

## Awarded Contracts for External Experts to Support the NIST World Trade Center (WTC) Disaster Investigation

<b>Contract No.</b>	<b>Awarded to</b>	<b>Date Awarded</b>
SB1341-04-Z-0002	Simpson Gumpertz & Heger, Inc. (SGH)	10/30/2003

### **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.