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.			
	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"
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.			
	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."

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.*

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.*
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.			
	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 ..."
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.			
	Reason for Comment:	Clarification.			
	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."
				FDS ISSUES	
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.			
	Reason for Comment:	Clarification.			
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.			
	Reason for Comment:	Accuracy.			

	Report #	Page #	Para./Sent.	Original Text	Suggestion for Revision
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

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

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. • 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. • 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. • 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. • 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"

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	
HAI-19	**Comment:**	Model validation and verification documentation/references have not been included.			
	Reason for Comment:	Clarification.			
				EVIDENCE/DATA ISSUES	
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 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-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*