1. Introduction

1.1 Purpose

This document summarizes the areas of willful blindness that NIST and its contractors are guilty of whilst compiling and researching the NCSTAR series of reports, published in 2005.

The contracts listed in section 3 outline the work which was to have been carried out for NIST. These listings came from

http://wtc.nist.gov/solicitations/ and

http://wtc.nist.gov/solicitations/solicitation_selection_process.htm

1.2 Rationale

Once the events of Sept 11th are revisited and closely re-examined, sticking firmly to known physical laws and properties of materials, most aspects of the generally assumed causes of the events do not stand up to scrutiny. The basic facts are thus:

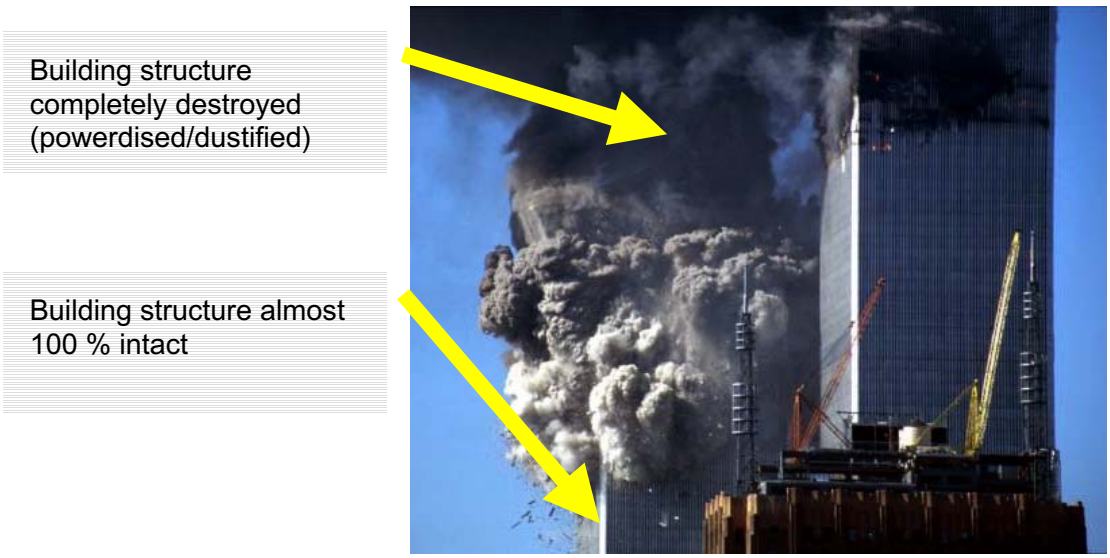
At a basic level, the stated combination of jet crashes, jet fuel gravity does not pulverize buildings - and NIST and its contractors should have realized this and it should have been written up in the reports.

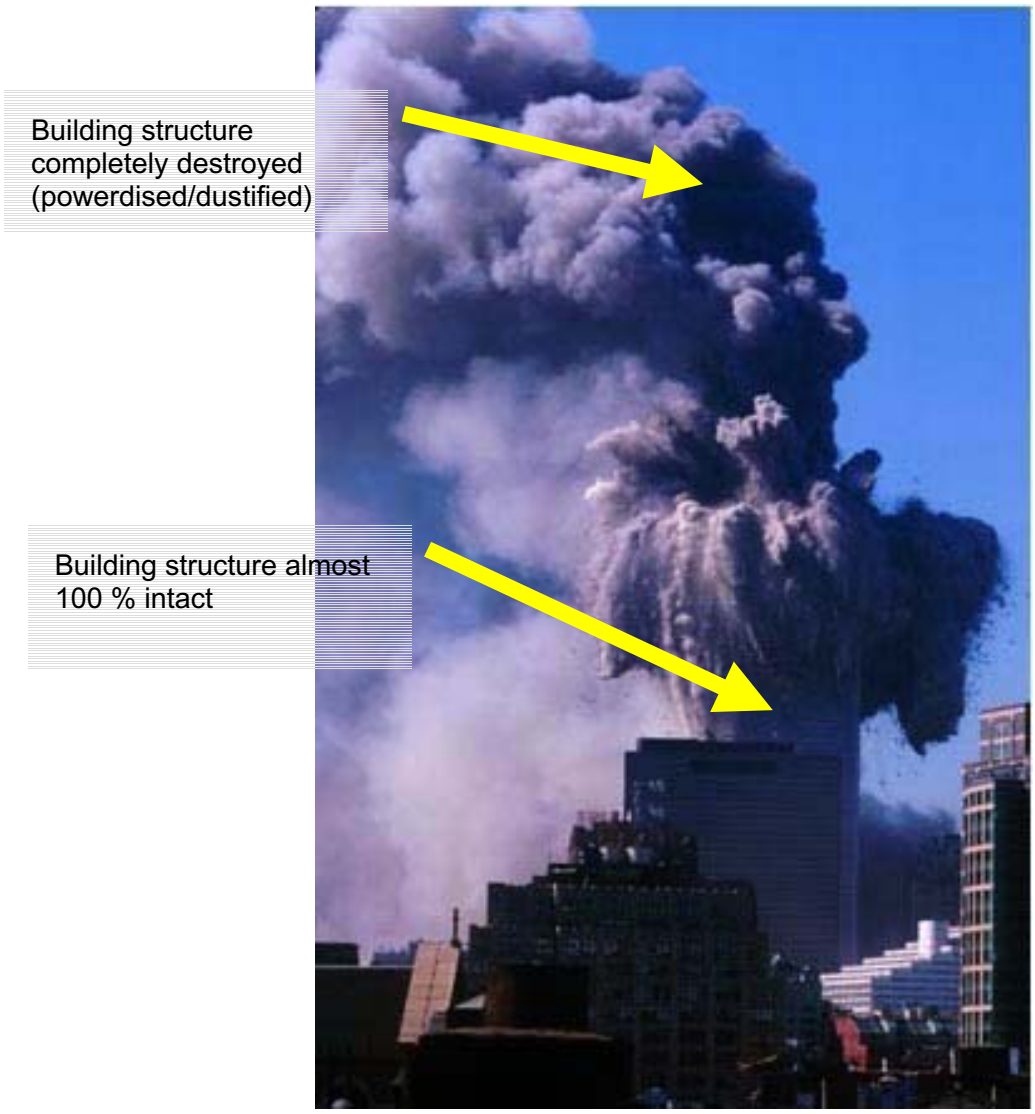
Instead, the contractors, without exception, chose to produce models and simulations which claimed to accurately depict the days events, and offer unproven theories as to their cause.

The theories advanced do not explain the observed events and technical experts exhibited willful blindness in not realizing this.

1.2.1 Destruction of WTC Complex

The towers turned largely into dust, in approximately 10 seconds each.





Where did the buildings go?

Figure 1-0 On the afternoon of 9/11/01 the "rubble pile" left from WTC1 is essentially non-existent.

At a basic level, the stated combination of jet crashes, jet fuel gravity does not pulverize buildings - and NIST and its contractors should have realized this and it should have been written up in the reports.

Instead, the contractors, without exception, chose to produce models and simulations which claimed to accurately depict the days events, and offer unproven theories as to their cause.

The theories advanced do not explain the observed events and technical experts exhibited willful blindness in not realizing this.

2. Defendants Listed in NIST Contract Solicitations

WTC No.	Solicitation No. Awarded	Title/Description	Awardee(s)
18	SB1341-06-8-0539 8/22/2006	R - World Trade Center 7 Structural Models and Collapse Hypothesis, Contract Modifications for Structural and Blast Analyses	Applied Research Associates

Extract:	Comments/Questions to Consider
As part of determining likely modes of failure in WTC 7, impact by falling debris [1] from WTC 1, fire events, and hypothetical blast events [2] are being considered for their contribution to the collapse of WTC 7. NIST has documented debris damage and fire growth and spread in WTC 7, based on available evidence [3]. NIST is analyzing scenarios for the event that initiated the collapse of the building. As a part of this work, NIST is considering whether hypothetical blast events could have played a role in initiating the collapse. While NIST has found no evidence of a blast or controlled demolition event [4], NIST would like to determine the magnitude of hypothetical blast scenarios that could have led to the structural failure of one or more critical elements as a result of blast [5] .	1. Other buildings, such as the bankers trust, also suffered impact from debris, yet they did not collapse. Why hasn't NIST considered this? 2. What evidence was considered to make hypothetical blast events a realistic target of time and money, especially considering note [4]. 3. Why wasn't more evidence available? What happened to the evidence? 4. WTC 7 fell in under 7 seconds – how can this have been a normal collapse? If there was no blast evidence, how can fire cause a "collapse" where the rubble pile barely stretches across the street to the next block? 5. Again, why are blasts being considered if there was no evidence? If ARA are an expert consultant, then why are they not asking basic questions such as 1 to 5 above?

17	SB1341-06-Q-0186 3/31/2006	R - World Trade Center 7 Structural Models and Collapse Hypothesis	Applied Research Associates

Extract:	Comments/Questions to Consider
• Vulnerability and progressive collapse analyses of buildings [6] for General Services Administration (GSA), including courthouses, embassies, and typical office buildings. ARA engineering services for GSA included development of the "Progressive Collapse Analysis & Design Guidelines for New Federal Office Buildings and Major Modernization Projects." • Studies of progressive collapse and the effects of blast on buildings for the United States Department of Defense (DoD). ARA services included development of the "Unified Facilities Criteria (UFC) – Design of Buildings to Resist Progressive Collapse" for the DoD [7]. • Studies on both static and dynamic buckling [8] and collapse of structures. Scope included development of explicit nonlinear finite element methodologies for prediction of buckling loads. • Studies on the degradation and failure of structures subjected to localized thermal loading [9]. Evaluation of combined effects of material degradation and geometric changes resulting from dynamic temperature profiles.	6. The buildings did not undergo a "progressive collapse". They turned into mostly dust in about 10 seconds each. ARA should have recognized this and adapted the description and their analysis accordingly. 7. No steel-framed buildings have undergone "progressive collapse" as a result of fire – also see note [6]. 8. There was no "buckling" in the main destruction of the building. There was virtually no debris left after the destruction of the WTC. ARA should have noticed this and adapted the description and their analysis accordingly. 9. "Localised Thermal Loading" would only apply to where the fires were burning, so does not apply to the whole structures of the buildings. ARA should have noticed this and the description and their analysis accordingly. Also see note [6].

14	SB1341-03-R-0044 10/30/2003	R -- Thermal-Structural Response Of The World Trade Center Towers With And Without Impact Damage To Determine Probable Collapse Initiation Sequences	Simpson Gumpertz & Heger, Inc. (SGH)

Extract:	Comments/Questions to Consider
• Develop and validate thermal-structural models of floor and column component and subsystem models, including passive fire protection [10]. • Determine the transient thermal-structural response of the component and subsystem models to standard test fire conditions (ASTM E119 and E1529). • Estimate the thermal environment necessary to damage or fail critical members or connections. [11] • Develop and validate a global thermal-structural model, including passive fire protection, assuming no impact damage. Conduct analysis for ASTM E119 and E1529 standard fires and for estimated heat flux densities and temperatures in undamaged compartments. • Develop and validate global thermal-structural models with aircraft impact damage by modifying the undamaged model for each tower [12]. Conduct thermal and structural analysis of possible fire growth and spread sequences in each tower. • Conduct parametric studies to determine the effect of uncertainty in influential parameters on predicted outcomes and on the most probable collapse sequence. • Identify candidate collapse initiation hypotheses for each tower from analyses. [13]	10. Not all columns and floors were heated by fire and therefore the building should not have collapsed – let alone turned to dust. SGH should have recognized this and adapted the description and their analysis accordingly. 11. Steel loses half its strength at 650C. The buildings safety factor was 20 to 1. Critical members should not have turned to dust in the circumstances which were apparent. SGH should have recognized this and adapted the description and their analysis accordingly. 12. The aircraft impact would not have contributed any significant amount to the collapse. All aircraft are made of light materials, so that they can fly and land safely and efficiently. The damage apparent on the face of both towers was not consistent with the impact of a Boeing airliner – aluminum and carbon fire tubes traveling at 540 mph cannot slice through steel girders. SGH should have recognized this and adapted the description and their analysis accordingly. 13. The towers did not collapse – they turned to dust. Therefore, there was no “collapse initiation” as the collapse never happened. SGH should have recognized this and adapted the description and their analysis accordingly.

15	SB1341-03-Q-0721 10/21/2003	R--Analysis of Active Fire Alarm Systems, WTC 1, 2, and 7	Rolf Jensen & Associates, Inc. (RJA)

Extract:	Comments/Questions to Consider
• Document the design and installation of the fire alarm systems [14] and compare designs to applicable code and standards requirements. • Document the normal expected operation and effect of the fully functional active fire alarm systems, including provisions for redundancy. • Document modifications made to fire alarm systems in WTC 1 and 2 after the 1993 bombing. • Document the probable performance [15] of the active fire alarm systems on September 11, 2001.	14. A large number of floors in the towers did not have fires before the buildings were turned into dust. RJA should have recognized this and adapted the description and their analysis accordingly. 15. What would be gained from documenting the "probable performance"? There was little or no evidence on which to base this study, because of the almost total destruction of WTC 1,2, and 7. RJA should have recognized this and adapted the description and their analysis accordingly.

11	SB1341-03-Q-0334 9/23/2003	R -- Analysis of Aircraft Impacts Into the World Trade Center Towers	Applied Research Associates, Inc. (ARA)

Extract:	Comments/Questions to Consider
• Provide estimates of the damage to structural systems due to aircraft impact [16] – including exterior walls, floor systems, and interior core columns. • Provide estimates of the aircraft fuel dispersal during the impact [17]. • Provide estimates and contours of accelerations and deformations [18] as a function of time in each of the two towers due to aircraft impact to be used for estimating damage to fire proofing. • Provide a database of the major fragments of the aircraft and destroyed structural components of the towers to be used for estimating damage to the mechanical and architectural systems inside the towers.	16. The damage to multiple steel girders (hard/thicker) caused by aircraft wings (soft/thin) should have been minimal. Consider the damage caused to a steel girder when struck by a lead bullet (which is more dense than an aluminum wing strut and it travels faster). The damage to the face of the towers was not consistent with the impact of a Boeing aircraft. ARA should have recognized this and adapted the description and their analysis accordingly. 17. Burning aircraft fuel cannot causes steel beams etc to weaken to the point of collapse (see Table 5-5 of NCSTAR 1-6B). 18. No significant deformation of steel beams should have been apparent due to the impact of Boeings – see note 16.

12	SB1341-03-Q-0463 9/22/2003	R--Analysis of Active Fire Protection Systems--Sprinklers, Standpipe, and Pre-Connected Hoses in WTC Buildings 1, 2, and 7	Hughes Associates, Inc. (HAI)

Extract:	Comments/Questions to Consider
• Document the design and installation of the fire sprinkler system, standpipe system, and pre-connected hoses and compare designs to applicable code and standards requirements. • Document the design and capacity of the water supply systems to the fire sprinklers, including provisions for redundancy.[19] • Identify and document differences in the design of the water supply, fire sprinkler system, standpipe system, and pre-connected hoses between WTC 1, 2, and 7. • Document the normal operation and effect of the fully functional fire sprinkler system, standpipe system, and pre-connected hoses for fire control [20]. • Document the performance of the fire sprinkler system, standpipe system, and pre-connected hoses on September 11, 2001.	19. Battalion Seven Chief reported "Battalion Seven ... Ladder 15, we've got two isolated pockets of fire. We should be able to knock it down with two lines. Radio that, 78th floor numerous 10-45 Code Ones." This would suggest the sprinkler systems had worked quite well enough on the floors where the fires were. HAI should have found this out and adapted the description and their analysis accordingly. 20. No fires were seen after the first 1 or 2 seconds that the towers began turning to dust, so the impact of sprinkler systems seems to be almost inconsequential. HAI should have recognized this and adapted the description and their analysis accordingly.

09	SB1341-03-Q-0281 8/22/2003	R -- Fire Endurance Testing of the World Trade Center Floor System (contract modification) *Also relates to SB1341-03-Q-0281 - 7/10/2003*	Underwriters Laboratory, Inc.

Extract:	Comments/Questions to Consider
• The first test represents current US practice for establishing a fire endurance rating of a building construction. The test assembly, fabricated to meet the design of the World Trade Center steel joist-supported floor system, will have a span of 17 ft (5.2 m). This span is typical of the floor assembly test furnaces used by the US testing laboratories that routinely conduct the ASTM E119 test for the construction industry. As is common practice, the floor assembly will be tested in the thermally restrained condition. This test will be conducted at UL's Northbrook, Illinois fire test facility. [21] • The second test will be at twice the scale of the first test, or a span of 35 ft (10.7 m). Note that this span represents a full-scale assembly of the 35 ft floor panel. The floor assembly for this test will be thermally restrained as in the first test thereby allowing direct comparison for the determination of the effect of test scale on fire endurance rating. In additionally, individual structural members of the steel joist with varying thickness of spray-on fire protection will be exposed to the standard fire environment and temperatures will be recorded. This will allow comparison of results for various amounts of fireproofing based on the end point criteria for steel temperatures. This and the third assembly will be tested at the UL Canada fire test facility. [22] • The third test will also span 35 ft and will be thermally unrestrained. The behavior of this test assembly will be compared with that of the second test allowing a determination of the effect of thermal restraint on fire resistance rating. Additionally, results from the second and third tests will bound behavior of an indeterminately restrained floor system. [23]	21. This test did not result in a structural failure. UL should have identified that the buildings did not undergo a collapse due to fire because (a) they turned largely into dust in 10 seconds each. 22. UL's own tests did not result in structural failure (see Table 5-5 of NCSTAR 1-6B). They should have highlighted this and insisted on looking at the level of destruction shown in the photos and videos of the day. 23. This test seems rather pointless. There were no significant "thermally unrestrained" sections of the building that could have contributed to the powderisation of the buildings.

07	SB1341-03-Q-0272 7/25/2003	R -- Analysis of Building and Fire Codes and Practices	Rolf Jensen & Associates, Inc. (RJA) S.K. Ghosh Associates, Rosenwasser/Grossman Consulting Engineers
Extract:			Comments/Questions to Consider
• Document the design and construction of structural systems for World Trade Center Buildings 1, 2, and 7. [24] • Document the design and construction of fire protection systems for WTC Buildings 1, 2, and 7. • Document the fuel system for emergency power in WTC Building 7 [25]. • Compare building regulatory and code requirements. • Document the maintenance and modifications to structural, fire protection and egress systems. [26].			24. Any experts in structural systems should have ultimately realized that gravity and a small fire (relative to the overall size of the structure) should not lead to a 10-second powerdisation of the building. RJA et al should have found this out and adapted the description and their analysis accordingly. 25. The emergency fuel system likely played little or no part in the 7 second destruction of WTC 7, so should not have been the subject of documentation in the context of this report. 26. No loss of life occurred in WTC 7, as it was evacuated properly, so why is there a need to document systems which worked effectively? RJA et al should have realized this and refused the contract on this basis.

10	SB1341-03-Q-0322 7/3/2003	R-Outside Experts for Baseline Structural Performance, Impact Analysis, Structural Response to Fire, Collapse ...	Area 4: Teng & Associates, Inc.
Extract:			Comments/Questions to Consider
• Provide expert technical assistance in finite element and analytical modeling of member failure sequences leading to collapse initiation, appropriate constitutive models for members experiencing thermally-induced capacity reduction and/or increased loads from load redistribution, and failure criteria for members and system failure. [27] • Conduct in-depth, review and critique of the work done on the collapse analysis of the WTC towers. The review shall include: a) appropriateness of the models for			27. UL tests showed that members did not fail, so any "analytical modeling of member failure sequences" would represent something which could not have happened. Most of the members did not "fail" they turned to dust. T & A should have recognized this and adapted the description and their analysis accordingly.

their intended uses [28], including modeling assumptions, level of detail, model geometry and material properties, and verification and validation procedures; and b) appropriateness of the analyses and accuracy of results.	28. The models can not have been appropriate because of (a) note 27 and (b) the real structural tests done by UL showed no failure, thus essentially this invalidated any models of a process (which never took place). T & A should have recognized this and adapted the description and their analysis accordingly.

13	SB1341-03-R-0028 10/27/2003	R-- Development of WTC 7 Structural Models and Collapse Hypotheses	**Gilsanz Murray Steficek LLP (GMS)**

Extract:	Comments/Questions to Consider
• Conduct preliminary structural analyses, without fire effects, of sequences of member failures and load redistribution to identify credible failure sequences up to the point of collapse initiation. [29] • Develop models of critical subsystems for identified failure sequences and analyze their response to representative fire conditions. [30] • Modify the structural finite element model of the WTC 7 building to incorporate simplifications and to support nonlinear structural analysis for building regions affected by fire. [31] • Analyze selected collapse initiation sequences for probable fire growth and spread sequences provided by NIST. of the global analyses to determine the effects of influential parameters and their uncertainty on analysis results. [32]	29. Other buildings, such as WTC6, also had significant fires, yet they did not collapse. Why hasn't NIST or the contractor considered this? 30. No steel framed building has ever collapsed due to fire. The relatively weak fires in WTC 7 should have been put out by the sprinkler system. Why didn't the contractor ask this question first? 31. Other high rise buildings burned longer than WTC 7 and did not collapse. The contractor should have noticed this. 32. Whatever the fire growth was, WTC 7 fell in under 7 seconds – how can this have been a normal collapse caused by fire? How can fire cause a "collapse" where the rubble pile barely stretches across the street to the next block? 33. If GMS is an expert consultant, then why are they not asking basic questions such as 29 to 32 above?

10	SB1341-03-Q-0322 6/23/2003	R-Outside Experts for Baseline Structural Performance, Impact Analysis, Structural Response to Fire, Collapse ...	Area 1: Skidmore, Owings & Merrill LLP
Extract:			Comments/Questions to Consider
• … conduct an independent, in-depth, third-party review and critique of the work conducted under contract SB1341-03-W-0332 for the development of structural databases from original computer printouts of the WTC towers, the development of reference structural analysis models, and the analysis of the baseline structural response of the towers under design wind and gravity loads [34]. The specific tasks the experts will perform include: • In-depth, written review and critique of the work done by the contractor. The review shall include: (1) random checks of the databases; (2) appropriateness of the models for their intended uses [35], and (3) appropriateness of the baseline performance analyses and accuracy of results. • In-depth, written review and critique of the wind loading criteria developed by NIST. • In-depth, written review of all interim and final reports produced by the contractor for development of models and baseline performance.			34. The towers did not undergo a collapse caused by a “gravity load” - the towers turned to dust in 20 seconds. Skidmore et al should have recognized this and adapted the description and their analysis accordingly. 35. The models were not “appropriate for their intended uses”, as they did not model or explain what actually happened, nor did they explain why. Skidmore et al should have recognized this and adapted the description and their analysis accordingly.

04	SB1341-03-Q-0155 6/9/2003	Document and Evaluate the Steel Recovered from the WTC Towers	Wiss, Janney, Elstner Associates, Inc.

Extract:	Comments/Questions to Consider
• Survey all WTC structural steel at NIST and identify those remnants or portion of remnants that may provide important information needed for the furtherance of tasks in Project 3 of the WTC Investigation [36] • Provide NIST with detailed photographs of all remnants or portion of remnants identified above [37] • Conduct detailed failure analyses of component parts selected for specific structural and metallurgical reasons [38] • Provide NIST with a detailed report describing the results of WJE's survey of the steel, identification of important remnants, and failure analyses of how each selected part behaved during the impact, fire, or beginning of the collapse • Provide NIST with a technical review of NIST's Draft Project 3 Report	36. Much of the steel turned to dust. Calculations show that there should have been a debris pile about 12 stories high. Photographs taken on 9/11 show that the maximum height of any debris pile was about 3 stories – and that was part of the outer shell of the WTC. WJE should have recognized this and adapted the description and their analysis accordingly. 37. Many NIST photographs of the steel remnants show damage which is not consistent with any known failure mode or "collapse" – for example multiple crease and severe warping and folding. WJE should have recognized this and adapted the description and their analysis accordingly. 38. A detailed failure analyses should have shown that the effects on samples were not consistent enough to explain damage caused by gravity, fire and jet fuel alone. The fact that large parts of the buildings turned to dust in seconds should have been discussed.

3. Other Defendants, not listed in NIST Contract Solicitations

3.1 COMPUTER AIDED ENGINEERING ASSOCIATES, INC.

Extract:	Comments/Questions to Consider
Computer Aided Engineering Associates Inc. (CAEA), Woodbury, Connecticut; Dr. Peter Barrett, Project Leader, who provided technical assistance to SGH and to NIST on the complex computer analyses. Xxxv of NIST NCSTAR 1-6, WTC Investigation	• The computer analyses were not representative of the events, nor their cause – they did not show powerdisation, nor did they correctly explain how the plane impact damage was caused. Computer Aided Engineering Associates Inc. (CAEA) should have recognized this and adapted the description and their analysis accordingly. • Just because a Computer Analysis was complex does not make it correct. (For example, complex computer analysis is done, using super computers, for meteorological forecasting – the complexity does make the end result "correct")

4. Contract Summary Listings

4.1 18 SB1341-06-8-0539 R - World Trade Center 7 Structural Models and Collapse Hypothesis, Contract Modifications for Structural and Blast Analyses

Applied Research Associates 8/22/2006 Award Information

http://wtc.nist.gov/solicitations/wtc_award0539.htm

WTC 7 STRUCTURAL ANALYSIS AND COLLAPSE HYPOTHESES, CONTRACT MODIFICATIONS FOR STRUCTURAL AND BLAST ANALYSES

Under GSA Contract number GS23F0278M, NIST Order No. SB1341-06-8-0539, as a firm fixed price effort, has been awarded to APPLIED RESEARCH ASSOCIATES, INC. (ARA) of Albuquerque, New Mexico, to append the following tasks to the original contract awarded on March 31, 2006. Under the appended tasks, the ARA (1) shall conduct analyses of impact damage and fire effects to provide candidate initiating events which may lead to structural failures and global collapse, and (2) shall determine if there is any scenario of a hypothetical blast event or events that could have occurred in WTC 7 on September 11, 2001.

As part of determining likely modes of failure in WTC 7, impact by falling debris from WTC 1, fire events, and hypothetical blast events are being considered for their contribution to the collapse of WTC 7. NIST has documented debris damage and fire growth and spread in WTC 7, based on available evidence. NIST is analyzing scenarios for the event that initiated the collapse of the building. As a part of this work, NIST is considering whether hypothetical blast events could have played a role in initiating the collapse. While NIST has found no evidence of a blast or controlled demolition event, NIST would like to determine the magnitude of hypothetical blast scenarios that could have led to the structural failure of one or more critical elements as a result of blast.

ARA is an engineering firm founded in 1979 that performs research and design studies for complex defense, security, environmental, transportation, and readiness problems. This study will be managed from the Silicon Valley Office of ARA that specializes in finite element analysis and nonlinear structural dynamics under blast and impact loading, impact and penetration mechanics, failure analysis, and blast effects and the analysis of progressive collapse in buildings. ARA is partnering with Simpson Gumpertz & Heger Inc. (SGH) of Waltham, Massachusetts, to conduct the appended tasks, and with Loizeaux Group International (LGI), the consulting services branch of Controlled Demolition Incorporated (CDI) of Phoenix, Maryland.

SGH is an engineering firm that specializes in design, investigation and retrofit of buildings and structures of all types. SGH has expertise in building structures, materials, and investigations and conducted the thermal-structural response

analyses of each WTC tower, as part of their contract for the WTC towers investigation.

Loizeaux Group International (LGI) has expertise in a wide range of demolition, explosion and explosives-associated technology. This includes explosive processes and their direct and collateral effects of blast and resulting vibration, projectiles, and overpressure. They have conducted investigations involving commercial explosives, terrorist devices, commercial gas, and industrial accidents involving dusts, hot metals, and combustion processes.

The specific tasks that ARA will perform with SGH (task 1) and LGI (task 2) include:

1. Identify and analyze hypothetical blast scenarios in three phases, with the results from each phase being used to decide if the analyses in the next phase is required:

A. Identify hypothetical blast scenarios, using analysis and/or experience, to determine conditions that would fail specified column sections by direct attachment of explosive materials.

B. Analyze the overpressure produced by the blast load and determine if the overpressure would have failed windows in WTC 7.

C. Determine if the overpressure would result in sound levels transmitted through intact WTC 7 windows that could be heard outside the building.

2. Conduct the following analyses using a three-dimensional ANSYS model (provided by NIST) of the lower 16 floors of WTC 7:

A. Review the ANSYS model provided by NIST for conducting structural analysis of damage to components and the effect of time-varying temperatures. Identify possible revisions/improvements to the ANSYS model that may improve efficiency, accuracy and/or capture of critical failure modes.

B. Work with NIST staff to incorporate agreed upon changes to the ANSYS model.

C. Determine the structural response of WTC 7 for up to six scenarios of structural damage from debris impact and temperature histories provided by NIST. NIST will conduct analyses of other scenarios in parallel. Work with NIST to identify the structural response and failure modes for each analysis.

The ARA team has expertise and experience in failure analysis, nonlinear structural analysis, damage of steel and concrete structures, progressive collapse analyses, nonlinear constitutive and damage modeling, analysis of structures subjected to thermal loads, and blast effects on structures. The team will be led by Dr. Steven W. Kirkpatrick. Select experience of key project personnel is summarized below:

* Dr. Steven W. Kirkpatrick is the program manager for this project. Dr. Kirkpatrick is a Principal Engineer with 21 years of experience in structural dynamics, failure analysis, finite element analysis, impact and blast/penetration mechanics, and vehicle crashworthiness. He has more than 40 publications in these areas. His research experience includes a wide range of government and commercial projects for rail, highway, civil, military, and aerospace applications. He has been a program leader for many studies requiring close collaboration between experimental and computational efforts with emphasis on model validation. Dr. Kirkpatrick was previously the PI for the ARA participation in the NIST WTC investigation in performing the aircraft impact analyses. Dr. Kirkpatrick has a doctorate in mechanical engineering from Stanford University.

* Mr. Charles Needham is a Principal Engineer for the Southwest Division of ARA. He has experience with numerical hydrodynamics, shock, fireball and thermal effects modeling, conventional explosives and munitions effects and structure interaction, explosive safety and storage. He has 14 years specific experience with SHAMRC, a state-of-the-art hydrodynamic code for two- and three-dimensional fluid dynamics problems with applications for conventional munitions. Mr. Needham has a master's degree in astrophysics from the University of New Mexico.

* Mr. Joseph Crepeau is a Principal Computer Scientist for the Southwest Division of ARA. His responsibilities include the maintenance and development of features for SHAMRC, as well as training for its applications. Mr. Crepeau has a master's degree in computer science from the University of New Mexico.

* Ms. Lee Ann Young is a Principal Engineer I for the Southwest Division of ARA. She has spent the last 14 years at ARA working in the areas of human vulnerability to explosions, penetration mechanics, and conventional weapon effects. Ms. Young has a master's degree in applied statistics from the University of New Mexico.

* Dr. Mehdi Zharghamee is a Principal and Head of the Engineering Mechanics and Infrastructure Division at SGH and has 30 years of engineering experience in analysis and design of precision structures. He has been responsible for analysis, design, and failure investigation of complex structural and mechanical systems. Dr. Zarghamee has a doctorate in structural engineering from the University of Illinois and his S.M. in Mathematics from the Massachusetts Institute of Technology.

* Dr. Omer Erbay is a Senior Engineer with SGH and has experience with the analysis of the structural response of the WTC towers to impact damage and fire conditions and structural analysis of buildings and bridge piers. Dr. Erbay has a doctorate in structural engineering from the University of Illinois.

* Frank Kan, a Senior Project Manager, has been with SGH for 16 years. He has been involved in structural and seismic analysis, design, and investigation of buildings, bridges and special structures. Mr. Kan received his M.S. in Civil Engineering from the Massachusetts Institute of Technology.

* Mr. Mark Loizeaux is CEO of LGI and President of CDI, and has been responsible for the design and performance of CDI's projects since 1976, including the felling of major steel industrial, commercial and office buildings across the United States and internationally. Several of these buildings were major structures up to 439 ft tall, with column flanges ranging from 6 in. thick (laminated steel flanges) to 4 in. thick (hot-rolled flanges). His experience with steel structures includes the demolition of major steel bridges and construction and communication towers as tall as 1,200 ft. He is responsible for all aspects of CDI explosives demolition design and control of related consequences, including control of fly of debris, air overpressure, vibration and debris impact on surrounding structures. He has been recognized as an expert in demolition and explosives operations in U.S. Federal Court and the Courts of Australia.

4.2 17 SB1341-06-Q-0186 R - World Trade Center 7 Structural Models and Collapse Hypothesis

Applied Research Associates 3/31/2006 Award Information

http://wtc.nist.gov/solicitations/wtc_awardQ0186.htm

WTC 7 STRUCTURAL ANALYSIS AND COLLAPSE HYPOTHESES

Under solicitation number SB1341-06-Q-0186, a fixed price purchase order has been awarded to APPLIED RESEARCH ASSOCIATES, INC. (ARA) of Albuquerque, New Mexico:

ARA is an engineering firm founded in 1979 that performs research and design studies for complex defense, security, environmental, transportation, and readiness problems. This study will be managed from the Silicon Valley Office of ARA that specializes in finite element analysis and nonlinear structural dynamics under blast and impact loading, impact and penetration mechanics, failure analysis, and blast effects and the analysis of progressive collapse in buildings. Specific examples of the team's past work include:

* Analysis of the aircraft impact on the WTC towers using explicit finite element analysis to model the dynamic impact loads and resulting progression of damage and component failures in the towers.

* Vulnerability and progressive collapse analyses of buildings for General Services Administration (GSA), including courthouses, embassies, and typical office buildings. ARA engineering services for GSA included development of the "Progressive Collapse Analysis & Design Guidelines for New Federal Office Buildings and Major Modernization Projects."

* Studies of progressive collapse and the effects of blast on buildings for the United States Department of Defense (DoD). ARA services included development of the "Unified Facilities Criteria (UFC) – Design of Buildings to Resist Progressive Collapse" for the DoD.

* Studies on both static and dynamic buckling and collapse of structures. Scope included development of explicit nonlinear finite element methodologies for prediction of buckling loads.

* Studies on the degradation and failure of structures subjected to localized thermal loading. Evaluation of combined effects of material degradation and geometric changes resulting from dynamic temperature profiles.

ARA will conduct analyses, in collaboration with NIST, to determine the location and cause of the initiating event (i.e., the first component or group of components that failed) that led to global collapse of WTC 7. The analyses will determine the series of component and subsystem failures subsequent to the initiating event that led to global collapse that are consistent with observations from video and photographic records and other evidence. NIST will conduct all fire analysis of the building and analysis of the structural response to fires in-house and supply ARA initiating event data based on the in-house analyses.

ARA will conduct nonlinear dynamic collapse analyses using LS-DYNA that include analyses of detailed full floor models and global models. The detailed floor analyses will determine likely modes of failure for Floors 8 to 46 due to failure of one or more supporting columns (at one or more locations), and aid the development of a more coarse model for use in the global analyses that captures essential behaviors and failure mechanisms. Two types of global analyses will be conducted. Sensitivity studies will be conducted to determine the response of WTC 7 to various scenarios of initiating events. Final analyses will support the determination of the location and cause of the initiating event, by incorporating data from NIST for simulating the initiating event, as well as the location and cause of subsequent failures that led to global collapse. The specific tasks that ARA will perform include:

1. Conduct detailed analyses of floor components and subsystems with appropriate steel and concrete constitutive models.

2. Determine the floor response to gravity loads for up to twenty initiating event scenarios

3. Develop an equivalent representation of the tenant floors for the global model.

4. Conduct global analysis under service gravity loads to determine the structural response of WTC 7 to different initiating events, including characterization of the load redistribution within the structural system for two states of damage from debris impact.

5. Conduct a sensitivity study to determine the global structural response to gravity loads for up to twenty initiating event scenarios

6. Conduct final global analyses that simulate up to five initiating events and the subsequent failure sequences up to the point of global instability.

The team from ARA has expertise and experience in failure analysis, nonlinear structural analysis, damage of steel and concrete structures, progressive collapse analyses, nonlinear constitutive and damage modeling, analysis of structures subjected to thermal loads, and blast effects on structures. The team will be led Dr. Steven W. Kirkpatrick. Select experience of key project personnel is summarized below:

* Dr. Steven W. Kirkpatrick is the program manager for this project. Dr. Kirkpatrick is a Principal Engineer with 21 years of experience in structural dynamics, failure analysis, finite element analysis, impact and penetration mechanics, and vehicle crashworthiness. He has more than 40 publications in these areas. His research experience includes a wide range of government and commercial projects for rail, highway, civil, military, and aerospace applications. He has been a program leader for many studies requiring close collaboration between experimental and computational efforts with emphasis on model validation. Dr. Kirkpatrick was previously the PI for the ARA participation in the NIST WTC investigation in performing the aircraft impact analyses. Dr. Kirkpatrick has a doctorate in mechanical engineering from Stanford University.

* Dr. Robert Bocchieri, Principal Engineer, will provide expertise in nonlinear dynamic finite element analysis, solid mechanics, materials constitutive modeling, rate-dependent material behavior, fracture mechanics and failure analysis, mechanics of composite materials, and structural dynamics. Dr. Bocchieri has a doctorate in aerospace engineering from the University of Texas at Austin.

* Mr. James Brokaw, Senior Security Engineer and Director of the Security Engineering Group, will provide expertise in the analysis of progressive collapse in buildings. He has served as the lead consultant for numerous projects of national

significance subject to terrorist threats and assisted in the development of GSA's progressive collapse analysis and design guidelines. Mr. Brokaw has a Master's Degree in civil engineering from West Virginia University.

* Mr. Robert MacNeill, Senior Engineer, will provide expertise in finite element analysis (FEA) and thermal analysis. Mr. MacNeill is an experienced user of LS-DYNA, having implemented many advanced features of the code and is skilled at constructing complex parametric finite element models designed to easily interface with simulation based design (SBD) systems and design databases. Mr. MacNeill has a Master's Degree in mechanical engineering from the Rochester Institute of Technology.

* Mr. Brian Peterson, Senior Engineer, will provide expertise in nonlinear dynamic finite element analysis, impact and penetration mechanics, solid mechanics, materials constitutive modeling, fracture mechanics, and failure analysis. Mr. Peterson has experience in testing of materials and structures and has extensive experience with advanced features of LS-DYNA. Mr. Peterson has a Master's Degree in mechanical engineering from Stanford University.

4.3 16 SB1341-03-Q-0835 R –Analysis of Smoke Management Systems in WTC Buildings

Hughes Associates, Inc. (HAI) 10/30/2003 Award Information

http://wtc.nist.gov/solicitations/wtc_awardQ0835.htm

Under solicitation number SB1341-03-Q-0835, a firm fixed price purchase order has been awarded to Hughes Associates, Inc. (HAI).

Established in 1980, HAI is a fire protection engineering, research, and consulting firm whose experience includes fire hazard and risk analysis, fire modeling, fire protection design, code consulting, product development, and litigation support. HAI's staff has earned an international reputation in the application of advanced technologies to solve both standard and unique fire protection problems.

Specific tasks related to WTC Buildings 1, 2, and 7 that the Hughes team will perform include:

1) Document the design and installation of the smoke management systems and compare designs to applicable code and standards requirements.

2) Document the normal operation of the fully functional smoke management systems and its potential effect on smoke conditions in WTC Buildings 1 & 2 on September 11, 2001.

HAI's project team includes senior level engineers and staff engineers with extensive experience in the design, specification, installation, testing, and performance assessment of smoke management systems, including new and existing systems. Experience in performance assessment includes (1) quantitative evaluations of system performance using fire models and building airflow models, (2) conceptual design of new or existing smoke management systems (both as the design engineer and as third party peer reviewer), (3) commissioning testing to evaluate the performance of installed smoke control systems and (4) code and standards compliance evaluation of existing systems.

Selected experience of the key personnel assigned to this effort is summarized below:

* Michael J. Ferreira, P.E., Principal Investigator – Mr. Ferreira has over 10 years experience including fire protection engineering R&D, quantitative fire hazards analysis, design and evaluation of smoke management systems and code and standards activities associated with smoke management systems. He is a member of NFPA Technical Committee on Smoke Management Systems and has published numerous technical papers on smoke control system design including the implementation of unique approaches in the application of building airflow and

contaminant transport analysis software to evaluate smoke movement and smoke management systems in large complex structures including WTC 1 and 2.

* Mark T. Wright, P.E., Staff Engineer – Mr. Wright has over 5 years experience in the modeling of smoke management systems in large complex structures including high-rise buildings. Other experience includes egress evaluations from large complex structures, code consulting, smoke control design. He is a member of NFPA, SFPE and is a two-time recipient of the SFPE Scholarship.

* Steve M. Strege, Staff Engineer – Mr. Strege's experience includes fire/smoke, building airflow and contaminant transport modeling for several large complex structures. Other experience includes egress evaluations from large complex structures, code consulting, on-site fire investigations and the modeling and study of smoke plume behavior under various fire scenarios. He is a member of SFPE, NFPA, University of Maryland College Park Scholars and the recipient of several academic engineering scholarships.

* John A. Lee, P.E., Senior Fire Protection Engineer – Mr. Lee has almost 30 years experience as a fire protection engineer. His experience includes design and testing installed smoke control systems for conformance to design and building codes. He also acted as a special inspector on several high-rise buildings including smoke management systems.

* Joseph L. Scheffey, P.E., Project QA/QC – Mr. Scheffey has over 20 years of experience in fire hazard analysis, fire/smoke modeling and smoke control system evaluation and is the author of over 100 technical publications.

4.4 14 SB1341-03-R-0044 R –Structural Response to the World Trade Center (WTC) Towers

Simpson Gumpertz & Heger, Inc. (SGH) 10/30/2003 Award Information

http://wtc.nist.gov/solicitations/wtc_awardR0044.htm

THERMAL-STRUCTURAL RESPONSE OF THE WORLD TRADE CENTER TOWERS WITH AND WITHOUT IMPACT DAMAGE TO DETERMINE PROBABLE COLLAPSE INITIATION SEQUENCES

Under solicitation number SB1341-03-R-0044, an indefinite deliverable, indefinite quantity (IDIQ) purchase order has been awarded to Simpson Gumpertz & Heger Inc. (SGH) of Waltham, Massachusetts, to determine the response of structural components and systems to the fire environment in the World Trade Center towers and to identify probable structural collapse mechanisms.

SGH is an engineering firm that specializes in design, investigation and retrofit of buildings and structures of all types. SGH has a highly skilled technical staff with expertise in building structures,

materials, and investigation and specialized research and is well qualified to conduct the structural fire response and collapse analysis of the World Trade Center towers.

SGH strengths include: advanced finite element analysis capabilities; expertise in building technology, materials analysis and testing and engineering mechanics; sophisticated investigative capabilities utilizing state of the art NDE and monitoring technologies. SGH is partnering with Computer Aided Engineering Associates (CAEA), an engineering consulting company specializing in advanced engineering analysis services. CAEA specializes in thermal-stress analysis and has extensive experience in applied mechanics, dynamics, contact mechanics and finite element code development.

Together, SGH and CAEA bring many years of experience in nonlinear finite analysis, high-rise building design, material studies for thermal effects and failure investigations.

The specific tasks that SGH will perform include:

* Develop and validate thermal-structural models of floor and column component and subsystem models, including passive fire protection.

* Determine the transient thermal-structural response of the component and subsystem models to standard test fire conditions (ASTM E119 and E1529).

* Estimate the thermal environment necessary to damage or fail critical members or connections.

* Develop and validate a global thermal-structural model, including passive fire protection, assuming no impact damage. Conduct analysis for ASTM E119 and E1529 standard fires and for estimated heat flux densities and temperatures in undamaged compartments.

* Develop and validate global thermal-structural models with aircraft impact damage by modifying the undamaged model for each tower. Conduct thermal and structural analysis of possible fire growth and spread sequences in each tower.

* Conduct parametric studies to determine the effect of uncertainty in influential parameters on predicted outcomes and on the most probable collapse sequence.

The studies are based upon the approach described in the paper “Assessing the Most Probable Structural Collapse Sequence: Integrating Impact Damage, Fire Dynamics, Thermal-Structural Response, & Collapse Initiation.”

* Identify candidate collapse initiation hypotheses for each tower from analyses.

The key personnel at SGH and CAEA include: Project Manager, Mehdi Zarghamee; Structural Performance Review Committee, Glen Bell, Ronald Hamburger and Pedro Sifre; Computation/Modeling Review Committee, Said Bolourch, Atis Liepins and Peter Barrett; and Computation Manager, Frank Kan.

* Mehdi S. Zarghamee, a Principal and Head of the Engineering Mechanics and Infrastructure Division at SGH, has 30 years of engineering experience in analysis and design of precision structures. He has been responsible for analysis, design, and failure investigation of complex structural and mechanical systems. Dr. Zarghamee earned his Ph. D. in Structural

Engineering from the University of Illinois and his S.M. in Mathematics from the Massachusetts Institute of Technology.

* Glen Bell, Principal and Chief Executive Officer, has been with SGH for 28 years. Mr. Bell specializes in structural failure investigations and has extensive experience in earthquake engineering, structural design and rehabilitation. He received his B.S. degree in Civil Engineering from Tufts University and his M.S. in Structural Engineering and Structural Mechanics from the University of California at Berkeley.

* Ronald Hamburger, a Principal at SGH, has 28 years of experience in civil and structural engineering, damage and forensic investigations, engineering research, building code and standards development and project management. He was a member of the Building Performance Assessment Team that investigated the collapse of the World Trade Center Buildings in New York. Mr. Hamburger received his M.B.A. from Golden Gate University and his B.S. and M.S. from the Polytechnic Institute of New York.

* Pedro Sifre, Senior Project Manager, has 16 years of experience in high-rise building design and optimization of lateral load resisting systems. He received his B.S. in Civil Engineering and his M.S. in Aeronautics and Astronautics from the Massachusetts Institute of Technology and his M.S. in Structural Engineering from the University of California at Berkeley.

* Atis Liepins, a Senior Associate has been with SGH for 25 years. He is an expert in the performance of finite element analysis, structural design, and failure analysis. Mr. Liepins received his S.B., S.M., and C.E. in Civil Engineering from the Massachusetts Institute of Technology.

* Said Bolourchi, Staff Consultant, has 24 years of experience. His expertise is in risk assessment and failure analysis and evaluations including nonlinear dynamic analysis and response spectrum analysis of structures. Dr. Bolourchi received his B.S. in Mechanical Engineering from Queen Mary College, London, and his M.S. in Mechanical Engineering and Ph.D. in Applied Mechanics from the Massachusetts Institute of Technology.

* Peter Barrett, Consultant, has over 20 years of experience in thermal-structural analysis applications using the finite element method and has been with CAEA since 1993. He has conducted numerous geometric and material nonlinear static and dynamic analyses to evaluate the strength, stability, and fatigue life of structures.

* Frank Kan, a Senior Project Manager, has been with SGH for 16 years. He has been involved in structural and seismic analysis, design, and investigation of buildings, bridges and special structures. Mr. Kan received his B.Eng. in Civil Engineering and Engineering Mechanics from McMaster University, Ontario, and his M.S. in Civil Engineering from the Massachusetts Institute of Technology. As Computation Manager, Mr. Kan will be responsible for all computational aspects of the project as well as coordination between the SGH Computation Team and the CAEA Consultant Team.

4.5 13 SB1341-03-R-0028 R– Development of WTC 7 Structural Models and Collapse Hypotheses

Gilsanz Murray Steficek LLP (GMS) 10/27/2003 Award Information

http://wtc.nist.gov/solicitations/wtc_awardR0028.htm

Under solicitation number SB1341-03-R-0028, an indefinite deliverable, indefinite quantity (IDIQ) purchase order has been awarded to Gilsanz Murray Steficek LLP

(GMS) of New York City and its team composed of Dr. John Fisher of Lehigh University, Pennsylvania, and Computer Aided Engineering Associates Inc., of Woodbury, Connecticut.

GMS is a structural engineering firm that specializes in new construction and renovation projects of office buildings, residential towers, industrial facilities, hospitals, and historic structures. Office building design projects include 300 Madison Avenue, and the Brooklyn Courthouse, high rise buildings. GMS partners have worked on several steel high rise buildings in New York City of the same vintage as WTC 7, prior to the formation of GMS in 1991. GMS also conducts blast design and progressive collapse analysis of steel and concrete buildings, which included nonlinear structural analysis and investigation of possible collapse initiation. Dr. John Fisher is a steel connections expert who specializes in the fatigue and fracture resistance of bolted and welded steel connections. CAEA specializes in transient thermal analysis, and has conducted training in nonlinear analysis for ANSYS software.

The GMS team will conduct analyses of the WTC 7 building's structural response to fire conditions. NIST will be conducting all fire analysis of the building in-house and supplying the time-temperature histories for the structural analysis to the GMS team. A rigorous review process of the work and products will be implemented. The review process includes independent reviews by third-party experts retained by NIST, Dr. Shankar Nair and Prof. Kaspar Willam, under solicitation number SB 1341-03-Q-0322, to augment in-house NIST reviews. Specific tasks that the GMS team will perform include:

1. Develop and validate a structural finite element model of WTC Building 7.

2. Conduct preliminary structural analyses, without fire effects, of sequences of member failures and load redistribution to identify credible failure sequences up to the point of collapse initiation.

3. Develop models of critical subsystems for identified failure sequences and analyze their response to representative fire conditions.

4. Conduct parametric studies of subsystems to determine the effects of influential parameters and their uncertainty on analysis results.

5. Develop approaches to simplify structural analyses for final global modeling and analyses.

6. Modify the structural finite element model of the WTC 7 building to incorporate simplifications and to support nonlinear structural analysis for building regions affected by fire.

7. Analyze selected collapse initiation sequences for probable fire growth and spread sequences provided by NIST.

8. Conduct parametric studies of the global analyses to determine the effects of influential parameters and their uncertainty on analysis results.

All major technical decisions involving contractor work require NIST guidance, review, and approval. In addition, findings, conclusions, and recommendations are the responsibility of NIST, not the contractor.

The GMS team combines engineers with experience in structural engineering of high rise steel office buildings, failure of structural steel connections, and thermal-structural analysis. Selected experience of key project personnel is summarized below:

All three founding Partners, Mr. Ramon Gilsanz, Mr. Philip Murray, and Mr. Gary Steficek, will be involved in this project. Mr. Gilsanz will act as the Principal for the project team.

* Mr. Ramon Gilsanz has over 20 years of experience as a structural engineer for a wide range of projects, including design, renovation, and progressive collapse analysis of high rise steel office buildings. He is a registered professional engineer and a registered structural engineer. He has received awards for design projects from the New York Association of Consulting Engineers and the American Consulting Engineers Council. He is a past president and a member of the Structural Engineers Association of New York and a member of American Society of Civil Engineers. He has a Master of Science degree in Civil Engineering from the Massachusetts Institute of Technology.

* Dr. John Fisher, P.E., is a Professor Emeritus of Civil Engineering at Lehigh University. He has over 35 years of experience in the design, behavior, and failure of steel structural connections of riveted, bolted, and welded structures and of composite steel-concrete members. He has conducted over 100 research projects in these areas since 1961. He has published over 260 reports and articles and is an author of several books on structural steel design and fatigue and fracture of steel connections. He has received numerous awards throughout his career in recognition of his contribution to structural engineering. He was elected to the National Academy of Engineering in 1986. In 1995 his work was recognized with the award of the ASCE John A. Roebling Medal for Lifetime Achievement in Bridge Engineering. In 2000 he received the John Fritz Medal for extraordinary vision in researching safety and performance of steel structures, and leadership in making discerning judgments for the public good. He has a Doctor of Philosophy degree in Civil Engineering from Lehigh University.

* Mr. Peter Barrett, P.E., is the Vice President of CAEA and a registered engineer. He has over 20 years of experience in thermal-structural applications using the finite element method. He has performed numerous geometric and material nonlinear static and dynamic analyses to evaluate the strength and stability of aerospace, nuclear, dam, and offshore structures. He has taught over

100 ANSYS training classes over the last 10 years about finite element theory, nonlinear analysis, and applied methods. He has a Master of Science degree in Structural Engineering Mechanics from the University of California Berkeley.

4.6 15 SB1341-03-Q-0721 R–Analysis of Active Fire Alarm Systems, WTC 1, 2, and 7

Rolf Jensen & Associates, Inc. (RJA) 10/21/2003 Award Information

http://wtc.nist.gov/solicitations/wtc_awardQ0721.htm

Under solicitation number SB1341-03-Q-0721, a firm fixed price purchase order has been awarded to Rolf Jensen & Associates, Inc. (RJA).

Founded in 1969, RJA is a leader in life safety and fire protection engineering providing consulting services to a wide range of government and private clients. RJA has extensive experience in the development of comprehensive fire protection design and analysis of fire detection and alarm systems for complex and unique facilities. RJA provides fire protection and life safety consulting services for many high-rise buildings in New York City. Engineers at RJA are actively involved in the building and fire code development process at the national level, including principal membership on the technical committees responsible for NFPA 72, The National Fire Alarm Code. RJA was heavily involved in the postfire investigation and analysis of the Meridian Plaza high-rise building fire in Philadelphia, Pennsylvania.

Specific tasks related to WTC 1, 2, and 7 that the RJA team will perform include:

1) Document the design and installation of the fire alarm systems and compare designs to applicable code and standards requirements.

2) Document the normal expected operation and effect of the fully functional active fire alarm systems, including provisions for redundancy.

3) Document modifications made to fire alarm systems in WTC 1 and 2 after the 1993 bombing.

4) Document the probable performance of the active fire alarm systems on September 11, 2001.

RJA's project team includes licensed engineers and supporting staff with a strong working knowledge of fire alarm and emergency communications systems and related design, systems analysis, construction, operations, and maintenance requirements. Principal members of the team are located in the Washington, D.C., and New York City areas.

Selected experience of the key personnel assigned to this effort is summarized below:

Mr. Raymond A. Grill, P.E. FSFPE, Principal Investigator, is the Senior Vice President for the Northeast offices of RJA, responsible for RJA operations in Boston, New York and Washington, D.C. He has practiced fire protection engineering for over 20 years. He served on the International Fire Code Performance Drafting Committee and as Chair of the Fundamentals of Fire Alarm Systems technical committee of NFPA 72, National Fire Alarm Code. Mr. Grill was a co-Chairperson of the New York City Fire Alarm Code Revision Committee responsible for converting the committee's work into code language. He has extensive experience in the development of comprehensive fire protection programs for major structures and the development of equivalencies to building and fire code requirements. He has published in a wide variety of fire protection publications including editing the Detection and Alarm Section of the 19th edition of the NFPA Fire Protection Handbook and a chapter of the recently published Handbook to the 2002 Edition of the National Fire Alarm Code. Mr. Grill is a registered Fire Protection Engineer and Mechanical Engineer. He is licensed in New York and in other states. He is a Fellow and member of the Board of Directors of the Society of Fire Protection Engineers.

Mr. Joseph Razza, P.E., is a Senior Consultant and Project Manager in the New York offices of RJA. He provides technical expertise in the area of New York City Code requirements for fire alarm systems and related operational issues. Mr. Razza has an extensive background in analysis of New York City, New York State, and International Building and Fire Codes, combined with fire protection inspection experience working as an inspector with the New York City Fire Department. Mr. Razza is an instructor in the School of Continuing and Professional Studies at New York University and an adjunct professor at John Jay College of Criminal Justice in New York City.

Mr. Ralph Transue, P.E., is Senior Vice President of RJA and an expert in fire alarm technologies extending from the 1960s to the present. He has been engaged in fire alarm system product development, application engineering, installation, inspection, maintenance, training, and the development of related codes and standards. He is an expert in fire detection, including that for special hazards, and operational interfaces with other systems. He has analyzed existing systems in New York City high-rise buildings. Mr. Transue was involved in the analysis of the conditions and performance of the fire alarm system based on the documentation reviewed and the artifacts collected. During the Meridian Plaza high-rise fire investigation, Mr. Transue was involved in the analysis of the conditions and performance of the fire alarm system based on the documentation reviewed and the artifacts collected. He is a principal member of the National Fire Alarm Code, NFPA 72, Technical Committee on Protected Premises, and was formally a principal member of the Technical Committee on (Fire) Detection Devices.

Mr. Thomas Brown, P.E., is a Senior Vice President with responsibility for the Fairfax, Virginia, Office of RJA. He has extensive experience in the design of fire alarm systems for buildings and in-depth construction management experience in coordinating the installation of fire alarm, life safety, emergency communication and fire alarm interfaces for smoke management, and fire suppression systems. Mr. Brown was heavily involved in the onsite investigation of the Meridian Plaza high-rise building fire that involved tracing of all fire alarm system conduits and devices to document system conditions prior to the fire and reviewing all documents relative to design and construction of the fire alarm system over the lifetime of the building.

4.7 11 SB1341-03-Q-0334 R – Analysis of Aircraft Impacts Into the World Trade Center Towers

Applied Research Associates, Inc. (ARA) 9/23/2003 Award Information

http://wtc.nist.gov/solicitations/wtc_awardQ0334.htm

Under solicitation number SB1341-03-Q-0334, an indefinite deliverable, indefinite quantity (IDIQ) purchase order has been awarded to APPLIED RESEARCH ASSOCIATES, INC. (ARA) of Albuquerque, New Mexico:

ARA is an engineering firm that specializes in the following areas: nonlinear structural dynamics under blast and impact loading, vehicle crashworthiness and impact behavior, aircraft impact analysis, dynamic fracture modeling and failure analysis, impact and penetration mechanics, probabilistic engineering mechanics, and structural engineering. ARA is well qualified to conduct the analysis of the aircraft impact into the WTC towers with active research programs in crash, impact, and blast damage of structures for over 20 years. ARA is selected by the Federal Highway Administration as a Center of Excellence in finite element crash analyses and is designated by Livermore Software Technology Corporation (the developer of the LS-DYNA software package) as a Research Collaborator. Specific examples of the team's past work include:

* Analysis of aircraft impact into nuclear power plant containment structures and storage containers.

* Analysis of a fighter aircraft impact into multiple reinforced concrete barriers.

* Fragmentation of aircraft components due to turbine rotor failure.

* Simulation of railcars in high-speed impacts.

* Studies of the effects of blast on buildings and their progressive collapse.

The specific tasks that ARA will perform include:

1) Provide estimates of the damage to structural systems due to aircraft impact – including exterior walls, floor systems, and interior core columns.

2) Provide estimates of the aircraft fuel dispersal during the impact.

3) Provide estimates and contours of accelerations and deformations as a function of time in each of the two towers due to aircraft impact to be used for estimating damage to fire proofing.

4) Provide a database of the major fragments of the aircraft and destroyed structural components of the towers to be used for estimating damage to the mechanical and architectural systems inside the towers.

The impact analyses will be conducted at various levels including: (1) the component level, (2) the subassembly level, and (3) the global level to estimate the probable damage to the towers due to aircraft impact. The analyses will also include simplified and approximate methods. Analysis of uncertainties using the component, subassembly, global, and simplified analyses will also be conducted to assess the effect of uncertainties associated with various parameters on the damage estimates.

The team from ARA combines engineers from several branches of ARA with diverse background and experience in crashworthiness, dynamic fracture analysis, applied mechanics and nonlinear dynamics, probabilistic mechanics, constitutive modeling, and structural engineering. The team is led by the three engineers with relevant backgrounds and appropriate knowledge in impact and crashworthiness studies. Select experience of these key project personnel is summarized below:

* Dr. Steven W. Kirkpatrick is the program manager for this project. Dr. Kirkpatrick is a senior engineer with 19 years of experience in vehicle crashworthiness, structural dynamics, finite element analysis, impact and penetration mechanics, and failure analysis. He has more than 80 publications in these areas. His research experience includes a wide range of government and commercial projects for rail, highway, civil, military, and aerospace applications. He has been a program leader for many studies requiring close collaboration between experimental and computational efforts with emphasis on model validation. Dr. Kirkpatrick has a doctorate in mechanical engineering from Stanford University.

* Dr. B. Samuel Holmes is the program supervisor for this project. Dr. Holmes is a principal engineer with 40 years of experience in vehicle crashworthiness, structural dynamics, failure analysis, and fluid mechanics. He has served as a program manager and group leader for a variety of projects combining analysis and experiments. He acted as principal investigator for studies of train crashworthiness and the design of a crashworthy locomotive cab, and automobile accidents including compatibility and structural design for high speed impact, train aerodynamics, and impact. His experience also includes studies of weapons and

blast effects on large structures. He has more than 40 publications in these areas. Dr. Holmes has a doctorate in applied mechanics from Drexel University.

* Dr. Justin Wu is the technical lead in performing the uncertainty analysis of this project. Dr. Wu is the director of probabilistic engineering at ARA. He is a renowned expert in probabilistic methods with 20 years of experience in the development and application of innovative physics-based probabilistic methods for a wide range of applications including structural reliability analysis and design of space shuttle, aircraft, offshore pipeline, power plant, and automotive; nuclear waste repository risk assessment, and hard target uncertainty analysis. Dr. Wu heads the development of ARA's ProFES (Probabilistic Function Evaluation System) software package, previously supported by the Air Force and NASA. He also leads the development of methodologies and software tools for hard target uncertainty analysis for DTRA, reliability-based multi-disciplinary design for NASA, and rotorcraft probabilistic damage tolerance analysis for FAA. He has more than 100 publications. Dr. Wu has a doctorate in mechanical engineering from University of Arizona.

Other key ARA team members include:

* Dr. Robert Bocchieri, Senior engineer, will provide expertise in constitutive modeling, rate-dependent material behavior, fracture mechanics and failure analysis, finite element analysis, structural dynamics, and crashworthiness. Dr. Bocchieri has a doctorate in aerospace engineering from the University of Texas at Austin.

* Dr. Lawrence A. Twisdale, Principal Engineer/Scientist, will provide expertise in structural engineering and building performance. Dr. Twisdale is a licensed professional engineer and has a doctorate in civil engineering from the University of Illinois.

* Mr. Robert Frank, Principal Engineer/Scientist, will provide expertise in structural mechanics, structural dynamics, finite element analysis, and development and application of simplified response models. Mr. Frank is a licensed professional engineer and has a Master of Science degree in civil engineering from the Massachusetts Institute of Technology.

In addition, the ARA team is augmented by the following experts:

* Dr. P. V. Banavalkar, President of Ingenium Inc., will provide expertise in the analysis and behavior of high-rise steel structures. Dr. Banavalkar has over 40 years of project experience and ten of his building designs are listed in "100 of the World's Tallest Buildings" published in 1998 by the Council of Tall Buildings and

Urban Habitat. His experience includes design for all conditions including critical seismic regions, blast-resisting structures and systems for prevention of progressive collapse. His notable projects include Library Tower in Los Angeles, Fountain Place in Dallas, Chase Tower in Houston, and U. S. Bank Place in Minneapolis. As a leading expert in his field, Dr. Banavalkar has authored more than 40 publications and lectured extensively on subjects such as steel structures, seismic stress, and concrete. Dr. Banavalkar is a licensed professional engineer and has a doctorate in civil engineering from Cornell University.

* Dr. Matthew H. Koebbe, independent consultant, will provide expertise in finite element modeling and automatic mesh generation, and nonlinear dynamics. Dr. Koebbe has a doctorate in Mathematics from the University of California, Santa Cruz.

4.8 12 SB1341-03-Q-0463 R–Analysis of Active Fire Protection Systems–Sprinklers, Standpipe, and Pre-Connected Hoses in WTC Buildings 1, 2, and 7

Hughes Associates, Inc. (HAI) 9/22/2003 Award Information

http://wtc.nist.gov/solicitations/wtc_awardQ0463.htm

Under solicitation number SB1341-03-Q-0463, a firm fixed price purchase order has been awarded to Hughes Associates, Inc. (HAI).

Established in 1980, HAI is a fire protection engineering, research, and consulting firm whose experience includes fire hazard and risk analysis, fire modeling, fire protection design, code consulting, product development, and litigation support. HAI's staff has earned an international reputation in the application of advanced technologies to solve both standard and unique fire protection problems.

Specific tasks related to WTC Buildings 1, 2, and 7 that the Hughes team will perform include:

1) Document the design and installation of the fire sprinkler system, standpipe system, and pre-connected hoses and compare designs to applicable code and standards requirements.

2) Document the design and capacity of the water supply systems to the fire sprinklers, including provisions for redundancy.

3) Identify and document differences in the design of the water supply, fire sprinkler system, standpipe system, and pre-connected hoses between WTC 1, 2, and 7.

4) Document the normal operation and effect of the fully functional fire sprinkler system, standpipe system, and pre-connected hoses for fire control.

5) Document the performance of the fire sprinkler system, standpipe system, and pre-connected hoses on September 11, 2001.

HAI's project team includes senior level engineers with extensive experience in the design, specification, installation, testing, and performance assessment of fire suppression systems, including automatic fire sprinkler systems, water supplies, and standpipe systems. The team's experience in performance assessments includes (1) experimental evaluations of new suppression concepts, (2) detailed engineering analyses of proposed and existing suppression systems in support of fire incident investigations and fire hazard analyses, and (3) code and standards compliance evaluation of existing systems.

The team is also experienced in evaluation of the effectiveness of manual fire fighting tactics, development of manual fire fighting doctrines and procedures, and evaluation of the effectiveness of existing fire department services.

Selected experience of the key personnel assigned to this effort is summarized below:

Edward K. Budnick, Principal Investigator - Mr. Budnick has over 25 years of experience including fire protection engineering R&D, quantitative fire hazards analysis, and design and evaluation of fire suppression systems. Mr. Budnick is the chair of the NFPA 13 Automatic Sprinkler Committee on Design Discharge and has participated in the development of standards for installation and performance of automatic sprinkler and standpipe systems and hose stream requirements for high rise buildings. He has performed code and standards compliance evaluations of existing and proposed suppression systems and has also designed, tested, and approved installations of automatic sprinkler and standpipe systems for high rise buildings. Mr. Budnick has also written handbook sections on fire sprinkler system performance and reliability in business and other types of occupancies.

Jack Mawhinney, Senior Engineer - As a member of HAI's Advanced Fire Suppression Systems Group Mr. Mawhinney brings over 30 years of experience in fire suppression technology to this effort. His expertise is unique in that he has suppression system design, installation and R&D experience. His experience ranges from actual pipe fitting and sprinkler installation to experimental R&D associated with automatic sprinkles and other water based suppression technologies. Mr. Mawhinney has performed suppression system investigations and failure analyses, is a past member of NFPA 13 where he participated in subcommittee activities related to evaluation of sprinkler performance under shielded or partial failure mode conditions, and is the current Chair of NFPA 750, Water Mist Suppression. Mr. Mawhinney has authored handbook chapters on fire suppression technologies.

Mark Hopkins, Senior Engineer - Mr. Hopkins is a senior engineer in HAI's Sprinkler and Suppression System Design Group. Mr. Hopkins has over ten years of experience in all aspects of automatic sprinkler and standpipe, water supply design, specification, installation and commissioning. His experience includes

interfacing of automatic sprinkler system with fire alarm systems in large, multistory, zoned high rise buildings. He also has performed failure analyses and related investigations of existing automatic sprinkler systems.

4.9 09 SB1341-03-Q-0281 R – Fire Endurance Testing of the World Trade Center Floor System (contract modification)

Underwriters Laboratory, Inc. 8/22/2003 Award Information

http://wtc.nist.gov/solicitations/wtc_awardQ0281.htm

Announcement of E119 Test

Under solicitation number SB1341-03-Q-0281, a firm fixed-price purchase order has been awarded to Underwriters Laboratory Inc. for the testing of the steel joist-supported floor system of the Word Trade Center towers under the fire conditions prescribed in ASTM E119. The results of the testing will provide the fire endurance ratings of typical floor construction to evaluate three primary factors, 1) test scale, 2) fireproofing thickness, and 3) thermal restraint.

Underwriters Laboratories Inc. (UL) is an independent, not-for-profit corporation dedicated to the testing, certification and quality assessment of products, systems and services. UL has been in operation since 1894 and today is a worldwide company with approximately 6000 employees. UL provides conformity assessment services for a wide range of products, equipment and construction materials, including determination of fire resistance ratings. Fire ratings are based upon the test method and acceptance criteria in ANSI/UL 263 (ASTM E119 and NFPA 251), “Fire Tests of Building Construction and Materials.”

Under this solicitation, three ASTM E119 tests of the WTC floor construction will be performed as follows:

1) 17 ft (5.2 m) span assembly, thermally restrained

2) 35 ft (10.7 m) span assembly, thermally restrained

3) 35 ft (10.7 m) span assembly, thermally unrestrained.

The first test represents current US practice for establishing a fire endurance rating of a building construction. The test assembly, fabricated to meet the design of the World Trade Center steel joist-supported floor system, will have a span of 17 ft (5.2 m). This span is typical of the floor assembly test furnaces used by the US testing laboratories that routinely conduct the ASTM E119 test for the construction industry. As is common practice, the floor assembly will be tested in the thermally restrained condition. This test will be conducted at UL’s Northbrook, Illinois fire test facility.

The second test will be at twice the scale of the first test, or a span of 35 ft (10.7 m). Note that this span represents a full-scale assembly of the 35 ft floor panel. The floor assembly for this test will be thermally restrained as in the first test thereby allowing direct comparison for the determination of the effect of test scale on fire endurance rating. In additionally, individual structural members of the steel joist with varying thickness of spray-on fire protection will be exposed to the standard fire environment and temperatures will be recorded. This will allow comparison of results for various amounts of fireproofing based on the end point criteria for steel temperatures. This and the third assembly will be tested at the UL Canada fire test facility.

The third test will also span 35 ft and will be thermally unrestrained. The behavior of this test assembly will be compared with that of the second test allowing a determination of the effect of thermal restraint on fire resistance rating. Additionally, results from the second and third tests will bound behavior of an indeterminately restrained floor system.

The key personnel at UL who are responsible for designing and conducting the fire resistance testing under this solicitation are listed here.

Robert Berhinig, PE, Senior Staff Engineer - Mr. Berhinig has over 35 years of experience in the testing and evaluation of fire resistive building assemblies. Mr. Berhinig represents UL on NFPA Technical Committees on Building Construction and Fire Protection Features and has participated in the development of NFPA 5000 - Building Construction and Safety Code. In addition, he represents the United States as Technical Expert on ISO TC92 (Fire Safety) WG1 (Fire Resistance) and WG4 (Ventilation and Dampers).

Joseph Treadway, Manager-Fire Resistance and Containment – Mr. Treadway has 13 years experience in the testing of protection materials for structural steel in accordance with ANSI/UL 263, “Fire Tests of Building Construction and Materials,” and ANSI/UL 1709, “Rapid Rise Fire Tests of Protection Materials for Structural Steel.”

Fred Hervey, Engineering Team Leader – Mr. Hervey has experience in testing and related work on structural steel protected with spray-applied fire resistive materials and mastic and intumescent coatings.

4.10 07 SB1341-03-Q-0272 R – Analysis of Building and Fire Codes and Practices

Rolf Jensen & Associates, Inc. (RJA) 7/25/2003 Award Information http://wtc.nist.gov/solicitations/wtc_awardQ0272.htm

Under solicitation number SB1341-03-Q-0272, a firm fixed price purchase order has been awarded to Rolf Jensen & Associates, Inc. (RJA), New York City and its

team composed of S.K. Ghosh Associates, Inc. (SKGA), Northbrook, IL and Rosenwasser/Grossman Consulting Engineers, P.C. (RG), New York City.

RJA is a consulting engineering firm specializing in life safety and fire protection engineering. RJA has extensive experience since 1968 in the development of fire protection programs for high-rise buildings and the application of codes and standards to these types of structures. SKGA is an engineering firm established in 1998 that provides structural, seismic, and code-related services to engineers, trade associations, code-writing bodies, and government agencies involved in design and construction programs. RG is a structural engineering firm specializing in the design of high-rise buildings since 1954. RG has designed over 500 high-rise buildings in New York City, and also provides services in inspection and repair of high-rise buildings.

Specific tasks that the RJA team will perform include:

1. Document the design and construction of structural systems for World Trade Center Buildings 1, 2, and 7.

2. Document the design and construction of fire protection systems for WTC Buildings 1, 2, and 7.

3. Document the fuel system for emergency power in WTC Building 7.

4. Compare building regulatory and code requirements.

5. Document the maintenance and modifications to structural, fire protection and egress systems.

The principal investigators of the team from RJA, SKGA and RG are world leaders in life safety, fire protection, codes and standards, and structural engineering. Both RJA and RG have extensive experience in fire safety and structural design of high-rise buildings in New York City, including the Millennium Hilton Hotel at the WTC site. The key members of SKGA have a long history of dealing with the development of provisions for national codes and standards and the investigation of code-related issues.

Selected experience of these key project personnel is summarized below:

Mr. Raymond A. Grill is a senior vice president of Rolf Jensen & associates. He has over 20 years of experience in the development of fire protection and life safety programs for buildings of all types. He has served as an expert on litigation involving building and fire code compliance and fire protection system performance. He has authored many articles on fire protection related topics and made

presentations at NFPA World Congresses. He is a fellow and a member of the board of directors of the Society of Fire Protection Engineers, and a member of the National Fire Protection Association, the International Code Council, and the Building Officials and Code Administrators International.

Dr. S. K. Ghosh is the president of S.K. Ghosh Associates, Inc. He has over 20 years of experience in the development of seismic design code provisions for national model building codes and standards including ASCE 7 Standard for Minimum Design Loads for Buildings and ACI 318 Building Code Requirements for Structural Concrete. He has carried out numerous code-comparison studies including comparison of the seismic provisions of the New York City Code with the NEHRP Recommended Provisions (1997), and the wind-load provisions of the New York City Code with the ASCE 7-98 Standard. He and RJA jointly published a guide on the structural provisions of the International Building Code (IBC), and prepared the 2000 IBC Handbook, which provides an in-depth commentary on the structural provisions of the 2000 IBC.

Mr. Jacob S. Grossman is the president and CEO of Rosenwasser/Grossman Consulting Engineers, P.C. He has been involved in the design of over 1000 steel and concrete buildings since 1957, three of these buildings are among the 100 tallest in the world. He is active in national and local code committees including the Building Code Committee for New York City. Mr. Grossman was a technical consultant to the Applied Technology Council for the development of “NEHRP Guidelines for the Seismic Rehabilitation of Buildings.” Mr. Grossman is a member of the Council on Tall Buildings and Urban Habitat, and has written, lectured, and given seminars on the design of steeland concrete structures, and on construction procedures.

The key project personnel will be supported by other experienced staff of their respective organizations for completing various sub-tasks of this project.

4.11 09 SB1341-03-Q-0281 R – Fire Endurance Testing of the World Trade Center Floor System

Underwriters Laboratory, Inc. 7/10/2003 Award Information

http://wtc.nist.gov/solicitations/wtc_awardQ0281.htm

Announcement of E119 Test

Under solicitation number SB1341-03-Q-0281, a firm fixed-price purchase order has been awarded to Underwriters Laboratory Inc. for the testing of the steel joist-supported floor system of the Word Trade Center towers under the fire conditions prescribed in ASTM E119. The results of the testing will provide the fire endurance ratings of typical floor construction to evaluate three primary factors, 1) test scale, 2) fireproofing thickness, and 3) thermal restraint.

Underwriters Laboratories Inc. (UL) is an independent, not-for-profit corporation dedicated to the testing, certification and quality assessment of products, systems and services. UL has been in operation since 1894 and today is a worldwide company with approximately 6000 employees. UL provides conformity assessment services for a wide range of products, equipment and construction materials, including determination of fire resistance ratings. Fire ratings are based upon the test method and acceptance criteria in ANSI/UL 263 (ASTM E119 and NFPA 251), “Fire Tests of Building Construction and Materials.”

Under this solicitation, three ASTM E119 tests of the WTC floor construction will be performed as follows:

1) 17 ft (5.2 m) span assembly, thermally restrained

2) 35 ft (10.7 m) span assembly, thermally restrained

3) 35 ft (10.7 m) span assembly, thermally unrestrained.

The first test represents current US practice for establishing a fire endurance rating of a building construction. The test assembly, fabricated to meet the design of the World Trade Center steel joist-supported floor system, will have a span of 17 ft (5.2 m). This span is typical of the floor assembly test furnaces used by the US testing laboratories that routinely conduct the ASTM E119 test for the construction industry. As is common practice, the floor assembly will be tested in the thermally restrained condition. This test will be conducted at UL’s Northbrook, Illinois fire test facility.

The second test will be at twice the scale of the first test, or a span of 35 ft (10.7 m). Note that this span represents a full-scale assembly of the 35 ft floor panel. The floor assembly for this test will be thermally restrained as in the first test thereby allowing direct comparison for the determination of the effect of test scale on fire endurance rating. In additionally, individual structural members of the steel joist with varying thickness of spray-on fire protection will be exposed to the standard fire environment and temperatures will be recorded. This will allow comparison of results for various amounts of fireproofing based on the end point criteria for steel temperatures. This and the third assembly will be tested at the UL Canada fire test facility.

The third test will also span 35 ft and will be thermally unrestrained. The behavior of this test assembly will be compared with that of the second test allowing a determination of the effect of thermal restraint on fire resistance rating. Additionally, results from the second and third tests will bound behavior of an indeterminately restrained floor system.

The key personnel at UL who are responsible for designing and conducting the fire resistance testing under this solicitation are listed here.

Robert Berhinig, PE, Senior Staff Engineer - Mr. Berhinig has over 35 years of experience in the testing and evaluation of fire resistive building assemblies. Mr. Berhinig represents UL on NFPA Technical Committees on Building Construction and Fire Protection Features and has participated in the development of NFPA 5000 - Building Construction and Safety Code. In addition, he represents the United States as Technical Expert on ISO TC92 (Fire Safety) WG1 (Fire Resistance) and WG4 (Ventilation and Dampers).

Joseph Treadway, Manager-Fire Resistance and Containment – Mr. Treadway has 13 years experience in the testing of protection materials for structural steel in accordance with ANSI/UL 263, “Fire Tests of Building Construction and Materials,” and ANSI/UL 1709, “Rapid Rise Fire Tests of Protection Materials for Structural Steel.”

Fred Hervey, Engineering Team Leader – Mr. Hervey has experience in testing and related work on structural steel protected with spray-applied fire resistive materials and mastic and intumescent coatings.

4.12 10 SB1341-03-Q-0322 R-Outside Experts for Baseline Structural Performance, Impact Analysis, Structural Response to Fire, Collapse ...

Area 4: Teng & Associates, Inc. 7/3/2003 Award Information

http://wtc.nist.gov/solicitations/awards0322.htm

Under solicitation number SB1341-03-Q-0322, firm fixed-price purchase orders have been awarded to experts in five technical areas for their experience and judgment at the most senior professional level to provide expert technical assistance as follows:

Area 4: Structural System Failure and Collapse Sequences

A purchase order for Area 4 has been awarded to Teng & Associates in Chicago, Illinois to provide technical expertise and assistance for analysis of structural systems, failure, and collapse sequences of WTC 1, 2, and 7. Structural system analysis includes the design, analysis, and behavior of high-rise steel buildings, lateral (wind) and gravity systems, connection design, structural redundancy, and load redistribution. Structural collapse analysis includes failure behavior and characterization of structural systems under extreme loads, finite element modeling of member and system failure, local and global instability, large deflections, yielding, fracture, and creep. The specific tasks the experts will perform include:

* Provide expert technical assistance in finite element and analytical modeling of member failure sequences leading to collapse initiation, appropriate constitutive models for members experiencing thermally-induced capacity reduction and/or

increased loads from load redistribution, and failure criteria for members and system failure.

* Conduct in-depth, review and critique of the work done on the collapse analysis of the WTC towers. The review shall include: a) appropriateness of the models for their intended uses, including modeling assumptions, level of detail, model geometry and material properties, and verification and validation procedures; and b) appropriateness of the analyses and accuracy of results.

The team from Teng & Associates consists of a Principal Structural Consultant and two licensed structural engineers (SE) with relevant backgrounds and appropriate knowledge in structural design and analysis of steel high-rise buildings and the behavior and characterization of structural system failure:

* Dr. Shankar Nair, Senior Vice President of Teng & Associates, is the Principal Structural Consultant. Dr. Nair is a licensed structural engineer with a doctorate in civil engineering and over 33 years of experience in the design and analysis of high-rise building structures. He has developed many of the structural designs of Chicago's tall buildings of 30 to 70 stories. Dr. Nair has published numerous technical papers on tall building design, advanced structural analysis methods, and global structural stability theory and analysis. The quality of engineering in Dr. Nair's work has been recognized by awards from the American Institute of Steel Construction, the American Consulting Engineers Council, and twelve awards from the Structural Engineers Association of Illinois, including six of the annual Most Innovative Structure awards. He served as the chairman of the Council on Tall Buildings and Urban Habitat from 1997 to 2001.

* Mr. Miroslav Sulc is a licensed structural engineer with a master's degree in architectural and structural engineering and over 30 years of experience in project management, structural design and analysis, and review of working and shop drawings. Mr. Sulc has a broad range of experience of building types and construction, with a specialization in wind analysis, shear walls, and foundation design.

* Dr. Todd Ude is a licensed structural engineer with a doctorate in civil engineering and experience in structural reliability, extreme loads and dynamic response analysis. His experience includes detailed nonlinear analyses of an existing steel bridge structure that consider yielding, fatigue, and fracture failure modes.

4.13 10 SB1341-03-Q-0322 R-Outside Experts for Baseline Structural Performance, Impact Analysis, Structural Response to Fire, Collapse ...

Area 5: Dr. Daniele Veneziano and **Dr. Jozef Van Dyck** 6/25/2003 Award Information

http://wtc.nist.gov/solicitations/awards0322.htm

Under solicitation number SB1341-03-Q-0322, firm fixed-price purchase orders have been awarded to experts in five technical areas for their experience and judgment at the most senior professional level to provide expert technical assistance as follows:

Area 5: Assessment of Most Probable Structural Collapse Sequences

One purchase order for Area 5 has been awarded to the team of Dr. Daniele Veneziano and Dr. Jozef Van Dyck as independent consultants to provide technical expertise and assistance for the formal probabilistic assessment approach that will be developed and implemented to support the determination of the most likely sequence of events leading to the structural collapse of WTC 1, 2, and 7. The analysis will integrate multiple disciplines effectively and discern which input and analysis parameters significantly influence the analysis methods used to simulate these events. Several methods shall be considered:

* Probabilistic and statistical methods, particularly event tree and Monte Carlo methods, Bayesian updating, stochastic modeling, and uncertainty quantification in complex systems.

* Application of probability and statistical methods to structural systems; structural reliability analysis; structural load modeling and analysis of combinations of loads; probabilistic risk assessment of engineered facilities.

Dr. Veneziano and Dr. Van Dyck have worked as a team for over 18 years on a large number of projects worldwide, involving probabilistic modeling of structural loads, engineering risk and reliability assessment, statistical data analysis, and uncertainty propagation. These projects often involve the use of sensitivity analysis, Monte Carlo simulations, and event-tree uncertainty propagation and Bayesian updating.

Dr. Veneziano has a doctorate in civil engineering and is an internationally recognized expert with numerous published papers in the fields of probabilistic modeling of structural loads, engineering risk and reliability assessment, statistical data analysis, and uncertainty propagation and Bayesian updating techniques. He has over 28 years of consulting experience in a broad range of fields, including analysis of seismic risk, hazard assessment, and Bayesian uncertainty updating, uncertainty quantification and decision in nuclear repositories for 69 sites in the eastern US, structural safety reliability of the Leaning Tower of Pisa, Italy based upon past field measurements, and a reliability analysis of the proposed Messina suspension bridge between Italy and Sicily for different failure modes. Dr. Veneziano holds a position of Professor of Civil and Environmental Engineering at the Massachusetts Institute of Technology in Cambridge, Massachusetts.

Dr. Van Dyck has a doctorate in civil engineering and is the Director of Probabilitas N.V., a Belgian company that specializes in engineering risk, probabilistic modeling, statistical analysis, and uncertainty management. He is a part-time professor at the University of Leuven, Belgium, where

he teaches probabilistic and statistical methods in engineering. He has over 18 years of experience and has published numerous papers in engineering risk, probabilistic modeling and statistical analysis, and uncertainty management.

4.14 10 SB1341-03-Q-0322 R-Outside Experts for Baseline Structural Performance, Impact Analysis, Structural Response to Fire, Collapse ...

Area 2: Dr. David M. Parks 6/24/2003 Award Information

http://wtc.nist.gov/solicitations/awards0322.htm

Under solicitation number SB1341-03-Q-0322, firm fixed-price purchase orders have been awarded to experts in five technical areas for their experience and judgment at the most senior professional level to provide expert technical assistance as follows:

Area 2: Computational Mechanics for Aircraft Impact Analysis

A purchase order for Area 2 has been awarded to Dr. David M. Parks, an independent consultant. Dr. Parks is a world-class expert in the fields of computational and applied mechanics and the mechanical behavior of engineering materials. The specific tasks Dr. Parks will perform include:

* Provide expert technical assistance in identifying appropriate constitutive relationships and failure criteria for the various structural materials considered in the analysis of aircraft impacts into the WTC towers.

* Conduct in-depth, review and critique of the work done on the finite element analysis of aircraft impacts into the towers. The reviews shall include (1) the appropriateness of the models for their intended uses, and (2) the appropriateness of the impact analyses and the accuracy of the results including estimates of damage to the towers and dispersal of fragments.

Dr. Parks has over 30 years of experience in finite element analysis of fracture, plasticity, constitutive modeling, and material strain-rate sensitivity. Dr. Parks' primary technical interests are in the application of numerical methods to the analysis of fracture and inelastic deformation of materials, both at the structural and micro-structural levels. He has more than 120 publications over a broad range of topics. He served as a principal investigator on many research projects sponsored by government and industry. Examples of his consulting work include failure analysis of gas turbines using fracture mechanics-based 3-dimensional finite element modeling, analysis of failure of heat exchangers, and analysis of the failure of the welded beam-column connection following the Northridge earthquake. Dr. Parks has a doctorate in mechanical engineering and holds a position of Professor

of Mechanical Engineering at the Massachusetts Institute of Technology in Cambridge, Massachusetts.

For the analysis of aircraft impact into the WTC towers, Dr. Parks will be providing expertise in the following areas:

* Nonlinear computational mechanics with emphasis on materials constitutive modeling, plasticity, dynamic plastic fracturing, material failure, and material strain rate sensitivity.

* Fracture mechanics and plasticity.

* Nonlinear finite element analysis including large deflections, plasticity, contact behavior, and failure of components (element erosion).

4.15 10 SB1341-03-Q-0322 R-Outside Experts for Baseline Structural Performance, Impact Analysis, Structural Response to Fire, Collapse ...

Area 1: **Skidmore, Owings & Merrill LLP** 6/23/2003 Award Information

http://wtc.nist.gov/solicitations/awards0322.htm

Under solicitation number SB1341-03-Q-0322, firm fixed-price purchase orders have been awarded to experts in five technical areas for their experience and judgment at the most senior professional level to provide expert technical assistance as follows:

Area 1: Analysis and Design of High-Rise Steel Buildings

A purchase order for Area 1 has been awarded to four experts from Skidmore, Owings & Merrill LLP (SOM) Structural Engineering Office in Chicago, Illinois. They are recognized international leaders in the design of tall buildings and specialize in design and analysis of high-rise steel buildings and performing independent peer reviews. Theseexperts are well qualified to conduct an independent, in-depth, third-party review and critique of the work conducted under contract SB1341-03-W-0332 for the development of structural databases from original computer printouts of the WTC towers, the development of reference structural analysis models, and the analysis of the baseline structural response of the towers under design wind and gravity loads. The specific tasks the experts will perform include:

* In-depth, written review and critique of the work done by the contractor. The review shall include: (1) random checks of the databases; (2) appropriateness of the models for their intended uses, and (3) appropriateness of the baseline performance analyses and accuracy of results.

* In-depth, written review and critique of the wind loading criteria developed by NIST.

* In-depth, written review of all interim and final reports produced by the contractor for development of models and baseline performance.

This expert team consists of four licensed structural engineers (SE) with relevant backgrounds and appropriate knowledge in structural design and analysis of high-rise steel buildings:

Mr. William F. Baker, PE, SE, is a structural engineering partner at SOM with over 22 years of structural engineering experience involving design of high-rise buildings, long span roofs, and special structures. He is a Fellow of the American Society of Civil Engineers (ASCE). He is widely recognized for his expertise in the fields of tall building design, innovative structural systems, and advanced structural analysis methods. His expertise has made him a frequent lecturer around the globe, and he is the author of numerous articles on innovation in structural engineering. Examples of his design projects include:

* AT&T Corporate Center, Chicago (1990): a 63-story office tower

* Structural engineering peer review of the Petronas towers, Kuala Lumpur, Malaysia (1996): two 88-story towers

* Jin Mao Tower, Shanghai, China (1998): a 88 story multi-use complex including office, hotel, and retail

* Plaza Rakyat Office Tower, Kuala Lumpur, Malaysia (1999): a 77 story tower

* 7 South Dearborn, Chicago (2002): a proposal for 110 story office, retail and residential tower

Mr. D. Stanton Korista, PE, SE, is a structural/civil engineering director at SOM with 38 years of structural engineering experience that includes about 200 projects around the world. His design and peer review work includes high-rise towers, hotels, educational projects, corporate headquarters, and residential towers. He is a distinguished member of more than twenty engineering associations, including several fellowships. Examples of his design projects include:

* AT&T Corporate Center, Chicago (1990): a 63-story office tower

* Jin Mao Tower, Shanghai, China (1998): a 88 story multi-use complex including office, hotel, and retail

* Xiamen Posts and Telecommunications Building, Fujian Province, China (2000): a 66-story office tower

* 7 South Dearborn, Chicago (2002): a proposal for 110 story office, retail and residential tower

* Tower Palace III, Seoul, South Korea (2003): a 73-story residential tower

Mr. John J. Zils, PE, SE, is a senior structural engineer and associate partner at SOM with about 37 years of structural engineering experience including many of SOM's best known and most complex structures. He is a fellow of the American Society of Civil Engineers (ASCE) and the American Institute of Architects (AIA). He has published numerous articles on engineering advancements, lectures frequently, and has served as an adjunct professor at the University of Illinois. Examples of his design projects include:

* The Sears Tower, Chicago (1974): a 110-story office building

* Onterie Center Tower, Chicago (1984): a 60 story residential tower

* Dearborn Tower, Chicago (1990): a proposal for 84-story office and retail complex

* 7 South Dearborn, Chicago (2002): a proposal for 110 story office, retail and residential tower

Mr. Robert C. Sinn, PE, SE, is a senior structural engineer and associate partner at SOM and has about 19 years of structural engineering experience ranging from high-rise buildings to long-span roofs. Mr. Sinn has extensive experience in computer-applied analysis and design techniques. He is a fellow of the American Society of Civil Engineers (ASCE). In 1999, he received ASCE's award for innovation in Civil Engineering for his work on the Guggenheim Museum, Bilbao, Spain. Examples of his design projects include:

* Structural engineering peer review of the Petronas towers, Kuala Lumpur, Malaysia (1996): two 88-story towers

* Plaza Rakyat Office Tower, Kuala Lumpur, Malaysia (1999): a 77 story tower

* Xiamen Posts and Telecommunications Building, Fujian Province, China (2000): a 66-story office tower

* 7 South Dearborn, Chicago (2002): a proposal for 110 story office, retail and residential tower

4.16 10 SB1341-03-Q-0322 R-Outside Experts for Baseline Structural Performance, Impact Analysis, Structural Response to Fire, Collapse ...

Area 3: Dr. Kaspar Willam 6/16/2003 Award Information

http://wtc.nist.gov/solicitations/awards0322.htm

Under solicitation number SB1341-03-Q-0322, firm fixed-price purchase orders have been awarded to experts in five technical areas for their experience and judgment at the most senior professional level to provide expert technical assistance as follows:

Area 3: Thermal-Structural Analysis of Structural Systems Exposed to Fire

A purchase order for Area 3 has been awarded to Prof. Kaspar Willam, a Professor of Civil Engineering at the University of Colorado at Boulder, Colorado. Dr. Willam will provide technical expertise and assistance for analysis of the structural response of the impact-damaged WTC 1 and 2, and of WTC 7, to uncontrolled fires. The analyses will include separate evaluations of components and subsystems (exterior and interior columns, floor truss members, floor system) and of the global structural system response. The specific tasks Dr. Willam will perform include:

* Provide expert technical assistance in finite element and analytical modeling for thermal-structural analysis of structural systems, characterization and constitutive relations of materials at elevated temperature, and thermal analysis and thermal-structural response of structural systems.

* Conduct in-depth, review and critique of the work done on the thermal-structural response of the WTC towers to fire. The review shall include: a) appropriateness of the models for their intended uses, including modeling assumptions, level of detail, model geometry and material properties, and verification and validation procedures; and b) appropriateness of the analyses and accuracy of results.

Dr. Willam has a doctorate in civil engineering and is a recognized expert with over 33 years of experience in the fields of finite element analysis, constitutive modeling, inelastic behavior, thermo-mechanical behavior of materials and structures, and computing in applied mechanics. He has published numerous papers in each of these fields. He is a Fellow of the American Society of Civil Engineers (ASCE), a Fellow of the American Society of Mechanical Engineers (ASME), and a Fellow of the US Association of Computational Mechanics (USACM). He received the Newmark medal of the American Society of Civil Engineers in 2003 for his outstanding contributions in structural engineering and mechanics. He will be providing technical assistance and expertise in the following areas.

* Temperature-dependent thermal and mechanical materials characterization and constitutive modeling.

* Analytical modeling and transient thermal and thermal-mechanical finite element analysis.

* Analytical modeling and nonlinear finite element analysis of structural systems subjected to degradation of mechanical properties at elevated temperatures.

4.17 04 SB1341-03-Q-0155 Document and Evaluate the Steel Recovered from the WTC Towers

Wiss, Janney, Elstner Associates, Inc. 6/9/2003 Award Information

http://wtc.nist.gov/solicitations/Elstner_Award.htm

Under solicitation number SB1341-03-Q-0155, a firm fixed price purchase order has been awarded to WISS, JANNEY, ELSTNER ASSOCIATES, INC. (WJE) of Chicago, Illinois:

WJE is an engineering firm that provides technical solutions to structural, architectural, and materials problems. They specialize in investigations, analysis, and design for contemporary and historic buildings, bridges, and other structures. WJE is well qualified to document the failure mechanisms and damage based on visual observations of steel recovered from the WTC. Specific examples of their past investigations include:

* **Damage to One Meridien Plaza Bank due to the multi floor fire**

* Assessment survey of 1993 bomb damage to the WTC

* Structural evaluation of fire damage to MacFrugal Center

* Analysis of the Husky Stadium grandstand collapse

* Investigation of the Cedar Rapids communication tower collapse

* Reconstruction of TWA Flight 800 Boeing 747 for failure analysis

* **In addition, a member of their staff carried out some of the first studies on the load-bearing capacity of the composite truss system used to support the floors of the WTC towers.**

The specific tasks that WJE will perform include:

1. Survey all WTC structural steel at NIST and identify those remnants or portion of remnants that may provide important information needed for the furtherance of tasks in Project 3 of the WTC Investigation

2. Provide NIST with detailed photographs of all remnants or portion of remnants identified above

3. Conduct detailed failure analyses of component parts selected for specific structural and metallurgical reasons

4. Provide NIST with a detailed report describing the results of WJE's survey of the steel, identification of important remnants, and failure analyses of how each selected part behaved during the impact, fire, or beginning of the collapse

5. Provide NIST with a technical review of NIST's Draft Project 3 Report

The team from WJE consists of two Principal Investigators that are both licensed structural engineers with relevant failure investigation backgrounds and appropriate knowledge of structural steel metallurgy. The team also includes another investigator who is a licensed structural engineer with significant experience in the structural design of highrise buildings, and with conducting structural failure investigations. Select experience of these key project personnel is summarized below:

Dr. Raymond H. R. Tide has over 35 years of structural engineering experience involving steel structures and has been a member of the AISC Specifications Committee for over 20 years. At the time of the design of the WTC complex, he was involved in research concerning composite behavior of open-web steel joists as used in the WTC towers. Later he was involved in the development of column buckling studies including compression members comprised of angles. Subsequent to the 1994 Northridge, California earthquake, he was involved in numerous AWS- and FEMA-sponsored investigations on performance of steel structures and their connections. His experience includes evaluation of numerous fire-damaged steel structures and the evaluation of fractures in structural steel. He has authored numerous technical papers in these areas.

Mr. Conrad Paulson has over 25 years experience in laboratory testing, research and failure investigation of structures, structural components and structural materials. He has been involved in structural analysis and design review of many highrise buildings, including wind load and gravity load analysis of the 84-story AON Center (formerly Amoco, and originally Standard Oil) building in Chicago. As consultant to the U.S. Department of State, he has performed post-earthquake reconnaissance and seismic structural analysis of highrise and lowrise buildings. He has participated in several major failure investigations, including the collapse of the New York State Thruway bridge over Schoharie Creek, and an analytical evaluation of a fire-damaged 38-story highrise structural steel building. His research and testing background includes studies for the National Cooperative Highway Research Program and others on elastic fatigue, inelastic fatigue, tensile properties and fracture of reinforcing steels.

Mr. James J. Hauck has significant experience in the structural analysis, design, detailing, and construction of midrise and highrise building structures. The analysis work has included extensive use of finite element analysis for strength and stability evaluation of multi-story frames, slab systems, and thin-shell domes. Mr. Hauck has investigated failures and problems in numerous buildings and other structures, including the evaluation of steel structures damaged by fire.

The key project personnel will also have available to them other experienced WJE structural engineers for consulting and discussion purposes.

4.18 05 SB1341-03-R-0013 World Trade Center (WTC) Investigation Survey Administration and Report Delivery: Questionnaires, Interviews and Focus Group Synopsis

NuStats 6/9/2003 Award Information

http://wtc.nist.gov/solicitations/wtc_awardr0013.htm

Under solicitation SB1341-03-R-0013, "World Trade Center (WTC) Investigation Survey Administration and Report Delivery: Questionnaires, Interviews and Focus Group Synopsis," an indefinite deliverable, indefinite quantity (IDIQ) purchase order has been awarded to NuStats of Austin, Texas.

NuStats is a full-service research and consulting firm, employing more than 60 social scientists, research managers, and technical specialists. Since 1984, NuStats has conducted hundreds of large-scale studies in 40 states and nearly every major metropolitan area of the United States. These projects utilize tools such as computer-assisted telephone interviewing (CATI), face-to-face interviews, focus groups, open-ended surveys, cognitive interviews, dyad and triad interviews, ethnographic studies, behavioral diaries, computer-assisted personal interviewing (CAPI) using hand held computers, web-based surveys, and self-administered mail out questionnaires. Many of these projects have substantial vulnerable population research components, including families with terminally ill children, at-risk youth, illegal immigrants, and parents of uninsured children.

This contract will implement the survey methodology designed in conjunction with experts contracted under solicitation number SB1341-02-Q-0710 (**Dr. Norman Groner, Dr. Dennis Mileti**, and **Dr. Guylene Proulx**). These experts will continue to be involved with the survey instrument development, database design, and data analysis. The survey methodology is contained as Appendix 6 of the May 2003 NIST Investigation Progress Report

The objective of this solicitation is to contract for survey services. The surveys shall minimize the impact upon the population, maximize the investigative yield, and coordinate with other studies. The results of these surveys will be delivered to NIST in an encoded database, along with a summary report describing the overall approach, final encoding book, execution, problems, and solutions encountered during the survey process within 7 months of contract award. NuStats will not analyze the data or develop any findings, conclusions, and recommendations based upon the data collection effort. The specific tasks which NuStats will perform include:

Telephone Interviews

* Develop a telephone interview schedule (script) meeting the objectives of the NIST WTC Investigation subject to the approval of NIST.

* Administer the telephone interviews using the prescribed methods, including follow-ups until obtaining at least the minimum response rates.

* Collect the results of the telephone interviews and store in a database meeting NIST specifications.

* Provide training to interviewers performing the telephone interview segment in order to effectively implement the prescribed methods and to possess mastery of the goals and objectives of the Investigation.

Face-to-face Interviews

* Conduct face-to-face interviews of building occupants, managers, families of victims, and first responders including achieving the minimum response rates.

* Provide training to interviewers performing the face-to-face interview segment in order to effectively implement the prescribed methods and to possess mastery of the goals and objectives of the Investigation, including the technical probes.

* Collect the results of the face-to-face interviews and store in a database meeting NIST specifications.

Focus Groups

* Provide training to moderators to effectively implement the prescribed focus group methods and to possess mastery of the goals and objectives of the Investigation.

* Collect the results of the focus group interviews and store in a database meeting NIST specifications.

Supporting Tasks

* Obtain Institutional Review Board (IRB) approval for all data collection activities, including mental health provisions to protect the well-being of the respondents, as well as the survey administrators.

* Contact and coordinate all human subjects used in data collection efforts.

* One staff person who was directly involved with the database development shall assist with statistical computations.

Dr. Johanna Zmud, president of NuStats, will act as overall Project Director. Dr. Zmud received her Ph.D. in communication research from the University of Southern California (USC). Dr. Zmud is certified by the Department of Health and Human Services (DHHS) in Human Subjects Assurance Training and serves as Human Protections Administrator at NuStats. Dr. Zmud's work has focused on behavior measurement, particularly on issues relating to the movement of persons. She has published widely in this field with an emphasis on instrument design, non-sampling errors, and survey methods. She will direct a team which includes in-house task managers, expert consultants from leading universities, and subcontracts to companies including DataSouce, GeoStats, and MBC Research Center.

The telephone interview task will be led by Ms. Heather Contrino, Director of NuStats Washington, D.C office. Ms. Contrino has extensive experience in the management, development, and conduct of qualitative and quantitative research for federal, state, and local agencies. Under subcontract, DataSource will perform the telephone interview task. DataSource is a large-scale, multi-stage survey research firm specializing in CATI programming and interviewing, data entry, and high-volume mailing. DataSource is an affiliate ompany of NuStats employing approximately 200 part-time interviewers.

The face-to-face interview task will be headed by Ms. Della Santos of NuStats. Ms. Santos has 15 years experience managing research activities for national, state, and local studies. Under subcontract, GeoStats, headed by Dr. Jean Wolf, will design and develop the computer assisted personal interview application which will record and deliver the interview results to NuStats. GeoStats is a company focused on the application of emerging technologies in the collection, processing, and display of survey data. NuStats and GeoStats have partnered previously to conduct year round, face-to-face interviews with visitors to Alaska for the State Department of Economic Development.

Ms. Kim Hilsenbeck, who has conducted more than 50 focus groups, including several for state and federal agencies, will be task manager for the focus groups. Dr. Carlos Arce will serve as primary moderator for the focus groups. Dr. Arce, who founded NuStats in 1984 after serving as a research scientist the Survey Research Center at the University of Michigan, has conducted over 400 focus groups over his 25 year career, which has focused on the application of anthropology, psychology, and survey research methods to the execution of large, complex studies.

Face-to-face interviews and focus group interviews will be conducted at the MBC Research Center. The MBC Research Center, located near Grand Central Station in New York City, offers convenience of location, a conference room for interviews and focus groups, and a state-of-the-art tiered viewing room.

All interview and focus group instruments, procedures, and protections developed by the contractor and its sub-contractors will be subject to the approval of appropriate Institutional Review Boards (IRBs). NIST will conduct an institutional review of the contractor's IRB documents.

Dr. Karol Krotki and **Mr. Robert Santos** of NuStats will provide statistical and sampling management over the implementation of the NIST methodology. Dr. Krotki is a sampling statistician with over 30 years experience in sample and survey design of special population research studies. Mr. Santos has over 20 years of research experience directing statistical and qualitative research designs, multi-mode complex survey designs, and rare element sampling. Mr. Santos has had senior level appointments at several world renowned research institutions including special mission appointment with the National Academy of Sciences and has served on the IRB of the Urban Institute. He has reviewed and critiqued numerous Human Subjects Protocol statements.

Dr. Jon Krosnick, a cognitive psychologist and survey methodologist with the Ohio State University Departments of Psychology and Political Science, will provide supplemental expertise to the instrument development tasks. Dr. Krosnick has served as a consultant to such organizations as Pfizer Pharmaceuticals, the Office of Social Research at CBS, the News Division of ABC, the National Institutes of Health, NASA, the U.S. Bureau of the Census, and the Urban Institute. Dr. Krosnick's scholarship has been recognized with the Phillip Brickman Memorial Prize for Research in Social Psychology, the Erik H. Erikson Early Career Award for Excellence and Creativity in the Field of Political Psychology from the International Society of Political Psychology, and a fellowship at the Center for Advanced Study in the Behavioral Sciences in Stanford, California. Additionally, Ms. Jamie Abelson, a senior research associate affiliated with the University of Michigan Institute for Social Research, will bring over 20 years of experience working on large-scale mental health studies and in training research groups who are dealing with sensitive interview situations.

In addition to prior work with the California Highway Patrol, Austin Police Department, and Austin Fire Department, NuStats has procured the services of a 12-year veteran of the Phillipsburg, NJ police department to provide expert consultation in police procedures, protocols, and jargon. This individual was among a group of first responders who responded to the World Trade Center disaster. High-ranking expert trainers with the Austin Fire Department have been retained in order provide fire department consultation in procedures, protocols, and jargon.

The entire NuStats-led team will work closely with the NIST team. The NIST team and its outside experts will contribute to the development of survey instruments, protocols, and procedures; and designing the database, including selection of encoding variables. The NIST team will work with its outside experts in the qualitative and quantitative analysis of the data to study occupant behavior and

human factors, evacuation technologies and practices, firefighting technologies and practices, and observed physical conditions within the buildings during evacuation and emergency response. The NIST team and its experts have worked extensively in the areas of evacuation, fire safety, emergency communications, emergency planning, and natural disasters, and have expertise in cognitive, environmental, and social psychology, sociology, statistical sampling, questionnaire design and methods, interview techniques, and risk communication.

4.19 08 SB1341-03-W-0471 (Pre-solicitation Notice/Sole Source) R – World Trade Center (WTC) Investigation First Person Accounts of Egress

National Fire Protection Association (NFPA) 4/14/2003 Award Information

http://wtc.nist.gov/solicitations/wtc_awardw0471.htm

Under solicitation number SB1341-03-W-0471, a firm fixed price purchase order has been awarded to the National Fire Protection Association (NFPA) of Quincy, Massachusetts:

The NFPA is a nonprofit organization specifically chartered to reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating scientifically-based consensus codes and standards, research, training, and education. Part of their charter includes investigations of technically significant fire incidents and fire data analysis.

This project is to provide a data set that includes selected publicly available published first-person accounts of the WTC evacuation. This data set includes approximately 500 existing accounts collected by the NFPA and the National Research Council of Canada (NRCC) since September 11, 2001, along with a matrix of encoding variables that captures important incident details for each account. The NFPA will enhance this existing data set to include additional accounts to be supplied by NIST and additional incident details of interest to the investigation of the WTC evacuation on September 11, 2001.

The principal investigator from the NFPA is Dr. Rita Fahy. Dr. Fahy is Manager of Fire Data Bases and Systems for the NFPA. Active in fire analysis and research for a decade and a half, Dr. Fahy manages all databases and computer analysis programs. She has special expertise and interest in computer modeling, database and computer analysis techniques, human behavior with respect to fire, and socioeconomic factors in fire risk. She studied the evacuation of the WTC towers following the 1993 bombing incident.

4.20 06 SB1341-03-W-0332 Development of Structural Databases and Baseline Models for the WTC Towers

Leslie E. Robertson Associates (LERA) 2/25/2003 Award Information

http://wtc.nist.gov/solicitations/LERA_Award.htm

Under solicitation number SB1341-03-W-0332, firm fixed-price purchase order has been awarded to:

Leslie E. Robertson Associates (LERA), R.L.L.P.; the firm responsible for the structural engineering of the World Trade Center towers. The project team from LERA includes the engineer of record for the design of the World Trade Center towers, the engineer of record for the repairs made after the 1993 bombing, the engineers of record for modifications based on tenant alterations and ongoing technical work, and the engineers of record for the structural integrity inspections of the towers. This team has detailed knowledge of the design, construction, and intended behavior of the towers over their entire 38-years life span.

This project has three tasks: (1) to digitize structural data from original computer printouts; (2) to develop reference structural analysis models that capture the intended behavior of the structures including modifications as a result of major tenant alterations and the 1993 bombing event; and (3) to analyze the baseline structural response under design wind and gravity loads. This project will not analyze the aircraft impact damage to the towers, the structural response of the towers to the fires, or the collapse sequence of the towers.

There are no existing models of the towers with the level of detail to be developed here. The reference structural models will be used to provide a basis for and comparison with more detailed and refined models to be developed independently in other parts of the NIST investigation for the analysis of (1) aircraft impact damage to the towers, (2) the structural response of the towers to the fires, and (3) the collapse sequence of the towers.

NIST has considered at length the appropriateness of involving LERA, the original structural engineering design firm, in its investigation. NIST has concluded that the firm's unique knowledge of the intended behavior of the original design is important to capture in developing its baseline model, but that LERA's work should be limited and appropriate reviews should be put into place.

Consequently, NIST has implemented rigorous procedures to mitigate potential conflicts of interest, consistent with all federal procurement laws and regulations, and is confident in the integrity and objectivity of the deliverables to be accepted from the contractor. The procedures to mitigate potential conflicts of interest include the following steps:

* The contractor shall have no role in the investigation other than providing NIST with the deliverables associated with the above tasks.

* The contractor shall not provide any findings, conclusions, or recommendations from its work on the three tasks. These are the sole and exclusive responsibility of NIST.

* The scope of work in this contract is limited to the three tasks listed above. It does not involve – in any way – the analysis of aircraft impact damage to the towers, the structural response of the towers to the fires, or the collapse sequence of the towers.

* NIST will conduct a comprehensive, independent review of each of the three tasks performed by the contractor. This review includes line-by-line review of the structural databases as well as extensive in-house verification and validation of the reference structural models and the baseline performance analyses. NIST has in its possession copies of all the original computer printouts, and other structural data and drawings for the towers. The contractor Statement of Work states that the deliverables are subject to review and approval by NIST for each of the tasks.

* NIST also will award a contract to another firm or individual through an open, competitive solicitation to conduct an independent third-party review and critique of each of the three tasks.

* This review includes random checks of the databases; appropriateness of the models for their intended uses considering model representation and assumptions, level of detail, and model geometry and material properties; and appropriateness of the baseline performance analyses and accuracy of the results.

* The contractor Statement of Work states that NIST will arrange for a third-party to conduct an independent review of the deliverables before final approval.

* The review will be conducted after LERA completes its work rather than while the work is in process to avoid influencing LERA's product and maintaining the integrity of the independent review.

4.21 02 SB1341-03-Q-0084 Fire Safety Engineering Expertise

Mr. Harold Nelson 12/23/2002 Award Information

http://wtc.nist.gov/solicitations/wtc_awardQ0084.htm

Under solicitation number SB 1341-03-Q-Q0084, a firm fixed-price purchase order has been awarded to Mr. Harold Nelson:

Mr. Harold E. Nelson, formerly a Senior Research Engineer with Hughes Associates, Inc. A graduate of Illinois Institute of Technology, Mr. Nelson has more than 50 years of fire protection engineering expertise, specializing in risk and hazard analysis. He was lead fire protection engineer for the U.S. General Services Administration, and led the team developing new technology for fire safety engineering at the National Bureau of Standards. Mr. Nelson was a participant in the Federal Emergency Management Agency's BPAT study of the World Trade Center disaster.

Mr. Nelson is uniquely qualified to provide the required fire safety engineering expertise for this project. Mr. Nelson's qualifications are listed below.

Mr.Nelson has a proven ability in fire investigations, including multi-floor fires in high rise buildings with experience in such buildings as One Meridien Plaza Bank.

Mr. Nelson participated in the FEMA BPAT study of the Trade Center disaster.

Mr. Nelson has over 50 years of fire protection engineering expertise, specializing in risk and hazard analysis.

Mr. Nelson has demonstrated experience in the development of practical fire safety for high-rise buildings.

Mr. Nelson has specialized experience in human behavior in fires, including egress and fire safety for handicapped persons.

Mr. Nelson has demonstrated knowledge and experience in the building design, construction, operations and maintenance, and inspection procedures, with particular emphasis in egress. He also has demonstrated knowledge and experience with U.S. building and fire codes, standards, and regulatory system.

The specific tasks to be performed by The Contractor and the specific methodologies to be used include:

Identification of sources of information about the interiors of the three buildings (WTC 1, 2, and 7), the types of fuels present, and the compartmentation.

Providing insights into the analyses developed during the FEMA World Trade Center Building Performance Study.

Assistance in formulating hypotheses regarding the dynamics of the fires in the interiors of the buildings;

Assistance in identifying key aspects of egress and human behavior during the fires;

Guidance in conceptualizing the floor-to-floor and cross-floor fire spread, and documenting renditions of the concepts.

Contributing to the selection of pre-fire conditions for modeling the thermal environment using Fire Dynamics Simulator (FDS) and documenting bases for his positions.

Participation in understanding the relationships between the model predictions and the accumulated photographic evidence and renditions of insights developed.

Assistance in the design of physical and computational tests to document the accuracy of the modeling predictions.

Providing documentation of his contributions, which will serve as input to the Final Report.

Providing a non-binding technical review of the Project 5 report. We don't have dates on any of the other tasks. Contractor deliverables may include summaries of the tasks. The Contractor will not generate conclusions of the Investigation. Contractor deliverables may include summaries of the tasks.

4.22 01 SB1341-02-Q-0710 Outside Expert Team Member

Dr. Norman Groner 10/16/2002 Award Information

http://wtc.nist.gov/solicitations/wtc_awards.htm

Under solicitation number SB 1341-02-Q-0710, firm fixed-price purchase orders have been awarded to:

* Dr. Norman Groner, an independent consultant from California. He has a doctorate in psychology and 25 years experience in the human factors field, much of it in the area of cognitive factors related to fire safety and emergency planning. He also has expertise and experience in interviewing techniques. **He is coordinator for the independent World Trade Center Evacuation Initiative**.

4.23 01 SB1341-02-Q-0710 Outside Expert Team Member

Dr. Guylene Proulx 10/16/2002 Award Information

http://wtc.nist.gov/solicitations/wtc_awards.htm

Under solicitation number SB 1341-02-Q-0710, firm fixed-price purchase orders have been awarded to:

* Dr. Guylene Proulx, Research Officer from the Institute for Research in Construction at the National Research Council of Canada. She has a doctorate in environmental psychology and 15 years experience in evacuation and emergency communications**. She also has experience in post-fire egress analysis using questionnaires and interviews. She studied the evacuation of the WTC towers following the 1993 bombing incident.**

4.24 01 SB1341-02-Q-0710 Outside Expert Team Member

Dr. Dennis Mileti 9/30/2002 Award Information

http://wtc.nist.gov/solicitations/wtc_awards.htm

Under solicitation number SB 1341-02-Q-0710, firm fixed-price purchase orders have been awarded to:

* Dr. Dennis Mileti, Director of the National Hazards Research and Applications Information Center within the Institute of Behavioral Science at the University of Colorado at Boulder. **He has a doctorate in sociology and 28 years experience in risk communication and social psychology of public action. He also has expertise in statistical sampling methods and questionnaire design and methods.**