

**Prepared Remarks by Dr. Shyam Sunder, Lead Investigator**  
**NIST Building and Fire Safety Investigation of the World Trade Center Disaster**  
**News Media Briefing**  
**December 9, 2002**

The NIST building and fire safety investigation is focused exclusively on three buildings: the WTC Towers-or WTC 1 and 2-and WTC 7, the 47-story building that collapsed later in the day on September 11, 2001.

We are striving to study the disaster holistically, paying particular attention to the interplay between the buildings, the occupants, and the emergency responders.

The lessons to be derived from our investigation are expected to benefit a broad range of new and existing buildings, not just the three buildings that are studied.

We are basing all of our review, analysis, modeling, and testing work for the investigation on a solid foundation of technical evidence. This requires access to critical data such as building documents, video and photographic records, emergency response records, and oral histories, in addition to the samples of steel that have been recovered.

We have received excellent cooperation from a variety of organizations in the discovery phase of our investigation. We have begun to receive large volumes of documentation from the Port Authority of New York and New Jersey, Silverstein Properties, their consultants and contractors, and the group of insurance companies that insured the WTC towers. We have also begun to receive information from the Fire Department of New York and the New York City Office of Emergency Management. These documents relate to the design, construction, operation, inspection, maintenance, repair, alterations, emergency response and evacuation of the WTC complex. Our progress report released today lists the specific types of information that we have received.

We also have a number of requests for materials that are currently pending with these organizations and with the New York City Police Department. Many of these requests relate to the emergency response and evacuation on September 11, 2001, including communications and operational records.

Our **progress report** also lists important documents and materials that have not yet been located or provided. We are informed that most of the items listed may have been destroyed in the collapse of the WTC towers and WTC 7. The Port Authority and Silverstein Properties are trying to locate any available information from their contractors and other sources.

The pie chart (right) shows the types of information we are requesting and a qualitative assessment of what we have in our possession, what we need to get, and what ultimately may be unavailable to us. We have begun to review and analyze the information already in our possession.

**Information needed to solve the World Trade Center collapse puzzle**

- = NIST has
- = NIST needs
- = Unavailable (destroyed, lost, or currently inaccessible)



Silverstein Properties and the group of insurance companies involved in the insurance litigation related to the WTC towers have provided us with full access to the large body of technical work completed independently by their respective technical experts. The NIST investigation team also received detailed and separate briefings from both parties.

The structural collapse scenarios discussed in those reports are among the critical issues we have included in our investigation plan. In addition, our plan goes beyond those considerations to include issues of evacuation, emergency response, and engineering practice.

We are reviewing the information provided and incorporating what is learned into our investigation. When we issue our analysis at the conclusion of the investigation, we will make certain that the different collapse scenarios are examined, either alone or in combination, and compared with available evidence to establish the facts rigorously and in an unbiased way.

The three or four leading scenarios differ considerably in the relative roles played prior to collapse initiation by the primary elements that comprised the tower structure - the columns, the floor system, the connections, and the hat truss that connected the perimeter and interior columns. Those relative roles were influenced by the extent of their damage due to aircraft impact and their weakening by the fires that followed.

Based on an initial assessment of the expert studies, NIST considers it to be premature to exclude any of the potential hypotheses related to the sequence of events between the aircraft impact and the collapse of each tower. Further work is needed to ensure that the results of any analysis can adequately explain the observed behavior.

We are using a balance of analytical, experimental, and numerical tools to help unravel the extremely complex physical phenomena associated with the events of September 11, 2001 and to support or refute alternative collapse hypotheses.

Among the key factors that need to be considered are:

- the speed, direction, orientation, and point of impact of each aircraft and dispersion of the jet fuel;
- the structural and non-structural mass of the towers that shared in absorbing the energy of aircraft impact;
- the properties of the structural steel at high temperatures and rates of loading;
- the performance of fireproofing and the extent to which it was missing or knocked off;
- and the spread of fire through the towers and the temperature of the steel as a function of time and location.

In our reconstruction of the thermal and tenability environment, we are taking into account:

- the fire load provided by building contents and other sources such as jet fuel and fuel storage tanks;
- the ventilation available for combustion; and
- the fire growth through partitions, ceiling/floor systems, and air passages within the buildings.

We are conducting a complementary experimental effort that provides critical input to our analytical and numerical work, including the validation of those results. These studies include:

- the mechanical properties of steel at high rates of loading to support aircraft impact damage analysis;
- the thermal-insulation properties of fireproofing and its ability to withstand shock and impact;

- the mechanical properties of steel at high temperatures to support the analysis of structural response to fires;
- fire tests to study floor truss-to-column connections and the local load transfer at the interface between the steel truss and the concrete deck in the composite floor system; and fire tests in large compartments to measure the heat release, distribution, and heat transfer rate to the compartment gases and typical steel specimens, both with and without fireproofing, to validate fire dynamics and thermal-structural analyses.

We also are reviewing previously completed tests on open-web steel truss systems, including their performance under gravity loads and fire. The past performance of such trusses in fires is being documented using available fire incident and insurance investigation reports.

As Dr. Bement said, our study of the WTC evacuation and emergency response requires a systematic collection of first-hand data from survivors, families of victims, and others with operational or command authority on September 11th.

The accumulated data will be used to evaluate the role of occupant behavior and the evacuation and emergency response technologies and practices for tall buildings. We will address issues such as decision-making and situation awareness, time-constrained evacuation strategies, communications, fire protection and firefighting, the role of fire wardens and fire safety directors, and those concerning people with disabilities. Our strategy—which includes face-to-face interviews, paper and web-based questionnaires, and focus group interviews—is based on well-established statistical sampling techniques. It is designed to:

- increase confidence in the findings,
- enable systematic hypothesis testing and generalization,
- probe specific information of particular value to the investigation, and
- enhance memory recall and accuracy.

We developed this strategy with three world-class experts selected by NIST on a competitive basis to augment our investigation team.

The data collection will be conducted by a yet-to-be selected contractor and the specific populations and the size of samples may be modified as we finalize additional details.

We currently plan to conduct up to 600 face-to-face interviews of occupants and up to 150 interviews of first responders. First responders will be drawn from FDNY, NYPD, the Port Authority Police Department, and the firm that provided security at the complex.

We also plan to collect data via approximately 800 returned web-based questionnaires using a "whole building" stratification and approximately 450 returned mailed questionnaires using a "selected-floors" stratification.

We plan five occupant focus groups with between five and 10 participants per group and 10 first-responder focus groups with five participants per group. The focus groups will elicit accurate group representations of specific events or themes such as the experience of unique types of people in unique places in the buildings.

We will use established procedures to review and approve all survey and interview questions, data collection methods, and safeguards for maintaining privacy and confidentiality of all instruments before proceeding with these critical data collection efforts.

NIST now has in its possession more than 200 pieces of World Trade Center steel. The vast majority of the pieces are of significant size and include perimeter prefabricated column-spandrel elements, rectangular box beams, wide flange sections, truss sections, and channels. We are also in possession of several smaller pieces, such as bolts. In addition, we are reviewing additional steel and other artifacts stored by the Port Authority at JFK airport to identify pieces of interest to our investigation.

Based on information we have on the grades of steel used in the towers and identifying marks on the recovered steel, we have been able to locate nine of the 12 steel strengths used for the perimeter columns and nine of the 11 steel strengths used for the spandrel beams. We are seeking to locate specimens of the remaining steel grades.

Also, approximately 250 chemical analyses have been completed. They indicate that the majority of the perimeter columns were made of specific steels obtained from Yawata Steel, now Nippon Steel. They have offered to cooperate fully in assisting NIST and begun to provide useful information, including the proprietary specifications for their steels. So far, our tests indicate that they are of higher strength micro-alloyed steels (similar to modern pipeline steels) or chromium-molybdenum steels that would meet U.S. specifications for heat resisting steels.

NIST also has identified the fabricators of the steel floor trusses. The firm, Laclede Steel, has been fully cooperative in providing us with information. Documents from the firm show that the trusses were fabricated with steels that routinely met or exceeded the strength specified. We are testing selected truss steels to determine their properties independently.

In addition, we have characterized the effects of high temperature on the primer paint used on the perimeter columns. From this analysis we know that steel that shows little visible evidence of discoloration or damage to the primer paint could still have experienced high temperature levels due to the fires. We are continuing to investigate methods to estimate the temperatures reached by the steel.

Photographic and video images of damage and fires in the WTC towers and WTC 7 are critical to developing guidance on the initial conditions for modeling the fires, the rates of fire spread through the buildings, and the floors on which the structural collapse may have initiated.

We have compiled a preliminary searchable database of over 1,900 still photos that were obtained from 55 private or independent photographers. The collection is expected to grow to multiples of the current size before it is complete.

I would like to reiterate Dr. Bement's call for photo and video images of the WTC Towers and WTC 7. We are especially interested in WTC 7 and views from the South and West faces of the WTC Towers. Also, there continues to be a dearth of photos of the south side of WTC 7. It has been suggested that the debris from the collapse of WTC 1 struck WTC 7 on this side and ignited the fires that led to its ultimate collapse. Those who are aware, or in actual possession, of such materials are encouraged to contact us by electronic mail at [wtc@nist.gov](mailto:wtc@nist.gov), facsimile at 301-975-6122, or regular mail at WTC Technical Information Repository, NIST, 100 Bureau Drive, Stop 8610, Gaithersburg, MD 20899-8610.

We are still in the early stages of our effort to obtain, catalog, and analyze photographic and video evidence and will share the analysis results broadly once the work is complete.

NIST has assembled a seasoned world-class team to carry out the investigation. This team has the needed technical expertise as well as experience from significant prior investigations. It includes two dozen NIST experts who are involved in the investigation. We are augmenting the in-house staff with external world-class experts in our project teams as contractors. The bulk of these contract solicitations will appear in the coming weeks. We are relying on full and open competition as the preferred contracting

process in most cases. Solicitations are posted on the NIST WTC web site at <http://wtc.nist.gov> as soon as they are issued.

NIST's public-private plan in response to the World Trade Center disaster includes an R&D program and a dissemination program. Both are concurrent with and an essential complement to the investigation. The R&D program addresses work in critical areas such as structural fire safety, mitigation of progressive collapse, building vulnerability reduction tools, and equipment standards for first responders. It feeds into the voluntary consensus process that is used to develop building and fire codes and standards in the United States.

The industry-led dissemination program is crucial for timely adoption and widespread use of the changes to practice, standards, and codes resulting from the WTC investigation and R&D program.

Selected portions of the R&D and dissemination programs have been funded and NIST has begun to make important progress as outlined in the written report. NIST has held and sponsored well-attended workshops—with leaders from industry, academia, and government—to develop detailed R&D roadmaps in specific areas such as fire resistance determination and the mitigation of progressive collapse. Also, we sponsored a workshop on Critical Infrastructure Protection Priorities organized by a group of industry associations and federal agencies that was led by the White House Office of Science and Technology Policy and the Civil Engineering Research Foundation. NIST is working through international organizations to address the global need for improvements to structural fire safety standards, codes, and practices. Thirteen laboratories around the world have already indicated their interest in such an effort.