RAS 6784

September 5, 2003

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board



| | | |
|---|---|---|
| In the Matter of | ) | |
| | ) | |
| PRIVATE FUEL STORAGE L.L.C. | ) | Docket No. 72-22 |
| | ) | |
| (Private Fuel Storage Facility) | ) | ASLBP No. 97-732-02-ISFSI |

**APPLICANT'S IDENTIFICATION OF WITNESSES FOR AIRCRAFT CRASH "CONSEQUENCES" PROCEEDING**

Applicant Private Fuel Storage, L.L.C. ("PFS") hereby provides the name, address, profession, employer, area of professional expertise, and educational and scientific experience of each person whom PFS expects to call as a witness at the upcoming aircraft crash "consequences" hearing. The educational and scientific experience of expected witnesses are provided in the form of a resume of the person attached to this notice.

PFS has identified the following persons whom it expects to call as witnesses at the aircraft crash consequences proceeding.

| | |
|---|---|
| Name and Address: | Maj. Gen. Wayne O. Jefferson, Jr., USAF (Ret.)<br>147 Cedar Glen Close<br>Nellysford, VA 22958 |
| Profession: | Consultant, Retired Air Force Major General |
| Employer: | Burdeshaw Associates, Ltd. |
| Professional Expertise: | U.S. Air Force senior executive, military aircraft operations and quantitative probabilistic analysis |

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SECY-02

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|---|---|
| Educational, Scientific Experience, and Professional Qualifications: | See attached resume. |
| Publications in the last ten years: | None |
| Testifying experience in last four years: | None |
| Subject matter of testimony: | The nature of potential aircraft crashes in Skull Valley. |
| Documents reviewed and/or relied upon: | See PFS expert reports and RAI responses. |

| | |
|---|---|
| Name and Address: | Dr. Indresh Rampall<br>Holtec International<br>555 Lincoln Drive West<br>Marlton, NJ 08053 |
| Profession: | Chemical Engineer |
| Employer: | Holtec International |
| Professional Expertise: | Process Design and Evaluation |
| Educational, Scientific Experience, and Professional Qualifications: | See attached resume. |
| Publications in the last ten years: | See attached resume. |
| Testifying experience as expert in last four years: | None |
| Subject matter of testimony: | Potential effects of jet fuel fire on HI-STORM spent fuel storage cask. |
| Documents reviewed and/or relied upon: | See PFS expert reports and RAI responses. |

| | |
|---|---|
| Name and Address: | Col. Ronald E. Fly, USAF (Ret.)<br>901 S. Frankland Road<br>Tampa, Florida 33629 |
| Profession: | Consultant, Retired Air Force Colonel |
| Employer: | Burdeshaw Associates, Ltd. |
| Professional Expertise: | Pilot/Military Flight Operations |
| Educational, Scientific Experience, and Professional Qualifications: | See attached resume. |
| Publications in the last ten years: | See attached resume. |
| Testifying experience as expert in last four years: | See attached resume. |
| Subject matter of testimony: | The nature of potential aircraft crashes in Skull Valley; the characteristics of the F-16 aircraft. |
| Documents reviewed and/or relied upon: | See PFS expert reports and RAI responses. |

| | |
|---|---|
| Name and Address: | Dr. C. Allin Cornell<br>110 Coquito Way<br>Portola Valley, CA 94028 |
| Profession: | Professor (Research) |
| Employer: | Stanford University |
| Professional Expertise: | Probabilistic Methods, Structural Engineering, Earthquake Engineering |
| Educational, Scientific Experience, and Professional Qualifications: | See attached resume. |

| | |
|---|---|
| Publications in the last ten years: | See attached resume. |
| Testifying experience as expert in last four years: | Testimony before California Earthquake Authority, July 1997 |
| Subject Matter of Testimony: | Probabilistic analyses related to the probability of an aircraft crash at the PFS Facility leading to a loss of storage cask or Canister Transfer Building structural integrity; analyses of aircraft crash impact probability distributions for Skull Valley; the effective area of the PFS Facility. |
| Documents reviewed and/or relied upon: | See PFS expert reports and RAI responses. |

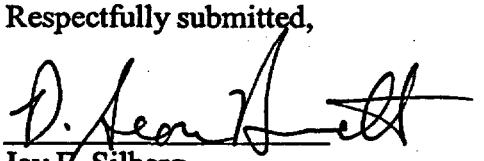
| | |
|---|---|
| Name and Address: | Mr. Bruce E. Ebbeson<br>Stone & Webster<br>3 Executive Campus<br>Route 70 & Cuthbert Boulevard<br>Cherry Hill, NJ 08034 |
| Profession: | Structural Engineer |
| Employer: | Stone & Webster, Inc. |
| Professional Expertise: | Structural design and analysis, including seismic analysis of nuclear facilities |
| Educational, Scientific Experience, and Professional Qualifications: | See attached resume. |
| Publications in the last ten years: | See attached resume. |
| Testifying experience as expert in last four years: | None |
| Subject Matter of Testimony: | The response of the Canister Transfer Building to the effects of an aircraft crash impact. |
| Documents reviewed and/or relied upon: | See PFS expert reports and RAI responses. |

| | |
|---|---|
| Name and Address: | Dr. Alan Soler<br>Holtec International<br>555 Lincoln Drive West<br>Marlton, NJ 08053 |
| Profession: | Mechanical Engineer |
| Employer: | Holtec International |
| Professional Expertise: | Mechanical design and dynamics of spent fuel casks and fuel racks |
| Educational, Scientific Experience, and Professional Qualifications: | See attached resume. |
| Publications in the last ten years: | See attached resume. |
| Testifying experience as expert in last four years: | None |
| Subject Matter of Testimony: | The robustness of the design of HI-STORM 100 cask storage system and its ability to withstand seismic aircraft crash effects; the potential effects of aircraft crash impacts on structures at the PFS Facility. |
| Documents reviewed and/or relied upon: | See PFS expert reports and RAI responses. |

| | |
|---|---|
| Name and Address: | Col. Lanny T.G. Lancaster, USAF (Ret.)<br>Burdeshaw Associates Ltd.<br>4701 Sangamore Road<br>Suite N. 100<br>Bethesda, MD 20816-5800 |
| Profession: | Consultant, Retired Air Force Colonel |
| Employer: | Burdeshaw Associates Ltd. |
| Professional Expertise: | See attached resume. |
| Educational, Scientific Experience, and Professional Qualifications: | See attached resume. |

| | |
|---|---|
| Publications in the last ten years: | See attached resume. |
| Testifying experience as expert in last four years: | None |
| Subject Matter of Testimony: | Resistance of HI-STORM spent fuel storage cask to penetration by jettisoned military ordnance. |
| Documents reviewed and/or relied upon: | See PFS expert reports and RAI responses. |

Respectfully submitted,



Jay E. Silberg
Paul A. Gaukler
D. Sean Barnett
SHAW PITTMAN, L.L.P.
2300 N Street, N.W.
Washington, DC 20037
(202) 663-8000

Dated: September 5, 2003

Counsel for Private Fuel Storage L.L.C.

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## CERTIFICATE OF SERVICE

I hereby certify that copies of Applicant's Identification of Witnesses for Aircraft Crash "Consequences" Proceeding, the attached resumes, and declaration of D. Sean Barnett were served on the persons listed below (unless otherwise noted) by e-mail with conforming copies by U.S. mail, first class, postage prepaid, this 5th Day of September, 2003.

Michael C. Farrar, Esq., Chairman
Administrative Judge
Atomic Safety and Licensing Board Panel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001
e-mail: MCF@nrc.gov

Dr. Jerry R. Kline
Administrative Judge
Atomic Safety and Licensing Board Panel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001
e-mail: JRK2@nrc.gov; kjerry@erols.com

Dr. Peter S. Lam
Administrative Judge
Atomic Safety and Licensing Board Panel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001
e-mail: PSL@nrc.gov

*Office of Commission Appellate Adjudication
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Office of the Secretary
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001
Attention: Rulemakings and Adjudications Staff
e-mail: hearingdocket@nrc.gov
(Original and two copies)

* Adjudicatory File
Atomic Safety and Licensing Board Panel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Catherine L. Marco, Esq.
Sherwin E. Turk, Esq.
Office of the General Counsel
Mail Stop O-15 B18
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
e-mail: pfscase@nrc.gov

John Paul Kennedy, Sr., Esq.
David W. Tufts, Esq.
Confederated Tribes of the Goshute Reservation and David Pete
Durham Jones & Pinegar
111 East Broadway, Suite 900
Salt Lake City, Utah 84105
e-mail: dtufts@djplaw.com

Diane Curran, Esq.
Harmon, Curran, Spielberg & Eisenberg, L.L.P.
1726 M Street, N.W., Suite 600
Washington, D.C. 20036
e-mail: dcurran@harmoncurran.com

Paul EchoHawk, Esq.
Larry EchoHawk, Esq.
Mark EchoHawk, Esq.
EchoHawk PLLC
P.O. Box 6119
Pocatello, ID 83205-6119
e-mail: paul@echohawk.com

* By U.S. mail only

Denise Chancellor, Esq.
Assistant Attorney General
Utah Attorney General's Office
160 East 300 South, 5th Floor
P.O. Box 140873
Salt Lake City, Utah 84114-0873
e-mail: dchancellor@utah.gov

Joro Walker, Esq.
Land and Water Fund of the Rockies
1473 South 1100 East
Suite F
Salt Lake City, UT 84105
e-mail: lawfund@inconnect.com

Tim Vollmann, Esq.
Skull Valley Band of Goshute Indians
3301-R Coors Road, N.W.
Suite 302
Albuquerque, NM 87120
e-mail: tvollmann@hotmail.com

D. Sean Barnett

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## DECLARATION OF D. SEAN BARNETT

D. Sean Barnett states as follows under penalties of perjury:

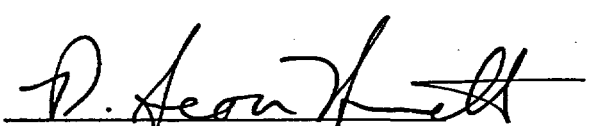
1. I am with the firm of Shaw Pittman, L.L.P., in Washington, D.C.

2. I am duly authorized to verify Applicant's Identification of Witnesses for Aircraft Crash "Consequences" Proceeding

3. I certify that the statements in such responses are true and correct to the best of my personal knowledge and belief.

4. I declare under penalty of perjury that the foregoing is true and correct.

Executed on September 5, 2003.



D. Sean Barnett

# Wayne O. Jefferson

Major General Wayne 0. Jefferson, Jr., USAF (Ret.)

Major General Jefferson is currently an Associate with Burdeshaw Associates, Ltd. (BAL).

From 1994 until the present, General Jefferson has been a consultant in management, management training, and quantitative probabilistic analysis. He also teaches risk management including risk identification, analysis and mitigation.

From May 1992 to May 1994, General Jefferson was employed in private industry as Executive Director of LCC, Inc. and responsible for the accounting and finance, human resources and training functions of that company. He also served as the acting chief financial officer for 6 months. From May 1991 to May 1992, he was the General Manager of TSI, Inc., with total profit and loss responsibility for this rapidly growing company. Both of these companies were involved with engineering design support and deployment of the wireless elements of cellular telephone systems.

From 1989 to 1991, General Jefferson was President of Jefferson Associates, Inc., a consulting firm, and an Associate with Burdeshaw Associates, Ltd. (BAL).

General Jefferson retired from the U.S. Air Force on 11 July 1989 after more than 30 years of highly successful experience in leadership, decision-making, planning and management.

From April 1988 until completing service, General Jefferson served as the Joint Staffs Deputy Director for Defense-Wide C3 Support. In this position, he ensured the integrity, interoperablity, evolutionary capability and technical efficiency of all systems employed in the Defense Department's entire command, control and communications system.

From 1985 to 1988, he headed NATO's Communications and Information Systems Division on the International Military Staff in Brussels, directing NATO's highest level military C3 policy structure.

From 1984 to 1986, General Jefferson headed the Joint Staff's first Deputy Directorate for C3 Connectivity and Evaluation, directing the exercise and evaluation of the Defense Department's command and control systems in order to assure their operational capability under severe stress.

From 1980 to 984, General Jefferson held positions of rapidly increasing responsibility with the Strategic Air Command (SAC). In 1983-84, he was Assistant Deputy Chief of Staff for Operations, overseeing the entire scope of SAC's worldwide bomber, tanker, missile and reconnaissance operations, including training range development and flight operations. In 1982-83 he was SAC's Director of Command Control, responsible for the operation of SAC's tight command and control system, including the underground command center in Omaha and the airborne command post. In 1981, as SAC's Assistant Director of Plans and Policy, he was responsible for the analysis and development of SAC's future force requirements, the preparation of SAC's annual budget, and basing plans for new weapons systems. In 1980-81, he commanded a B-52 bomb wing with 17 B-52H bombers and 22 KC-135 tankers.

Prior experience included nuclear test and evaluation, Air Staff mission area planning, Vietnam flight operations, and faculty member at both the US Air Force Academy and the National War College in simulation, economics and management, focusing on operations research and quantitative decision making involving probabilistic methods.

Educational Background

Senior Managers in Government Program, Harvard University
M.S. in Operations Research, Stanford University
M.B.A, Auburn University
Technical University of Munich, Germany. Two years E.E. (in German)
B.S., U. S. Air Force Academy (distinguished graduate)
National War College (graduate and faculty member)

Air Command and Staff College (distinguished graduate)

Overseas experience
Belgium, Germany, Vietnam
Language capability in German, French, and Spanish

# Indresh Rampall

**INDRESH RAMPALL, Ph.D.**

**PRINCIPAL ENGINEER**
**HOLTEC INTERNATIONAL**

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## EDUCATION

University of Notre Dame
Ph.D. in Chemical Engineering (1992)

University of Notre Dame
M.S. in Chemical Engineering (1989)

Indian Institute of Technology
B. Tech in Chemical Engineering (1978)

## PROFESSIONAL EXPERIENCE

**HOLTEC INTERNATIONAL**
Marlton, New Jersey
April 1993 - Present — Principal Engineer

**CLARKSON UNIVERSITY**
Potsdam, NY
1992 - 1993 — Research Associate

**UNIVERSITY OF NOTRE DAME**
Notre Dame, Indiana
1988-1992 — Graduate Assistant

**ENGINEERS INDIA LIMITED (EIL)**
New Delhi, India
1978 - 1987 — Senior Engineer, Research and Development Department

## PATENTS

*An improved process scheme for production of phthalic anhydride by oxidation of o-xylene in multistage reaction systems*, by I. Rampall, A. Datta and P.K. Mukhopadhayay.

## DRY AND WET SPENT FUEL STORAGE TECHNOLOGY

- Developed the thermal design and evaluation methodologies for metal and concrete dry cask storage systems.
- Devised thermosiphon cooling of spent nuclear fuel in dry casks.
- Developed Computational Fluid Dynamics methodologies for thermal-hydraulic evaluation of wet and dry fuel storage systems.
- Performed site-specific accident evaluations (vegetation fire, fuel explosion, partial cask submergence in flood water) using Computational Fluid Mechanics models for Private Fuel Storage, L.L.C., and other Holtec clients.

- Principal Analyst responsible for thermal-hydraulic qualification of HI-STAR dual-purpose (storage and transportation) and HI-STORM storage casks (Docket Nos. 72-1008, 71-9261, and 72-1014).

- Rerack licensing of Sizewell-B, KEPCO, Waterford-3, Millstone-3, CP&L, and a dozen other spent nuclear fuel pools.

**PROCESS DESIGN AND DEVELOPMENT**

1. Process design work including Heat and Material Balance Calculations, preparation of Process Flow and P&I Diagrams, Specifications for Process Instruments, Pumps and Equipment (Pressure Vessels, Heat Exchangers, etc.). Also prepared Operations Manuals for start-up, operations, shutdown, emergency procedures and plant safety.

2. Developed process models for design of two-phase flow high pressure pipelines from off-shore platforms.

3. Developed steady state and dynamic process design models of heterogeneous fixed bed catalytic reactors used in refineries and petrochemical plants. The models were used to analyze industrial and pilot-plant data for the o-xylene and ethylene oxidation reactors to develop a complete reactor simulation model.

4. Development of a process design and simulation model for the zeolites based ZSM-5 catalyst used in the xylenes isomerization reactor for a large petrochemical complex. Appointed as the lead process engineer for planning of bench scale experiments at plant site as well as analysis of data to obtain a detailed kinetic model of the process.

Chemical Process Plant Operation

1. Appointed as the *lead process engineer* for development of the Ethylene epoxidation technology. Completed the process design, construction supervision and operation of a highly automated, full-scale, single tube, medium pressure, pilot plant for the catalytic oxidation of ethylene to ethylene oxide. Highly experienced with hands-on work involving process instrumentation, continuous on-line analyzers as well as process gas chromatographs. Developed process models from statistical analysis of pilot-plant data to evaluate catalyst/reactor performance.

2. Commissioning of a 25 million lbs/yr industrial plant for the production of phthalic anhydride by oxidation of o-xylene. Worked in pre-commissioning activities, preparation for start-up, establishing stable and safe operating conditions and guarantee test runs to meet all process specifications for yield and purity of products.

**Ph.D. RESEARCH**

Shear induced structure and migration in non-colloidal suspensions

1. *Experimental determination of the pair distribution function for a suspension of spheres in simple shear flow*

   A new direct flow visualization technique, employing a thin sheet of laser light, is developed for imaging the interior of suspensions. This is combined with a novel pattern recognition algorithm to simultaneously locate the position and size of particles in a dynamic cross-section of a suspension of 3 mm acrylic spheres sheared in a flow visualization apparatus.

Fundamental information on the nature of particle interactions and the suspension micro-structure is obtained. In addition to direct applications in predicting rheological properties of the suspension such as the bulk viscosity, we also gain insight into the more complex phenomena such as normal stress differences, anisotropy, particle migration, etc.

2. *The influence of shear induced migration on turbulent resuspension*

A new model is proposed to predict the condition when particles are first ejected from the viscous sub-layer of a fluid flowing over a settled layer of particles into the turbulent core of the fluid. The resuspension process is modeled in terms of a set of non-linear integro-differential convection-diffusion equations with moving singular boundaries. The equations are discretized and solved as a large set of *dense* differential and algebraic equations using the DASSL solver on the Convex mini-supercomputer.

Important Applications of PhD Research

- Knowledge of the micro-structure (i.e., the local arrangement and orientation of particles) has important applications in the area of Rheology of Suspensions and mechanical properties of Filled Polymer Composites. The bulk properties of the suspension such as effective viscosity, thermal and electrical conductivities are strongly influenced by this local distribution of particles.

- In the area of Multi-Phase Flow, the resuspension and transport of an initially settled bed of particles due to turbulent flow of fluid is solved. This work has applications in viscous systems such as flow of coal-oil slurry or drilling muds.

- Solved the mass transfer due to turbulent eddies near a wall in sedimenting systems. The model is applicable for the analysis of the improved performance of cross-flow microfiltration of suspended particles as well as in ultrafiltration of large molecular species. Increased mass fluxes can be obtained due to an induced secondary eddy flow in the near wall region.

Computational Experience

Developed programs in Fortran and C for solving complex engineering problems using advanced numerical techniques on a variety of hardwares - IBM, Vax, Convex, and Sun workstations - and operating systems - DOS, VAX/VMS, Unix, etc.

Supercomputer Training

Undertaken special training programs to take advantage of the Convex vectorization support in Fortran. Familiar with programming techniques on the massively parallel Connection Machine.

Post-Doctoral Research

- Influence of buoyancy-induced flow temperature fields in closed cavities.
- Developed analytical techniques for computing buoyant flows under time-varying gravity conditions.

## PUBLICATIONS

1. *Measurement of the shear-induced microstructure of concentrated suspensions of non-colloidal spheres*, by D.T. Leighton and I. Rampall, Review paper in "Particulate Two-Phase Flow", M. Roco (editor), Butterworths, (1993).

2. *The influence of shear induced migration on turbulent resuspension*, by I. Rampall and D.T. Leighton, Int. J. of Multiphase Flow, 20 (3), 631-650 (1994).

3. *The influence of surface roughness on the pair-particle distribution function in dilute suspensions of non-colloidal spheres in simple shear flow*, by I. Rampall, J.R. Smart, D.T. Leighton, Journal of Fluid Mechanics, 339, 1-24 (1997).

4. *Studies in reactor configuration for phthalic anhydride production*, by I. Rampall, A. Datta and P.K. Mukhopadhayay, "Frontiers in Chemical Reaction Engineering", vol. II, L.K. Doraiswamy and R.A. Mashelksar (Editors), 241-258, John Wiley and Sons, (1984).

5. *Parameter estimation and simulation of multi-tubular ethylene oxide reactor*, by R. Aggarwal, I. Rampall and A. Datta, "Recent Trends in Chemical Reaction Engineering", vol. II, B.D. Kulkarni, R.A. Mashelkar and M.M. Sharma (Editors), 360-374, Wiley Eastern, (1987).

6. "Application of Transient Analysis Methodology to Heat Exchanger Performance Monitoring", I. Rampall, A.I. Soler, K.P. Singh, and B.H. Scott. Heat Exchange Equipment and Valve Design and Operability Improvements, ASME Publication NE-Vol. 14 (1994).

## PRESENTATIONS

1. *Flow driven by oscillatory gravitational fields in a vertical channel wall effects*, by I. Rampall and R. Shankar Subramanian, First international workshop on g-jitter, Clarkson University, Potsdam, NY (June 13-18, 1993).

2. *A direct flow visualization method to study the shear-induced microstructure of non-colloidal suspensions*, by I. Rampall, Invited seminar talk at Clarkson University, Potsdam, NY (1993).

3. *Particle dynamics near a solid wall in concentrated suspensions of non-colloidal spheres*, by G. Krishnan, I. Rampall and D.T. Leighton, Presented at the AIChE Annual meeting in Miami, FL (1992).

4. *The influence of shear induced migration on turbulent resuspension*, by I. Rampall and D.T. Leighton, Presented at the AIChE Annual meeting in Los Angeles, CA (1991).

5. *On the pair-particle distribution function in dilute suspensions of non-colloidal spheres in simple shear flow*, by I. Rampall, J.R. Smart and D.T. Leighton, Paper presented at the AIChE Annual meeting in Chicago (1990).

# Ronald E. Fly

RONALD E. FLY, Colonel, USAF (Retired)
901 S. Frankland Rd., Tampa, Florida 33629
(813) 254-2069

## CAREER SUMMARY

Twenty-four years of demonstrated accomplishment in leadership, management and staff positions. Extensive operational experience to include leading three large organizations.

## LEADERSHIP POSITIONS

Commander, 388th Fighter Wing, Led 2,200 personnel in nine squadrons with an annual budget of $66M.

- Maintained a 4% higher aircraft readiness rate at a 20% lower operating cost than two similar organizations, an annualized saving of $6,970,000.
- Executed the first "no-notice" Air Expeditionary Force, generated the tasked aircraft and 5 spares 12 hours ahead of schedule.

Commander, 8th Operations Group. In charge of 830 personnel in 3 squadrons with an annual budget of $24M.

- Exceeded every command readiness standard, fighter squadrons took first and second place in the command wide bombing competition.
- Aggressively managed aircraft engine repair flow to prevent the loss of 25 engines.

Commander, 63rd Fighter Squadron. Responsibilities for 325 personnel and an annual operations and maintenance budget of $10M.

- Turned the perennial "also ran" into the wing's premier fighter squadron. Won the Annual Top Combat Unit competition by the largest margin on record and swept every major maintenance and operational category.
- Maintained the wing's highest readiness rate using only 54% of the operations and maintenance budget.

## STAFF POSITIONS

Chief, Defense and Space Operations Division, The Joint Staff. Responsible for operational cognizance over all air and missile defense matters, and space operations. Worked extensively at the inter-agency level on Intelligence and Missile Defense. Co-chaired the Quadrennial Defense Review Navigation Warfare subpanel.

Action Officer, International Affairs Division, Headquarters USAF. One of only six officers designated by the Secretary of the Air Force with the authority to release sensitive classified and unclassified information and technologies to foreign governments and international organizations.

OPERATIONS

Seventeen years experience in all phases of aviation to include, flight operations, maintenance, logistics, quality assurance, training and scheduling.

STRATEGIC PLANNING

Co-chaired the operations panel for the 1995-96 Advanced Battlespace Information Study commissioned by the Undersecretary of Defense Deputy for Research and Engineering and the Joint Chiefs of Staff. The Department of Defense accepted the report recommendations and redirected command and control research funds to those programs which supported the study's technology roadmap. This study, published in 1996, served as a cornerstone for the Joint Chiefs of Staffs 15 year strategic plan, *Joint Vision 2010.*

Instituted an infrastructure planning process addressing the unit's 77 buildings and 1.3 million square feet of floor space. Procured $80,000 from regional headquarters for a long-term engineering development plan.

OPERATIONAL ANALYSIS

Used unit cost and repair data to isolate a low-cost, high failure rate item in the F-16 wheel brake system. Formed and directed a team of technical experts to investigate the problem and develop corrective actions. The locally developed procedures were adopted Air Force wide in 1995.

Developed a unit based metric for tracking aircraft engine transportation to and from the Pacific regional repair facility. This metric was adopted throughout the Pacific Air Forces in 1995 and led to an asset reallocation reducing the transportation time 375%.

EDUCATION

National Security Manager's Course, Syracuse University, 1996
(2 month executive education)
Master of Science (Management), Troy State University 1985
Bachelor of Science (Economics), US Air Force Academy, 1974

PROFESSIONAL MILITARY EDUCATION

NATO Defense College, Rome, Italy, 1994
Air War College, 1988
Air Command and Staff College. 1985

RONALD E. FLY, Colonel, USAF (Retired)
Addendum

EDUCATION & TRAINING

Member, Board of Directors, Air Combat Command's Professional Military Education. Set the education and training policy and guide lines for approximately 90,000 USAF personnel.

Eight years experience as a formal course instructor.

- Wrote course objectives, study guides, teaching manuals, tests and other academic courseware.
- Designed syllabi to include integrated academic and advanced practical training flow.
- Academic instructor, taught all phases of aerial combat, air-to-air munitions, radar, electronic countermeasures, and aerospace physiology.
- Multiple awards as the Top Academic Instructor and the Best Instructor Pilot.

INTERNATIONAL AFFAIRS

Over four years experience in the HQ USAF International Affairs Division Office of the Vice Chief of Staff.

- 2½ years on the Middle East Africa desk, 2 years as the NATO and multinational desk officer
- Daily interaction with foreign attaches concerning access to USAF information and visits to USAF installations
- Technology Transfer . . . served as the gatekeepers for technology
    - Chairman, F-16 Multinational Technical Coordinating Group (US and the four NATO F-16 co-production partners). Responsible for resolving all technology transfer issues within the group.
    - Recognized expert in weapons systems, fighter aircraft, radars, and electronic countermeasures
    - Authored the USAF LANTIRN release policy, approved by CSAF

- IIQ USAF lead on the UK and French E-3 AWACS sale, adroitly handled several key issues concerning software and technical drawings.

SPACE OPERATIONS

Planned and led the ICS sponsored Tactical Exploitation of National Capabilities (TENCAP) Special Project 97 exercise. Focused on providing national capability to support theater ballistic missile defense initiatives.

Defense Support Program. The JCS lead for the current shared early warning program. Met the aggressive schedule directed by the President to provide Israel with an early warning capability, established the baseline architecture for the growing SEW initiative.

Routinely Co-chaired the NIMA Customer Advisory Board involving over 12 different agencies. Helped ensure a smooth transition as NIMA was formed by merging other agencies.

NATIONAL MISSILE DEFENSE

Designed and developed the exercise evaluation program to test NMD weapons engagement scenarios and weapons release authority levels.

PLANNING

Planned and procured funding for $7M major runway infrastructure repair project at Kunsan AB, Korea. The project, involving moving over 600 personnel and $1B dollars worth of assets to two other operating locations, was successfully executed providing much needed infrastructure repair and enhancement.

CONTINGENCY EXECUTION

Led the Hurricane Andrew evacuation, involving 75 airplanes and over 200 personnel, from MacDill AFB, FL to Dobbins AFB, GA. The short notice evacuation was smoothly executed with minimum problems.

OPERATIONAL TEST AND EVALUATION

Commander of the Utah Test and Training Range., the largest overland range in the free world and the only overland range authorized for test of cruise missiles and other large safety footprint weapons.

- Directed the use and implementation of test range assets for calibration of airborne laser targeting systems. Leveraged the use of test equipment to improve operational capability.

- Implemented new procedures to increase range safety and minimize the possibility of damage to non-test facilities located on the range.

LOGISTICAL SUPPORT

Identified problems with a high cost, high failure rate component of the F-I 6 radar.

- Developed local operational and repair procedures to increase the mean time between failure rate and increase the radar reliability.
- Directed technicians to work with the regional repair facility and identify a long term improvement. A redesign of the component involving a new memory chip was developed and an 18 month replacement plan initiated.

# C. Allin Cornell

# C. ALLIN CORNELL

## EDUCATION

| | | |
|---|---|---|
| Stanford University, Architecture | A.B. | 1960 |
| Stanford University, Civil Engineering (Structures) | M.S. | 1961 |
| Stanford University, Civil Engineering (Structures) | Ph.D. | 1964 |

Doctoral Thesis: *Stochastic Process Models in Structural Engineering*

## PROFESSIONAL EMPLOYMENT:

Stanford University: Acting Assistant Professor 1963-1964

Universidad Nacional Autonoma de Mexico: Visiting Professor Summer 1966

University of California, Berkeley: Visiting Associate Professor 1970-1971

Basler and Hofmann, Zurich: Research Engineer Summer 1972

Laboratorio Nacional de Engenharia Civil, Lisbon: Visiting Investigator 1974-1975

Massachusetts Institute of Technology:

| | |
|---|---|
| Assistant Professor and Ford Post-Doctoral Fellow | 1964-1966 |
| Assistant Professor | 1966-1968 |
| Associate Professor | 1968-1974 |
| Holder of Gilbert Winslow Career Development Chair | 1971-1974 |
| Professor | 1974-1983 |

Stanford University:

| | |
|---|---|
| Visiting Professor | 1981-1983 |
| Professor (Research) - Half-Time | 1983-present |
| Co-Director, Reliability of Marine Structures Program | 1988-2002 |
| Fellow, SU-USGS Institute on Earthquake Engineering and Seismology | 1986-1996 |

| | | | |
|---|---|---|---|
| Consulting Practice: | | Part-Time | 1965-1981 |
| | | Half-Time | 1981-present |
| Cygna, Inc., San Francisco | Senior Vice President | | 1984-1985 |
| C. Allin Cornell, Co. | | President | 1981-present |

## PROFESSIONAL ORGANIZATIONS AND COMMITTEES (Current and Former):

American Iron and Steel Institute:

Advisory Committee on Load-Factor Building Design

American National Standards Institute:
Building Loads Code Committee A58

American Society of Civil Engineers:
Committee on Structural Safety
Committee on Nuclear Power Plant Safety
Committee on Bridge Safety
Committee on Offshore Structure Safety

Earthquake Engineering Research Institute:

| | |
|---|---|
| Editorial Board: Earthquake Spectra | 1991-1993 |
| Seismic Risk Committee | |
| Planning Committee, 50th Anniversary Annual Meeting | 1998-1999 |

Joint European Committee on Structural Safety

National Academy of Engineering
(Elected 1981)

Phi Beta Kappa

Seismological Society of America:

| | |
|---|---|
| Board of Directors | 1984-1987 |
| Vice-President | 1985-1986 |
| President | 1986-1987 |

Sigma Xi

Society of Risk Analysis:
Senior Advisory Board, 1991 P.S.A.M. Conference

**JOURNAL EDITORIAL BOARDS:**

Structural Safety; Probabilistic Engineering Mechanics; Engineering Structures; Earthquake Spectra; Uncertainties in Structural Mechanics

**GOVERNMENT COMMITTEES AND SERVICE:**

| | |
|---|---|
| NBS, Consultant | 1967-1975 |
| USGS, Advisory Committee to Seismicity and Risk Analysis Branch | 1974 |
| UNESCO, Working Group on Definition of Seismicity and Ground Motion | 1974 |
| USGS, Workshop on Earthquake Prediction and Engineering Hazards | 1977 |

National Academy of Engineering/National Research Council-Marine Board

Committee on Offshore Technology 1979-1981
Committee on Marine Structures
Loads Advisory Group 1986-1987
Parent Committee 1987-1989

National Academy of Science
Committee on Seismology 1981-1984
Committee on Science of Earthquakes 1996-2001

National Academy of Science
Water Board
Committee on Techniques for Estimating Probabilities
of Extreme Floods 1986-1988

National Academy of Engineering/National Research Council
Geotechnical Board
Comm. for Workshop on Reliability Methods for
Risk Mitigation in Geotechnical Engineering 1992-1994

Nuclear Regulatory Commission
Seismic PRA Seminar Technical Coordinator 1982

OECD-CSNI Specialist Meetings: Probabilistic Methods in SRA for NPPs
Chairman 1980
Technical Organizing Committee 1983

NATO, Advanced Study Institute,
Reliability of Structures and Soils, Lecturer, (Seismic Safety of NPPs) 1982

**AWARDS RECEIVED:**

Huber Research Prize, American Society of Civil Engineers 1971

Guggenheim Fellowship 1974-1975

Fulbright-Hayes Advanced Research Grant 1974-1975

Moisseiff Award, American Society of Civil Engineers 1977

Norman Medal, American Society of Civil Engineers 1983

(First) ICASP Award, Committee of Inter. Conference on Applications of
Statistics and Probability in Soils and Structures 1987

Fruedenthal Medal, American Society of Civil Engineers 1988

Offshore Technology Research Center Honors Lecture, OTC 1995

EERI Distinguished Lecturer 1999

| | |
|---|---|
| EERI Outstanding Paper of 1998 (Earthquake Spectra)<br>(Co-authors: Shome, Bazzurro, and Carballo) | 2000 |
| Medal of the Seismological Society of America | 2001 |
| Fellow, American Geophysical Union | 2002 |
| EERI Housner Medal | 2003 |
| Norman Medal, American Society of Civil Engineers | 2003 |

**SOME REPRESENTATIVE RECENT SPONSORED UNIVERSITY RESEARCH CONTRACTS:**

SPONSOR:

NSF Stochastic Models of Structural Loads
Spatial and Temporal Memory in Earthquake Recurrence and Hazard
Nonlinear Seismic Assessment Procedures for Buildings
Probabilistic Prediction of Near-Source Strong Ground Motion and Nonlinear Structural
Response

PEER (NSF Earthquake Engineering Center): Technical Foundation for Performance-Based Design

SAC Nonlinear Seismic Demands in Fracturing Steel Moment-Resisting Frames

ONR Reliability Analysis of Moored Marine Structures

EPRI Multi-site Wind Record Analysis for Transmission Lines Structural Loads
Effectiveness of Strong Ground Motions

MMS Probability-Based Design Procedures for Offshore Structures

NRC Hazard-Consistent Nonlinear Analysis of Structures and Soils

JOINT INDUSTRY PROJECT:
36-company consortium, managed by Amoco Production Company
Structural Systems Reliability Analysis for Offshore Structures.

INDUSTRIAL AFFILIATES PROGRAM
Reliability of Marine Structures

## PUBLICATIONS

Books:

Benjamin, J.R. and Cornell, C.A., *Probability, Statistics, and Decision for Civil Engineers*, McGraw-Hill Book Company, 1970.

Papers in Referenced Journals:

Torres, G.G.B., Brotchie, J.R., and Cornell, C.A., "A Program for the Optimum Design of Prestressed Concrete Highway Bridges," *Journal of the Prestressed Concrete Institute*, Vol. 11, No. 3, June 1966.

Reinschmidt, K.F., Cornell, C.A., and Brotchie, J.R., "Alternative Design and Structural Optimization," *Journal of the Structural Division*, ASCE, Vol. 92, No. ST6, December 1966, pp. 281-318.

Sturman, G.M., Albertson, L C., Cornell, C.A., and Roesset,J.M., "A Computer-Aided Bridge Design System," *Journal of the Structural Division*, ASCE, Vol. 92, No. ST6, December 1966, pp. 141-165.

Cornell, C.A., "Bounds on the Reliability of Structural Systems," *Journal of the Structural Division*, ASCE, Vol. 93, No. ST1, February 1967, pp. 171-200.

Ayer, F. and Cornell, C. A., "Grid Moment Maximization by Mathematical Programming," *Journal of the Structural Division*, ASCE, Vol. 94, No. ST2, February 1968, pp. 529-549.

Cornell, C.A. and Vanmarcke, E.H., "Some Practical Implications of Elementary Safety Analysis," *Journal of the Boston Society of Civil Engineers*, Vol. 55, No. 3, July1968.

Cornell, C.A., "Engineering Seismic Risk Analysis," *Bulletin of the Seismological Society of America*, Vol. 58, No. 5, October 1968, pp. 1583-1606.

Cornell, C.A., "Probability-Based Structural Code," *Journal of the American Concrete Institute*, No. 12, Proc. Vol. 66 December 1969, pp. 974-985.

Corotis, R.B., Vanmarcke, E.H., and Cornell, C.A., "First Passage of Non-Stationary Random Processes," *Journal of the Engineering Mechanics Division*, ASCE, No. EM2, April 1972, pp. 401-414.

Peir, J.C. and Cornell, C.A., "Spatial and Temporal Variability of Live Loads," *Journal of the Structural Division*, ASCE, Vol. 99, No. ST5, May 1973, pp. 923-943.

McGuire, R.K. and Cornell, C.A., "Creep of Concrete Under Stochastic Live Load," *Journal of the Structural Division*, ASCE, Vol. 99, No. ST5, May 1973, pp. 923-943.

Merz, H.A. and Cornell, C.A., "Seismic Risk Analysis Based on a Quadradic Magnitude-Frequency Law," *Bulletin of Seismological Society of America*, Vol. 63, No. 6, December 1973, pp. 1999-2006.

McGuire, R.K. and Cornell, C.A., "Live Load Effects in Office Buildings," *Journal of the Structural Division*, ASCE, Vol. 100, No. ST7, July 1974, pp. 1351-1366.

Ang, A.H.S. and Cornell, C.A., "Reliability Bases of Structural Safety Design," *Journal of the Structural Division*, ASCE, Vol. 100, No. ST9, September 1974, pp. 1755-1770.

Whitman, R.V., et al., "Seismic Design Decision Analysis," *Journal of the Structural Division*, ASCE, Vol. 101, No. ST5, May 1975, pp. 1067-1084.

Garson, R.C., Morla-Catalan, J., and Cornell, C.A., "Tornado Design Winds Based on Risk," *Journal of the Structural Division*, ASCE, Vol. 101, No. ST9, September 1975, pp. 1883-1897.

Cornell, C.A. and Merz, H.A., "Seismic Risk Analysis of Boston," *Journal of the Structural Division*, ASCE, Vol. 101, No. ST10, October 1975, pp. 2027-2034.

Morla-Catalan, J. and Cornell, C.A., "Earth Slope Reliabilityby a Level-Crossing Method," *Journal of the Geotechnical Division*, ASCE, Vol. 102, No. GT3, June 1976.

Veneziano, D., Grigoriu, M., and Cornell, C.A., "Vector-Process Models for System Reliability," *Journal of the Engineering Mechanic Division*, ASCE, Vol. 103, No. EM3, Proc. paper 12981, June 1977, pp. 441-460.

Ravindra, M.K., Cornell, C.A., and Galambos, T.V., "Wind and Snow Load Factors for Use in LRFD," *Journal of the Structural Division*, ASCE, Vol. 104, No. ST9, Proc. Paper 14006, September 1978, pp. 1443-1457.

Fardis, M.N. and Cornell, C.A., "Containment LinerSeismic Reliability Under Statistical Uncertainty," *Nuclear Engineering and Design*, Vol. 49, No. 3, September 1978, pp. 279-294.

Fardis, M.N. and Cornell, C.A., "Seismic Soil-Containment Interaction: Pipe Safety," *Journal of the Engineering Mechanics Division*, ASCE, Vol. 104, No. EM6, Proc. Paper 14218, December 1978, pp. 1353-1370.

Fardis, M.N., Cornell, C.A., and Meyer, J.E., "Accident and Seismic Containment Reliability," *Journal of the Structural Division*, ASCE, Vol. 105, No. ST1, Proc. Paper 14305, January 1979, pp. 67-83.

Larrabee, R.D. and Cornell, C.A., "Upcrossing Rate Solution for Load Combinations," *Journal of the Structural Division*, ASCE, Vol. 105, No. ST1, Proc. Paper 14329, January 1979, pp. 125-132.

Cornell, C.A., Shakal, A., and Banon, H., "Seismic Motion and Response Prediction Alternatives," *Earthquake Engineering and Structural Dynamics*, Vol. 7, 1979, pp. 295-315.

Millman, R., Kilcup, R., and Cornell, C.A., "Design Temperature for Structural Elements," *Journal of the Structural Division*, ASCE, Vol. 106, No. ST4, Proc. Paper 15364, April 1980, pp. 877-895.

Kennedy, R.P., Cornell, C.A., Campbell, R.D., Kaplan, S. and Perla H.F., "Probabilistic Seismic Safety Study of an Existing Nuclear Power Plant," *Nuclear Engineering and Design*, Vol. 59, No. 2, August 1980, pp. 315-338.

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Larrabee, R.D. and Cornell, C.A., "Combination of Various Load Processes," *Journal of the Structural Division*, Vol. 107, No. STI, January 1981, pp. 223-239.

Fardis, M.N. and Cornell, C.A., "Analysis of Coherent Multistate Systems," *IEEE Transactions on Reliability*, Vol. R-30, No. 2, June 1981, pp. 117-122.

Galambos, T.V., Ellingwood, B., MacGregor, J.G. and Cornell, C.A., "Probability-Based Load Criteria: Assessment of Current Design Practice," *Journal of the Structural Division*, ASCE, Vol. 108, No. ST5, May 1982, pp. 959-977.

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Winterstein, S.R. and Cornell, C.A., "The Energy Fluctuation Scale and Diffusion Models," *Journal of Engineering Mechanics*, ASCE, No. 2, February 1985, pp. 125-142.

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Bjerager, P., Loseth, R., Winterstein, S.R. and Cornell, C.A., "Reliability Method for Marine Structures Under Multiple Environmental Load Processes," *Proceedings of the 5th International Conference on Behavior of Offshore Structures*, BOSS, N.I.T., Trondheim, Norway, June 1988.

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De, R.S., Karamchandani, A., and Cornell, C.A., "Offshore Structural System Reliability Under Changing Load Pattern," *Applied Ocean Research*, V. 13, No. 3, June 1991.

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Bazzurro, P. and Cornell, C.A., "Seismic Hazard Analysis for Non-Linear Structures. I: Methodology," *Journal of Structural Engineering*, ASCE, Vol. 120, No. 11, November 1994.

Bazzurro, P. and Cornell, C.A., "Seismic Hazard Analysis for Non-Linear Structures. II: Applications," *Journal of Structural Engineering*, ASCE, Vol. 120, No. 11, November 1994.

Banon, H., Bea, R.G., Bruen, F.J., Cornell, C.A., and Krieger, W.F., "Assessing Fitness for Purpose of Offshore Platforms. I: Analytical Methods and Inspections," *Journal of Structural Engineering*, ASCE, Vol. 120, No. 12, Dec. 1994.

Wu, S.C., Cornell, C.A., and Winterstein, S.R., "A Hybrid Recurrence Model and Its Implication on Seismic Hazard Results," *BSSA*, Vol. 85, No. 1, pp. 1-16, February1995.

Jackson, D.D., Aki, K., Cornell, C.A., Dieterich, J.H., Henyey, T.L., Mahdyiar, M., Schwartz, D., and Ward, S.N. (Working Group on California Earthquake Probabilities), "Seismic Hazard in Southern California: Probable Earthquakes, 1994 to 2024," *BSSA*, Vol. 85, No. 2, pp. 379-439, April 1995.

Bazzurro, P., Cornell, C.A., Diamantidis, D., and Manfredini, G.M., "Seismic Damage Hazard Analysis for Requalification of Nuclear Power Plant Structures: Methodology and Application," *Nuclear Engineering and Design*, Vol. 160, pp. 321-332, 1996.

Manuel, L., and Cornell, C.A., "The Influence of Alternative Wave Loading and Support Modeling Assumptions on Jack-up Rig Response Extremes," *Transactions of ASME, Journal of Offshore Mechanics and Arctic Engineering*, pp. 109-114, Vol. 118, No. 2, May 1996.

Shome, N., Cornell, C.A., Bazzurro, P., and Carballo, J.E., "Earthquakes, Records and Nonlinear Responses," *Earthquake Spectra*, Vol. 14, No. 3, pp. 469-500, August 1998.

Bazzurro, P., Cornell, C.A., Shome, N., and Carballo, J.E., "Three Proposals for Characterizing MDOF Nonlinear Seismic Response," *Journal of Structural Engineering, ASCE*, Vol. 124, No. 11, pp. 1281-1289, November 1998.

Budnitz, R.J., Apostolakis, G., Boore, D.M., Cluff, L.S., Coppersmith, K.J., Cornell, C.A., and Morris, P.A., "Use of Technical Expert Panels: Applications to Probabilistic Seismic Hazard Analysis," *Risk Analysis*, Vol. 18, No. 4, pp. 463 –469, 1998.

Manuel, L., Schmucker, D.G., Cornell, C.A. and Carballo, J.E., "A ReliabilityBased Design Format For Jacket Platforms Under Wave Loads," *Marine Structures*, Vol.11, No. 10, pp. 413-428, 1998.

Bazzurro, P., and Cornell, C.A., "On Disaggregation of Seismic Hazard," *Bulletin of Seismological Society of America, B.S.S.A.*, Vol. 89, No.2, pp. 501-520, April 1999.

Luco, Nicolas and Cornell, C. Allin, "Effects of Connection Fractures on SMRF Seismic Drift Demands," *ASCE Journal of Structural Engineering*, Vol. 126, No. 1, pp.127-136, January2000.

Stahl, Bernhard, Gebara, Joseph M., Aune, Stig and Cornell, C. Allin, "Acceptance Criteria for Offshore Platforms," *Journal of Offshore Mechanics & Arctic Engineering*, Vol. 122,No. 3, pp. 153-156, August 2000.

Hanks, Thomas C. and Cornell, C. A., "Probabilistic Seismic Hazard Analysis: A Beginner's Guide," submitted to *Earthquake Spectra*, 2002.

Cornell, C.A., Jalayer, F, Hamburger, R.O. and Foutch, D.A., "The Probabilistic Basis for the 2000 SAC/FEMA Steel Moment Frame Guidelines," *Journal of Structural Engineering*, Vol. 128, No. 4, pp. 526-533, April 2002.

Yun, S-Y., Hamburger, R. O., Cornell, C.A., and Foutch, D.A., "Seismic Performance for Steel Moment Frames," *Journal of Structural Engineering*, Vol. 128, No. 4, pp. 534-545, April 2002.

Vamvatsikos, D. and Cornell, C.A., "Incremental Dynamic Analysis", *Earthquake Engineering and Structural Dynamics*, 31(3): 491-514, March 2002.

Luco, N. and Cornell, C.A., "Structure-Specific Scalar Intensity Measures for Near-Source and Ordinary Earthquake Ground Motions," *Earthquake Spectra*, Submitted, 2003.

Banon, H., Cornell, C.A., Crouse, C.B., Marshall, P.W., and Younan, A.H., "ISO Seismic Guidelines for Offshore Platforms," accepted for publication, *Journal of OMAE*, ASME, 2002.

Luco, N., Cornell, C.A. and Yeo, G.L., "Annual Limit-Sate Frequencies for Partially-Inspected Earthquake-Damage Buildings," *Structural Safety*, Vol. 24, Issues 2-4, pp. 281-296, April-October 2002.

Sweetman, B., Winterstein, S.R. and Cornell, C.A., "Airgap Analysis of Floating Structures: First and Second Order Transfer Functions from System Identification," *Applied Ocean Research*, Vol. 24, Issue 2, pp. 107-118, May 11, 2002.

Luco, N., Mori Y., Funahashi, Y., Cornell, C.A., and Nakashima M., "Evaluation of Predictors of Nonlinear Seismic Demands Using "Fishbone" Models of SMRF Buildings," accepted for publication, *Earthquake Engineering and Structural Dynamics*, 2003.

Field, E. H., Jordan, T.H., and Cornell, C.A., "Open SHA: A Developing Community-Modeling Environment for Seismic Hazard Analysis," *Seismological Research Letters*, Vol. 74, Number 4, pp. 406-419, July/August, 2003.

Giovenale, P., Cornell, C.A., Esteva, L., "Efficient Comparison of Alternative Ground Motion Intensity Measures; Transforming Conditional Distributions of Non-Linear Structural Response," accepted for publication, *Earthquake Engineering and Structural Dynamics*, 2003.

Hamburger, R.O., Foutch, D.A., and Cornell, C.A., "Translating Research to Practice: FEMA/SAC Performance-based Design Procedures," *Earthquake Spectra,* Vol. 19, No. 2, pp. 255-267, May, 2003.

**Conference Proceedings and Book Chapters:**

Cornell, C.A., Benjamin, J.R., and Gabrielsen, B.L., "A Stochastic Model of the Creep Deflection of Reinforced Concrete Beams," *Proceedings of International Symposium in the Flexural Mechanics of Reinforced Concrete*, Mami, Florida, November 1964.

Cornell, C.A., Reinschmidt, K.F., and Brotchie, J.R., "A Method of Structural Optimization," *Proceedings of International Symposium on the Use of Computers in Structural Engineering*, University Newcastle, England, February 1966.

Cornell, C.A. and Vanmarcke, E.H., "The Major Influences on Seismic Risk," *Proceedings of the Fourth World Conference on Earthquake Engineering*, Santiago, Chile, January1969.

Rascon, O.A. and Cornell, C.A., "A Physically Based Model to Simulate Strong Motion Earthquake Records on Firm Ground," *Proceedings of the Fourth World Conference on Earthquake Engineering,* Santiago, Chile, January 1969.

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Cornell, C.A., "Structural Safety Specifications Based on Second-Moment Reliability Analysis," Final Report, IABSE Symposium on Concepts of Safety of Structures and Methods of Design, London, England, September 1969.

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Vanmarcke, E.H. and Cornell, C.A., "Seismic Risk and Design Response Spectra," *Proceedings of the ASCE Conference on the Safety and Reliability of Metal Structures*, Pittsburgh, Pennsylvania, November 1972.

Cornell, C.A. and Rokach, A.J., "Statistical Strength Analysis and Steel Columns," *Proceedings of the ASCE Conference on the Safety and Reliability of Metal Structures*, Pittsburgh, Pennsylvania, November 1972.

Cornell, C.A., "First-Order Analysis of Model and Parameter Uncertainty," *Proceedings of the International Symposium on Uncertainties in Hydrologic and Water Resource Systems*, University of Arizona, Tucson, Arizona, December 1972 (invited lecture).

Cornell, C.A., "Second-Moment Structural Code Formats," Invited Paper, *Proceedings of 50th Anniversary Symposium*, Deutscher Betonverein, Berlin, Germany, May 1973.

Vanmarcke, E.H., Cornell, C.A., Whitman, R.V., and Reed, J.W., "A Methodology for Optimum Seismic Design," *Proceedings of the Fifth World Conference on Earthquake Engineering*, Rome, Italy, June 1973.

Merz, H.A. and Cornell, C.A., "Aftershocks in Engineering Seismic Risk Analysis," *Proceedings of the Fifth World Conference on Earthquake Engineering*, Rome, Italy, June 1973.

Cornell, C.A., "Decision Analysis for Seismic Design," *Proceedings of Joint United States-Japan Seminar on Earthquake Engineering*, Berkeley, CA, September 1973.

Cornell, C.A., "Statistics of Tall Building Damage During the 1971 San Fernando Earthquake," *Proceedings of Joint United States-Japan Seminar on Earthquake Engineering*, Berkeley, California, September 1973.

Cornell, C.A., "Characterization of Hazards," *Proceedings of Designing to Survive Disaster Conference*, Illinois Institute of Technology, Chicago, Illinois, November 1973.

Whitman, R.V., Cornell, C.A., and Taleb-Agha, G., "Analysis of Earthquake Risk for Lifeline Systems," *Proceedings of U.S. National Conference on Earthquake Engineering*, Ann Arbor, Michigan 1975.

Cornell, C A. and Vanmarcke, E.H., "Seismic Risk Analysis for Offshore Structures," *Proceedings of Offshore Technology Conference*, Dallas, Texas, May 1975, Paper # OT2350.

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Cornell, C.A., "Summary Report on Structural Design Parameters," *Proceedings of Second International Conference on Applications of Statistics and Probability to Soil and Structural Engineering*, ICOSSAR, Aachen, West Germany, September 1975.

Whitman, R.V. and Cornell, C.A., "Design," Chapter 9, *Seismic Risk and Engineering Analysis*, Rosenblueth, E. and Lomnitz, C., eds., Elsevier Press, Amsterdam, The Netherlands, 1976.

Cornell, C.A., "Theme 2 Summary Report: Ground Motion, Seismicity, Seismic Risk and Zoning," *Proceedings of the Sixth World Conference on Earthquake Engineering*, New Delhi, India, January 1977.

Cornell, C.A., "Optimization: The Only Rational Way or Only a Rationalistic Way?" *Proceedings of the Sixth World Conference on Earthquake Engineering*, Contribution to a Panel on Design and Engineering Decisions, New Delhi, India, January 1977.

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Larrabee, R.D. and Cornell, C.A., "A Combination Procedure for a Wide Class of Loading Processes," *Proceedings of the ASCE Specialty Conference on Probabilistic Mechanics and Structural Reliability*, Tucson, Arizona, January 1979.

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**Plus Progress Reports, and Discussions in Professional Journals**

REPRESENTATIVE CONSULTING PROJECTS

1999 *Seismic Studies (Seismic Hazard Analysis;*
*Seismic Probability Risk Assessment;*
*Seismic Margins; Criteria Development;*
*Policy Advising, etc.):*
DOE/Woodward-Clyde (Yucca Mountain PSHA Peer Review)
NRC/REI (Ground Motions Procedures Peer Review Panel)
SAC (Reliability-based Building Assessment Guidelines)
BP Amoco/EQE (ISO Offshore Seismic Guidelines)
Westinghouse (Savannah River Seismic Review)
NRC/ICF (Advisory Committee: New Dry Storage Cask Guidelines)
*Offshore Platform Structures/Marine Reliability*
REI/JIP (Riser Reliability)
E&P Forum JIP/REI (Low Probability Storm Assessment)
ABS (M.O.B.: Probability-based Design Procedures)
BP-Amoco (Prob. Asses. Of Extreme Ice Effects)
*Other*
DOE/Geomatrix (Design Decision Process: Yucca Mtn.)
BC Hydro (Dam Safety Guidelines; review)
WES/Ben Gerwick (Dam PRA Methodology)

1998 *Seismic Studies (Seismic Hazard Analysis;*
*Seismic Probability Risk Assessment;*
*Seismic Margins; Criteria Development;*
*Policy Advising, etc.):*
DOE/Woodward-Clyde (Yucca Mountain PSHA Peer Review)
DOE/Geomatrix (Yucca Mountain Volcano Hazard Analysis)
NRC/REI (Ground Motions Procedures Peer Review Panel)
B.C. Hydro (Keenleyside Dam Seismic Risk, Peer Review Panel)
Bechtel (Hanford Vitrification Plant PSHA)
*Offshore Platform Structures/Marine Reliabiity*
REI/JIP (Riser Reliability)
ABS (Risk-Based Ship Criteria)
Mobil (Seismic Design Frequency)
E&P Forum JIP/REI (Low Probability Storm Assessment)
EPR (Reliability Tutorial)
ABS (M.O.B.: Probability-based Design Procedures)
*Other*
DOE/Geomatrix (Design Decision Process: Yucca Mtn.)
BC Hydro (Dam Safety Guidelines; review)

1997 *Seismic Studies (Seismic Hazard Analysis;*
*Seismic Probability Risk Assessment;*
*Seismic Margins; Criteria Development;*
*Policy Advising, etc.):*
DOE/Woodward-Clyde (Yucca Mountain PSHA Peer Review)
DOE/Geomatrix (Yucca Mountain Volcano Hazard Analysis)
NRC/REI (Ground Motions Procedures Peer Review Panel)
NRC/Waterways Exper.Sta. (Probabilistic Liquefaction Analysis)
B.C. Hydro (Keenleyside Dam Seismic Risk, Peer Review Panel)
DOE/Pacific Engineering (Probabilistic Soil Amplification; Savannah River Site)

Cal. Earthquake Authority (Expert testimony)

*Offshore Platform Structures/Marine Reliabiity*

Amoco (Offshore Reliability)
REI/JIP (Riser Reliability)
ABS (Risk-Based Ship Criteria)
Bechtel (M.O.B.: Extreme Environment Characterization; Reliability)
ABS (M.O.B.: Probability-based Design Procedures)
Exxon Production Research (Seismic Criteria)

*Other*

EPRI/Sargent and Lundy (Temporary Loads Reliablity)
BC Hydro (Dam Safety Guidelines; review)

1996 *Seismic Studies (Seismic Hazard Analysis;*
*Seismic Probability Risk Assessment;*
*Seismic Margins; Criteria Development;*
*Policy Advising, etc.):*
USGS/DOE (Review of U.S. Hazard Maps)
DOE/Woodward-Clyde (Yucca Mountain PSHA Peer Review)
DOE/Geomatrix (Yucca Mountain Volcano Hazard Analysis)
NRC/REI (Ground Motions Procedures Peer Review Panel)
NRC/Waterways Exper.Sta. (Probabilistic Liquefaction Analysis)
Warburg Pincus (Seismic Insurance Risk Methods)
Aon Insurance Services (Seismic Insurance Risk Analysis)
Seattle Seahawks (King Dome Seismic Review)
B.C. Hydro (Keenleyside Dam Seismic Risk, Peer Review Panel)

*Offshore Platform Structures/Marine Reliability*

Chevron (Hurricanes)
Amoco (Offshore Reliability)
REI/JIP (Riser Reliability)
Shell/PMB (Maui A and B Seismic Reliability)
ABS (Risk-Based Ship Criteria)

1995 *Seismic Studies (Seismic Hazard Analysis;*
*Seismic Probability Risk Assessment;*
*Seismic Margins; Criteria Development;*
*Policy Advising, etc.):*
DOE/Woodward-Clyde (Yucca Mountain PSHA Peer Review)
DOE/Geomatrix (Yucca Mountain Volcano Hazard Analysis)
DOE/BNL (Short-term Seismic Exposure)
MMS/LLNL (Santa Barbara Channel PSHA )
B.C. Hydro (Seismic Risk Methods)
NRC/LLNL (Seismic Source Characterization)
EQE (Review of Cal. Eq. Auth. Analysis)
USGS/ATC (Paper/Workshops on PSHA)

*Offshore Structures Reliability*

Exxon Pro.Res. (Seismic Hazard and Response: Caspian Sea/Sakalin Island)
Mobil (Seismic Hazard and Response: Holly Platform)
PMB/JIP (Hurricane Andrew Bayesian Update of
Structural Loads and Capacities II)

1994 *Seismic Studies (Seismic Hazard Analysis;*
*Seismic Probability Risk Assessment;*
*Seismic Margins; Criteria Development;*
*Policy Advising, etc.):*
DOE/LLNL (Senior Hazard Advisory Committee;

site hazard revisions)
DOE/BNL (Tanks Seismic Expert Panel; site reviews)
NRC/LLNL (Appendix B Revision; expert committee)
DOE/High-Level Waste Review Board
*Commonwealth Edison Co. (Short-Term Criteria)*
Woodward-Clyde (Hazard Methodology Update)
SRI/EDF (France) (SPRA Methodology)
Westinghouse Hanford (Safety Class Definition)
REI/DOE (SHA review)
Guy Carpenter Inc. (Loss estimation review)
ISEC/Golden Gate Bridge Retrofit
*Offshore Structures Reliability:*
PMB/JIP (Hurricane Andrew Bayesian Update of Foundation Capabilities)
PMB/JIP (Hurricane Andrew Bayesian Update of Structural Loads and Capacities II)
REI/JIP (Reliability Software Development Advice)
Chevron (Hurricane Statistics)
Exxon Production Research (Response Analysis)
Statoil (Failure Probability Bases}

1993 *Seismic Studies (Seismic Hazard Analysis; Seismic Probability Risk Assessment; Seismic Margins; Criteria Development; Policy Advising, etc.):*
DOE/LLNL (Senior Seismic Hazard Advisory Committee; site reviews)
DOE/BNL (Tanks Seismic Expert Panel)
Woodward-Clyde (SHA)
San Diego Gas & Electric (SHA Review)
EPRI (Max. Magnitude Project)
NRC/CNWRA (HLW Seismic Criteria)
ISEC/Golden Gate
REI/NRC(Seismic Motions/PRA)
EPRI (Max. Magnitude Project)
*Ofshore Structures Reliability:*
PMB/JIP (Hurricane Andrew Bayesian Update of Structural Loads and Capacities)
Unocal (Seismic safety review; SHA reviews)
Chevron (Extreme Wave Reliability-Methodology)
Statoil (Norway) (North Sea SHA review)
PMB/JIP (Dynamic Capacity)

1992 *Seismic Studies (Seismic Hazard Analysis; Seismic Probability Risk Assessment; Seismic Margins; Criteria Development; Policy Advising, etc.):*
DOE/LLNL (NPR Senior Advisory Committee; Interim Criteria, site reviews)
DOE/BNL (TSEP; site SHA reviews)
NRC/LLNL (Appendix B Revision, expert panel)
EPRI (Maximum Magnitude Project)
Geomatrix (CalTrans SHA reviews)
Woodward-Clyde (CalTrans SHA reviews)
Portland General Electric (Senior Seismic Panel)
ISEC/Golden Gate
REI/NRC (Seismic Motions/PRA)

ESA (Aqueduct Analysis)
REI/NSF (Loma Prieta Motions Analysis)

*Offshore Structures Reliability:*
Unocal (SHA review; SHA and criteria)
REI (TLP-LRFD JIP)
PMB/USN
PMB/JIP (Dynamic Capacity)
PMB/JIP (Andrew Bayesian Update)
Chevron (Reliability Methodology)
API (Seismic Requalification Criteria)

1991 *Seismic Studies (Seismic Hazard Analysis; Seismic Probability Risk Assessment; Seismic Margins; Criteria Development; Policy Advising, etc.):*
DOE/LLNL (Natural Hazards; NPR Senior Advisory Committee; Interim Criteria, site reviews)
BC Hydro (Seismic Hazard Committee)
Portland General Electric (Senior Seismic Panel)
EPRI (Maximum Magnitude Project)
NRC
REI/CGMG (Seismic Motion Analysis)
REI/NRC (Seismic Motions/PRA)
*Offshore Structures Reliability:*
PMB/USN (Underwater Array Reliability)
EPR (Seismic Review)
API (Seismic Requalification Criteria)
*Other:*
Paul, Hastings, Janofsky and Wal (Fiber Pipe Reliability)

1990 *Seismic Studies (Seismic Hazard Analysis; Seismic Probability Risk Assessment; Seismic Margins; Criteria Development; Policy Advising, etc.):*
DOE/LLNL/BNL (NPR Senior Advisory Committee; Interim Criteria; Site Reviews; High-Level Waste Tanks)
EPRI/NUMARC/IPEEE
Exxon Production Research (Reliability)
USGS/NEPEC (Bay Area Seismic Hazard)
NRC/ACNW
Portland General Electric
Woodward-Clyde Consultants
*Offshore Structures Reliability:*
Exxon Production Research (EPR) (reliability software)
PMB/NCEL
ELF Aquitaine (France)/LRFD Development
*Other:*
NASA/Veritas Research (Structural Reliability)

1989 *Seismic Studies (Seismic Hazard Analysis; Seismic Probability Risk Assessment; Seismic Margins; Criteria Development; Policy Advising, etc.):*

DOE/LLNL (Senior Review Group: External Events Assessment and Criteria; NPR Criteria)
Pacific Gas and Electric
Portland General Electric
Electric Power Research Institute (Severe Accident Policy, Seismic Hazard, High Frequency Ground Motion Effects)
Nuclear Regulatory Commission/ANL
Woodward Clyde Consultants
Risk Engineering, Inc.
Geomatrix

*Offshore Structures Reliability:*

Joint Industry Project (12 sponsors); Full-scope Reliability ("MCAPS"); Amoco Production Co., Manager.
ELF Aquitaine (France)
Exxon Production Research
Statoil (Norway)

1988 *Seismic Studies (Seismic Hazard Analysis; Seismic Probability Risk Assessment; Seismic Margins; Criteria Development; Policy Advising, etc.):*

Pacific Gas and Electric Co. (Diablo Canyon Long-Term Seismic Program, Advisory Board and Consultant)
Electric Power Research Institute (Senior Advisory Group: Eastern U.S. Seismic Hazards Project)
Risk Engineering, Inc.
U.S. Nuclear Regulatory Commission/ANL
Portland General Electric (Senior Seismic Panel)
Bechtel Corporation
Canada Oil and Gas Administration
Statoil (Norway)

*Offshore Structures Reliability:*

Joint Industry Project (36 sponsors); Structural Systems Reliability; Amoco Production Co., Manager
Joint Industry Project (12 sponsors): Full-Scope Systems Reliability ("MCAPS"); Amoco Production Co., Manager
ELF Aquitaine (France)
Amoco Production Co.
Exxon Production Research

*Bridge Loadings:*

NCHRP (Jointly with Imbsen and Associates, Inc.)

1987 *Seismic Studies (Seismic Hazard Analysis; Seismic Probability Risk Assessment; Seismic Margins; Criteria Development; Policy Advising, etc.):*
Pacific Gas and Electric Co. (Diablo Canyon Long-Term Seismic Program, Advisory Board and Consultant)
Electric Power Research Institute (Senior Advisory Group: Eastern U.S. Seismic Hazards Project)
(Non-Poissonian Earthquake Recurrence Analysis Project)
U.S. Nuclear Regulatory Commission
Geomatrix
*Offshore Structural Reliability:*
Joint Industry Project (36 sponsors); Systems Reliability; Amoco Production Co., Manager
Joint Industry Project (12 sponsors): Full-Scope Systems Reliability ("MCAPS"); Amoco Production Co, Manager
ELF Aquitaine (France)
Site-Specific Bridge Loads:
NCHRP (Jointly with Imbsen and Associates, Inc.)

1986 *Seismic Studies (Seismic Hazard Analysis; Seismic Probability Risk Assessment; Seismic Margins; Criteria Development; Policy Advising, etc.):*
Pacific Gas and Electric Co. (Diablo Canyon Long-Term Seismic Program, Advisory Board and Consultant)
Electric Power Research Institute (Senior Advisory Group: Eastern U.S. Seismic Hazards Project)
Woodward-Clyde
Impell
Bechtel Corp.
Yankee Atomic Electric Co.
U.S. Nuclear Regulatory Commission
*Offshore Structures Reliability:*
Joint Industry Project (36 sponsors); Systems Reliability; Amoco Production Co., Manager
Joint Industry Project (12 sponsors): Full-Scope Systems Reliability ("MCAPS"); Amoco Production Co., Manager
ELF Aquitaine (France)
Amoco Production Co.

1985 *Seismic Studies (Seismic Hazard Analysis; Seismic Probability Risk Assessment; Seismic Margins; Criteria Development; Policy Advising, etc.):*
Pacific Gas and Electric Co. (Diablo Canyon Long-Term Seismic Program, Advisory Board and Consultant)
Electric Power Research Institute (Senior Advisory Group: Eastern U.S. Seismic Hazards Project)
(Non-Poissonian Earthquake Recurrence Analysis Project)
Maine Yankee Power Co.

Yankee Atomic Electric Co.
U.S. Nuclear Regulatory Commission (Design Margins and SPRA Validation Senior Advisory Committees)
Bechtel Corp.
Sandia (Long-Term Nuclear Waste Disposal)
Electricite de France

*Structural Systems Reliability:*
G.A. Technologies (through DOE) (HTGR Probability-Based Design Criteria Advisory Board)

*Offshore Structures Reliability:*
ELF Aquitaine (France)
Joint Industry Project (36 sponsors); Structural Systems Reliability; Amoco Production Co., Manager
Joint Industry Project (12 sponsors): Full-Scope Systems Reliability ("MCAPS"); Amoco Production Co., Manager

*Statistical Analysis of Construction Quality Sampling:*
Anolik et al (Shelter Ridge Condominiums)
Fairfield et al (Hunters Point Housing Project)

1984 *Seismic Studies (Seismic Hazard Analysis; Seismic Probability Risk Assessment; Seismic Margins; Criteria Development; Policy Advising, etc.):*
Maine Yankee Power Co. (Maine Yankee)
Lawrence Livermore National Laboratory
Pacific Gas and Electric Co. (Diablo Canyon)
Yankee Atomic Electric Co. (Yankee Rowe, et al)
Niagara Power (through Dames and Moore)
NRC (Design Margins and SPRA Validation Senior Advisory Committees)
Dames and Moore (Millstone)
Electric Power Research Institute (Senior Advisory Group: Eastern U.S. Seismic Hazards Project)

*Probabilistic Extreme Precipitation and Flood Analysis:*
Yankee Atomic Electric Co.

*Risk Analysis Tutorials, Short Courses, etc.:*
Woodward-Clyde Consultants
ACTA, Inc.

*Offshore Structures Design Criteria:*
PMB Systems (SOHIO, Shell)

1983 *Seismic Studies (Seismic Hazard Analysis: Seismic Probability Risk Assessment; Seismic Margins; Criteria Development; Policy Advising, etc.):*
Maine Yankee Power Co. (Maine Yankee)
Lawrence Livermore National Laboratory
NRC, (ACRS)
Yankee Atomic Electric Company
Cygna, Inc.
Boston Edison (through Yankee Atomic Electric Co.)
Pickard, Lowe & Garrick, Inc. (Seabrooke)
Niagara Power (through MPR, and Dames and Moore)

Electric Power Research Institute (Research through Yankee Atomic Electric Co.)
Electric Power Research Institute (Eastern Seismic
Hazard Project Senior Advisory Committee)
Law Engineering and Testing Co. (Duke Power Co.)
Office of Naval Research
A. Anolik (Westborough Housing Study)

*Structural Code Development:*
Electric Power Research Institute/Col. State Univ. (Transmission Lines)
ACTA, Inc.

*Probabilistic Extreme Precipitation and Flood Analysis:*
Yankee Atomic Electric Co.

*Risk Analysis Tutorials, Short Courses, etc.:*
Woodward-Clyde Consultants (Probabilistic Methods)
ACTA, Inc. (Extreme Events)

*Offshore Structures Design Criteria (Waves, Ice, System Reliability, etc.):*
PMB Systems (SOHIO, Shell)

1982

*Seismic Studies (NPP Sites)*:
Pickard, Lowe and Garrick (Zion, Indian Point, Seabrooke)
Yankee Atomic Electric Co. (Yankee Rowe)
Maine Yankee Power Co. (Maine Yankee)
Woodward-Clyde Consultants
Stone and Webster Corp. (Millstone)
Dames and Moore (Millstone)
Electric Power Research Institute (through Yankee
Atomic Electric Co.: Development of Historic SHA)
NRC, Lawrence Livermore National Laboratory

*Pile Foundation System Reliability*:
NUCLEN, (Brazil)

*Structural Code Development*:
Electric Power Research Institute/Colorado State Univ.
ACTA, Inc.

*Load Combination Analysis*:
Lawrence Livermore National Laboratory

*Risk Analysis Tutorials, Short Courses, etc.*:
NRC (through Sandia National Laboratory)
Woodward-Clyde Consultants

1980-81

*Seismic Studies*:
Pickard, Lowe and Garrick
Yankee Atomic Electric Power Co.
Lawrence Livermore National Laboratory

*Pile Foundation System Safety*:
NUCLEN, (Brazil)

*Load Combination Analysis*:
Lawrence Livermore National Labortory

1979-80

*Seismic Studies*:
Pickard, Lowe and Garrick
Weston Geophysical Research
Woodward-Clyde Consultants
Lawrence Livermore National Laboratory/NRC

Yankee Atomic Electric Co.
*Air Pollution Hazard Study*:
Pickard, Lowe and Garrick
*Structural Safety Short Course:*
Raytheon Co.
*Load Combination Analysis:*
G.E. Mark II Reactor Owners Group (through N.M. Newmark)

1978-79 *Seismic Studies*:
T.V.A.
Weston Geophysical Research
Southern California Edison Co.
Woodward-Clyde Consultants
Lawrence Livermore National Labortory/NRC
*Load Combination Studies*:
G.E. Mark II Reactor Owners Group (through N.M. Newmark)

1977-78 *Seismic Risk Analysis and Ground Motion Predictions*:
T.V.A.
Pacific Gas and Electric Co.
Woodward-Clyde Consultants
*Seismic Reliability Studies of Nuclear Power Plant Systems*:
Southern California Edison Co. Pacific Gas and Electric Co.
Pickard, Lowe and Garrick
Technical Chairman; one-week seminar for German Government (BAM)
Nuclear Regulatory Commission and Lawrence Livermore National Laboratory;
Senior Advisory Group: Seismic Safety Margins Research Project

1976-77 *Seismic Risk Analysis and Ground Motion Consultation*
Bell Laboratories
Pacific Gas and Electric Co.
Law Engineering
U.S. Army Corps of Engineers
Boston Edison Co.
Weston Geophysical Research, Inc.
*Statistical Analysis of Fires*:
NFPA

1975-76 *Probabilistic Systems Analysis; Dutch Oosterschelde Closure Project*:
T. W. Lambe and Associates
*Seismic Risk Analysis and Ground Motion Consultation*:
Nuclear Fuel Services
Dames and Moore
Weston Geophysical Research, Inc.
Boston Edison Co.
Basler and Hofmann
*Advisory Committee on NFPA Project on Probabilistic Fire Safety Analysis*

1974-75 *Seismic Risk Analysis Consultation*:
Dames and Moore
Weston Geophysical Research, Inc.

*Aircraft Crash Risk Consultation*:
Pickard and Lowe

1973-74 *Aircraft Crash Risk Studies for Nuclear Power Plants*
for PEPCO and Stone and Webster through Weston Geopysical Research, Inc. and others
*Seismic Risk Analyses and Artificial Design Motions*
for Several Engineering Projects
*Assorted Hazard Study Reviews*
for Pickard and Lowe
*Refinement and Documentation of Seismic Risk Analysis Programs*
for J. A. Blume and Associates
*Wind-Loading Studies on Boston's John Hancock Building*
for Hansen, Holley and Biggs
National Bureau of Standards Building Live Loads Survey
Report Preparation; and (through J. H. Wiggins and Company)
Survey Implementation Review

1972-73 *Through Weston Geophysical Research, Inc., American Electric Power; Stone and Webster; et al.*:
Design Response Spectra and Probabilistic Artificial Motions for Several
Nuclear Power Plant Projects
*For Pickard and Lowe*:
Wind-Induced Wave Risks on Great Lakes
*Review of Seismic Risk Analysis for Dames and Moore*
*Consultation to NBS on Live Load Survey Implementation*
*Aircraft Crash Risk Analysis for Nuclear Power Plants*
for Oregon Nuclear and Thermal Energy Council

1971-72 *Design of a Building Live Loads Survey*
for National Bureau of Standards
*Through Weston Geophysical Research, Inc.:*
a) Response Spectra and Seismic Design Criteria for Several Nuclear Power Plants
b) Development of Seismic Risk Map for American Electric Power
*Retained as Seismic Consultant to Environmental Research, Inc., Las Vegas, Nevada*
*Through Hansen, Holley and Biggs*:
Seismic Design Levels and Response Spectra for Drydock Sites on West Coast
for Crandall Drydocks, Inc.
*Wind Dispersion Analysis*
for Pickard and Lowe
*Advisor to University of Mexico Earthquake Engineering Project*
for UNESCO

1970-71 *Review of Fire Loads Survey Analysis for CEACM, Paris*
*Through Weston Geophysical Research, Inc.*: Seismic Design Criteria
for several Nuclear Power Plants
*Aircraft Crash Risk Analysis* for Pickard and Lowe

# Bruce E. Ebbeson

## Bruce E. Ebbeson — Senior Lead Engineer

### Experience Summary

Mr. Ebbeson has 30 years of experience in the engineering industry. Currently, he is the supervisor of the structural division for Stone & Webster's Cherry Hill office. He is presently involved in a number of projects, including the decommissioning of the Maine Yankee nuclear plant and the design of a facility in Utah to store spent nuclear fuel. He serves as a structural engineering consultant on various projects performed in Stone and Webster's Cherry Hill, Boston, Denver and Taiwan offices. Previously, his experience has included assignments on many nuclear power plant projects as a Principal Structural Engineer in a supervisory capacity. He has designed plant modifications and performed safety evaluations to meet licensing requirements. He also has coordinated the implementation of modifications with construction groups and has performed independent design reviews of nuclear power plants at various stages of licensing/operation.

Upon joining Stone & Webster Engineering Corporation in 1973, he was first assigned as a Career Development Engineer in the Structural Division where he was assigned to the Structural Mechanics Section. He was later assigned to the Engineering Mechanics Division as a support engineer in the Structural Mechanics Staff Group. He was reassigned to the Cherry Hill Office in July 1979, to assume the responsibilities as Principal Structural Mechanics Engineer on the River Bend Project. He has worked on various projects where his duties have included conceptual arrangement, analysis, and design of structural components of nuclear power plants.

Prior to joining Stone & Webster Engineering Corporation, Mr. Ebbeson was a Structural Design Engineer with the Philadelphia Water Department, Philadelphia, Pennsylvania.

### Education

M.S., Civil Engineering - 1973
B.S., Civil Engineering - Tufts University - 1970

### Training

Various courses in Engineering Management - Drexel University
Various Stone & Webster Management Training Classes

### Licenses, Registrations, and Certifications

Professional Engineer - Massachusetts - 1977
Professional Engineer - Louisiana - 1981
Professional Engineer - New Jersey - 1983

### Professional Affiliations

American Society of Civil Engineers - Member

## Bruce E. Ebbeson — Senior Lead Engineer

### Experience Summary

Mr. Ebbeson has 28 years of experience in the engineering industry. Currently, he is the supervisor of the structural division for Stone & Webster's Cherry Hill office. He is presently involved in a number of projects, including the decommissioning of the Maine Yankee nuclear plant and the design of a facility in Utah to store spent nuclear fuel. He serves as a structural engineering consultant on various projects performed in Stone and Webster's Cherry Hill, Boston, Denver and Taiwan offices. Previously, his experience has included assignments on many nuclear power plant projects as a Principal Structural Engineer in a supervisory capacity. He has designed plant modifications and performed safety evaluations to meet licensing requirements. He also has coordinated the implementation of modifications with construction groups and has performed independent design reviews of nuclear power plants at various stages of licensing/operation.

Upon joining Stone & Webster Engineering Corporation in 1973, he was first assigned as a Career Development Engineer in the Structural Division where he was assigned to the Structural Mechanics Section. He was later assigned to the Engineering Mechanics Division as a support engineer in the Structural Mechanics Staff Group. He was reassigned to the Cherry Hill Office in July 1979, to assume the responsibilities as Principal Structural Mechanics Engineer on the River Bend Project. He has worked on various projects where his duties have included conceptual arrangement, analysis, and design of structural components of nuclear power plants.

Prior to joining Stone & Webster Engineering Corporation, Mr. Ebbeson was a Structural Design Engineer with the Philadelphia Water Department, Philadelphia, Pennsylvania.

### Education

M.S., Civil Engineering - 1973
B.S., Civil Engineering - Tufts University - 1970

### Training

Various courses in Engineering Management - Drexel University
Various Stone & Webster Management Training Classes

### Licenses, Registrations, and Certifications

Professional Engineer - Massachusetts - 1977
Professional Engineer - Louisiana - 1981
Professional Engineer - New Jersey - 1983

### Professional Affiliations

American Society of Civil Engineers - Member

## Experience History

### STONE & WEBSTER ENGINEERING CORPORATION, CHERRY HILL, NEW JERSEY - 1979 TO PRESENT

**Structural Division Supervisor (Apr 1999 to Present)**

Presently, Mr. Ebbeson is responsible for all Civil/Structural activities in the Cherry Hill Office, including hiring, personnel evaluations and technical direction. Additionally, he is actively involved as a consultant on a number of projects, including the Maine Yankee Nuclear Plant decommissioning and the AT&T 700 A Street office building project.

**AT&T Point of Presence (POP) Building, 700A Street, Wilmington, DE (Sept 1999 to Jan 2000)**

Mr. Ebbeson provided civil/structural consulting support for the development of conceptual designs for the 24,000 sq. ft. network building. He was involved in the review of the Geotechnical report and in the preparation of a report performed to evaluate the risk to the facility from floods.

**AT&T (Oct 1998 to Nov 1999)**

Mr. Ebbeson was assigned to a team responsible for performing reliability assessments of AT&T facilities including those in Durham NC, Dublin O, Chicago, Boston, Staten Island, Miami, Florham Park and Jersey City. He was responsible for performing the civil/structural portion of the assessments, including preparation of reports.

**Private Fuel Storage Facility (Oct 1998 to Present)**

Mr. Ebbeson is responsible for the seismic analysis and structural design of the Canister Transfer Building for a proposed facility that will store spent nuclear fuel. His duties included planning and supervising the preparation of calculations and drawings for the facility, and responding to questions posed by the Nuclear Regulatory Commission.

**Public Service Electric & Gas Company (Feb 1990 to Oct 1998)**

As Lead Civil/Structural Task Manager, Mr. Ebbeson was responsible for coordinating the civil/structural activities on all tasks for the Hope Creek and Salem Nuclear Generating Stations. He has developed design criteria and technical standards for the design of structures and structural components. He has performed and directed structural activities for a number of major design changes, including feedwater heater replacement, control room architectural renovation, auxiliary building ventilation upgrades, containment fan coil unit upgrades, addition of tornado missile barriers and Salem Unit 3 leakage/spill containment. These activities include design of HVAC, electrical raceway and piping systems, seismic qualification of safety-related equipment, design of equipment supports, design of new structures, evaluation of existing structures for increased loadings, and design of rigging systems. When necessary, finite element and structural dynamic analyses were performed. He also served as Task Manager, responsible for developing schedules and budgets, managing the task execution, and interfacing with the client's Project Manager, for a number of projects.

**Browns Ferry Nuclear Plant (Sept 1989 to Dec 1989)**
**Tennessee Valley Authority**

Assigned to the site as lead Structural Engineer, Mr. Ebbeson was responsible for the update and verification of the Final Safety Analysis Report (FSAR).

**Industrial Projects Group (May 1989 to Sept 1989)**

As Principal Structural Engineer, Mr. Ebbeson was responsible for a variety of structural tasks, including design of steel and concrete structures for a solid waste resource recovery facility (Pasco County), design of improvements to office buildings (New Jersey Bell), and rewriting of structural specifications (Niagara Mohawk Power Corporation's Nine Mile Point Nuclear Station). Also responsible for investigation of structural adequacy at IBM's East Fishkill, New York, facility.

**Limerick Generating Station - Unit 2 (June 1988 to Apr 1989)**
**Philadelphia Electric Company**

As Lead Structural Engineer, Mr. Ebbeson was responsible for the preparation of review plans, performing technical reviews and writing a final report for submittal to the NRC as part of the integrated design and construction assessment.

**Brown's Ferry Nuclear Plant (Feb 1988 to Apr 1989)**
**Tennessee Valley Authority**

As Lead Structural Engineer, Mr. Ebbeson was responsible for directing the structural portion of the calculation review program. This program consisted of a technical review of the structural design to verify the adequacy of the existing facility. Also responsible for directing the structural design and analysis tasks required to improve the design of the existing plant.

**Comanche Peak Steam Electric Station (Sept 1986 to Jan 1988)**
**TU Electric Company**

As Assistant Lead Engineer, Mr. Ebbeson was responsible for design verification of the containment building base mat and shell, the auxiliary/electric building and the safeguards building. Responsible also for the verification of structural seismic analysis results. Duties also included preparation of estimates, development of design criteria, and writing of reports.

**Beaver Valley Power Station Unit 2 - (May 1986 to June 1986)**
**Duquesne Light Company**

As Technical Reviewer, Mr. Ebbeson was responsible for the overall review of structural work. Activities included review of licensing criteria, design basis, technical review of calculations, review of drawings and specifications, and preparation of a final report.

**BWR Continuing Services Project (Mar 1986 to Aug 1987)**

As Lead Structural Engineer, Mr. Ebbeson was responsible for all structural work performed by SWEC on three existing BWR nuclear projects.

**Oyster Creek Nuclear Generating Station (Nov 1983 to Feb 1986)**
**General Public Utilities Nuclear Corporation**

As Lead Structural Engineer, Mr. Ebbeson was responsible for all structural work, concerned with field modifications to the existing nuclear facility.

**Structural Division Staff (June 1982 to Feb 1985)**

As Principal Staff Engineer, Mr. Ebbeson was responsible for planning and supervising all structural seismic and hydrodynamic analyses for nuclear projects.

**Field Assignment (March 1983 to June 1983)**

Temporary assignment to Washington Public Power Supply System (WPPSS) offices in Richland, Washington. Mr. Ebbeson served as a consultant to WPPSS in the civil/structural area during final design reverification of a nuclear project.

**River Bend Station - Unit 1 (July 1979 to May 1982)**
**Gulf States Utilities Company**

As Principal Engineer, Mr. Ebbeson was responsible for the planning and supervision of the analysis and design of the reactor building concrete structures and steel containment as well as the dynamic analyses of all Category I buildings. Also responsible for preparing licensing documents, writing reports, and resolving construction problems.

**STONE & WEBSTER ENGINEERING CORPORATION, BOSTON, MASSACHUSETTS - 1973 TO 1979**

As Structural Engineer (Dec 1978 to July 1979), Mr. Ebbeson was responsible for analysis and design of nuclear power plant containment structures and internal structural components. Projects included Montague (miscellaneous studies), NYSE&G, and the EPRI breeder conceptual study (structural design of reactor building). Also worked on a special task force to re-analyze five nuclear plant shut down in March 1979.

As Support Engineer (Aug 1973 to Dec 1978), Mr. Ebbeson was responsible for working in the area of barrier designs for protection from tornados and accident generated missiles. Also responsible for development of computer programs, planning of a physical testing program, inspection of a tornado disaster area, and analysis and design of steel and concrete missile barriers. Also worked on analysis and design of structures on various projects. Projects included Shoreham, Philadelphia Electric (equipment drop impact problems), SWEC's Reference Nuclear Power Plant (RNPP) (conceptual design of containment internal structures and seismic analysis), and Beaver Valley - Unit 2 (seismic analysis and checking of containment internal structures design).

**Oswego Steam Station - Units 5 and 6**
**Niagara Mohawk Power Corporation (June 1973 to Aug 1973)**

As Career Development Engineer, Mr. Ebbeson was responsible for assisting Structural Engineers on a fossil fuel power plant project. Duties included helping with the preparation of specifications, comparison of bids, and coordination of design and construction activities.

## PHILADELPHIA WATER DEPARTMENT, PHILADELPHIA, PENNSYLVANIA - 1970 TO 1971

As Structural Design Engineer (June 1970 to Aug 1971), Mr. Ebbeson was responsible for design of steel and concrete structural elements, preparation of drawings, and checking of designs and drawings.

# Alan I. Soler

**ALAN I. SOLER, Ph.D.**

**EXECUTIVE VICE PRESIDENT**
**HOLTEC INTERNATIONAL**

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## EDUCATION

University of Pennsylvania
Ph.D. in Mechanical Engineering (1962)

California Institute of Technology
M.S. in Mechanical Engineering (1959)

University of Pennsylvania
B.S. in Mechanical Engineering (1958)

## AREAS OF PROFESSIONAL CONCENTRATION

Dynamics of casks and fuel racks, impact, mechanical design of cask and MPCs, failure analysis of reinforced concrete structures, cask transporter design, NUREG-0612 compliance, crane design and stress analysis.

## PROFESSIONAL EXPERIENCE

**HOLTEC INTERNATIONAL**
Marlton, New Jersey
1986 – Present — Executive Engineer

**UNIVERSITY OF PENNSYLVANIA**
Philadelphia, Pennsylvania
1966 - 1991 — Professor of Mechanical Engineering and Applied Mechanics

**INGERSOLL-RAND RESEARCH CENTER**
Princeton, New Jersey
May 1964–Sept. 1965 — Member of Technical Staff

**DYNASTRUCTURES, INC., CONSULTANTS IN APPLIED MECHANICS**
Philadelphia, Pennsylvania
May 1962–May 1964 — Research Specialist

## ACADEMIC HONORS

Tau Beta Pi
Sigma Tau
Society of Sigma Xi

## PROFESSIONAL SOCIETY MEMBERSHIPS/ACTIVITIES

Member, ASME, Fellow ASME, 1986
Treasurer, University of Pennsylvania Chapter, Sigma Xi, 1968-70.
General Arrangements Committee Member, 1969, ASME Vibrations Conference.
ASEE Local Activity Coordinator, 1968-1974.

Member, Rotordynamics Subcommittee, ASME Design Division, 1973-1974.
Local Arrangements Committee, 1971 Summer ASME Applied Mechanics Meeting.
Recording Secretary, ASME Applied Mechanics Division, Publication Committee, 1971-1972.
-Applied Mechanics Representative to ASME Power Division Subcommittee on Environmental Policy, 1974-1976.
Member, Turbine and Auxiliaries Committee, ASME Power Division, 1974-76, Papers Review
Member, Task Group on Heat Transfer Equipment, ASME, working group #1 (tubesheets), 1975-1998.
Member - Subcommittee on Pressure Vessels and Piping, Nuclear Engineering Division, ASME, 1976-1987, Chairman, 1984-1987.

## TECHNICAL CONSULTING

Consultant to Solid Mechanics Group, Ingersoll-Rand Research Center, Princeton, New Jersey, September 1965 - December 1966.
Consultant to Condenser Engineering Department, Ingersoll-Rand Corporation, Phillipsburg, New Jersey, September 1965 – 1982. Consultant to Structural Mechanics Associates, November 1958 - January 1969.
Visiting Scientist, Mechanical Engineering Research Division, Livermore Laboratories, Livermore, CA, Summer 1973, 1974 (AEC "Q" Clearance).
Member of Consulting Group, Thermac Associates, 1975 - 1986.
Consultant to Joseph Oat Corp. - Manufacturers of Nuclear Heat Exchangers. Camden, New Jersey, 1975 - 1986.
Consultant to Heat Exchange Institute - Nuclear HEX, 1978-1979.
Consultant, Inc., Wilson Div., Reading, PA, 1979-1980.
Consultant, NADC, Willow Grove, PA, 1984-1986.

## PATENTS

Patent #3,382,918, May 1968, Reinforcing Structure for Direct Flow Steam Dome for Condensers (with Mr. R. J. Stoker and Dr. B. Paul of Ingersoll-Rand Corporation).

## DRY SPENT FUEL STORAGE TECHNOLOGY

1992-Present: Lead Analyst in Mechanical/Seismic/Structural analysis in support of Holtec=s Dry Storage submittals for dual-purpose casks (HI-STAR 100 for Storage and Transport) and for METCON casks (HI-STORM 100 for Storage).

1994: Performed cask tip-over and drop analysis to support §50.59 effort for defueling Shoreham Station using IF-300 casks.

1995: Principal Analyst for evaluating cask drop events for Connecticut Yankee.

1997: Co-developer of the dynamic formalism to predict peak cask deceleration from cask tip-over and drop event on ISFSI pads.

1996: Principal designer of HI-STAR 100 Impact Limiter.

1998: *Developer of the "penetration area principle" to predict impact limiter response under cask drop events; method was verified using quarter-scale tests.*

1999: Designer and principal analyst for Holtec International's autonomous "Cask Transfer Facility" (CTF).

HIGH DENSITY FUEL RACK STRESS ANALYSIS

- Principal developer of Holtec's rack dynamic analysis code DYNARACK. This code is widely recognized as the most sophisticated program for high density rack seismic analysis.
- Performed seismic analysis of high density racks for 36 Nuclear Power Plants in the period 1980 to present.
- Pioneered dynamic analysis techniques of elevated pool slabs. Qualified the elevated pool slabs of Quad City Units 1 and 2, Grand Gulf and Oyster Creek using dynamic reinforced concrete analysis (all approved by the USNRC).

LICENSING SUPPORT

- Provided licensing support on over forty high-density rack applications to the USNRC (in the past twenty years).
- Appeared as expert witness (support) for Pacific Gas & Electric in Diablo Canyon reracking license review (1987).

PUBLICATIONS/PRESENTATIONS

1. "On the Lobar and Longitudinal Vibrations of Solid Propellant Rocket Motors", (with H. B. Kingsbury and J. R. Vinson) Proceedings of the 6th Solid Propellant Rocket Conference, AIAA, Washington, D.C. (February 1965).
2. "On the Solution to Transient Coupled Thermoelastic Problems by Perturbation Techniques", (with M. A. Brull) presented at the Summer Applied Mechanics Meeting of ASME (June 1965) and published in the Journal of Applied Mechanics (June 1965).
3. "A New Perturbation Technique for Differential Equations with Small Parameters", (with M. A. Brull), Quarterly of Applied Mathematics XXIV, No. 2 (July 1966) and presented at the 5th National Congress on Applied Mechanics, Minneapolis, Minnesota (June 1966).
4. "On Rolling Contact and the Theorem of Angular Momentum", (with S. C. Batterman), Journal of Engineering Education 67, 9 (May 1967).
5. "Higher Order Effects in Thick Rectangular Beams", International Journal of Solids and Structures 4, (July 1968) pp. 723-739.
6. "On the Vibrations and Stability of Moving Bands", Journal of the Franklin Institute (October 1968).
7. "Higher Order Theories for Structural Analysis Using Legendre Polynomial Expansions", presented at ASME Winter Annual Meeting, Los Angeles, CA (November 1969), and published in Journal of Applied Mechanics (December 1969).

8. "One Dimensional Viscous Magnetofluidynamic Flow in an Annulus", (with S. Schwietzer), presented at the AIAA Fluid and Plasma Dynamics Conference, San Francisco, California (June 1969), and published in Journal of the Franklin Institute 289, No. 6 (June 1970).

9. "On the Solution of Finite Deformation Problems of Beams Using Rate Equations", (with J. Lehner), Journal of Applied Mechanics, (March 1970) pp. 207-210.

10. "Approximate Theory for Locally Loaded Plant Orthotropic Beams", (with H. Tsai), International Journal of Solids and Structures 6, (1970) pp. 1055-1068.

11. "Approximate Solution of the Finite Cylinder Problem Using Legendre Polynomials'< (with J. Fellers), AIAA Journal 8, No. 11 (November 1970) and presented at the 6th U.S. Congress on Applied Mechanics (June 1970).

12. "On Analysis of Cable Network Systems Using Galerkin's Method", (with H. Afshari), Journal of Applied Mechanics, (September 1970) pp. 606-612.

13. "On the Buckling of Rings", (with S. C. Batterman), ASCE Engineering Mechanics Journal (December 1970).

14. "Dynamic Response of Sincle Cables with Initial Sag", Journal of the Franklin Institute (October 1970).

15. "Analysis of Cable Dynamics and Optimum Towing Strategies for Tethered Submersibles", (with B. Paul), presented at the Ocean Engineering Symposium, University of Pennsylvania (November 19-20, 1970), and published in Journal of Marine Technology 6, 2 (April 1972) pp. 34-41.

16. "Circumferential Forces and Moments in Edge Loaded Conical Shell Elements", Journal of Applied Mechanics (March 1972) pp. 290-291.

17. "Pre-twisted Curved Beams of Thin-Walled Open Section", Journal of Applied Mechanics (September 1972) pp. 779-786.

18. "Thermal Stresses and Initial Deformation of Heated Condenser Tubes", Journal of Engineering for Power (April 1973) pp. 84-91.

19. "New Results on Applications of Multi-Segment Stepwise Integration to First Order Equations", (with G. J. Hutchins), Journal of Computer Methods in Applied Mechanics and Engineering (1972) pp. 307-316.

20. "Dynamics of Cables and Cable Systems", Shock and Vibration Digest 5, 3 (March 1973) pp. 1-9.

21. "Cable Network Vibrations Using Galerkin's Method of Polynomial Approximating Functions", (with H. Afshari), Journal of Applied Mechanics (June 1973) pp. 622-624.

22. "Analysis of Moderately Thick Shells of Revolution", (with G. J. Hutchins), Journal of Applied Mechanics (December 1973) pp. 955-961.

23. "Project Cyclops - A Design Study of a System for Detecting Extraterrestrial Life", contributing author, NASA Report CR114445 (October 1972).

24. "Vibration of Cable Gridworks with Small Initial Deformation", (with H. Afshari), Journal of Applied Mechanics (December 1973), and presented at Winter ASME Meeting, Detroit, Michigan (November 1973).

25. "Transverse Elastic Buckling of Plane Pipe Gridworks", (with H. Afshari, Journal of Structures, ASCE (April 1974).

26. "On Seal Forces in Removable End Closure in Very High Pressure Test Chambers", ASME Journal of Pressure Vessel Technology (February 1975).

27. "Limit Design of Condenser Hotwell Floors", ASME Journal of Engineering for Power (October 1975) pp. 628-633.

28. "Stability of Rotor-Bearing Systems with Generalized Support Flexibility and Damping and Aerodynamic Cross-Coupling", (with R. E. Warner), presented at ASME Lubrication Conference, Toronto (October 1974), and published in the ASME Journal of Lubrication Technology (July 1975) pp. 461-472.

29. "Tubesheet Design in U-Tube Heat Exchangers Including the Effect of Tube Rotational Restraint", published in Journal of Engineering for Industry 98, 4 (November 1976) pp. 1157-1160 and presented at Design Engineering Conference, Chicago, IL (April 1976).

30. "Effective Bending Properties for Stress Analysis of Rectangular Tubesheets", (with W. Hill), published in ASME Journal for Power 99, 3 (July 1977) pp. 365-370, presented at 1976 ASME Annual Meeting.

31. "Stress Analysis of a U-Tube Heat Exchanger Tubesheet with an Integral Channel and an Unperforated Rim", presented by Pressure Vessel and Piping Division, ASME Mexico City Conference (September 1976) (76-PV-58).

32. "Analysis of Beam Columns on Elastic Plastic Foundations with Application to Power Plant Condenser Support Plate Design", (with C. Shahravan), published in ASME Journal of Engineering for Power, 100 (January 1978) pp. 182-188.

33. "Analysis of Closely Spaced Double Tubesheets under Mechanical and Thermal Loading", presented at 1977 Joint Power Generation Conference, ASME, Los Angles, California (77-JPGC-NE-21).

34. "The Tubesheet Analysis Method in the New HEI Condenser Standards", (with M.D. Bernstein), presented at the 1977 Joint Power Generation Conference, ASME, Los Angeles, California, published in ASME Journal for Power 100 (April 1978) pp. 363-368.

35. "Design Curves for Stress Analysis of U-Tube Heat Exchanger Tubesheet with Integral Channel and Head", (with J. E. Soehrens) Journal of Pressure Vessel Technology 100 (May 1978) pp. 221-233.

36. "Design of Condenser Hotwell Floor for Pressure Loading", presented at ASME 1978 Annual Meeting, ASME Advances in Reliability and Stress Analysis H00119 (1979) pp. 203-215.

37. "A Preliminary Assessment of the HEI Tubesheet Design Method - Comparison with a Finite Element Solution", presented at ASME 1978 Winter Annual Meeting, ASME Advances in Reliability and Stress Analysis H00119 (1979) pp. 127-146.

38. "Analysis of Bolted Joints with Nonlinear Gasket Behavior", ASME Journal of Pressure Vessels 102 (August 1980) pp. 249-256.

39. "Stress Analysis of Rectangular Tubesheets for Condensers", Paper 80-C2/NE-14 presented at ASME Nuclear Engineering Conference, San Francisco, California (August 1980).

40. "A Finite Element Model for Thick Beams", (with D. Barrett) Computer Methods in Applied Mechanics and Engineering 25 (1981) pp. 299-313.

41. "A Design Concept for Minimizing Tubesheet Stress and Tubejoint Load in Fixed Heat Exchangers", (with K. P. Singh) 1982 ASME Pressure Vessel and Piping Conference, Orlando, Florida; Int. Journal for Pressure Vessel Technology, Trans. ASME (c. 1982).

42. "Dynamic Coupling in a Closely Spaced Two Body System Vibrating in a Liquid Medium: The Case of Fuel Racks", (with K. P. Singh) 1982 SMIRT Conference, Keswick, England (May 1982).

43. "A Finite Element Model for Thickwalled Axisymmetric Shell", (with D. J. Barrett), ASME Journal of Pressure Vessel Technology 104, (August 1982) pp. 215-222.

44. "Design Parameters Affecting Bolt Load in Ring Type Gasketed Joints", (with K. P. Singh), Journal of Pressure Vessel Technology, Trans. ASME (1984).

45. "Effect of Non-Uniform Inlet Air Flow on Air-Cooled Heat Exchanger Performance", (with K. P. Singh and T. L. Ng) presented at Joint ASME-JSME Transfer Conference, Hawaii (March 1983) and published in Conference Proceedings.

46. "A Method for Computing Maximum Water Temperature in a Fuel Pool Containing Spent Nuclear Fuel", (with K. P. Singh) presented at Fourth International Conference on Pressure Vessels and Piping, Portland, Oregon (June 1983), Nuclear Technology, ANS (c. 1984).

47. "Seismic Response of Free Standing Fuel Rack Constructions to 3-D Floor Motions", (with K. P. Singh) presented at the Fourth International Conference on Pressure Vessels and Piping, Portland, Oregon (June 1983) and published in Nuclear Engineering and Design 80, (1984) pp. 315-329.

48. "Analysis of Tube-Tubesheet Joint loading Including Thermal Loading", (with Xu Hong) published in Journal of Applied Mechanics (June 1984), and presented at 1984 Pressure Vessels and Piping Conference.

49. "Analysis and Design of Pressure Vessel Bolted Flanges with Non Linear Gasket Materials", 11th Conference on Production Research and Technology - Computer Based Factory Automation, Conference Proceedings, Carnegie Mellon University, Pittsburgh, PA (May 1984).

50. "Foundation Stresses under Support of Freestanding Equipment Subjected to External Loads", (with K. P. Singh and I. Gottesman), International Journal of Pressure Vessels and Piping, Vol. 20, No. 2 (1985) pp. 127-138.

51. "Finite Elements for Thick 3-D Shells", (with A. Khaskia), International Journal of Pressure Vessel Technology, 1985.

52. "Tube-to-Tubesheet Rolled Joints: Part I - Analysis Including Strain Hardening and Temperature Dependent Properties", (with S. Weinstock), Proceedings of ASME 1985 Pressure Vessel and Piping Conference H00329, New Orleans, LA.

53. "Tube-to-Tubesheets Rolled Joints: Part II - Experimental Analysis", (with K. Reinis), Proceedings of ASME 1985 Pressure Vessel and Piping Conference H00329, New Orleans, LA.

54. "An Elastic Plastic Analysis of the Integral Tubesheet in U-Tube Heat Exchangers - Towards an ASME Code Oriented Approach", (with K. P. Singh), Proceedings of ASME 1985 Pressure Vessel and Piping Conference H00329, New Orleans, LA.

55. "A Design Procedure for Evaluating the Tube Axial Load due to Thermal Effects in Multi-Pass Fixed Tubesheet Exchangers", (with K. P. Singh), ASME Journal of Pressure Vessel Technology (c. 1986).

56. "Tubesheet Analysis - A Proposed ASME Design Procedure" (with S. Caldwell and K. P. Singh), ASME Karl Gardner Memorial Symposium Proceedings (c. 1986). Channel and an Unperforated Rim, presented by Pressure Vessel and Piping Division, ASME.

57. "Some Results From Simultaneous Seismic Simulations of all Racks in a Fuel Pool", with K.P. Singh, INMM Spent Fuel Management Seminar X, Washington, D.C., January, 1993.

58. Application of Transient Analysis Methodology to Quantify Thermal Performance of Heat Exchangers, I. Rampall, K.P. Singh, A. Soler, and B. Scott, Heat Transfer Engineering, 1997.

59. "Seismic Response Characteristics of HI-STAR 100 Cask System on Storage Pads", with K.P. Singh and Mark G. Smith, INMM Conference, Washington, DC, January, 1998.

# Lanny T. G. Lancaster

# LANNY T. G. LANCASTER
## RESUME
**MAY 2003**

CAREER HISTORY: US Air Force, 1962 - 1986
Consultant, 1986 - present

CAREER HIGHLIGHTS (USAF)

Command Pilot; Over 1,200 hours in various models of the C-130; over 2,000 hours in tactical fighters (F-100, F-4, F-16); 525 combat missions in Southeast Asia (1967-68 & 1971-1972).

Staff officer, Headquarters, USAF (1974-1978); programmed and budgeted all gun and ammunition R&D and procurement programs, the aircraft and stores compatibility program (Project SEEK EAGLE) and the foreign weapons evaluation program — now called Foreign Comparative Testing (FCT). Also, Executive Officer to Special Assistant to the Chief of Staff, USAF (1977-1978).

Special Assistant to Commander, Tactical Air Command (1978-1980).

Chief of Safety; then, Assistant Deputy Commander for Operations, 474th TFW (1981-1982)

Assistant Deputy Chief of Staff, Operations & Intelligence, 13AF; and Air Defense Commander of the Philippines (1982-1984).

Director of Development Planning for Tactical Systems, Air Force Systems Command (1984-1986)

Retired, Colonel, 1 July 1986.

MAJOR MILITARY DECORATIONS:

Silver Star
Legion of Merit
Distinguished Flying Cross (7 OLC)
Bronze Star
Meritorious Service Medal (1 OLC)
Air Medal (37 OLC)
Purple Heart
Air Force Commendation Medal
Philippine Medal for Military Merit
Vietnamese Cross of Gallantry

CAREER HIGHLIGHTS (Civilian)

Program analyses for Boeing Military Airplane Company, British Aerospace Dynamics Group (UK); Bofors Explosives (Sweden); the duPont Corporation; General Electric Armament Systems; Honeywell Defense Group; Israel Military Industries; Lockheed Martin Aeronautical Company; Lockheed Martin Vought Systems; Northorp Corporation; Northrop Grumman Corporation; Raytheon-TI Systems; Texas Instruments Defense Group; and Textron-Avco Corporation.

Project analyses for Ajay-Inquim Group (France/US); BCI Development Corporation; Bear Stearns; CTAI, Ltd. (joint venture, France/UK); CTA International (UK/France); Chrysler Aerospace Technologies; Charles Stark Draper Laboratory; General Dynamics/Pomona; GEC-Marconi, USA; Gulfstream Aerospace Corporation; The Hamilton Group; Hercules Defense Systems; Horizon Technologies; Hughes Aircraft Company; Israel Aircraft Industries; Israel Military Industries; Litton/Itek; Litton/ATD; Lockheed Corporation (Marietta, GA); Lockheed Martin Corporation (Orlando) LTV Missiles & Space Company; Martin-Baker Aircraft, Ltd.; Northrop Grumman Corporation; Pacific Scientific Corporation; Raytheon Corporation; Sandia National Laboratories; Textron Systems Division; and United Technologies (Advanced Systems Division).

Strategic business plan development for Aerojet Ordnance Company; Babcock & Wilcox; Digital Signal Corporation; General Dynamics Armament Systems; Royal Ordnance (UK); ThinkTools (SZ); Thomson-CSF (France); Thomson-Brandt Armaments (France); United Technologies (Advanced Systems Division); and Varian Corporation.

Special project financing assistance to GTE Corporation (Waltham, MA).

CURRENT BUSINESS ARRANGEMENTS

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|---|---|
| Advisor: | Drax Holdings (Southampton, Bermuda) |
| Associate: | Burdeshaw Associates (Bethesda, MD) |
| | Defense Systems & Technology (Arlington, VA) |
| Consultant: | Rafael, USA (Washington, DC) |
| | Toyon Research (Goleta, CA) |
| President: | Moore & Lancaster Associates (Arlington, VA) |

EDUCATION

BS, US Air Force Academy (General Science, 1962)
MBA, Embry-Riddle University (Distinguished Graduate, 1981)
Postgraduate work, University of Southern California (Systems Management, 1982-83)

PROFESSIONAL HONORS

Published, Society of Automotive Engineers, *Aerospace Symposium Journal*, 1980
Listed, *Jane's Who's Who in Aviation and Aerospace*, First U.S. Edition