imminent structural failure mode (bending, stability, fracture) or assembly integrity breach (burn-through or flame penetration through assembly or the furnace enclosure) should be clearly identified and reported.

The practical implication of this approach is that test duration should be limited by laboratory safety. Termination of a test would be indicated by fire penetration or burn-through of the assembly, or other breaches of the furnace enclosure or test apparatus that would pose a danger to the laboratory staff and facility. This structural failure/integrity endpoint of the test would generate much additional valuable information at a relatively small increment of effort. The time, mode and mechanism of the assembly failure should be clearly described (ductile, brittle, in bending, shear, tension, squash, or buckling) and documented as part of the standard.

Actual Strength of Assembly Structural Materials at Ambient Temperature

> *Recommendation S-9: Material strength tests should be performed on samples extracted from the primary structural assembly members to determine their actual mechanical properties at ambient (including yield and ultimate strength, and elastic modulus).*

Typical structural testing requires knowledge of the actual stress-strain properties and dimensions of the specimen material(s) at ambient temperatures. This mechanical property data is needed to accurately correlate the experimental results to predictor equations or analyses that utilize the material's yield or ultimate strength. Simple use of the minimum specified strength gradation of the structural material for this purpose is inadequate and could be grossly misleading for interpretation of the results, especially if the actual strength is substantially different (either more or less) from its nominal value. Current standards have no detailed requirements for determination of actual strength properties of the test assembly's structural materials, other than the general recording of their physical properties. The latter is mostly interpreted as being identification of the materials and their product designations, together with overall assembly dimensions. Often, the characteristic 28-day compression strength of poured concrete has been experimentally verified through standard ASTM C 39 cylinder tests and reported. However, the real steel, wood, or masonry properties of test assemblies commonly are not more precisely documented other than their nominal size and grade designation. Yet, it is possible, even currently probable for some lower grade, mild structural steels such as ASTM A 36, that their actual material strength may be 50% higher than its minimum nominal value. (ANSI/AISC 341-05). Petterson and Wittenveen (1979) cited examples in the 1970s of such artificial increases in fire resistance rating time achieved principally because the base structural material had an actual strength 25% higher than nominal.

Use of production mill certificates that show measured ambient strength of the material origination lot of the structural member is more reliable than mere dependence on nominal values, but due to potential variability within the lot as well as piece identification and tracking errors, this may also not be necessarily representative of the material to be fire tested. The best approach is to require standard ASTM strength tests of material samples used in the assembly construction, to include:

a. ASTM A 370-06, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products;*

b. ASTM E 8-04, *Standard Test Methods for Tension Testing of Metallic Materials;*

c. ASTM C 31/C31M-06, *Standard Practice for Making and Curing Concrete Test Specimens in the Field,* American Society for Testing and Materials, West Conshohocken, PA;

d. ASTM C 39/C39M-05e1, *Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens;*

e. ASTM C 1314-03b, *Standard Test Method for Compressive Strength of Masonry Prisms;* and

f. ASTM D 198-05a, *Standard Test Methods of Static Tests of Lumber in Structural Sizes*.

Explicit requirements for structural material strength determination to this effect should be provided in the test standard.

Determination of Structural Properties at Elevated Temperatures

> *Recommendation S-10: Material strength tests should be performed on materials used in the primary structural assembly members to determine their actual mechanical properties at high temperatures (including yield and ultimate strength, and elastic modulus).*

The major mechanical properties needed for structural fire resistance engineering are yield and ultimate strength, Young's (elastic) modulus, and stress-strain curves. The first two strength and stiffness parameters as a function of temperature, may be deduced from a series of stress-strain data. All materials exhibit degradation of their ambient mechanical properties with higher temperatures, and this representation, often depicted as a percentage of ambient, or so-called retention ratio, is crucial to an accurate modeling of fire resistance, and ultimately any fire-induced collapse prediction.

In contrast to long-standing test standards for determination of ambient material strength, such as A370-06 tensile testing for steel, none exists for such applications at high temperatures. The determination of high temperature mechanical properties requires a heating apparatus (oven) in combination with the conventional load testing equipment. The material specimen can either be heated to certain uniform temperatures and then load-tested until failure to develop a family of stress-strain curve for those temperatures, or it can be loaded at various constant levels inside an oven and heated to increasing temperatures until a creep failure occurs. A correlation could be made between these two sets of high temperature results.

Published information exists from various sources, domestic and international, on the "typical" mechanical properties of traditional structural materials (commonly steel, concrete, wood or masonry) at the high temperatures that could be experienced during a fire exposure. (SFPE, 2002 and ASCE Manual #78, 1992, among others). However, many of these tests were done decades ago, on generic material grades customary for that time and country, and with experimental procedures that were not entirely consistent for all, including differences in applied strain rates, instrumentation, data interpretation, and consideration of creep. This accounts for some of the additional scatter of these reported results. While it has been demonstrated that material retention ratios at high temperatures can be similar within a given material class, a substantially different response can be manifest in a separate class of the same material. For example, SFPE (2002) and other literature show that high strength concrete and steel will perform differently at high temperatures than their lower "normal" strength counterparts. Therefore, a related uncertainty of how far to extrapolate existing retention ratio data to other conventional material grades, types, or species or to specialty products, i.e., what are the specific limits of existing data applicability. Of course, as newer construction materials evolve into more common practice, such as resin-based, polymer composites, steel-concrete composite construction, steel cables or pre-stressing strands, fiber-reinforced concrete or even more higher strength steels and concretes, their high-temperature mechanical properties will need to be established.

To resolve these issues, supplemental high temperature testing for mechanical properties of the test assembly materials could be made mandatory, in general. However, this would severely burden every E 119 test and likely produce many redundant results. A more efficient alternative is central development within a separate program the standard procedures for such testing of these properties to conduct sufficient high temperature experiments of the common construction materials and grades, compile and publish the results for engineering applications. The recent WTC investigation Report NIST NCSTAR 1-3D provides an excellent central source of test data and available references on mild structural steel, together with revised best-fit formulations for the basic steel mechanical properties as a function of temperature, including the rarely reported Poisson's ratio. As the common construction materials and grades are likely to change over time, this high temperature material testing and official documentation should be periodically repeated, perhaps every 10–20 years, for validation and/or recalibration. If modern material property data is not available, it will be necessary for the materials to be tested in conjunction with the furnace testing.

In addition to the basic mechanical properties at elevated temperatures, the gross behavior of the assembly materials during the test fire exposure must be described, especially with regard to its damage/degradation through spalling, charring, and the like. This is further discussed under documentation.

Inclusion of Load Eccentricity for Walls and Columns

*Recommendation S-11: Require column and wall tests to be conducted with a minimum d/6 eccentricity of axial compression load from centerline, where d is the depth of column or wall.*

Most of the structural column fire resistance ratings have been derived from tests on unloaded, nominally straight specimens that are fully engulfed (uniformly heated) in the fire, and that are subject only to temperature endpoints. Use of this type of critical steel temperature test obscures a great deal of real fire response information for the member. Effects of accidental load eccentricity, initial column curvature or imperfections, column mechanical strength properties, length slenderness ratio, and type of structural failure (squash or stability/buckling) under fire exposures are relatively unknown.

In addition, compression members can potentially experience non-uniform heating in real fires (for example, in perimeter framing or tall columns subjected to lower, partial height heating), which will cause bowing curvatures (Cooke, 1988) due to thermal gradients through the section depth (see Figure 17). These induced thermal curvatures reduce the strength of the members due to P-delta effects, and hence, influence the stability of the columns. Such thermal effects will depend on whether the fire totally engulfs a given structural column, in which case similar thermal exposures on all sides can be expected, (uniform heating) or if not, gives rise to the non-uniform heating cases.

This behavior at elevated temperatures, as well as the adherence of the fire protection material under lateral column deflections, will only become manifest when columns are tested until actual/incipient failure under maximum design load and without temperature limits. The benefit of using different strength grades of column materials for fire resistance will also become better established.

As illustrated in Figure 17, non-uniform heating can be full height, but incomplete fire exposure of entire column section contour or a partial height exposure of some or all the section contour. Loaded column tests with non-uniform heating are expected to show asymmetric structural response and failure mechanisms that are not obviated from the currently unloaded, uniformly-critical E 119 temperature tests with their idealized conditions. Similar performance differences can exist for some wall assemblies due to non-uniform heating, applied load and deformation, even for non-loadbearing elements such as those that may be used as fire separations for large record storage compartments (Beyler and Iwankiw, 2005). Bailey (2004) reported that during the Cardington building tests in the UK, a non-loadbearing compartment wall failed during the fire due to large deflections imposed from adjacent beam framing.

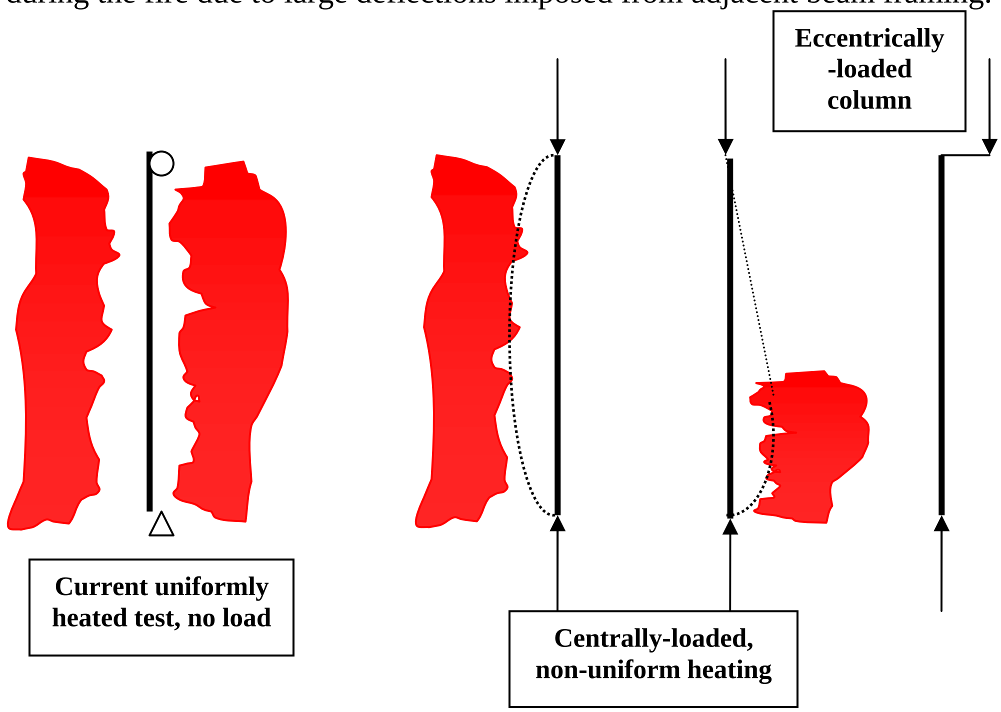



Figure 17. Column fire-testing alternatives.

A number of recent papers have addressed the fire resistance of light wood and steel-framed walls. In Alfawakhiri et al. (1999), and Alfawakhiri and Sultan (1999), the authors cite the paucity of experimental data on loadbearing light-frame walls with steel studs. Greater research focus in this area is endorsed, along with more complete instrumentation of standard test assemblies for structural property and response variables in order to expand performance-based fire design options. Clancy (2002a and 2002b), Clancy and Young (2004) developed predictive time to failure models and comparison tests on wood stud walls with gypsum board. Buckling effects, wall crookedness, stud size, spacing, charring, variability of wood and gypsum properties, as well as loadbearing and non-loadbearing applications were studied. Kodur et al. (1999), Alfawakhiri and Sultan (2000), Sultan (1995), and Alfawakhiri et al. (2000) present additional standard fire test results for lightweight steel framed walls, along with analytical modeling that correlates with this test data. Feng et al. (2003) and Feng and Wang (2005) reported experimental and analytical findings on cold-formed steel wall studs with gypsum board. Effects of channel section sizes and spacing, thermal bowing, stability and loading were examined under standard fire exposures.

Provision for investigating loaded column and wall response under non-uniform fire exposure should be studied, as this may be a more severe condition than uniform heating. In the interim, a surrogate approach for simulation of wall and column assembly strength degradation due to geometric imperfections and additional non-uniform heating effects is the imposition of a minimum eccentricity for compressive loads. Minimum compressive load eccentricity is already required in some test standards and structural design methods.

At this time, in view of the eccentricity requirements contained in ASTM E 72 for wall panel strength tests and those implied in ACI 318 for structural concrete design in compression, a load eccentricity of d/6 from the wall or column centerline is recommended, where d is the actual depth of the wall stud perpendicular to the wall or the largest depth of the column. This d/6 value also has a theoretical engineering basis in the so-called “kern” distance for a compressively loaded rectangular section, which is the maximum eccentricity in such a member that will still maintain all combined material stresses in compression, without any net tension from the eccentric bending. This load eccentricity should be applied toward the assembly side such as to magnify the fire and thermally-induced effects as a worst case. Steel and concrete members will bow towards the fire-exposed side due to thermal gradients and steel expansion; hence, the compressive load eccentricity should be applied away from the furnace to exaggerate this curvature. On the other hand, wood tends to bow away from the fire due to asymmetric charring deterioration; hence, its d/6 load eccentricity should be applied towards the furnace. Prior to the test, any initial wall or column geometric imperfections, such as vertical out-of straightness, should be measured and documented.

<u>No Hose Stream Test Requirement for Walls and Partitions</u>

> *Recommendation S-12: Hose stream test procedure and its acceptance criteria for walls and partitions are no longer required.*

The hose stream test provides little substantive information to either current life safety practices or PBSFE. The interpretation of its results is not well defined, and the hose stream application may be conducted after two alternative fire exposure durations. The use of the hose stream test is in direct conflict with the requirements of the “test to failure” approach adopted here.

<u>Structural Instrumentation Check/Calibration</u>

> *Recommendation S-13: Prior to initiation of fire test, check/calibrate all of assembly’s structural instrumentation (transducers, strain gauges, load cells) under superimposed load.*

The functionality and accuracy of all the structural instrumentation installed on the assembly should be checked under load immediately prior to the fire ignition. This process should include comparison of the expected elastic deflections and strains of the structural members under load to those recorded just prior to the fire test. Any installation corrections or replacements of instrumentation can then be made, as needed. An easy method for similar pre-test verification of the load cells (for boundary restraint) should be developed and implemented.

## 5.0 TEST METHOD RECOMMENDATIONS – TEST DOCUMENTATION

The proposed test requirements for procedures, instrumentation, or load/scale issues will all necessarily require accompanying documentation, as outlined herein in 5.1–5.6.

### 5.1 Furnace Description

- Lining (T-11)
- Dimensions (T-12)
- Gas type (T-13)
- Burner description (T-14)
- Secondary air flow rate (T-15)

### 5.2 Furnace Exposure Conditions and Instrumentation

- Furnace temperature measurement (T-1)
- Target fire exposure curve including tolerances (T-9)
- Pressure measurement and location(T-2)
- Oxygen concentration sampling description and analyzer for measurement (T-3)

### 5.3 Calibration Test Results

- Thermal (T-10)
- Structural (S-13)

### 5.4 Specimen/assembly Description

- General – size/dimensions (S-6), ambient material strengths (S-9)

All the test assembly original conditions (structural framing and span, loading, end supports) should be accurately provided. In addition, the description and major properties of the fire protection materials should be provided. For compressively-loaded assemblies (walls and columns), initial-out-straightness of the test assembly and other imperfections should be regularly measured and recorded, as this could be an important factor in its ultimate strength.

- Instrumentation (type and locations) – thermal (T-4, T-5, T-7, and T-8) and structural (S-1, S-2, and S-3)
- Superimposed loading – design basis and magnitude, application means (S-4, S-5, S-11)
- Conditioning – e.g., curing of concrete, of protective materials, etc.

## 5.5 Test Results

- Time-history records of all measured values
- Pertinent visual observations – discoloration, damage and detachment of protective and structural materials, cracking, spalling, buckling, creation of gaps-openings, flame and gas penetration, other unusual behavior

During the test, the time of occurrence and type of major structural damage, such as local buckling of steel, detachment of metal deck from slab, spalling or crushing of concrete, fractures and cracks, splitting or ignition/charring of wood and the like should be documented. The ignition and charring of wood is well-documented. However, though research literature on fire-induced concrete spalling exists, such as the more recent contributions of Bostrom et al. (2004), and Breunese and Fellinger (2004), such spalling damage in concrete is still not known in sufficient scientific rigor to be predictable or controllable. Therefore, if spalling in concrete or other unusual high temperature material behavior is manifest during the fire test, the nature and occurrence time of this phenomenon, along with its accompanying conditions should be documented.

Equally important, other observations on degradation, damage, distortion or detachment of the fire protection material, that could accelerate thermal penetration of the assembly during the test, should be made.

- Identification of Structural Failure Endpoint Time and Mode(s) (S-8)
- Other – photographs, videos, identification of any malfunctioning of instrumentation or test apparatus, possibly sample extraction of residual assembly materials

## 5.6 Post-Test Inspection

- Thermal damage – material state, char extent and depths, spalling area and depths, burn-through areas, missing/detached protection material, etc.
- Structural – local and global damage (cracking, spalling, buckling, fractures, char-reduced sections, etc.)

The ambient, post-test (cold) condition of the assembly should be well-documented, in particular all the fire protection and structural damage, and final displaced configuration of the assembly. This information would reveal any changes and additional damage from thermal contraction after the fire and during the cooling stage.

## 6.0 GENERAL RESEARCH RECOMMENDATIONS IN SUPPORT OF PBSFE

While the objective of this project was to develop recommendations for testing in support of PBSFE, a number of general research topics were brought to light in the course of the work. These topics are introduced in the following subsections for reference. The topics are neither complete nor novel, but bear enumeration.

### 6.1 Develop Guidelines for Definition of Imminent Structural Failure

Recommendation S-8 calls for testing under full design load until structural failure is reached, or until an integrity/safety breach occurs. Much is left to the subjective judgment of the laboratory staff or the test sponsor as to when structural failure is imminent immediately prior to any total specimen collapse. The purpose of this recommendation is to develop a common set of Guidelines that can be used in the determination of imminent failure. The Guidelines are intended to facilitate safe and effective laboratory operations and provide greater test termination consistency among laboratories.

Large, uncontrolled deflections are usually the best indicator of an imminent failure. Harmathy (1967) addresses such for steel beam supported floors. In contrast to ductile failures that develop more gradually, brittle fractures or instability can occur almost instantaneously without forewarning and are much less predictable. The laboratory is usually very careful in trying to prevent full assembly collapse in order to avoid any personnel injuries and to safeguard its furnace and instrumentation. That is why a reliable predictive limit for imminent structural failure of the test assembly, at least for ductile response, is desirable. These, and more general unresolved issues in practice with identification of structural "failure" during a fire, were raised by Lane (2003).

Rapidly increasing ("runaway") deflections and loss of stiffness can often be seen real-time during the fire test on the plot of assembly deflection time-history. Current standards do not provide any definitive criteria on exactly when ductile deflections are to be regarded as being uncontrolled, with failure being imminent. Ryan and Robertson (1959) had developed arguably the first deflection failure criteria for steel beams tested in a standard E 119 fire test under full load (Ryan and Robertson, 1959). One of these postulated limits is the magnitude of the maximum beam transverse deflection, formulated from curve fit of test data in consistent length units of inches as

$$\delta = \frac{L^2}{800d} \qquad (5)$$

where

$\delta$ = maximum beam transverse deflection during the fire exposure, in
L = beam span length, in
d = beam section depth, in

Due to the difficulty of representing in a simplified manner all the other specimen design variables, such as material properties, member sizes, and end connection restraint for this critical deflection value, Ryan and Robertson (1959) proposed a second accompanying limit that checks the rate of transverse deflection. This criterion draws from the experience that specimen failure is imminent when the deflection itself is not only sufficiently large, but also when it starts increasing at a rapid, or "runaway" rate, indicated by the slope of the deflection time-history curve. Such an accelerated rate of deflection signals pending beam instability. This second limit postulated by Ryan and Robertson, 1959, is expressed as the hourly rate of fire induced deflection equaling or exceeding $L^2/(150d)$. The authors recommend the structural failure time of the beam, floor or roof assembly be taken as the time when both of these limiting criteria are exceeded.

These, or comparable, beam, floor and roof deflection criteria should be developed for adoption to explicitly define imminent structural failure for ductile materials. Several international fire standards, such as ISO 834, BS 476 and DIN 4102, have already included similar type of deflection-based criteria for "loadbearing capacity," not only for members in bending, but also for axially loaded elements in compression (columns and walls). These ISO 834 limits are shown in Eq. 6, with both criteria necessary to be exceeded for failure identification. These deflection limits are substantially higher than those originally proposed by Ryan and Robertson (1959). For flexural elements and $D \geq L/30$:

$$D = \frac{L^2}{400d} \qquad \frac{dD}{dt} = \frac{L^2}{9000d} \tag{6}$$

where

D, dD/dt = limiting flexural deflection, mm, and rate of deflection, mm/min, respectively
L = clear span of assembly, mm
d = bending section depth, mm

For axially loaded elements:

$$C = \frac{h}{100} \qquad \frac{dC}{dt} = \frac{3h}{1000} \tag{7}$$

where

C, dC/dt = limiting axial shortening, mm, and rate of axial shortening, mm/min, respectively
h = initial element height, mm

These and additional recommendations should be developed as Guidelines to minimize risk of sudden brittle fractures or stability collapses in order to preserve general safety and mitigate damage to the laboratory facility. In addition to any specific deflection-based indexes, monitoring and interpretation of temperature readings, observations on the physical deterioration of the assembly, duration of the fire exposure, and similar factors should be addressed. The resulting Guidelines will provide a common and rational platform for identification of the imminent structural failure test endpoint for typical conditions.

### 6.2 Develop Guidance for the Design of Furnace Assemblies and Application of Results

Test method provisions for furnace-scaled assembly testing and guidelines for application of results should be developed. Criteria should be provided for when and how furnace-scaled fire tests can be used and interpreted relative to actual construction via extrapolation of results to larger and heavier assemblies. This need follows directly from Recommendation S-7 to employ dimensional scaling principles in the design of the test assembly to represent the actual construction applications.

### 6.3 Conduct a Round-robin using the Furnace Calibration Test Method

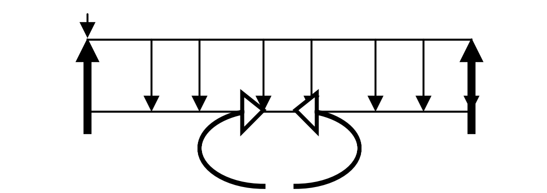
A round-robin using the furnace calibration test (Recommendation T-10) would provide important data and evaluation of the relative operating performance of existing laboratory furnace. Given the differences in size, depth, fuels, burners etc of the existing furnaces, the round-robin would also serve to evaluate the potential effects of not controlling the furnace operation as recommended in this report. The round-robin would provide testing and statistical analysis in support of test method development, standardization, and analysis of variances.

### 6.4 Develop Test Procedure and Data on Fire Performance of Common Structural Connections

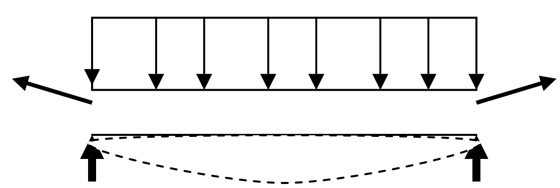
FEMA 403 and NIST NCSTAR 1-6B identify structural connections under fire exposures as a vital area for further study. Very few fire tests have been conducted on assemblies with real end connections, in place of the common insertion of the assembly frame into the furnace. Most assemblies typically have simple bearing supports butted against the test frame for floors and roofs, or to the load device for walls. While the current prescriptive code provisions in the U.S. requiring fire protection of connections to be at the same level as for the most highly rated adjoining structural member have generally been considered adequate, the fire response of connections, of its constitutive elements and details (bolts, welds, reinforcing bars and development lengths, ties, etc.) is not well understood or developed. Moreover, the ductility, or lack thereof, of connections under potentially very high strain demands and reduced strength at elevated temperatures could be a critical factor in the integrity assessment of adjacent structural member(s) and framing, as well as for development of any secondary load redistribution paths. The Cardington building tests amply demonstrated this aspect of real structural fire performance (University of Edinburgh, 2000 and BRE 215-741).

End connections and member splices are conventionally detailed only for the design loads required by the applicable building code, which primarily involve shear forces and/or bending moments for moment frames, axial tension or compression and/or shear for braced frames and trusses. Columns typically carry only compression loads, but may experience uplift for some braced frame conditions. Ordinary structural design for beams and floors does not regularly include the secondary effects of larger axial tension forces and strains from catenary action (see Figure 18) that are likely to become manifest only under the final strength limit states of fire exposure, blast, or impacts. One example of this type of tensile limit state in a connection is the beam splice failure during the 9-11 disasters in WTC 5, as described in the FEMA 403 Report.

One approach to acquire fire performance data on connections is to require every assembly to be detailed and tested with real connections. However, development of standard provisions for such would be rather difficult, given the wide variety of alternative connection types and details, and it would regularly encumber every test. It is likely better to allow the assembly supports to continue being of the customary fitted/bearing type within the test frame, or at the sponsor's discretion, use of actual structural connections should be permitted.



Bending/Shear at Service Conditions



Catenary Action at Ultimate

Figure 18. Change in floor system resistance from primary bending to catenary action.

A seemingly more viable alternative is to develop in a special research study a unique set of fire test criteria and results for a suite of typical steel connectors (mechanical fasteners, welds, shear studs), connections and steel reinforcing details (longitudinal rebar, shear stirrups, ties, etc.) for steel, concrete and masonry that form typical simple (shear only) and rigid (moment-resisting) connections, composed of different base materials in beam-to-beam and beam-to-column designs. This could be done within or separate from the standard review. Given suitable instrumentation and loading, important new information on connection ductility, force transfer mechanisms, and their ultimate failure limit states under load and high temperature exposures would be thereby obtained, including effects from cooling after the fire. These connection results could supplement the conventional assembly ratings, and form a basic set of input properties for modeling of connections in PBSFE.

### 6.5 Develop and Standardize Test Methods for High Temperature Thermal, Physical, and Structural Properties of Materials

In support of Recommendations T-17 and S-10, test methods for high temperature thermal, physical, and structural properties of materials are needed. Thermal properties (conductivity, specific heat capacity, heat of decomposition) need to be measured at temperatures as close to the highest temperature the material is expected to reach. Physical properties (density, moisture content, expansion/contraction, decomposition kinetics) also need to be measured as a function of temperature up to temperatures the material is expected to reach. Material strength tests need to be performed on materials used in the primary structural assembly members to determine their actual mechanical properties at high temperatures (including yield and ultimate strength, and elastic modulus.

While there are a number of test methods available for these measurements, none of them are fully satisfactory and none are accepted as standards for this use. Research is needed to develop and evaluate the available methods. This will support the selection of the best methods that can then be subjected to V&V and ultimately become accepted standard test methods for this application.

### 6.6 Compile Fire Test Database

Compilation of a comprehensive database on all fire tests of an assembly, including those that were not successful, is recommended. Fire resistance data and rating results from any fire test can differ, sometimes quite markedly from one identical test to another, both in terms of recorded thermal and structural performance. This is due to the many random experimental variables and inaccuracies (laboratory facilities and practices, furnace temperatures and pressures, loading, instrumentation, test frame boundary conditions), combined with differences in actual material properties and workmanship quality of the individual assembly construction. At times, multiple fire resistance tests have been conducted for an assembly to achieve a desired rating outcome, and only the single best “passing” test is used as the benchmark for the fire resistance listing.

The actual “track” record, including any failed or unsatisfactory tests, assembly modifications, and variability of fire tests should be compiled in a database. This information would serve to not only assess the test variability, but also provide additional model validation benchmarks.

The database will not only provide a much better understanding of fire performance, but also give invaluable specific results against which structural fire design and analysis tools can be validated and calibrated.

### 6.7 Analyze Repeatability (Scatter) of Tests

A rigorous statistical study of the random variations in standard fire tests (as compiled in the database) should be performed to determine the expected probability distribution of experimental results for identical or similar assemblies. To the extent possible, the variability of all the experimental and assembly-specific factors should be established. Such rationally assigned statistics of the published test data could be used to improve interpolation of existing test results and to assess validation accuracy of analytical models, whose solutions otherwise may not exactly match the output of any single test.

## 7.0 SUMMARY OF RECOMMENDATIONS

### 7.1 Furnace Instrumentation Recommendations

Recommendation T-1: Furnace Temperature Control – Plate thermometers should be used to measure furnace temperature and control the furnace exposure. There should be nine plate thermometers equally distributed across the test specimen surface. Plate thermometers are typically placed 0.10 m (4 in.) away from the sample; however, a larger spacing is desired to prevent them from potentially being damaged by failing test articles. Testing needs to be performed to demonstrate that a larger spacing does not affect the thermometer measurement.

Recommendation T-2: Furnace Differential Pressure – Tests should be performed with a positive furnace pressure (relative to laboratory conditions) across the entire test article. All furnace pressures should be measured using the tube sensor provided in ISO 834 and EN1363-1. In a vertical furnace, pressure should be measured at the bottom and top of the test specimen. The neutral plane in the furnace should be maintained at the bottom of the test specimen with no limit on the pressure at the top of the specimen. In a horizontal furnace, the furnace pressure should be measured at one location and maintained at 20 Pa. Pressure tube sensors should be located at the same distance away from test articles as the plate thermometers.

Recommendation T-3: Furnace Oxygen Concentration – Furnace oxygen concentration should be measured in the furnace stack and maintained at greater than 6% during the test. Gas samples should be continuously drawn out of the duct through a sampling line and measured using a paramagnetic type oxygen analyzer. The recommended sampling probe should be similar to the sampling probe used in duct measurements of hood calorimeters.

Recommendation T-4: Unexposed Side Temperatures – The unexposed side temperatures should be measured with a thermocouple placed between the specimen and a noncombustible, insulating pad. The insulating pad should be a low density, low thermal conductivity material with known thermal properties. The pads should be approximately 0.15 m (6 in.) square and 25 mm (1 in.) thick and placed in at least three locations that provide a range of heat-transfer performance.

Recommendation T-5: Total Heat Flux off the Unexposed Side – The total heat flux off the unexposed side of the assembly should be measured using a Schmidt-Boelter type water-cooled total heat flux gauge. At a minimum, a heat flux gauge should be placed near the center of the test article and as close as possible to the unexposed side. In cases where the assembly contains a transparent section, a heat flux gauge should also be placed at the center of the transparent section as close as possible to the unexposed surface.

Recommendation T-6: Furnace Velocity – Velocity measurements inside the furnace should not be made.

Recommendation T-7: Temperature Profile through Test Specimen – Temperatures should be measured through the thickness of the test assembly at locations that are representative of the different heat-transfer paths within the assembly. Repeat temperature profiles are recommended in case some thermocouples fail during the test.

Recommendation T-8: Gas Temperature Measurement – Gas temperatures on the exposed and unexposed side of the test specimen should be measured using aspirated thermocouples. Gas temperatures should be measured at each location where a temperature profile is being measured. Aspirated thermocouples should be placed as close as possible to the test article surface.

## 7.2 Furnace Operations Recommendations

Recommendation T-9: Furnace Time-Temperature Exposure Curve – The furnace time-temperature exposure should linearly increase to 1200°C in six minutes and remain constant at 1200°C for the remainder of the test.

Recommendation T-10: Calibration Test – A calibration test should be conducted with a noncombustible boundary containing instrumentation to quantify the thermal exposure. Instrumentation installed in the boundary should include total heat flux gauges and calibration boards instrumented with thermocouples. Instrumentation should be installed in at least five locations (center of each quadrant and center of the boundary) to quantify the furnace exposure. The calibration test should be performed for one-hour using the required furnace exposure and instrumentation.

Recommendation T-11: Furnace Lining Material – All interior furnace surfaces should be lined with a ceramic fiber material.

Recommendation T-12: Minimum Furnace Depth – The minimum furnace depth should be 4 ft (1.2 m).

Recommendation T-13: Burner Fuel – Propane gas should be used as the furnace fuel in all fire resistance furnaces.

Recommendation T-14: Type of Burner – Pre-mixed burners should be used in all fire resistance furnaces.

Recommendation T-15: Secondary Air Capability – When necessary, a means for providing secondary air should be provided such that the minimum oxygen content within a furnace is not less than 6%.

Recommendation T-16: Exhaust Control – A means for controlling the internal furnace pressure (e.g., damper in exhaust stack) should be provided.

Recommendation T-17: Thermal Properties of Materials – The thermal and physical properties of materials in the test article assembly should be measured. Thermal properties (conductivity, specific heat capacity, heat of decomposition) should be measured at temperatures as close to the highest temperature the material is expected to reach during the test. Physical properties (density, moisture content, expansion/contraction, decomposition kinetics) should also be measured as a function of temperature up to temperatures the material is expected to reach during the test. Thermal property test should be performed on materials taken from the same lot of materials used to construct the test article.

## 7.3 Structural Instrumentation Recommendations

Recommendation S-1: Assembly End Restraint – Place load cells at the assembly end boundaries to record magnitude of thermal restraining forces throughout test duration: minimum of three cells at one edge of furnace for the top, center, and bottom of a middle beam or stud of assembly.

Recommendation S-2: Deflections – Record, as a minimum, the time-history of transverse deflections at mid-span in all primary structural members (beams, joists, columns, and wall studs) of the assembly, together with axial shortening of loaded columns and wall studs.

Recommendation S-3: Strain Gauges – Require high-temperature strain gauges at critical sections (typically ends and/or mid-span) of main structural members (beams, joists, columns, wall studs) and of other important load transfer elements (shear studs, metal deck, floor slabs and reinforcement, and connections).

## 7.4 Structural Operations Recommendations

Recommendation S-4: Standardized Assembly Load Application – Superimposed loading on all assemblies should only be applied through mechanical or hydraulically controlled apparatus.

Recommendation S-5: Standardized Assembly Loading – The standard should require the maximum assembly design load to be based on the greater of the design load computed from either allowable stress design or limit states-LRFD and the controlling strength failure mode to be used for each type of assembly construction.

Recommendation S-6: Minimum Assembly Size – Specified minimum sizes of construction assemblies should be as follows: walls and partitions – 100 sq ft with neither dimension less than 9 ft, columns – not less than 9 ft. length, floors/roofs – 180 sq ft, with neither dimension less than 12 ft, beams – not less than 12 ft span length. Standards making bodies should consider the formation of furnace classes to recognize furnace capabilities larger than the minimum size.

Recommendation S-7: Size Effects and Experimental Scaling – Employ dimensional scaling principles in the design of the test assembly to represent the actual construction applications.

Recommendation S-8: Mandatory Fire Testing Under Design Load to Structural Failure – All assembly fire tests should be conducted under maximum design load until an imminent or actual structural failure limit state is attained, or until an major integrity breach occurs, irrespective of the assembly's other thermal conditions.

Recommendation S-9: Actual Strength of Assembly Structural Materials at Ambient Temperature – Require material strength tests be performed on samples extracted from the primary structural assembly members to determine their actual mechanical properties at ambient (including yield and ultimate strength, and elastic modulus).

Recommendation S-10: Determination of Structural Properties at Elevated Temperatures – Material strength tests should be performed on materials used in the primary structural assembly members to determine their actual mechanical properties at high temperatures (including yield and ultimate strength, and elastic modulus).

Recommendation S-11: Inclusion of Load Eccentricity for Walls and Columns – Require column and wall tests to be conducted with a minimum d/6 eccentricity of axial compression load from centerline, where d is the depth of column or wall.

Recommendation S-12: No Hose Stream Test Requirement for Walls and Partitions – Hose stream test procedure and its acceptance criteria for walls and partitions are no longer required.

Recommendation S-13: Structural Instrumentation Check/Calibration – Prior to initiation of fire test, check/calibrate all of assembly's structural instrumentation (transducers, strain gauges, load cells) under superimposed load.

## 7.5 Recommendations Potentially Applicable to Existing Test Methods

While the objective of this project was to develop requirements for testing in support of PBSFE, many of the recommendations could be implemented within the context of the existing tests used in prescriptive design. The recommendations developed here fall into three categories; 1) fully capable of being implemented in existing test methods, 2) potentially capable of being implemented into existing test methods with minor modifications to the test standard, and 3) require major modifications to existing test standards. The category classification of the recommendations is shown in Table 4.

Recommendations falling into Category 1 are generally recommendations that add instrumentation that is not required in the existing standards. The recommendations do not restrict what is allowed in any way, but rather supplement the requirements of existing tests.

Recommendations falling into Category 2 are incremental changes or restrictions that go beyond the requirements of the existing test methods, but would not require major modifications to the test standard.

Recommendations falling into Category 3 are major departures from the existing test methods that could not be accommodated as incremental changes.

Table 4. Applicability to Existing Test Methods

| Recommendation | Category |
|---|---|
| T-1: Furnace Temperature Control | 2 |
| T-2: Furnace Differential Pressure | 2 |
| T-3: Furnace Oxygen Concentration | 2 |
| T-4: Unexposed Side Temperatures | 2 |
| T-5: Total Heat Flux off the Unexposed Side | 1 |
| T-6: Furnace Velocity | 1 |
| T-7: Temperature Profile through Test Specimen | 1 |
| T-8: Gas Temperature Measurement | 1 |
| T-9: Furnace Time-Temperature Exposure Curve | 3 |
| T-10: Calibration Test | 2 |
| T-11: Furnace Lining Material | 2 |
| T-12: Minimum Furnace Depth | 2 |
| T-13: Burner Fuel | 2 |
| T-14: Type of Burner | 2 |
| T-15: Secondary Air Capability | 2 |
| T-16: Exhaust Control | 2 |
| T-17: Thermal Properties of Materials | 1 |
| S-1: Assembly End Restraint Measurement | 1 |
| S-2: Deflections | 1 |
| S-3: Strain Gauges | 1 |
| S-4: Standardized Assembly Load Application | 2 |
| S-5: Standardized Assembly Loading | 2 |
| S-6: Assembly Size | 2 |
| S-7: Size Effects and Experimental Scaling | 2 |
| S-8: Fire Testing to Structural Failure | 2 |
| S-9: Actual Strength of Structural Materials at Ambient Temperature | 1 |
| S-10: Determination of Structural Properties at Elevated Temperatures | 1 |
| S-11: Inclusion of Load Eccentricity for Walls and Columns | 2 |
| S-12: No Hose Stream Test Requirement for Walls and Partitions | 2 |
| S-13: Structural Instrumentation Check/Calibration | 1 |
| Test Documentation | 1 |

Category 1- supplemental to existing test method
Category 2- incremental changes or restrictions to existing test method
Category 3- major departure from the existing test

# 8.0 PROPOSED EXPERIMENTAL RESEARCH

A test plan outline involving composite concrete slab/steel beam floor assemblies and gypsum-protected load bearing steel-stud walls assemblies has been developed to evaluate the feasibility and value of the instrumentation and operations recommendations. The test plan outline also calls for reporting consistent with the documentation recommendations of this report. The test plan outline is provided in this section of the report. Other experimental research proposals are included in the general research recommendations of Section 6.

## 8.1 Test Plan Outline

This test method is intended to support the continuing development and use of Performance-Based Structural Fire Engineering (PBSFE). This supplementary test plan outline reflects the majority of the recommendations for enhanced fire resistance testing of building construction assemblies. Its objective is to provide the key variables and configuration of two test assemblies for a series of fire tests intended to further explore, validate and/or refine the test recommendations and criteria.

As specified by the Fire Protection Research Foundation (FPRF) for this Project, light frame walls and composite steel/concrete floors are to serve as the generic two assembly types for this testing assessment. HAI selected the particular construction described herein based on their representative nature of the assemblies of interest, the specifics of which can be adjusted at the discretion of FPRF, including the identification of particular proprietary products. These selections of the test assemblies were made based on their prevalent fire resistance rated construction as determined from HAI project experience including listings in the 2007 UL Fire Resistance Directory.

This test plan outline contains the essential information for FPRF to plan the test program and to finalize assembly details and test series parameters. The specific nature of the assemblies, variables to be changed, number of repeat tests, and intended test duration are all important considerations in this regard that are addressed. To avoid repetition, it is assumed that the reader is familiar with and has ready access to the HAI report (Beyler et al., 2007). For the sake of brevity, the test requirements simply reference the parent report and its various itemized recommendations, which contain their background and more specific details.

This outline provides general test requirements and those specific to the light frame wall and the composite floor assemblies.

### 8.1.1 General Requirements

The general requirements are:

- The minimum furnace depth (both horizontal and vertical furnaces) is 4 ft (Per Recommendation # T-12)
- All interior furnace surfaces are to be lined with ceramic fiber materials. (Per Recommendation # T-11)
- The furnaces will be fired using propane gas. (Per Recommendation # T-13)

- The furnaces will use premixed burners. (Per Recommendation # T-14)
- The furnaces will be equipped with a controlled source of secondary air for minimum oxygen content of 6% throughout test. (Per Recommendation # T-3 & T-15)
- Furnace shall be fired to follow the recommended time/temperature curve. (Per Recommendation # T-9)
- Plate thermometers will measure and control the fire exposure. (Per Recommendation # T-1)
- The fire tests will be conducted under positive furnace pressure across the entire test assembly, with laboratory capability to accordingly monitor and adjust pressure. (Per Recommendation # T-2 & T-16)
- Velocity measurements within the furnace are not required. (Per Recommendation # T-8)
- Minimum assembly sizes shall be as specified in ASTM E 119. (Per Recommendation # S-6)
- Both temperatures and heat flux on the unexposed side of the assembly be measured and recorded. (Per Recommendation # T-4 & T-5)
- Aspirated thermocouples will record the gas temperatures on the exposed and unexposed sides. (Per Recommendation # T-8)
- Temperature profiles through the assembly be measured and recorded. (Per Recommendation # T-7)
- Prior to the test, a general calibration of the thermal instrumentation is required. In this calibration test, plate thermometers used to control the furnace shall be installed at the location desired in the actual testing with some select measurements at other distances from the test article to evaluate the impact of thermometer offset on furnace temperature measurement. (Per Recommendation # T-10)
- The structural instrumentation requires load cells for measuring thermal end restraint, transducers for deflection data and high-temperature strain-gages at critical assembly locations. See specific test details below for locations. (Per Recommendation # S-1, S-2 & S-3)
- The live load shall be applied via hydraulic/mechanical equipment. (Per Recommendation # S-4)
- The maximum assembly design load shall be based on the ultimate strength/LRFD method. (Per Recommendation # S-5)
- For walls, a specific compression load eccentricity shall be used. (Per Recommendation # S-12)
- No hose stream test shall be conducted. (Per Recommendation # S-14)
- Continue the test until either an actual or an imminent structural failure occurs or occurrence of a major breach in the assembly or until safety considerations dictate. Unless other guidelines or criteria for imminent failure in ductile bending and axial compression are determined, the deflection-based limits described in Recommendation S-9 be used. (Per Recommendation # S-8 & S-9)
- Supplementary testing of the key protection and structural materials is necessary to identify their relevant ambient and high-temperature properties. Samples of materials

used in constructing the assemblies should be set aside for use in conducting thermal and mechanical property testing. (Per Recommendation # T-17, S-10 and S-11)

- Test documentation includes assembly dimensions, construction and instrumentation details, initial conditions, raw and processed data of all instrumentation, photos, and visual observations of damage, unusual behavior, and failure mode(s).
- Each test assembly will be run in duplicate in order to assess reproducibility of results, and possibly to correct any problems with the first iteration.

### 8.1.2 Light Frame Walls

Light frame walls consist of either wood or cold-formed steel studs protected by gypsum board or plaster. Consequently, heavy concrete or masonry walls are not considered to be within this category of building construction.

The strategy for planning this set of wall tests is to evaluate the performance of the common construction of this type using the proposed test procedure. Since the test procedure focuses on both thermal and structural performance during fire exposure, it was necessary for the wall assemblies to be load bearing and be tested at their maximum design load. It was also decided to use cold-formed steel studs rather than wood studs due to the wide use of steel studs and the much greater variability of wood stud properties.

Common fire-resistance rated light wall construction is typically constructed by applying gypsum wallboard to each side of the steel studs. Test Wall Assembly No. 1 will have one layer of ⅝ inch thick, Type X gypsum board on each side of the studs and a layer of 3.5-inch thick mineral wool insulation (4 lb/ft$^3$ density) installed in the cavities. Test Wall Assembly No. 2 and Wall Assembly No. 3 will have two layers of ⅝ inch thick, Type X gypsum board on each side of the studs and a layer of 3.5-inch thick mineral wool insulation (4 lb/ft$^3$ density) installed in the cavities. Each wall will have overall dimensions of 10 ft, high x 12 ft wide.

Table 5 provides a summary of the test wall assemblies.

Table 5. Test Matrix – Wall Assemblies

| Test No. | Studs | Cavity Insulation | Gypsum Wallboard Facers | Loading |
|---|---|---|---|---|
| 1A | Steel – 3½-in. deep, 20-ga., 24-in. OC | 3½-inch thick - (4 lb/ft3 density) | 1 layer of ⅝-in. thick, Type X on each face – Vertically applied – joints staggered | Centrally |
| 1B | Steel – 3½-in. deep, 20-ga., 24-in. OC | 3½-inch thick - (4 lb/ft3 density) | 1 layer of ⅝-in. thick, Type X on each face – Vertically applied – joints staggered | Centrally |
| 2A | Steel – 3½ in. deep, 20-ga., 24-in. OC | 3½-inch thick - (4 lb/ft3 density) | 2 layers of ⅝-in. thick, Type X on each face – Vertically applied – joints staggered | Centrally |
| 2B | Steel – 3½-in. deep, 20-ga., 24-in. OC | 3½-inch thick - (4 lb/ft3 density) | 2 layers of ⅝-in. thick, Type X on each face – Vertically applied – joints staggered | Centrally |
| 3A | Steel – 3½-in. deep, 20-ga., 24-in. OC | 3½-inch thick - (4 lb/ft3 density) | 2 layers of ⅝-in. thick, Type X on each face – Vertically applied – joints staggered | Eccentrically |
| 3B | Steel – 3½-in. deep, 20-ga., 24-in. OC | 3½-inch thick - (4 lb/ft3 density) | 2 layers of ⅝-in. thick, Type X on each face – Vertically applied – joints staggered | Eccentrically |

In order to assess the potentially adverse effects of compressive load eccentricity as recommended in Recommendation S-12, a centrally loaded wall configuration will also be tested with eccentrically applied maximum design load for direct comparison with the predecessor assembly. At this time, in view of the eccentricity requirements in ASTM E 72 for wall panel strength tests and those implied in ACI 318 for structural concrete design in compression, a load eccentricity of d/6 off the wall centerline is recommended, where d is the actual depth of the wall stud perpendicular to the wall (see Figure 19) .

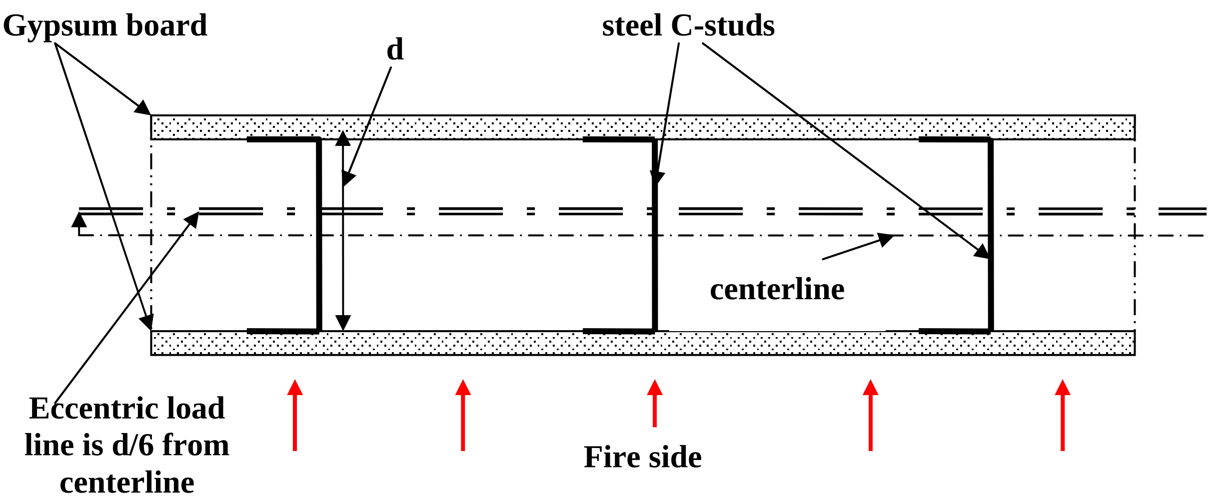



Figure 19. Cross-section of Proposed Wall Assembly, including Eccentric Load Line (away from fireside for steel studs only) – (cavity insulation not shown).

Instrumentation of each wall will consist of:

1. Structural Instrumentation: (see Figure 20)

   a. Deflections – transducer at mid-span of each wall stud for transverse deflection, and at top of studs for axial shortening (2/stud x 6 studs = 12 total)

   b. Strain gauges for steel wall studs – for central and approx. ¼-points of wall - both flanges and center of web, at both stud ends and at mid-span (3 studs x 3 locations x 3/location = 27 total)

   c. Restraint - load cells at top, middle and bottom of wall stud on one end (3 total)

2. Thermocouples for assembly, see Figures 20 and 21, (in addition to furnace control thermocouples) – (78 total)

   a. Wall studs – at both flanges and mid-web, for central and approx. ¼-points of wall, at mid-span and both ends

   b. Gypsum board and cavity insulation (see Figure 21) – for central and approx. ¼-points of wall, at mid-height and both ends, at stud and 12 inches away from these 3 studs, at exterior and interior of exposed and unexposed sides, and at middle of wall cavity insulation

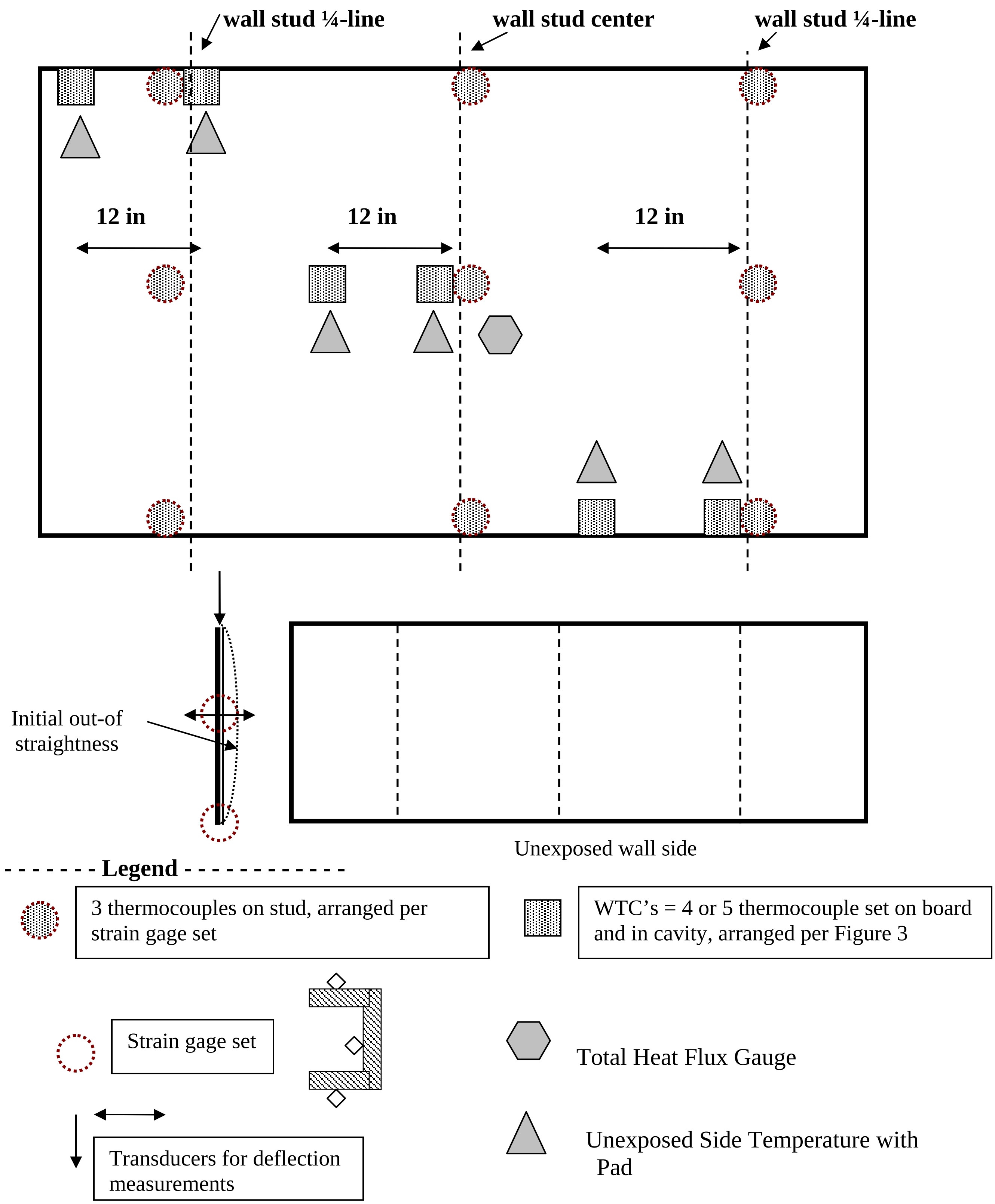



Figure 20. Elevation Layout of Structural and Thermal Instrumentation for Wall Assemblies.

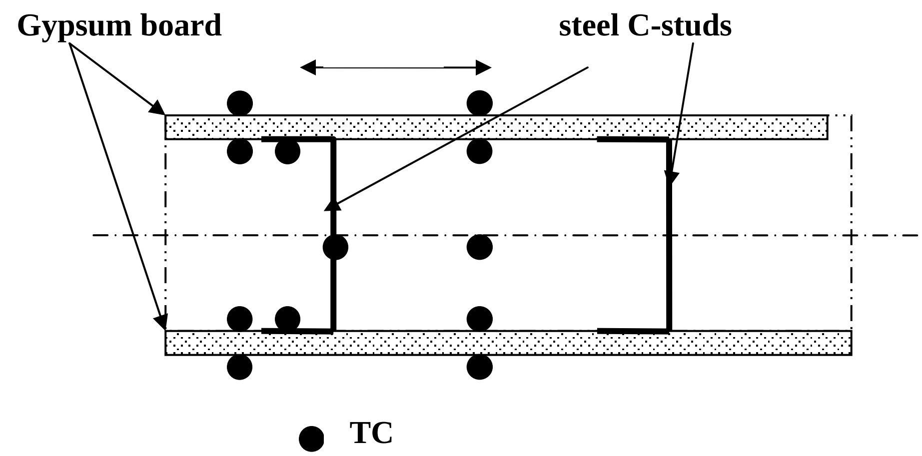



Figure 21. Cross-section for thermocouple (TC) layout – Wall No. 1.

The instrumentation for Wall Assembly No. 2 and No. 3 is similar to that for Wall assembly No. 1 except for additional TCs added between the layers of gypsum wallboard. This is shown in Figure 22.

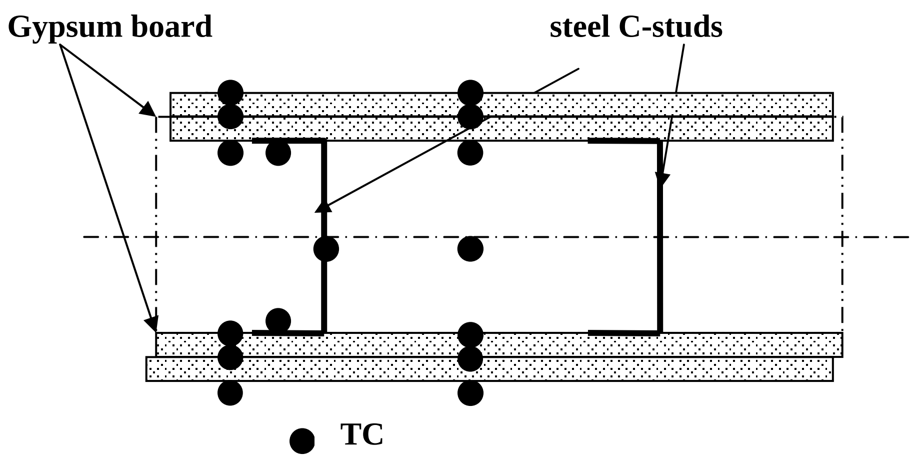



Figure 22. Cross-section for thermocouple (TC) layout – Wall Nos. 2 & 3.

8.1.3 Composite Steel Beam with Concrete Floor

This type of very common floor construction generically consists of either a poured in-place concrete on metal deck supported by protected, steel wide flange beams or joists or a poured in-place reinforced concrete slab supported by protected, steel wide flange beams or joists. Composite action between the concrete and deck and between the concrete and beams (through shear studs) is typically employed for efficiency. Since the reinforced concrete slab composite floor assembly could exhibit different thermal restraining forces and concrete slab response (spalling) than the concrete on metal deck assembly, it was decided to employ both types of floor construction in this test series.

The selection of the floor assembly details (concrete weight and thickness, depth of metal deck, etc.) and minimum spray-applied fire resistive material (SFRM) thickness on the beams will largely depend on its required level of fire resistance. A range of such protected assemblies is available for floor designs. For purposes of establishing the complete description of the test assembly configuration, it was decided to base this prototype on approximately a conventional 2-hr. restrained assembly and 2-hr. unrestrained beam commonly required for this type of floor system, with protection enhancements due to the more severe proposed fire exposure. Therefore, the proposed baseline floor assemblies are as follows:

The first assembly will employ a metal deck and its construction is proposed to be:

1. Poured in place concrete: normal strength, either normal weight (NWC) or lightweight (LWC), with thickness above metal deck of 4 ½ inches (NWC) to 3 ¼ inches (LWC), with 6 x 6, 10 x 10 SWG welded wire fabric

2. Unprotected steel floor deck: 3 inches deep, galvanized composite units of 24-inch width, blend of cellular and fluted, ribs perpendicular to supporting steel beam

3. Rolled steel beam, probably W8 x 28 shape, Grade 50 (ASTM A 992 or equivalent), with shear studs for composite action with concrete

4. SFRM **–** on beam only, minimum 35 pcf density, installed per appropriate UL XR ratings for UL 1709 exposure, contour protection thickness to be determined (about 1 inch)

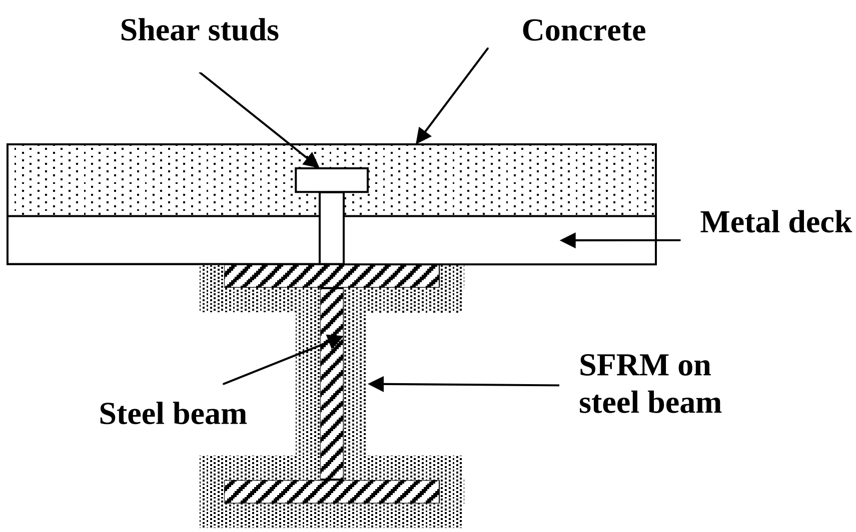



Figure 23. Cross-section of concrete/metal deck & steel beam composite floor assembly.

The second test assembly will not employ a metal deck and its construction is proposed to be:

1. Poured in place concrete slab (unprotected): 5 inch thickness, normal strength, either normal weight (NWC) or lightweight (LWC), with reinforcing steel bars designed per ACI 318 provisions

2. Rolled steel beam, probably W8x28 shape, Grade 50 (ASTM A 992 or equivalent), with shear studs for composite action with concrete

3. SFRM – on beam only, minimum 35 pcf density, installed per appropriate UL XR ratings for UL 1709 exposure, contour protection thickness to be determined (about 1 inch)

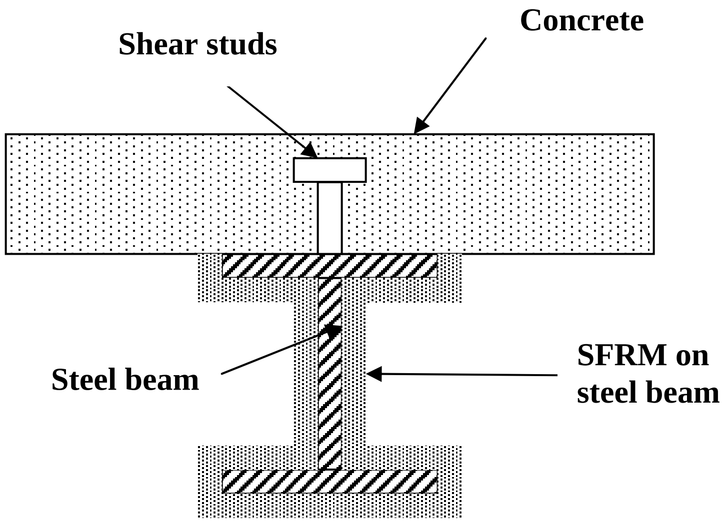



Figure 24. Cross-section of reinforced concrete & steel beam composite floor assembly.

Table 6 provides a summary of the test floor assemblies.

Table 6. Test Matrix – Floor Assemblies

| Test No | Floor Assembly |
|---|---|
| 4A | Concrete floor with metal deck |
| 4B | Concrete floor with metal deck |
| 5A | Reinforced concrete slab |
| 5B | Reinforced concrete slab |

The instrumentation for the concrete/metal deck floor assembly will consist of:

1. Structural Instrumentation: (see Figures 25 and 26)

   a. Deflections – transducer at mid-span of steel beam, at center of each side of metal deck's mid-span (3 total)

b. Strain gauges – (27 total)

   i. Steel beam – middle of top and bottom flanges, and center of web – at both beam ends and at mid-span (9 subtotal)

   ii. Metal deck – at above mid-span deflection locations, bottom and top rib surfaces (6 subtotal)

   iii. Shear studs – bottom of two studs near beam mid-span, bottom of two studs near each quarter-points of beam span (6 subtotal)

   iv. Concrete – top and middle of thickness above deck, at mid-span of beam; at top and middle thickness above deck at deck mid-span locations (6 subtotal)

c. Restraint – load cells at top, middle and bottom of beam on one end (3 subtotal)

2. Thermocouples for assembly (in addition to furnace control thermocouples) (48 total):

   a. Beam – top and bottom flanges, and mid-web at mid-span and at each quarter-points of span

   b. Deck – same as for strain gauge locations

   c. Concrete – same as for strain gauge locations

The instrumentation for the reinforced concrete floor assembly will consist of:

1. Structural Instrumentation: (see Figures 25, 26)

   a. Deflections – transducer at mid-span of steel beam, at center of each side of slab's mid-span (3 total)

   b. Strain gauges – (27 total)

      i. Steel beam – middle of top and bottom flanges, and center of web – at both beam ends and at mid-span (9 subtotal)

      ii. Shear studs – bottom of two studs near beam mid-span, bottom of two studs near each quarter-points of beam span (6 subtotal)

      iii. Concrete – at top, middle and bottom of slab thickness, at mid-span of beam; and at the two slab mid-span locations for deflections (9 subtotal)

      iv. Steel reinforcing bars – over beam mid-span and at center of each side of slab's mid-span (3 subtotal)

v. Restraint – load cells at top, middle and bottom of beam on one end (3 total)

2. Thermocouples for assembly (in addition to furnace control thermocouples) (48 total):

   a. Beam – top and bottom flanges, and mid-web at mid-span and at each quarter-points of span

   b. Concrete slab – same as for strain gauge locations

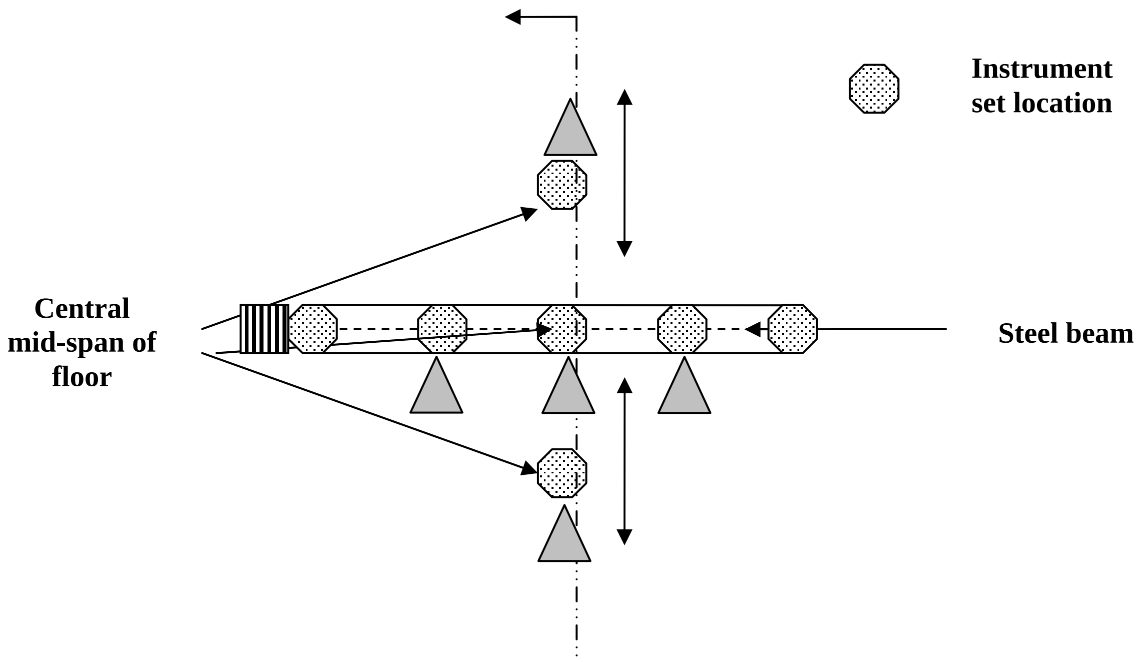



Figure 25. Schematic plan view of instrumentation set locations for deflections, strain gauges and thermocouples of floor assembly.

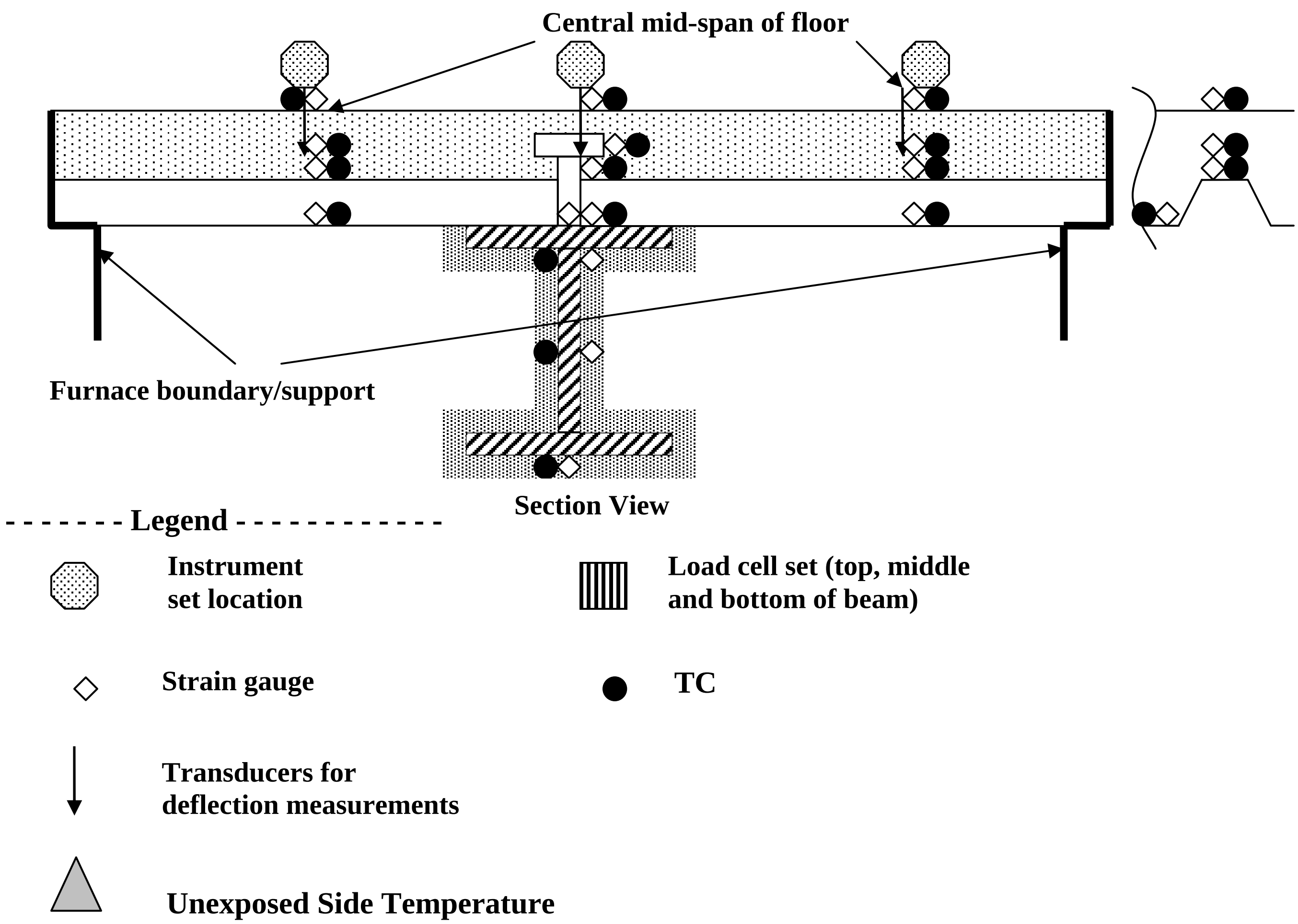



Figure 26. Schematic section view of instrumentation set locations for deflections, strain gauges, and thermocouples of floor assembly.

Cost Estimates

At this point in time, it is not possible to provide a precise cost per test due to many factors such as costs for materials, instrumentation, lab capabilities to meet requirements, etc. However, based on HAI's experience with these types of tests, and assuming, the laboratory has the capability to meet the test requirements, it is estimated that approximate test costs are:

- Furnace calibration tests – 2 @ $20,000 per test
- Wall assembly tests – 6 @ $25,000 per test
- Floor assembly tests – 4 @ $50,000 per test

## 9.0 SUMMARY

Based upon this investigation it is indeed possible for fire resistance testing to provide critical data for use in performance-based structural fire engineering. The needs of PBSFE differ from the prescriptive design approach. This investigation has identified seventeen specific test method recommendations relating to thermal aspects of fire resistance testing, including instrumentation and operation of the furnace. In addition thirteen specific test method recommendations relating to the structural aspects, including structural instrumentation and operation of the furnace. In addition, recommendations for documentation of test procedures and results were provided. A number of general research areas that would serve the development of PBSFE were identified. Collectively, the recommendations and research areas identified provide a way forward to the achievement of PBSFE.

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From: Shyam Sunder <sunder@nist.gov>
To: "'wtc@nist.gov'" <wtc@nist.gov ...snip... michael.newman@nist.gov>
Subject: FW: According to CNN your report said WTC7 fell from burning furniture-

---

Dr. S. Shyam Sunder
Director
Building and Fire Research Laboratory
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Gaithersburg, MD 20899-8600
Tel.: 301-975-5900; Fax: 301-975-4032

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**From:** lldenneysr [mailto:lldenneysr@hotmail.com]
**Sent:** Thursday, August 21, 2008 6:19 PM
**To:** Shyam Sunder
**Subject:** According to CNN your report said WTC7 fell from burning furniture-

Dr Mr. Shyam-Sunder,

Does that mean you found that WTC 7 was designed improperly as the FIRST skyscraper in the world to fall from office furniture? Does this allow the insurance Company to sue the construction Co?

Have you proposed new rules to stop future buildings from falling from burning furniture?

**Does that mean that ALL NY high-rises will now have all office furniture removed or made fireproofed?**

**Can I get a copy of the report and assisting efforts?**

**Lance Denney**
**1020 Linda Vista Way**
**Rio Vista, Ca 94571**

From: "Leo Razdolsky" <lrengineering@comcast.net>
To: <wtc@nist.gov>
Subject: Re:Comments to NIST Report

To whom it may concern:

This is a very comprehensive report, but has many questions not answered or even not discussed. They are as follows:

I. **"We did not find any evidence that explosives were used to bring the building down".**

The Report has a reference to possible use of a solid explosive, but doesn't have the discussion and analysis of any possible air-vapor, air-gas or air-dust explosions ( see for example my paper published at "Metropolis & Beyond" Conference, ASCE & SEI, April 20-24, 2005). The chain of events that could lead to the collapse of the whole building in this case can be described as follows (See Figure 1) :

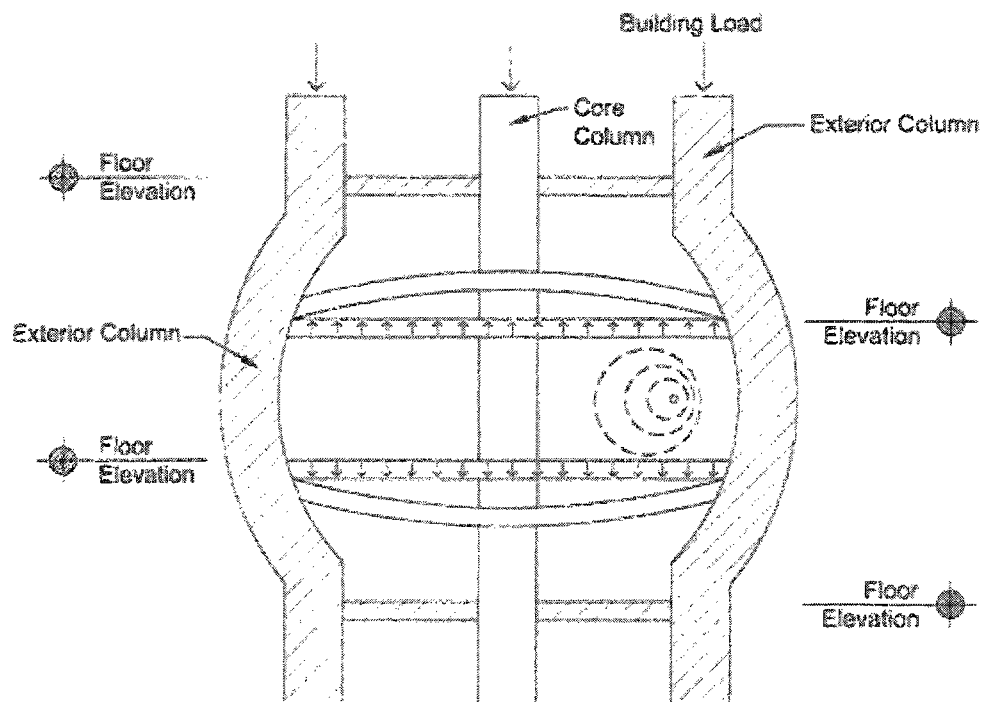


FIGURE 1

If two structural floor systems have failed completely (See Figure 1), than one out of three scenarios may occur:

1. Interior core columns normally have the utilization ratio of 60% before the impact effect from explosion load, and it could be increased after explosion up to approximately 80%. Sudden increase in unbraced length (3 times) for these columns in combination with such high utilization ratio can create total failure and therefore "domino effect."
2. Exterior columns normally have utilization ratio of under20%. However they are experiencing additional lateral load from "local" explosion. Gravity load, lateral load coupled with three times larger unbraced length of the column could create its total failure and therefore a "domino effect."
3. Overall (global) stability of the portion of the building above the compromised structure of the building suddenly became critical in torsional buckling mode.

)bviously this type of explosions does not produce an " incredibly loud sound" and smoke. Our :alculations had shown that the internal pressure can be equal to (max.) 670psf ( WTC1 & 2) and 1100psf (WTC7).

I. Temperature effect and structural design.

The abnormal fire has six major characteristics from structural design loads point of view.

1. The incident flux is very high ( when the fire reaches its peak heat release rate ); therefore the dynamic impact on the structural system should be taken into consideration.
2. The fire could be localized and act on individual structural members, as well as a fully-developed fire, that acts on the major part of the whole structural system. From structural design load point of view it means, that the thermal load is a function of coordinates and time.
3. The duration of such fire could be much longer than prescriptive recommendations given by the standard fire test, and the question is how to extrapolate the " standard " data in this case in order to prevent the progressive collapse of the whole structure.
4. The elevated temperatures can cause the rapid decrease in concrete and steel strength, stiffness of structural elements and the system as a whole, which in turns requires consideration of large deformations with the catenary's action of structural members in case of progressive collapse prevention structural calculations.
5. The existing fire test facilities have some size limitations (3.7X 2.7m), therefore the extrapolation of fire tests results of structural elements (beams, slabs etc. ) on the real-world building elements and systems raises a potential concern.
6. In a high-rise building the incident flux on the structural elements or major portions of the whole structural system is expected to fluctuate with the time causing the dynamic stresses on top of static stresses created by temperature load application. In order to achieve all this goals the general theory of creep deformations has to be employed, since it allows a structural engineer to analyze the structural problem from the very beginning of a fire development to the very end.

The current "Report" doesn't address all of these six major issues. The most important comments here are as follows:

1. The structural design process (connections and structural members) is based on statically load application, but not a combination of both static and dynamic effect, which will reflect the real-life fire development with the time.
2. Time (t) should be used as real variable in structural analysis by using the general theory of creep. Only in this case the structural engineer will be able to answer the main question: how many hours it will take before progressive collapse of the structure will occur.
3. It is equally important to create thermal loading conditions (loading coefficients and loading combinations) similar to wind load, live load etc.

Approximate structural analysis in case of thermal load are very useful in weeding out the less important parameters required for structural design and, on the other hand, they are very helpful in establishing the group of parameters that are critical for structural analysis and design. Normally, the results of any approximate structural analysis are presented in a compact analytical form, that can be used later on in establishing a set of goals or rules, i.e. codes or standards. I had discussed most of these problems in my resent publications. (List of these publications can be provided).

Best Regards,
Leo Razdolsky, Ph.D.,P.E.,S.E.

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From: "lilmag" <popeye5@bestmail.us>
To: wtc@nist.gov
Subject: Dr. Sunder's findings on Bldg #7

Dear nist & Dr. Sunder,
I was thrilled to finally see someone with the courage to debunk the conspiracy theories with such aplomb. But, to be fair, there are a few lingering questions that I would like to ask Dr. Sunder or his team that worked so hard on debunking this myth:
1) can Dr Sunder determine why Mr. Silverstein clearly stated on national TV that he decided to (with the Fire Chief, of course) "pull Building #7"?...and
2) can Dr. Sunder find out who ordered the BBC reporter on national TV to read the statement that building #7 had fallen, when in fact building #7 was clearly visible over her shoulder as she read that report on live TV? In fact, Building #7 continued to stand for another 20-25 minutes after the BBC reporter was told to say it had fallen. This bothers me because no such building in history had fallen like that, and to say it had fallen leaves some doubts.
3) Can Dr. Sunder say how building #7 could have fallen at free fall speed (as did WTC 1 & 2)? Wouldn't each successive floor slow the falling process (unless each supporting beams on every floor below were blown out of the way?) If each lower floor slowed the fall of the building, as it should have in physics, building #7 would have taken a lot longer than 10 seconds to fall...maybe a few minutes, and likely the whole building wouldn't have been totally pulverized and leveled as a demolition would have done and by chance, the way building #7 actually fell?

There might be more questions, but if the good doctor can at least address these three nagging ones, it might help the remaining stubborn conspiracy theorists admit they are wrong. And though these questions may not necessarily all be engineering in nature, I do recall Dr. Sunder stated that he didn't think explosives were used because "there were no reports of sufficient noise characteristic of explosives".

Thank you for any help you can be
Sincerely
--
http://www.fastmail.fm - Faster than the air-speed velocity of an
unladen european swallow

From: Shyam Sunder <sunder@nist.gov>
To: "'wtc@nist.gov'" <wtc@nist.gov>
Subject: FW: letter to the editor

==========================================

Dr. S. Shyam Sunder
Director
Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899-8600
Tel.: 301-975-5900; Fax: 301-975-4032

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**From:** Gail Porter
**Sent:** Tuesday, August 26, 2008 9:40 AM
**To:** Shyam Sunder; Stephen Cauffman; 'therese.mcallister@nist.gov'
**Cc:** 'ben.stein@nist.gov'; 'Michael E. Newman'; Heyman, Matthew; 'ann.jones@nist.gov'
**Subject:** FW: letter to the editor

FYI.

Gail

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**From:** Laura Ost
**Sent:** Tuesday, August 26, 2008 9:34 AM
**To:** 'mnewman@nist.gov'; Benjamin Stein; Gail Porter
**Subject:** letter to the editor

http://www.dailycamera.com/news/2008/aug/26/26elet/

*9/11*

**Fallen towers still unexplained**

Given the task of explaining why a 47-story steel framed structure collapsed symmetrically in seven seconds, the scientists at NIST (Washington, D.C.) blamed a "new phenomenon" that allowed structural steel to fail due to the heat of an ordinary hydrocarbon fire similar to those "...experienced in other tall buildings..."

Although I am not a scientist, I have the ability to read in the English language. And I did read in Appendix C of FEMA's World Trade Center Building Performance Study, that the steel from 7 World Trade Center showed evidence of a "severe high temperature corrosion attack on the steel, including oxidation and sulfidation, with subsequent intergranular melting..." NIST does not explain how a hydrocarbon fire could produce temperatures high enough to cause these reactions. And NIST does not explain how a gravity-induced collapse occurring symmetrically at free-fall speed does not contradict basic Newtonian physics. Coincidentally, two other steel-framed high-rise structures collapsed symmetrically at free-fall speed the same day. But what do I know? I'm not a scientist.

**MARC KRULEWITCH**

*Longmont*

****************************
Laura Ost
NIST Boulder Director of Media Relations
325 Broadway
Boulder, CO 80305
(303) 497-4880 phone
(303) 497-5222 fax
lost@nist.gov

## Stephen Cauffman

**From:** wtc@nist.gov
**Sent:** Tuesday, September 09, 2008 3:02 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Final Report on Collapse of WTC 7
**Attachments:** letter to nist.doc

>X-Sieve: CMU Sieve 2.3
>To: NIST <wtc@nist.gov>
>From: mark phillips <mrppy@fix.net>
>Subject: Final Report on Collapse of WTC 7
>Date: Mon, 8 Sep 2008 09:20:54 -0700
>X-Mailer: Apple Mail (2.753.1)
>X-Proofpoint-Virus-Version: vendor=fsecure
>engine=1.12.7160:2.4.4,1.2.40,4.0.166
>definitions=2008-09-08_10:2008-09-02,2008-09-08,2008-09-08 signatures=0
>X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0
>spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0
>classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000
>definitions=main-0809080113
>X-PP-SpamScore: 0
>X-NIST-MailScanner: Found to be clean
>X-NIST-MailScanner-From: mrppy@fix.net
>X-NIST-MailScanner-Information:
>
>Mr. Stephen Cauffman,
>
>Attached are my questions and comments regarding the presentation by
>Dr. Shyam Sunder regarding NIST NCSTAR 1A, Final Report on the Collapse
>of World Trade Center Building 7.
>
>This letter is also being sent to you via certified mail.
>
>Please advise when and in what form i will receive answers to my
>questions and comments.
>
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>
>
>thank you,
>
>
>mark phillips
>
>
>
>
>
>Content-Type: application/octet-stream;
>	x-mac-type=5738424E;
>	x-unix-mode=0644;
>	x-mac-creator=4D535744;
>	name=letter to nist.doc
>Content-Disposition: attachment;
>	filename="letter to nist.doc"

To: September 8, 2008

WTC Technical Information Repository
Attn: Mr. Stephen Cauffman
National Institute of Standards and Technology
100 Bureau Drive Stop 8611
Gathersburg, Md., 20899-8611

(Via e-mail and certified letter)

Mr. Cauffman,

The following comments and questions refer to the August 26, 2008 technical presentation by Dr. Shyam Sunder and the report, NIST NCSTAR 1A, Final Report on the Collapse of World Trade Center Building 7

1) During the first round of questions of the technical presentation by Dr. Sunder (at 1:01:45 into the presentation) the following question was asked by David Chandler of the American Association of Physics Teachers:

"Any number of competent measurements using a variety of methods indicate the northwest corner of WTC 7 fell with an acceleration within a few percent of the acceleration of gravity. Yet your report contradicts this, claiming 40% slower than the free fall based on a single data point. How can such a public, visible, easily measurable quantity be set aside?"

Dr. Sunder replies:

"Could you repeat the question?"

[*The question is repeated, leaving out the word, "competent" as well as the last sentence*]

"Well…um…the…first of all gravity…um…gravity is the loading function that applies to the structure…um…at…um…applies….to every body…every…uh…on…all bodies on…ah…on…um… this particular…on this planet not just…um…uh…in ground zero…um…the…uh…the analysis shows a difference in time between a free fall time, a free fall time would be an object that has no…uh… structural components below it. And if you look at the analysis of the video it shows that the time it takes for the…17…uh…for the roof line of the video to collapse down the 17 floors that you can actually see in the video below which you can't see anything in the video is about…uh… 3.9 seconds. What the analysis shows…and…uh…the structural analysis shows, the collapse analysis shows that same time that it took for the structural **model** [*emphasis in original*] to come down from the roof line all the way for those 17 floors to disappear is…um… 5.4 seconds. It's…uh…, about one point…uh…five seconds or roughly 40% more time for that free fall to happen. And that is not at all unusual because there was [*emphasis in original*] structural resistance that was provided in this particular case. And you had...you had a sequence of structural failures that had to take place and everything was not instantaneous."

It seems surprising that Dr. Sunder apparently had such difficulty in answering this straightforward question. In the end, this answer by Dr. Sunder is very confusing. Dr. Sunder states that analysis of the video shows that the time it takes for the roof line to collapse 17 floors is 3.9 seconds, which, according to the report, would be equal to that of free fall. But he states that the model collapse time is 5.4 seconds.

However, the report itself contradicts Dr. Sunder's statement. In section 3.6, "Collapse Time" pages 40-41 the report states that analysis of the video shows the time for this same collapse to be 5.4 seconds and that this is 40% longer than 3.9 seconds, the value one would obtain assuming free-fall.

So, which are we to believe? What Dr. Sunder said or what is written in the report?

If the former, then clearly the report is in error and it must be corrected. In addition, a response is required to explain why the model does not agree with observed reality.

If the latter, then an answer to Mr. Chandler's question is still required. NIST should show the public (who paid for the investigation) exactly how the rate of acceleration was measured, and plot the speed vs. time curve of this measurement. This must be done in order to see the instantaneous acceleration, which is of utmost importance, rather than the average acceleration, which may obscure important, even crucial, information. Mr. Chandler has performed this analysis and made it available for anyone to critique (http://www.youtube.com/watch?v=gC44L0-2zL8). In his analysis, he shows that for about 2.5 seconds, the roofline of WTC 7 fell with an acceleration that is indistinguishable from free-fall. Calculating an average acceleration that might include periods of time before and/or after this period of free fall would result in a lower average rate of acceleration and perhaps explains the discrepancy between his results and those reported by NIST. It would seem imperative that NIST show Mr. Chandler's analysis to be in error since any period of constant acceleration equal to free-fall would immediately imply that the thousands of tons of structural steel and concrete below the roofline provided exactly zero resistance. This would clearly be impossible (as Dr. Sunder implies) and would mean the official theory advanced by NIST is incorrect. An acceleration equal to free-fall would be consistent, however, with a controlled demolition.

The calculation of the velocity vs. time graph and derivation of a valid numerical estimate of the instantaneous acceleration throughout the time of fall is so straightforward that it is inconceivable that NIST would settle for two data points and an a priori assumption of uniform acceleration, unless the intention is to cover up what went on in between. Mr. Chandler is correct in asserting that it is the instantaneous acceleration throughout the fall, rather than an average acceleration, that is relevant to the dynamics of the building collapse. If NIST chooses to ignore Mr. Chandler's analysis rather than to challenge its accuracy, the logical conclusion is that NIST is complicit in a cover up, and all the other conclusions of the report become suspect.

2) During the final round of questions at the end of the technical presentation, at least 2 questions were asked regarding the possibility of controlled demolition. Dr. Sunder stated that at the beginning of the investigation a range of possible avenues for investigation were considered and that during this initial screening process, the possibility that controlled demolition might have contributed to the collapse of WTC 7 was dismissed. This dismissal was based entirely on computer modeling without the benefit of gathering any evidence such as metallurgical analysis of the steel or the WTC dust. Dr. Sunder later describes this practice as, "scientific."

When I was taught the scientific method I learned that one must first gather evidence before drawing any conclusions. With respect to the possibility of controlled demolition it seems particularly appalling that NIST would rule this out as a possibility since there are several aspects of the collapse of all three buildings (WTC 1,2 and 7) that are consistent with controlled demolitions. For example, all 3 buildings exhibited sudden onset of collapse. They all fell straight down. All of the collapses were at near free-fall speed. All of the collapses were total. All of the collapses produced pulverized concrete and large dust clouds. Horizontal ejections were observed before and during all of the collapses. All of these characteristics would have been known to NIST by the start of its investigation with little or no effort on the part of NIST.

Given that, it seems appalling that NIST would declare investigation of controlled demolition off limits. What, exactly, is the down side of investigating the steel and dust, for example. Even if you found nothing of interest in such an examination, would it not help to put to rest the numerous questions regarding the possibility of controlled demolition?

3) What is NIST's explanation for the molten steel that was observed during the clean up efforts? The evidence for this molten steel is overwhelming and cannot in good faith be disputed. For example, here is a link to an object called the "meteorite" that was found in the rubble.

http://www.whatreallyhappened.com/IMAGES/wtc_meteorite.wmv

There are also numerous reports of molten steel from the firefighters and others involved in the clean up efforts. For example, it is reported that Leslie Robertson, structural engineer involved in the design of the twin towers, stated, "As of 21 days after the attack, the fires were still burning and molten steel was still running." Also there are at least 3 papers (2 published and one on line) that report iron rich molten spheres in the WTC dust. It is claimed that these could only result from temperatures high enough to melt steel (2800°F), which is beyond the range of the WTC fires.

[1]RJ Lee Group, WTC Dust Signature Report, December 2003

[2]Heather A. Lowers and Gregory P. Meeker, Particle Atlas of World Trade Center Dust
[3]Steven E. Jones (et. al.) Extremely High Temperatures during the World Trade Center Destruction, Journal of 9/11 Studies or at:
http://www.journalof911studies.com/articles/WTCHighTemp2.pdf

4) My last question is related to transparency. Will NIST engage in an open and public discussion with experts from architecture, engineering and physics to answer the questions that are not satisfactorily addressed in your report?

Clearly NIST can continue to ignore the possibility of controlled demolition. But to do so in the face of so much evidence to the contrary will only further erode the public's confidence in NIST. Only your clear and resolute pursuit of the truth, regardless as to where that truth might lead, can stem the ever-increasing tide of cynicism that currently erodes our democracy.

Sincerely,

Mark Phillips B.S.M.E., P.E. (retired)
Atascadero, Ca.

From: "Szebeni, Marton" <mszebeni@seroscience.com>
To: wtc@nist.gov
Subject: comment

Dear Dr. Shyam Sunder!

I would like to comment on your statement with regard to the WTC7 investigation, in which you stated, referring to the alternative hypotheses of controlled demolition that you found some hypotheses so unrealistic that you did not even investigate the possibility of their occurrence.

Could you explain to me, or the public, why the possibility of controlled demolition by high-tech thermite is unrealistic?
Since I and many other people across the world do not see it that way. You need to state scientifically why
you ruled this possibility out.

You also stated repeatedly, that your mission was not to convince skeptics, but to find out what caused the collapse.

If you truly believe this, please act accordingly. Ignoring evidence that does not support you preconceptions is not science,
and by doing this you are not acting according to your stated mission.

For example, you stated that if there had been a controlled demolition a loud boom would have been heard, which was not heard,
therefore there was no controlled demolition.

To me, this little kid's argument is unacceptable.

As far as I know methods exist for destroying steel without having a loud explosion produced. If you also know this
to be true, than why present this little kid's argument? If thermite is not a viable possibility than please, provide evidence that
it was not, or could not have been used.

You also need to address the videos on the internet that do in fact show a loud boom from building 7, and ones that
show firefighters saying the building is coming down, along with other eyewitness testimony and evidence of foreknowledge
that you ignore. Please provide proof that no loud explosion was heard from the building.

As a scientist, you can't make such a statement without providing proof of it.

You also need to release the models and evidence that you used in your report for scrutiny by the public.
If your models are indeed correct, you should not be afraid to make them available for independent analysis.

Until you do actually address the hard questions one by one, you are not credible.

Personally I find you not credible, argument made by scientists in the 9/11 truth movement are to me much more credible.

Kind Regards,

Marton Szebeni

From: "consultnetwork@libero.it" <consultnetwork@libero.it>
To: wtc@nist.gov
Subject: FAQ ...about Jennings

Hi, I'm Massimiliano, from Italy.

I'm interested into your report about WTC7. I've read at your FAQ about.

I would lik to bring your attention at this point:

"An emergency responder caught in the building between the 6th and 8th floors says he heard two loud booms. Isnâ€™t that evidence that there was an explosion?
The sound levels reported by all witnesses do not match the sound level of an explosion that would have been required to cause the collapse of the building.
If the two loud booms were due to explosions that were responsible for the collapse of WTC 7, the emergency responder—located somewhere betweeen the 6th and 8th floors in WTC 7—would not have been able to survive the neaar immediate collapse and provide this witness account."

I think that after the question there's no answer.
I'm sorry in telling you this but I think that a very important Institute like yours, must geeve a correct answer evrytime.
So I ask you if you can better explane the second affermation: "If the two loud booms were due to explosions that were responsible for the collapse of WTC 7, the emergency responder—located somewhere between the 6th and 8tth floors in WTC 7—would not have been able to survive the near immediate collappse and provide this witness account."

It is clear that you're refferred to Jennings words.
But it is also known that Jennings spoked about explosions before the south tower collapse (the first to collapse of the two towers).
So I think that if you had wanted to explain what Jennings heard, it is necessary that you first go to answer to those questions:
- Why Jennings was trapped before south tower collapse? (I've read the story in your report some months ago)
- Whitch provenience had the explosions that Jennings heard before south tower collapse?

I Think that after those correct answer you can better answer to the question you put in your FAQ:

"Isnâ€™t that evidence that there was an explosion?"

I think you can also understand why your answer is a non-answer. I hope that you know about some demolition aborts... And that somebody can be found inside the building whitout to died.

Thank you very much for your attention.

Buon lavoro

From: "Andregg, Michael M." <mmandregg@stthomas.edu>
To: "'wtc@nist.gov'" <wtc@nist.gov>
Subject: Question per your report on WTC #7

**Dear NIST,**

**You have invited comments or questions.**

**My question is: What is the probability that fire alone brought down WTC tower #7?**

**There are many words in your report that make your general position clear but I did not see any numerical estimate per the question above. Perhaps I missed a numerical estimate more suitable to engineers than long-known principles like thermal expansion. Thank you for attention to this question.**

**Michael Andregg**
**University of Minnesota and**
**University of St. Thomas**
**2115 Summit Ave. (JRC-153)**
**St. Paul, MN 55105**

From: Mike Smith <smittynm@hotmail.com>
To: <wtc@nist.gov>
Subject: Comments on the WTC 7 Draft Reports

Mr. Stephen Cauffman,

Thank you for taking time to review this.

**Name:** Michael Smith
**Affiliation:** concerned citizen
**Contact:** smittynm@hotmail.com
**Report Number:** NCSTAR 1A
**Page Number:** 23 (continues on 24)
**Paragraph/Sentence:** paragraph 2/sentences 6-11
**Comment:** The report is describing hypothetical blast scenarios and states, "The sound from such a blast in a urban setting would have been reflected and channeled down streets with minimum attenuation. The sound would have been attenuated behind buildings, but this would have also generated multiple echoes. These echoes could have extended the time over which the sound could have been detected and could possibly have had an additive effect if multiple in-phase reflections met." There is a video with this exact effect recorded on the soundtrack, available at the following link:
http://www.youtube.com/watch?v=0YvrKfWkxdw
While the firefighters are talking on the phone, a very loud blast startles them, and another firefighter comes running up and tells them that they "gotta get back seven is exploding." This gives us an approximate time, place, and amplitude of the sound. Clearly, it is very near to Building 7, it occurs before the collapse of Building 7 but long after the collapse of the 2 towers, and it is a very loud sound. After listening again, I clearly heard multiple echoes that slowly died out, which precisely matches the description of reflection and attenuation given in the report.
The report then states, "However, the soundtracks from videos being recorded at the time of the collapse did not contain any sound as intense as would have accompanied such a blast (NIST NCSTAR 1-9, Chapter 5)." This statement is clearly incorrect, given the clear soundtrack of the above video and the criteria described immediately prior to this statement in the report.
The reports goes on, "Therefore, the Investigation Team concluded that there was no demolition-tyoe blast that would have been intense enough to lead to the collapse of WTC 7 on September 11, 2001." This makes it clear that the only evidence considered for controlled demolition was auditory, and the auditory evidence was false, as seen above, so for the Investigation Team has no ground to make this absurd conclusion. In a report by Richard Gage titled "Undisputed Facts Point to the Controlled Demolition of WTC 7" he covers extensive evidence of controlled demolition, including the molten metal and unusually high temperatures present days or weeks after the collapse, the metallurgical study in Appendix C of the FEMA report, the chemical signature of thermate, and the fact that visually the collapse bore a very close resemblance to a controlled demolition. I read this report from a link on the NIST website, so I know it has been brought to the attention of the organization. The information presented is not easily refutable, so for the Investigation Team to only consider auditory evidence, when so much more was available, is criminally negligent.
The most glaring neglect of all the above points brought forth by Gage is the neglect of the government's own recommendations! Appendix C of the FEMA report titled "Limited Metallurigical Examination" studies two metal samples. The first sample was from WTC 7 and they found "evidence of a severe high temperature corrosion attack on the steel, including oxidation and sulfidation with subsequent intergranular melting" in several areas. The report concludes, "The severe corrosion and subsequent erosion of Samples 1 and 2 are a very unusual event. No clear explanation for the source of the sulfur has been identified ... A detailed study into the mechanisms of this phenomenon is needed..." and this was published in 2002! In all the time it took NIST to make its report, surely the Investigation Team could have investigated this, as it seems to pertain directly to the inability of the steel to hold the building up. As stated in the Preface of this NIST report, on pg. xxv, paragraph 4, sentence 1, one of the specific objectives is to determine "why and how Building 7 collapsed." NIST failed at this objective by purposefully ignoring bountiful evidence, especially the evidence presented by FEMA with a recommendation for further research.
**Reason for Comment:** The sentence which claims that "the soundtracks being recorded at the time of the collapse did not contain any sound as intense as would have accompanied such a blast" is false and needs to be corrected. Using this false statement as conclusive evidence that there were no explosives planted is not a logical step to take, and is a criminally negligent step to take in light of all the other evidence of explosives or

other similar products of controlled demolition (such as thermite). I hope that legal action is brought against NIST for this blatant disregard of evidence. It is 2008 already! By this time NIST should have studied and reported on ALL credible evidence and ALL credible hypotheses of collapse.

Suggestion for Revision:

The sound from such a blast in a urban setting would have been reflected and channeled down streets with minimum attenuation. The sound would have been attenuated behind buildings, but this would have also generated multiple echoes. These echoes could have extended the time over which the sound could have been detected and could possibly have had an additive effect if multiple in-phase reflections met. This exact phenomena was found on the soundtrack of videotape recorded at the time of the collapse, and is backed up by eye witness testimony recorded at the time of the collapse and in later interviews. Therefore, the investigation Team concluded that there was a good probability of a demolition-type blast that would have been intense enough to lead to the collapse of WTC 7 on September 11, 2001. Further research and examination of corroborating evidence, such as the chemical signature of thermite and the presence of a eutectic reaction on the steel, will be necessary in the very near future and will be completed promptly.

Thank you again for taking the time to review this,
Mike Smith

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To: wtc@nist.gov
From: Michael Swanson <miklas@bluebottle.com>
Subject: Four Questions re: "WTC 7 Investigation Report for Public Comment"

To whom it may concern at NIST,

My name is Michael Swanson, I am interested in perhaps getting a clarification of certain items in the recent NIST report on WTC building number seven. According to the report for public comment, in my opinion the most likely cause of the building's collapse--the use of explosives--is dismissed. I would like some clarification on this dismissal. The reasons the report gives for ruling out the use of explosives are as follows:

1. The sound of explosives (MDX?) would have been deafening, and it would have been audible on the video footage of the collapse though it wasn't

2. The preparation for planting explosives would have been improbable in order to plant explosives on most or all of the buildings support columns

3. Thermite or thermate was not used because 100 lbs of thermite would have had to be used to melt just one foot of steel and it is "unlikely" that thermite was carried into the WTC and applied without detection

4. Ananysis of WTC debris for thermate signatures would not have been conclusive because the metallic compounds would have been present in construction materials making up the WTC.

My questions are:

A. When the sound of explosives are cited to point to the improbability of explosives used, does this sound hypothesis include thermite/thermate, or is it the sound of MDX only?

B. I was wondering what thermite/thermate compounds (such as Thermate-TH3 etc.) NIST looked at to set this figure of the proper application of 100 lbs of thermite per foot of steel. Are there expert interviews I could get a copy of, or experimental results or references with regard to thermite/thermate compounds that could be released to the public?

C. What data was looked at to justify the assumption that it was unlikely that thermate would have been applied without detection? Specifically, what data did NIST look at to determine the preparation work needed to apply these different thermate compounds to columns and steel inside the building such as cutting with torches? Again, if there's a transcript of the expert testimony or section of the full report with experimental results I would like to see it if possible.

D. Finally, in regard to reason #4 against the use of explosives-- the NIST WTC7 Report Q and A states "Analysis of the WTC steel for the elements in thermite/thermate would not necessarily have been conclusive. The metal compounds also would have been present in the construction materials making up the WTC buildings..." Did NIST look at any metal or debris from WTC7 in order to check for telltale signs of a probable thermite/thermate reaction such as "Iron spherules" found in other scientific studies about the collapse of the WTC towers, or did the NIST study simply assume that byproducts of a possible thermite/thermate reaction were

irrevelant because the chemical elements that compose these byproducts are present in the building in some form or another? Am I right in assuming that since the Q and A states that analysis for thermate signatures "would not have been conclusive" that the full NIST report did not look for any evidence of byproducts in debris of a thermite/the!
rmate reaction?

I appreciate your consideration, and if I could receive the relevant sections from the full report, or even (if pressed for time) the whole thing in its entirety I would be very grateful.

Sincerely,

Michael Swanson
2219 N. Camino Emiliano
Tucson AZ 85745

Subject: Question for Technical Briefing
From: "mike@baltimoregrassrootsmedia.org" <mike@baltimoregrassrootsmedia.org>
To: <wtc@nist.gov>

Revisiting David Chandler's question about the time of decent of the visible part of the NW corner. Why, again, does it fall so much faster in the videos than in your model?

Mike Shea
Baltimore Grassrrots Media

>X-Sieve: CMU Sieve 2.3
>From: "Abboud, Najib" <abboud@wai.com>
>To: "'wtc@nist.gov'" <wtc@nist.gov>
>Date: Mon, 15 Sep 2008 11:42:57 -0400
>Subject: Comments on Draft NCSTAR 1A and 1-9
>Thread-Topic: Comments on Draft NCSTAR 1A and 1-9
>Thread-Index: AckXSbmTrNF+GqL1QQKgCAbvKNNHyA==
>Accept-Language: en-US
>X-MS-Has-Attach: yes
>X-MS-TNEF-Correlator:
>acceptlanguage: en-US
>X-Proofpoint-Virus-Version: vendor=fsecure
>engine=1.12.7160:2.4.4,1.2.40,4.0.166
>definitions=2008-09-15_11:2008-09-02,2008-09-15,2008-09-15 signatures=0
>X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1
>score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0
>classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000
>definitions=main-0809150096
>X-PP-SpamScore: 0
>X-NIST-MailScanner: Found to be clean
>X-NIST-MailScanner-From: abboud@wai.com
>X-NIST-MailScanner-Information:
>
>Sept 15, 2008
>
>WTC Technical Information Repository
>Attention: Mr. Stephen Cauffman
>National Institute of Standards and Technology
>Stop 8610
>Gaithersburg, MD 20899-8610
>
>Stephen:
>Please find attached my comments concerning the draft reports. I
>hope they are of some help.
>Best Regards
>Najib
>
>Najib N. Abboud, Ph.D.
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>375 Hudson Street
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>

## Comments on Draft NCSTAR 1A and NCSTAR 1-9 Submitted by

**Name:** Najib N. Abboud

**Affiliation:** Weidlinger Associates Inc.

**Contact:** abboud@wai.com

## EXTENT OF DEBRIS DAMAGE

**Comment:** The debris damage was more severe and widespread than indicated in several locations of the report. Based on NIST's assessment in NCSTAR 1-9 Fig. 5-83 (and related text) and NCSTAR 1A Fig. 2-1, the structural damage caused by debris impact includes seven bays over twelve floors in the southwest perimeter of WTC7, floors 44 to 47 over 2 bays in the south face, an 18 floor high gouge over 1 bay with possible structural damage, and possibly other damage in the unobservable areas encompassing nearly half the south face. The eyewitness account documented in NCSTAR 1-9, p. 301 (5th bullet) suggests that the 18 floor high gouge probably resulted in column impairment of columns 19 or 20.

**Reason for Comment:** Completeness

| Report # | Page # | Para./Sent. | Original Text | Suggestion for Revision |
|---|---|---|---|---|
| 1A | xxxi | last par. / 2nd sent. | "The debris also caused some structural damage to the southwest perimeter of WTC 7." | *Change to:* "The debris also caused structural damage to the southwest perimeter of WTC 7 over twelve floors and seven bays, between floor 44 and the roof over two bays near the center on the south face, possibly along the 18 floor gouge in the center of the south face, and possibly in other, unobservable areas on the south face." |
| 1A | xxxiii | 3rd full par. /2nd sent. | "The building withstood debris impact damage that resulted in seven exterior columns being severed …" | *Change to:* "The building withstood debris impact damage that resulted in at least seven exterior columns being severed plus substantial other structural damage … |
| 1A | 14 | 5th par. /3rd sent. | "Pieces of WTC 1 hit WTC 7, severing six columns on Floors 7 through 17 on the south face and one column on the west face near the southwest corner. " | *Add after 3rd sent:* "The debris from WTC 1 also caused structural damage between floor 44 and roof over two bays near the center on the south face, possibly along the 18 floor gouge in the center of the south face, and possibly in other, unobservable areas on the south face." |
| 1A | 19 | 4th par. / 1st sent. | "The collapse of WTC 1 damaged seven exterior columns on the lower floors of the south and west faces of WTC 7 and initiated fires on 10 floors between Floors 7 and 30." | *Change to:* "The collapse of WTC 1 damaged seven exterior columns on the lower floors of the south and west faces of WTC 7, plus substantial other structural damage, and initiated fires on 10 floors between Floors 7 and 30." |
| 1A and 1-9 | 1A (p43) and 1-9 (p. 609) | objective 1 /bullet 1 | "WTC 7 withstood debris impact damage that resulted in seven exterior columns being severed and subsequently withstood …" | *Change to:* "WTC 7 withstood debris impact damage that resulted in seven exterior columns being severed over twelve stories at the southwest perimeter, one column over four stories near the roof on the south face, possibly along the 18 floor gouge in the center of the south face, and possibly other columns in the unobservable areas on the south face. The building subsequently withstood …" |
| 1A and 1-9 | 1A (p46) and 1-9 (p612) | section 4.3.1 and 14.3.1/ bullet 2 | "The structural damage to WTC 7 was primarily located at the southwest corner and adjacent areas of the west and south faces, on Floors 5 through 17. Severed columns were located between Floors 7 and 17 on the south face (six columns) and the west face (one column) near the southwest corner." | *Add after 2nd sent:* "The debris from WTC 1 also caused structural damage between floor 44 and roof over two bays near the center on the south face, possibly along the 18 floor gouge in the center of the south face, and possibly in other, unobservable areas on the south face." |
| 1-9 | 601 | 1st par. /3rd sent. | "The collapse of WTC 1 damaged seven exterior columns on the lower floors of the south and west faces and initiated fires at five separate locations between Floors 7 and 30." | *Change to:* "The collapse of WTC 1 damaged seven exterior columns on the lower floors of the south and west faces of WTC 7, plus substantial other structural damage, and initiated fires on 10 floors between Floors 7 and 30." |
| 1-9 | 602 | 2nd par. /2nd sent. | "The collapse of WTC 1 caused (1) structural damage that severed seven (out of 58) exterior columns on the lower floors of WTC 7;" | *Change to:* "The collapse of WTC 1 caused (1) structural damage that severed seven (out of 58) exterior columns on the lower floors of WTC 7, plus substantial other structural damage shown in Fig 5-83;" |

## DEGREE OF CERTAINTY REGARDING EXTENT OF DAMAGE TO THE SFRM

**Comment:** There is no direct evidence for the condition of the SFRM in WTC 7 after the collapse of WTC 1.

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|---|---|
| **Reason for Comment:** | Clarification |

| **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
|---|---|---|---|---|
| 1A and 1-9 | 1A (p44) and 1-9 (p610) | 3rd full par./bullet 7 of objective 1 | "Prior to its collapse, there had been no damage to the SFRM that was applied to the steel columns, girders, and beams, except in the vicinity of the structural damage from the collapse of WTC 1, which was near the west side of the south face of the building." | *Replace with:* "Based on the observed damage to the SFRM in Bankers Trust building, it was assumed that WTC 7, prior to its collapse, did not sustain damage to its SFRM applied to the steel columns, girders, and beams, except in the vicinity of the structural damage from the collapse of WTC 1." |

## PROGRESSIVE COLLAPSE PROVISIONS

| | |
|---|---|
| **Comment:** | Application of current progressive collapse provisions (e.g., GSA) to WTC 7 would not have prevented the collapse. The GSA progressive collapse provisions apply to exterior columns only, and the perimeter frame of WTC-7 clearly demonstrated its ability to resist substantial damage, much beyond what is contemplated by current progressive collapse provisions known to the industry. The report could be read to suggest that had current progressive collapse provisions been applied, the collapse would have been averted, and this is clearly not the case. |
| **Reason for Comment:** | Completeness |

| **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
|---|---|---|---|---|
| 1A | xxxii | 1st full par. /after last sentence | | *Add a sentence after last sentence:* "It should be noted that application of current progressive collapse provisions, such as GSA provisions, would not have prevented this collapse." |
| 1A and 1-9 | 1A (p 44) and 1-9 (p 612) | Objective 1 / 5th bullet | | *Add paragraph from NCSTAR 1-1 (Sept 2005): "* Building codes lack explicit structural integrity provisions to mitigate progressive collapse. Federal agencies have developed guidelines to mitigate progressive collapse and routinely incorporate such requirements in the construction of new federal buildings." *Continue paragraph by adding:* "One such agency is the GSA. It should also be noted that WTC-7 would have been found in compliance with current GSA progressive collapse provisions since these apply to exterior columns. The ability of WTC 7 to sustain column loss in the exterior frame without progressive collapse was amply demonstrated on 9/11." |

## COLLAPSE SEQUENCE

| | |
|---|---|
| **Comment:** | The LS-DYNA analysis indicates that the horizontal progression of collapse occurs through a damage propagation through the upper floors and is not attributable to the “strong” floors between 5 & 7. NIST’s preliminary results up to the technical presentation on Dec 18, 2007 (WTC 7 Working Collapse Hypothesis) could be misconstrued to mean that that absent such “strong” floors, the collapse might have remained confined to the bays adjoining columns 79-81. |
| **Reason for Comment:** | Accuracy and Completeness |

| **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
|---|---|---|---|---|
| 1A | 39 and 44 | 39 (1st par.) and 44 (top of page) | | *Add:* "The collapse analysis established that the "strong" floors (floors 5 and 7) are not the cause of the horizontal propagation of failure." |

| | |
|---|---|
| **Comment:** | The LS-DYNA analysis in Section 3.4.6 which incorporated the debris impact damage to the south face is more consistent with the observed collapse. That statement should be reflected in the global collapse summary on p 51. |
| **Reason for Comment:** | Accuracy and Completeness |

| **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
|---|---|---|---|---|
| 1A | 51 | 1st par/2nd sent. | "The overall features and timing of the prediction were consistent with the videographic evidence." | *Replace with:* "The overall features and timing of the prediction were more consistent with the videographic evidence when the debris impact damage is taken into account in the computer analysis." |

| EXTENT OF FIRE INDUCED DAMAGE | | | | |
|---|---|---|---|---|
| **Comment:** | Extensive thermal weakening and failure of connections and floor beams was not limited to the floor framing surrounding column 79. The NIST analyses also show extensive thermal weakening and failure of connections and floor beams occurring in areas surrounding columns 80 and 81, where similar conditions exist (i.e. asymmetric framing and similar span lengths), and other columns in the core perimeter, where similar conditions do not exist. See Figures 11.31 through 11.37 in NCSTAR 1-9 Volume 2. | | | |
| **Reason for Comment:** | Completeness | | | |
| **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| 1A and 1-9 | 1A (p44) and 1-9 (p610) | 1st full par./bullet 5 of objective 1/sent. 3 & 4 | "Despite extensive thermal weakening of connections and buckled floor beams, fire-induced damage in the floor framing surrounding Column 79 over nine stories was the determining factor causing the buckling of Column 79 and, thereby, initiating progressive collapse." | *Add a sentence before the last sentence in the paragraph:* "Fire-induced damage to floor framing and connections around Columns 80 and 81 over nine stories contributed to the collapse of the building." |
| **SFRM THICKNESS AND BUILDING FIRE RATING** | | | | |
| **Comment:** | WTC 7 was compliant with the NYCBC in all respects, including with respect to fire rating. The average measured SFRM thickness for the floor beams was 0.534 inches, which is larger than 0.5 inches required for 2 hour fire rating. The average measured thickness for the floor metal deck was 0.416 inches, which is larger than 3/8 inches required for 2 hour fire rating. These numbers indicate that the building met the fire resistance requirements of Type 1B (unsprinklered) construction. Code compliance of the SFRM is demonstrated in NCSTAR 1A page 7. | | | |
| **Reason for Comment:** | Correction of some inconsistencies in the text | | | |
| **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| 1A | xxxiii | 1st full par./1st and 2nd sent. | "The design of WTC 7 was generally consistent with the New York City Building Code of 1968 (NYCBC), with which, by policy, it was to comply. The installed thickness of the thermal insulation on the floor beams was below that required for unsprinklered or sprinklered buildings, but it is unlikely that the collapse of WTC 7 could have been prevented even if the thickness had been consistent with building code requirements." | *Change to:* "The design of WTC 7 was consistent with the New York City Building Code of 1968 (NYCBC), with which, by policy, it was to comply. " |
| 1A | 53 | 2nd bullet | "The type of building classification used to design and construct the building was not clear from the available documents. Based on the height, area, primary occupancy classification, and installation of a fire sprinkler and standpipe system, the minimum construction type (permitted by NYCBC) was type I-C (2 h protected) classification. However, some documentation, including some building drawings and specifications for bidders on the contract for applying SFRM to the structural steel, indicate a type I-B (3 h protected) classification." | *Delete first sentence and Change next two sentences to:* "Based on the height, area, primary occupancy classification, and installation of a fire sprinkler and standpipe system, the minimum construction type (permitted by NYCBC) was type I-C (2 h protected) classification. The fire resistance was designed to type I-B (3 h protected) classification." |
| 1-9 | 11 | par. 5/sent. 3 | "Chapter 11 in NIST NCSTAR 1-1D gives a summary of fire protection measures used in WTC 7, which were consistent with a Type 1-C classification." | *Change to:* "Chapter 11 in NIST NCSTAR 1-1D gives a summary of fire protection measures for Type 1-C classification, which is the NYCBC classification for a sprinklered building. However, the fire protection measures used in WTC 7 were consistent with a Type 1-B classification." |
| 1-9 | 11 | par. 6/sent. 2 | "The SFRM thickness measurements were consistent with a Type 1-B classification, with the exception of the floor system." | *Change to:* "The SFRM thickness measurements were consistent with a Type 1-B classification." |

| | | | | |
|---|---|---|---|---|
| 1-9 | 12 | 1st full par./1st and 3rd sent. | "Based on the SFRM measurements and project correspondence, the columns had SFRM thicknesses consistent with a 3 h fire resistance rating, the metal deck had SFRM thicknesses consistent with a 2 h fire resistance rating, and the floor framing (beams and girders) had SFRM thicknesses consistent with a 1 h fire resistance rating. ... In this report, Type 1-C classification was assumed, but the actual classification may have been type 1-B." | *Change to:* "Based on the SFRM measurements and project correspondence, the columns had SFRM thicknesses consistent with a 3 h fire resistance rating, the metal deck and the floor framing (beams and girders) had SFRM thicknesses consistent with a 2 h fire resistance rating. Although in this report, Type 1-C classification was assumed, NIST has since determined that the actual classification was Type 1-B." |
| 1-9 | 81 | section 4.7.2/bullet 2/sent. 2 | "The bottom of the slab was insulated with 3/8 in. thick Monokote MK-5 to achieve a 1 h fire resistance rating." | *Change to:* "The bottom of the slab was insulated with 3/8 in. thick Monokote MK-5 to achieve a 2 h fire resistance rating." |
| 1-9 | 85 | Sect. 4.7.3 /bullet 3 | "... (insulated for a 1 h rating), ..." | *Change to:* "... (insulated for a 2 h rating), ... " |

**BUILDING CODE COMPLIANCE**

| | |
|---|---|
| **Comment:** | WTC 7 was building code compliant. The word “generally” suggests that there are some design issues not consistent with the NYCBC. The two raised issues in the report are the SFRM thickness and the stairwell size; as explained elsewhere in these comments, both met code. |
| **Reason for Comment:** | Clarification |

| **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
|---|---|---|---|---|
| 1A | xxxiii | 1st full par. /first sent. | "The design of WTC 7 was generally consistent with …" | *Delete:* "generally" |
| 1A | xxxiii | 1st full par. /last sent. | "The stairwells were narrower than those required by the NYCBC, but, combined with the elevators, were adequate for a timely evacuation on September 11, 2001, since the number of building occupants was only about half that expected during normal business hours." | *Delete sentence.* |
| 1A | 13 | last sent. | "The stairwells, although somewhat narrow for the maximum possible 14,000 occupants (estimated using the formula in the NYCBC), were more than adequate to evacuate roughly one-third of that number in the building that morning." | *Change to:* "The stairwells were code compliant and more than adequate to evacuate all the tenants in the building on that day." |
| 1A and 1-9 | 1 A (p45) and 1-9 (p 611) | objective 3/bullet 1 | "The design of WTC 7 was generally consistent with the NYCBC." | *Delete:* "generally" |
| 1A and 1-9 | 1A (p 51) and 1-9 (p617) | section 4.4.1 and 14.4.1, 4th bullet | "... if the building were occupied at the calculated maximum level (~ 14,000 people). " | *Change to:* "... if the building were occupied at the calculated maximum level (~ 12,000 people). " |
| 1A and 1-9 | 1A (p 53) and 1-9 (p619) | section 4.5.2 and 14.5.2/ bullet 1 | "NIST found no evidence to suggest that WTC 7 was not designed in a manner generally consistent with applicable building codes and standards." | *Delete:* "generally" |
| 1-9 | 309 | 1st par./last sent. | "… 34,800 $ft^2$, or 3,200 $m^2$ (41,600 gross $ft^2$ less 6,800 $ft^2$ of core space)." | *Change to:* "… 30,000 $ft^2$, or 2,787 $m^2$ (41,600 gross $ft^2$ less 11,600 $ft^2$ of core space/non-occupied space)." |
| 1-9 | 309 | 2nd par./1st sent. | "… maximum occupant floor load of 348 persons … " | *Change to:* "… maximum occupant floor load of 300 persons …" |
| 1-9 | 309 | 1st Bullet | "Sufficient capacity for 348 persons would have required six units of exit width, or<br>3.35 m (132 in.)." | *Change to* : "Sufficient capacity for 300 persons would have required five units of exit width, or 2.79 m (110 in.)." |

| | | | | |
|---|---|---|---|---|
| 1-9 | 309 | 2nd Bullet | "Two equally sized stairwells meeting the design requirements of the NYCBC would have been at least 1.68 m (66 in.) wide each. Three stairwells, each 44 in. wide, would also have provided the minimum egress capacity for business occupancy floors." | *Change to* : "Two equally sized stairwells meeting the design requirements of the NYCBC would have been at least 1.40 m (55 in.) wide each."   *Delete 2nd sent.* |
| 1-9 | 309 | 4th par. | "... was not consistent with the NYCBC." | *Delete* "not" |
| 1-9 | 315 | Section 7.5.2, 3rd bullet | "... 348 persons per floor. Assuming approximately 40 occupied floors (ignoring mechanical floors and lobbies), this would yield a rough occupant load of approximately 14,000 persons." | *Change to:* "... 300 persons per floor. Assuming approximately 40 occupied floors (ignoring mechanical floors and lobbies), this would yield a rough occupant load of approximately 12,000 persons." |
| **FUTURE FACTORS THAT COULD HAVE MITIGATED STRUCTURAL COLLAPSE** | | | | |
| **Comment:** | The introductory sentence incorrectly suggests that there were contemporaneous capabilities in the 1980's that could have altered the outcome . | | | |
| **Reason for Comment:** | Clarification | | | |
| **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| 1A and 1-9 | 1A (p 55) and 1-9 (p 621) | section 4.6 and 14.6, 1st par. | | *Strike out first sentence.* |
| **Comment:** | Current and contemporaneous practice did not consider thermal expansion effects as a design load case. | | | |
| **Reason for Comment:** | Clarification | | | |
| **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| 1A and 1-9 | 1A (p 55) and 1-9 (p 621) | Sections 4.6 and 14.6/1st bullet | "More robust connections and framing systems to better resist the effects of thermal expansion on the structural system." | *Change to: "* Connections and framing systems expressly designed to resist the effects of thermal expansion on the structural system, a load currently not considered in practice." |
| | | | | |
| **RECOMMENDATIONS** | | | | |
| **Comment:** | In some places (e.g., Relevance to WTC 7), the text could be read to suggest: (1) the recommendations are particularly relevant to WTC 7, as opposed to all or most tall buildings designed according to current or contemporaneous standards, (2) what is actually a NIST proposed future standard is a current standard or one contemporaneous with the design of WTC 7, and (3) that the adoption of these proposed standards "would have" instead of "might have" averted the collapse. Given that the NIST report in Section 4.6 recognizes that future technologies show promise but have yet to be investigated, the language of the Recommendations should reflect the fact that some of these require further studies. For example, the adoption of performance-based design requires the specification of a "design basis fire". The possibility of a collapse can only be eliminated as long as an actual fire does not substantially exceed in extent or depart in character from the "design basis fire". | | | |
| **Reason for Comment:** | Context | | | |
| **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| 1A | 58 (For example) | For example, Recomm. A, Relevance to WTC 7 | "Had WTC 7 been expressly designed for prevention of fire-induced progressive collapse, it would have been sufficiently robust to withstand local failure due to fires without suffering total collapse." | *Change to:* "Had contemporaneous practice and standard been to expressly design buildings for prevention of fire-induced progressive collapse, WTC 7 might have been sufficiently robust to withstand local failure due to fires without suffering total collapse." |
| **Comment:** | Statement "which collapsed due to ordinary building fires " is inconsistent with the rest of the NIST report. | | | |
| **Reason for Comment:** | Consistency and Accuracy | | | |
| 1A | 64 | last par. under 5.1.5 | "...which collapsed due to ordinary building fires..." | *Delete* |

| CONSISTENCY OF TEXT AND FIGURES IN CHAPTER 11 | | | | |
|---|---|---|---|---|
| **Comment:** | Figures 11-23 to 11-29, 11-31 to 11-37, and 11-39 to 11-45 show the seated connections to have "no damage" in the vertical direction, indicating that these connections did not unseat. The occurrence of girder seat walk-off described in the text is not consistent with the figures. | | | |
| **Reason for Comment:** | Consistency | | | |
| **Report #** | **Page #** | **Para./Sent.** | | |
| 1-9 | Chapter 11 | | See examples below: | |
| | | (Vol1-9 p503) "the girder… failed due to buckling, followed by walk off of the of the bearing seat (floors 12 and 13)" conflicts with figure 11-35 and 11-36 | | |
| | | (Vol1-9 p504) "the girders between columns 79 and 44 and Columns 26 and 81 had walked off the bearing seat at Column 79 and 81, respectively" conflicts with figure 11-36 | | |
| | | (Vol1-9 p523) "... girder between… 26 and… 81, which had buckled and walked off the bearing seat" conflicts with figure 11-29 | | |
| | | (Vol1-9 p524) "... had walked off the bearing seat.." (col 79 at 13th flr and col 81 at 12th flr) conflicts with figure 11-36 | | |
| | | (Vol1-9 p525) "... girder between column 26 and 81 buckled and walked off the bearing seat..." conflicts with figure 11-29 | | |
| | | (Vol1-9 p525) "... (2) walk off of seated connections…" conflicts with associated figures | | |
| | | (Vol1-9 p525) "Loss of vertical support occurred when the beam or girder 'walked off' the bearing seat…" conflicts with associated figures | | |
| | | (Vol1-9 p534) "At temperature less than approximately 400 deg C… girder walk off of seated connections… at Columns 79 and 81." conflicts with associated figures and 3.5 hr temperatures around column 81 appear to be higher than 400deg C in Figure 11-47. | | |

| UNCERTAINTY IN COLLAPSE INITIATION | | | | |
|---|---|---|---|---|
| **Comment:** | Uncertainties in the analyses affect the accuracy with which the collapse initiation sequence can be determined. As such, assertions that column 79 buckled first should be revised to reflect this degree of uncertainty by recognizing that the initiating event could have involved one or more of columns 79, 80 and/or 81. Prominent sources of uncertainty include the following:<br>• The discrepancy in timing between the observed fires over approximately 6 floors and when their analytical representations in FDS occur in the Northeast corner suggests uncertainty in the ability to reliably establish the precise sequence of events leading up to the collapse of the building.<br>• The ANSYS model does not account for collapse initiation in its failure estimates and the sequence of floor failures is not represented in the analyses.<br>• Figure 11-49 shows the floor damage is widespread around columns 79, 80, and 81 and all three columns appear to have a substantial loss of lateral restraint over multiple floors prior to the collapse execution phase of the analysis.<br>• Discrepancy in time scales between the 1.3 second duration of the buckling sequence shown in figure 12-43 and the 4 hour period of the aggregated damage used to initiate the global collapse model suggests that the buckling sequence could be influenced by modeling approach.<br>• The global collapse analysis inherits all of the uncertainties inherent in the previous FDS, and ANSYS analyses as well as those associated with the global collapse analyses and the modeling assumptions that go with each of these. | | | |
| **Reason for Comment:** | Accuracy and Completeness | | | |
| **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| 1A | 19, 20, 43, 44, 47, 49, 50 and 82 | | | *Assertions that column 79 buckled first in actual fact (as opposed to what is shown in this specific analysis) should be revised to reflect the degree of uncertainty in the analyses by including the initiating event could have been one or more of columns 79, 80 and/or 81.* |
| 1-9 | 596-597, 601, 606, 609, 615-616 | | | |
| 1A | 43 | For example, last par. | "The probable collapse sequence that caused the global collapse of WTC 7 was initiated by the buckling of Column 79, which was unsupported over nine stories after local fire-induced damage led to a cascade of floor failures. The buckling of Column 79 led to a vertical progression of floor failures up to the east penthouse and to the buckling of columns 80 and 81" | *Change to:* "The probable collapse sequence that caused the global collapse of WTC 7 was initiated by the buckling of at least one of the Columns 79, 80 and/or 81, which was unsupported over multiple stories after widespread fire-induced damage led to a cascade of floor failures. The buckling of these columns led to a vertical progression of floor failures up to the east penthouse." |

| INITIAL LOCAL FAILURE FOR COLLAPSE INITIATION | | | | |
|---|---|---|---|---|
| **Comment:** | Referring to figures 11-23 through 11-29, for example, the analyses show that numerous different failures occur between 3.5 hour and 4.0 hour scenarios over a widespread area. | | | |
| **Reason for Comment:** | Accuracy and Completeness | | | |
| **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| 1A | 19-20 | bottom of 19, top of 20 | "Fire induced thermal expansion of the floor system surrounding Column 79 led to the collapse of Floor 13, which triggered a cascade of floor failures. In this case, the floor beams on the east side of the building expanded enough that they pushed the girder connection Columns 9 and 44 to the west on the 13th floor... this movement was enough for the girder to lose its connection to Column 79. the displaced girder and other local fire-induced damage caused Floor 13 to collapse..." | *Change to:* "NIST's analysis shows that widespread fire-induced damage to the 13th floor framing system in areas around columns 79, 80 and 81 led to the collapse of a large area of the 13th floor onto other floors below which were already weekend by other fires. The collapse of multiple floors left columns 79, 80, and 81 laterally unrestrained to a degree sufficient to leave them unstable, triggering a cascade of failure leading to the ultimate collapse of the building." |
| 1-9 | 603 | Section 11 | "Further thermal expansion of the floor beams pushed the girder off its seat, which led to the failure of the floor system surrounding Column 79 on Floor 13" | *Change to:* "NIST's analysis shows widespread fire-induced damage to the 13th floor framing system in areas around columns 79, 80 and 81 led to the collapse of a large area of the 13th floor onto other floors below which were already weekend by other fires. The collapse of multiple floors left columns 79, 80, and 81 laterally unrestrained to a degree sufficient to leave them unstable, triggering a cascade of failure leading to the ultimate collapse of the building." |

| INITIATING FAILURE TEMPERATURE | | | | |
|---|---|---|---|---|
| **Comment:** | Assertions in the report that the collapse sequence occurs at temperatures below 400 degrees C do not appear to be supported by the analysis and tend to oversimplify the complex fire environment and misrepresent the behavior of the building. | | | |
| **Reason for Comment:** | Accuracy and Completeness | | | |
| **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
| 1A | 19 | 6th par./2nd sent. | "This buckling arose from a process that occurred at temperatures at or below approximately 400°C (750 °F)..." | *Change:* "occurred" *to* "began to manifest in localized damage" |
| 1A | 32 | 5th par. | "… connections, floor beams, and girders were damaged or had failed at steel temperatures that were approximately 400° C…" | *Change to:* "… connections, floor beams, and girders were damaged or had failed at steel temperatures associated with the Case B scenario" |
| 1A and 1-9 | 1A (p 49) and 1-9 (p 615) | 2nd bullet | "The connection, beam, and girder failures in the floor systems, and the resulting structural responses, occurred at temperature below approximately 400° C..." | *Change to:* "The connection, beam, and girder failures in the floor systems occurred as a result of a process of complex behaviors. In some instances, that process began to initiate at temperature below approximately 400°C..." |
| 1A and 1-9 | 1A (p 54) and 1-9 (p 620 ) | 4th bullet | "The thermal expansion of the WTC 7 floor beams that initiated the probable collapse sequence occurred at temperatures below approximately 400°C." | *Change to:* "The thermal expansion of the WTC 7 floor beams that participated in the probable collapse sequence, in some instances, began to initiate at temperatures below approximately 400°C. " |
| 1-9 | 534 | 4th bullet | "girder walk off of seated connections... at Columns 79 and 81, and" | *Delete bullet. Related figures do not appear to support text. For instance, the 3.5 hr temperatures around column 81 appears to be higher than 400 deg C in Figure 11-47.* |
| 1-9 | 534 | 7th bullet | "Many floor beams on Floors 12, 13 and 14 ... prior to beam temperatures reaching 400° C (averaged over the beam length)" | *Delete Sentence. Related figures do not appear to support text. For instance, comparing the temperatures in figure 11-47 with the buckled /failed members in figure 11-28, only three beams at the north side of the building can be identified as failing prior to 400 degrees.* |

| SHEAR STUD MODELING | |
|---|---|
| **Comment:** | It is difficult to judge with certainty how accurately the interaction of floor beams with the floor slab and decking has been captured in the various modeling efforts. It appears that the number of shear studs included in the ANSYS model of the floor beams is not consistent with the number of shear studs shown in the drawings. Floor beams in the northeast corner of the building are indicated in Figure 11-10 to have about 19 studs per beam while the excerpt from the erection drawings in Figure 8-16 indicates that there should be 28. |

| | |
|---|---|
| **Reason for Comment:** | Consistency |

| **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
|---|---|---|---|---|
| 1-9 | 473 | par. Above Fig 11-10 | "The floor area where failure of floor framing connections and shear studs was modeled…" | *Include a note to describe how the discrepancy in the number of studs was accounted for in the modeling approach.* |

| | |
|---|---|
| **Comment:** | Shear stud failure criterion is derived on the basis of localized concrete failure due to stresses acting along the axis of a composite floor beam in order to determine if composite action is lost. However, it appears that the modeling approach for shear stud failure eliminates all horizontal connection between the floor slab and the beam in the event that the estimated stud capacity is exceeded, thereby also eliminating any horizontal restraint at the top flange of the beam. Given that non-composite beams are frequently designed as laterally restrained (roof beams are a common example) based solely on the nominal restraint provided by the decking alone, the assumptions behind this failure model should be clarified. |
| **Reason for Comment:** | Consistency |

| **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
|---|---|---|---|---|
| 1-9 | 482 | last par. | "…wherein failure occurred when the […] SRSS of the force components in the x and y directions exceeded the temperature dependent shear capacity of the stud." | *Provide discussion of potential lateral restraint provided by decking.* |

| | |
|---|---|
| **Comment:** | The actual (as-built) number of shear studs on beams (and perhaps girders) may be more than what is specified on structural drawing S-8 revision H. Erection drawing sheets E8/9 through E44/45 incorporate a note for additional studs. This note placed for revision dated 11/12/85 states "Note for additional studs (X54)". And the statement at the bottom of the drawing sheets says "For additional studs see cust. dwg. S8 rev. I". |
| **Reason for Comment:** | Consistency |

| **Report #** | **Page #** | **Para./Sent.** | **Original Text** | **Suggestion for Revision** |
|---|---|---|---|---|
| 1-9 | 14 and 15 | last sent. of p.14, first sent. of p.15 | | *The existence of revision I of drawing S-8 developed for additional shear studs should be mentioned. If this drawing shows more studs on the beams or even studs on the girders, these additional studs should be incorporated into the thermal weakening analysis of the floor system.* |
| 1-9 | 342 | footnote 2 | | |

6930 E. Girard Ave., Apt. 110
Denver, CO 80224
Sept. 7, 2008

Mr. Stephen Cauffman
WTC Technical Information Repository
National Institute of Standards and Technology, Stop 8610
Gaithersburg, MD 20899-8610

Dear Mr. Cauffman:

I have read the instructions for submission of comments on the World Trade Center 7 Draft Reports, and to partially follow them, here is some of the required information: Name, Nancy M. Hall; Affiliation, U.S. citizen, retired; Contact, (303) 691-1971; Report number, NIST NCSTAR 1-9.

I realize my failure to cite page numbers, etc., will disqualify me from your considering the comments below, but I must offer them. Please read them. I've studied Dr. Frank R. Greening's response to the Reports; I agree with his conclusions. The fires were not widespread or hot enough to fatally damage the structural steel, and your description of the collapse doesn't jibe with the visual evidence.

In my childhood home, science was held in high regard. In 1877 my great-grandfather Asaph Hall, astronomer, discovered the moons of Mars at the U.S. Naval Observatory; and at Gallaudet College, Washington, DC, my father taught mathematics and my uncle, biology. My education in science was limited: I took a semester each of chemistry and physics in high school, and during my four years at Oberlin College, geology and geography. But most of the 250 books I read before my retirement from 10 years of freelance proofreading dealt with history, international politics, and science, and I've read the 9/11 literature extensively. I consider alleged facts carefully and critically, and give weight to common sense. So do not dismiss me out of hand for having believed for several years that WTC Building 7's collapse was a classic case of controlled demolition. It was a beautifully professional job: #7 came straight down, at very near free-fall speed, into its own footprint. Anyone watching the videos would immediately, rightfully conclude, *Demolition.* Thousands of reputable chemists, physicists, architectural engineers, and other scientists agree. Owner Larry Silverstein ordered, "Pull it!" David Ray Griffin's scholarly, heavily documented books are convincing. Have you and your colleagues read them?

Perhaps you've already studied the materials of the 9/11 Truth movement, now international in reach. I hope for an eventual new, fully independent investigation of what happened on and around 9/11. Meantime, cover-up of the truth continues in the U.S., and apparently NIST is planning to be complicit. Allowing a mere *three weeks* for comments on the Final Report on WTC 7 is a bad sign. I am assuming NIST has been under pressure by the Bush-Cheney administration to get it published before they're out of office. I can understand that NIST would comply; perhaps your jobs are at risk if you were to refuse. But if the Reports, produced at taxpayers' expense, contain deliberate falsehoods and reach wrong conclusions, you will not be serving the United States well. And someday when truth and justice prevail, as should happen in a democracy, you may wish you had balked. *Please, postpone publication!*

Sincerely,

Nancy M. Hall

Nancy M. Hall

cc: at NIST, Dr. S. Shyam Sunder, Dr. James M. Turner, Dr. Richard Keyser, and Dr. Willie E. May

Philip J. Tompkins
22142 SE 41st Lane
Issaquah, WA 98029
philtomp@cablespeed.com

WTC Technical Information Repository
Attention: Mr. Stephen Cauffman
National Institute of Standards and Technology
Stop 8610
Gaithersburg, MD 20899-8610

Dear Mr. Cauffman:

I am a concerned private citizen who is following the WTC 7 collapse investigation.

Here are my comments on the Draft Report NIST NCSTAR 1A "Final Report on the Collapse of World Trade Center Building 7, Draft for Public Comment", issued by NIST in August, 2008.

1.) I do not see how NCSTAR 1A explains the fact that WTC 7 collapsed

smoothly
rapidly
vertically
completely

as seen in the videos.

2.) I do not see how the NCSTAR 1A explains the contents of the pile at the end of the collapse. Where and in what condition were all the long core columns? How did all the concrete floors entirely crumble to dust?

I also wish to comment on NIST NCSTAR 1-9 Federal Building and Fire Safety Investigation of the World Trade Center Disaster, Structural Fire Response and Probable Collapse Sequence of World Trade Center Building 7, Volume 2, page 593, Figure 12-69:

3.) I do not see how the pictured object in Figure 12-69 at all resembles the actual collapse as shown in the videos. In the actual collapse the top of the building is not all crumpled as in Figure 12-69. See my attachments.

Yours truly,

Philip J. Tompkins

Philip J. Tompkins

September 7, 2008

By 13.5 (26.8) s, all the interior columns had buckled and, at 15.5 (28.8) s, the global collapse (i.e., buckling of exterior columns) was underway, as shown in Figure 12–69. The exterior columns buckled near mid-height of the building, approximately between Floors 17 and 29.

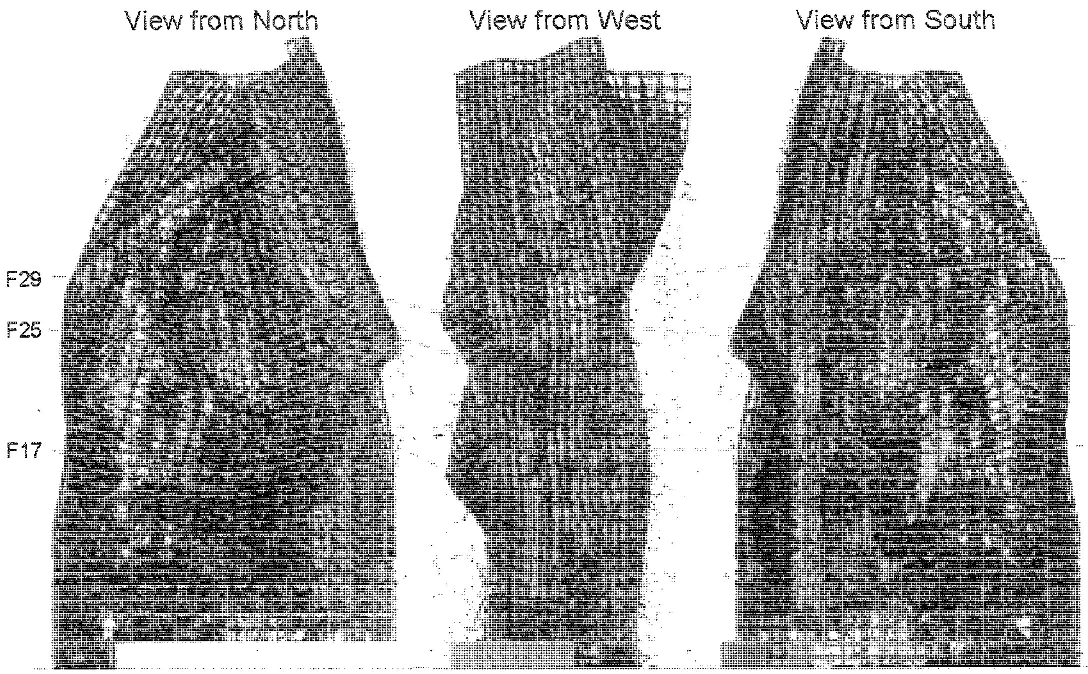


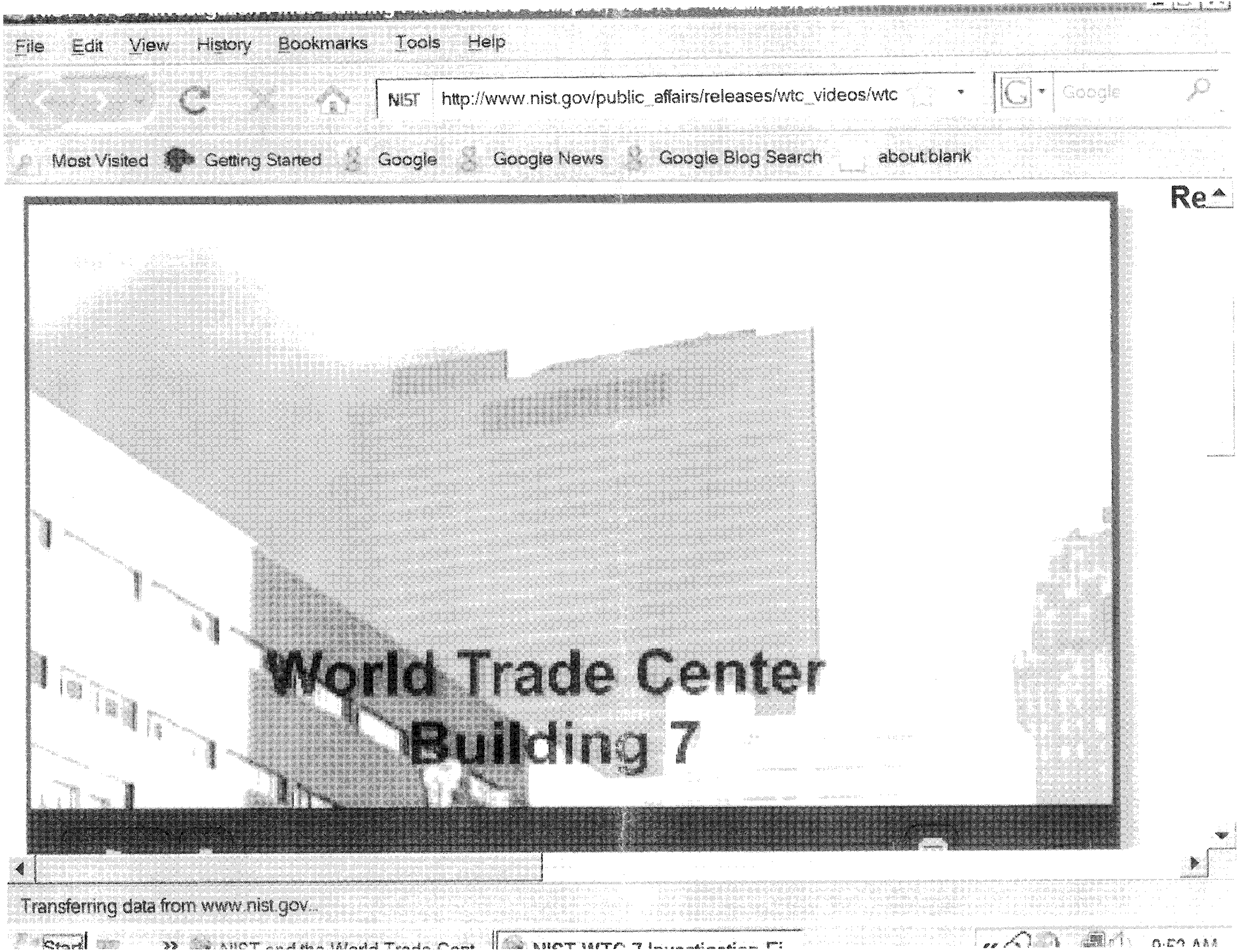

**Figure 12–69 Exterior buckling after global collapse initiation.**

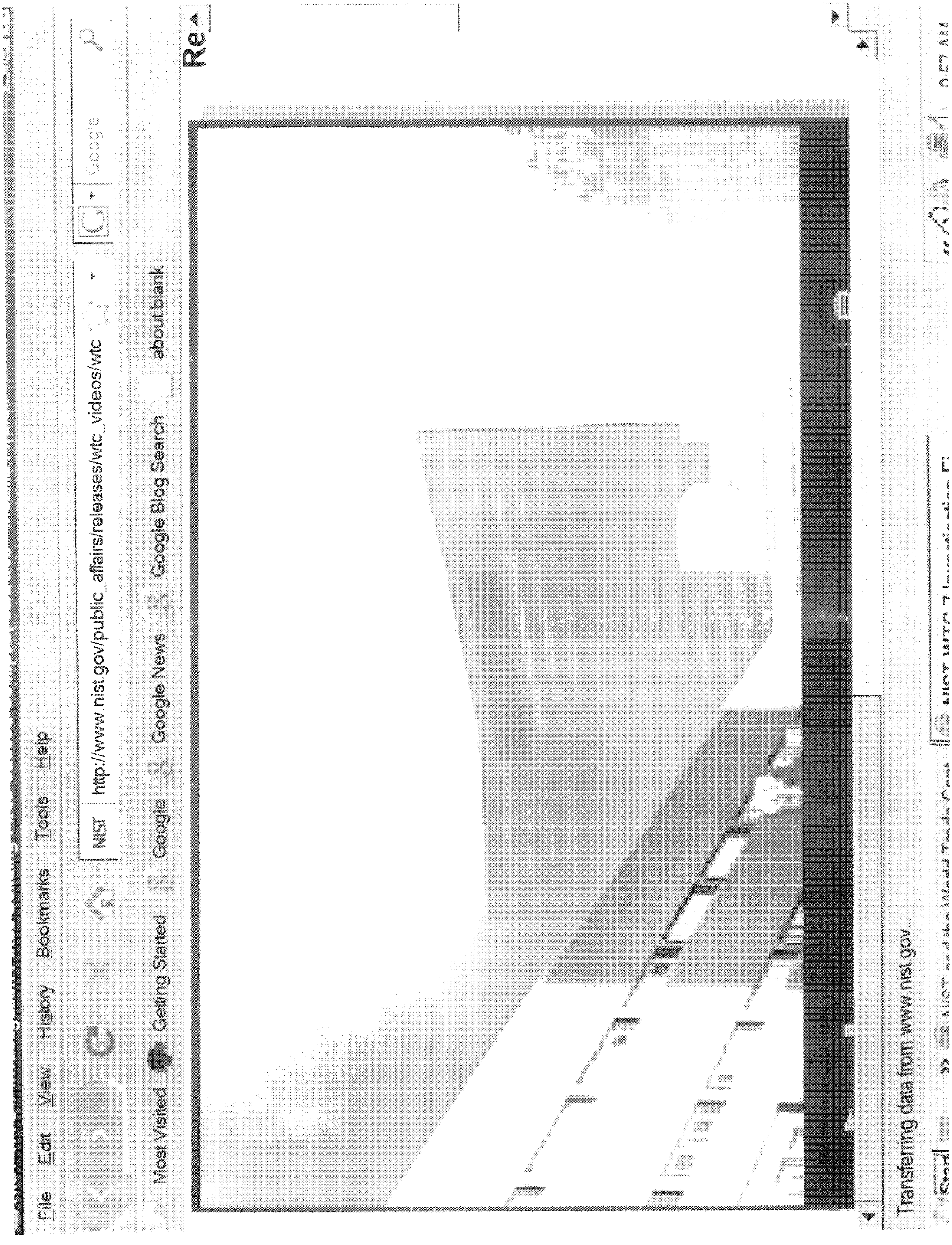
## 12.5 COMPARISON OF SIMULATIONS WITH OBSERVABLES

### 12.5.1 Aspects prior to the Global Collapse

Table 12–2 lists the major observed collapse events with corresponding times (collapse reference time frame) from the observable events and from the two global analyses with and without debris impact damage for Case B temperatures at 4.0 h. As shown in the table, the calculated time for the buckling of Columns 79, 80, and 81, the calculated and observed times for the start of the East Penthouse downward movement due to the vertical collapse progression, and the calculated and observed times for the descent of the East penthouse below the roofline were quite similar, independent of the debris impact damage.

The cascading failure of floors surrounding Column 79 and the buckling of Column 79 could not be ascertained from any videographic evidence. However, analysis of the east-west vibration of the building prior to collapse (Chapter 5 and Appendix C) revealed horizontal motion (± 2 in.) 6 s before the East Penthouse began to move downward. The horizontal building motion started at nearly the same time as the cascading floor failures started in the LS-DYNA analysis (-6.5 s), which preceded the buckling failure of Column 79. The LS-DYNA analyses indicated that Column 79 buckled approximately 1.3 s prior to the downward motion of the East Penthouse.


File Edit View History Bookmarks Tools Help
NIST http://www.nist.gov/public_affairs/releases/wtc_videos/wtc
Google
Most Visited Getting Started Google Google News Google Blog Search about:blank
Re
World Trade Center
Building 7
Transferring data from www.nist.gov...


File Edit View History Bookmarks Tools Help
http://www.nist.gov/public_affairs/releases/wtc_videos/wtc
Most Visited Getting Started Google Google News Google Blog Search about:blank
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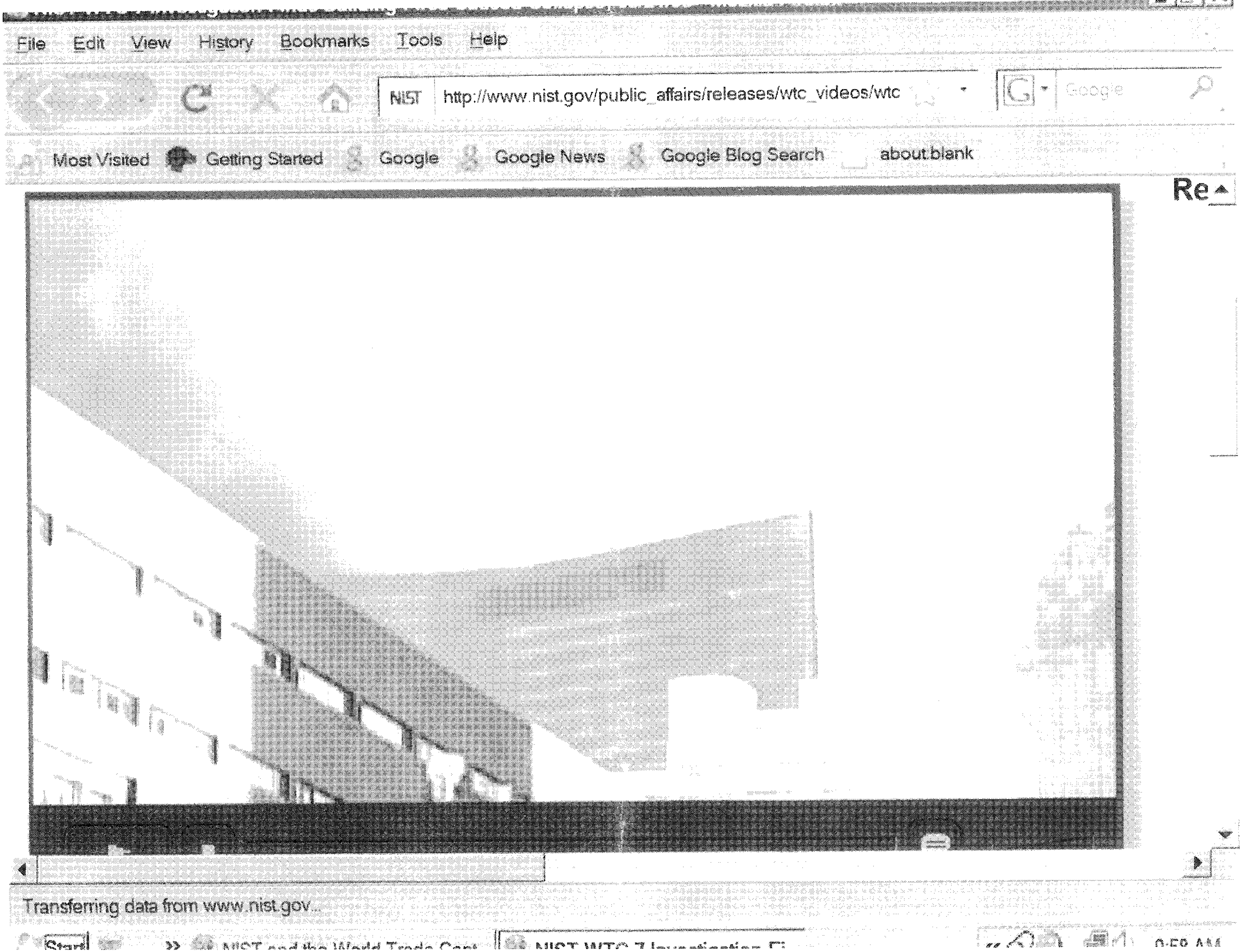
Transferring data from www.nist.gov...


File Edit View History Bookmarks Tools Help
NIST http://www.nist.gov/public_affairs/releases/wtc_videos/wtc
Google
Most Visited Getting Started Google Google News Google Blog Search about:blank
Re
Transferring data from www.nist.gov...
Start

X-Sieve: CMU Sieve 2.3
Date: Thu, 11 Sep 2008 22:05:38 +0100
From: Pieter Blue <pblue@staffmail.ed.ac.uk>
To: wtc@nist.gov
Subject: Final Report on WTC 7
X-Edinburgh-Scanned: at nougat.ucs.ed.ac.uk
with MIMEDefang 2.60, Sophie, Sophos Anti-Virus, Clam AntiVirus
X-Scanned-By: MIMEDefang 2.60 on 129.215.13.205
X-Scanned-By: MIMEDefang 2.52 on 129.215.149.64
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-09-11_12:2008-09-02,2008-09-11,2008-09-11 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0809110136
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: pblue@staffmail.ed.ac.uk
X-NIST-MailScanner-Information:

(I have attached a copy of this letter as pdf file. )

To Whom It May Concern,

I am writing to comment on the recently released ``Final Report on the Collapse of World Trade Center Building 7" (NIST NCSTAR 1A) and ``Structural Fire Response and Probable Collapse Sequence of World Trade Center Building 7" (NIST NCSTAR 1-9). It has been suggested in the media that the fuel oil system for the Office of Emergency Management (OEM) contributed to the collapse of World Trade Center 7. The report concluded that fires on floors 7-12, particularly 7, 11, and 12, lead to the collapse of the building. Given this, I would like to know if the OEM system did contribute to the fires on floor 7 or nearby floors, and, if so, to what extent, and if this contributed to the collapse of WTC 7. I am a US citizen currently living abroad.

The reports investigate several possible contributing factors and scenarios. The reports contain an extensive investigation of the possibility of a fuel oil fire on floors 5 and 6 and conclude that such a fire is not consistent with observations. The report also conclude that the oil in the day tanks would not have been sufficient to significantly contribute to the fires. On page 11 of NCSTAR 1A, it is reported that fuel which supplied the generators on floors 8 and 9 was recovered. Thus, the reports clearly concludes that it is not possible that fuel oil fires on floors 5, 6, 8, and 9 contribute to the collapse of the building and that the fuel in the day tanks did not contribute significantly to the fire which caused the collapse of the building.

I have not been able to find a similar conclusion concerning the possibility that the fuel system for the generators on floor 7 contributed to the fires and the collapse of the building. On the contrary, on page 12 of NCSTAR 1A, concerning the possibility that fuel in the first floor tanks could have supplied the fires on floor 7, the report states that ``NIST assumed that all the fuel was available". On page 26 of NCSTAR 1A, the report states that diesel fuel could have contributed to the fires on floor 7. In the longer report NCSTAR 1-9, I have also been unable to find a clear conclusion about the possibility of the OEM fuel system contributing significantly to the fires on floor 7. On page 63 of volume 1, concerning the possibility that the fuel for the generators on floor 7 could have contributed to the fire, it is stated that it is ``possible that a break in the day tank supply line on the 7th floor could [have led] to a diesel fuel pool on this floor." On page 355 of volume 1, it is again concluded that the collapse of the building was not caused by either fuel fires supplied by the supply lines to the generators on floor 5 or by the fuel in the day tanks on floors 5, 7, 8, and 9, but no conclusion was made about the possible role of the fuel supplying the generators on floor 7. On page 377 of volume 2, the report concludes that a fire fueled by the oil supply for the generators on floor 7 would not have generated so much smoke so as to be inconsistent with what was observed. In addition, from the calculations on this page, that the 600 gallons of fuel oil in the three day tanks on floors 7-9 would have provided an average of 1% more to to the total combustible materials if spread evenly over the three floors, it seems reasonable to me to conclude that had all 6000 gallons of fuel oil supplying the generators on floor 7 could have contributed roughly 30% to the total amount of combustible material on floor 7. This does not seem inconsequential. Despite this, it is further stated on page 355 of volume 2 of NCSTAR 1-9, that the possible effect of diesel fuel oil fires on floor 7 were not included in the computer simulations of the fire. The computer simulations, shown on page 380 and 383 of volume 2 of the report, suggest that the highest temperatures of the fire were not in the north east corner, where the failure of column 79 triggered the collapse of the building. Thus, it would seem reasonable to conclude that a hypothetical diesel oil fueled fire on floor 7, even on the south side of the building, could have contributed to the collapse of the building.

Given that the report did not rule out the possibility that diesel fuel oil supplying the generators could have contributed to the fires on floor 7, that such a fire would have been consistent with the level of smoke observed, that it seems that the amount of fuel available could have contributed significantly to the total amount of combustible materials on floor 7, and that fires on floor 7 contributed significantly to the collapse of the building, I would be interested in seeing a further analysis of the possible effects of such a fire. Amongst other things, I would be interested in seeing a summary of computer simulations which compared possible collapse scenarios both with and without such fires.

The attack on the World Trade Center on 11 September 2001 was probably the worst tragedy on US soil since the civil war. In comparison to the enormous loss of life, the collapse of WTC 7 is relatively minor. Nonetheless, I would like to thank you and everyone involved with preparing these reports. I hope you will be able to respond to my concerns.

Sincerely,
Pieter Blue

--


WTC7.pdf

Pieter Blue
The University of Edinburgh
James Clerk Maxwell Building
The King's Buildings
Mayfield Road
Edinburgh
Scotland EH9 3JZ
P.Blue@ed.ac.uk

11 September 2008

WTC Technical Information Repository,
Attn: Stephen Cauffman,
NIST,
100 Bureau Dr.,
Stop 8611,
Gaithersburg, Md. 20899-8610
wtc@nist.gov

To Whom It May Concern:

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The attack on the World Trade Center on 11 September 2001 was probably the worst tragedy on US soil since the civil war. In comparison to the enormous loss of life, the collapse of WTC 7 is relatively minor. Nonetheless, I would like to thank you and everyone involved with preparing these reports. I hope you will be able to respond to my concerns.

Sincerely,

Pieter Blue

To: wtc@nist.gov
From: "John L. Gross" <jgross@nist.gov>
Subject: Fwd: Molten metal at World Trade Center site in connection with September 11th 2001

X-Sieve: CMU Sieve 2.3
From: "Richard Caruana" <rca08207@bigpond.net.au>
To: <john.gross@nist.gov>
Cc: <admin@911oz.com>, <jim@ennes.com>, <megvics@bigpond.com>, <contact@allianz.com.au>, <lobsang.ralo@gmail.com>, <wtcbill@gmail.com>, <investigations@911truth.org>, <ken@ussliberty-inquiry.us>, <today@nine.com.au>, <meganis4u@hotmail.com>, <license@c-spanarchives.org>, <info@theorionproject.org>, <goodkarma@goodkarmapr.com>, <foreign2@your.abc.net.au>, <cases@allisondubois.com>, <neundaimonionen@hotmail.com>, <inquiries@un.org>, <dialogue_quest@hotmail.com>, <attorney@ag.gov.au>, <richard.simon@latimes.com>
Subject: Molten metal at World Trade Center site in connection with September 11th 2001
Date: Thu, 4 Sep 2008 11:52:07 +1000
X-Mailer: Microsoft Outlook, Build 10.0.6626
X-RPD-ScanID: Class unknown; VirusThreatLevel unknown, RefID str=0001.0A150202.48BF3F3E.004C,ss=1,fgs=0
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-09-04_01:2008-09-02,2008-09-03,2008-09-03 signatures=0
X-PP-SpamDetails: rule=spampolicy2_notspam policy=spampolicy2 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0809030208
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: rca08207@bigpond.net.au
X-NIST-MailScanner-Information:

Dear Mr John Gross and for considration by richard.simon@latimes.com ,

Can you please tell me if you are still unaware of the presence of molten metal (steel) and witnesses to the presence of molten metal (steel) being present after the events of September 11th 2001
and continuing to remain hot for some three months afterwards in connection with the World Trade Center site ( not including molten aluminium or titanium ), namely molten steel ?

Can you please conduct thorough investigations for the presence of thermate, thermite or small metal spheres in connection with the 9-11 attacks.
Also, was cordite smelt by witnesses at the Pentagon on 9-11 directly after the explosion at the Pentagon which affected the budgeting section of the Pentagon?
Colonel Paul Hughes was a witness apparently.

kind regards

Richard Caruana

AUSTRALIA

John L. Gross, Ph.D., P.E.
Research Structural Engineer
National Institute of Standards and Technology
100 Bureau Drive, Stop 8611
Gaithersburg, MD 20899-8611
Tel: 301-975-6068
Fax 301-869-6275

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Confidential and Pre-Decisional Communication

---

From: "Richard Gage" <rgage@ae911truth.org>
To: <wtc@nist.gov>
Cc: <cauffman@nist.gov>, "'Michael...snip... Gourley'" <jrpatent@gmail.com>
Subject: Re: AE911Truth - Public comments of NIST Report NCSTAR 1-9 volume 2

WTC Technical Information Repository

Attention: Mr. Stephen Cauffman

National Institute of Standards and Technology

Stop 8610

Gaithersburg, MD 20866-8610

Re: Public comments of NIST Report NCSTAR 1-9 volume 2

"Structural Fire Response and Probable Collapse Sequence of World Trade Center Building 7"

Dear Mr. Cauffman:

Pursuant to the instructions contained on the NIST website, I offer the below and attached public comments.

**Name:** Richard Gage, AIA, Architect

**Affiliation:** Architects and Engineers for 911Truth

**Contact:** rgage@ae911truth.org

**Report Number:** NIST Report NCSTAR 1-9 volume 2

**Page Number:** 383

**Paragraph/Sentence: Figure 9-11. Progression of simulated fire on Floor 12 of WTC 7.**

**Comment:** The Floor 12 fire simulation graphics on page 383 are not consistent with the photographs of the fires or the NIST Appendix L Report which states that the fire on Floor 12 had burned out before 4:45 p.m.

**Reason for Comment:** Although exact simulations are not possible, a reasonable estimate of the fire progression can be made from the photographs. This is essential to ascertain the viability of the proposed hypothesis.

**Suggestion for Revision:** Enter the correct data into the computer program which is consistent with the photographic evidence provided in your report. Make that data available to the public as well. Since the results are quite inconsistent with the photographic evidence, it is clear that the computer input data was incorrect.

Attached is a side by side comparison of a reasonable depiction of the fire progression adjacent to the photographic evidence and the NIST simulation. Clearly the NIST simulation shows extensive fire *after* 4:45 p.m. where the photographs indicate the 12th floor had burned out on the East end at about 4pm - almost 1 1/2 hours prior to collapse!

*****************************************************

Report Number: Technical Briefing August 26, 2008

Page Number: 32

Graphic

Report Number: NIST Report NCSTAR 9-1 volume 1

Page Number: 353

Paragraph: 1

**Comment:** In the NIST technical briefing, Shyam Sunder states: "Forces from thermal expansion failed the connection at Column 79, then pushed the girder off the seat." *[to the west]*

In NCSTAR 1-9 Volume 1 page 353 it states: "Axial compression then increased in the floor beams, and at a beam temperature of 436°C, shown in Figure 8-27 (a), leading to the collapse of the floor system, and rocking the girder off its seat at Column 79 as shown in Figure 8-27 (b) *[to the East]*

**Reason for Comment:** NIST has two different explanations for the same event.

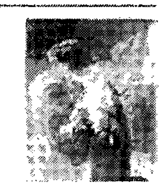
**Suggestion for Revision:** Either the girder was pushed off its seat to the West - or it was rocked off its seat to the East. Please choose one.

---

ARCHITECTS
& ENGINEERS
for 9/11 TRUTH

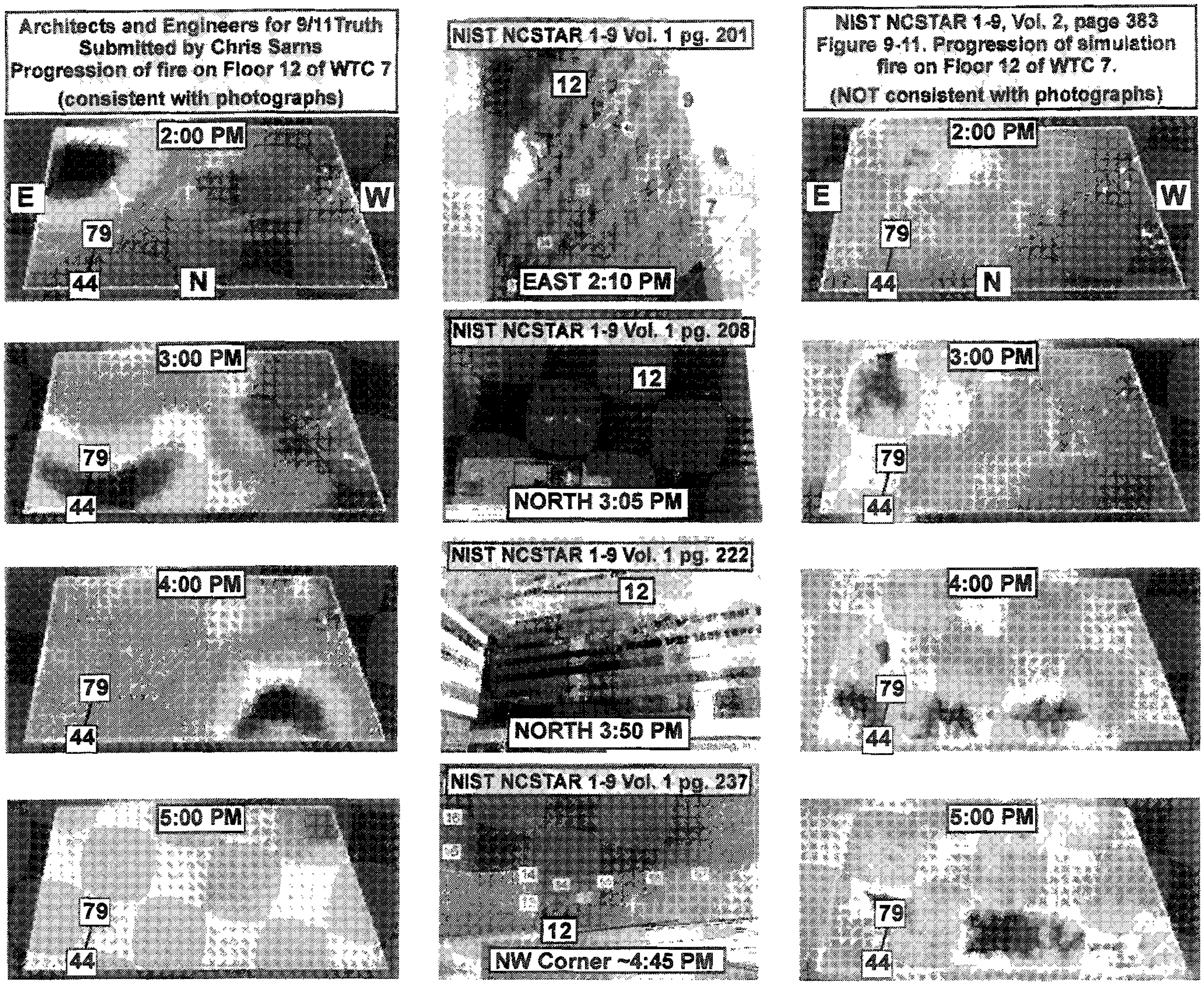
Richard Gage AIA, Architect
rgage@ae911truth.org
AE911Truth.org

9/11: Reexamining the 3 WTC high-rise "collapses"



WTC_fire_sim_comparison_080912c.pdf

# AE911Truth Challenges NIST's WTC 7 Floor 12 Fire Analysis




According to NIST, the fire on floor 12 caused the girder between columns 79 and 44 under floor 13 to fail at 5:20 PM. Theoretically, this was the beginning of the initiating event that led to the implosion of WTC 7.

On page 383 of NIST NCSTAR 1-9 Vol. 1 (2008), the fire simulations graphic of floor 12 shows the fire burning around column 79 at 4:00 and 5:00 PM. The NIST simulation is not consistent with the photographs of the fire. The photographs show, and the NIST Appendix L report (2004) states "Around 4:45 PM, a photograph showed fires Floors 7, 8, 9, and 11 near the middle of the north face; Floor 12 was burned out by this time." In fact, it had burned out in the east end before 4:00 PM.

**Therefore, the fire on floor 12 could not have caused floor 13 to collapse (at 5:20 PM) and the implosion of WTC 7 could not have occurred as NIST has proposed.**

**via Electronic Mail: wtc@nist.gov**
WTC Technical Information Repository
Attention: Mr. Stephen Cauffman
National Institute of Standards and Technology
Stop 8610
Gaithersburg, MD 20899-8610

September 15, 2008

Re: Public Comments on WTC 7 Draft Reports

Dear Mr. Cauffman,

I am writing on behalf of a group of scientists, scholars, engineers and building professionals who are dedicated to scientific research regarding the destruction of all three high-rise buildings (WTC 1, 2 and 7) on September 11, 2001. We have examined the draft reports recently released by NIST purporting to explain the demise of WTC Building 7 (collectively referred to herein as the "Report"). We have found many areas that need to be revised and re-examined by NIST personnel before they release a final report on this matter. We have provided our names and affiliations at the end of this document, in accordance with the guidelines for submittal of comments promulgated by NIST at (http://wtc.nist.gov/media/comments2008.html).

At the outset, we would like to call attention to the fact that we requested a reasonable extension of time for the public to submit comments. Given the rate at which we were finding incorrect or contradictory statements in the Report, we would likely have found many more areas NIST needs to re-examine before issuing a final report. As we pointed out in our original correspondence with you requesting the extension, the original three week deadline was completely unreasonable. First, it took NIST more than three years to compile this 1000+ page Report. Why, then, were members of the public only given three weeks in which to comment? Moreover, NIST lists ten authors and dozens of contracted and employed staff, which over the three year investigation would yield somewhere in the neighborhood of 200,000 man-hours of labor. How did NIST expect members of the public to match or even come close to NIST's labor expenditure in three weeks? This first reason alone was enough to warrant a significant extension in the deadline for public comment.

Second, in NIST's "Questions and Answers" page (http://www.nist.gov/public_affairs/factsheet/wtc_qa_082108.html), NIST has attempted to refute many of the points that members of our group and others have made regarding the WTC 7 destruction. However, NIST did not provide any references to sections of the Report that support its alleged refutations. How is a member of the public, then, able to verify NIST's refutation without reading through the entire 1000+ page Report? Our comments are directed to many of the areas addressed in the "Questions and Answers" page, and without citations directly to the Report itself, it was extremely difficult and time consuming for us see whether our main criticisms of the NIST theory of collapse have been adequately addressed in the Report. This is especially true in light of the fact that this latest draft Report is the third different story NIST has come up with.

Your response to our request was dismissive, based primarily on your belief that a six-week comment period on the 10,000 page report NIST issued for the Twin Towers was reasonable. You also saw no problem with NIST's failure to provide any references in its Questions and Answers page to the 1000 page Report itself, apparently satisfied with NIST committing the logical fallacy of appeal to authority. As things stand right now, your position in this matter can be seen as nothing less than a deliberate attempt to hamstring the public's ability to review and comment on NIST's work in this extremely important area of research.

Nevertheless, we have been able to spend some time reading and analyzing the report, and have already found numerous problems that severely undermine its veracity and usefulness. Our comments on the Report are detailed below. Note that we declined NIST's invitation to comment only on the summary report, NCSTAR 1A. These comments are all regarding the more detailed NCSTAR 1-9 document. Of course, once NCSTAR 1-9 is revised according to these comments, the summary report NCSTAR 1A will need to be revised as well.

Based on our comments below, it is readily apparent that the NIST collapse explanation relies solely on extremely suspect computer models. Furthermore, at each juncture where NIST was given the opportunity to input data into each subsequent model, NIST has chosen to use those inputs which would cause the highest temperatures and the most amount of structural damage. Therefore, the submitters of these comments hereby call on NIST to publicly release its models and modeling data so that members of the scientific community can test whether other, more reasonable, assumptions will also result in global collapse of the structure. After all, a scientific hypothesis cannot be widely accepted unless it is repeatable by others.

**Chapter 9: Fire Simulations**

*Contradictions between Floor 12 Fire Simulations and Other Evidence*

Figure 9-11 from NCSTAR 1-9 (page 383) depicts the upper layer air temperatures on the 12$^{th}$ floor fire simulation. As can be seen therein, significant fires are present across at least half of the north face of the building at 5:00pm.

This part of the fire simulation presents two problems. First, it contradicts an earlier report issued by NIST regarding the fires on floor 12. Second, it contradicts NIST's own photographic evidence of the fire activity on floor 12.

**COMMENT:** Appendix L to NIST's June 2004 "Progress Report on the Federal Building and Fire Safety Investigation of the World Trade Center" contains NIST's "Interim Report on WTC 7". (See http://wtc.nist.gov/progress_report_june04/appendixl.pdf) On page L-26 of this interim report, NIST states that "Around 4:45 p.m., a photograph showed fires on Floors 7, 8, 9, and 11 near the middle of the north face; Floor 12 was burned out by this time."

**REASON FOR COMMENT:** The contrast between NIST's prior assertion that floor 12 was "burned out" by 4:45pm, and NIST's current computer model, that shows a raging inferno at 5:00pm, could not be more apparent. This discrepancy calls into question the veracity of the Report.

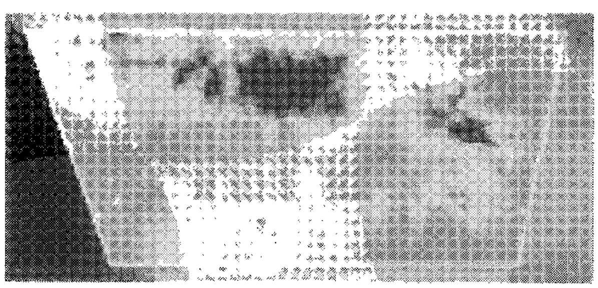
**SUGGESTED REVISION:** This discrepancy must be acknowledged and explained in the Report. Furthermore, the photographic or other visual evidence NIST relied upon for its statement in Appendix L that floor 12 was burned out by 4:45pm must be included in the final version of its report.

**COMMENT:** To support NIST's assertion that there was indeed fire present on floor 12 at 5:00pm, NIST has provided a single photograph from an "unknown source" (Figure 5-152, NCSTAR 1-9, p. 237), that was purportedly taken at around 5:00pm, and shows fire in the two windows that comprise the northwest corner. NIST contends that it has determined that this photograph was taken at approximately 5:00pm, with a margin of error of "at least 10 minutes," using shadow analysis.

**REASON FOR COMMENT:** We find it unlikely that NIST could estimate the time the "unknown source" photograph in Figure 5-152 was taken with such accuracy.

**SUGGESTED REVISION:** NIST must explain how it was able to estimate the photograph's time using shadow analysis to a margin of error even close to 10 minutes.

**COMMENT:** The following graphic is excerpted from Figure 9-11, and purports to describe the state of the fires on the 12th floor of WTC 7 at 5:00pm:



As can be seen, this graphic depicts raging fires across at least half of the north face of the building. However, when compared with Figure 5-152, which only shows a small fire in the extreme northwest corner, clearly the computer model is not representative of reality.

**REASON FOR COMMENT:** It appears that NIST's computer fire simulations are not representative at all of the fires actually occurring in WTC 7.

**SUGGESTED REVISION:** NIST needs to describe why (assuming Figure 5-152 accurately describes the floor 12 fires at about 5:00pm) the computer models show significant fires across at least half of the north side of the building at 5:00pm. NIST should clearly explain why its fire simulation models of the 12th floor should be accepted by the public as an accurate representation of the fires actually occurring in WTC 7.

Separately submitted by Chris Sarns and Richard Gage is a graphic that compares NIST's computer model fire data for floor 12 with actual pictures of the fires in WTC 7. It is attached hereto as Exhibit A. They present a more realistic depiction of what a computer model for the floor 12 fires should look like if it were to agree with the available visual evidence. NIST should take this into consideration when they are re-running their computer models based on these public comments, and revise their Report to use computer models that are more representative of reality, which would look more like the depictions contained therein.

*Combustible Fuel Loading on Floors 11 and 12*

**COMMENT:** This comment relates to NIST's assumptions regarding combustible fuel loading for the 11th and 12th floors. In NCSTAR 1-9, at p. 375 (para. 1, sent. 7-9) NIST states:

> NIST assumed that the combustible mass of furniture was about the same in an office as in a cubicle. Since the loading of other combustibles was reported to have been high on the 11th and 12th floors (Chapter 3), NIST assumed that the total combustible mass in an office was double that of a cubicle. Thus, the average combustible fuel load on the 11th and 12th floors was estimated as 32kg/m2.

However, Chapter 3 tells us that, contrary to NIST's assertions in Chapter 9, the loading of other combustibles was not reported to have been high on the 11th and 12th floors. On page 55 (para. 6, sent. 1) of NCSTAR 1-9, NIST reports that the U.S. Securities and Exchange Commission occupied the 11th and 12th floors and the north side of the 13th floor. On page 56 (para. 1, sent. 1) NIST further reports that American Express occupied the southwest sector of the 13th floor. On the same page, NIST reports that the "combustible load in the offices was described as high by interviewed American Express managers." (NCSTAR 1-9, p. 56, para. 4, sent. 3)

**REASON FOR COMMENT:** Recall that American Express occupied only the southwest sector of the 13th floor. How, then can NIST credibly claim that the combustible load on the entirety of the 11th and 12 floors, both occupied solely by the SEC, was reported to have been high? Were American Express managers given regular access to the SEC offices, such that they would be qualified to comment on the combustible fuel load there? Moreover, are American Express managers qualified to give an opinion on the quantity of combustible fuel load as compared to offices in the Twin Towers?

**SUGGESTED REVISION:** Clearly American Express personnel are competent to provide information only on the state of the American Express offices, which were confined to the southwest sector of the 13th floor. NIST must provide real support for its assertion that the combustible load on the 11th and 12th floors was high in order to merit any increase in estimated average combustible fuel load on these floors. If it cannot provide such support, it should re-run its computer models with the lower combustible fuel load on these floors and report those results to the scientific community and the American public.

*Combustible Fuel Loading on Floor 13*

**COMMENT:** This comment is regarding NIST's treatment of the combustible fuel load of the 13th floor. On page 375 of NCSTAR 1-9 (para. 1, sent. 8, 9) NIST states as follows: "The density of combustibles on the 13th floor was varied and not well known. The average value [for the 13th floor] was assumed to be the same as the 12th floor." Here again, the only reported description of the combustible load on the 13th floor was from American Express managers, who were competent to comment only on the southwest sector of the 13th floor. In Chapter 3 of NCSTAR 1-9, page 57 (para. 2, sent. 2, 3) NIST reports that in the SEC occupied sections of northern perimeter of the 13th floor were "a hearing room and multiple testimony rooms facing it. There were additional testimony rooms on the northern portion of the east and west sides of the floor, and a storage room at the northwest corner."

Importantly, NIST reports that the "testimony rooms were sparsely furnished, with just a table and a few chairs." (NCSTAR 1-9, p. 57, para. 2, sent. 4) Furthermore, an examination of the schematic diagram of floor 13 (Figure 3-8, p. 57) reveals that the hearing room appears similar to a court room. Court rooms are also sparsely furnished, with a few tables and chairs. Finally, it is doubtful that there was any appreciable level of additional combustibles present in these testimony and hearing rooms.

**REASON FOR COMMENT:** NIST has apparently greatly overestimated the fuel loading on the 13th floor.

**SUGGESTED REVISION:** NIST must justify its use of the higher combustible fuel load on the 13th floor in Chapter 9 of the Report with more than just bare assertions. NIST clearly had more information available to it regarding the layout and make up of floor 13, as reported in Chapter 3, than it lets on in Chapter 9. This discrepancy must be reconciled.

*Combustible Load Sensitivity Tests*

**COMMENT:** NIST claims that it did sensitivity tests to determine whether these exorbitant combustible fuel loads adversely affected the outcome of its simulations. However, the fact that NIST even performed the sensitivity tests brings up the question of why NIST went to the trouble of increasing the fuel load in the first place if it would have a negligible effect on the simulation. That point aside, Chapter 9 contains statements that directly contradict the results of these alleged sensitivity tests.

On page 381 of NCSTAR 1-9 (para. 3, sent. 3) NIST flatly states that, in its fire simulations for the 12th floor, "[t]he [fire] spread rate was about one-third to one-half slower than that on the lower floors due to the higher fuel load [on the 12th floor simulation]." NIST goes on to report that the burn time across the north face in the simulation was longer than observed in the visual evidence. (NCSTAR 1-9, p. 381, para. 3, sent. 4) NIST then rejects the possibility that this could have resulted from the fuel load being too high, citing the sensitivity analysis in Section 9.3.3. (para. 3, sent. 4-8)

In Section 9.3.3, we find the referenced sensitivity analysis. Here, NIST reports that doubling the fuel load on the 8th floor resulted in the fires moving distinctly more slowly than in the visual evidence. (NCSTAR 1-9, p. 382, para. 5, sent. 1-3) Confusingly, NIST also reports that decreasing the fuel load by more than one-third on floor 12 "showed little effect on the rate of fire progression." (Id., para. 6, sent. 1-3)

**REASON FOR COMMENT:** NIST's contradictory statements raise the question of why reducing the fuel load by more than one-third would show no appreciable effect on the fire rate of progression on the 12th floor, when doubling the fuel load on the 8th floor did result in an appreciable change.

**SUGGESTED REVISION:** NIST should explain here exactly what the differences in the fire progression rate were in each case and let the public judge whether the effect was "little". More important, however, is the direct contradiction between NIST's statement that the "spread rate was about one-third to one-half slower than that on lower floors due to the higher fuel load" (NCSTAR 1-9, p. 381, para. 3, sent. 3) with its statement that decreasing the fuel load to a value equal to that of the lower floors "showed little effect on the fire rate of progression." (NCSTAR 1-9, p. 382, para. 6, sent. 1-3) Surely NIST can see this direct contradiction. On page 381, it is claimed that higher fuel load slows down the fire spread rate. On page 382, it is claimed that a lower fuel load will not speed up the rate of fire progression. This contradiction must be reconciled.

*Fire Simulations for Floors 11 and 13*

NIST used the data generated by its 12th floor fire simulation for floors 11 and 13. (NCSTAR 1-9, p. 382, para. 1, 3) The 13th floor simulation used the 12th floor data delayed by one-half hour because visual evidence indicated that the 13th floor fire followed the 12th floor fire. (Id., para. 3, sent. 5) The 11th floor simulation used the 12th floor fire data delayed by 1 hour, although the visual evidence indicated that the 11th floor fire was delayed from the 12th floor fire by 1.5 hours. (NCSTAR 1-9, p. 382, para. 1, sent. 5)

**COMMENT:** Our first comment in this regard simply notes the discrepancy between the visual evidence that the 11th floor fire was delayed from the 12th floor fire by 1.5 hours, yet in its fire simulations for the 11th floor, it was only delayed from the 12th floor fire by 1.0 hour.

**REASON FOR COMMENT:** This represents yet another discrepancy in the Report that needs to be rectified.

**SUGGESTED REVISION:** NIST must explain why the visual evidence was not relied upon for inputs on the 11th floor, when it was relied upon for inputs on the 13th floor. The computer models should be re-run with the 11th floor fire delayed by 1.5 hours, not 1.0 hour, and the results reported accordingly.

**COMMENT:** Our second comment concerns both the 11th and 13th floor fires. As we demonstrated above, the 12th floor fire simulation is not representative of reality, and likely grossly overestimates the fires that were present there. By using its grossly overestimated 12th floor fire data on both the 11th and 13th floors, it has magnified this error three-fold.

**REASON FOR COMMENT:** By magnifying an obvious error by three times, the results of all of NIST's subsequent computer models are again called into question.

**SUGGESTED REVISION:** The computer models should be re-run for the 12th floor using more realistic fire scenarios, and if NIST can still justify using the 12th floor data on the 11th and 13th floors, it should use that more realistic data on both floors. The results should then be reported accordingly.

**COMMENT:** Our third comment concerns the propagation of error through NIST's approach to using a purely computer model driven approach. On page 382 of NCSTAR 1-9 (para. 1-3, sent. last) NIST acknowledges that its computer models for the fires on floors 11 and 13 "could have led to a mild overestimate of the heating on the north side of the floor."

**REASON FOR COMMENT AND SUGGESTED REVISION:** In order to assure public confidence in the document, NIST must explain how such an error in overestimating the heating would propagate itself throughout all of NIST's subsequent computer models, and how such propagation of error will affect the reliability of the ultimate results. The Report should be revised to include such a propagation of error analysis.

**Chapter 11: Structural Analysis of Initial Failure Event**

*Section 11.4 – Structural Response to Case B and Case C Fires*

**COMMENT:** In Section 11.4 (NCSTAR 1-9, p. 523-532), NIST goes through a detailed comparison of the structural response of the lower floors of WTC 7 to Case B and Case C fire scenarios. Case B used gas temperatures that were 10% higher than Case A, while Case C used gas temperatures that were 10% lower than Case A. No analysis of the structural response is shown or discussed for Case A.

On page 533 of NCSTAR 1-9 (para. 1, sent. 1) NIST makes the unsupported assertion that "comparison of Case B and Case C results at 4 h (Section 11.3.3) showed that the Case C structural response would be nearly identical to the Case B structural response at a time between 4.0 h and 4.5 h." However, when we read Section 11.3.3, we see that the analysis of Case C structural response was not carried out to 4.5 hours. Instead, we see that the response of Case C at 4.0 h was somewhat similar to the response of Case B at 3.5 h. NIST must explain how it extrapolated the Case C damage to 4.5 hours, when it was using lower temperatures in Case C than in Case B.

Also, no detailed analysis is disclosed for the Case A temperatures. NIST must include this data generated by Case A temperatures in its Report so the public can independently determine whether Case A profiles should be used in the subsequent LS-DYNA model.

**REASON FOR COMMENT:** Most important is the fact that NIST's use of the structural response to only Case B temperatures in its subsequent LS-DYNA model represents yet another example of NIST choosing input data that would tend to overestimate the temperatures and structural damage caused during the WTC 7 fires. We explained above how NIST did this before with respect to gross overestimates of combustible loads on floors 11, 12 and 13. These happen to be the exact floors on which the most damage was caused in NIST's black box model. Why did NIST not use the Case A and Case C structural response in the LS-DYNA model? Or, if it did, why did it not report the results of these models?

**SUGGESTED REVISION:** The final report must be revised to correct this error. If Case A and Case C structural responses were never used with the LS-DYNA model, the models should be re-run and the results reported to the scientific community and the American people. This is especially true in light of the fact that the 3.5 h Case B structural response did not result in global building collapse in the LS-DYNA model.

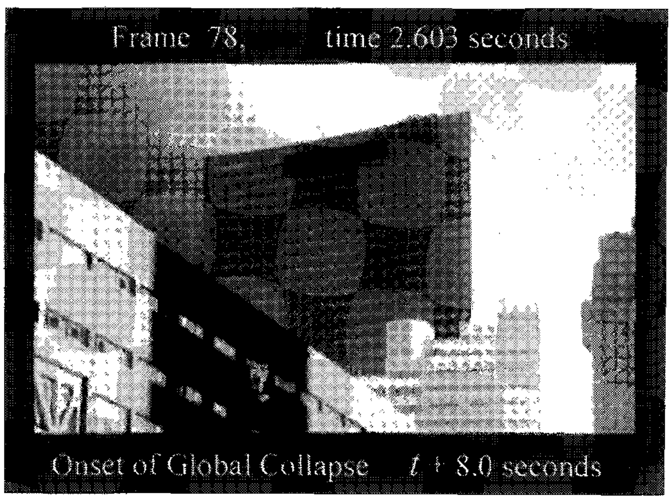
**Chapter 12: WTC Global Collapse Analysis**

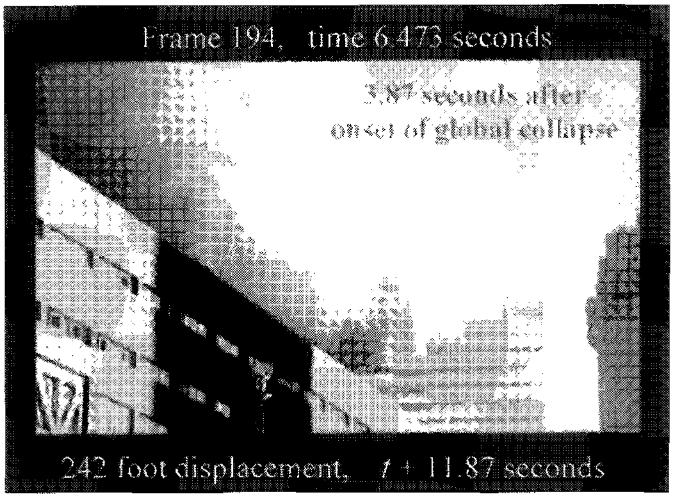
*Section 12.5.3 – Collapse Time*

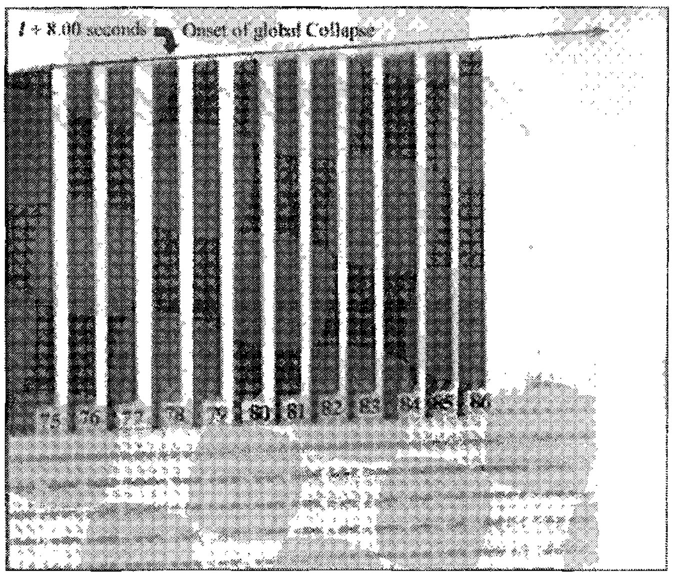
**COMMENT:** This comment concerns NIST's estimation of the time it took for the WTC 7 structure to fall. Specifically, this concerns NIST's comparison to the actual descent time with a hypothetical free-fall time. (NCSTAR 1-9, p. 595; NCSTAR 1A, p. 40-41) Basically, NIST took two data points, and assumed a constant acceleration throughout the collapse. (Id.) The first data point was allegedly taken at the time the top of the parapet wall on the roofline of the north face began descending. The second data point was allegedly taken at the time the roofline was no longer visible in Camera 3. NIST claims that the time it takes for the building to fall this distance, 242 feet, is 5.4 seconds, plus or minus 0.1 seconds. No graphical or visual support is given for this time estimate.

**REASON FOR COMMENT:** Members of this group have conducted an independent analysis of the Camera 3 footage and come to an entirely different conclusion regarding the collapse time. Our analysis was done on a frame-by-frame basis using a frame rate of 29.97 frames per second. As shown in the figure below, our analysis concludes that it takes 3.87 seconds for the top of the roofline to descend out of view of Camera 3. This time matches almost exactly the free-fall time.

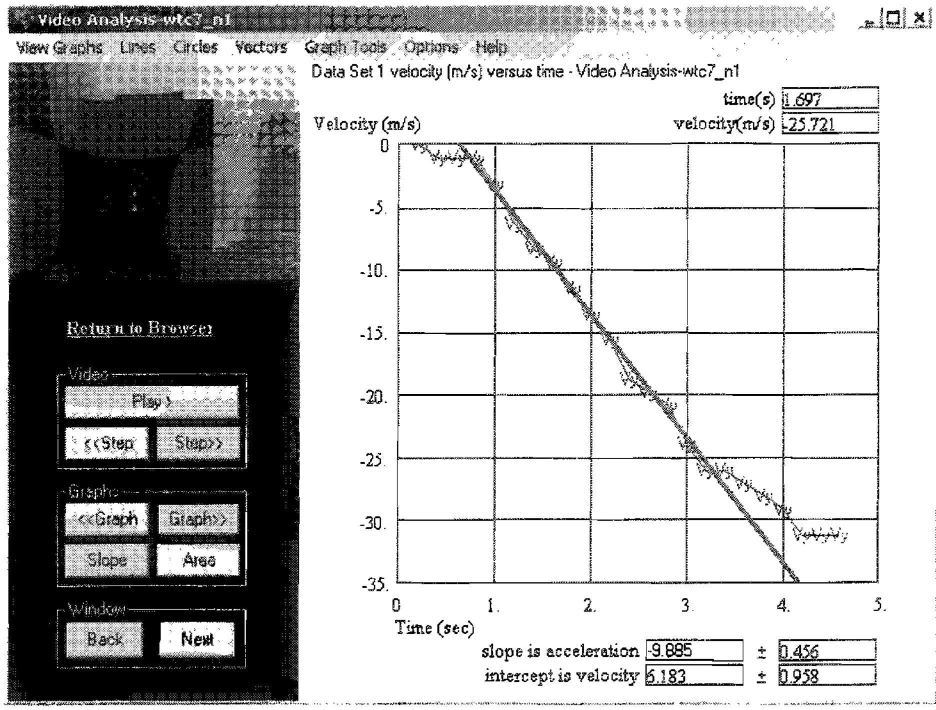
**SUGGESTED REVISION:** NIST must revise its Report to show the exact frames it used from Camera 3 in determining the time it took for the roofline to fall out of view. 5.4 seconds appears to be a gross overestimate. The frames we used in our collapse analysis are shown below (times "t + X seconds" reference the times given in NIST's Appendix L, Table L-1) along with a graphical analysis of how we determined which frame represented the onset of global collapse:






Members of this group have used the Physics Toolkit computer software to plot Velocity vs. Collapse Time using discrete data points gathered during the entire collapse from the view NIST calls Camera 2. This plot is reproduced below and provides a much more detailed look at the dynamics of the WTC 7 collapse than is provided by NIST's two-data-point analysis. Also included in the graph is a linear regression for approximately 2.6 seconds of the collapse that appears to have a constant acceleration. As can be seen, the slope (acceleration) during this portion of the collapse was approximately constant at about 9.8 m/s/s, or acceleration due to gravity with little to no resistance below. The r-squared value for this linear regression analysis was 0.9931 – a very good fit. This clearly demonstrates that NIST is being extremely misleading in reporting to the public that the structure did not descend at free-fall speed, especially given the implications of this documented feature of WTC 7's destruction.




## Chapter 8: Initiating Event Hypothesis

*Inconsistencies Between Report and NIST Technical Presentation Slides*

**COMMENT:** On page 353 of NCSTAR 1-9 (para. 1, sent. 9) NIST states that "Buckling of other floor beams followed as shown in Figure 8-27 (a), leading to collapse of the floor system, and rocking of the girder off its seat at Column 79 as shown in Figure 8-27(b)." Slide 33 of Dr. Sunder's August 26, 2008 technical presentation states that "Forces from thermal expansion failed the connection at Column 79, then pushed the girder off the seat." (http://wtc.nist.gov/media/WTC7_Technical_Briefing_082608.pdf)

**REASON FOR COMMENT:** There seems to be an inconsistency in what NIST is telling the public. In the Report it seems as if the floor system collapses, which drags the girder off its seat to the east. In Dr. Sunder's presentation, the floor beams appear to remain rigid and push the girder off its seat to the west. These conflicting statements make it difficult for the public to determine which story NIST actually believes.

**SUGGESTED REVISION:** NIST must reconcile the difference between its public presentation and the substance of the Report.

*"Perfectly Fixed" Exterior Columns and Rigid Floor Beams*

**COMMENT:** On page 350 of NCSTAR 1-9 (para. 2) the exterior columns and column 44 were modeled as "perfectly fixed" at a number of locations during the finite element analysis of the northeast corner of the building. This computer model was purporting to demonstrate that thermal expansion could cause the girder to disconnect from Column 79. Obviously, if the floor beams were to elongate due to thermal expansion, it would expand in both axial directions. This, in turn, would put pressure on whatever was connected to each end of the expanded beam.

**REASON FOR COMMENT:** To the extent "perfectly fixing" the exterior columns and column 44 caused the computer model to neglect the pressure put on the exterior columns due to thermal expansion, the computer model does not represent reality. The exterior columns should have been allowed to bow outward in response to this pressure. It is also unclear whether the floor beams were allowed to sag as they heated in the computer model. In NIST's report on the Twin Towers, the main reason given for global collapse initiation was sagging floor beams. If NIST did not allow the floor beams to sag in its WTC 7 model, then it did not allow any of the thermal expansion to express itself as sagging rather than pressure on the connections. Even the Cardington tests cited by NIST showed that floor beams to sag when they are heated.

**SUGGESTED REVISION:** NIST must more clearly explain how the thermal expansion of the floor beams in both axial directions was accounted for in the computer models. If "perfectly fixing" the exterior columns caused all of the thermal expansion to occur in one direction, the computer models needs to be modified to comport with reality, and allow outward bowing of the external columns. Also, if the floor beams and girders were not allowed to sag as they heated, there is a fundamental disconnect between the WTC 7 computer models and the WTC 1 and 2 computer models. The computer models should be re-run with appropriate revisions made to the floor beam properties, which allow them to sag as they heat.

*Temperatures Applied to Beams and Girders*

**COMMENT:** In Figure 8-25 on p.352 of NCSTAR 1-9, NIST applies temperatures of 600°C and 500°C to the floor beams and girders, respectively, over a period of about 2.6 seconds. Putting aside for a moment the fact that applying that much heat over a 2.6 second time interval could not possibly approximate the reality of the fires at WTC 7, other problems still remain. For example, these extreme temperatures were applied uniformly for all nodes of the beams and girders. (NCSTAR 1-9, p. 351)

**REASON FOR COMMENT:** On page 452 of NCSTAR 1-9, NIST only reports that some "sections" of the floor beams exceeded 600°C. Nowhere does NIST indicate that the computer models show ***uniform*** temperatures of 600°C for floor beams and virtually no information is given for temperatures of girders. Again, these temperatures are applied uniformly over an extremely small amount of time, which is not representative of an actual fire.

**SUGGESTED REVISION:** Run the computer models for the northeast section of floors again using realistic temperatures and realistic application times. Report the results accordingly.

*Only High Explosives Considered in Hypothetical Blast Event*

**COMMENT:** In its analysis of "hypothetical blast scenarios" that might have lead to the collapse of WTC 7, NIST only considers blast events using RDX, an extremely high explosive. (NCSTAR 1-9, p. 355, last sentence) NIST goes on to argue that because no loud sounds were heard, and because no window breakage was observed, that RDX was not used to bring down WTC 7.

**REASON FOR COMMENT AND SUGGESTED REVISION:** However, as documented by Kevin Ryan at the Journal of 9/11 Studies (http://www.journalof911studies.com/volume/2008/Ryan_NIST_and_Nano-1.pdf) many scientists working for and associated with NIST have experience with nanoenergetic compounds, or nanothermites, that have the potential to be used for building demolitions. And because nanothermites are primarily high-temperature incendiaries rather than explosives, they could cause damage to steel structures without producing the sound and destruction levels associated with RDX. Because NIST personnel have intimate experience with these materials, NIST should revise its report to specifically analyze whether such nanoenergetic materials could have been used as a component in a "hypothetical blast scenario" at WTC 7.

Furthermore, the National Fire Protection Association Manual for fire and explosion investigations, in Section 921, very clearly indicates that the possibility of explosives should have been thoroughly investigated by NIST. Specifically in NFPA 921 18.3.2 "High Order Damage" – "High-order damage is characterized by shattering of the structure, producing small, pulverized debris. Walls, roofs, and structural members are splintered or shattered, with the building completely demolished. Debris is thrown great distances, possibly hundreds of feet. High-order damage is the result of rapid rates of pressure rise." WTC 7 clearly met this definition. Therefore NIST should have investigated more thoroughly the possibility that explosive were used. Specifically, the use of "exotic accelerants" should have been investigated. In NFPA 921 19.2.4 – "Exotic Accelerants," three indicators were clearly met that should have led to a thorough investigation into the possible use of "exotic accelerants," specifically as stated in the guideline, "Thermite mixtures." NIST should comply with NFPA Section 921 and test the debris from WTC 7 for thermite residues and report the results to the scientific community.

**Omissions from the NIST Report**

*Foreknowledge of Collapse*

NIST omitted from the Report information relating to foreknowledge by several groups of people that WTC 7 was going to collapse.

What we mean by foreknowledge is a quality of detail and a strength of conviction that allow us to say, in light of the building's collapse at approximately 5:21 p.m., that they *knew* in advance that it was coming down.

Such knowledge is highly significant in light of the facts that (a) no steel framed skyscraper in history (indeed, NIST says, "no tall building" in history) had ever before collapsed from fire alone; and (b) the collapse, according to NIST, was the result of a series of accidental and unpredictable factors, which did not come together in such a way as to determine the fate of the building until minutes, or possibly even seconds, before the collapse took place.

In any situation where someone demonstrates foreknowledge of an extremely unusual event, the possibility must be considered that the knowledge derived from those who had control over the event. In other words, foreknowledge of WTC 7's collapse greatly strengthens our suspicions that the building was subjected to controlled demolition and that the knowledge of its demise derived ultimately from those who intended to bring it down.

NIST has tried to evade the issue of foreknowledge of WTC's collapse by implying:

(a) that the FDNY, on the scene, saw the damage to the building caused by the collapse of WTC 1 and rationally concluded that WTC 7 might collapse.

From NIST NCSTAR 1A, p.16:

"The emergency responders quickly recognized that WTC 7 had been damaged by the collapse of WTC 1...

As early as 11:30 a.m., FDNY recognized that there was no water coming out of the hydrant system to fight the fires that were visible. With the collapses of the towers fresh in their minds, there was concern that WTC 7 too might collapse..."

(b) that an engineer, early in the day, saw the damage to the building and concluded it might collapse, passing on this assessment to others (Lead Investigator Shyam Sunder, in a discussion with Graeme MacQueen on CKNX Radio, Wingham, Ontario, Aug. 25, 2008)

It is true that damage to WTC 7 was directly witnessed by some firefighters and led a few of them (about seven) to worry that the building might collapse, but the great majority (approximately 50) who were worried about collapse did not base this worry on what they perceived but on what they were told. (See Graeme MacQueen, "Waiting for Seven: WTC 7 Collapse Warnings in the FDNY Oral Histories", *Journal of 9/11 Studies*, June 11, 2008) Moreover, while it is apparently also true that an engineer communicated his opinion, early in the day, that the building might collapse, neither this communication nor communications from the FDNY is sufficient to explain the evidence of foreknowledge that we possess.

Below are seven reasons why the above NIST explanations of foreknowledge are inadequate. One example is given to illustrate each of the seven reasons. More details can be found in the paper by Graeme MacQueen titled "Waiting for Seven: WTC 7 Collapse Warnings in the FDNY Oral Histories" published at the Journal of 9/11 Studies (http://www.journalof911studies.com/volume/200701/MacQueenWaitingforSeven.pdf).

1. Certainty
To worry that a damaged building *might* collapse in some fashion is one thing; but to be certain that it *will* collapse is another. Detailed study of the accounts of the FDNY shows that over half of those who received warnings of WTC 7's collapse (where degree of certainty can be determined from the reports) *were certain or were told with certainty* that it was coming down. (The figures are: 31 out of 58. See "Waiting for Seven".)

2. Early announcement
If someone was observing the fires in WTC 7 and was able to determine, in the last few moments of the building's existence, that a peculiar set of circumstances was beginning to threaten the building, that would be one thing; but to receive warnings of the building's collapse well before this set of circumstances was in place raises far more suspicions. Yet a detailed study of the FDNY reports show that of the 33 cases where the time of warning can be determined, in ten cases warnings were received two or more hours in advance and in six cases warnings were apparently received four of more hours in advance. (See "Waiting for Seven.") In other words, long, long before the unique set of circumstances had come together to cause the building's collapse, the collapse was being spoken of widely.

3. Precision
If the collapse warnings derived from vague worries and concerns they would not have been precise. No building had come down from these causes before, and, in fact, *complete collapse* such as happened to WTC 1, WTC 2, and WTC 7 was very rare, apart from cases of controlled demolition. That is why FDNY member James McGlynn could say on 9/11, speaking of one of the Towers, "Any time I've heard of a collapse, it was never an entire building like this turned out to be." (See "Waiting for Seven.") Yet, despite the rareness of complete collapse, many people apparently knew in advance that WTC 7 would be undergoing such a collapse. Consider the following from the FDNY oral histories:

Q. "Were you there when building 7 came down in the afternoon?"
A. "Yes."
Q. "You were still there?"
A. "Yes, so basically they measured out how far the building was going to come, so we knew exactly where we could stand."
Q. "So they just put you in a safe area, safe enough for when that building came down?"

A. "5 blocks. 5 blocks away. We still could see. Exactly right on point, the cloud stopped right there." (See "Waiting for Seven.")

4. New information
If the collapse warnings derived from worries and concerns expressed early in the day by engineers and firefighters, why would the collapse of WTC 7 have been reported by CNN (one hour and 10 minutes in advance) and BBC (23 minutes in advance) as *breaking news* based on just received information? CNN anchor Aaron Brown said "*We are getting information now.*" CNN anchor Judy Woodruff: *"We're hearing for the first time"* (See Appendix.) BBC anchor: *"We've got some news just coming in"*.

5. Premature announcement
CNN and the BBC did not merely report that the building was damaged or that it might collapse; they *prematurely announced its actual collapse.*

CNN's Aaron Brown, one hour and ten minutes in advance of the collapse: "We are getting information now that one of the other buildings, Building 7, in the World Trade Center complex, is on fire and has either collapsed or is collapsing..."

BBC anchor, 23 minutes before the collapse: "the Salomon Brothers Building in New York, right in the heart of Manhattan, has also collapsed."

No satisfactory explanation has been forthcoming about these premature announcements, which were obviously based on data fed to these announcers.

6. Continuity
The BBC *continued to announce* that WTC 7 had collapsed, even when the building could be seen standing directly behind reporter Jane Standley, for about 17 minutes until the story was pulled abruptly.

When CNN personnel realized they had made an error in their early announcement, they could simply have corrected it. They could, at the very least, have withdrawn their attention from WTC 7 and stopped covering it since it was obviously still standing. Instead, CNN *continued to keep WTC 7 in the forefront of its coverage* over the hour and ten minutes preceding its collapse, repeatedly warning that it was going to come down and keeping the image of the building in front of the viewer until it had actually collapsed. (See Appendix.)

7. Progression
According to NIST's study, WTC 7's fires had been reduced from ten floors, soon after the collapse of WTC 1, to essentially two floors as the collapse time approached. This was a building in which the fires were actually dying down. Why, then, did CNN show awareness of the building's approaching doom, and why did it revise its captions accordingly, from "may collapse" to "poised to collapse" (approximately 15 minutes before actual collapse) and then to "on verge of collapse" (approximately 1.5 minutes before actual collapse). (Appendix)

Any one of these seven factors would be enough to make us consider the possibility of *foreknowledge* of WTC 7's collapse. Taken together, they make an unanswerable case.

As further support, below we have provided a timeline of events based on CNN's coverage of Building 7. The times in the left-hand column are within 30 seconds of actual time.

| Time | Event in progress |
|---|---|
| 4:11:16 | Anchor Aaron Brown: "We are getting information now that one of the other buildings, Building 7, in the World Trade Center complex, is on fire and has either collapsed or is collapsing and I, I...[pauses, looks at monitor, where WTC 7 stands, apparently firm and stable] you, to be honest, can see these pictures a little bit more clearly than I..."<br><br>Fixed Caption near bottom of screen: "Building 7 at World Trade Ctr. on fire, may collapse" |
| 4:13:25 | Anchor Judy Woodruff reaffirms what Aaron Brown has just announced, saying "we're hearing for the first time" that "one of the support buildings [in the World Trade Center complex] is on the verge of collapse if it has not already collapsed".<br><br>Fixed Caption near bottom of screen: "Building 7 at World Trade Ctr. on fire, may collapse" |
| 4:21:16 | Judy Woodruff : "one of the buildings may have collapsed or may be in the process of collapsing"<br><br>Fixed Caption near bottom of screen: "Building 7 at World Trade Ctr. on fire, may collapse" |
| 4:35:58 | Running Caption at very bottom of screen scrolls by, saying that WTC 7 has caught fire and may collapse |
| 4:50:33 | After many split screen shots with WTC 7 as one of two images, we now get WTC 7 filling most of the screen<br><br>Fixed Caption near bottom of screen: "Building 7 at World Trade Ctr. on fire, may collapse" |
| 5:06:15 | Running Caption at very bottom of screen scrolls by, saying: "World Trade Center Building 7 ablaze, poised to collapse" |
| 5:19:31 | Fixed Caption: "Building 7 at World Trade Ctr. on fire, on verge of collapse" |
| 5:21:12 | Shot of NY skyline with WTC 7 gone and large clouds of dust rising. Anchor Aaron Brown announces: "just in the last few seconds another building—we will speculate carefully here that it was Building Number 7...has collapsed" |

The NIST Report should be revised to include a detailed analysis of all of the reports of specific foreknowledge of the collapse of Building 7. NIST's Lead Investigator, Dr.

Sunder, when challenged with reports like this during radio interviews recently has stated that NIST's investigation was not a criminal investigation, but instead is a technical one. However, this position belies the fact that NIST did opine in the Report that the controlled demolition hypothesis was unlikely because NIST didn't believe that the explosives could be placed without being detected. Such an opinion is not a technical opinion, but an operational one that goes more to logistically how a criminal could have committed the crime than technically how it was done. Clearly NIST could consider the many reports of foreknowledge and note the impossibility of such specific and detailed foreknowledge. The Report should be revised accordingly.

*FEMA Building Performance Study – Appendix C*

The NIST WTC 7 Report does not attempt to explain the "*severe high-temperature corrosion attack*" on apparently the only piece of WTC 7 steel which was tested, as documented in Appendix C, "Limited Metallurgical Examination" of the Federal Emergency Management Agency (FEMA) Building Performance Study, which can be found at the link below on the NIST website.

http://wtc.nist.gov/media/AppendixC-fema403_apc.pdf

The detailed further study deemed necessary by FEMA was – as far as we know - never done, and the observed "*intergranular melting*" of the steel can not be explained within the framework of the present NIST hypothesis. Why would NIST ignore the recommendations made by FEMA investigators for additional research of the unexplained material behavior?

In a taped interview Worcester Polytechnic Institute Fire Engineering professor Dr. Jonathan Barnett, one of the authors of the 13 page report in Appendix C, made the comment that normal investigative protocol was not followed in the case of the WTC 7 collapse. He says that the steel from WTC 7 was not photographed, examined, and cataloged before being removed. The comments he makes are at the 3:00 minute mark in the below linked video.

http://www.911podcasts.com/display.php?cat=9998&med=0&ord=Name&strt=180&vid=58&epi=0&typ=0

It is reported that WTC 7 was fully evacuated long before its collapse and that there were no fatalities or missing persons involved with its demise. The photos in the figures below show the collapsed WTC 7 to have its debris field confined to within a short distance of its footprint.

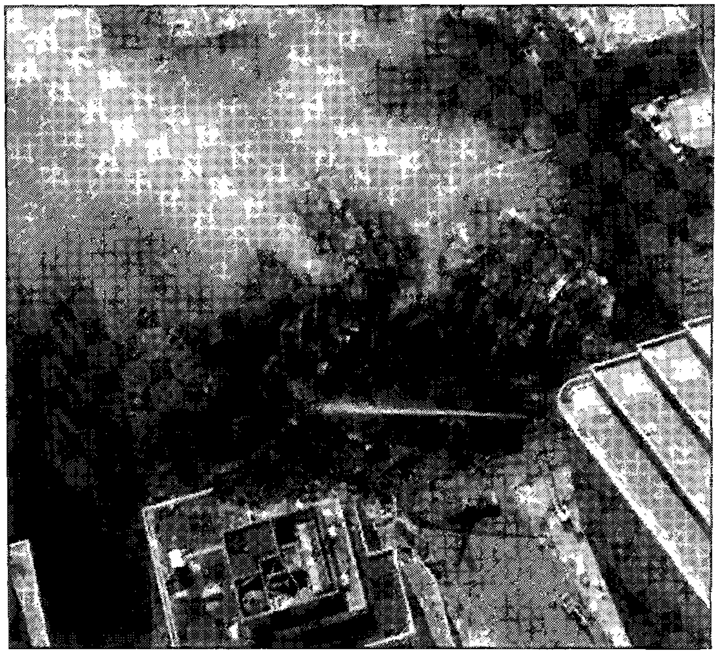


**Figure 1. The rubble pile of WTC 7 on Sept. 15, 2001, four days after the building collapsed**

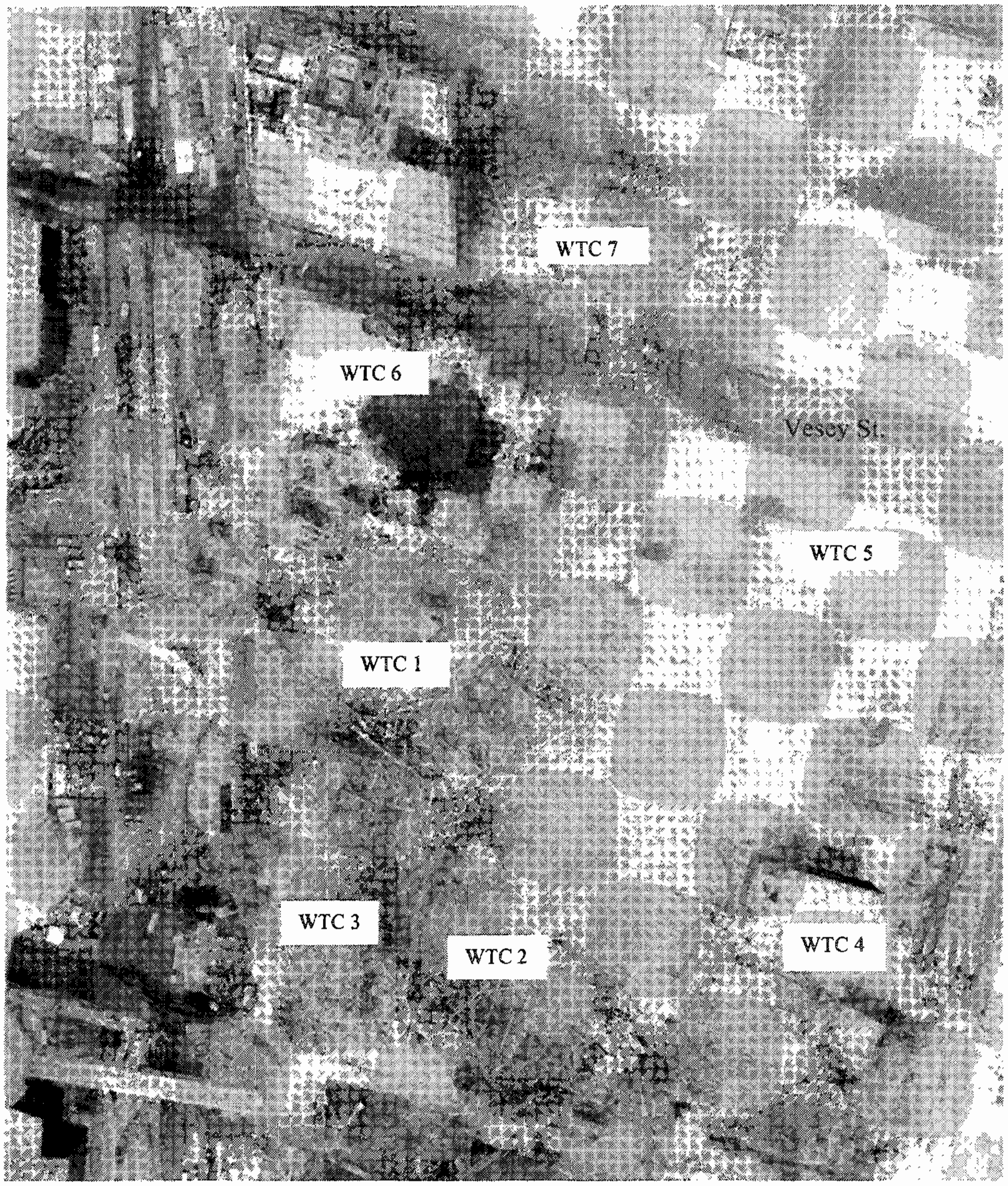



**Figure 2. NOAA aerial photo of Ground Zero on Sept. 23, 2001 showing the relative location of the WTC 7 rubble with respect to debris of the other WTC buildings and a somewhat clear line of demarcation on Vesey Street**

In addition to showing the relatively tight confinement of the debris field of WTC 7, the photo in Figure 2 also shows that debris from WTC 6 and WTC 5 was contained within their footprints or very nearby.

The FEMA report debris field map for the Twin Towers, below in Figure 3, shows that only a small percentage of the debris from WTC 1 made it the 350 feet to WTC 7's location. The lighter areas on the map represent low debris density and the darker areas high debris density.

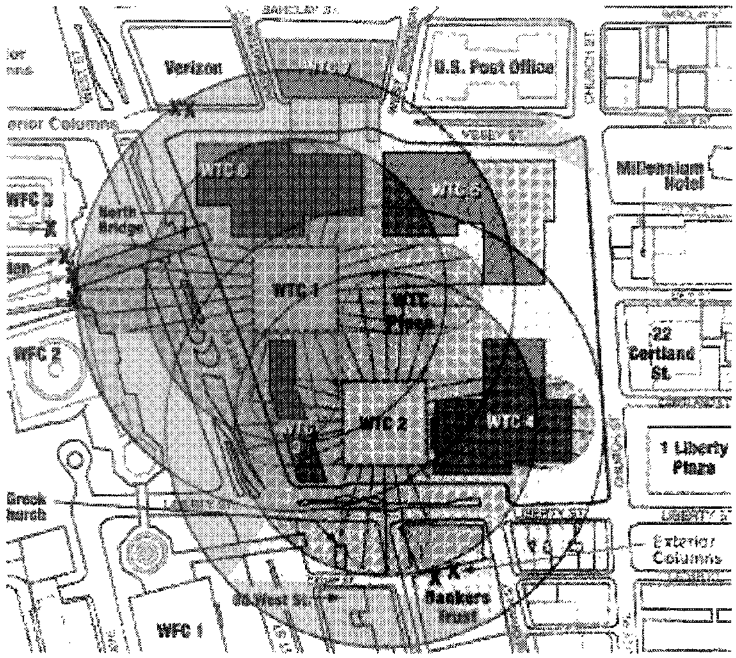



**Figure 3. FEMA debris map for the Twin Towers**

The seeming separation of the WTC 7 debris field from those of the other buildings, and the fact there were no missing persons or fatalities involved with its collapse, make it hard to accept the History Channel program narrator's comment, in the video above, that the mingling of the steel from the different buildings, and the need for search and rescue, were the reasons for the removal of the WTC 7 steel, before it could be properly photographed, examined, and cataloged, at the collapse site.

Even if the WTC 7 steel was moved, without being examined and cataloged at the site of the collapse, an additional question arises as to why it wasn't recovered and stored for later testing, evaluation, and a systematic forensic analysis. This is especially pertinent in light of the FEMA recommendation that additional research was needed due to the strange findings in their very limited metallurgical examination.

In the August 2008 NIST draft Report on WTC 7 there is no mention of testing of any recovered steel from the collapsed remains of the building. In sections where the properties of the steel need to be discussed reference is curiously made to WTC steel samples, not specifically those of WTC 7. This can be understood if one is aware that in an earlier draft of the WTC 7 report NIST made the stark admission that "No metallography could be carried out because no steel was recovered from WTC 7. Other physical properties are the same as those estimated in Chapter 8 for the WTC steels".

Since NIST report on the collapse of WTC 7 suffers from a lack of physical evidence to support its findings, it should go into some level of detail on: why normal investigatory protocol was not followed, why none of the steel was recovered, and whether any laws were violated in not doing so. If there are questions as to the legality of the removal and lack of recovery for investigatory purposes, NIST should recommend that an investigation be commenced to determine who was involved with the decision to remove the steel and why NIST did not receive any of it for its investigation.

There are also several seemingly contradictory issues between the FEMA Building Performance Study Appendix C and the NIST WTC 7 Report, for which no explanations have been provided, and they are:

- NIST states "No steel was recovered from WTC 7" while FEMA section C.2 shows that at least one piece of WTC 7 steel was tested, with the results being alarming, considering the highly unusual formation of a liquid eutectic, intergranular melting, and erosion. Features not seen before, by the experienced investigators, in steel subject to common office fires.

- FEMA section C.3 Summary for Sample 1 states that the steel was heated to around 1,000° C. (1,800° F.), which is much hotter than the steel temperatures NIST is claiming to have caused the collapse, and seemingly far outside the ability of office fires to heat the steel. Additionally, this section states that steel liquefied at these temperatures, due to the formation of the eutectic, which would dramatically lower the usual 2750° F melting point temperature of the steel.

- FEMA Section C.6 Suggestions for Future Research states "It is also possible that the intergranular melting, eutectic formation, and erosion phenomenon started prior to collapse and accelerated the weakening of the steel structure."

Why hasn't the "future research" been done, and the results from it published, especially when FEMA itself suggested that this melting and erosion may have started "prior to collapse"? NIST was charged with investigating the conditions that led to the collapse of WTC 7, and clearly something that possibly occurred prior to collapse and "accelerated the weakening of the steel structure" is something NIST should have investigated. NIST should revise the Report accordingly after it has performed the needed metallurgical analysis.

These public comments on the NIST WTC 7 Report are being submitted by the following individuals:

James R. Gourley, Esq.
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Richard Gage
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Graeme MacQueen, Ph.D.
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Dr. Steven Jones
Ph.D. Physicist
S&J Scientific Co.

Kevin Ryan
Chemist
Scholars for 9/11 Truth & Justice

Chris Sarns
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Kamal Obeid, SE PE
Structural Engineer
Architects & Engineers for 9/11 Truth

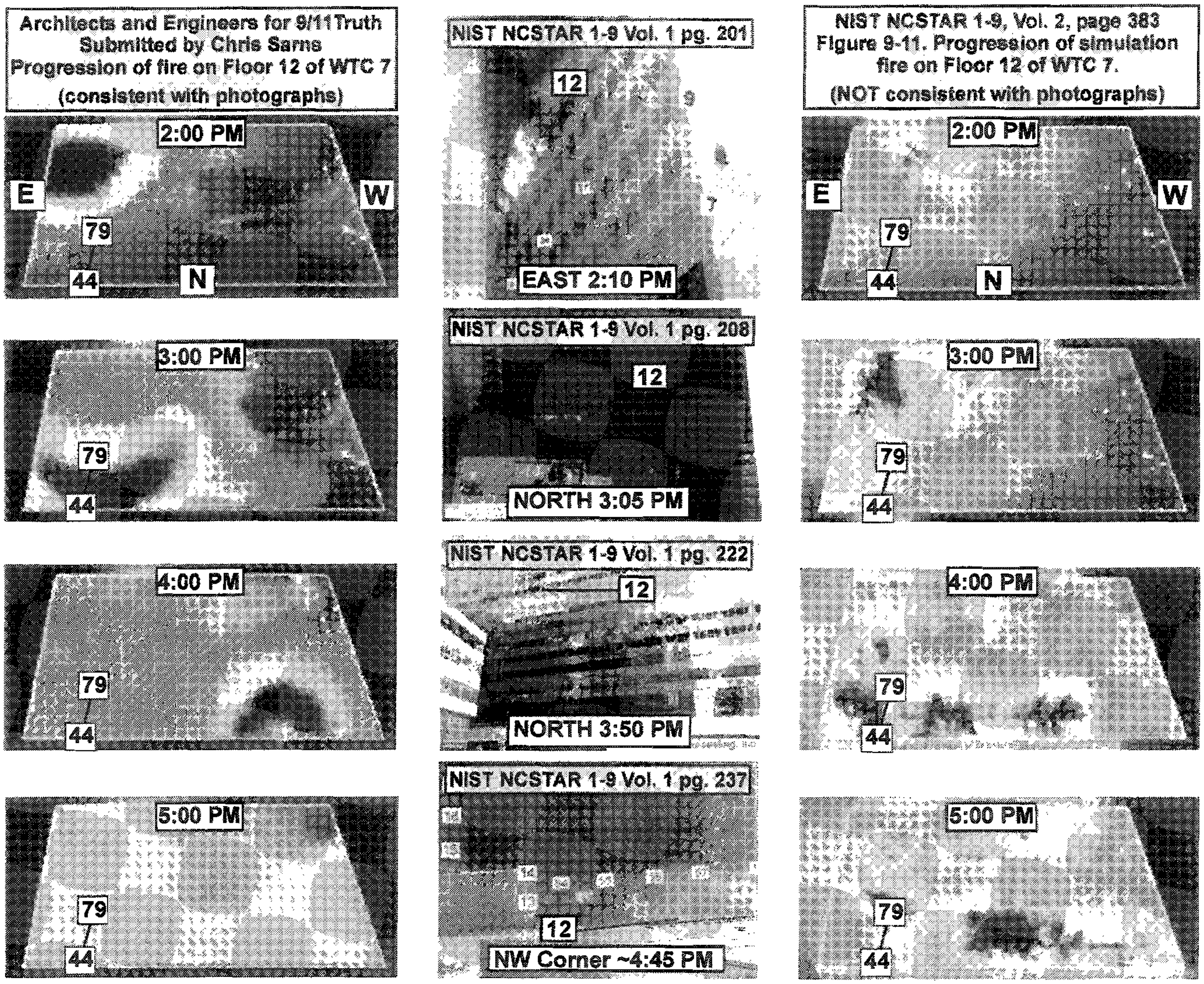
Scott Grainger, PE
Forensic Engineer
Civil Engineer
Architects & Engineers for 9/11 Truth

**Exhibit A**
**Graphical Examination of NIST**
**WTC 7 Floor 12 Fire Analysis**

ARCHITECTS
& ENGINEERS
for 9/11 TRUTH

*9/11: Re-examining the 3 WTC high-rise "collapses".*

# AE911Truth Challenges NIST's WTC 7 Floor 12 Fire Analysis




According to NIST, the fire on floor 12 caused the girder between columns 79 and 44 under floor 13 to fail at 5:20 PM. Theoretically, this was the beginning of the initiating event that led to the implosion of WTC 7.

On page 383 of NIST NCSTAR 1-9 Vol. 1 (2008), the fire simulations graphic of floor 12 shows the fire burning around column 79 at 4:00 and 5:00 PM. The NIST simulation is not consistent with the photographs of the fire. The photographs show, and the NIST Appendix L report (2004) states "Around 4:45 PM, a photograph showed fires Floors 7, 8, 9, and 11 near the middle of the north face; Floor 12 was burned out by this time." In fact, it had burned out in the east end before 4:00 PM.

**Therefore, the fire on floor 12 could not have caused floor 13 to collapse (at 5:20 PM) and the implosion of WTC 7 could not have occurred as NIST has proposed.**

**Stephen Cauffman**

| | |
|---|---|
| **From:** | wtc@nist.gov |
| **Sent:** | Friday, September 05, 2008 4:01 PM |
| **To:** | Stephen Cauffman |
| **Subject:** | Fwd: Public Comment (Technical) |

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Tue, 26 Aug 2008 17:30:23 EDT
Subject: Public Comment (Technical)
To: WTC@nist.gov
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-26_13:2008-08-25,2008-08-26,2008-08-26 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808260178
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 611

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) 2nd bullet point under Objective 3

Comment: The statement that there was no redundancy for the water supply for the low zone sprinkler system is incorrect. The secondary water supply for the low zone sprinkler system was the fire department connection.

The upper sprinkler system zones in the building were provided with gravity tanks as a secondary water supply due to the high pressure required to be pumped into the fire department connection to reach the higher zones.

Reason for Comment: The statement that the low zone water supply did not have a redundant water supply is incorrect. The low zone water supply did not have an automatic secondary water supply, which is different from not have a redundant supply.

Suggestion for Revision: The statement should be revised to be technically accurrate.

---

**Stephen Cauffman**

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 4:01 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Public Comment (Editorial)

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Mon, 25 Aug 2008 17:40:47 EDT
Subject: Public Comment (Editorial)
To: WTC@nist.gov
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-25_05:2008-08-25,2008-08-25,2008-08-25 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808250180
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 390

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) 3rd paragraph/last sentence

Comment: The term "ceiling beams" is used in this sentence. I assume that this term is intended to mean floor beams.

Reason for Comment: The term "ceiling beams" is an imprecise term.

Suggestion for Revision: If the term "ceiling beams" is intended to refer to floor beams, it is suggested that the term "floor beams" be used.

It's only a deal if it's where *you* want to go. Find your travel deal **here**.

**Stephen Cauffman**

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 4:01 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Public Comment (Editorial)

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Mon, 25 Aug 2008 17:25:24 EDT
Subject: Public Comment (Editorial)
To: WTC@nist.gov
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
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X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808250175
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

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Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 386

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) 2nd paragraph/1st sentence

Comment: The word "rich" is sort of rich with meaning, but probably shouldn't be used in a formal report.

Reason for Comment: The word "rich" as used in the report probably should not be used in a formal report.

Suggestion for Revision: Suggest using the word "extensive" in lieu of the word "rich".

It's only a deal if it's where *you* want to go. Find your travel deal **here**.

**Stephen Cauffman**

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 4:01 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Public Comment (Technical)

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Mon, 25 Aug 2008 15:06:31 EDT
Subject: Public Comment (Technical)
To: WTC@nist.gov
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
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X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808250138
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 372

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) Last sentence on page

Comment: There isn't much information on the design of the sprinkler system, however, in the low zone, it is possible that operating sprinklers would have a water supply from the sprinkler piping higher in the zone (if check valves were not provided at each connection to the sprinkler riser). In other words, the sprinkler/standpipe piping located on higher floors would act as a gravity tank supplying sprinklers on lower floors.

Assuming that sprinkler piping in the low sprinkler zone was broken when the building was struck with debris from the collapse of WTC 1, the supply for operating sprinklers would not have lasted for any significant length of time.

Reason for Comment: In several places in the report, statements are made that there was no water supply for the sprinkler systems, in particular the low zone. This is only technically accurate if check valves were provided at each connection of the sprinkler piping on the floors to the riser. If check valves were not provided at this location, the sprinkler piping on the upper floors of the low zone would act as a gravity tank for operating sprinklers on lower floors in the zone.

Suggestion for Revision: It is suggested that the issue of whether or not there were check valves in the sprinkler system at each connection to the riser be addressed. Depending on whether or not there were check valves, a discussion of whether or not the piping on the upper floors acted as a gravity tank to supply operating sprinklers or broken piping on the lower floors may be required.

---

**Stephen Cauffman**

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 4:01 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Public Comment (Technical)

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Mon, 25 Aug 2008 14:39:49 EDT
Subject: Public Comment (Technical)
To: WTC@nist.gov
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
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X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808250129
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
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X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 363 (pdf page 25)

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) 3rd point in the 1st paragraph in the "Floor-to-Floor Fire Spread" section.

Comment: This point appears to make the assumption that the only means of spread of fire between floors is via the outside of the building. Fire spread between floors is possible through the opening between the edge of the floor slab and the curtain wall if this space is not firestopped properly. Obviously, floor-to-floor fire spread could also occur through improperly firestopped obvious in the floor construction. I believe I am correct in saying that the principle means of fire spread between floors in the One Meridian Plaza Building fire was through improperly firestopped openings in the floor construction, not via the exterior of the building.
The granite spandrel panels would likely have prevented floor-to-floor fire spread.

Reason for Comment: To this point in the report, there has been no discussion of the firestopping provided for the opening between the floor construction and the curtain wall.

Suggestion for Revision: The firestopping details and installation at the intersection of the floor construction and the curtain wall needs to be addressed in this report.

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**Stephen Cauffman**

| | |
|---|---|
| **From:** | wtc@nist.gov |
| **Sent:** | Friday, September 05, 2008 3:59 PM |
| **To:** | Stephen Cauffman |
| **Subject:** | Fwd: Public Comment (Technical) |

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Mon, 25 Aug 2008 13:03:31 EDT
Subject: Public Comment (Technical)
To: WTC@nist.gov
CC: Nadine_Post@mcgraw-hill.com
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-25_05:2008-08-25,2008-08-25,2008-08-25 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808250107
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 361 (pdf page 23)

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) 3rd paragraph/2nd sentence

Comment: Typically there is an opening between the edge of the floor construction and the curtain wall. Up until this point in the report, I have not seen any description or discussion of the construction details of this space. If this space existed in the construction, how was this space firestopped? This detail is extremely important to the investigation.

It is my experience that the space between the floor and the curtain wall is often improperly detailed or improperly installed.

Reason for Comment: The sentence in question indicates that there was no pathway for flames and heat to pass from one floor to the floor above. This is only true if the space between the curtain wall and the floor is properly firestopped.

Suggestion for Revision: This construction detail should be addressed in the report.

**Stephen Cauffman**

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 2:58 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Public Comment (Technical)

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Mon, 25 Aug 2008 09:49:22 EDT
Subject: Public Comment (Technical)
To: WTC@nist.gov
CC: Nadine_Post@mcgraw-hill.com
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808250066
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 358

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) Section 8.10

Comment: This entire section fails to mention the lack of manual fire suppression efforts. As indicated in another comment, the simple act of pre-wetting combustible by the FDNY would have completely changed the heat exposure to the building structure. The tactic of pre-wetting by fire fighters was utilized to control the fire in the First Interstate Bank Building. Similarly, pre-wetting by sprinklers was able to control the spread of fire in the One Meridian Plaza Building. (The tactic of pre-wetting is also used to control wild land fires.) In other words, the initiating event (other than fire ignition) was the decision to abandon the building and let the building burn.

Reason for Comment: Section 8.10 only addresses the collapse from a structural point of view. If temperatures had been reduced by "pre-wetting" the combustibles, the temperatures to which the building structure were exposed would likely been significantly reduced and the collapse avoided.

Avoiding the issue of the lack of manual suppression efforts, avoids the question of whether or not building should be designed assuming both the failure of the sprinkler system and the total failure of the fire department.

Although the water supply in Lower Manhattan had failed due to the collapse of WTC 1 and WTC 2, water supply was available from the Hudson River and from hydrants located further north. The FDNY is a large enough fire department that water supply relay (engine pumping to engine through 4 inch, 5 inch or 6 inch supply lines) from hydrants further north could have been established.

It also appears that the sprinkler system serving the low zone in the building could have been supplied through the fire department connection. Although the sprinkler system was damaged, so far in the report, NIST has not estimated the extent of the damage to the sprinkler system.

The intent of this comment is not to criticize FDNY for their decision not to fight the fire, but rather to indicate that in most fires, the fire department has options and the probability that both the sprinkler system will be ineffective and that manual fire suppression will be totally ineffective is miniscule. **Again, the question that needs to be answered clearly is whether we expect our buildings to be designed to withstand a 9/11 attack or whether our buildings should be designed for typical events.**

Suggestion for Revision: Suggest that the lack of manual suppression activities be considered as a direct cause of the collapse.

---

**Stephen Cauffman**

| | |
|---|---|
| **From:** | wtc@nist.gov |
| **Sent:** | Friday, September 05, 2008 2:57 PM |
| **To:** | Stephen Cauffman |
| **Subject:** | Fwd: Public Comment (Technical) |

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Mon, 25 Aug 2008 09:05:31 EDT
Subject: Public Comment (Technical)
To: WTC@nist.gov
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808250061
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 342 (pdf page 393)

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) last paragraph/

Comment: The paragraph does not address the fact that there were no manual fire suppression efforts. Even minimal manual fire suppression efforts in the building would have reduced the exposure of the structural system to heat generated by the fires.

Reason for Comment: The paragraph neglects to address the issue of the effects of manual fire suppression on the fire. In the fire in the First Interstate Bank Building, the LAFD was able to prevent the spread of fire up the building by, in effect, pre-wetting the combustible on the floors above the fire. Any pre-wetting of combustibles by the FDNY would have reduced the heat exposure to the WTC 7 structural systems and, more than likely, prevented the collapse of the building. Hence, it could be stated that the lack of any attempt to manually suppress the fires in the building, combined with the structural damage to the building from the collapse of the adjacent structures, was the proximate cause of the collapse.

Suggestion for Revision: Suggest that importance of the lack of manual fire suppression by the FDNY be considered.

---

## Stephen Cauffman

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 2:57 PM
**To:** Stephen Cauffman
**Subject:** FW: NIST WTC 7 Draft Report-Beam Fire Ratings

X-Sieve: CMU Sieve 2.3
From: Shyam Sunder <sunder@nist.gov>
To: "'wtc@nist.gov'" <wtc@nist.gov>
CC: Stephen Cauffman <cauffman@nist.gov>, Gail Crum <crum@nist.gov>
Date: Mon, 25 Aug 2008 07:47:05 -0400
Subject: FW: NIST WTC 7 Draft Report-Beam Fire Ratings
Thread-Topic: NIST WTC 7 Draft Report-Beam Fire Ratings
Thread-Index: AckGTryx8NmwO4j2RTuBupaYN++kWAAWkeLw
Accept-Language: en-US
X-MS-Has-Attach:
X-MS-TNEF-Correlator:
acceptlanguage: en-US
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: sunder@nist.gov
X-NIST-MailScanner-Information:

---

Dr. S. Shyam Sunder
Director
Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899-8600
Tel.: 301-975-5900; Fax: 301-975-4032

---

**From:** FPESCHULTE@aol.com [ mailto:FPESCHULTE@aol.com]
**Sent:** Sunday, August 24, 2008 9:11 PM
**To:** Shyam Sunder
**Cc:** Nadine_Post@mcgraw-hill.com
**Subject:** Re: NIST WTC 7 Draft Report-Beam Fire Ratings

In a message dated 8/24/2008 7:36:14 P.M. Central Daylight Time, sunder@nist.gov writes:

> The sentence relating to the beams should read they had SFRM consistent with a 2 hour rating. This statement is in error and will be fixed tomorrow. In other parts of the report, including findings, you will see reference to the beams having SFRM consistent with a 2 hour rating.
>
> The fire rating and SFRM for the buildings were consistent with 1-B classification/specification for unsprinklered buildings (3 hour columns and 2 hour floors) even though the buildings had sprinklers. This was confirmed by the Port Authority.
>
> We also talk about the lack of water for the sprinklers, the effect of the structural damage, and the fact these were uncontrolled fires later in the report under principal findings and recommendations.

Thanks Shyam.  You're working late tonight.

rich

---

It's only a deal if it's where you want to go. Find your travel deal here.

**Stephen Cauffman**

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 2:57 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Public Comment (Technical)

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Mon, 25 Aug 2008 08:54:38 EDT
Subject: Public Comment (Technical)
To: WTC@nist.gov
CC: Nadine_Post@mcgraw-hill.com
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808250057
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 341 (pdf page 393)

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) 3rd paragraph/1st sentence

Comment: The sentence does not mention that WTC 7 is the only building of the four which incurred significant structural damage immediately prior to the fires.

Reason for Comment: One of the most significant questions which should at least be attempted to be answered in the report was whether or not the structural damage prior to the fires played a significant role in the collapse of the building. The "key" question to be answered is: Would WTC 7 have collapsed if no structural damage had been occurred immediately prior to the fires?

Suggestion for Revision: See above.

It's only a deal if it's where *you* want to go. Find your travel deal **here**.

**Stephen Cauffman**

| | |
|---|---|
| **From:** | wtc@nist.gov |
| **Sent:** | Friday, September 05, 2008 2:08 PM |
| **To:** | Stephen Cauffman |
| **Subject:** | Fwd: Public Comment (Editorial) |

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Sun, 24 Aug 2008 18:28:02 EDT
Subject: Public Comment (Editorial)
To: WTC@nist.gov
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808240262
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 341

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) 1st paragraph/last sentence

Comment: The National Institute of Standards and Technology is normally abbreviated NIST, not Nist.

Reason for Comment: Just editorial. (Who in the hell edited this report?)

Suggestion for Revision: Replace Nist with NIST.

---

**Stephen Cauffman**

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 2:08 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Public Comment (Technical/Editorial)

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Sun, 24 Aug 2008 16:23:25 EDT
Subject: Public Comment (Technical/Editorial)
To: WTC@nist.gov
CC: Nadine_Post@mcgraw-hill.com
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808240224
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 314

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) section 7.4.2/1st paragraph

Comment: Not to be picky, but the attack on the WTC towers did not begin at 8:46:30 AM. While it could be arguable, it is my opinion that the attack began with the hi-jacking of the aircraft. The time noted is the time at which the aircraft struck the towers.

Reason for Comment: Indicating that the attack began at 8:46:30 seems to imply that the hi-jackers did not plan the attack and that the collision of the aircraft with the towers was accidental.

It is likely that the passengers and crew of the hi-jacked aircraft (as well as United Airlines and American Airlines) would disagree that the attack began at 8:46:30, if the passengers and crew were still alive. Out of respect for the passengers and crew of the hi-jacked aircraft who were slaughtered, the statement which reference the time the attack began should be changed.

Suggestion for Revision: No suggestions. Just a comment.

---

**Stephen Cauffman**

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 2:08 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Public Comment (Technical)

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Sun, 24 Aug 2008 16:12:39 EDT
Subject: Public Comment (Technical)
To: WTC@nist.gov
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808240224
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 311

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) Section 7.2.3

Comment: NIST estimates the capacity of the elevators for emergency evacuation. No criteria is given for how the capacity was determined, other than the criteria that the engineers used to determine the capacity.

In the high rise building in which I live, elevators seems to be constantly "out-of-service" for one reason or another. (The elevator equipment was damaged when the City of New Orleans was flooded as a result of Hurricane Katrina.) Given this, it is suggested that the report also address the reliability of elevators when used for evacuation purposes. It appears that the engineers' calculations and NIST's calculations assume that all of the elevators are operable. Elevators taken out of service for equipment maintenance or for purposes of moving furniture should be considered.

Reason for Comment: The criteria for determining the capacity of elevators is time-dependent. Hence, a criteria which establishes a time in which the evacuation is to be accomplished must have been utilized to determine the capacity. It appears that NIST utilized the same criteria as the engineers to determine the capacity. If this is the case, it is recommended that NIST specifically state that this is the case so that readers will be 100 percent sure that this is the time criteria being utilized.

Suggestion for Revision: Explicitly state the time criteria being used to determine the evacuation capacity of the elevators.

---

**Stephen Cauffman**

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 2:07 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Public Comment (Editorial)

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Sun, 24 Aug 2008 15:33:32 EDT
Subject: Public Comment (Editorial)
To: WTC@nist.gov
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=1 spamscore=1 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808240213
X-PP-SpamScore: 1
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 309

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) 2 paragraph/1st sentence

Comment: It is recommended that the term "design occupant load" be used rather than "nominal maximum occupant load".

Reason for Comment: The maximum floor occupant load is determined based upon the egress capacity provided. The computation of dividing the floor area by 100 SF/person produces the minimum occupant load for which the egress facilities serving an office floor would be required to be designed.

Most codes allow the occupant load of a floor to exceed the minimum occupant load provided that sufficient egress facilities are provided. For example, an occupant load which produces an average occupant load of 80 SF/person would be permitted on an office floor provided that the egress facilities provided are sufficient.

Suggestion for Revision: Substitute the term "design occupant load" rather than "nominal maximum occupant load".

---

**Stephen Cauffman**

| | |
|---|---|
| **From:** | wtc@nist.gov |
| **Sent:** | Friday, September 05, 2008 2:07 PM |
| **To:** | Stephen Cauffman |
| **Subject:** | Fwd: Public Comment (Technical) |

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Sun, 24 Aug 2008 16:01:00 EDT
Subject: Public Comment (Technical)
To: WTC@nist.gov
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808240222
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 313

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) Section 7.3.2

Comment: This section only appears to address a fire emergency within the building. It would seem that utilizing the elevators for an emergency other than a fire emergency within the building would be acceptable, i.e. an aircraft purposely flies into an adjacent building.

Reason for Comment: This section seems to have forgotten that the use of elevators to address non-fire emergencies within the building should be acceptable.

Suggestion for Revision: No suggestion for a revision.

It's only a deal if it's where *you* want to go. Find your travel deal **here**.

**Stephen Cauffman**

| | |
|---|---|
| **From:** | wtc@nist.gov |
| **Sent:** | Friday, September 05, 2008 1:31 PM |
| **To:** | Stephen Cauffman |
| **Subject:** | Fwd: Public Comment (Editorial) |

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Sun, 24 Aug 2008 09:09:53 EDT
Subject: Public Comment (Editorial)
To: WTC@nist.gov
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808240094
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 125

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) 3rd paragraph/1st sentence.

Comment: It is assumed that the reference to Broadway refers to a street name,not a section of Manhattan. Hence, the report should refer to Broadway Street, not simply Broadway.

Reason for Comment: The NIST report is intended to be a formal report. Hence, the report should be in a formal style, not conversational style.

Suggestion for Revision: Use the term Broadway Street, rather than simply Broadway.

It's only a deal if it's where *you* want to go. Find your travel deal **here**.

**Stephen Cauffman**

| | |
|---|---|
| **From:** | wtc@nist.gov |
| **Sent:** | Friday, September 05, 2008 1:30 PM |
| **To:** | Stephen Cauffman |
| **Subject:** | Fwd: Public Comment |

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Sat, 23 Aug 2008 12:11:03 EDT
To: WTC@nist.gov
CC: Nadine_Post@mcgraw-hill.com
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808230074
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
Subject: Public Comment
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: xxxvi

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) 1st paragraph/2nd point

Comment: Item (b) in the 2nd point reads as follows:

"(b) provide the technical basis for cost-effective improvements to national building codes . . . . "

NIST has previously stated that NIST has not determined the cost of complying with the proposed recommendations. NIST has also stated that NIST has not performed a "cost/benefit" analysis and that it is not NIST's responsibility to determine either costs or to do a cost/benefit analysis.

Assuming that NIST's statements regarding developing cost impact and a cost/benefit analysis are correct, how does NIST know that NIST's proposal are "cost-effective improvements"?

Reason for Comment: Assuming that NIST's statements regarding developing cost impact and a cost/benefit analysis are correct, how does NIST know that NIST's proposal are "cost-effective improvements"?

In the prior reports on the WTC towers, NIST has not provided a technical basis for NIST's recommendations. Dr. Sunder has disputed this fact, however, if NIST has provided the technical basis, then NIST should be able to point to the technical basis for each recommendation. To my knowledge, NIST has not done so to date (simply because the reports do not contain a concise technical basis for each recommendation).

Once again, it is my recommendation that the technical basis for each recommendation be included immediately following each recommendation so that readers of the report do not have to search all 10,000 pages of the various reports in an attempt to find "the technical basis needle" in the 10,000 page "haystack".

Suggestion for Revision: Either include a cost analysis and cost/benefit analysis for each recommendation or delete any reference as to whether or not the recommendations are "cost effective".

---

**Stephen Cauffman**

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 1:30 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Public Comment (Technical)

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Sat, 23 Aug 2008 13:25:43 EDT
Subject: Public Comment (Technical)
To: WTC@nist.gov
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808230085
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 33

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) 3rd paragraph/last sentence

Comment: Structural steel frames with bolted or welded connections are considered to be restrained. It's really a simple concept with structural steel frames. The same can be said for concrete floor construction.

Reason for Comment: The NIST tests at Underwriters Laboratories in August 2004 were tests on trusses. Structural steel frames and concrete floor construction react differently than trusses to thermal restraint. The paragraph as written implies that the structural fire resistance of restrained structural steel frames and concrete floors is less than unrestrained construction. That notion is simply incorrect.

It should be noted that the reactions to fire where a floor assembly is simultaneously exposed to fire from both above and below is different from a floor assembly where the floor is only exposed from below.

Suggestion for Revision: The paragraph should be rewritten so that it is technically correct. If the fire resistance tests on trusses is to be referenced in this paragraph, it is suggested that it be specifically stated that the August 2004 tests involved trusses, not structural steel frames.

---

**Stephen Cauffman**

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 1:30 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Public Comment (Technical)

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Sat, 23 Aug 2008 13:32:40 EDT
Subject: Public Comment (Technical)
To: WTC@nist.gov
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808230090
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 33

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) 6th paragraph/4th sentence

Comment: The statement that there are no code requirements for inspection of existing spray-applied fireproofing is incorrect. The International Fire Code (IFC) specifically requires that all fire protection systems, including fireproofing materials, be maintained over the life of a building. Further, the IFC specifically permits the fire code official to make inspections of fireproofing materials.

Reason for Comment: The statement contained in the draft regarding the inspection of existing structural fire protection (fireproofing materials) is incorrect.

It should be noted that, while the IFC requires that fireproofing materials for structural steel be maintained and authorizes the fire official to make periodic inspections of the fireproofing materials, most fire authorities fail to enforce this provision of the code. This is an enforcement issue.

Suggestion for Revision: Modify the paragraph so that it correctly addresses the issue. The failure of fire code enforcement officials to properly enforce the code.

---

**Stephen Cauffman**

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 1:30 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Public Comment (Technical)

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Sat, 23 Aug 2008 12:41:41 EDT
Subject: Public Comment (Technical)
To: WTC@nist.gov
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808230082
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 75 and 76

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) 5th paragraph, page 75; 2nd paragraph, page 76

Comment: The 3rd sentence in the 5th paragraph on page 75 indicates that a 4 sprinkler array cover roughly 750 square feet. The 1st sentence in the first full paragraph of page 76 indicates that the sprinkler spacing is 168 SF. 4 times 168 equals 672 SF. 672 SF vs. 750 SF, which is it?

Reason for Comment: 672 SF and 750 SF are two different values for the area protected by 4 sprinklers. 672 SF is not approximately 750 SF.

Suggestion for Revision: Reconcile the differences between these two values.

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**Stephen Cauffman**

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 1:30 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Public Comment NCSTAR 1-9

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Sat, 23 Aug 2008 11:59:03 EDT
Subject: Public Comment NCSTAR 1-9
To: WTC@nist.gov
CC: Nadine_Post@mcgraw-hill.com
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808230074
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: xxxiv

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) Last paragraph/2nd sentence

Comment: The second sentence of this paragraph makes reference to "effecting necessary change". It is my opinion that the consensus that has developed is that the recommendations proposed by NIST are unnecessary change. Hence, a reference to "necessary" change is only NIST's opinion.

Reason for Comment: It has been 7 years since the terrorist attacks on 9/11 and no further major terrorist attack within the United States have occurred. Some (mainly Democrats) would ascribe this mostly to luck, while others (mainly Republicans) credit the United States military and the Department of Homeland Security, along with our intelligence agencies, the FBI and the CIA, with taking the necessary steps to prevent another attack.

The record of the last 7 years calls into question whether the implementation of NIST's recommendations is actually necessary. While a consensus that the implementation of some changes may have developed in the immediate aftermath of 9/11/2001, it is clear that such a consensus no longer exists. The events which have occurred on September 11th are rarely mentioned in Congress or in the political campaigns.

It is unlikely that most Americans have forgotten that day, however, offensive tactics against terrorism have proved to be both effective and efficient. It is my opinion that most Americans now realize that defensive tactics, such as those proposed by NIST, will be both costly and ineffective.

America is a "target-rich" country. If we improve our defenses in new high rise buildings, terrorists can simply attack older high rise buildings or other buildings such as shopping malls or our transportation infrastructure. NIST's recommendations barely scratch the surface of improving America's defenses against terrorism.

Addressing terrorism in every building and all of America's other infrastructure would likely bankrupt the country without making an appreciable change in America's vulnerability to terrorism. The NIST proposals are simply changes so that the Government can say that Washington is addressing the problem, while accomplishing little or nothing.

Suggestion for Revision: The NIST investigation should stick to the facts and not offer opinions, other than those relevant to the investigation.

If NIST wants to express opinions in the investigation report, the report should clearly indicate that an opinion is being expressed and include a qualifier that the opinion expressed is not necessarily the opinion of the Administration, Congress or the American people. I don't believe that NIST speaks for the current Congress, the Bush Administration or the American people on this subject.

---

**Stephen Cauffman**

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 1:30 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Public Comment (Editorial/Technical)

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Sat, 23 Aug 2008 11:27:57 EDT
Subject: Public Comment (Editorial/Technical)
To: WTC@nist.gov
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808230069
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte
Affiliation: (Optional) Schulte & Associates
Contact: Phone number or e-mail address where you can be contacted in case of questions.
(Optional) fpeschulte@aol.com
Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9
Page Number: xxxi
Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) 3rd paragraph/1st sentence

Comment: The events in New York on September 11th are referred to as a "disaster". The events of September 11th were not a disaster, but a planned "military-style" attack on the World Trade Center towers and an attack on the economy of the United States.

Reason for Comment: No one that I know has ever referred to the dropping of atomic bombs on Hiroshima and Nagasaki in August 1945 as disasters, nor is the fire bombing of Dresden and other cities in Germany during World War II considered to be a disaster. Hiroshima, Nagasake and Dresden were planned military attacks on civilian populations. Given this, the September 11th attacks on the World Trade Center towers utilizing hi-jacked civilian aircraft as missiles in "kamakazi' attacks should not be referred to as a disaster.

Suggestion for Revision: Utilize the word "attack" rather than "disaster".

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## Stephen Cauffman

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 1:29 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Public Comment (Editorial)

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Sun, 24 Aug 2008 08:58:43 EDT
Subject: Public Comment (Editorial)
To: WTC@nist.gov
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=1 spamscore=1 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808240094
X-PP-SpamScore: 1
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 120

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) 2nd (complete) paragraph/2nd sentence

Comment: The report indicates that data sheets were created using Microsoft Excel. Is it really necessary to identify the computer software program utilized to create a spreadsheet?

Reason for Comment: The results determined from the data sheets would be the same, regardless of software manufacturer. Hence, the manufacturer of the software is irrelevant to the results. It should be noted that the report does not identify the manufacturers of the camera and video equipment used to take photographs and video. The reason for that is that the manufacturers of the cameras and video equipment is irrelevant to the conclusions drawn. The report should be consistent, either identify the manufacturers of all equipment used in the investigation or none of the manufacturers.

Suggestion for Revision: Delete the reference to Microsoft.

---

It's only a deal if it's where *you* want to go. Find your travel deal **here**.

**Stephen Cauffman**

| | |
|---|---|
| **From:** | wtc@nist.gov |
| **Sent:** | Friday, September 05, 2008 9:57 AM |
| **To:** | Stephen Cauffman |
| **Subject:** | Fwd: Public Comment |

X-Sieve: CMU Sieve 2.3
From: FPESCHULTE@aol.com
Date: Sat, 23 Aug 2008 10:03:24 EDT
Subject: Public Comment
To: WTC@nist.gov
X-Mailer: 9.0 Security Edition for Windows sub 15301
X-Spam-Flag: NO
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808230056
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: fpeschulte@aol.com
X-NIST-MailScanner-Information:

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 48

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) 5th (last) paragraph; last line on the page

Comment: Suggest that the report utilize the term "suspended ceiling", rather than "drop ceiling".

Reason for Comment: The term "drop ceiling" is slang for "suspended ceiling".

Suggestion for Revision: Substitute the term "suspended ceiling" for the term "drop ceiling" throughout the report.

It's only a deal if it's where *you* want to go. Find your travel deal **here**.

From: Shyam Sunder <sunder@nist.gov>
To: "'wtc@nist.gov'" <wtc@nist.gov>
Subject: FW: NIST WTC 7 Draft Report-Beam Fire Ratings

Dr. S. Shyam Sunder
Director
Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899-8600
Tel.: 301-975-5900; Fax: 301-975-4032

**From:** FPESCHULTE@aol.com [mailto:FPESCHULTE@aol.com]
**Sent:** Sunday, August 24, 2008 9:11 PM
**To:** Shyam Sunder
**Cc:** Nadine_Post@mcgraw-hill.com
**Subject:** Re: NIST WTC 7 Draft Report-Beam Fire Ratings

In a message dated 8/24/2008 7:36:14 P.M. Central Daylight Time, sunder@nist.gov writes:

> The sentence relating to the beams should read they had SFRM consistent with a 2 hour rating. This statement is in error and will be fixed tomorrow. In other parts of the report, including findings, you will see reference to the beams having SFRM consistent with a 2 hour rating.
>
> The fire rating and SFRM for the buildings were consistent with 1-B classification/specification for unsprinklered buildings (3 hour columns and 2 hour floors) even though the buildings had sprinklers. This was confirmed by the Port Authority.
>
> We also talk about the lack of water for the sprinklers, the effect of the structural damage, and the fact these were uncontrolled fires later in the report under principal findings and recommendations.

Thanks Shyam. You're working late tonight.

rich

From: Shyam Sunder <sunder@nist.gov>
To: "John L. Gross" <jgross@nist.gov ...snip... wtc@nist.gov'" <wtc@nist.gov>
Subject: FW: Public Comment (Technical)

Dr. S. Shyam Sunder
Director
Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899-8600
Tel.: 301-975-5900; Fax: 301-975-4032

**From:** Shyam Sunder
**Sent:** Monday, August 25, 2008 11:48 AM
**To:** 'Post, Nadine'
**Cc:** Gail Crum
**Subject:** RE: Public Comment (Technical)

Nadine,

We have reviewed both comments you sent this moring. A few points are worth noting:

1. The intent of current codes is that building components and subassemblies resist fires (represented by the ASTM E 119 time-temperature relationship) without any pre-wetting to reduce temperatures.
2. WTC 7 was unable to resist the fires (real fires, not the more conservative ASMT E 119 fires), due primarily to the effects of thermal expansion which are not explicitly considered in current design practice.
3. The draft NIST report explicitly states that (1) the sprinkler system did not function since water supply was cut off and (2) the fires burned uncontrolled without any manual fire suppression.
4. The key premise of NIST's recommendation is that buildings should not collapse in infrequent (worst-case) fires that may occur when active fire protection systems are rendered ineffective. Both sprinklers and manual suppression are considered to be active fire protection systems.

Shyam

Dr. S. Shyam Sunder
Director
Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899-8600
Tel.: 301-975-5900; Fax: 301-975-4032

**From:** Post, Nadine [mailto:nadine_post@mcgraw-hill.com]
**Sent:** Monday, August 25, 2008 10:17 AM
**To:** Shyam Sunder
**Subject:** FW: Public Comment (Technical)

Shyam: Pls. address this comment from Rich Schulte as you did his comment about the 1-hr

fire rating. I will be sending you other comments (from Rich and others) for your reaction, as well.
Thanks, Nadine

Nadine M. Post
Editor-at-Large
Buildings--Design and Construction
Engineering News-Record
McGraw-Hill Construction Media
2 Penn Plaza, 9th fl
New York, N.Y. 10121-2298
w: 212-904-4139
f: 212-904-2820

------ Forwarded Message
**From:** <FPESCHULTE@aol.com>
**Date:** Mon, 25 Aug 2008 09:49:22 EDT
**To:** <WTC@nist.gov>
**Cc:** <Nadine_Post@mcgraw-hill.com>
**Subject:** Public Comment (Technical)

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional)
fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 358

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4)
Section 8.10

Comment: This entire section fails to mention the lack of manual fire suppression efforts. As indicated in another comment, the simple act of pre-wetting combustible by the FDNY would have completely changed the heat exposure to the building structure. The tactic of pre-wetting by fire fighters was utilized to control the fire in the First Interstate Bank

Building. Similarly, pre-wetting by sprinklers was able to control the spread of fire in the One Meridian Plaza Building. (The tactic of pre-wetting is also used to control wild land fires.) In other words, the initiating event (other than fire ignition) was the decision to abandon the building and let the building burn.

Reason for Comment: Section 8.10 only addresses the collapse from a structural point of view. If temperatures had been reduced by "pre-wetting" the combustibles, the temperatures to which the building structure were exposed would likely been significantly reduced and the collapse avoided.

Avoiding the issue of the lack of manual suppression efforts, avoids the question of whether or not building should be designed assuming both the failure of the sprinkler system and the total failure of the fire department.

Although the water supply in Lower Manhattan had failed due to the collapse of WTC 1 and WTC 2, water supply was available from the Hudson River and from hydrants located further north. The FDNY is a large enough fire department that water supply relay (engine pumping to engine through 4 inch, 5 inch or 6 inch supply lines) from hydrants further north could have been established.

It also appears that the sprinkler system serving the low zone in the building could have been supplied through the fire department connection. Although the sprinkler system was damaged, so far in the report, NIST has not estimated the extent of the damage to the sprinkler system.

The intent of this comment is not to criticize FDNY for their decision not to fight the fire, but rather to indicate that in most fires, the fire department has options and the probability that both the sprinkler system will be ineffective and that manual fire suppression will be totally ineffective is miniscule. **Again, the question that needs to be answered clearly is whether we expect our buildings to be designed to withstand a 9/11 attack or whether our buildings should be designed for typical events.**

Suggestion for Revision: Suggest that the lack of manual suppression activities be considered as a direct cause of the collapse.

---



------ End of Forwarded Message

---

From: Shyam Sunder <sunder@nist.gov>
To: "John L. Gross" <jgross@nist.gov ...snip... wtc@nist.gov'" <wtc@nist.gov>
Subject: FW: Request from ENR

---

Dr. S. Shyam Sunder
Director
Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899-8600
Tel.: 301-975-5900; Fax: 301-975-4032

---

**From:** Post, Nadine [mailto:nadine_post@mcgraw-hill.com]
**Sent:** Monday, August 25, 2008 10:17 AM
**To:** Shyam Sunder
**Subject:** FW: Request from ENR

Here's another.

Nadine M. Post
Editor-at-Large
Buildings--Design and Construction
Engineering News-Record
McGraw-Hill Construction Media
2 Penn Plaza, 9th fl
New York, N.Y. 10121-2298
w: 212-904-4139
f: 212-904-2820

------ Forwarded Message
**From:** <FPESCHULTE@aol.com>
**Date:** Mon, 25 Aug 2008 09:08:00 EDT
**To:** <Nadine_Post@mcgraw-hill.com>
**Subject:** Fwd: Public Comment (Technical)

---



------ End of Forwarded Message

---

From: "FPESCHULTE@aol.com" <FPESCHULTE@aol.com>
To: "WTC@nist.gov" <WTC@nist.gov>
Date: Mon, 25 Aug 2008 09:05:31 -0400
Subject: Public Comment (Technical)
Thread-Topic: Public Comment (Technical)
Thread-Index: AckGvJ+xNkoTuitiTAamFK8rAnNZAw==
Message-ID: <c76.2db6827a.35e4081b@aol.com>
X-MS-Has-Attach:
X-MS-TNEF-Correlator:
full-name: FPESCHULTE
Content-Type: multipart/alternative;
boundary="_000_c762db6827a35e4081baolcom_"
MIME-Version: 1.0

Name: (Optional) Richard Schulte

Affiliation: (Optional) Schulte & Associates

Contact: Phone number or e-mail address where you can be contacted in case of questions. (Optional) fpeschulte@aol.com

Report Number: (e.g., NCSTAR 1-1) NCSTAR 1-9

Page Number: 342 (pdf page 393)

Paragraph/Sentence: (e.g., paragraph 2/sentences 2-4) last paragraph/

Comment: The paragraph does not address the fact that there were no manual fire suppression efforts. Even minimal manual fire suppression efforts in the building would have reduced the exposure of the structural system to heat generated by the fires.

Reason for Comment: The paragraph neglects to address the issue of the effects of manual fire suppression on the fire. In the fire in the First Interstate Bank Building, the LAFD was able to prevent the spread of fire up the building by, in effect, pre-wetting the combustible on the floors above the fire. Any pre-wetting of combustibles by the FDNY would have reduced the heat exposure to the WTC 7 structural systems and, more than likely, prevented the collapse of the building. Hence, it could be stated that the lack of any attempt to manually suppress the fires in the building, combined with the structural damage to the building from the collapse of the adjacent structures, was the proximate cause of the collapse.

Suggestion for Revision: Suggest that importance of the lack of manual fire suppression by the FDNY be considered.

From: Shyam Sunder <sunder@nist.gov>
To: '"terri@nist.gov"' <terri@nist.gov ...snip... Cauffman <cauffman@nist.gov>
Subject: FW: Beam Ratings; W/D ratios

Dr. S. Shyam Sunder
Director
Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899-8600
Tel.: 301-975-5900; Fax: 301-975-4032

**From:** Shyam Sunder
**Sent:** Tuesday, August 26, 2008 9:46 AM
**To:** 'FPESCHULTE@aol.com'
**Cc:** Nadine_Post@mcgraw-hill.com; Pregrp@aol.com; Gail Crum
**Subject:** RE: Beam Ratings; W/D ratios

Rich,

Most of the major beams used for the east and north side floor system were W24x55; just a few were W21x44. The smaller beams (W12s) were secondary framing elements they would not have a significant affect on the thermal response of the floor system.

We did calculations for both 5/8" and 3/4" SFRM thickness, representing 25 percent and 50 percent greater thickness than the 0.5" restrained SFRM thickness that was used based on current practice.

Our conclusion, see page 54 of the NCSTAR 1A, states:

> "It is unlikely that the collapse of WTC 7 would have been prevented had the insulation thickness on the floor beams been increased by 50 percent (from ½ in. to ¾ in.). NIST calculations indicated that the time to reach the steel temperature of 649 °C (1200 °F) would have increased by about 10 min to 20 min."

While we have not done a calculation for 7/8" SFRM thickness, it is unlikely that increased SFRM thickness would have made much difference, since thermal expansion effects occur at temperatures well below the 649 °C (1200 °F) and the time delay due to the increased SFRM thickness would have been minimal. The shear studs between the beam and the concrete slab failed due to differential thermal expansion, not due to reduced strength and stiffness which occurs at higher temperatures.

In addition, as we have shown previously for the floor system used in the WTC towers, there are significant thermally-induced scale effects not considered in current practice, i.e., the ASTM E 119 test method. Specifically, most ASTM E 119 tests are done in furnaces smaller than about 20 ft. Our WTC tower floor tests indicated that even if an acceptable fire rating is obtained in a standard size furnace, the fire rating of the full-scale subassembly may be less than acceptable. In WTC 7, the floor system was as much as three times as long as the typical furnace test specimen.

Finally, it was *not the rating of the composite floor subassembly itself that governed the fire-induced collapse initiation process; instead, it was the effect of the thermally expanded floor subassembly on adjacent girders critical to structural stability. In short, the failure of the critical girder was not dictated by its own fire rating.* That is why it is essential to account for the thermal interactions between components and subassemblies, including connections, which make up a structural system. Just using unrestrained ratings will not address this key problem.

Shyam

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**From:** FPESCHULTE@aol.com [mailto:FPESCHULTE@aol.com]
**Sent:** Monday, August 25, 2008 8:46 PM
**To:** Shyam Sunder
**Cc:** Nadine_Post@mcgraw-hill.com; Pregrp@aol.com
**Subject:** Beam Ratings; W/D ratios

Shyam-

The following are W/D ratios for the various beam sizes shown in **Figure 8-16**. (The W/D ratio are from Chapter 7 in the IBC.)

| | | |
|---|---|---|
| W8X28 | W/D = 0.80 | **1 hour unrestrained rating w/ 1/2 inch SFRM** |
| W12X19 | W/D = 0.53 | **NOT OK** |
| W12X26 | W/D = 0.60 | **NOT OK** |
| W12X30 | W/D = 0.69 | **NOT OK** |
| W21x44 | W/D = 0.73 | **NOT OK** |
| W24X55 | W/D = 0.82 | OK |
| W33X130 | W/D = 1.31 | OK |

Based upon NIST structural analysis, it is my opinion that many of the floor beams in the building should have been considered to be unrestrained, rather than restrained. (Section 8.7 in the NIST report.) Given this, it would appear that many of the beams in the building had a fire resistance rating of < 1 hour and that it would be improper to consider many of the beams to have a 2 hour rating.

This is not to point a finger at the fireproofing contractor or architect for the building, but rather to indicate that their is a problem with how "restraint" was determined-a problem with ASTM E119 and the UL Fire Resistance Directory ever since the issue of restrained vs. unrestrained ratings were included.

If I recall correctly, the Uniform Building Code (UBC) required all assemblies to be considered to be unrestrained, unless structural calculations were submitted to justify a restrained classification. I am not sure how long this provision was included in the UBC.

**Section 703.2.3 the 2006 IBC requires that the design professional certify that restraint is achieved in order for restrained fire resistance ratings to be used. This provision essentially requires structural calculations to demonstrate restraint, although many design professionals would simply point to ASTM E119 and the UL Fire Resistance Directory.**

It would be interesting to know what would have happened from a structural standpoint if the thickness of the SFRM would have been 7/8 inch thick in order to meet the requirement for a 2 hour restrained rating, rather than 1/2 inch thick.

rich

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From: Shyam Sunder <sunder@nist.gov>
To: "'terri@nist.gov'" <terri@nist.gov ...snip... rgann@nist.gov'" <rgann@nist.gov>
Subject: FW: Section 13.2, NIST Report WTC 7

==========================================
Dr. S. Shyam Sunder
Director
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National Institute of Standards and Technology
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Tel.: 301-975-5900; Fax: 301-975-4032
==========================================

**From:** Shyam Sunder
**Sent:** Tuesday, August 26, 2008 5:56 PM
**To:** 'FPESCHULTE@aol.com'; Nadine_Post@mcgraw-hill.com
**Cc:** Pregrp@aol.com; Gail Crum
**Subject:** RE: Section 13.2, NIST Report WTC 7

Rich,

Our report states that observations support a single point of fire ignition on any given floor in WTC 7. We also state that there were no obvious pathways for the flames and heat to pass from one floor to another, aside from the debris damaged area in the southwest corner of the building. We also did not see flame spread outside the building.

The fires in WTC 7 were similar to fires in the other buildings cited due to seven specific factors we identify in the report:

1. Ordinary combustibles and combustible load levels.
2. Local fire origin on any given floor.
3. No widespread use of accelerants.
4. Consecutive fire spread from combustible to combustible.
5. Fire-induced window breakage providing ventilation for continued fire spread and accelerated fire growth.
6. Concurrent fires on multiple floors.
7. Active fire protection systems rendered ineffective (sprinklers and manual suppression systems).

Shyam

==========================================
Dr. S. Shyam Sunder
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Tel.: 301-975-5900; Fax: 301-975-4032
==========================================

**From:** FPESCHULTE@aol.com [mailto:FPESCHULTE@aol.com]
**Sent:** Tuesday, August 26, 2008 5:47 PM

**To:** Nadine_Post@mcgraw-hill.com
**Cc:** Shyam Sunder; Pregrp@aol.com
**Subject:** Section 13.2, NIST Report WTC 7

Nadine-

Item 9 on page 602 of the report indicates that the collapse of WTC 1 caused the ignition of fires on 10 separate floors. These floors occurred in groups-7/8/9, 11/12/13, 19, 22, 29/30.

Based upon what I have read in the report, I do not believe that this is the case. **NIST indicates that 6 separate fires must have occurred on Floors 7, 8, 9, 11, 12 and 13 because NIST did not see any indication of flame spread outside the building.**

My opinion is that the collapse of WTC 1 caused fires on Floors 7 and 11 and that the fires spread to floors 8 and 9 and 12 and 13 through either improperly firestopped penetrations or through the improperly firestopped space between the edge of the floor construction and the exterior curtain wall. In other words, the fire spread was interior to the building. This would account for the fire spread on various floors lagging each other.

NIST cites both fire in the First Interstate Bank Building and the One Meridian Plaza Building as examples of where fires spread between floors on the exterior of the building, however, the fire spread in the One Meridian Plaza Building was interior, not exterior. The fire spread through improperly firestopped penetrations.

Just as an aside, fire spread between floors occurred in the fire at the Las Vegas Hilton Hotle fire in 1981. If I recall correctly, in this fire, the fire spread 8 floors in 25 minutes via the outside of the building-window to window above.

The NIST report on WTC 7 includes no information on the firestopping detail of the space between the edge of the floor construction and the curtain wall. This is a glaring omission in the report.

rich

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From: Shyam Sunder <sunder@nist.gov>
To: "'terri@nist.gov'" <terri@nist.gov ...snip... Cauffman <cauffman@nist.gov>
Subject: FW: Section 14.2. WTC 7 report

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**From:** Shyam Sunder
**Sent:** Tuesday, August 26, 2008 6:07 PM
**To:** 'FPESCHULTE@aol.com'; Nadine_Post@mcgraw-hill.com
**Cc:** Pregrp@aol.com; Gail Crum
**Subject:** RE: Section 14.2. WTC 7 report

Rich,

I have tried to answer these questions in my several previous responses. Thermal expansion effects are fundamentally different from loss of structural strength and stiffness which is the basis of ASTM E 119. This method simply does not work when interaction effects between components/subassemblies dominate the thermal response. ASTM E 119 is not capable of representing such interaction since it only tests single components/subassemblies.

Shyam

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**From:** FPESCHULTE@aol.com [mailto:FPESCHULTE@aol.com]
**Sent:** Tuesday, August 26, 2008 6:06 PM
**To:** Nadine_Post@mcgraw-hill.com
**Cc:** Shyam Sunder; Pregrp@aol.com
**Subject:** Section 14.2. WTC 7 report

Nadine-

The second bullet point under Objective One in Section 14.2 reads as follows:

**"The collapse of WTC 7 represents the first known instance of the total collapse of a tall building primarily due to fires. The collapse could not have been prevented**

**without controlling the fires before most of the combustible building contents were consumed."**

A number of errors in this statement. First, many people consider WTC 1 and WTC 2 to be total collapses of a tall building due primarily to fire. (I am not one of these people, but WTC 1 and WTC 2 are the first buildings which come to mind.) Second, it is my opinion that the collapse of WTC 7 was due to an error in applying the "restrained" fire resistance ratings, rather than the "unrestrained" fire resistance ratings.

Although the NIST report indicates that increasing the thickness of the fireproofing from 1/2 inch to 7/8 inch on the floor beams and girders would have only increased the structural capabilities a very short time, this statement is simply not logical. A fire on an office floor with a fire loading of 6.4 pounds per square foot does not cause beams with a 2 hour rating to loose their structural capabilities. This is simply not logical.

How can an increase in the thickness of the insulation increase the fire rating by 1 hour in an ASTM E119 test, but only increase the actual fire resistance rating of a structural member by only a few minutes? A 2 hour exposure to the ASTM E119 time-temperature curve is far more severe that an exposure to a real fire with a fire loading of only 6.4 pounds. No way is a 20 or 30 minute exposure in a real fire more severe than a 2 hour exposure to ASTM E119. The temperatures which develop in the real fire may be higher than those in the ASME E119 test for a very short period of time, but for only a few minutes.

Something is amiss here.

rich

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From: Shyam Sunder <sunder@nist.gov>
To: '"terri@nist.gov"' <terri@nist.gov ...snip... Sadek'" <fahim.sadek@nist.gov>
Subject: FW: Section 14.2. WTC 7 report

==========================================
Dr. S. Shyam Sunder
Director
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==========================================

**From:** Shyam Sunder
**Sent:** Tuesday, August 26, 2008 6:25 PM
**To:** 'FPESCHULTE@aol.com'
**Cc:** Gail Crum
**Subject:** RE: Section 14.2. WTC 7 report

Rich,

I really appreciate your note. This was indeed the issue that perplexed me for the past several months as we conducted the analysis. I probed this issue to satisfy myself adequately. My sense is that this topic will require much more study before we can fully understand this interplay. We are committed to ongoing research in this area and would welcome contributions from other researchers. This is an important problem around which we need to get our arms around. I will pass on this note to my colleagues so we can be in touch as we pursue the research.

Shyam

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==========================================

**From:** FPESCHULTE@aol.com [mailto:FPESCHULTE@aol.com]
**Sent:** Tuesday, August 26, 2008 6:25 PM
**To:** Shyam Sunder
**Subject:** Re: Section 14.2. WTC 7 report

In a message dated 8/26/2008 5:12:21 P.M. Central Daylight Time, sunder@nist.gov writes:

> I have tried to answer these questions in my several previous responses. Thermal expansion effects are fundamentally different from loss of structural strength and stiffness which is the basis of ASTM E 119. This method simply does not work when interaction effects between components/subassemblies dominate the thermal response. ASTM E 119 is not capable of representing such interaction since it only tests single components/subassemblies.

Shyam-

You're response to my e-mail note was **excellent** and the report does an **excellent** job of illustrating the point of the expansion of the structural members exposed to fire. **(And I mean that sincerely.)** You've convinced me and I agree 100 percent with the structural analysis, however, what puzzles me is the fact that an additional 3/8 inch of SFRM will only provide a short increase in the fire resistance. An additional 3/8 inch of SFRM should knock the temperatures of the steel down quite a bit, hence, significantly reducing the forces which develop in the beams as they expand. A 20 or 30 minute fire should be no match against a 2 hour beam. A 20 or 30 minute fire against a beam which only has a 50 minute fire resistance rating is another thing.

I don't have the capabilities to redo NIST's calculations, but I am just applying logic and common sense. Perhaps Arup can take a look at this.

rich

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From: Shyam Sunder <sunder@nist.gov>
To: "'terri@nist.gov'" <terri@nist.gov>,
...snip... <rgann@nist.gov>
Subject: Fw: Section 13.2, NIST Report WTC 7

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**From:** FPESCHULTE@aol.com
**To:** Shyam Sunder
**Cc:** Nadine_Post@mcgraw-hill.com
**Sent:** Tue Aug 26 18:28:39 2008
**Subject:** Re: Section 13.2, NIST Report WTC 7

In a message dated 8/26/2008 5:22:09 P.M. Central Daylight Time, sunder@nist.gov writes:

> I appreciate your field experience and your comments below. The key point we make is that the fires in WTC 7 had characteristics similar to those experienced in several other buildings. Our report cites the seven characteristic that make them similar.

Shyam-

Again, an excellent analysis, however, the report makes the point that the other buildings were symmetrical, while WTC 7 had an assymetrical design. An excellent observation. And an observation which leads me to question the use of restrained ratings vs. unrestrained ratings.

It's my opinion that the guidelines for the use of the "restrained" rating in ASTM E119 and the UL test standard are not definitive enough and are actually misleading. The report does an excellent job of making this point.

rich

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From: Shyam Sunder <sunder@nist.gov>
To: "'terri@nist.gov'" <terri@nist.gov ...snip... Cauffman <cauffman@nist.gov>
Subject: Fw: Further comment

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**From:** Shyam Sunder
**To:** 'FPESCHULTE@aol.com'
**Cc:** 'Nadine_Post@mcgraw-hill.com'
**Sent:** Wed Aug 27 23:04:26 2008
**Subject:** Re: Further comment

Rich,

As always thank you for your incisive and insightful comments. Our position is consistent with the NFPA approach to design fire scenarios and the chavacteristics we have identified for them is consistent with fires experienced in several tall buildings. The intent clearly is not for multi-floor fires to be synchronized as you have inferred but again to be consistent with prior fires.

Shyam

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**From:** FPESCHULTE@aol.com
**To:** Shyam Sunder
**Cc:** Nadine_Post@mcgraw-hill.com
**Sent:** Wed Aug 27 20:03:10 2008
**Subject:** Re: Further comment

Shyam-

My apologies. Thank you for taking the time to send me back to your previous e-mail notes. I'm in New Orleans right now and everybody, including me, is a little bit skittish. Right now, the NOAA has predicted landfall of Hurricane Gustav at the Louisiana/Mississippi line about 30 miles from New Orleans. Almost exactly were Katrina went through. Katrina made landfall about 6 AM on a Monday morning. It looks like Gustav will also make landfall on a Monday, but a little later in the day. Of course, NOAA 5 day predictions are actually anywhere between the Florida Panhandle and Houston-about 500 miles of coastline.

Item 6 on the list is the one that I'm not sure of. The fire starts in exactly the same place on every floor at exactly the same time? Highly improbable.

Does the fire loading change every time a tenant changes? That is certainly possible. I keep hearing how the fire loading has been increasing due to new materials (plastics) and that the fire loading now is much higher than it was in the 1940's. Of course, that is nonsense that the passive fire protection salesmen use to sell their passive fire protection products. The fire loading has been decreasing as time goes by-most of the finishes in a building are noncombustible these days.

In fire protection, active fire protection generally refers to sprinklers. The use of the term active fire protection to include manual fire fighting is new to me and to most everyone in the fire protection field. The typical terms are automatic fire protection, manual fire protection and passive fire protection with egress being separate from the three terms, although I've heard egress being considered to be passive fire protection lately (again by the passive fire protection salesmen).

In my mind, assuming the failure of both the sprinkler and standpipe systems, while possible, is simply so improbable that it is the same as assuming a simultaneous hurricane and snowstorm. The only time this has ever happened is on September 11th. Note that at the One Meridian Plaza fire, the standpipe system failed, but the sprinkler system functioned (beautifully, I might add).

NFPA 14 requires that each standpipe riser be provided with a control valve at the base of the riser, so that in the event that a riser breaks, the broken riser can be isolated. Each standpipe system in a high rise building is required to be provided with two water supply sources, an automatic water supply and the fire department connection. Often, fire departments require two fire department connections and will supply both fire department connections in case a pumper malfunctions. The likelihood of a standpipe system failure is minimal if the system is tested properly.

My concern is that NIST's recommendation is looking for absolute perfection in the protection that we provide for occupants of a building. Absolute perfection is nice, but there comes a time when we need to simply stop engineering and get on with it. The NFPA statistics indicate that the average number of Americans who die in all of the office buildings in the United States in 1 over the past several years. More than likely that means the number of Americans who die in high rise office buildings protected by a sprinkler system is 0. We can't do any better than that. Right now, over 40,000 Americans die in traffic accidents every year and close to 100,000 Americans die as a result of medical errors in hospitals. What is the justification for spending any more money than we are already spending on high rise office building fire safety when that money could be used to reduce the number of traffic fatalities or the number of fatalities from medical errors in hospitals.

Whether you die in a fire, die in a traffic accident or die as a result of a hospital medical error, you're still dead. The question that I have is it morally acceptable to continue to spend more and more money on building fire safety when that same money could be allocated to reducing the number of deaths that occur due to traffic accidents or medical errors? I don't think that there is any moral justification for continuing to throw money at a problem that has been solved. I think that an average of 1 person per year dying as a result of fires in office buildings is as close to zero as we are going to get.

I have been looking at the number of deaths that occur due to lightning strikes. The number varies from 40 to 70 Americans dying each year due to lightning strikes. Given the probability of being struck by lightning and being killed are just about 0, it difficult for me to understand why we need to be concerned about 1 person per year dying in office building fires. It's time to pat ourselves on the back for doing a great job and move on to the next problem.

Given the choice between what NIST has recommended and sprinkler protection in 1- and 2-family dwellings, my choice would be sprinkler protection in dwellings. The cost/benefit of sprinklers in dwellings is far greater than the cost/benefit of considering fire as a design load. Sometimes it's difficult to see the forest for the trees. The objective is to save lives, not just save lives from fire.

Don't mean to lecture you, but after studying the fire statistics for more than 20 years, I've come to the conclusion that we sure waste a whole lot of money on fire protection. I just read an article yesterday asking the question whether or not the United States Government is bankrupt. When we continually throw money at problems, regardless of whether or not we actually accomplish anything, sooner or later we're going to end up being bankrupt. When voters figure out that they can vote themselves money by voting for politicians who pander to them, then sooner or later the producers decide it's not worth it to produce and the whole thing comes apart.

Without a cost/benefit analysis to justify the need to implement NIST's recommendation, I simply can't support the recommendation. We need to address probable events, like traffic accidents, before we try to address events that simply don't happened (i.e. simultaneous hurricanes and snow storms).

I really appreciate you taking the time to walk me through the report. I'm sure that the above has bored you to death, but maybe it will help you get to sleep tonight.

Regards-

Rich

The fires in WTC 7 were similar to fires in the other buildings cited due to seven specific factors we identify in the report:

1. Ordinary combustibles and combustible load levels.
2. Local fire origin on any given floor.
3. No widespread use of accelerants.
4. Consecutive fire spread from combustible to combustible.
5. Fire-induced window breakage providing ventilation for continued fire spread and accelerated fire growth.
6. Concurrent fires on multiple floors.
7. Active fire protection systems rendered ineffective (sprinklers and manual suppression systems).

In a message dated 8/27/2008 5:54:33 P.M. Central Daylight Time, sunder@nist.gov writes:

> We have identified the seven key characteristics of these infrequent (worst-case) fires in the report. I included them in one of my responses yesterday.
>
> Shyam
>
> ---
>
> **From:** FPESCHULTE@aol.com <fpeschulte@aol.com>
> **To:** Nadine_Post@mcgraw-hill.com <nadine_post@mcgraw-hill.com>
> **Cc:** Shyam Sunder; Pregrp@aol.com <pregrp@aol.com>
> **Sent:** Wed Aug 27 17:35:52 2008
> **Subject:** Further comment
>
> "The intent of current practice, based on prescriptive standards and codes, is to achieve life safety, not collapse prevention. However, the key premise of NIST's recommendations is that buildings should not collapse in infrequent (worst-case) fires that may occur when active fire protection systems are rendered ineffective, e.g., when sprinklers do not exist, are not functional, or are overwhelmed by the fire."
>
> **Comment: The recommendation, as stated, is not specific enough to determine what NIST has in mind. Just what does NIST actually mean when they refer to "worst-case" fires?**
>
> **The "worst-case" fire in a building would assume simultaneous fires on all floors in the building, all reaching their peak temperatures throughout every floor simultaneously. The probability of this scenario is essentially the same as having the worst-case earthquake while simultaneously having a hurricane and a snowstorm. In order for NIST's recommendation to be meaningful, NIST needs to clarify what the term "worst-case" is actually intended to mean.**
>
> **While NIST's recommendation indicates that the design scenario assumes that the sprinkler system is non-functional, the recommendation does not address the issue of whether or not the fire department will attempt to manually control**

the fire.

The fire at the First Interstate Bank Building in Los Angeles in 1988 clearly demonstrated that fire spread between floors can be controlled by "pre-wetting" combustibles on floors immediately above the fire. The "pre-wetting" tactic can be used whenever a large fire occurs in a high rise building where the sprinkler system fails to control the fire. Hence, fire spread between more than 2 floors should never occur in the event of a sprinkler system failure. Eventually, the fire will consume all of the combustibles on the 2 floors involved and, without further fuel, simply burn itself out.

It is my opinion that the fires in the WTC 7 Building would not have caused the collapse in the building if the FDNY had chosen to actively fight the fires. Given the events of earlier in the day, the FDNY certainly can't be criticized for making that decision.

Rich Schulte
Schulte & Associates
Building Code Consultants
Chicago/New Orleans (if New Orleans is not destroyed by Hurricane Gustav)

From: Shyam Sunder <sunder@nist.gov>
To: "'terri@nist.gov'" <terri ...snip... Cauffman <cauffman@nist.gov>
Subject: Fw: Fwd: ENR Question Responses

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**From**: Shyam Sunder
**To**: 'FPESCHULTE@aol.com'
**Sent**: Wed Aug 27 11:59:21 2008
**Subject**: Re: Fwd: ENR Question Responses

Rich,

All 13 recommendations are in the summary WTC 7 report NCSTAR 1A.

Shyam

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**From**: FPESCHULTE@aol.com
**To**: Shyam Sunder
**Sent**: Wed Aug 27 11:05:26 2008
**Subject**: Fwd: ENR Question Responses

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From: Shyam Sunder <sunder@nist.gov>
To: "'terri@nist.gov'" <terri ...snip... Cauffman <cauffman@nist.gov>
Subject: Fw: ENR Question Responses

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**From:** FPESCHULTE@aol.com
**To:** Nadine_Post@mcgraw-hill.com
**Cc:** Shyam Sunder
**Sent:** Wed Aug 27 10:41:32 2008
**Subject:** ENR Question Responses

Nadine-

I may have a few more comments in a day or two, but this should do for now.

2) Does this open up a can of worms re: liability and litigation? What do you think the ramifications might be if a building collapses in a fire after an engineer had a) evaluated a building frame, as recommended; and b) made recs to an owner that then are not addressed by the owner.

**Response: Not really. The probability of a collapse due to a building fire is essentially nil. The fire safety record of steel-framed buildings protected by spray-applied fireproofing is actually magnificent.**

3) Re: Legal liability: What do you think the ramifications might be if an engineer tells an owner that it does not think a building needs to be beefed up for a worst-case design fire and then a fire happens and the building collapses?

**Response: The probability of a collapse due to a building fire is, for all practical purposes, zero.**

**In the case of WTC 7, the collapse only occurred as a result of a chain of improbable events. In the last 40 years, a major fire has never occurred in a sprinklered high rise building in the United States, other than as a result of the September 11th attacks.**

**Even if a sprinkler system protecting a steel-framed high rise office building did fail, manual firefighting operations should prevent a collapse. The collapse of the WTC 7 Building occurred due to the combined failure of the sprinkler system protecting the low zone of the building and the FDNY's decision not to fight the fire.**

**It is my opinion that designing buildings to withstand a September 11th attack is simply an irrational reaction to 9/11. High rise building designed to the codes which existed in 2001 provide more than adequate protection for our buildings. Just tweaking ASTM E119 a little should be all that is really necessary.**

ENR statement, question: NIST says it does not have any cost data to support its contention that engineers should be able to find "cost-effective" fixes. Pls. react to this assumption that "fixes" could be cost-effective. Wouldn't this depend on the specific building design?

**Response: Cost is relative. What really is of interest is cost/benefit. Since the**

**probability of a collapse is practically nil, the benefits of "fixing" the problem are essentially zero. Given this, the costs to "fix" for the problem will necessarily be high.**

ENR questions: Pls. speak out in support of or otherwise the conclusions and recommendations in the report. I'm wondering, for example, whether designing for structures to resist thermal resistance would add to the cost of design and if so, by how much?

**Response: Once again, cost is relative. The cost-effective solution to the problem has nothing to do with structural fire resistance, but making sprinkler systems protecting high rise buildings even more reliable than they already are. This could be easily and economically accomplished simply by providing a secondary water supply, a water storage tank, for the sprinkler system. Providing a water storage tank (or tanks) for a high rise building eliminates the total dependence on the municipal distribution system.**

NIST was purposely silent about narrowing the field to any specific building type, size and whether the new standard (and code) should apply to new buildings or all buildings. Please react.

**Response: The fire statistics for buildings protected by a sprinkler system clearly indicate that sprinklers address the fire problem and that sprinkler systems are highly reliable. Spending more money on additional passive fire protection than already required for buildings protected by a sprinkler system is a mistake.**

Do you agree with NIST that "the standards for estimating load effects of potential hazards (e.g. progressive collapse, wind) and the design of structural systems to mitigate the effects of those hazards should be improved to enhance structural integrity"?

**Response: NIST has identified a problem regarding how "structural restraint" is determined for purposes of determining fire resistance ratings. The solution to this problem is to expand ASTM E119's guidelines on "restraint" and to start to pay more attention to the protection of connections in steel construction. In other words, just a little tweak of ASTM E119.**

rich

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From: Shyam Sunder <sunder@nist.gov>
To: "'terri@nist.gov'" <terri@nist.gov>,
...snip... <cauffman@nist.gov>
Subject: Fw: Design Scenario 8

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**From:** Shyam Sunder
**To:** 'FPESCHULTE@aol.com'
**Cc:** 'Nadine_Post@mcgraw-hill.com'
**Sent:** Thu Aug 28 10:57:21 2008
**Subject:** Re: Design Scenario 8

Rich,

Thanks for the clarification. We maintain the approach is consistent with NFPA. Our approach does not require both the active and the passive fire protection systems to be rendered ineffective simultaneously. We define the characteristice of such building fires based on historical experience which NFPA does not do adequately.

Shyam

---

**From:** FPESCHULTE@aol.com
**To:** Shyam Sunder
**Cc:** Nadine_Post@mcgraw-hill.com
**Sent:** Thu Aug 28 10:23:30 2008
**Subject:** Re: Design Scenario 8

In a message dated 8/27/2008 10:10:13 P.M. Central Daylight Time, sunder@nist.gov writes:

> Our position is consistent with the NFPA approach to design fire scenarios and the chavacteristics we have identified for them is consistent with fires experienced in several tall buildings.

Shyam-

The Life Safety Code indicates that the provisions contained in the Code are only based upon **a single fire**, not multiple fires, occurring in the building. (See section 4.3 in the 2006 edition of the LSC.) Hence, the assumption of fire spread to multiple floors would be from a fire originating at a single point in the building.

Design Scenario 8 (section 5.5.3.8 in the LSC-2006) does not require that both the passive and active fire protection systems be assumed to fail. Hence, if it assumed that the sprinkler system is non-functional, then it is assumed that the passive fire protection systems are still functional. Simultaneous failures of both the sprinkler system and passive fire protection systems (the floor construction) are not required to be assumed.

If the fire is assumed to originate at a single point in the building and the passive fire protection systems do not fail (Design Scenario 8), then the fire would be contained to a single floor.

**Hence, the scenario contemplated in the NIST recommendations far exceeds the requirements contained in Design Scenario 8 in the LSC. Also note that Design**

**Scenario 8 does <u>not</u> contemplate no manual fire fighting.**

rich

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From: Shyam Sunder <sunder@nist.gov>
To: "'terri@nist.gov'" <terri@nist.gov>,
...snip... <cauffman@nist.gov>
Subject: Fw: Fwd: Design Scenario 8-Follow-Up

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**From:** FPESCHULTE@aol.com
**To:** Nadine_Post@mcgraw-hill.com
**Cc:** Shyam Sunder
**Sent:** Thu Aug 28 12:02:37 2008
**Subject:** Fwd: Design Scenario 8-Follow-Up

In a message dated 8/28/2008 10:03:20 A.M. Central Daylight Time, sunder@nist.gov writes:

> Thanks for the clarification. We maintain the approach is consistent with NFPA. Our approach does not require both the active and the passive fire protection systems to be rendered ineffective simultaneously. We define the characteristice of such building fires based on historical experience which NFPA does not do adequately.

Nadine-

See the above. NIST is proposing a performance-design scenario which is far and above that required by the LSC and NFPA 5000.

The following are excerpts from the 2006 edition of the Life Safety Code:

**4.3* Assumption.** The protection methods of this Code assume a single fire source.

**5.5.3.8* Design Fire Scenario 8.** Design fire scenario 8 shall be as follows:

(1) It is a fire originating in ordinary combustibles in a room or area with each passive or active fire protection system independently rendered ineffective.

(2) It addresses concerns regarding the unreliability or unavailability of each fire protection system or fire protection feature, considered individually.

(3)*It is not required to be applied to fire protection systems for which both the level of reliability and the design performance in the absence of the system are acceptable to the authority having jurisdiction.

The NIST report does not make a case for assuming fire spread throughout all floors of a high rise building occurring at the same time that sprinkler system failure occurs and the fire department makes a decision not to apply water to the building.

The fire at the WTC 7 Building on September 11th is an excellent illustration. Despite the previous events of earlier that day, fire did not spread throughout all of the floors in the building. Even with the failure of the municipal water supply, it appears that the sprinkler system was still able to control the fires in the upper zones of the sprinkler system. If the low zone of the sprinkler system was provided with a water storage tank as a secondary supply, it is possible that WTC 7 would still be standing today.

Assuming sprinkler system failure followed by a major fire is an event which has never occurred in any high rise building fire in the United States, other than on 9/11. Assuming sprinkler system failure and failure of the fire department to manually fight the fire at the same time is a freak event.

The question after the WTC 7 report is really the same question which surfaced after the WTC 1 and WTC 2 report: should we design our buildings to withstand freak events. If the answer to the that question is yes, what freak occurrences should be used as a design basis? Hi-jacked airplanes intentionally flown into buildings, meteor and asteroid strikes or simultaneous massive hurricanes and massive snowstorms?

According to NIST, simply because it has never happened before, doesn't mean that it can't happen. We simply can't afford to design buildings for any and every freak event that could potentially occur-the list of events is endless. Given this, the question which NIST should address is why draw the line at simultaneous total burnout without sprinkler protection or manual fire fighting? Why not assume along with total burn-out another catastrophic building event?

Common sense and reason has to play a role in deciding the design basis for our high rise buildings. In my opinion, total burnout assuming sprinkler system failure and failure of the fire department to make any attempt to control the fire is outside the bounds of common sense and reason.

rich

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Received: from rly-dc06.mx.aol.com (rly-dc06.mail.aol.com [172.19.136.35]) by air-dc06.mail.aol.com (v121_r2.12) with ESMTP id MAILINDC063-b2848b6be1e97; Thu, 28 Aug 2008 11:03:19 -0400
Received: from smtp.nist.gov (rimp2.nist.gov [129.6.16.227]) by rly-dc06.mx.aol.com (v121_r2.11) with ESMTP id MAILRELAYINDC064-b2848b6be1e97; Thu, 28 Aug 2008 11:02:54 -0400
Received: from wsex01.xchange.nist.gov (WSEX01.nist.gov [129.6.16.38])
by smtp.nist.gov (8.13.1/8.13.1) with ESMTP id m7SF2iVm023286;
Thu, 28 Aug 2008 11:02:44 -0400
Received: from wsex01.xchange.nist.gov ([129.6.16.38]) by
wsex01.xchange.nist.gov ([129.6.16.38]) with mapi; Thu, 28 Aug 2008 10:57:22
-0400
From: Shyam Sunder <sunder@nist.gov>
To: "'FPESCHULTE@aol.com'" <FPESCHULTE@aol.com>
CC: "'Nadine_Post@mcgraw-hill.com'" <Nadine_Post@mcgraw-hill.com>
Date: Thu, 28 Aug 2008 10:57:21 -0400
Subject: Re: Design Scenario 8
Thread-Topic: Design Scenario 8
Thread-Index: AckJGPv7WpLOsUnBR12/22j0ve8/FgABWPxX
Message-ID:
<9A7597AAF4D11D499C585567A505904601F7AAC253@wsex01.xchange.nist.gov>

Accept-Language: en-US
Content-Language: en-US
X-MS-Has-Attach:
X-MS-TNEF-Correlator:
acceptlanguage: en-US
x-nist-mailscanner: Found to be clean
x-nist-mailscanner-from: sunder@nist.gov
x-aol-ip: 129.6.16.227
x-aol-scoll-authentication: domain : nist.gov ; SPF_822_from = n
Content-Type: multipart/alternative;
boundary="_000_9A7597AAF4D11D499C585567A505904601F7AAC253wsex01xchange_"
MIME-Version: 1.0

Rich,

Thanks for the clarification. We maintain the approach is consistent with NFPA. Our approach does not require both the active and the passive fire protection systems to be rendered ineffective simultaneously. We define the characteristice of such building fires based on historical experience which NFPA does not do adequately.

Shyam

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**From:** FPESCHULTE@aol.com
**To:** Shyam Sunder
**Cc:** Nadine_Post@mcgraw-hill.com
**Sent:** Thu Aug 28 10:23:30 2008
**Subject:** Re: Design Scenario 8

In a message dated 8/27/2008 10:10:13 P.M. Central Daylight Time, sunder@nist.gov writes:

> Our position is consistent with the NFPA approach to design fire scenarios and the chavacteristics we have identified for them is consistent with fires experienced in several tall buildings.

Shyam-

The Life Safety Code indicates that the provisions contained in the Code are only based upon **a single fire**, not multiple fires, occurring in the building. (See section 4.3 in the 2006 edition of the LSC.) Hence, the assumption of fire spread to multiple floors would be from a fire originating at a single point in the building.

Design Scenario 8 (section 5.5.3.8 in the LSC-2006) does not require that both the passive and active fire protection systems be assumed to fail. Hence, if it assumed that the sprinkler system is non-functional, then it is assumed that the passive fire protection systems are still functional. Simultaneous failures of both the sprinkler system and passive fire protection systems (the floor construction) are not required to be assumed.

If the fire is assumed to originate at a single point in the building and the passive fire protection systems do not fail (Design Scenario 8), then the fire would be contained to a single floor.

**Hence, the scenario contemplated in the NIST recommendations far exceeds the requirements contained in Design Scenario 8 in the LSC. Also note that Design Scenario 8 does not contemplate no manual fire fighting.**

rich

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It's only a deal if it's where *you* want to go. Find your travel deal **here**.

From: Shyam Sunder <sunder@nist.gov>
To: "'terri@nist.gov'" <terri@nist.gov>,
...snip... <cauffman@nist.gov>
Subject: Fw: Design Scenario 8 (Failures)

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**From:** Shyam Sunder
**To:** 'FPESCHULTE@aol.com'
**Cc:** 'Nadine_Post@mcgraw-hill.com'
**Sent:** Fri Aug 29 07:29:50 2008
**Subject:** Re: Design Scenario 8 (Failures)

Rich,

I agree, consistent with the NFPA approach, designs should consider both scenarios: one in which the active system fails, the other in which the passive system (SFRM) fails.

With regard to the characteristics of the fire, the historical experience should provide guidance since the NFPA document does not do so adequately.

Nowhere in our report do we cite the NFPA design scenario; it is the general approach that guided us.

All our recommendations from our investigation of the WTC towers and WTC 7 have been performance-based changes to practice, standards, and codes.

Shyam

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**From:** FPESCHULTE@aol.com
**To:** Shyam Sunder
**Cc:** Nadine_Post@mcgraw-hill.com
**Sent:** Fri Aug 29 06:26:49 2008
**Subject:** Re: Design Scenario 8 (Failures)

In a message dated 8/28/2008 10:03:20 A.M. Central Daylight Time, sunder@nist.gov writes:

> Thanks for the clarification. We maintain the approach is consistent with NFPA. Our approach does not require both the active and the passive fire protection systems to be rendered ineffective simultaneously. We define the characteristice of such building fires based on historical experience which NFPA does not do adequately.

Shyam-

**NIST's interpretation of the LSC Design Scenario 8 is incorrect.**

The following summarizes NIST's position with respect to Design Scenario 8:

| | |
|---|---|
| Sprinkler System: | fails |
| Manual Fire Fighting: | fails to take any action |
| Floor-to-Floor Compartmentation: | fails to contain fire spread to 2 floors |

NIST's proposed approach to building design assumes three total failures in the building fire protection system design. While NIST assumes total failures of the sprinkler system, fire department and building compartmentation , NIST then proposes to assume that the building's structural fire protection can be made to be 100 percent effective.

Based upon my field experience, I have never seen a building where the insulation of a building's structural steel frame has been installed correctly throughout the building and then maintained in this state throughout the life of the building. NIST's recommendation does not provide any guidance with respect to the assumption regarding the adequacy of the SFRM installation and the maintenance of the SFRM installation. The changes to the IBC regarding the inspection of SFRM installations in no way guarantees that the installation will be 100 percent effective thirty or forty years after the building is constructed.

In summary, on the one hand, NIST assumes that the sprinkler system will fail, that the fire department will fail to respond to the fire and that the floor-to-floor compartment will fail and then assumes that the building's SFRM will be installed and maintained so that it achieves 100 percent effectiveness. The least likely of all four of the different types of protection provided to be installed 100 percent correctly and to be maintained perfectly is the SFRM installation.

Given the above, NIST's recommendation regarding designing the structural frame to resist a total burn-out of the building appears to defy logic and common sense.

NIST's explanation of why NIST believes that the design should be based upon the complete failure of 3 of the 4 fire protection systems provided for high rise buildings, while at the same time assuming that the fourth fire protection system in a building will be completely effective would be of interest. No fire protection provided in a building will ever be 100 percent effective over the life of a high rise building. The closest that we have come to 100 percent effectiveness is the sprinkler system.

rich

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From: Shyam Sunder <sunder@nist.gov>
To: "'terri@nist.gov'" <terri@nist.gov>,
...snip... <cauffman@nist.gov>
Subject: Fw: Design Scenario 8 (Failures)

---

**From**: Shyam Sunder
**To**: 'FPESCHULTE@aol.com'
**Cc**: 'Nadine_Post@mcgraw-hill.com'
**Sent**: Fri Aug 29 08:52:40 2008
**Subject**: Re: Design Scenario 8 (Failures)

Rich,

As with all our recomendstions, specific code change proposals will now need to be developed through industry participation and leadership.

We continue to maintain that our "approach" is consistent with the NFPA approach with more specific characteristics of design fires based on historical experience as stated in our report.

Shyam

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**From**: FPESCHULTE@aol.com
**To**: Shyam Sunder
**Cc**: Nadine_Post@mcgraw-hill.com
**Sent**: Fri Aug 29 08:32:01 2008
**Subject**: Re: Design Scenario 8 (Failures)

In a message dated 8/29/2008 6:35:34 A.M. Central Daylight Time, sunder@nist.gov writes:

> Nowhere in our report do we cite the NFPA design scenario; it is the general approach that guided us.

Shyam, I agree, however, in one of your recent e-mail notes you indicated that the NIST recommendation was consistent with NFPA design scenarios. My point is that the NIST recommendation is <u>not</u> consistent with NFPA design scenarios. It far exceeds the NFPA design scenario #8.

Again, the NIST recommendation does not address the assumptions regarding SFRM. Is it NIST's intent to assume that SFRM for steel is 100 percent effective (unlikely) or is it NIST intent to assume a lesser degree of protection by SFRM than 100 percent? If it is less than 100 percent effective, what guidance do designers have from NIST regarding the effectiveness of SFRM. Missing SFRM at a strategic point could compromise the protection provided by SFRM (as was noted in the WTC 1/WTC 2 report.

NIST's recommendation is incomplete at best. It doesn't seem that this recommendation has actually been completely thought out and a whole lot more thought on this recommendation is needed.

rich

rich

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From: Shyam Sunder <sunder@nist.gov>
To: "'terri@nist.gov'" <terri@nist.gov>,
...snip... <cauffman@nist.gov>
Subject: Fw: Design Scenario 8 (Failures)

---

**From:** Shyam Sunder
**To:** 'FPESCHULTE@aol.com'
**Sent:** Fri Aug 29 09:27:42 2008
**Subject:** Re: Design Scenario 8 (Failures)

Rich,

We obviously disagree. You are interpreting from a prescriptive and literal viewpoint. We are not.

Take care as Gustav makes landfall.

Have a great weekend.

Shyam

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**From:** FPESCHULTE@aol.com
**To:** Shyam Sunder
**Sent:** Fri Aug 29 09:04:35 2008
**Subject:** Re: Design Scenario 8 (Failures)

In a message dated 8/29/2008 7:58:18 A.M. Central Daylight Time, sunder@nist.gov writes:

> We continue to maintain that our "approach" is consistent with the NFPA approach with more specific characteristics of design fires based on historical experience as stated in our report.

Shyam-

As my grandfather used to say, "shoot yourself". It's very apparent that the recommendation is not consistent with NFPA Design Scenario #8. I don't expect to be able to persuade you of that, but at least I tried. NIST's credibility is on the line. My recommendation is for NIST to avoid making that statement. Just some advice, but I don't expect that NIST will heed the advice. Hence, the reason for my grandfather's missive.

rich

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From: Shyam Sunder <sunder@nist.gov>
To: "'terri@nist.gov'" <terri@nist.gov>,
...snip... <cauffman@nist.gov>
Subject: Fw: Bolt Failure-NCSTAR 9 (page 718)

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**From:** Shyam Sunder
**To:** 'FPESCHULTE@aol.com' ; 'Nadine_Post@mcgraw-hill.com'
**Sent:** Mon Sep 01 12:54:19 2008
**Subject:** Re: Bolt Failure-NCSTAR 9 (page 718)

Rich,

The focus is on a "methodology". This implies an accepted/established methodology, particularly one that can be used routinely in practice.

We used a detailed and rigorous modeling approach that would not be an approach to use routinely in practice.

We also clearly indicate that our modeling approach is sufficient to come up with firm findings and recommendations.

Our recommendations call for much greater effort in developing an understanding and filling critical gaps in knowledge about the fire behavior of structural systems, including connections.

I am glad Gustav has spared New Orleans. Be safe!

Shyam

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**From:** FPESCHULTE@aol.com
**To:** Nadine_Post@mcgraw-hill.com
**Cc:** Shyam Sunder
**Sent:** Mon Sep 01 12:03:52 2008
**Subject:** Bolt Failure-NCSTAR 9 (page 718)

Nadine-

This excerpt taken from page 718 of the NIST report is rather interesting:

"***Bolt failure is complex both at room- and elevated-temperature and no methodology exists for modeling the failure of bolts, as distinct from the steels in which they are made, at elevated temperature.***"

Of course, this raises the question of whether or not the modeling of a structural steel frame at elevated temperatures is actually accurate and, perhaps, calls into question whether or not we have sufficient knowledge to perform a reasonably accurate structural analysis under "worst case" fire conditions as recommended by NIST.

On another note, the hurricane is pretty much over as far as New Orleans is concerned (I think). Actually, it was no big deal. The trash cans on the street are upright and still where they were yesterday. My apartment is in the business district and the lights are still on. So far, not much rain in downtown. Looks like the levees protecting New Orleans held. I sure am glad I couldn't leave yesterday-sitting in bumper-to-bumper traffic for 10 hours would have been far more nerve-racking that the 60 mph winds we got here. I guess I should thank the hotel engineer for locking up the parking garage so I couldn't get my car out.

rich

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## Stephen Cauffman

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 3:59 PM
**To:** Stephen Cauffman
**Subject:** FW: WTC 7

X-Sieve: CMU Sieve 2.3
From: Shyam Sunder <sunder@nist.gov>
To: "'wtc@nist.gov'" <wtc@nist.gov>
CC: Stephen Cauffman <cauffman@nist.gov>,
"'ben.stein@nist.gov'"
<ben.stein@nist.gov>,
"'Michael E. Newman'" <michael.newman@nist.gov>,
Gail
Porter <porter@nist.gov>, "Heyman, Matthew" <heyman@nist.gov>,
"Michael R.
Rubin" <mrubin@nist.gov>, Gail Crum <crum@nist.gov>
Date: Mon, 25 Aug 2008 12:27:20 -0400
Subject: FW: WTC 7
Thread-Topic: WTC 7
Thread-Index: AckEsx2HRoQIjG+aQsuiUyb4NQYpCACHQJ0w
Accept-Language: en-US
X-MS-Has-Attach:
X-MS-TNEF-Correlator:
acceptlanguage: en-US
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: sunder@nist.gov
X-NIST-MailScanner-Information:

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Dr. S. Shyam Sunder
Director
Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899-8600
Tel.: 301-975-5900; Fax: 301-975-4032

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**From:** contact@wholetruthtv.com [mailto:contact@wholetruthtv.com]
**Sent:** Friday, August 22, 2008 8:04 PM
**To:** Shyam Sunder
**Subject:** WTC 7

Greetings Dr. Sunder.

I have just read of the findings that WTC 7 collapsed because of "thermal expansion". Dr., I am not an educated man in the sense of schools of higher learning. But, my senses of sight and sound are on par with many people. I have researched 9/11 extensively. As a boy I watched with fascination as buildings were demolished, carefully orchestrated to drop right in their footprints, "Pulled", the same term used by NYPD officers to disperse bystanders near WTC 7 and used by demolitions experts.

How do you explain the never before observed “new phenomenon” of “thermal expansion”? How, if this is a never before observed phenomenon, do you explain how the building dropped with such precision as if it were a controlled demolition?

This explanation doesn't wash. The news reports I have seen says this report will put the 9/11 "conspiracy theory" to rest. Your report has only made it stronger!

We will not stop our quest for the truth. And, one day you will have to stand before God and explain why you took the cowards route by lying to your fellow countrymen and to the world.

If a war crimes tribunal is ever convened, you should be indicted along with George W. Bush and Richard Cheney for the crimes of murder and treason.

Sincerely,
Rick James
Member:We Are Change, New York

# Response to the NIST Report on WTC 7

by

Robert M. Korol, Emeritus Professor, Civil Engineering, McMaster University

Hamilton, Ontario, Canada L8S 4L7

It is clear from your WTC 7 report (dated August 2008) that you are not holding anyone responsible for the collapse of this 47 storey structure, but suggest that its demise was caused by fires which inadvertently started by burning debris that was propelled about 350 feet during the collapse of WTC 1. Indeed, we are all grateful that no loss of life occurred when #7 came down late in the afternoon of that tragic day, forever remembered as 9/11.

I wish to divide my remarks/criticisms of the above-mentioned report (herein referred to as "the WTC 7 NIST or simply the NIST report) into several general remarks, followed by specific comments that I believe are weaknesses/omissions that should be addressed. No doubt others will be making submissions equally valid, and so my hope is that an incorporation of such inputs will be included in an appropriate way to embrace legitimate issues that NIST ought to address, before describing the August 2008 report as "Final".

## General Comments

a) Global Collapse Time

Unfortunately, the NIST report has omitted providing details of the "physical principles" employed to calculate the collapse time of the uppermost part of the structure (noted in Section 3.6). While your calculated time for the motion of the top 18 storeys may appear reasonable, i.e. 40% longer than freefall in a vacuum, my calculations which account very modestly for floor system failures into the plastic range and energy losses in end support deformations up to a failure state, suggest that the collapse time is likely significantly longer than freefall if Newton's laws are properly applied. While not stated in your report, it appears as if energy dissipation during the stages of a collapse sequence may not been taken into account. Indeed, video camera observations and frame-by-frame analysis put the time of collapse, not counting the penthouse at about 6.5 sec. Whether or not this estimate will stand up to scrutiny remains to be seen. In the meantime, a study done by this author suggests a time of collapse for a storey-by-storey progression to rubble of this once majestic structure to be of the order of 11.5 sec. (ref.1). Although the scenario I assumed was different from the one you describe, I fail to see how your collapse hypothesis could result in a faster rate of descent than the one I assumed. Despite being unable to obtain structural member sizes or connection details prior to undertaking an independent study, I used FEMA information (Ch. 5 of their WTC 7 report) and information gleaned from the NIST reports for

WTC 1 and 2. My knowledge of design details, added to what could be surmised as likely structural layouts, allowed calculations of energy dissipation scenarios embracing conservation of energy and linear momentum principles. Information about column sizes and steel properties, would have allowed inclusion of larger energy dissipation values to be added to those of the floors and their connections to the columns. Despite such an omission and the very conservative assumptions made, I nonetheless calculated the time to collapse to be of the order of 80% higher than the 6.5 seconds mentioned earlier. I should point out that my plans were and remain - to use the Bazant model for column collapse as a basis. And, had I been able to do so, I would have expected a much higher collapse time than computed. This point highlights another weakness in the NIST report – a lack of information about the structural and architectural details necessary for others who may wish to add their thoughts and expertise to a first-of-its-kind fire protected structural steel hi-rise building collapse.

b) Combustibles Within Offices

Clearly lacking in the report is any mention about regulations needed to limit combustible building contents within cubicles and offices. To more adequately protect fire-protected steel structures, beyond the installation of sprinkler systems, fire alarms, heat detectors etc., NIST ought to consider a recommendation that imposes some restrictions on tenants' use of wood furnishings, book holdings and exposed paper materials (the latter would reasonably be expected to be locked up in steel filing cabinets, in any event, especially those deemed confidential). Another important issue is that no mention is made in the NIST report about moveable and "permanent" partitions. These should, in my opinion have a required fire rating, and address the problem of flashover – an issue raised by your experts as a cause of fire spread.

c) Implications of NIST Recommendations on Engineering and Architectural Design for Hi-Rise Construction

Very competent experts designed and built WTC 7. Your acknowledgement that fires both weakened steel members and the floor-to-column connections is both troubling to the structural steel fraternity and the architectural community having, until now, an unblemished record of structural safety. If, as you say, fires burning at high temperatures over a height of 5 or 6 storeys, with little if any storey- to- storey migration of fire spread, suggests that despite the fireproofing, applied in accordance with the standard of the industry, building 7 nonetheless succumbed, casts a pall of despair on all steel buildings . If NIST is right, it puts steel hi-rises at a huge disadvantage compared to super strength reinforced concrete structures. Potential owners will want to minimize construction costs, insurance premiums, and possible regulations in tenant use of space. The inference, if not stated outright, is that steel, even with fire-protection does not appear to meet such needs.

d) New Curriculum Changes Needed in the Training of Engineers?

The science of fire engineering has, until now, been beyond the scope of engineering schools, and rightly so. The demands on engineering faculties have been enormous, given the new technologies that have evolved, the skill sets needed to master ever more complicated software programs, and the constant debate of basic science versus practical engineering applications. Fire loads, heat and flame spreads, flashover phenomena and the thermodynamics that are so basic to a proper understanding of the science will pose an enormous challenge to those who must teach the engineers and architects of tomorrow, and to those who must learn another science together with the practical engineering-knowhow that fire engineering involves. So again the point – NIST must appreciate the challenges that the present report poses.

Specific Comments

a) Damage to the South Face

As stated in Sect.2.2.2 (p.14), "Pieces of WTC 1 hit WTC 7, severing six columns on Floors 7 through 17 on the south face…..", represents the initial damage done to #7. Since these vertical members were load bearing (of unspecified size), the kinetic energy of the projected materials must have been enormous. Indeed, "severing" is a word which engineers would interpret as being "shearing" off. As you have indicated, this event happened more than an hour and a half after the airplane strike and explosion within WTC 1. The NIST report on the twin towers rules out explosives as causing their collapse. However, it does raise the question of where the energy sources came from to cause such havoc to #7, considering that large debris items had to be propelled from a collapsing building 350 feet away, and when the lateral component of velocity responsible for "severing" must be used.

b) Expansion Effects

As noted in the "Recommendations", Section 5.1.2 , NIST recommends …"the effects of thermal expansion in buildings with …..long-span floor systems….connection designs (especially shear connections)….shear studs that could fail…in composite floor systems,…lack of shear studs on girders…" etc. This is an extremely tall order that has huge implications for a building load analysis. It will require consideration of fire loads, combustible materials in office spaces, heat transfer mechanisms be they by radiation, convection or conduction, or a combination of all three. But, without controls on what tenants will be allowed to do with their rental space, i.e. provide personnel with specific non-combustible furnishings, make mandatory requirements regulating the number of loosely placed sheets of paper on desks and on book shelves, and in paper trays of computers etc., it will not be possible to adequately design the building to resist fire loadings. NIST clearly advocates "Industry should partner with the research community to fill critical gaps in knowledge about how structures perform in *real fires* (my emphasis – see p. 59 of 5.1.2). But surely, the users of building space must also cooperate! How else can any design team possibly predict the damage that real fires can do to a structure? It is important to make the point that long spans unencumbered with columns, and composite construction have made hi-rise building construction very attractive both to the design/build industry, and to corporations leasing such space. In this author's view, such benefits are at risk if the NIST recommendations are implemented.

## Summary

Having taught structural mechanics and steel design for 30 plus years (at McMaster University in Hamilton, Canada) with a variety of practical experience with structural steel projects, I am of the opinion that NIST is being overly hasty in making recommendations, essentially based on one fire collapse failure. There are questions which remain unanswered about why the structure collapsed more rapidly than even conservative assumptions concerning energy dissipation of structural elements would predict. There is the issue of fire as a building design load being a far more complex subject area than educational institutions will be reasonably able to address with new engineering students in tow. There is the matter of competitiveness of steel versus reinforced super strength concrete in high rise building design, and then there is the question of regulating tenants use of space with regard to what combustibles will be allowed either as furnishings, partitions, even working papers on desks or stacked on open shelves. Discouraging the use of composite construction and long span floor design provides yet another matter which NIST should re-think.


## References


1. Korol, R.M., "Do High Rise Steel Structures Deserve a Loss of Image After 9-11?, Canadian Conference on the Effective Design of Structures, May 2008, McMaster University, Hamilton, Canada.
2. NIST NCSTAR 1A, "Final Report on the Collapse of World Trade Center Building 7, August 2008.
3. FEMA report, "World Trade Center Building Performance Study", Chapter 5, 2002.
4. Bazant, Z.P., "Why Did the World Trade Center Collapse? – Simple Analysis", Journal of Engineering Mechanics, Jan, 2002, pp1-6.

From: "Robert Tharp" <spanlib@earthlink.net>
To: wtc@nist.gov
Subject: Unresolved questions concerning WTC 7 "Swiss cheese" steel.

Gentlemen,

It has come to my attention that no conclusive position has been taken concerning the steel in WTC 7 which showed signs of eutectic melting, which some conspiracy theorists have taken as signs of thermite or other exoptic accelerrants in the building.

My first enlistment in the military was in the US Air Force as a Fire Protection Specialist. During that time, I had occassion to get college-level training in arson investigations. As a part of that course, I had occassion to work weith several types of thermite, including a cast charge using rust, aluminum powder and plaster of Paris. This is the only compound of thermite which I can concieve of capable of doing the sort of damage that would have been neccessary. The problem, from the perspective of conspiracy theorists, is that it would have left a crust of alumina on the steel which water would not have removed.

During the years that I was out of the service, from 1970-77, I took several art courses in which I had occassion to do metal etching using acid resist and nitric acid. To me, some of the pictures of the Swiss cheese steel resemble the effects of acid on metal, specificly the vermiculated pattern shown on the eroded surfaces of some samples. This would account for the thinning of the steel. The deposits of copper in the grain of the steel are, to my thinking, consistant with the exposure of the steel to copper sulphate, which, in an aqueous solution, tends to release copper to the surface of steel.

Among the items known or to be expected to be in any office building which depends to any extent on lead-acid batteries for back-up power supplies, would be a great quantity of sulphuric acid. Given the nature of the OEM, I should expect there to have been a large number of such batteries in the facility.

Given the nature of the fires in the rubble, and the nature of the fuels being burned, I should expect there to have been some dilute sulphuric acid and other similar acids percolating through the entire mass. This would form copper sulphate from the plumbing and wiring of the building. Dillute sulphuric acid will erode steel more quickly that does fuming sulphur acid.

This cause of the erosion and eutectic melting should be investigated for the final report. It would, if supported by findings, greatly diminish the value that this phenomenon has to the conspiracy theorists. The questions raised at the public announcement of the draft report by Mr Geiger from Infowars included referrence to this material, as I recall.

Thank you for any consideration you may give to this theory.

Staff Sergeant Robert S. Tharp USA RET
14917 10th Ave Ct S
Spanaway, WA
98387

253 535 0923

Robert Tharp
spanlib@earthlink.net
EarthLink Revolves Around You.

## Stephen Cauffman

**From:** wtc@nist.gov
**Sent:** Wednesday, September 03, 2008 3:40 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Final Report on the Collapse of WTC 7

X-Sieve: CMU Sieve 2.3
Subject: Final Report on the Collapse of WTC 7
Date: Fri, 22 Aug 2008 09:32:05 -0500
X-MS-Has-Attach:
X-MS-TNEF-Correlator:
Thread-Topic: Final Report on the Collapse of WTC 7
Thread-Index: AckEY9jLUWrxF+lqQGO3MK3z/qv4oQ==
From: "Allyn, Richard B." <RBAllyn@rkmc.com>
To: <wtc@nist.gov>
X-OriginalArrivalTime: 22 Aug 2008 14:32:06.0153 (UTC)
FILETIME=[D9F18F90:01C90463]
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-22_04:2008-08-21,2008-08-22,2008-08-21 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808220042
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: rballyn@rkmc.com
X-NIST-MailScanner-Information:

>>>> Please read the confidentiality statement below <<<<

On page ix of the list of Cooperating Organizations - "Robbins, Kaplan, Miller & Ciresi," the first name is spelled "Robins."
This report represents a tremendous effort.

Thank you.

---

Thank you in advance for your cooperation.

Robins, Kaplan, Miller & Ciresi L.L.P.
http://www.rkmc.com

---

## Stephen Cauffman

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 9:50 AM
**To:** Stephen Cauffman
**Subject:** Fwd: WTC7 Draft - Comment submittal

>X-Sieve: CMU Sieve 2.3
>X-OB-Received: from unknown (205.158.62.90)
> by wfilter.us4.outblaze.com; 22 Aug 2008 22:20:39 -0000
>From: "Ryan Owens" <rowens4@lsu.edu>
>To: wtc@nist.gov
>Date: Fri, 22 Aug 2008 18:20:39 -0400
>Subject: WTC7 Draft - Comment submittal
>X-Originating-Ip: 67.237.195.234
>X-Originating-Server: ws4-3.us4.outblaze.com
>X-Proofpoint-Virus-Version: vendor=fsecure
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>spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=16
>classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000
>definitions=main-0808220124
>X-PP-SpamScore: 0
>X-NIST-MailScanner: Found to be clean
>X-NIST-MailScanner-From: rowens4@paws.lsu.edu
>X-NIST-MailScanner-Information:
>

>Name: Ryan Owens
>Affiliation: None
>Contact: 504-452-7806
>Report Number: NCSTAR 1-9 volume 2
>Page Number: 596
>Paragraph/Sentence: paragraphs 1 & 2, all sentences
>Comment: This is more of a grammar concern than an engineering one, but
>it seems that the first paragraph on the page, "Thus, the actual
>collapse time for the upper 18 stories to collapse, based on video
>evidence, was approximately 40 percent longer than the computed free
>fall time and was consistent with physical principles." was repeated in
>the paragraph immediately following it with only slight grammar
>changes, "The actual collapse time of the upper 18 floors of the north
>face of WTC7 (the floors clearly visible in the video
>evidence) was 40 percent greater than the computed free fall time.
>This is consistent with physical principles." It seems that the author
>may have decided to alter the grammar of the paragraph, but then forgot
>to omit the original version of the paragraph, so that both appear in
>the report one after the other.
>Reason for Comment: I was simply concerned that a minor grammar mistake
>could throw the readers off of focusing on the engineering aspects of
>the report and onto focusing on why the nearly identical paragraph
>appears twice, as happened while I was reading it.
>Suggestion for Revision: Perhaps one of the paragraphs (whichever was
>the original version) should be omitted.

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September 15, 2008

<u>BY ELECTRONIC TRANSMISSION AND FACSIMILE</u>

Mr. Stephen Cauffman
National Institute of Standards and Technology
100 Bureau Drive Stop 8611
Gaithersburg, MD 20899-8611

Re: Comments on NIST NCSTAR 1A (*Final Report on the Collapse of World Trade Center Building 7*) and 1-9 (*Structural Fire Response and Probable Collapse Sequence of World Trade Center Building 7*)

Dear Mr. Cauffman:

On behalf of Silverstein Properties, Inc., I am hereby submitting comments to the National Institute of Standards and Technology Reports NIST NCSTAR 1A and 1-9. Silverstein Properties would like to thank NIST for its investigation and analysis of the tragic and unprecedented events of September 11, 2001 as it attempts to reach a fuller understanding of the World Trade Center disaster and the extensive damage suffered by World Trade Center Building 7 that resulted in its destruction. Our comments are as follows:

First, World Trade Center 7 was built under the authority of the Port Authority of New York and New Jersey and was designed and built in accordance with the applicable building codes at the time of its design and construction. Therefore, in Report NCSTAR 1A, page xxxiii (and elsewhere), it is incorrect to say that "[t]he design of WTC 7 was *generally* consistent with the New York City Building Code of 1968." (emphasis added). Indeed, we understand that the only examples cited in the report of purported non-compliance with the building code concern the thermal insulation required

645019.2

on the floor beams and the building's stairwell capacity. (NCSTAR 1A at xxxiii.) However, it is our understanding that each of these examples is incorrect, as the building's thermal insulation was installed pursuant to the building code and the required stairway capacity – which we understand was calculated incorrectly in the report – was similarly consistent with the building code. Therefore we recommend deleting the word "generally."

Second, as the NIST report states, the evacuation of World Trade Center 7 was successful in the midst of an "unprecedented" disaster (NCSTAR 1A at 51); indeed, there was no loss of life or life-threatening injuries among the building's occupants thanks to the heroic efforts of emergency personnel, Silverstein employees, and Silverstein's tenants. In fact, NIST credits evacuation drills, the decision to prevent building occupants from exiting to the streets, and the use of the loading dock exit by building management personnel with contributing to the positive outcome. (NCSTAR 1A at 52; NCSTAR 1-9 at 320.) And, NIST agrees that "[t]he full building evacuation of WTC 7 was unusual, due to the presence of an exterior threat to the occupants for the duration of the evacuation." (NCSTAR 1-9 at 315.)

Therefore, it is unnecessary for NIST to qualify the successful outcome by suggesting that it be measured "[b]y the conventional measure of life safety" (NCSTAR 1A at 51) and we suggest deleting that phrase. Given the harrowing conditions and chaotic circumstances recounted in the reports, the evacuation should be regarded as an unqualified success. Similarly, NIST's statement on page 51 that the evacuation "was about 30 min longer than the estimated minimum time if the elevators and stairs had been used to maximum advantage" should be deleted, since building occupants are trained not to take the elevators during an emergency and NIST found that "[e]levators were available and widely used for occupant evacuation." (NCSTAR 1-9 at 319). Finally, we question the conclusion that "[e]vacuation management at every level did not provide timely evacuation instructions to building occupants during the event" (NCSTAR 1A at 52; NCSTAR 1-9 at 320) and believe it should be deleted, particularly since the report acknowledges "NIST was not able to determine whether specific guidance was delivered to the occupants via the public address system" (NCSTAR 1A at 52) and states "NIST inferred from the limited interviews, and the total time it took to clear the building that most of the occupants began moving to the stairwells and elevators within minutes of the aircraft impact on WTC 1." (NCSTAR 1-9 at 317).

Third, we wish to correct one additional factual point. Silverstein Properties representatives recall that American Express had removed its generator from the 8th floor prior to September 11, 2001. Therefore, the references to that generator in NCSTAR 1A (at 11) and in NCSTAR 1-9 (at 52, 60, 61) should be deleted.

645019.2

Finally, I would note that I should be listed in the report solely under Friedman Kaplan Seiler & Adelman LLP not Silverstein Properties.

Thank you again for this opportunity to provide comments and please do not hesitate to contact us if we may be of any further service to your inquiry.

Sincerely yours,

Kent K. Anker

645019.2

FedEx Kinko's of 300 7th Avenue Telephone: 646.366.9160 Fax: 646.366.9262

Date 9/15/08

Number of pages 3 (including cover page)

**To:**

Name MR. STEPHEN CAUFFMAN

Company NIST

Telephone 301-975-6051

Fax 301-869-6275

**From:**

Name skeptosis

Company n/a

Telephone n/a

Comments please find attached two comments submitted for your consideration re: NCSTAR 1A.

thank you.

Fax - Domestic Send

Fax - Local Send

Fax - International Send

Name: skeptosis

Affiliation: none

Contact: skeptosis@hotmail.com

Report Number: NCSTAR 1A

Page Number: 21

Paragraph/Sentence: paragraph 1/sentence 6

Comment: In describing its 'gathering of evidence', NIST makes no mention of any of the actual steel from WTC 7, but rather refers to pre-existing NCSTAR documents (1-3D, 1-3E, et al.) which themselves assert that no steel was recovered from WTC 7. NIST seems to have made no effort to obtain or examine existing steel samples (such as the heavily corroded beam featured in FEMA 403, Appendix C) known to have come from WTC 7, choosing instead to estimate the properties of the steel "completely from the literature." (NCSTAR 1-3D, page 273, paragraph 1/sentence 2)

Reason for Comment: Surely the theoretical steel described in the literature would not show any signs of sulfidation and erosion (as were found on the actual steel recovered from WTC 7), ensuring that NIST would not be required to investigate or identify the cause of this bizarre phenomenon.

Suggestion for Revision: "While steel from WTC 7 was, in fact, recovered, NIST made no efforts to obtain or examine this steel. Despite the failures of previous examinations to determine the cause of the sulfidation and erosion of steel samples from WTC 7, NIST felt that an investigation into the potential causes of this deterioration could threaten the Institute's ability to arrive at a conclusion that would not implicate domestic saboteurs."

Name: skeptosis

Affiliation: none

Contact: skeptosis@hotmail.com

Report Number: NCSTAR 1A

Page Number: 22

Paragraph/Sentence: paragraph 6/sentences 1-2

Comment: Section 3.3, HYPOTHETICAL BLAST SCENARIOS, is the epitome of a straw man argument. The fact that NIST chose to focus solely on the likelihood of WTC 7 having been brought down by explosives, rather than by a wider range of destructive and/or corrosive elements, shows that NIST was determined to avoid examining all but the most implausible of theoretical scenarios, so as to easily disprove the plausibility of such a scenario.

Reason for Comment: FEMA 403, Appendix C, found that steel from WTC 7 had melted, due to a corrosive attack by a liquid slag containing high levels of sulfur. Several chemical compounds (FeS/FeO/SiO2/C) could potentially have caused this phenomenon, and none of them are explosives. By ignoring potential non-explosive scenarios which could have caused the collapse of WTC 7, NIST neglected its duties as outlined in the 'Guiding Principles' of its November 12th, 2002 publication, failing to conduct an investigation that was comprehensive, thorough, or objective.

Suggestion for Revision: "In its evaluation of alternate hypotheses re: the collapse of WTC 7, NIST chose to ignore the likelihood of chemical compounds having been used to amplify the effects of fire on the steel structure, and instead focused exclusively on the least plausible of these alternate theories, the use of high explosives. While the physical evidence from the scene (steel recovered from the WTC 7 debris field) showed high levels of sulfidation and erosion, NIST saw no reason to investigate this unprecedented phenomenon."

From: "Srinivasa Sarma" <vsssarma@gmail.com>
To: cauffman@nist.gov, ben.stein@nist.gov
Subject: Re: COLLAPSE OF WORLD TRADE CENTRE 7 BUILDING ON 9/11 - NO REPORT TILL NOW ?
Cc: wtc@nist.gov

I have watched the webcast of WTC-7 collapse made by Dr. Shyam Sunder just now.

two questions: 1) How was it that many people appeared to have known that the building would be falling ?
-giuliani knew it in advance.
- firefighters knew it in advance.
- one employee, indira singh, said that by the afternoon they were evacuated saying that the building would collapse.
- fox news, cnn, bbc announced it before the building actually fell.
2) why is it that the same thing did not happen to other buildings like building 6 which is next to building 1 and standing in between building 1 and building 7 ?

regards.

v.s.s.sarma

**Stephen Cauffman**

**From:** wtc@nist.gov
**Sent:** Tuesday, September 09, 2008 2:53 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Letter of Comment to NIST re: NIST "Final Report" on WTC 7

X-Sieve: CMU Sieve 2.3
Date: Sat, 30 Aug 2008 21:35:42 -0700
From: "Stephen M. St. John" <metatron.metatron@verizon.net>
Subject: Letter of Comment to NIST re: NIST "Final Report" on WTC 7
To: <wtc@nist.gov>
Cc: "Michael B. Mukasey, Attorney General" <AskDOJ@usdoj.gov>,
"Glenn A. Fine, Inspector General, Office of the Inspector General, US Department of Justice" <oig.hotline@usdoj.gov>,
"Sir Rudolph W. Giuliani" <info@giulianipartners.com>,
"David Ray Griffin" <davraygrif@cox.net>, <jfetzer@d.umn.edu>,
"Dr. Steven E. Jones" <steven_jones@byu.edu>,
"Richard Gage, Architects & Engineers for 9/11 Truth" <rgage@ae911truth.org>,
<onlinetv@yahoo.com>, "A. K. Dewdney" <a.d.k@sympatico.ca>,
"Carl Weis" <cmxarts@aol.com>, <cfurlong@socal.rr.com>,
"International Atomic Energy Agency" <info@iaea.org>,
"Mark H. Gaffney" <markhgaffney@earthlink.net>,
"Karl Schwarz" <kwbschwarz@chello.hu>, <jazzyday@earthlink.net>,
"ted Walter" <tedfwalter@yahoo.com>
X-Mailer: Microsoft Windows Mail 6.0.6001.18000
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-30_01:2008-08-28,2008-08-29,2008-08-30 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808300136
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: metatron.metatron@verizon.net
X-NIST-MailScanner-Information:

Stephen M. St. John
Post Office Box 449
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29 August 2008

WTC Technical Information Repository
Attention: Mr. Stephen Cauffman
National Institute of Standards and Technology
Stop 8610

Gaithersburg, MD 20899-8610

Dear Mr. Cauffman,

I hereby submit eight comments on NIST NCSTAR 1A, the Final Report on the Collapse of World Trade Center Building 7 by the Federal Building and Fire Safety Investigation of the World Trade Center Disaster, which is a draft for public comment released on 21 August 2008. This letter also appears on my website http://www.show-the-house.com/ under the title "Schlock & Awe on Top of Shock & Awe: the NIST Report on WTC 7."

The contents of this letter are as follows:

1. Preface. Genesis of this Investigation, page xxv, paragraph 2/sentences 2-4

2. Executive Summary. This Report, page xxxi, paragraph 3/sentence 4

3. Executive Summary. Principal Findings of the Investigation, page xxxii, paragraph 2(1st new paragraph)/sentences 1 and 2

4. Executive Summary. Principal Findings of the Investigation, page xxxii, paragraph 5/sentences 1 and 2

5. Executive Summary. Principal Findings of the Investigation, page xxxii, paragraph 5/sentences 3 and 4

6. Executive Summary. Recommendations, page xxxiv, paragraph 1/sentence 1

7. Executive Summary. Recommendations. Recommendation I, page xxxv, page 4/sentence 1

8. Executive Summary. Principal Findings of the Investigation, pages xxxi (paragraph 5/sentences 1 and 2) and xxxii (top paragraph continued/sentences 2-5)

1. Preface. Genesis of this Investigation, page xxv, paragraph 2/sentences 2-4

"On October 1, 2002, the National Construction Safety Team Act (Public Law 107-231) was signed into law. (A copy of the Public Law is included in Appendix A.) The NIST WTC Investigation was conducted under the authority of the National Construction Safety Team Act."

1.1 Comment: The National Construction Safety Team Act (Public Law 107-231) is an ex post facto law with respect to its putative authority to investigate the events of 11 September 2001, and as such this act conflicts with prohibitions against ex post facto laws which are expressed in the Constitution of the United States, Article 1, sections 9 and 10.

1.2 Reason for Comment: There is a very great need for a solid legal foundation for a real investigation of the crime of the century, the events of 11 September 2001. Fraud and force muted preexisting laws, rules and procedures for a proper investigation and a new law was given. Inasmuch as 9/11 served as a pretext to execute preexisting plans to invade Iraq and resulted in the deaths of over a million Iraqis and displacement of over 4 million, and has raised our national debt to a dangerous level, and has caused untold suffering here and abroad, our national honor requires establishment of historical truth and pursuit of justice.

1.3 Suggestion for Revision: An entirely new investigation under proper legal authority is required. Scientific findings and analysis will be components of such a new investigation.

2. Executive Summary. This Report, page xxxi, paragraph 3/sentence 4

"However, the reader should keep in mind that the building and the records kept within it were destroyed, and the remains of all the WTC buildings were disposed of before congressional action and funding was available for this Investigation to begin."

2.1 Comment: This sentence in this NIST Report on the mysterious collapse of World Trade Center 7 is a classic example of what the founding fathers of the USA sought to prevent happening in our republic when they included two prohibitions against ex post facto laws in Article I, sections 9 and 10 of our Constitution.

2.2 Reason for comment: It must be pointed out that this NIST Report rests on the false assumption that there was no preexisting agency authorized to investigate Ground Zero in New York during the long interval between the 9/11 attacks and the 1 October 2002 passage of the National Construction Safety Team Act. Our Congress acted in combination with local, state and federal officials and private entities to countenance the illegal removal of evidence from a crime scene and the suppression of a legal discovery process and thereby thwarted a proper criminal investigation and redress for victims and their survivors. This game of legal thimblerig does not conduce to the establishment of historical truth and the proper administration of justice. Such corruption supported the stated goals of the war mongers who had the motive, means and opportunity to carry out a false flag intelligence operation and did in fact benefit by fulfillment of policy objectives. NIST has been used to lend a veneer of authority and respectability to an assault on our justice system.

2.3 Suggestion for revision: An entirely new investigation under proper legal authority is required. Matters of law are not subservient to affairs of state which are totally unhinged from the Constitution of the United States and international law. A scientific report teetering on such shaky legal foundation naturally has as much to hide as it reveals, and I list in items 3 through 8 below the notable false statements, omissions and unsupported assertions in this report.

2.3.1 Background But first, let me say I know I sound somewhat harsh in my assertions, but please believe me that I address these heavy issues with sincerity and deep concern. I am not blaming everybody at NIST or other federal, state and local government agencies and private entities. I realize that in this age of specialization, people play compartmentalized roles and very often do not have a clear look at the big picture. We all have our prejudices too, and must keep them in check so as not to affect our judgments. We also live in an age of technological wonders that can be devilishly deceiving. We must be on guard at all times.

Before I continue in this fault finding exercise, let me tell you that I was a federal employee working out of the New York Regional Office of the US Department of Commerce on 9/11. I lost my boss, our Assistant Regional Director, Marion Britton, who, I've been told, was on United Airlines Flight 93 which, I've been told, went down near Shanksville, Pennsylvania. I only know I never saw Marion again after 9/11. The empty ditch in the field looked like a bomb crater. And debris was scattered as far as 8 miles to the east in New Baltimore.

My skepticism about the official story of 9/11 began with the realization that there were no video surveillance images of Marion at Newark's Liberty International Airport on the morning of 9/11. The more I thought about it, the more I started to realize we have NEVER seen ANY credible video surveillance images of ANY of the passengers – let alone hijackers – at ANY of the three airports from which the ill fated flights of 9/11 are said to have departed. Nearly seven full years after that terrible morning we will never forget, we have yet to hear an explanation why we have not seen routine video surveillance footage of passengers or hijackers. Isn't this a bit beyond strange?

Right after the shock and awe of 9/11 and during the subsequent anthrax attacks, people, including me, were on edge and not thinking in a critical fashion and therefore were susceptible to the repeated broadcast videos of two Arab suspects passing through a security checkpoint at the Portland Maine International Airport. That kind of brainwashing was proof enough for the vast majority of people. But such film, problematic in many ways, proved nothing. The same goes for surveillance video images of alleged hijackers passing through security at Dulles International Airport. With no timestamp and afternoon shadows outside the terminal door, this film was shown only briefly and then withdrawn.

Most telling about the video surveillance problem was the 9/11 Commission's decision to downplay or otherwise ignore it. This was very strange behavior for an investigatory commission. When you also consider that none of the flight manifests published by American and United Airlines showed the names of the alleged hijackers, you can understand why the FBI website does not include 9/11 in Osama Bin Laden's "10 Most Wanted" poster. These are elements of a high tech lynching.

Were this the only problem, maybe I could live with it. But there is more. Much more. I'll give just one example. A trusted colleague at the Department of Commerce whom I've known for 18 years shared his experiences with me weeks after 9/11. His desk was four tenths of a mile north northeast of the World Trade Center complex, on the 37th floor of the Federal Building at 26 Federal Plaza, on Broadway between Duane and Worth Streets. He sat about 20 feet from a window with a view of the World Trade Center complex. He heard two very loud bangs spaced a few seconds apart as the attacks of 9/11 began. This observation was later corroborated by many other witnesses, most notably William Rodriguez. Minutes later my colleague was in a conference room and looking out a window with a southern exposure. He told me that at first he thought his eyes were playing tricks on him, because when he first caught sight of the aerial vehicle that plowed into the south tower WTC 2 as it moved over New York harbor, one wing was pointed almost straight down to the water and the other straight up to the sky. This highly unusual attitude and flight path of a large commercial sized jet in New York City airspace, I later learned, was also witnessed by personnel in the control tower at Newark's Liberty International Airport as well as by many others on the streets and in the buildings of lower Manhattan and surrounding areas.

I also discovered on the Internet that aviation professionals expressed deep doubt that such an accurate, high speed descending arc of flight which induced great G forces was humanly possible. These aviation professionals believe that remote control of the aerial vehicle is the only possible explanation for the hits on WTC 2 and the Pentagon. These two jets flew more like missiles than jets in the hands of flight students on their maiden voyages. With this in mind, and after hearing that 9/11 Commission Co-Chairmen

Thomas Kean and Lee Hamilton expressed strong doubts as to the veracity of testimonies from high ranking personnel in the US Air Force, I had also to reckon with the location of the New York Regional Office of the US Air Force not more than 60 feet to the left of where my colleague stood when he saw that incoming aerial vehicle. Having had time to examine this matter further, I have come to the conclusion that this aerial vehicle was headed right for the New York Regional Office of the US Air Force, our neighbor on the 37th floor of the Federal Building, but hit WTC 2 first! Certainly this office would have been convenient for placing a homing device or directional aerial.

These matters about lack of video evidence and missile-like trajectories into 9/11 targets are just the tip of the iceberg. I will forebear, at least for now, from telling you the rest, and will focus on my comments on the NIST Report on WTC 7. I just feel it is best to make a clean breast of it so you know from where I am coming and perhaps guide me to where I would like to go. My goals are to establish historical truth and pursue justice. I am available to head a full, fair and impartial investigation 9/11. Real science will be a real aid to a real investigation.

A full, fair and impartial investigation of 9/11 will consider all who had the motive, means and opportunity to pull off a complex "false flag" intelligence operation and, after seven full years, who has benefitted in their own perverse ways by implementation of policy objectives. A clue may be found in who benefitted by the ex post facto law exonerating American and Israeli telecommunications companies for conspiracy to wiretap illegally.

Finally, a full, fair and impartial investigation of 9/11 will overcome the conspiracy of silence engendered by the Talmudic Law of the Moser, or Law of the Jewish Informer, which prohibits a Jew from informing on another Jew to a non-Jew, directly or indirectly. This law is very much like the Mafioso Code of Omerta. It is diametrically opposed to the adversarial and discovery processes of our judicial system, and an impediment to frank exchanges of information within our intelligence and law enforcement communities. The Talmudic Law of the Moser is not conducive to the establishment of historical truth or the pursuit of justice. A real investigation of 9/11 must grapple with this reality.

I am available to head a proper investigation of 9/11, and will be happy to work with NIST.

3. Executive Summary. Principal Findings of the Investigation, page xxxii, paragraph 2(1st new paragraph)/sentences 1 and 2

"Eventually, the fires reached the northeast of the building. The probable collapse sequence that caused the global collapse of WTC 7 was initiated by the buckling of a critical interior column in that vicinity."

3.1 Comment: History shows that severe fires deform but do not collapse steel structures.

3.2 Reason for comment: I am at a loss to understand how NIST can conceivably make the leap to fire-induced mechanical collapse at virtually free fall speed when no fire has ever done this to a steel structured building except on 9/11. NIST's strained inference is rendered plausible only by computer graphic gimmickry and suppression and exclusion of contradictory evidence.

3.3 Suggestion for revision: An entirely new investigation under proper legal authority is required. Such investigation will consider responsible dissenting views such as those expressed by Mr. Richard Gage and his Architects & Engineers for 9/11 Truth. Fifteen different characteristics of a controlled demolition have been described and identified in the collapses of WTC 7, 1 and 2.

4. Executive Summary. Principal Findings of the Investigation, page xxxii, paragraph 5/sentences 1 and 2

"Hypothetical blast events did not play a role in the collapse of WTC 7. NIST concluded that blast events did not occur, and found no evidence whose explanation required invocation of a blast event."

4.1 Comment: These statements are false and misleading. The Lamont Doherty Earth Observatory of Columbia University recorded two seismic events at 17:20:42 and 17:20:50 EDT, exactly when WTC 7 collapsed. Each of the two seismic events registered 0.6 on the Richter scale, which is comparable to a typical quarry blast at distances even greater than the WTC from the seismograph's sensors. So it is indeed curious that NIST uses the plural form ("hypothetical blast events") even as it excludes mention of these two seismic events in this executive summary.

4.2 Reason for comment: The Lamont Doherty Earth Observatory's definite seismic evidence of two blast events coinciding with the collapse of World Trade Center 7 needs to be pointed out, as it supports a conclusion of controlled demolition rather than NIST's fire induced global (mechanical) collapse theory. It also needs to be pointed out that although clear evidence of blast events from seismic recordings appears in Figures B-2 and B-9 of NIST's NCSTAR 1-9, WTC Investigation (pages 652 and 667 respectively, or 314 & 329/382 in PDF file at http://wtc.nist.gov/media/NIST_NCSTAR_1-9_vol2_for_public_comment.pdf), the authors of this executive summary totally ignore and otherwise avoid their very own strong evidence that real blast events did play a role in the collapse of

WTC 7. Such gross neglect or lack of candor undermines this finding. After shock and awe, we are getting schlock and awe! Americans and the international community deserve better.

4.3 Suggestion for revision: An entirely new investigation under proper legal authority is required. Such investigation will not ignore seismic evidence of blast events coinciding with the collapse of WTC 7. Such investigation will also review seismic evidence of blast events coinciding with the collisions of aerial vehicles into WTC 1 & 2 and the collapses of WTC 1, 2 & 7. Such investigation will consider the engineered resilience of the Twin Towers' structures as well as the man-made and natural surface layers in, around and under the World Trade Center complex as factors precluding building collapses and impacts of aerial vehicles as seismic events.

5. Executive Summary. Principal Findings of the Investigation, page xxxii, paragraph 5/sentences 3 and 4

"Blast from the smallest charge capable of failing the critical column would have resulted in a sound level of 130 dB to 140 dB at a distance of at least half a mile. There were no witness reports of such a loud noise, nor was such a noise heard on the audio tracks of video recordings of the WTC 7 collapse."

5.1 Comment: These are false statements offering slight information when there is much more. Contrary to what the NIST Report says, there were indeed eyewitness accounts of explosions heard and shock waves seen right before and during the collapse of WTC 7 just before 5:21 PM on 11 September 2001.

5.2 Reason for comment: NIST is making a false statement to the effect that there were no eyewitness testimonies to the sounds of explosions before and during the collapse of WTC 7. Such false statements, compounded by suppression of seismic evidence as shown in item 4 and other scientific evidence as shown in item 8, can only lead to wrong conclusions.

5.3 Suggestion for revision: An entirely new investigation under proper legal authority is required. Eyewitnesses who heard and recorded explosions with their video cameras should be properly deposed and not excluded from consideration. Ground noise, the muffling effects of buildings and building materials and other objects must be taken into account in determining why there were witnesses who did not hear or record the sounds of explosions. In this regard, Professor Steven Jones, a leading exponent of aluminum powder incendiaries as one of the methods employed in the controlled demolitions of WTC 1, 2 and 7, whose voice has been muffled by the mainstream news media, can attest to the relative quiet of these kinds of explosives. I have seen on the Internet videos with soundtracks including sounds of explosions before and during the collapse of WTC 7. If these are fake, they ought to be exposed as fake and the perpetrators should be prosecuted to the full extent of the law. Also to be considered are numerous testimonies indicating foreknowledge of the impending implosion, including Larry Silverstein's famous admission that a decision was made to "pull it"; i.e., bring down WTC 7 by controlled demolition. How the BBC managed to report the collapse as a fait accompli twenty minutes before it actually happened deserves thorough examination.

6. Executive Summary. Recommendations, page xxxiv, paragraph 1/sentence 1

"The partial or total collapse of a building due to fire is an infrequent event."

6.1 Comment: This is quite an understatement if applied only to steel structured buildings. As previously stated, history shows that strong fires may deform steel structures but do not cause them to collapse. No steel structure has ever collapsed as a result of a fire, and NIST argues unconvincingly that this record of integrity of steel structures was broken three times on 9/11 in the space of a few hours.

6.2 Reason for comment: It is necessary to show that this statement misleads the reader into thinking such collapses can and do happen but are exceedingly rare events. To know that in the entire history of mankind the collapse of steel structured buildings is specific only to the events of 11 September 2001 in New York City is to know that the fire induced global collapse hypothesis simply does not fly, especially when evidence to the contrary has been suppressed. The NIST finding is absurd!

6.3 Suggestion for revision: An entirely new investigation under proper legal authority is required. Best evidence of controlled demolitions of WTC 1 and WTC 2 is contained in the remarkable film of the Twin Tower collapses made by Richard A. Siegel on a pier in Hoboken, New Jersey. The soundtrack is calibrated to the sound of the tone at 10:00 EDT from radio station 1010WINS New York, which plays in the background. The sounds of massive explosions correlate perfectly with the seismic readings taken at the Lamont Doherty Earth Observatory further up the Hudson in the Palisades. Siegel's film is positive proof that the seismic readings before and during the collapses of each of the Twin Towers were very high powered blast events. Likewise, the seismic readings are positive proof that Siegel's film captured sounds of explosions and not sounds of debris hitting the ground. As previously state in item 4, seismic evidence of 2 blast events 8 seconds apart does indeed pertain to the collapse of WTC 7.

7. Executive Summary. Recommendations. Recommendation I, page xxxv, page 4/sentence 1

"Establishment and implementation of codes and protocols for ensuring effective and uninterrupted operation of the command and control system for large-scale building emergencies."

7.1 Comment: This recommendation raises a very pertinent question. Why did Mayor Rudolf Giuliani prefer an impromptu command post in the field at 75 Barclay Street to his expensive, state of the art emergency command post on the 23rd floor of WTC 7? 75 Barclay Street is approximately 60 feet from the Barclay Street entrance of WTC 7, or the distance a baseball thrown by Nolan Ryan will travel in the blink of an eye. Giuliani's decision to stay away from WTC 7 was made well before any damage was inflicted on the building. In fact, in this time frame Giuliani expressed foreknowledge of the collapse of WTC 2 in a live interview with Peter Jennings of ABC News.

7.2 Reason for comment: Proper scrutiny of the as yet unexplained decision by Mayor Giuliani to stay away from the established emergency command post on the 23rd floor of WTC 7 at a time when he expressed awareness of the impending collapse of WTC 2 – a first in the annals of steel structured buildings – will shed light on the mayor's "establishment and implementation of codes and protocols for ensuring effective and uninterrupted operation of the command and control system for large-scale building emergencies" in the World Trade Center complex on 11 September 2001 and much, much more.

7.3 Suggestion for revision: An entirely new investigation under proper legal authority is required. Such investigation will consider possible advantages derived for nefarious purposes from the "establishment and implementation of codes and protocols for ensuring effective and uninterrupted operation of the command and control system for large-scale building emergencies" relative to the heinous crimes committed on 11 September 2001, from foreknowledge of unprecedented building collapses to disposal of evidence by a former US Attorney who presumably knows the importance of preserving evidence at a crime scene. Criminal investigations whose records were conveniently destroyed in WTC 7 must be enumerated with a view toward reconstruction of case files from other sources. Building records reflecting engineering on WTC must likewise be reconstructed from other sources to determine if and how charges were placed inside the building.

8. Executive Summary. Principal Findings of the Investigation, pages xxxi (paragraph 5/sentences 1 and 2) and xxxii (top paragraph continued/sentences 2-5)

"The fires in WTC 7 were ignited as a result of the impact of debris from the collapse of WTC 1, which was approximately 370 feet to the south. The debris also caused some structural damage to the southwest perimeter of WTC 7. The fires were ignited on at least 10 floors; however, only the fires on Floors 7 through 9 and 11 through 13 grew and lasted until the time of the building collapse. These uncontrolled fires had characteristics similar to those that have occurred previously in tall buildings. Their growth and spread were consistent with ordinary building contents fires."

8.1 Comment: These findings of fires consistent with "ordinary building contents fires" fail to explain pools of molten metal, glowing steel beams and signs of vaporized steel observed by recovery crews and other competent and reliable eyewitnesses in the basement levels of WTC 7 as well as WTC 1 and WTC 2.

8.2 Reason for comment: Since "ordinary building contents fires" do not explain pools of molten metal and glowing steel girders which lingered in the sub-basement levels of WTC 7 as well as WTC 1 and WTC 2 for seven full weeks after the attacks of 11 September 2001, nor do they explain signs of vaporized steel in the World Trade Center complex, another explanation for these highly unusual thermal effects must be found in a new investigation. NIST studiously avoided proper examination of these thermal effects and thereby left a major flaw in its investigation and findings.

8.3 Suggestion for revision: An entirely new investigation under proper legal authority is required. NIST needs to entertain the overwhelming evidence of aluminum powdered incendiaries offered by Physics Professor Steven Jones as a partial explanation of the building collapses. NIST also needs to carefully weigh and consider the 15 characteristics of a controlled demolition which are evident in the collapse of WTC 7 as well as in the collapses of WTC 1 and WTC 2. And NIST must be guided by the seismic evidence of blast events coincidental to the collapses of WTC 7, WTC 1 and WTC 2. A real investigation that takes all of this scientific evidence into account will have to consider the time and labor involved in planting charges in the World Trade Center complex, as well as the expertise and access needed for such a project, and from there narrow down the range of possible suspects. At this point, we can rule out a man in a cave or tent in Afghanistan.

In light of the eight comments outlined above, I reiterate the very strong need for a real investigation of the events of 11 September 2001. I ask you to share my comments within the National Institute of Standards and Technology and also with the United States Department of Commerce and the United States Department of Justice and any other individuals and entities concerned. And I repeat that I am available to head a full, fair and impartial investigation of 9/11.

Very truly yours,
Stephen M. St. John

## Stephen Cauffman

**From:** wtc@nist.gov
**Sent:** Friday, September 05, 2008 2:06 PM
**To:** Stephen Cauffman
**Subject:** Fwd: Comment on NIST WTC 7 Report

X-Sieve: CMU Sieve 2.3
Date: Sun, 24 Aug 2008 11:55:55 -0700
From: "Stephen M. St. John" <metatron.metatron@verizon.net>
Subject: Comment on NIST WTC 7 Report
To: <ben.stein@nist.gov>, <mnewman@nist.gov>, <wtc@nist.gov>
Cc: "metatron" <metatron.metatron@verizon.net>,
"Ted F. Walter" <tedfwalter@yahoo.com>,
"Lucille Krasne" <lukrasne@yahoo.com>,
"Steve Sample Jones" <sleepbelt@aol.com>, <info@nyc911initiative.org>
X-Mailer: Microsoft Windows Mail 6.0.6001.18000
X-Proofpoint-Virus-Version: vendor=fsecure engine=1.12.7160:2.4.4,1.2.40,4.0.166 definitions=2008-08-22_05:2008-08-21,2008-08-22,2008-08-21 signatures=0
X-PP-SpamDetails: rule=spampolicy1_notspam policy=spampolicy1 score=0 spamscore=0 ipscore=0 phishscore=0 bulkscore=0 adultscore=0 classifier=spam adjust=0 reason=mlx engine=5.0.0-0805090000 definitions=main-0808240199
X-PP-SpamScore: 0
X-NIST-MailScanner: Found to be clean
X-NIST-MailScanner-From: metatron.metatron@verizon.net
X-NIST-MailScanner-Information:

Ben Stein
Michael Newman
Stephen Cauffman
National Institute of Standards & Technology
100 Bureau Drive, Stop 8611
Gaithersburg, Maryland 20899-8610

Dear Mr. Stein,

NIST's Report on WTC 7 is woefully inadequate on several counts.

Chiefly, the conclusion disregards a basic law of physics. A fire-induced mechanical collapse such as NIST describes would have met resistance from that part of the structure beneath the initial area of collapse. This opposing force of resistance from underneath against the pull of gravity from above precludes the observed phenomenon of a total and uniform collapse at free fall speed. Therefore, another explanation for the collapse -- which was as fast as a rock dropped from the roof -- must be found.

Just look at the films showing the collapse and common sense will tell you a controlled demolition brought the building down. Professional physicists, architects and engineers have described fifteen different characteristics of a controlled demolition, and the collapse of WTC 7 shows all of these characteristics. (See http://www.ae911truth.org) [I personally examined the ground level brick and wrought iron lattices decorating the Verizon building on the west side of Washington Street, a narrow alley separating it from WTC 7, and could not find even the slightest signs of damage. This is incredible when you consider that a 47 story building less than 50 feet away fell to the ground in a heap!]

These considerations require a criminal investigation. This NIST Report is a politically motivated attempt to prevent a referral for a criminal investigation.

NIST needs to start over at square one. I am available to conduct a proper investigation. I will send my resume in a separate email.

Added to this email is a text copy of my fax and email broadcast of my most recent letter (#19) on 9/11 to the Attorney General of the USA, Michael B. Mukasey. It deals (in very limited space) with the NIST WTC 7 Report.

Let me add on a personal note that I am a former federal employee with the US Department of Commerce, Bureau of the Census, and my boss, Assistant New York Regional Director Marion Britton is said to have perished on United Airlines Flight 93 near Shanksville, Pennsylvania. All I know is that I never saw Marion again after 9/11. I am very, very deeply disturbed that I have not seen one image showing her at Newark's Liberty International Airport on that terrible morning. The more I thought about it, the more I began to realize that we have not seen ANY credible routine video surveillance images of ANY of the passengers -- let alone hijackers -- at ANY of the airports from where the ill-fated flights of 9/11 are said to have departed. How can this be explained? Who is hiding what? My investigations have led me to conclude that missing videos are just the tip of the iceberg. We really need to start from scratch. The official story is transparently bogus.

Very truly yours,
Stephen M. St. John

P.S. Copies of this email are designated to friends in the New York City 9/11 Ballot Initiative for a new, comprehensive, fair and impartial investigation of 9/11. They will succeed, and sooner or later NIST will be obliged to work with them. Why not start to ball rolling right now? I am ready to begin.

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************************************************

Text of fax broadcast:

OPEN LETTER #19 ON 9/11 TO THE ATTORNEY GENERAL OF THE USA MICHAEL B. MUKASEY

Mr. Attorney General,

Yesterday's release of the National Institute of Standards & Technology (NIST) report on the mysterious collapse of World Trade Center 7 is a classic example of what the founding fathers of the USA sought to prevent happening in our republic when they included two prohibitions against ex post facto laws in Article I, sections 9 and 10 of our Constitution.

This lame NIST report rests on the false assumption that there was no existing agency authorized to investigate Ground Zero in the long interval between the 9/11 attacks and the 1 October 2002 passage of the National Construction Safety Team Act.

Our Congress acted in combination with other officials to countenance the removal of evidence from a crime scene and thereby thwarted a proper criminal investigation.

Such corruption supported the goals of the war mongers.

A scientific report teetering on such shaky legal foundation naturally has as much to hide as it reveals, and I list the notable lies, omissions and unsupported assertions.

Contrary to what the report says, there were indeed eyewitness accounts of explosions heard and shock waves seen right before WTC 7 went down at 5:21 PM on 11 September 2001.

Not mentioned were numerous testimonies indicating foreknowledge of the impending implosion, including Larry Silverstein's famous admission that a decision was made to "pull it"; i.e., bring down WTC 7 by controlled demolition. How the BBC managed to report the collapse as a fait accompli twenty minutes before it actually happened remains an unexplained mystery.

Pools of molten steel in the sub-basements of WTC 1, 2 & 7 remained for seven full weeks, a thermal effect studiously ignored by the NIST nincompoops.

Why did Mayor Sir Rudolf Giuliani prefer 75 Barclay Street to his expensive, state of the art emergency command post on the 23rd floor of WTC 7 before any damage was inflicted on the building?

What is the seismic record of the WTC 7 event, and why are these matters beyond the scope of the report?

What combustable contents or source of energy can induce the temperature of 900 C that NIST reports?

History shows that severe fires deform but do not collapse steel structures. How can NIST conceivably make the leap to fire-induced mechanical collapse at free fall speed?

This is nuts!

Please visit http://www.ae911truth.org for thoughtful and apolitical assessments of the WTC building collapses by professional architects and engineers.

Stephen M. St. John
POB 449, NYC, NY 10185

http://www.show-the-house.com/

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29 August 2008

WTC Technical Information Repository
Attention: Mr. Stephen Cauffman
National Institute of Standards and Technology
Stop 8610
Gaithersburg, MD 20899-8610

Dear Mr. Cauffman,

I hereby submit eight comments on NIST NCSTAR 1A, the Final Report on the Collapse of World Trade Center Building 7 by the Federal Building and Fire Safety Investigation of the World Trade Center Disaster, which is a draft for public comment released on 21 August 2008. This letter also appears on my website http://www.show-the-house.com/ under the title "Schlock & Awe on Top of Shock & Awe: the NIST Report on WTC 7."

The contents of this letter are as follows:

1. Preface. Genesis of this Investigation, page xxv, paragraph 2/sentences 2-4

2. Executive Summary. This Report, page xxxi, paragraph 3/sentence 4

3. Executive Summary. Principal Findings of the Investigation, page xxxii, paragraph 2(1st new paragraph)/sentences 1 and 2

4. Executive Summary. Principal Findings of the Investigation, page xxxii, paragraph 5/sentences 1 and 2

5. Executive Summary. Principal Findings of the Investigation, page xxxii, paragraph 5/sentences 3 and 4

6. Executive Summary. Recommendations, page xxxiv, paragraph 1/sentence 1

7. Executive Summary. Recommendations. Recommendation I, page xxxv, page 4/sentence 1.

8. Executive Summary. Principal Findings of the Investigation, pages xxxi (paragraph 5/sentences 1 and 2) and xxxii (top paragraph continued/sentences 2-5)

1. <u>Preface</u>. <u>Genesis of this Investigation</u>, page xxv, paragraph 2/sentences 2-4

"On October 1, 2002, the National Construction Safety Team Act (Public Law 107-231) was signed into law. (A copy of the Public Law is included in Appendix A.) The NIST WTC investigation was conducted under the authority of the National Construction Safety Team Act."

1.1 <u>Comment</u>: The National Construction Safety Team Act (Public Law 107-231) is an *ex post facto* law with respect to its putative authority to investigate the events of 11 September 2001, and as such this act conflicts with prohibitions against *ex post facto* laws which are expressed in the Constitution of the United States, Article 1, sections 9 and 10.

1.2 <u>Reason for Comment</u>: There is a very great need for a solid legal foundation for a real investigation of the crime of the century, the events of 11 September 2001. Fraud and force muted preexisting laws, rules and procedures for a proper investigation and a new law was given. Inasmuch as 9/11 served as a pretext to execute preexisting plans to invade Iraq and resulted in the deaths of over a million Iraqis and displacement of over 4 million, and has raised our national debt to a dangerous level, and has caused untold suffering here and abroad, our national honor requires establishment of historical truth and pursuit of justice.

1.3 <u>Suggestion for Revision</u>: An entirely new investigation under proper legal authority is required. Scientific findings and analysis will be components of such a new investigation.

2. Executive Summary. This Report, page xxxi, paragraph 3/sentence 4

"However, the reader should keep in mind that the building and the records kept within it were destroyed, and the remains of all the WTC buildings were disposed of before congressional action and funding was available for this Investigation to begin."

2.1 Comment: This sentence in this NIST Report on the mysterious collapse of World Trade Center 7 is a classic example of what the founding fathers of the USA sought to prevent happening in our republic when they included two prohibitions against *ex post facto* laws in Article I, sections 9 and 10 of our Constitution.

2.2 Reason for comment: It must be pointed out that this NIST Report rests on the false assumption that there was no preexisting agency authorized to investigate Ground Zero in New York during the long interval between the 9/11 attacks and the 1 October 2002 passage of the National Construction Safety Team Act. Our Congress acted in combination with local, state and federal officials and private entities to countenance the illegal removal of evidence from a crime scene and the suppression of a legal discovery process and thereby thwarted a proper criminal investigation and redress for victims and their survivors. This game of legal thimblerig does not conduce to the establishment of historical truth and the proper administration of justice. Such corruption supported the stated goals of the war mongers who had the motive, means and opportunity to carry out a false flag intelligence operation and did in fact benefit by fulfillment of policy objectives. NIST has been used to lend a veneer of authority and respectability to an assault on our justice system.

2.3 Suggestion for revision: An entirely new investigation under proper legal authority is required. Matters of law are not subservient to affairs of state which are totally unhinged from the *Constitution of the United States* and international law. A scientific report teetering on such shaky legal foundation naturally has as much to hide as it reveals, and I list in items 3 through 8 below the notable false statements, omissions and unsupported assertions in this report.

2.3.1 Background But first, let me say I know I sound somewhat harsh in my assertions, but please believe me that I address these heavy issues with sincerity and deep concern. I am not blaming everybody at NIST or other federal, state and local government agencies and private entities. I realize that in this age of specialization, people play compartmentalized roles and very often do not have a clear look at the big picture. We all have our prejudices too, and must keep them in check so as not to affect our judgments.

We also live in an age of technological wonders that can be devilishly deceiving. We must be on guard at all times.

Before I continue in this fault finding exercise, let me tell you that I was a federal employee working out of the New York Regional Office of the US Department of Commerce on 9/11. I lost my boss, our Assistant Regional Director, Marion Britton, who, I've been told, was on United Airlines Flight 93 which, I've been told, went down near Shanksville, Pennsylvania. I only know I never saw Marion again after 9/11. The empty ditch in the field looked like a bomb crater. And debris was scattered as far as 8 miles to the east in New Baltimore.

My skepticism about the official story of 9/11 began with the realization that there were no video surveillance images of Marion at Newark's Liberty International Airport on the morning of 9/11. The more I thought about it, the more I started to realize we have NEVER seen ANY credible video surveillance images of ANY of the passengers – let alone hijackers – at ANY of the three airports from which the ill fated flights of 9/11 are said to have departed. Nearly seven full years after that terrible morning we will never forget, we have yet to hear an explanation why we have not seen routine video surveillance footage of passengers or hijackers. Isn't this a bit beyond strange?

Right after the shock and awe of 9/11 and during the subsequent anthrax attacks, people, including me, were on edge and not thinking in a critical fashion and therefore were susceptible to the repeated broadcast videos of two Arab suspects passing through a security checkpoint at the Portland Maine International Airport. That kind of brainwashing was proof enough for the vast majority of people. But such film, problematic in many ways, proved nothing. The same goes for surveillance video images of alleged hijackers passing through security at Dulles International Airport. With no timestamp and afternoon shadows outside the terminal door, this film was shown only briefly and then withdrawn.

Most telling about the video surveillance problem was the 9/11 Commission's decision to downplay or otherwise ignore it. This was very strange behavior for an investigatory commission. When you also consider that none of the flight manifests published by American and United Airlines showed the names of the alleged hijackers, you can understand why the FBI website does not include 9/11 in Osama Bin Laden's "10 Most Wanted" poster. These are elements of a high tech lynching.

Were this the only problem, maybe I could live with it. But there is more. Much more. I'll give just one example. A trusted colleague at the Department of Commerce whom I've known for 18 years shared his experiences with me weeks after 9/11. His desk was four tenths of a mile north northeast of the World Trade Center complex, on the 37th floor of the Federal Building at 26 Federal Plaza, on Broadway between Duane and Worth Streets. He sat about 20 feet from a window with a view of the World Trade Center complex. He heard two very loud bangs spaced a few seconds apart as the attacks of 9/11 began. This observation was later corroborated by many other witnesses, most notably William Rodriguez. Minutes later my colleague was in a conference room and looking out a window with a southern exposure. He told me that at first he thought his eyes were playing tricks on him, because when he first caught sight of the aerial vehicle that plowed into the south tower WTC 2 as it moved over New York harbor, one wing was pointed almost straight down to the water and the other straight up to the sky. This highly unusual attitude and flight path of a large commercial sized jet in New York City airspace, I later learned, was also witnessed by personnel in the control tower at Newark's Liberty International Airport as well as by many others on the streets and in the buildings of lower Manhattan and surrounding areas.

I also discovered on the Internet that aviation professionals expressed deep doubt that such an accurate, high speed descending arc of flight which induced great G forces was humanly possible. These aviation professionals believe that remote control of the aerial vehicle is the only possible explanation for the hits on WTC 2 and the Pentagon. These two jets flew more like missiles than jets in the hands of flight students on their maiden voyages. With this in mind, and after hearing that 9/11 Commission Co-Chairmen Thomas Kean and Lee Hamilton expressed strong doubts as to the veracity of testimonies from high ranking personnel in the US Air Force, I had also to reckon with the location of the New York Regional Office of the US Air Force not more than 60 feet to the left of where my colleague stood when he saw that incoming aerial vehicle. Having had time to examine this matter further, I have come to the conclusion that this aerial vehicle was headed right for the New York Regional Office of the US Air Force, our neighbor on the 37th floor of the Federal Building, but hit WTC 2 first! Certainly this office would have been convenient for placing a homing device or directional aerial.

These matters about lack of video evidence and missile-like trajectories into 9/11 targets are just the tip of the iceberg. I will forebear, at least for now, from telling you the rest, and will focus on my comments on the NIST Report on WTC 7. I just feel it is best to make a clean breast of it so you know from where I am coming and perhaps guide me to where I would like to go. My goals are to establish historical truth and pursue justice. I am available to head a full, fair and impartial investigation 9/11. Real science will be a real aid to a real investigation.

A full, fair and impartial investigation of 9/11 will consider all who had the motive, means and opportunity to pull off a complex "false flag" intelligence operation and, after seven full years, who has benefitted in their own perverse ways by implementation of policy objectives. A clue may be found in who benefitted by the *ex post facto* law exonerating American and Israeli telecommunications companies for conspiracy to wiretap illegally.

Finally, a full fair and impartial investigation of 9/11 will overcome the conspiracy of silence engendered by the Talmudic Law of the Moser, or Law of the Jewish Informer, which prohibits a Jew from informing on another Jew to a non-Jew, directly or indirectly. This law is very much like the Mafioso Code of Omerta. It is diametrically opposed to the adversarial and discovery processes of our judicial system, and an impediment to frank exchanges of information within our intelligence and law enforcement communities. The Talmudic Law of the Moser is not conducive to the establishment of historical truth or the pursuit of justice. A real investigation of 9/11 must grapple with this reality.

I am available to head a proper investigation of 9/11, and will be happy to work with NIST.

3. Executive Summary. Principal Findings of the Investigation, page xxxii, paragraph 2(1st new paragraph)/sentences 1 and 2

"Eventually, the fires reached the northeast of the building. The probable collapse sequence that caused the global collapse of WTC 7 was initiated by the buckling of a critical interior column in that vicinity."

3.1 Comment: History shows that severe fires deform but do not collapse steel structures.

3.2 Reason for comment: I am at a loss to understand how NIST can conceivably make the leap to fire-induced mechanical collapse at virtually free fall speed when no fire has ever done this to a steel structured building except on 9/11. NIST's strained inference is rendered plausible only by computer graphic gimmickry and suppression and exclusion of contradictory evidence.

3.3 Suggestion for revision: An entirely new investigation under proper legal authority is required. Such investigation will consider responsible dissenting views such as those expressed by Mr. Richard Gage and his Architects & Engineers for 9/11 Truth. Fifteen different characteristics of a controlled demolition have been described and identified in the collapses of WTC 7, 1 and 2.

4. Executive Summary. Principal Findings of the Investigation, page xxxii, paragraph 5/sentences 1 and 2

"Hypothetical blast events did not play a role in the collapse of WTC 7. NIST concluded that blast events did not occur, and found no evidence whose explanation required invocation of a blast event."

4.1 Comment: These statements are false and misleading. The Lamont Doherty Earth Observatory of Columbia University recorded two seismic events at 17:20:42 and 17:20:50 EDT, exactly when WTC 7 collapsed. Each of the two seismic events registered 0.6 on the Richter scale, which is comparable to a typical quarry blast at distances even greater than the WTC from the seismograph's sensors. So it is indeed curious that NIST uses the plural form ("hypothetical blast events") even as it excludes mention of these two seismic events in this executive summary.

4.2 Reason for comment: The Lamont Doherty Earth Observatory's definite seismic evidence of two blast events coinciding with the collapse of World Trade Center 7 needs to be pointed out, as it supports a conclusion of controlled demolition rather than NIST's fire induced global (mechanical) collapse theory. It also needs to be pointed out that although clear evidence of blast events from seismic recordings appears in Figures B-2 and B-9 of NIST's NCSTAR 1-9, WTC Investigation (pages 652 and 667 respectively), the authors of this executive summary totally ignore and otherwise avoid their very own strong evidence that real blast events did play a role in the collapse of WTC 7. Such gross neglect or lack of candor undermines this finding. After shock and awe, we are getting schlock and awe! Americans and the international community deserve better.

4.3 Suggestion for revision: An entirely new investigation under proper legal authority is required. Such investigation will not ignore seismic evidence of blast events coinciding with the collapse of WTC 7. Such investigation will also review seismic evidence of blast events coinciding with the collisions of aerial vehicles into WTC 1 & 2 and the collapses of WTC 1, 2 & 7. Such investigation will consider the engineered resilience of the Twin Towers' structures as well as the man-made and natural surface layers in, around and under the World Trade Center complex as factors precluding building collapses and impacts of aerial vehicles as seismic events.

5. Executive Summary. Principal Findings of the Investigation, page xxxii, paragraph 5/sentences 3 and 4

"Blast from the smallest charge capable of failing the critical column would have resulted in a sound level of 130 dB to 140 dB at a distance of at least half a mile. There were no witness reports of such a loud noise, nor was such a noise heard on the audio tracks of video recordings of the WTC 7 collapse."

5.1 Comment: These are false statements offering slight information when there is much more. Contrary to what the NIST Report says, there were indeed eyewitness accounts of explosions heard and shock waves seen right before and during the collapse of WTC 7 just before 5:21 PM on 11 September 2001.

5.2 Reason for comment: NIST is making a false statement to the effect that there were no eyewitness testimonies to the sounds of explosions before and during the collapse of WTC 7. Such false statements, compounded by suppression of seismic evidence as shown in item 4 and other scientific evidence as shown in item 8, can only lead to wrong conclusions.

5.3 Suggestion for revision: An entirely new investigation under proper legal authority is required. Eyewitnesses who heard and recorded explosions with their video cameras should be properly deposed and not excluded from consideration. Ground noise, the muffling effects of buildings and building materials and other objects must be taken into account in determining why there were witnesses who did not hear or record the sounds of explosions. In this regard, Professor Steven Jones, a leading exponent of aluminum powder incendiaries as one of the methods employed in the controlled demolitions of WTC 1, 2 and 7, whose voice has been muffled by the mainstream news media, can attest to the relative quiet of these kinds of explosives. I have seen on the Internet videos with soundtracks including sounds of explosions before and during the collapse of WTC 7. If these are fake, they ought to be exposed as fake and the perpetrators should be prosecuted to the full extent of the law. Also to be considered are numerous testimonies indicating foreknowledge of the impending implosion, including Larry Silverstein's famous admission that a decision was made to "pull it"; i.e., bring down WTC 7 by controlled demolition. How the BBC managed to report the collapse as a *fait accompli* twenty minutes before it actually happened deserves thorough examination.

6. Executive Summary. Recommendations, page xxxiv, paragraph 1/sentence 1

"The partial or total collapse of a building due to fire is an infrequent event."

6.1 Comment: This is quite an understatement if applied only to steel structured buildings. As previously stated, history shows that strong fires may deform steel structures but do not cause them to collapse. No steel structure has ever collapsed as a result of a fire, and NIST argues unconvincingly that this record of integrity of steel structures was broken three times on 9/11 in the space of a few hours.

6.2 Reason for comment: It is necessary to show that this statement misleads the reader into thinking such collapses can and do happen but are exceedingly rare events. To know that in the entire history of mankind the collapse of steel structured buildings is specific only to the events of 11 September 2001 in New York City is to know that the fire induced global collapse hypothesis simply does not fly, especially when evidence to the contrary has been suppressed. The NIST finding is absurd!

6.3 Suggestion for revision: An entirely new investigation under proper legal authority is required. Best evidence of controlled demolitions of WTC 1 and WTC 2 is contained in the remarkable film of the Twin Tower collapses made by Richard A. Siegel on a pier in Hoboken, New Jersey. The soundtrack is calibrated to the sound of the tone at 10:00 EDT from radio station 1010WINS New York, which plays in the background. The sounds of massive explosions correlate perfectly with the seismic readings taken at the Lamont Doherty Earth Observatory further up the Hudson in the Palisades. Siegel's film is positive proof that the seismic readings before and during the collapses of each of the Twin Towers were very high powered blast events. Likewise, the seismic readings are positive proof that Siegel's film captured sounds of explosions and not sounds of debris hitting the ground. As previously state in item 4, seismic evidence of 2 blast events 8 seconds apart does indeed pertain to the collapse of WTC 7.

7. Executive Summary. Recommendations. Recommendation I, page xxxv, page 4/sentence 1.

"Establishment and implementation of codes and protocols for ensuring effective and uninterrupted operation of the command and control system for large-scale building emergencies."

7.1 Comment: This recommendation raises a very pertinent question. Why did Mayor Rudolf Giuliani prefer an impromptu command post in the field at 75 Barclay Street to his expensive, state of the art emergency command post on the 23rd floor of WTC 7? 75 Barclay Street is approximately 60 feet from the Barclay Street entrance of WTC 7, or the distance a baseball thrown by Nolan Ryan will travel in the blink of an eye. Giuliani's decision to stay away from WTC 7 was made well before any damage was inflicted on the building. In fact, in this time frame Giuliani expressed foreknowledge of the collapse of WTC 2 in a live interview with Peter Jennings of ABC News.

7.2 Reason for comment: Proper scrutiny of the as yet unexplained decision by Mayor Giuliani to stay away from the established emergency command post on the 23rd floor of WTC 7 at a time when he expressed awareness of the impending collapse of WTC 2 – a first in the annals of steel structured buildings – will shed light on the mayor's "establishment and implementation of codes and protocols for ensuring effective and uninterrupted operation of the command and control system for large-scale building emergencies" in the World Trade Center complex on 11 September 2001 and much, much more.

7.3 Suggestion for revision: An entirely new investigation under proper legal authority is required. Such investigation will consider possible advantages derived for nefarious purposes from the "establishment and implementation of codes and protocols for ensuring effective and uninterrupted operation of the command and control system for large-scale building emergencies" relative to the heinous crimes committed on 11 September 2001, from foreknowledge of unprecedented building collapses to disposal of evidence by a former US Attorney who presumably knows the importance of preserving evidence at a crime scene. Criminal investigations whose records were conveniently destroyed in WTC 7 must be enumerated with a view toward reconstruction of case files from other sources. Building records reflecting engineering on WTC must likewise be reconstructed from other sources to determine if and how charges were placed inside the building.

8. Executive Summary. Principal Findings of the Investigation, pages xxxi (paragraph 5/sentences 1 and 2) and xxxii (top paragraph continued/sentences 2-5)

"The fires in WTC 7 were ignited as a result of the impact of debris from the collapse of WTC 1, which was approximately 370 feet to the south. The debris also caused some structural damage to the southwest perimeter of WTC 7. The fires were ignited on at least 10 floors; however, only the fires on Floors 7 through 9 and 11 through 13 grew and lasted until the time of the building collapse. These uncontrolled fires had characteristics similar to those that have occurred previously in tall buildings. Their growth and spread were consistent with ordinary building contents fires."

8.1 Comment: These findings of fires consistent with "ordinary building contents fires" fail to explain pools of molten metal, glowing steel beams and signs of vaporized steel observed by recovery crews and other competent and reliable eyewitnesses in the basement levels of WTC 7 as well as WTC 1 and WTC 2.

8.2 Reason for comment: Since "ordinary building contents fires" do not explain pools of molten metal and glowing steel girders which lingered in the sub-basement levels of WTC 7 as well as WTC 1 and WTC 2 for seven full weeks after the attacks of 11 September 2001, nor do they explain signs of vaporized steel in the World Trade Center complex, another explanation for these highly unusual thermal effects must be found in a new investigation. NIST studiously avoided proper examination of these thermal effects and thereby left a major flaw in its investigation and findings.

8.3 Suggestion for revision: An entirely new investigation under proper legal authority is required. NIST needs to entertain the overwhelming evidence of aluminum powdered incendiaries offered by Physics Professor Steven Jones as a partial explanation of the building collapses. NIST also needs to carefully weigh and consider the 15 characteristics of a controlled demolition which are evident in the collapse of WTC 7 as well as in the collapses of WTC 1 and WTC 2. And NIST must be guided by the seismic evidence of blast events coincidental to the collapses of WTC 7, WTC 1 and WTC 2. A real investigation that takes all of this scientific evidence into account will have to consider the time and labor involved in planting charges in the World Trade Center complex, as well as the expertise and access needed for such a project, and from there narrow down the range of possible suspects. At this point, we can rule out a man in a cave or tent in Afghanistan.

In light of the eight comments outlined above, I reiterate the very strong need for a real investigation of the events of 11 September 2001. I ask you to share my comments within the National Institute of Standards and Technology and also with the United States Department of Commerce and the United States Department of Justice and any other individuals and entities concerned. And I repeat that I am available to head a full, fair and impartial investigation of 9/11.

Very truly yours,
Stephen M. St. John

STATE OF NEW YORK
COUNTY OF NEW YORK
SWORN TO OR AFFIRM AND SUBSCRIBED
BEFORE ME THIS 29 DAY OF August 2008
Pearl Aird
NOTARY PUBLIC

PEARL E. AIRD
Notary Public, State of New York
No. 01AI6076025
Qualified in Bronx County
Commission Expires 6/17 2010

From: Tim Sharpe <myhat2u@yahoo.com>
Subject: Your WTC 7 Fairy Tale
To: wtc@nist.gov

What happened to this? Why no mention of it in the NIST report? Is it because it is evidence of a controlled demolition of WTC 7?

**Appendix C of FEMA's World Trade Center Building Performance Study:**
**Evidence of a severe high temperature corrosion attack on the steel, including oxidation and sulfidation with subsequent intergranular melting, was readily visible in the near-surface microstructure. A liquid eutectic mixture containing primarily iron, oxygen, and sulfur formed during this hot corrosion attack on the steel... The severe corrosion and subsequent erosion of Samples 1 and 2 are a very unusual event. No clear explanation for the source of the sulfur has been identified.**

Dear Sirs,

Here are my comments on the long-awaited draft for public comment of NIST's report on WTC 7, issued by NIST on August 21st, 2008.

## *1. Collapse Models*

NIST's computer-generated models of the collapse of WTC 7, as in Figure 12-69 of NCSTAR 1-9 and Figure E-4 of NCSTAR 1-9A, as well as the collapse models presented at http://www.nist.gov/public_affairs/releases/wtc_videos/wtc_videos.html do not correspond with the way in which the building can be seen descending on the several videos that captured the collapse. In the videos, the perimeter walls, connected to and supported by the large number of perimeter columns, retain their rectangular shape until late in the collapse; the perimeter columns clearly do not almost immediately buckle inwards over the building as they do in NIST's models. Therefore, NIST needs to develop a collapse model that describes the way in which WTC 7 actually collapsed on September 11th.

## *2. Heating of the Steel*

The NIST draft report claims that parts of the steel were heated to high temperatures of up to and over 600 degrees Celsius (NCSTAR 1A, p. 19). However, as already stated in the NIST Advisory Committee meeting last December, the fires at any location in the building burned out quite rapidly, in approximately 20 minutes:

"At any given location the combustibles needed about 20 minutes to be consumed."

(Meeting of the National Construction Safety Team Advisory Committee, December 18, 2007, http://wtc.nist.gov/media/NCSTACMeetingMinutes121807.pdf, p. 5.)

Field Code Changed

Dr. Shyam Sunder repeated several times that any combustibles at any one location in the building took about 20 minutes to be consumed. It is, of course, self-evident that fires cannot last for very long in one place in an office building, as there is not so much burnable material available. As NIST now (quite correctly) rules out any asymmetric edifice damage as a contributor to the building's sudden total collapse, all the changes that the fireproofed steel members might have undergone had to result from such short-lived fire exposure.

However, as detailed in the following engineering document by the Finnish Constructional Steelwork Association, for example, the temperature of fireproofed steel members remains under 200 degrees Celsius (390 Fahrenheit) during a 20-minute fire exposure in normal office fires, such as you now admit the fires in WTC 7 were:

http://www.terasrakenneyhdistys.fi/suunnittelijoille/hitsatutprofiilit/HP5%20199-222%20A4.pdf

Field Code Changed

Please see the graph on p. 216. Allow me to translate the key terms for your convenience:

Aika = time (in minutes)
Lämpötila = temperature (Celsius)
Palosuojatun poikkileikkauksen lämpötila = temperature of a fireproofed steel support

For floors 11 and 12, in NCSTAR 1-9, vol. 2, p. 375, NIST estimates a fuel load of 32 kg per square meter, which would yield a longer maximum fire time of 32 minutes. However, even after an exposure that long, the temperature of fireproofed steel would remain at, or below, 300 degrees Celsius (Finnish Constructional Steelwork Association, *op.cit.*, p. 216). Even such a temperature does not weaken construction steel significantly. As for thermal expansion, based on the equation for linear thermal expansion, the beams, 15.8 meters in length, could have expanded 0.019 meters for every 100 °C increase in temperature. As a beam expands in both directions and not just in one, half of that could have affected the "critical" girder in question. Thus, for a ~280-degree increase over its normal temperature, the beam would have expanded by less than 2.7 centimeters against the girder in question. Moreover, as different sections of the beam were exposed to varying temperatures below the maximum of 300 degrees Celsius, in reality the beam's expansion would have been correspondingly smaller – and certainly not enough to dislodge a large girder.

### *3. Shear Studs*

However, any significant expansion against the girder would likely have been counteracted by the large number of shear studs that held the concrete floor attached to the beams and girders. As NIST points out in a 2005 document, "Most of the beams and girders [in WTC 7] were made composite with the slabs through the use of shear studs. Typically, the shear studs were 0.75 in. in diameter by 5 in. long, spaced 1 ft to 2 ft on center." (NCSTAR1-1, p. 14).

In the new draft report NIST states "In WTC 7 no studs were installed on the girders" (NCSTAR 1-9, p. 346), which contradicts the above-quoted earlier statement of shear studs being used in WTC 7's girders. NIST bases the new statement on the following reference: Irwin G. Cantor PC, Structural Engineers (1985). *Structural design drawings, 7 World Trade Center*. However, as NIST points out in Appendix L to the June 2004 progress report (L-6 and L-7), "Studs were not indicated on the design drawings for many of the core girders. The design drawings specified design forces for connections and suggested a typical detail, but did not show specific connection designs; this is standard practice on the U.S. east coast."

NIST needs to clarify the new evidence that indicates that, contrary to the earlier statements, shear studs were, after all, *not* used in the girders, as the use of shear studs would further counteract any potential heat expansion effects. If studs were in fact used, as NIST reported earlier, their effect on the expansion needs to be carefully scrutinized.

## *4. Evidence of Explosions in the Building*

In the draft report, NIST excludes controlled demolition based on the argument that no loud sound was heard (NCSTAR 1-A, p xxxii). In fact, several people heard what they described as explosions from the building, including Craig Bartmer of the NYPD. His interview can be watched here:

http://www.dailymotion.com/video/xr89c_craig-bartmer-says-911-was-an-insid_news

Field Code Changed

Barry Jennings of the Port Authority testified to the 9/11 Commission that he and his colleague Michael Hess (who has confirmed this) were trapped inside the building as a result of a powerful explosion that blocked their way out of the building. The men had to be helped out by the fire department.

In "Questions and Answers about the NIST WTC 7 Investigation," NIST discusses the explosions reported by Jennings as follows:

"If the two loud booms were due to explosions that were responsible for the collapse of WTC 7, the emergency responder – located somewhere between the 6th and 8th floors in WTC 7 – would not have been able to survive the near immediate collapse and provide this witness account."

An explosion somewhere inside a skyscraper can obviously weaken the integrity of the building without leading to an *immediate* collapse; therefore, the above argument is incorrect. The role of such an explosion in a later collapse would need to be investigated.

Furthermore, in the following excerpt from an investigative program by Italian TV, several loud explosions can be heard, one such explosion startling first responders close to WTC 7. In addition, a police officer can be seen and heard stating repeatedly, referring to WTC 7, that "the building is about to blow up".

http://www.youtube.com/watch?v=Nu1VLMVv08s

Field Code Changed

As loud booms can in fact be heard on videos, as there are witnesses to explosions, and as the testimony by one emergency worker has been ignored by NIST on false pretenses, NIST needs to reconsider the role of explosions in the collapse of WTC 7.

## *5. Evidence of Extremely High Temperatures*

In the draft report, NIST does not address the issue of the extremely high temperatures, in excess of 730 ° C., measured by NASA in the WTC 7 site as many as five days after the destruction, and the numerous reports and visual evidence of molten steel observed in and excavated from the remains:

http://pubs.usgs.gov/of/2001/ofr-01-0429/thermal.r09.html
http://911research.wtc7.net/wtc/evidence/moltensteel.html
http://wtc7.net/articles/stevenjones_b7.html

Field Code Changed

Field Code Changed

Field Code Changed

Intergranular melting of the steel was also noted by FEMA based on one of the very few WTC 7 steel pieces salvaged from the building's remains.

http://911research.wtc7.net/wtc/evidence/metallurgy/WTC_apndxC.htm

Field Code Changed

NIST, of course, is on the record claiming that "no steel was recovered from WTC 7."

Ordinary office fires are incapable of producing such high residual temperatures, let alone melting steel.

Before finalizing its report, NIST should also familiarize itself with the following two peer-reviewed articles. The first, published in an engineering journal, refers e.g. to residues of molten iron and molybdenum (melting point of the latter: 2,623° C.) in the samples collected by several research teams, including the U.S. Geological Survey; the second, published in an environmental science journal, finds evidence of energetic nanocomposites in the pile at Ground Zero. Clearly, the peer-reviewed evidence for such extremely high temperatures and anomalies needs to be explained.

Steven Jones, Frank Legge, et al, "Fourteen Points of Agreement with Official Government Reports on the World Trade Center Destruction," *The Open Journal of Civil Engineering*, Volume 2 Issue 1,
http://www.bentham-open.org/pages/content.php?TOCIEJ/2008/00000002/00000001/35TOCIEJ.SGM

Field Code Changed

Kevin Ryan, James Gourley, and Steven Jones, "Environmental anomalies at the World Trade Center: evidence for energetic materials," *The Environmentalist*, August 2008, DOI: 10.1007/s10669-008-9182-4,
http://www.springerlink.com/content/f67q6272583h86n4/

Field Code Changed

Yours sincerely,

Vesa Raiskila
M. Soc. Sc
Helsinki, Finland
fouilleur@gmail.com

Field Code Changed

From: Zach Boettner <boettnerz@yahoo.com>
Subject: Re: NIST WTC 7 Investigation Finds Building Fires Caused Collapse
To: wtc@nist.gov, ben.stein@nist ...snip... gov, shyam.sunder@nist.gov

Dear Ben, Shyam, Michael, et al,

I am curious about two things:

1) How do you explain in your WTC7 report this significant piece of contradicting evidence - Larry Silverstein's own admission on video that they "pulled" WTC7? And in order to "pull" the building it would have had to be rigged many days in advance of 9/11, suggesting foreknowledge of the attacks. See video: http://www.youtube.com/watch?v=7WYdAJQV100

2) What are the odds a random "fire" would cause a perfect vertical colapse which looks just like a professional demolition which takes many days or weeks to properly rig. See video: http://www.youtube.com/watch?v=LD06SAf0p9A

Please explain.

Thanks,

Zach Boettner
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boettnerz@yahoo.com