

May 11, 1999

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 SUPPLEMENTAL RESPONSE TO
STATE'S FIRST REQUESTS FOR DISCOVERY**

Applicant Private Fuel Storage L.L.C. ("Applicant" or "PFS") files this Supplemental Response to "State of Utah's First Set of Discovery Requests Directed to the Applicant ("State's First Discovery Requests"). The Applicant files this Supplemental Response pursuant to 10 C.F.R. § 2.740(e), to name additional witnesses it expects to call at hearing. The Applicant's original response to the State's First Discovery Requests noted that it would file such supplemental responses as it identified additional witnesses.¹ The Applicant has advised counsel for the State in a telephone call on May 4, 1999 of most of the additional witnesses identified in this Supplemental Response.

¹ Applicant's Objections and Non-Proprietary Responses to State's First Requests for Discovery, dated April 21, 1999, at 17.

I. GENERAL DISCOVERY REQUESTS

A. GENERAL INTERROGATORIES

Pursuant to agreement between the State and PFS, these general interrogatories apply to all Utah admitted contentions, are in addition to the ten interrogatories per contention allowed by the Board's Order dated April 22, 1998 (LBP-98-7), and are continuing in accordance with 10 CFR § 2.740(e).

GENERAL INTERROGATORY NO. 3. For each admitted Utah contention, give 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 hearing. For purposes of answering this interrogatory, the educational and scientific experience of expected witnesses may be provided by a resume of the person attached to the response.

APPLICANT'S RESPONSE: The Applicant supplements its response to the State's First Discovery Requests by identifying the following additional persons whom the Applicant expects to call as witnesses at the hearing with respect to the State's admitted contentions.

Utah K – Credible Accidents

Name and Address:

Jerry L. Cooper
Stone & Webster
7677 Berry Avenue
Denver, Colorado 80111-2137

Profession:

Lead Senior Engineer

Employer:

Stone & Webster Engineering Corp.

Professional Expertise:

The engineering, design, construction, operation, and maintenance of nuclear power plants and Independent Spent Fuel Storage Installations.

**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:

Susceptibility of the PFS ISFSI to wildfires. Mr. Cooper will testify to the layout of the Private Fuel Storage Facility with respect to protecting the facility from accidents caused by wildfires. The facts and opinions to which Mr. Cooper will testify include those set forth in the PFSF SAR and RAI Response 8-3 concerning layout of the site and PFS's Submittal of Commitment Resolution Information regarding RAI 8-2, dated March 24, 1999 concerning onsite explosions.

Documents reviewed and/or relied upon:

The documents reviewed and relied upon by Mr. Cooper include the PFSF SAR and the references cited in PFS's response to Requests for Additional Information 8-3 and in PFS's Submittal of Commitment Resolution Information regarding RAI 8-2. In addition, Mr. Cooper may review and rely upon other responses to RAIs, documents produced by the State as well as any new information that may come into PFS's possession

Name and Address:

Bruce E. Brunsdon
Stone & Webster
7677 Berry Avenue
Denver, Colorado 80111-2137

Profession:

Mechanical Engineer

Employer:

Stone & Webster Engineering Corp.

Professional Expertise:

Dynamic response analysis of nuclear-related mechanical systems and evaluation of barrier penetration and impact effects

Educational and 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:

Hazards posed to PFSF by activities at the Tekoi Rocket Engine Test Facility, including rocket motor explosions and accidents. He will testify that potential rocket motor explosions do not pose a significant hazard to the ISFSI and will review and evaluate other potential hazards to the PFSF from the Tekoi facility.

Documents reviewed
and/or relied upon:

The documents reviewed and relied upon by Mr. Brunsdon include the letter from Alliant Techsystems provided to Stone & Webster regarding the hazard from rocket motor explosions at Tekoi, the PFSF and cask vendor SARs, documents concerning Tekoi produced by the State, and any other relevant documents that may come into his possession.

Name and Address:

Dr. Krishna P. Singh
Holtec Center
555 Lincoln Drive West
Marlton, NJ 08053

Profession:

Executive and Mechanical Engineer

Employer:

Holtec International

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 in last four years:

Expert witness in fall 1995 trial between owners of the South Texas Project and Westinghouse concerning the South Texas steam generators and was subsequently deposed in 1996 in litigation involving Pacific Northwest Laboratories.

Subject matter of testimony:

Dr. Singh will testify to the ability of the HI-STORM 100 cask storage system to withstand fires.

Documents reviewed and/or relied upon:

Dr. Singh will rely on the Topical Safety Analysis Report for the HI-STORM 100 and materials and analyses referenced therein. In addition, Dr. Singh may rely on the PFSF SAR and on documents produced by the State and other documents that may come into PFS's possession.

Name and Address:

Dr. Ram Srinivasan
BNFL Fuel Solutions
1 Victor Square
Scotts Valley, CA 95066

Profession:

Civil Engineer

Employer:

BNFL Fuel Solutions

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 in last four years:

None

Subject matter of testimony:

Dr. Srinivasan will testify to the ability of the TranStor cask storage system to withstand fires.

Documents reviewed and/or relied upon:

Dr. Srinivasan will rely on the Topical Safety Analysis Report for the TranStor 100 and material sand analyses referenced therein. In addition, Dr. Srinivasan may rely on the PFSF SAR and on documents produced by the State and other documents that may come into PFS's possession.

Name and Address:

Dr. Mujid S. Kazimi
Department of Nuclear Engineering
Massachusetts Institute of Technology
Room 24-205
Cambridge, Massachusetts 02139

Profession:

Nuclear Engineer and Educator

Employer:

Massachusetts Institute of Technology

Professional Expertise:

Nuclear Engineering; Safety Analysis

**Educational, Scientific
Experience and
Professional Qualifications:**

See Attached Resume

Publications in the last ten years:

See Attached Resume

**Testifying experience in last
four years:**

None

Subject matter of testimony:

Dr. Kazimi will testify about the ability of the PFSF design to protect against radiation releases resulting from potential impacts of activities or materials emanating from the facilities falling within the scope of Utah K.

**Documents reviewed
and/or relied upon:**

Dr. Kazimi will rely on the PFS license application, responses to RAIs, and the NRC pleadings. Also, a

list of additional documents reviewed is attached. In addition, Dr. Kazimi may rely on documents produced by the State and any other documents that may come into the possession of PFS.

Utah M – Probable Maximum Flood

<u>Name and Address:</u>	Clyde W. French Stone & Webster 7677 Berry Avenue Denver, Colorado 80111-2137
<u>Profession:</u>	Civil Engineer
<u>Employer:</u>	Stone & Webster
<u>Professional Expertise:</u>	Hydrology and Hydraulic Design
<u>Educational, Scientific Experience and Professional Qualifications:</u>	See Attached Resume
<u>Publications in the last ten years:</u>	See Attached Resume
<u>Testifying experience in last four years:</u>	None
<u>Subject matter of testimony:</u>	In his testimony regarding the impacts of flooding, Mr. French will testify that the access road will not be adversely impacted by flooding in Skull Valley.
<u>Documents reviewed and/or relied upon:</u>	Mr. French will rely upon the PFS License Application, responses to RAIs as well as the flood and road design calculations and materials referenced therein. In addition, Mr. French will rely upon documents produced by the State as well as any new information that may come into PFS's possession.

Utah R – Emergency Plan

Name and Address:

Jerry Cooper
See Contention Utah K for information

Subject matter of testimony:

Susceptibility of the PFS ISFSI to accidents caused by wildfires. See Contention Utah K above.

Documents reviewed and/or relied upon:

See Contention Utah K above.

Name and Address:

Dr. Krishna P. Singh
See Contention Utah K for information

Subject matter of testimony:

Effects of wildfires on Holtec storage casks. See Contention Utah K for information

Documents reviewed and/or relied upon:

See Contention Utah K above.

Name and Address:

Dr. Ram Srinivasan
See Contention Utah K for information

Subject matter of testimony:

Effects of wildfires on TranStor storage casks. See Contention Utah K for information

Documents reviewed and/or relied upon:

See Contention Utah K above.

Name and Address:

Wayne Lewis
Stone & Webster
7677 Berry Avenue
Denver, Colorado 80111-2137

<u>Profession:</u>	Mechanical Engineer
<u>Employer:</u>	Stone & Webster Engineering Corp.
<u>Professional Expertise:</u>	Facility design and construction
<u>Educational, Scientific Experience and Professional Qualifications:</u>	See Attached Resume
<u>Publications in the last ten years:</u>	See Attached Resume
<u>Testifying experience in last four years:</u>	None
<u>Subject matter of testimony:</u>	In his testimony, Mr. Lewis will testify about PFS's firefighting equipment and capabilities.
<u>Documents reviewed and/or relied upon:</u>	Mr. Lewis will rely on the PFS License Application, responses to Requests for Additional Information, PFS's Emergency Plan as well as all documents referenced therein. In addition, Mr. Lewis may also rely on NFPA Codes 295 and 224, documents produced by the State, Bureau of Land Management guidance documents and that may otherwise come into PFS's possession.

Utah Security C – Local Law Enforcement

<u>Name and Address:</u>	David A. Axt Northern States Power Company 414 Nicollett Mall (RS-6) Minneapolis, Minnesota 55401-1927
<u>Profession:</u>	Security Coordinator
<u>Employer:</u>	Northern States Power Company
<u>Professional Expertise:</u>	Security Management and Operations

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:

In his testimony regarding the timeliness of the LLEA response, Mr. Axt will testify that in his professional opinion the PFS Physical Protection Plan satisfies the NRC regulations.

Documents reviewed
and/or relied upon:

Mr. Axt will review and rely upon the PFS Physical Protection Plan, Contingency Plan and related information, and the NRC regulations. In addition, Mr. Axt may review and rely upon RAI responses, documents produced by the State as well as any new information that may come into PFS's possession.

Name and Address:

Dr. Mujid S. Kazimi
See Contention K for information.

Subject matter of testimony:

Dr. Kazimi will testify about the ability of the PFSF design to protect against a loss of control of the facility that could cause a radiation exposure exceeding the dose as described in 10 C.F.R. § 72.106.

Documents reviewed
and/or relied upon:

Dr. Kazimi will rely on the PFS license application, and its responses to RAIs. In addition, Dr. Kazimi may rely on documents produced by the State and any other documents that may come into the possession of PFS. See Contention K above.

The Applicant is still in the process of identifying the witnesses that it expects to call at the hearings and will supplement this response in accordance with 10 C.F.R.

§ 2.740(e).

GENERAL INTERROGATORY NO. 4. For each admitted Utah contention, identify the qualifications of each expert witness whom PFS expects to call at the hearing, including but not limited to a list of all publications authored by the witness within the preceding ten years and a listing of any other cases in which the witness has testified as an expert at a trial, hearing or by deposition within the preceding four years.

APPLICANT'S RESPONSE: See Response to General Interrogatory 3 above.

The Applicant is still in the process of identifying expert witnesses that it expects to call at the hearings and will supplement this response in accordance with 10 C.F.R.

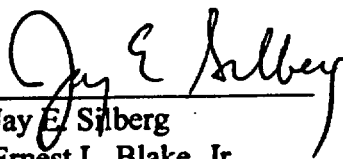
§ 2.740(e).

GENERAL INTERROGATORY NO. 5. For each admitted Utah contention, describe the subject matter on which each of the witnesses is expected to testify at the hearing, describe the facts and opinions to which each witness is expected to testify, including a summary of the grounds for each opinion, and identify the documents (including all pertinent pages or parts thereof), data or other information which each witness has reviewed and considered, or is expected to consider or to rely on for his or her testimony.

APPLICANT'S RESPONSE. See Applicant's Response to General

Interrogatory No. 3 above. Applicant will supplement this response in accordance with 10 C.F.R. § 2.740(e) as it obtains further information.

Respectfully submitted,



Jay E. Silberg

Ernest L. Blake, Jr.

Paul A. Gaukler

SHAW, PITTMAN, POTTS & TROWBRIDGE

2300 N Street, N.W.

Washington, DC 20037

(202) 663-8000

Counsel for Private Fuel Storage L.L.C.

Dated: May 11, 1999

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CERTIFICATE OF SERVICE

I hereby certify that copies of the Applicant's Supplemental Response to State's First Requests For Discovery and the accompanying Declaration of Paul A. Gaukler 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 11th day of May 1999. The attached resumes of Applicant's witnesses are being sent by first class mail. In addition, the resumes of the following witnesses were provided electronically: Clyde W. French, David Axt, Jerry Cooper, Dr. Krishna Singh, Dr. Ram Srinivasan, and Wayne Lewis.

G. Paul Bollwerk III, Esq., Chairman
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e-mail: hearingdocket@nrc.gov
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* Susan F. Shankman
Deputy Director, Licensing & Inspection
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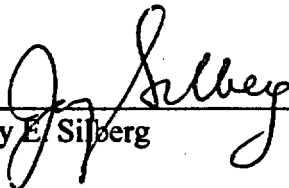
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* By U.S. mail only


Jay E. Silberg

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PRIVATE FUEL STORAGE L.L.C.)	Docket No. 72-22
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DECLARATION OF PAUL A. GAUKLER

Paul A. Gaukler states as follows under penalties of perjury:

1. I am counsel with Shaw Pittman Potts & Trowbridge in Washington, D.C.
2. I am duly authorized to verify Applicant's Supplemental Response to State's First Requests for Discovery; specifically, those supplemental responses to General Interrogatory Nos. 3-5.
3. I certify that the statements in such responses are true and correct to the best of my personal knowledge and belief.

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

Executed on May 9, 1999.



Paul A. Gaukler

RESUME OF
DAVID A. AXT

David A. Axt

3812 Thistle Lane, Burnsville, MN 55337, (612) 890-1284

*20-years experience involving: security management, operations, security auditing, contingency planning, risk analysis, and training. BS Business Management
MSc candidate in Security & Crime Risk Management*

WORK HISTORY

1994-Present, Northern States Power (NSP) Company

Corporate Senior Security Coordinator Review, monitor & advise Security Director on operational security programs for two nuclear power plants and multiple remote power-related facilities encompassing 200 security personnel and 9-million O&M budget. Ensure security programs comply with state and federal requirements. Developed Corporate Defensive Business Intelligence and Foreign Travel Security Programs; provide employee training. Conceived of, performed, and successfully presented to senior management a risk analysis of the NSP delivery system – identified security system for critical substations. Developed and wrote Incident Command (IC) procedure for responding to nuclear security emergencies; provided IC training to security supervisors. During emergencies, represent NSP Security at MN State Capital Joint Public Information Center. Managed target & vulnerability analysis at NSP nuclear facilities resulting in successful NRC performance tests. Currently providing EPRI (Mr. Ian Walls) with technical assistance for developing nuclear industry guideline for performing nuclear sabotage target analysis and developing contingency response procedures. Planned and managed joint law enforcement-plant security exercises involving SWAT, State Patrol, Bomb Squads, and NSP Media Relations. Internal analysis & report on US President's Commission on Critical Infrastructure Protection. Wrote RFP for contract security services (\$12-million). Wrote company Executive Protection Manual & NSP Mergers & Acquisitions Security Plan. Formal presentations to FBI, NSP CEO and NRC. Serve as Survey Team Leader for industrial security and defensive business Intelligence surveys, and design security performance specifications for vendors. Periodically serve as **Acting Security Director** during the Director's absence – manage staff of 27 personnel. **Acting Protection Services Manager**, supervising five investigators and security specialists; oversaw physical and operational security for 50 non-nuclear facilities and 100 security officers. **1995-Acting Security Superintendent**, Prairie Island Nuclear Plant: 3-million O&M budget, 52 security personnel; managed on-site security programs, contract, and facilities management. Completed four federal inspections with no violations.

1989-1994, American Protective Services, Inc. (APS) Government & Energy Division

Special Operations Manager. Provided business operational management of company's consulting branch, Special Services Group (SSG). Directed activities of ten (10) independent security and engineering professionals in connection with client support and consulting services at 25 nuclear facilities. Services included: NRC-OSRE inspection preparation, counter-terrorism planning, and security training program development. Monitored contract security force operations for five nuclear facilities. Served as corporate liaison with on-site contract security managers. Advised Corporate Director on policy decisions regarding client relations, security force operations, training, personnel administration and cost issues. Met with clients to determine contractor performance. Identified potential threat targets for radiological sabotage. Conceived of and developed unique contingency response procedures enabling limited numbers of security responders to avert government prescribed terrorist threats. Developed several presentations and technical security workshops and courses. Panel moderator for Institute of Nuclear Materials Management (INMM) workshop on *How to Implement a Viable QA Program*. Gave workshop on *Innovative Physical Protection Methodologies* at the Tactical Response Association's 5th Annual International Conference. Published in the *Tactical Response International Magazine*, "Realistic Adversaries, Realistic Exercises." Writer and Editor-in-Chief for APS nuclear security news journal, *Chain-Reaction*. Served as Proposal Manager for government and nuclear utility contracts. Wrote four company brochures. Wrote and gave sales presentations to prospective clients. Served as Team Leader for pre-NRC inspections.

1985-1989, Wackenhut, Department of Energy (DOE), Savannah River Site, nuclear weapons complex. *Quality Assurance Analyst.* Identified programmatic and problem areas in the employment of site protective forces (1000 personnel) for seven DOE facilities. Assured compliance with federal and program requirements. ***Special Response Team, Team Leader.*** Received and conducted training for 6-man dedicated response team: live-fire hostage rescue, and dynamic assault, helicopter insertion and small unit SWAT operations. Served as Team Sniper.

1978-1985, US Marine Corps

Personnel Chief. Seven years active duty, US Marine Corps. Qualified in Basic Infantry. Achieved Expert marksmanship qualification. Supervised office staff in matters pertaining to pay and benefits and personnel records. Extensive overseas posts. Other assignments included Long Beach, CA, and 2-years with Marine Security Guard Battalion in Germany & East Africa.

Training, Memberships & Qualifications

- Regularly attend local FBI conferences on domestic and international terrorism
- ASIS conference on Intellectual Property Protection and Terrorism, 1997
- Minnesota Incident Management System (MIMS) Training Course, 1997
- The Reid Technique of Interviewing and Interrogation, Basic & Advanced Course, 1996
- Competitive Intelligence seminar, University of St. Thomas, 1996
- Security Education Strategies, Department of Defense, Security Institute, 1996
- Competitive Business Strategies, NSP Quality Academy, 1995
- Seven Habits of Highly Effective People, Stephen Covey, 1995
- Project Management Training course, NSP Quality Academy, 1995
- Vulnerability Assessment course, DOE, Central Training Academy, 1993
- Tactical Explosive Entry School, 1993
- Physical Protection course, Barnwell Engineering, Inc., 1991
- Member, American Society of Industrial Security (ASIS), since 1990
- Statistical Quality and Productivity Improvement Techniques, QualPro, 1988
- Lead Security Auditor Certification course, Gilbert/Commonwealth, 1988
- 3rd Place, National Special Forces Survival Run, South Carolina, 1986
- DOE Training Academy Security Inspector Course, Distinguished Honor Graduate, 1985
- DOE Training Academy Special Response Course, Honor Graduate, 1985
- DOE "Q" (Top Secret), inactive status; NRC Unescorted Access Authorization

EDUCATION

MSc Candidate in Security & Crime Risk Management, Leicester University, Leicester, UK; 2000
BS Business Management., La Salle University, Mandeville, LA 1994
Augusta University, Augusta, Georgia, undergraduate studies, 1985
US International University, Nairobi Kenya, undergraduate studies 1982

HOBBIES

Running, weight lifting, and Internet

RESUME OF
BRUCE F. BRUNSDON

BRUCE E. BRUNSDON

EDUCATION

Massachusetts Institute of Technology - BSME 1980
UCLA Extension Short Course in Pressure Vessel Engineering - November 1982
Stone & Webster Project Simulation Workshop - 1981
DOE Natural Phenomena Hazard Mitigation Workshop - November 1998

LICENSES AND REGISTRATION

Registered Professional Engineer - Colorado
Registered Professional Engineer - South Carolina

CLEARANCES

DOE "Q" Clearance - Active at Rocky Flats Environmental Technology Site

EXPERIENCE SUMMARY

Mr. Brunson has extensive experience in the dynamic response analysis of mechanical systems, structures, piping systems, and vessels in the commercial nuclear power industry and DOE weapons programs. He is experienced in calculating system response using linear elastic and non-linear finite element analysis methods under static, response spectra modal dynamic, time history modal dynamic, and direct integration transient loading. He is also familiar with techniques for evaluating barrier penetration and impact effects using energy balance and ductility ratio considerations. He has over twelve years of experience in the design and analytical evaluation of nuclear material processing systems and directing project activities for DOE facilities at Rocky Flats, Lawrence Livermore National Laboratory, Idaho National Engineering Laboratory, and the Savannah River Site.

Mr. Brunson is experienced in the application of DOE Orders and Standards to seismic qualification and nuclear safety analysis, including DOE Orders 6430.1A and 5481.1B, DOE-STD-1020-94 and DOE-STD-1021-93. He is familiar with a wide variety of computer codes used for static and dynamic structural analysis.

STONE & WEBSTER ENGINEERING CORPORATION, DENVER, COLORADO - 1980 TO PRESENT

Actinide Packaging and Storage Facility (Jan 1998 to Present) Department of Energy Savannah River Site

As Lead Dynamic Analyst, Mr. Brunson was responsible for all seismic design and response analysis activities associated with the Actinide Packaging and Storage Facility, a 10,000 square foot plutonium processing and storage complex to be installed at the DOE Savannah River Site. Design responsibilities included the development of detailed drawings and specifications for safety class storage systems for nuclear material; gloveboxes, handling systems, and tooling for use in disassembling nuclear material shipping packages; and first-of-a kind, massive security barriers and deployment systems using air bearing and linear motor technology. Analysis responsibilities included seismic qualification of all safety class structures, systems, and components, generation of the acceleration response spectra used in seismic qualifications,

oversight of the detailed soil-structure interaction analyses performed on major structures, and evaluation of security barriers under bulk explosive, missile, and penetration weapon attack. Principal structures analyzed included an underground Material Access Area building, Auxiliary Building, Diesel Storage Tank Vault, and a secure Truck Bay. Safety class utility systems and their associated supports, including building and glovebox ventilation systems, emergency power distribution systems, and buried diesel fuel oil supply piping, were designed and qualified in accordance with applicable nuclear codes and standards.

Salt Residue Stabilization and Repack (May 1995 to Dec 1997)

Department of Energy Rocky Flats Environmental Technology Site

As Project Engineer, Mr. Brunsdon was responsible for the technical direction of all project conceptual design, title design, and field engineering activities through startup for a \$6.0 million retrofit of a plutonium processing line to stabilize actinide residues at the DOE Rocky Flats Environmental Technology Site. The project involved reconfiguration of existing glovebox and process facilities for nuclear material receipt and unpackaging, stabilization, non-destructive assay, and repackaging activities. Significant technical issues addressed as part of the project included demolition and modification of existing contaminated gloveboxes; design and tie-in of new gloveboxes and safety class utilities to the existing glovebox line; design of pyrochemical furnaces, stirring mechanisms, and utility and control systems and associated glovebox pass-throughs; integration of through-wall non-destructive assay spectroscopy equipment into the glovebox design; and design and installation of contamination control cells and safety class storage facilities for out-of-line handling of special nuclear material. Extensive criticality, shielding, and seismic and related dynamic response evaluations were prepared to support the design and develop the nuclear safety basis for operating the facility. The facility is currently stabilizing actinide residues in support of the cleanup and decommissioning of Rocky Flats.

Cooper Nuclear Station (Oct 1993 to Apr 1995)

Nebraska Public Power District

As Systems Engineer, responsible for the review of site engineering activities impacting the service water system to ensure compliance with regulatory and site requirements, commitments made in response to Generic Letter 89-13, and safety analysis assumptions and single failure criteria. The review was conducted in preparation for a comprehensive audit of the service water system conducted by the Nuclear Regulatory Commission. The scope of the review included maintenance histories of major service heat exchangers and pumps, Microbiologically Induced Corrosion detection and mitigation activities, and preventative maintenance activities to evaluate the potential for biofouling, flooding, or other system hazards. Operating and surveillance activities used to verify operability in accordance with plant safety analyses, ASME XI test activities used to monitor and trend equipment performance capabilities, and corrective actions resulting from nonconformances or deficiencies were also reviewed. The review resulted in recommendations to upgrade maintenance procedures and preventative maintenance practices, develop calculations to demonstrate compliance with regulatory requirements, and establish programmatic controls for regulatory commitments.

Additional responsibilities included development of a system to trend safety related heat exchanger performance, preparing responses to Nuclear Regulatory Commission bulletins, dispositioning nonconformance reports, reviewing maintenance practices and component classifications, and evaluating the applicability of generic industry issues to plant systems.

Healy Clean Coal Project (Apr 1993 to Sept 1993)

Alaska Industrial Development Authority

As Engineer, responsible for preparation of stress analyses for main steam and extraction steam piping for a DOE clean coal power project. Also developed pipe support designs and loading requirements for a variety of high energy piping systems for the plant.

NO_x Abatement Facility (May 1992 to Mar 1993)

Department of Energy Idaho National Engineering Laboratories

As Lead Seismic Engineer, responsible for the implementation of all seismic analysis activities associated with the project in accordance with DOE and site regulations, as well as national codes and standards. Principal analyses included facility structural analysis incorporating the effects of soil-structure interaction, buried piping analysis, dynamic analysis of large above-ground ammonia storage vessels, dynamic analysis of nuclear piping and equipment, and qualification of components required to operate during and after seismic events. Related activities included development of a seismic analysis plan to document analysis scope and calculation techniques and coordination with site safety analysis staff to ensure consistent implementation of DOE regulations.

Resumption of Plutonium Operations - Bldg 559 (Aug 1991 to Apr 1992)

Department of Energy Rocky Flats Plant

As System Engineer, responsible for development and processing of Maintenance Work Requests to support resumption of operations in a DOE Plutonium Analytical Laboratory. MWR development included review and approval of planned work instructions, specification of system isolation and post-maintenance test requirements and resolution of non-conformances resulting from the modifications. Primary responsibility was the glovebox fire detection system.

Resumption of Plutonium Operations – Bldg 771 (May 1991 to July 1991)

Department of Energy Rocky Flats Plant

As Lead Mechanical Engineer, responsible for review/revision of the scope of work and estimation of resources required to define system operability in support of resumption of operations at a DOE Plutonium Recovery facility. Also responsible for directing the development of walkdown packages and processing of field verified data in order to create mechanical P&ID's for safety systems at the facility. Walkdown package development included procedure development and plant document research activities. Data was also gathered during walkdowns to support systems analyses to be performed after P&ID's were prepared in accordance with plant standards, national codes and industrial practice.

Resumption of Plutonium Operations – Bldg 559 (Feb 1991 to Apr 1991)

Department of Energy Rocky Flats Plant

As Engineer, responsible for preparation of engineering analysis of a vacuum sampling system in a DOE Plutonium Analytical Laboratory to resolve system operability issues. Analysis included both technical evaluation to establish overall system capacity and provide a basis for alarm setpoints, and operational testing to verify performance in accordance with established procedures. As a result of the analysis, design modification packages were prepared to reset critical setpoints and rewire control circuits to enhance the backup capability of the system.

Resumption of Plutonium Operations – Bldg 559 (July 1990 to Jan 1991)

Department of Energy Rocky Flats Plant

As Engineer, responsible for developing mechanical sections of a design basis reconstitution pilot program for vital safety systems at a Department of Energy weapons fabrication facility. The program was designed to recover system performance capabilities for use in justification of plant safety analysis and support of plant modification projects. Two phases were implemented, including a document search and compilation phase to generate the historical account of regulatory and site-specific requirements and system design which meets those requirements, and a design verification phase to ensure that the system as installed met the performance requirements. The pilot program was implemented on a confinement HVAC system for a laboratory used to analyze plutonium samples.

Tritium Research Facility Safety Analysis Report (Feb 1990 to July 1990)

Department of Energy Lawrence Livermore National Laboratories

As Lead Mechanical Engineer, responsible for researching and writing mechanical sections and integrating other disciplines' sections in a safety analysis report for a Department of Energy tritium research facility. The effort included researching design capabilities and responses of mechanical systems under various accident scenarios, and evaluating and identifying deficiencies in documents used to support the accident analyses.

Plutonium Research Facility Triton Separation Project (Oct 1989 to Feb 1990)

Department of Energy Lawrence Livermore National Laboratories

As Engineer, responsible for design and analysis of gas cooling system piping for Triton Isotope Separation process. Stress calculations were performed in accordance with ANSI B31.1 Piping Codes, under normal operating and design basis accident loading. Static and modal dynamic finite element analysis techniques were used in the calculations.

Fort St. Vrain Nuclear Power Station (Aug 1989 to Sept 1989)

Public Service Company of Colorado

As Engineer, responsible for database reconstitution and trending analysis of data from a system used to monitor control rod drive performance to ensure compliance with plant Technical Specifications. Also used data and other analyses to identify and document the failure mechanism for a control rod drive which failed to insert during surveillance testing.

Plutonium Research Facility Engineering Demonstration Project (Oct 1987 to July 1989)

Department of Energy Lawrence Livermore National Laboratories

As Engineer, responsible for design and analysis of process equipment and utility systems associated with the Engineering Demonstration System prototype version of the Laser Isotope Separation process. The process is being developed as a means of enriching plutonium using high energy laser light. The process environment must meet stringent vacuum and radioactive containment requirements, throughout normal operation and postulated accident scenarios. Systems analyzed include gas scattering cells, a rail-based transport and lift system, and vacuum roughing and utility piping.

Salton Sea #3 Geothermal Power Station (June 1987 to Sept 1987)

Union Oil of California

As Engineer, responsible for the design and analysis of brine and steam piping and supports in accordance with ANSI B31.1 codes.

Fort St. Vrain Nuclear Power Station (Jan 1985 to May 1987)

Public Service Company of Colorado

As Engineer, responsible for design review and coordination of qualification testing of dry-film lubricated bearings for the control rod drive mechanisms in a HTGR. Tasks included analytical investigations as well as design and implementation of test rigs, development of test specifications and evaluation of bearing failure mechanism at vendor test facilities. Other responsibilities included design and implementation of a system to monitor the performance of the control rod drive mechanisms on-line. This system utilizes the capacitance-generated back-EMF voltage signal in CRD shim motors to detect machine faults in gear trains and bearings via fourier analysis techniques. The system is implemented on HP 200 series computer systems, using codes developed in Basic and Pascal.

River Bend Nuclear Power Station-Unit No. 1 (May 1984 to Dec 1984)

Louisiana Power and Light

As Engineer, responsible for qualification of pipe whip restraints on high energy piping inside containment. Tasks included development of thrust loads based on limit analyses, resolution of applied loads through nonlinear energy absorbing components, and time-history dynamic analyses of support structure response using STARDYNE computer program.

Nine Mile Point Nuclear Power Station-Unit No. 2 (Mar 1984 to May 1984)

Niagara Mohawk Power

As Engineer, responsible for seismic qualification of polar crane in containment and auxiliary cranes in diesel-generator building. Dynamic models were developed and modal analysis performed using STARDYNE computer program.

Enrico Fermi II Nuclear Generating Station (Oct 1983 to Feb 1984)

Detroit Edison

As Engineer, responsible for on-site inspection and evaluation of pipe supports. Also processed QC Category I design change requests and piping deflection interference problems.

WPPSS-Unit No. 2 (July 1983 to Sept 1983)

Washington Public Power Supply System

As Engineer, responsible for inspection and analysis of nuclear safety-related pipe supports as part of an independent third party review of as-built program for quality Class I piping and supports. Also, implemented computerized tracking system to identify trends in support deviations.

Rancho Seco Nuclear Generating Station (Mar 1983 to July 1983)
Sacramento Municipal Utility

As Engineer, responsible for the design and analysis of pressurizer relief line supports inside primary containment. Analysis involved nonlinear finite element techniques using ANSYS computer program.

Fort St. Vrain Nuclear Power Station (May 1981 to Feb 1983)
Public Service Company of Colorado

As Engineer, responsible for onsite computer stress analysis of as-built, nuclear safety-related piping and supports for the seismic review program on a high temperature gas-cooled reactor. Analysis was in accordance with ANSI B31.1 and AISC Codes and NRC requirements. Computer programs used include NUPIPE, STRUDL, and ANSYS.

Prairie Island Nuclear Generating Station (Mar 1981 to Apr 1981)
Northern States Power Company

As Engineer, responsible for seismic stress analysis of nuclear safety-related piping for modifications to the containment cooling system.

SMUDGE No. 1 Geothermal Power Station District (Dec 1980 to Feb 1981)
Sacramento Municipal Utilities

As Engineer, responsible for dynamic finite element analysis of turbine building and turbine pedestal to support the licensing effort.

Fort St. Vrain Nuclear Power Station (May 1980 to Nov 1980)
Public Service Company of Colorado

As Engineer, responsible for breakdown of as-built, nuclear safety-related piping systems into packages for computer analysis, as part of the seismic review program.

RESUME OF
JERRY L. COOPER

Experience Summary

Mr. Cooper has 28 years experience in the Engineering, Design, Construction, Operation and Maintenance of Nuclear Power Plants. He is a Lead Senior Engineer in the Mechanical Division and has been with Stone & Webster Engineering Corporation for 23 years. He has over 19 years experience with the Duquesne Light Company's Beaver Valley Unit Nos. 1 and 2 Nuclear Plants.

Mr. Cooper is currently assigned as Project Engineer for the Private Fuel Storage Facility project (PFSF). His responsibilities include directing the engineering and design activities in support of the project license application.

Mr. Cooper returned to Stone and Webster in April 1997 after spending 15 months working for Lockheed Martin Advanced Environmental Systems on the Pit 9 Remediation Project. The Pit 9 project was an environmental remediation project using state of the art technology to retrieve and process buried transuranic waste from the Subsurface Disposal Area at the Idaho National Engineering and Environmental Laboratory. Mr. Cooper served as the Offsites/Treatment Manager responsible for engineering and design of the Treatment Facility Building and the Offsites Support Area.

Prior to this Mr. Cooper was the Assistant Project Engineer for the Continuing Services activities for the Beaver Valley Power Station Unit Nos. 1 and 2. He was responsible for the organization, administration and direction of all Engineering Disciplines to ensure proper technical interface with the Duquesne Light Nuclear Engineering Department. Specific responsibilities included the preparation of Design Change Packages for plant modifications, engineering calculations, equipment procurement specifications and resolution of detailed engineering problems. Additionally, he has served as the Mechanical Engineer on the Evaluation Team for the Safety System Functional Evaluation of the Recirculation spray System and the Residual Heat Removal System.

He was assigned to the Beaver Valley Unit No. 2 Site Engineering Office in 1981 as an Engineer in the Nuclear/Mechanical Group. His responsibilities included engineering support of such major construction activities as turbine erection, turbine lube oil flush, main condenser erection, fuel handling crane erection and operation, and ASME XI In-Service Inspection for piping welds. He also served as the piping engineer responsible for all major piping installation. In 1984, he was assigned to the Integrated Construction Support Group. This group was established to work directly with construction and contractor personnel to provide technically acceptable and construction conscious solutions to field problems. In 1987, Mr. Cooper became the Principal Engineer, supervising all Mechanical Division activities of this group. During start-up testing and initial operations, he served as Principal Engineer responsible for all Mechanical Division activities of the Site Engineering Group and later as Assistant Superintendent of Engineering responsible for Mechanical, Structural and Engineering Mechanics disciplines as well as administration and direction of the Site Engineering Group's policy and procedures.

Prior to his site assignment, Mr. Cooper spent six years in Stone & Webster's Boston Office assigned to the Beaver Valley Power Station Unit No. 2 Nuclear Project in both the Piping Engineering Group and the Nuclear Group. His duties included: responsible engineer for all NSSS systems and equipment; preparation of specifications for cartridge type liquid filters, valves, strainers and steam traps; coordination of purchase orders with vendors; review and approval of vendors' equipment drawings; and resolution of N&Ds from the Vendor Surveillance Group or the Site Quality Control Group.

Prior to joining Stone & Webster, Mr. Cooper spent five and one-half years in the U.S. Naval Nuclear



Power Program where he served as a Mechanical Operator on an S5W Poseidon submarine. His duties included maintenance, operation, training, and testing of nuclear fluid, ships propulsion, and various support systems.

Education

B.S., Engineering - Geneva College
U.S. Navy Nuclear Power Program



RESUME OF
CLYDE W. FRENCH

Experience Summary

Mr. French has 22 years of progressive experience in engineering design for power and process plant site development and for water resource project hydraulic design and site work. Currently, he is developing a geothermal plant site on the Salton Sea. In the Denver Office he is assigned to the Civil/Structural Division where he designs and reviews the technical aspects of civil engineering work. He has developed guide specifications for civil work, designed process unit sewer systems, designed power plant drainage systems, developed wastewater/stormwater segregation plans, and engineered site development civil work plans. His experience includes both grass roots and revamp work in refinery process units, tank farms, power plants, and other industrial plants.

Previously, Mr. French worked for the US Army Corps of Engineers in Wilmington, North Carolina as a Civil Engineer, where he began his experience in engineering design. Initially, he conducted hydrologic engineering analyses and developed hydraulic models for water resources studies. As experience and training increased, this work evolved into technical expertise for unsteady flow analysis and complex hydraulic models for dams, dikes, and channels. He utilized HEC-1, HEC-2, HEC-5, and NWS DAMBRK extensively.

Subsequently, at the Corps he prepared plans and specifications for military and water resource projects. He designed road and railroad relocations, storm water and sanitary sewer collection systems, and related site work. Most recently, Mr. French formulated conceptual plans for water resource problems and developed preliminary design and cost estimates for alternative solutions. This required the coordination of diverse professional, regulatory and local interests to develop viable projects.

Education

BS, Civil Engineering - North Carolina State University, Raleigh, North Carolina - 1977

BA, Philosophy - Virginia Polytechnic Institute & State University, Blacksburg, Virginia - 1968

Training

ASCE Continuing Education Courses:

- NPDES Requirements for Industrial and Construction Site Stormwater Discharges, January 1999 (refresher course)
- Stormwater Management for Construction Activities, October 1992.
- NPDES Requirements for Industrial and Construction Site Stormwater Discharges, January 1992
- Pipeline Materials and Design, November 1991
- Rapidly Changing Environmental Industry, October 1991
- Wetlands Regulations, June 1990

ACI Continuing Education Courses:

- Concrete Paving, October 1995.

Stone & Webster Engineering Corporation Training Courses

- The Basics of Supervision, November 1992
- Introduction to Intergraph Microstation, March 1991
- Q200 Quality Education, October 1990
- Introduction to Intergraph Inroads, April 1990



US Army Corps of Engineers Training Courses

- Hydrology, Statistics, Hydraulic Modeling (multiple courses), and Hydropower Planning including HEC-1, HEC-2, HEC-3, HEC-5 and NWS DAMBRK computer models; Hydrologic Engineering Center; 1978 through 1984
- Hydraulic Design of Flood Control Channels, Waterways Experiment Station, 1984
- Unsteady Flow Analysis, Pennsylvania State University, 1983
- Water Resource Planning, Board of Engineers for Rivers and Harbors, 1987

Licenses, Registrations, and Certifications

Professional Engineer, Civil - North Carolina, 10735 - 1982, Active

Professional Engineer, Civil - Texas, 68197 - 1990, Active

Professional Engineer, Civil - Colorado, 30417 - 1995, Active

Professional Engineer, Civil - South Carolina, 18490 - 1997, Active

Professional Affiliations

American Society of Civil Engineers, Active Member

Publications

Instructed "Underground Piping Design" for process units at the University of Houston

Experience History

STONE & WEBSTER ENGINEERING CORPORATION, DENVER, COLORADO - 1993 TO PRESENT

Salton Sea Unit No. 5 (October 1998 to Present)

Calipatria, California - CalEnergy Company, Inc.

Lead Civil Engineer

Improvements to the Reservoir at Mud Lake (May 1998 to October 1998)

Minden, Nevada - Bently Agridynamics

Lead Civil Engineer

Tuban Petrochemical Complex Infrastructure Projects (October 1997 to May 1998)

Jakarta, Indonesia - Trans-Pacific Petrochemical Indotama

Project Engineer

Coal Handling Improvements (March 1996 to October 1997)

J.H. Miller Power Plant - Alabama Power Company

Civil Engineer

Actinide Packaging and Storage Facility (August 1997 to October 1997)

South Carolina - US DOE Savannah River Site

Lead Engineer

Big Brown Railroad Spur and Unloading Loop (March 1996 to October 1997)

Dallas, Texas - Texas Utilities

Civil Engineer



Private Fuel Storage Facility (Oct 1995 to Jun 1997)
Three Rivers, New Mexico - Private Fuel Storage LLC
& Skull Valley, Utah
Lead Civil Engineer

Malden Mills Textile Plant Reconstruction (Feb 1996 to April 1996)
Methuen/Lawrence, Massachusetts - Malden Mills, Inc.
Lead Civil Engineer

Goodhue County ISFSI (Oct 1995 to Jan 1995)
Goodhue County, Minnesota - Northern States Power
Lead Civil Engineer

Navajo Generating Station (Sept 1993 to Dec 1995)
Page, Arizona - Salt River Project
Lead Civil Engineer

STONE & WEBSTER ENGINEERING CORPORATION, HOUSTON, TEXAS - 1989 TO 1993

W.A. Parish Generating Station (May 1993 to Aug 1993)
Thompsons, Texas - Houston Lighting and Power Company
Civil Engineer

Settegast Area Trunk and Lateral Sewers (Jan 1993 to Mar 1993)
Houston, Texas - City of Houston, Texas
Civil Engineer

EU 1543 Revamp, Ethylene Expansion (June 1992 to Oct 1992)
Port Arthur, Texas - Chevron Products USA, Inc.
Civil Engineer

Settegast Area Trunk and Lateral Sewers (Oct 1991 to May 1992)
Houston, Texas - City of Houston, Texas
Project Engineer

Wastewater Collection System for a 220 ac Tank Farm (Feb 1991 to Sept 1991)
Pasadena, Texas - GATX Terminals Corp.
Project Engineer

Houston Olefins Plant Revamp (Mar 1991 to June 1991)
Pasadena, Texas - Mobil Chemical Co.
Civil Engineer

Middle Plant Site Development (Sept 1990 to Jan 1991)
Corpus Christi, Texas - Koch Refining Co.
Lead Civil Engineer

Stormwater\Wastewater Segregation Project for a 220 ac Tank Farm (Apr 1990 to Nov 1990)
Pasadena, Texas - GATX Terminals Corp.
Lead Civil Engineer



FCCU 1241 Revamp (Aug 1989 to June 1990)

Port Arthur, Texas - Chevron USA, Inc.

Civil Engineer

Crude Oil Storage Tanks Site Development (Nov 1989 to Apr 1990)

Big Spring, Texas - Fina Oil & Chemical Co.

Civil Engineer

U.S. ARMY CORPS OF ENGINEERS, WILMINGTON, NORTH CAROLINA - 1988 TO 1989

Study Manager, Small Navigation Projects

- Study Manager (June 1988 to May 1989)
Hodges Street Bulkhead Replacement
Town of Oriental, NC
- Study Manager (June 1988 to May 1989)
Whittaker Creek Navigation Channel Improvements
Town of Oriental, NC

Civil Engineer, Small Navigation Projects

- Civil Engineer (June 1988 to May 1989)
Morehead City Harbor Deepening (bulkhead replacement design)
Morehead City Port Authority, NC
- Civil Engineer (June 1988 to May 1989)
White River Small Navigation Channel
North Carolina Dept. of Natural Resources and Economic Development
- Civil Engineer (June 1988 to May 1989)
Deer Island Small Navigation Channel
North Carolina Dept of Natural Resources and Economic Development



Civil Engineer, Water Resource Project Plan Formulation

His assignments included:

- Civil Engineer (June 1988 to May 1989)
Lower Creek Flood Control Channel
City of Lenoir, NC
- Civil Engineer (May 1986 to May 1989)
Flood Control Channels and Dams
City of Roanoke, VA
- Civil Engineer (June 1988 to May 1989)
Flood Control Channel
City of Wilson, NC
- Civil Engineer (June 1988 to May 1989)
Flood Control Channel
City of Kinston, NC
- Civil Engineer (May 1986 to May 1989)
Flood Control Channels and Dams
City of Salem, VA
- Civil Engineer (May 1986 to Feb 1988)
Flood Control Channels and Dams
City of Raleigh, NC
- Civil Engineer (May 1986 to Oct 1987)
Flood Control Channels and Dams
City of Chapel Hill, NC
- Civil Engineer (May 1986 to June 1987)
Buckhorn Lake Multi-purpose Project
City of Wilson, NC

Civil Engineer, Detailed Engineering for Site Development and Infrastructure

His assignments included:

- Civil Engineer (Feb 1985 to Nov 1985)
Military Infrastructure
US Army Reserve Equipment Concentration Site
Fort Bragg, Fayetteville, NC
- Lead Civil Engineer (June 1985 to May 1986)
Multi-purpose Reservoir Site Development
City of Wilson, NC



RESUME
MUJID S. KAZIMI

ADDRESS:

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Massachusetts Institute of Technology
Room 24-205
Cambridge, MA 02139

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Facsimile No. 617/258-8863
Email: kazimi@mit.edu

PRINCIPAL FIELDS OF INTEREST:

Engineering and safety analysis of nuclear reactors, radioactive waste facilities and fusion technology. Multiphase heat transfer.

- Lead Civil Engineer (Feb 1986 to May 1986)
Pumped Storage Hydropower Site Development
US Army Corps of Engineers, Wilmington, NC
- Field Office Coordinator (Nov 1985 to Jan 1986)
Disaster Recovery Assignments
Federal Emergency Management Agency

Hydraulic Engineer, Hydrologic and Hydraulic Studies and Designs

- Hydraulic Engineer (Nov 1978 to Jan 1985)
Dam Break Flood Analysis for Falls Dam, B. Everett Jordan Dam, Philpott Dam
US Army Corps of Engineers, Wilmington, NC
- Hydraulic Engineer (May 1983 to Nov 1985)
Wildlife Management Areas at Falls Lake
B. Everett Jordan Lake Hydraulic Structure Design
Randleman Dam Diversion Plan
US Army Corps of Engineers
- Hydraulic Engineer (Mar 1982 to Oct 1984)
Neuse River Basin Study
North Carolina Dept of Natural Resources and Economic Development
- Hydraulic Engineer (Nov 1984 to May 1985)
John H. Kerr Dam Reregulation Study
US Army Corps of Engineers
- Hydraulic Engineer (June 1981 to Aug 1983)
Charity Lake Pumped Storage Project
US Army Corps of Engineers
- Hydraulic Engineer (May 1977 to Sept 1984)
Flood Insurance Studies for Guilford, Durham, Halifax, and Chatham Counties, NC
Federal Emergency Management Agency



RESUME OF
MUJID S. KAZIMI

Resume

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Facsimile No. 617/258-8863
Email: kazimi@mit.edu

PRINCIPAL FIELDS OF INTEREST:

Engineering and safety analysis of nuclear reactors, radioactive waste facilities and fusion technology. Multiphase heat transfer.

EDUCATION:

Massachusetts Institute of Technology
Massachusetts Institute of Technology
Alexandria University, Egypt

Ph.D., Nuclear Engineering 1973
M.S., Nuclear Engineering 1971
B.Eng., Nuclear Engineering 1969

EMPLOYMENT:

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MA 1976-present

Professor of Nuclear Engineering	1986-present
Head, Department of Nuclear Engineering	1989-1997
Associate Professor of Nuclear Engineering	1979-1986
Assistant Professor of Nuclear Engineering	1976-1979

Supervisor of 24 Ph.D. theses, 3 Engineer theses and 37 S.M. theses.

Member, Plasma Fusion Center Advisory Committee	1979-present
MIT Reactor Safeguards Committee, Member	1983-1996
Chair	1997-present
Member, Center of Materials Science & Engineering Advisory Committee	1989-1997
Co-Leader, MIT Summer Reactor Safety Course	1990-present
Member, Energy Laboratory Program Development Committee	1992-1996
Member, Magnet Laboratory Advisory Committee	1993-1997
Leader: Nuclear Fuel Cycle Economics and Environmental Management Program	1996-present
Member, Sea Grant Advisory Committee	1997-present

BROOKHAVEN NATIONAL LABORATORY, UPTON, NY 1974-1976

Associate Nuclear Engineer, Department of Applied Science.
Task Leader for post-accident heat removal analysis and experiments.

WESTINGHOUSE ELECTRIC CORPORATION, MADISON, PA 1973-1974

Senior Engineer, Advanced Reactors Division. Worked in thermal analysis of operating and faulty conditions in the Clinch River Breeder Reactor Project.

RECENT PROFESSIONAL ACTIVITIES:

Chairman, Severe Accident Working Group, Heavy Water Reactor NPR, U.S. DOE, 1990-1991.

Member, Thermal Hydraulic Working Group, Heavy Water Reactor, NPR, U.S. DOE, 1990-1991.

Member, Fusion Program Visiting Committee, Argonne National Laboratory, 1991.

Member, Technical Oversight Board for U.S. DOE/EM Independent Engineering Review of Major Projects, 1991-1993.

Member, Panel on Separations Technology and Transmutation Systems (STATS), National Research Council, 1991-1994.

Member, Committee to Review Severe Accident Experiments (Joint NRC, DOE and EPRI), 1992-1994.

Member, Safety Subcommittee, Integral Fast Reactor Program, University of Chicago, 1990-1994.

Chairman, High-Level Waste Tank Advisory Panel, U.S. DOE 1990-1995 and DOE-Richland, 1998 - present.

Member, Committee to Review Reactor Neutron Sources at National Laboratories for DOE/Basic Sciences Advisory Committee, 1996.

Member, Nuclear Engineering Department Review Committee, University of California, Berkeley, CA, 1996.

Member, Ford Nuclear Reactor Review Committee, University of Michigan, Ann Arbor, MI, 1996.

Member of expert panel on combustible gases in Hanford Waste Tanks, Sandia National Laboratory, May 1996 - 1998.

Chairman: Review Panel of the Accelerator Transmutation of Waste (ATW) project of Los Alamos's National Laboratory, 1998.

Member, University Working Group as advisory to Office of Nuclear Energy Science and Technology, DOE, 1997 - 1998.

Consultant, Advisory Committee on Nuclear Waste, U.S. Nuclear Regulatory Commission, 1998 - present

Member, Technical Review Committee of the Fission Energy and Systems Safety Program, Lawrence Livermore National Laboratory, 1998.

PUBLICATIONS:

Author or co-author of over one hundred publications in technical journals and conference proceedings.

Co-author of *Nuclear Systems: Volume I - Thermal Hydraulic Fundamentals* and *Volume II - Elements of Thermal Hydraulic Design*, Taylor and Francis, 1990.

HONORS:

Graduation With Excellence, University of Alexandria, Egypt, 1969.

Yahya AlMashad Award for Special Contributions In Science and Technology. Association of Arab-American University Graduates, 1987.

Who's Who in America, 1995 - present.

Fellow, American Nuclear Society, 1995.

PROFESSIONAL MEMBERSHIPS:

American Nuclear Society (ANS). Board of Directors of Northeast Chapter, 1978 and 1980; Member of Executive Committee of the Thermal Hydraulics Division, 1988-1990.

American Society of Mechanical Engineers (ASME).

American Institute of Chemical Engineers (AIChE). Chairman of the Nuclear Heat Transfer Committee, 1980-1983.

American Society for Engineering Education (ASEE), Member of Executive Committee for Nuclear Engineering Division, 1995-1997.

American Association for the Advancement of Science (AAAS).

M.S. Kazimi
PUBLICATIONS

1. Books and Chapters in Books

1. N.E. Todreas and M.S. Kazimi, *Nuclear Systems: Volume I Thermal Hydraulic Fundamentals and Volume II Elements of Thermal Hydraulic Design*, Hemisphere 1990.
2. M.S. Kazimi, *First Wall and Blanket Safety*, A Chapter in *Safety, Environmental Impact and Economic Prospects of Nuclear Fusion*, Brunelli and Knoepfel, Eds., Plenum Press, New York, 1990.

2. Papers in Refereed Journals

M.S. Kazimi, J.E. Massidda and M. Oshima, *Thermal Limits for Passive Safety of Fusion Reactors*, 8th ANS Top. Mtg. on the Technology of Fusion Energy, Salt Lake City, UT, October 9-13, 1988, *Fusion Technology*, Vol. 15, March 1989.

D.S. Barnett and M.S. Kazimi, *Modeling Lithium Reactions with Steam-Air Mixtures*, *Fusion Engineering & Design*, 11, 1989: 321-334.

M.S. Kazimi, *On the Liner Failure Potential in MARK-I BWR's*, *Nuclear Science & Engineering*, Vol. 103, 1989: 59-69.

M. Koch and M.S. Kazimi, *A Comparison of Radioactive Waste from an Experimental Fast Fission Reactor and an Experimental D-T Fusion Reactor*, *Proceedings of the Second International Symposium on Fusion Nuclear Technology*, Part B, *Fusion Engineering and Design* 17, December 1991: 387-393.

C.P. Liao, B. Labombard, B. Lane and M.S. Kazimi, *On Modelling of Plasma Edge Conditions at Divertors with Solid Metal Neutralizers*, *Fusion Technology*, Vol. 21, Jan. 1992: 41-51.

C.P. Liao, M.S. Kazimi and J.E. Meyer, *On Hydrogen Transport and Edge Plasma Modeling of Liquid Metal Divertors*, *Fusion Technology*, Vol. 23, March 1993.

M. Siddique, M.W. Golay and M.S. Kazimi, *Local Heat Transfer Coefficients for Forced Convection Condensation of Steam in a Vertical Tube in the Presence of Noncondensable Gas*, *Nuclear Technology*, Vol. 102, June 1993: 386-402.

M.S. Kazimi, Book Review: *Multiphase Science and Technology Volume 6*, *Nuclear Technology*, Vol. 103, September 1993: 434.

C.P. Liao, M.S. Kazimi and B. LaBombard, *MHD Effects on Liquid Metal Film Flow*, *Nuclear Engineering and Design*, Vol. 146, February 1994.

M. Siddique, M.W. Golay and M.S. Kazimi, *Theoretical Modelling of Forced Convection Condensation of Steam in a Vertical Tube in the Presence of a Noncondensable Gas*, *Nuclear Technology*, Vol. 106, May 1994: 202-215.

R.P. Golinescu and M.S. Kazimi, *Probabilistic Analysis of Divertor Plate Lifetime in Tokamak Reactors*, *Proceedings of the Eleventh Topical Meeting on the Technology of Fusion Energy*, 1994 ANS Annual Meeting, New Orleans, Louisiana, June 19-23, 1994, *Fusion Technology*, Vol. 26, Number 3, Part 2, November 1994.

MSK Publications (Continued)

B. Lekakh, J.E. Meyer and M.S. Kazimi, *Mechanisms for Extreme Heat Transfer Conditions in Water-Cooling of Fusion Reactor Components.*, Fusion Engineering and Design 28 (1995): 59-62.

H.A. Hasanein, M.S. Kazimi and M.W. Golay, *Forced Convection in-Tube Steam Condensation in the Presence of Noncondensable Gases*, Int. J. Heat Mass Transfer, Vol. 39, No. 13, pp. 2625-2639, 1996.

R.P. Golinescu and M.S. Kazimi, *Enhanced Probabilistic Decision Analysis for Radiological Confinement Barriers of the International Thermonuclear Experimental Reactor*, in Fusion Engineering and Design, October 1996.

B.M. Lekakh, M.S. Kazimi, J.E. Meyer, *Heat Transfer for High Velocity Subcooled Flow Boiling with Water*, submitted for publication in Int. J. Heat Mass Transfer, May 1997.

R.P. Golinescu, F. Morosan and M.S. Kazimi, *A Probabilistic Methodology for the Design of Radiological Confinement of Tokamak Reactors*, Reliability Engineering and Systems Safety, August 1997.

3. Proceedings of Refereed Conferences

3.a Full Length Papers

M. Siddique, M.W. Golay and M.S. Kazimi, *The Effect of Hydrogen on Forced Convection Steam Condensation*, AIChE Symposium Series, Nat'l Heat Transfer Conf., Philadelphia, PA, August 6-9, 1989.

J.E. Massidda, Y. Parlattan and M.S. Kazimi, *Passive Safety Considerations in Thermal Design of Fusion Blankets*, presented at NURETH-4, Karlsruhe, Germany, October 1989.

A.A. Dehbi, M. Golay and M.S. Kazimi, *The Effect of Air in Steam Condensation Under Turbulent Natural Convection*, presented at the 1990 ANS Winter Meeting and accepted for publication in the proceedings of the meeting, Washington, DC, November 1990.

A.A. Dehbi, M.W. Golay and M.S. Kazimi, *Condensation Experiments in Steam-Air and Steam-Air-Helium Mixtures Under Turbulent Natural Convection*, presented at the 27th National Heat Transfer Conference (AIChE), Minneapolis, Minnesota, July 1991.

A.A. Dehbi, M.W. Golay and M.S. Kazimi, *A Theoretical Modelling of the Effects of Noncondensable Gases on Steam Condensation Under Turbulent Natural Convection*, presented at the 27th National Heat Transfer Conference, Minneapolis, Minnesota, July 1991. Also, presented at the Seventh Proc. of Nuclear Thermal Hydraulics, ANS Winter Mtg., San Francisco, CA, November 1991: 229-236.

M. Koch and M.S. Kazimi, *A Comparison of Radioactive Waste from Fast Fission and D-T Fusion Reactors*, presented at the IECEC Conference, Boston, MA, August 1991.

M. Siddique, M.W. Golay and M.S. Kazimi, *Local Heat Transfer Coefficients in a Vertical Tube in the Presence of Air*, Seventh Proc. of Nuclear Thermal Hydraulics, ANS Winter Mtg., San Francisco, CA, November 1991: 221-228, also presented at the National Heat

MSK Publications (Continued)

Transfer Conference, San Diego, August 1992 and accepted for publication in the Proceedings of the ASME Symposium on Basic Aspects of Two-Phase Flow and Heat Transfer.

A.E. Hechanova and M.S. Kazimi, *Thermo-Mechanical Performance of Beryllium-Coated Copper Divertors*, presented at the Tenth ANS Topical Meeting on the Technology of Fusion Energy, Boston, MA, June 7-11, 1992.

C.P. Liao and M.S. Kazimi, *A Feasibility Assessment of Liquid Metal Divertors*, presented at the Tenth ANS Topical Meeting on the Technology of Fusion Energy, Boston, MA, June 7-12, 1992.

A.E. Hechanova, M.S. Kazimi and J.E. Meyer, *Thermal Limits for Water Cooling of High Heat Flux Fusion Reactor Components*, presented at NURETH-5, Fifth International Topical Meeting on Nuclear Reactor Thermal Hydraulics at Salt Lake City, Utah, September 21-24, 1992.

C.P. Liao and M.S. Kazimi, *MHD Effects on Liquid Metal Film Flow*, presented at NURETH-5, Fifth International Topical Meeting on Nuclear Reactor Thermal Hydraulics at Salt Lake City, Utah, September 21-24, 1992.

M. Siddique, M.W. Golay and M.S. Kazimi, *Theoretical Modelling of Forced Convection Condensation of Steam in a Vertical Tube in the Presence of a Noncondensable Gas*, presented at NURETH-5, Fifth International Topical Meeting on Nuclear Reactor Thermal Hydraulics at Salt Lake City, Utah, September 21-24, 1992.

H.A. Hasanein, M.W. Golay and M.S. Kazimi, *The Effect of Cooling Water Conditions on In-Tube Condensation in the Presence of Noncondensables*, presented at the 1993 Winter Annual ANS Meeting, San Francisco, CA, and appeared in the Ninth Proceedings of Nuclear Thermal Hydraulics: 140-147, 1993.

M.S. Kazimi, *Nuclear Engineering for a New Era*, presented at the Nuclear Engineering Session of the American Society for Engineering Education Conference, Anaheim, CA, June 25-29, 1995.

C.P. Liao and M.S. Kazimi, *On Control of Ferrocyanide/Nitrate Thermal Runaway Reactions*, presented at the Session on Recent Advances in Multicomponent Reacting Fluid Flows, AIChE 1995 Summer Meeting, Boston, MA, July 30-August 2, 1995.

B.M. Lekakh, J.E. Meyer and M.S. Kazimi, *Heat Transfer Conditions in Water-Cooling of a Fusion Reactor Divertor*, presented at the 16th IEEE/NPSS Symposium on Fusion Engineering, Urbana, IL, September 30-October 5, 1995.

R. Golinescu and M.S. Kazimi, *On the Risk Based Limits for ITER*, presented at the 16th IEEE/NPSS Symposium on Fusion Engineering, Urbana, IL, September 30-October 5, 1995.

A.E. Hechanova, M.S. Kazimi and J.E. Meyer, *A Framework for Critical Heat Flux Prediction in High Heat Flux Components*, presented at the High Heat Flux Thermal Management Session of the 1995 International Mechanical Engineering Congress and Exposition, San Francisco, CA, November 12-17, 1995.

MSK Publications (Continued)

C.A Bollmann, M. S. Kazimi, and M. J. Driscoll, *Verification of the Application of a Square Lattice Modeling Program to CANDU Fuel Bundle Models*, MIT Nuclear Engineering Department, ICONE-6, San Diego, CA, May 15, 1998.

C.A Bollmann, Xianfeng Zhao, M. J. Driscoll and M. S. Kazimi, *Analytical Determination of DUPIC Cycle Fuel Utilization*, MIT Nuclear Engineering Department, ICONE-66136, San Diego, CA, May 15, 1998.

F. Morrison and M.S. Kazimi, *Multi-attribute Analysis of Alternatives for Hanford Tanks Remediation System*, Proc. PSAM-4, New York, September, 1998.

X. Zhao, M.J. Driscoll and M.S. Kazimi, *Reuse of Spent Fuel in PWRs via Dry Processing*, ICONE-7, Tokyo, April 1999.

3.b Summaries (accepted for publication in the proceedings of the media).

M. Siddique, M.W. Golay and M.S. Kazimi, *Local Condensation Heat Transfer Coefficients for Internally Flowing Steam-Air Mixtures*, Trans. Am. Nucl. Soc., 1991.

A.A. Dehbi, M.W. Golay and M.S. Kazimi, *A Model of Condensation in Stagnant Steam-Noncondensable Gas Mixtures*, Trans. Am. Nucl. Soc., 1991.

C H. Kang and M.S. Kazimi, *Transuranic Inventory Reduction in Repository by Partitioning and Transmutation*, Trans. Am. Nucl. Soc. 66, 1992: 79.

H.A. Hasanein, M.W. Golay and M.S. Kazimi, *The Effect of Cooling Conditions on Condensation in the Presence of Noncondensables*, Trans. Am. Nucl. Soc., Vol. 69, 1993: 525-527.

R.P. Golinescu and M.S. Kazimi, *Probabilistic Analysis of Divertor Plate Lifetime in Tokamak Reactors*, summary prepared for the 11th Topical Meeting on the Technology of Fusion Energy, 1994 ANS Annual Meeting, New Orleans, Louisiana, June 19-23, 1994.

4. Other Major Publications

D.S. Barnett and M.S. Kazimi, *The Chemical Kinetics of the Reactions of Lithium with Steam-Air Mixtures*, PFC/RR-89-03, DOE/ID-01570-4, MIT Plasma Fusion Ctr. and Nucl. Eng. Dept., April 1989.

J.P. Holdren, et. al., *Summary of the Report of the Senior Committee on Environmental, Safety and Economic Aspects of Magnetic Fusion Energy*, ESECOM, UCRL-53766-Summary, September 1989.

M. Koch and M.S. Kazimi, *A Comparison of Radioactive Waste from First Generation Fusion Reactors and Gas Fission Reactors with Actinide Recycling*, PFC/RR-91-9, MIT Plasma Fusion Ctr., April 1991.

MSK Publications (Continued)

A.A. Dehbi, M.W. Golay and M.S. Kazimi, *The Effects of Noncondensable Gases on Steam Condensations Under Turbulent Natural Convection Conditions*, MIT-ANP-TR-004, June 1991, MIT Nucl. Eng. Dept.

A.A. Dehbi, M.S. Kazimi and M.W. Golay, *Passive Containment Cooling for a 900 MWe Reactor*, MIT-ANP-TR-006, Aug. 1991, MIT Nucl. Eng. Dept.

M.S. Kazimi and High-Level Waste Tank Advisory Panel, *Approach to Resolution of Safety Issues Associated with Ferrocyanides in the Hanford Waste Tanks*, January 21, 1992.

M. Siddique, M.W. Golay and M.S. Kazimi, *The Effects of Noncondensable Gases on Steam Condensation Under Forced Convection Conditions*, MIT-ANP-TR-010, March 1992, MIT Nucl. Eng. Dept.

C.P. Liao and M.S. Kazimi, *An Evaluation of the Feasibility of Liquid Metal Divertors*, PFC/RR-92-10, MIT Plasma Fusion Ctr. and Nucl. Eng. Dept., July 1992.

C.H. Kang and M.S. Kazimi, *Transmutation Effects on Transuranic Waste Inventory and its Repository Risk*, MIT-ANP-TR-015, March 1993, MIT Nucl. Eng. Dept.

H.A. Hasanein, M.W. Golay and M.S. Kazimi, *Steam Condensation in the Presence of Noncondensable Gases Under Forced Convection Conditions*, MIT-ANP-TR-024, July 1994, MIT Nucl. Eng. Dept.

A.E. Hechanova, M.S. Kazimi and J.E. Meyer, *Thermal Hydraulics of High Heat Flux Components*, PFC/RR-95-1, January 1995, MIT Plasma Fusion Center.

Committee on Separations and Transmutation Systems, "Nuclear Wastes," National Research Council, 1995 (Kazimi was member of committee chaired by Norman Rasmussen).

M. van der Helm and M.S. Kazimi, *Natural Convection in High Heat Flux Tanks at the Hanford Waste Site*, MITNE-311, February 1996, MIT Nucl. Eng. Dept.

R.P. Golinescu and M.S. Kazimi, *Enhanced Probabilistic Decision Analysis for Radiological Confinement Barriers in Tokamak Reactors*, PFC/RR-96-4, MIT Plasma Fusion Ctr. and Nucl. Eng. Dept., June 1996.

F. Morosan and M.S. Kazimi, *Multiattribute Analysis of Alternatives for Hanford Tanks Remediation System*, MIT-NFC-TR-002, February 1997, MIT Nucl. Eng. Dept.

C. Bollman, M. Driscoll and M.S. Kazimi, "Environmental and Economic Performance of Direct Use of PWR Spent Fuel in CANDU Reactors." *MIT-NFC-TR-014*, MIT. Nucl. Eng. Dept., Jun. 1998.

DOCUMENTS REVIEWED

DR. MUJID KAZIMI

Tab	Date	Description
1.	08/31/84	Final Waste Confidence Decision, 49 Fed. Reg. 34,658.
2.	09/18/90	Review and Final Revision of Waste Confidence Decision, 55 Fed. Reg. 38,474.
3.	07/07/80	Utility Nuclear Waste Management Group and Edison Electric Institute, The Capability for the Safe Interim Storage of Spent Fuel.
4.	03/00/87	N. Z. Godlewski, <i>Spent-Fuel Storage -- An Update</i> , <u>Nuclear News</u> .
5.	00/00/00	NRC Technical Issues Paper (TIP # 15): Dry cask Storage of Spent Nuclear Fuel.
6.	08/00/79	NUREG-0575: Final Generic Environmental Impact Statement on Handling and Storage of Spent Light Water Power Reactor Fuel. Executive Summary.
7.	04/00/80	NUREG/CR-1223: Dry Storage of Spent Nuclear Fuel, A Preliminary Survey of Existing Technology and Experience. Table of Contents and Summary.
8.	08/00/84	NUREG-1092: Environmental Assessment for 10 CFR Part 72 "Licensing Requirements for the Independent Storage of Spent Fuel and High-Level Radioactive Waste."
9.	02/00/89	DOE/RW-0220: Final Version Dry Cask Storage Study.
10.	11/01/89	Nuclear Waste: Is There a Need for Federal Interim Storage? (Report of the Monitored Retrievable Storage Review Commission.
11.	09/00/83	PNL-4835: Technical Bases fir Storage of Zircaloy-Clad Spent Fuel in Inert Gases.
12.	01/00/86	PNL-5456: Spent Fuel Behavior Under Abnormal Thermal Transients During Dry Storage.

Tab	Date	Description
13.	05/00/87	PNL-6189: Recommended Temperature Limits for Dry Storage of Spent Light Water Reactor Zircaloy-Clad Fuel Rods in Inert Gas.
14.	09/00/87	UCID-21181: Spent Fuel Cladding Integrity During Dry Storage.
15.	10/00/87	PNL-6364: Control of Degradation of Spent LWR Fuel During Dry Storage in an Inert Atmosphere.
16.	06/00/97	PNNL-11576: Spent Nuclear Fuel Integrity During Dry Storage - Performance Tests and Demonstrations.

Document #: 759893 v.1

RESUME OF
DONALD WAYNE LEWIS

May 1999

LEWIS, DONALD WAYNE

**LEAD ENGINEER
MECHANICAL DIVISION**

EDUCATION

Montana State University - Bachelor of Science, Civil Engineering - 1980
Daniel International Corp. - Course in ASME Section III - 1982
Daniel International Corp. - Course in Welding - 1983

REGISTRATIONS

Professional Engineer - New York (1988)
Colorado (1997)

EXPERIENCE SUMMARY

Mr. Lewis has 17 years of engineering experience in the power generation industry, and has participated in all phases of power plant engineering from design through construction, pre-operational testing to on-line modifications.

Mr. Lewis has experience on several nuclear facilities. Assignments include the design of spent nuclear fuel storage facilities, plant systems design modifications, and on-site engineering of mechanical systems installation. Spent fuel storage facility design involved preparation of the design of mechanical aspects and related licensing of the facilities, including an on-site assignment as project engineer for the client for construction of one of the facilities. Plant systems modification assignments involved resolving system design problems, preparing design changes and supporting analyses, revising drawings and preparing specifications. On-site engineering of mechanical systems installation involved resolving pipe and equipment installation conflicts, reviewing and revising design drawings, ensuring code compliance, procuring system components, and developing start-up procedures.

Mr. Lewis has experience on four coal-fired boiler plants. Assignments included the design of mechanical systems on a flue gas scrubber project, development of system descriptions and operating instructions; and the evaluation of a coal to natural gas conversion design. Work involved design of piping systems, component selection and sizing, preparing calculations and specifications, reviewing proposal submittals, initiating process flow and layout drawings; writing plant operation instructions; and preparing cost analyses.

Mr. Lewis is currently assigned to several projects: the Indian Pt 2 spent fuel conceptual design project where he is Project Engineer, the Maine Yankee Atomic Plant spent fuel storage project where he is Lead Mechanical Engineer, the Private Fuel Storage Project where he is Lead Mechanical Engineer, and the Northern States Power Prairie Island Generating Plant where he is Project Engineer, responsible for overseeing the High Energy Line Break Upgrade Project and spent fuel storage issues.

D. Wayne Lewis

DETAILED EXPERIENCE RECORD
LEWIS, DONALD WAYNE

STONE & WEBSTER ENGINEERING CORPORATION, DENVER, COLORADO

(Apr 1988 - Present)

Appointments:

Lead Engineer, Mechanical Division - Jan 1998

Senior Mechanical Engineer, Mechanical Division - Nov 1990

Mechanical Engineer, Mechanical Division - Jan 1989

Indian Point 2 Nuclear Plant, Buchanan, NY – Consolidated Edison

(January 1999 - Present)

PROJECT ENGINEER

Maine Yankee Atomic Plant, Wiscasset, ME – Maine Yankee Power Company

(November 1998 - Present)

LEAD MECHANICAL ENGINEER

Yucca Mountain Project, Las Vegas, NV - U.S. Department of Energy

(June 1998 - August 1998)

SYSTEMS ENGINEER

Rocky Flats Environ. Tech. Site, Golden, CO - Rocky Flats Engineers & Contractors, L.L.C.

(May 1998 - Sept 1998)

RADIOLOGICAL CONSULTANT

Prairie Island Generating Plant, Red Wing, MN - Northern States Power Company

(Oct 1997 - Present)

PROJECT ENGINEER

National Wind Technology Center, Golden, CO - National Renewable Energy Laboratory

(Oct 1997 - Apr 1998)

SENIOR MECHANICAL ENGINEER

Rocky Flats Environmental Technology Site, Golden, CO - BNFL

(July 1997 - Oct1997)

SENIOR MECHANICAL ENGINEER

Private Fuel Storage Facility, Goshute Indian Res., UT - Private Fuel Storage

(Oct 1996 - Present)

SENIOR MECHANICAL ENGINEER

Goodhue County ISFSI, Frontenac, MN - Northern States Power Company

(Aug 1995 - Sept 1996)

PROJECT ENGINEER

D. Wayne Lewis

Navajo Generating Station, Page AZ - Salt River Project

(Sept 1993 - Nov 1995)

SENIOR MECHANICAL ENGINEER

Prairie Island Generating Plant, Red Wing, MN - Northern States Power Company

(Jan 1992 - Aug 1993)

SENIOR MECHANICAL ENGINEER

Neil Simpson Station, Gillette, WY - Black Hills Power Company

(Sept 1991 - Dec 1991)

SENIOR MECHANICAL ENGINEER

North Omaha Station, Omaha, NE - Omaha Public Power District

(July 1991 - Aug 1991)

SENIOR MECHANICAL ENGINEER

Fort Calhoun Power Station, Ft Calhoun, NE - Omaha Public Power District

(Apr 1988 - June 1990) (Nov 1990 - Aug 1991)

SENIOR MECHANICAL ENGINEER

Prairie Island Generating Plant-Unit 2, Red Wing, MN - Northern States Power Company

(July 1990 - Oct 1990)

LEAD MECHANICAL ENGINEER

EG&G Rocky Flats Inc., Golden, CO - U. S. Department of Energy

(July 1990)

MECHANICAL ENGINEER

U. S. Department of Energy, Hanford, WA

(June 1990)

MECHANICAL ENGINEER

STONE & WEBSTER ENGINEERING CORP., CHERRY HILL, NEW JERSEY

(Sept 1983 - Mar 1988)

Appointments:

Engineer, Mechanical Division - Aug 1987

Construction Engineer - Oct 1985

Senior Field Engineer - Oct 1984

Field Engineer - Sept 1983

Nine Mile Point Nuclear Station, Unit 2, Lycoming, NY - Niagara Mohawk Power Corporation

(Sept 1983 - Mar 1988)

ENGINEER, Mechanical Division (Aug 1987 - Mar 1988)

ENGINEER, Construction Division (Sept 1983 - July 1987)

D. Wayne Lewis

Oswego Steam Station Units 5 & 6, Oswego, NY - Niagara Mohawk Power Corporation

(Dec 1986)

CONSTRUCTION ENGINEER

DANIEL INTERNATIONAL CORPORATION, GREENVILLE, SOUTH CAROLINA

(June 1982 - Aug 1983)

Wolf Creek Nuclear Plant, New Strawn, KS - Kansas Gas & Electric

CONSTRUCTION ENGINEER II

J.A. JONES CONSTRUCTION COMPANY, CHARLOTTE, NORTH CAROLINA

(Oct 1981 - Apr 1982)

Washington Nuclear Plant No. 1, Handford, WA - Washington Public Power Supply System

FIELD ENGINEER

WRIGHT SCHUCHART HARBOR-BOECON-GERI, RICHLAND, WASHINGTON

(Mar 1981 - Oct 1981)

Washington Nuclear Plant No. 2, Handford, WA - Washington Public Power Supply System

ASSOCIATE STRUCTURAL ENGINEER

MONTANA STATE HIGHWAY DEPARTMENT, HELENA, MONTANA

(July 1979 - Sept 1979, July 1980 - Mar 1981)

CIVIL ENGINEER I (Traffic Division, Jan 1981 - Mar 1981)

ENGINEER AIDE (July 1979 - Sept 1979)

RESUME OF
KRISHNA P. SINGH

RESUME

**KRISHNA P. SINGH, Ph.D.
PRESIDENT & CEO**

EDUCATION

University of Pennsylvania
Ph.D. in Mechanical Engineering (1972)

University of Pennsylvania
M.S. in Mechanical Engineering (1969)

B.I.T. Sindri, Ranchi University
B.S. In Mechanical Engineering (1967)

PROFESSIONAL EXPERIENCE

HOLTEC INTERNATIONAL
Marlton, New Jersey

1986 - Present President and CEO

JOSEPH OAT CORPORATION
Camden, New Jersey

1979 - 1986 Vice President of Engineering

1974 - 1979 Chief Engineer

1971 - 1974 Principal Engineer

R.I.T. ALLAHABAD
India

1967 - 1968 Assistant Professor of Applied Mechanics

LICENSES

Registered Professional Engineer - Pennsylvania (1974 - present)

Registered Professional Engineer - Michigan (1980 - present)

PROFESSIONAL MEMBERSHIPS/ACTIVITIES

Fellow of the ASME; Member ANS; Chairman, TEMA Vibration Committee (1979 - 1986); Chairman, PVP Committee Of the ASME, Nuclear Engineering Division (1988-92); Member, ASME O&M Committee (1991 to present); Member ASCE (1977-83), Member, Heat Exchange Institute (1976-86).

PATENTS

"Heat Exchanger for Withstanding Cycle Changes in Temperature" (with M. Holtz and A. Soler), Patent No. 4,207,944 (1980).

"Radioactive Fuel Cell Storage Rack" (with M. Holtz), U.S. Patent No. 4,382,060 (May, 1983).

BOOKS AND ARCHIVAL VOLUMES (authored or edited):

1. "Mechanical Design of Heat Exchangers and Pressure Vessel Components", (with A. I. Soler), Arcturus Publishers, Cherry Hill, New Jersey, 1100 pages, hardbound (1984).
2. "Theory and Practice of Heat Exchanger Design", Arcturus Publishers (c. 1995).
3. "Feedwater Heater Workshop Proceedings", with Tom Libs, EPRI 78-123 (1979).
4. "Feedwater Heater Technology: State-of-the-Art", EPRI - cs - 4155 (1985).
5. "Analytical Correlations of Fluid Drag of Fuel Drag of Fuel Assemblies in Fuel Rack Storage Locations", EPRI Project RP-2124.
6. "Thermal/Mechanical Heat Exchanger Design", ASME, PVP - Vol. 118 (1986).
7. "Time Dependent and Steady State Characterization of the CAES Recuperator", EPRI TR-104224 (July 1994).
8. "Pressure Vessels, Heat Exchangers and Piping", Proc. ASME, IEEE Joint Power Generation Conference, NE-14 (1994).

ACADEMIC ACTIVITIES

Chair, Advisory Committee On Mechanical Engineering and Mechanics, University of Pennsylvania (1993-)

Professor (Adjunct) in Mechanical Engineering and Mechanics, University of Pennsylvania (1986-92), Graduate and Undergraduate Courses in Heat Transfer Equipment

CONTINUING EDUCATION COURSES OFFERED ON HEAT EXCHANGE AND STEAM GENERATION

1. I.I.T. Bombay, One Week Course on Heat Exchanger Design (1979).
2. Duke Power Company, Charlotte, NC (1982, 1983, 1986, 1990) - In-house Course on Heat Exchanger Design and Testing.

3. National Italian Reactor Authority, Genoa, Italy - On Condensers, Steam Generators, and Moisture Separator Reheaters (1985).
4. Mississippi Power & Light Company, In-House Course on Moisture Separator Reheaters and Surface Condensers (1987).
5. Center for Professional Advancement (1988, New Brunswick, NJ; 1990, Caracas, Venezuela; 1991, Houston, Texas; 1992, Amsterdam, Holland).

CONSULTING

Consultant to Electric Power Research Institute (EPRI); Pressure Vessel Research Council (PVRC); Tubular Exchanger Manufacturers Association (TEMA); Department of Energy (DOE) (Idaho Operations); Department of Energy (DOE) (Chicago Operations); American Electric Power Corporation; Baltimore Gas and Electric; Carolina Power & Light; Commonwealth Edison Company; Detroit Edison Company; Duke Power Company; Entergy Operations; GPU Nuclear; Iowa Electric Light and Power; New York Power Authority; Niagara Mohawk Power Corporation; North Atlantic Energy Services; Northeast Utilities; Northeast Nuclear Energy; Pacific Gas and Electric Company; PECO Energy; Southern Nuclear Operating Company; Tennessee Valley Authority.

PUBLICATIONS

1. "A Method for Solving Ill-Posed Integral Equations of the First Kind", (with B. Paul), Computer Methods in Applied Mechanics and Engineering 2 (1973) 339-348.
2. "Numerical Solutions of Non-Hertzian Elastic Contact Problems", (with B. Paul), Journal of Applied Mechanics, Vol. 41, No. 2, 484-490, June, 1974.
3. "On the Inadequacy of Hertzian Solution of Two Dimensional Line Contact Problems", Journal of the Franklin Institute, Vol, 298, No. 2, 139-141 (1974).
4. "How to Locate Impingement Plates in Tubular Heat Exchangers", Hydrocarbon Processing, Vol. 10, 147-149 (1974).
5. "Stress Concentration in Crowned Rollers", (with B. Paul), Journal of Engineering for Industry, Trans. ASME, Vol. 97, Series B, No. 3, 990-994 (1975).
6. "Application of Spiral Wound Gaskets for Leak Tight Joints", Journal of Pressure Vessel Technology, Trans. ASME, Vol. 97, Series J, No. 1, 91-93 (1975).
7. "Contact Stresses for Multiply-Connected Regions - The Case of Pitted Spheres:, with B. Paul and W. S. Woodward, Proceedings of the IUTAM Symposium on Contact Stresses, August 1974, Holland, Delft University Press, 264-281, (1976).
8. "Design of Skirt-Mounted Supports:, Hydrocarbon Processing, Vol. 4, 199-203, April 1976.
9. "Predicting Flow Induced Vibration in U-Bend Regions of Heat Exchangers - An Engineering Solution". Journal of the Franklin Institute, Vol. 302, No. 2, 195-205, August 1976.

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10. "A Method to Design Shell-side Pressure Drop Constrained Tubular Heat Exchangers", with Mr. Holtz, Journal of Engineering for Power, Trans. of the ASME, Vol. 99, No. 3 July 1977, pp 441-448.
 11. "An Efficient Design Method for Obround Pressure Vessels and Their End Closures", International Journal of Pressure Vessel and Piping, Vol. 5, 1977, pp 309-320.
 12. "Analysis of Vertically mounted Through-Tube Heat Exchangers", Journal of Engineering for Power, Trans. ASME, Vol. 100, No. 2, April, 1978, pp 380-390.
 13. "Study of Bolted Joint Integrity and Inter-Tube-Pass Leakage in U-Tube Heat Exchangers: Part I - Analysis", Journal of Engineering for Power, Trans. ASME, Vol. 101, No. 1, pp 9-15 (1979).
 14. "Study of bolted Joint Integrity and Inter-Tube-Pass Leakage in U-Tube Heat Exchangers, Part II - Applications", Journal of Engineering for Power, Trans. ASME, Vol. 101, No. 1, pp 16-22 (1979).
 15. "On Thermal Expansion Induced Stresses in U-Bends of Shell-and-Tube Heat Exchangers", (with Maurice Holtz); Trans. ASME, Journal of Engineering for Power, Vol. 101, No. 4, October, 1979, pp. 634-639.
 16. "Heat Transfer Characteristics of a Generalized Divided Flow Heat Exchanger", Proceedings of the Conference on Industrial Energy Conservation Technology, Houston, Texas, pp 88-97 (1979).
 17. "An Approximate Analysis of Foundation Stresses in Horizontal Pressure Vessels", (with Vincent Luk), Paper No. 79-NE-1, Trans. ASME, Journal of Engineering for Power, Vol. 102, No. 3, pp 555-557, July, 1980.
 18. "Generalization of the Split Flow Heat Exchanger Geometry for Enhanced Heat Transfer", (with Michael Holtz), AIChE. Symposium Series 189, Vol. 75, pp 219-226 (1979).
 19. "Analysis of Temperature Induced Stresses in the Body Bolts of Single Pass Heat Exchangers", ASME Winter Annual Meeting, Paper No. 79 QA/NE-7, New York, NY, 1979.
 20. "Optimization of Two-Stage Evaporators for Minimizing Rad-Waste Entrainment", (with Maurice Holtz), Journal of Mechanical Design, Trans. of the ASME, Vol. 102, No. 4, pp 804-806 (1980).
 21. "A Comparison of Thermal Performance of Two and Four Tube Pass Designs for Split Flow Shells", (with M. J. Holtz), Journal of Heat Transfer, Trans. of the ASME, Vol. 103, No. 1, pp 169-172, February, 1981.
 22. "A Method for Maximizing Support Leg Stress in a Pressure Vessel Mounted on Four Legs Subject to Moment and Lateral Loadings". International Journal of Pressure Vessels and Piping, Vol. 9, No. 1, pp 11-25 (1981).
 23. "Design, Stress Analysis and Operating Experience in Feedwater Heaters", (with Tom Libs), Proceedings of the Conference on Industrial Energy Conservation Technology, Houston, pp 113-118 (1980).
 24. "On the Necessary Criteria for Stream Symmetric Tubular Heat Exchanger Geometries", Heat Transfer Engineering, Vol. 3, No. 1 (1981).

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25. "Some Fundamental Relationships for Tubular Heat Exchanger Thermal Performance", Trans. ASME, Journal of Heat Transfer, Vol. 103, pp 573-578 (1981).
 26. "Transient Swelling of Liquid Level During Pool Boiling in an Emergency Condenser", (with J. P. Gupta). Letters in Heat and Mass Transfer, Vol. 8, No. 1, pp 25-33, Jan/Feb., 1981.
 27. "An Approximate Method for Evaluating the Temperature Field in Tubesheet Ligaments Under Steady State Conditions", (with M. Holtz), Journal of Engineering for Power, Trans. ASME, Vol. 104, pp 895-900 (1982).
 28. "Feasibility Study of A Multi-Purpose Computer Program to Optimize Power Cycles for Operative Plants", (with Y. Menuchin and N. Hirota), Proceedings of the Conference on Industrial Energy Conservation Technology, Houston, (1981).
 29. "Design Parameters Affecting Bolt Load in Ring Type Gasketed Joints", (with A. I. Soler), Trans. ASME, Journal of Pressure Vessel Technology, Vol 105, pp 11-13 (1983).
 30. "A Design Concept for Minimizing Tubesheet Stress and Tubejoint Load in Fixed Tubesheet Heat Exchangers", (with A. I. Soler), Trans. ASME (C. 1982).
 31. "Dynamic Coupling in a Closely Spaced Two-Body System Vibrating in Liquid Medium: The Case of Fuel Racks", (with A. I. Soler), Proceedings of the Third International Conference on "Vibration in Nuclear Plant", Keswick, England, May, 1982, pp. 815-834.
 32. "Effect of Nonuniform Inlet Air Flow on Air Cooled Heat Exchanger Performance", (with A. I. Soler and Lee Ng), Proceedings of the Joint ASME-JSME Heat Transfer Conference, 1983, pp. 537-542.
 33. "Seismic Response of Free Standing Fuel Rack Constructions to 3-D Motions", (with A. I. Soler), Nuclear Engineering and Design, Vol. 80, (1984), pp. 315-329.
 34. "A Method for Computing Maximum Water Temperature in a Fuel Pool Containing Spent Nuclear Fuel", Heat Transfer Engineering, Hemisphere, Dec. (1986).
 35. "On Minimization of Radwaste Carry-Over in a N-stage Evaporator", (with Maurice Holtz and Vincent Luk), Heat Transfer Engineering, pp. 68-73, Vol. 5, No. 1-1 (1984).
 36. "Feedwater Heater Procurement Guidelines - Some New Performance Criteria", Symposium on State-of-the-art Feedwater Heater Technology, EPRI (c. 1984).
 37. "Method for Quantifying Heat Duty Derating due to Inter-Pass Leakage in Bolted Flat Cover Heat Exchangers", Heat Transfer Engineering, pp. 19-23, Vol. 4, No. 3-4 (1983).
 38. "On Some Performance Parameters for Closed Feedwater Heaters, Journal of Pressure Vessel Technology, Trans. ASME (1987).
 39. "A Design Procedure for Evaluating the Tube Axial Load Due to Thermal Effects in Multi-Pass Fixed Tubesheet Heat Exchangers", (with A. I. Soler), Journal of Pressure Vessel Technology, Trans. ASME (1987).

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40. "An Elastic-Plastic Analysis of the Integral Tubesheet in U-Tube Heat Exchangers - Towards an ASME Code Oriented Approach", Int. Journal of Vessel and Piping (c. 1987).
 41. "Feedwater Heaters", Heat Transfer Equipment Design, R. Shal et. al (editor), Hemisphere (c. 1988).
 42. "Surface Condensers", Heat Transfer Equipment Design, R. Shal et. al (editor), Hemisphere (c. 1988).
 43. "Flow Induced Vibration", Heat Transfer Equipment Design, R. Shal et. al (editor), Hemisphere (c. 1988).
 44. "Mechanical Design of Heat Exchangers", Heat Transfer Equipment Design, R. Shal et. al (editor), Hemisphere (c. 1988).
 45. "A Rational Method for Analyzing Expansion Joints":, (with A. Soler), ASME, Journal of Pressure Vessel Technology (c. 1988).
 46. "An Analysis of the Improvement in the Thermal Performance of Surface Condenser Equipped with Tweener Supports", ASME Joint Power Generation Conference, Miami (Oct. 1987).
 47. "Pressure Vessels - Design & Operation", Chemical Engineering, pp 62-70, Chemical Engineering, July 1990, McGraw Hill, N.Y.
 48. "Spent Fuel Storage Options: A Critical Appraisal", Power Generation Technology, pp 137-140, Sterling Publications, U.K. (1990-91).
 49. "Design Strength of Primary Structural Welds in Free-Standing Structures", with A.I. Soler and S. Bhattacharya, Journal of Pressure Vessel Technology, Trans. ASME (c' 1991).
 50. "Seismic Qualification of Free-Standing Nuclear Fuel Storage Modules - The Chin Shan Experience", Nuclear Engineering International, U.K. (March, 1991).
 51. "Transient Response of Large Inertia Cross Flow Heat Exchangers", with Y. Wang, A.I. Soler and K. Iulianetti, ASME 91-JPGC-NE-27 (1991).
 52. "Some Results from Simultaneous Seismic Simulations of All Racks in a Fuel Pool", with A.I. I. Soler, INNM Spent Fuel Management Seminar X, Washington, D.C., January, 1993.
 53. "A Case for Wet Storage", INNM Spent Fuel Management Seminar X, Washington, D.C., January, 1993.
 54. "Application of Transient Analysis Methodology to Heat Exchanger Performance Testing" with I. Rampall and Benjamin H. Scott, ASME Joint Power Generation Conference, October, 1994.
 55. "Predicting Thermal Performance of Heat Exchangers Using In-Situ Testing and Statistical Correlation", with K. Iulianetti and Benjamin H. Scott, ASME Joint Power Generation Conference (1994).
 56. "Shellside Boiling in Narrow Crevices", with I. Rampall (to be submitted for publication, Heat Transfer Engineering (ca. 1996).

RESUME OF
RAM SRINIVASAN

INDIVIDUAL EXPERIENCE RECORD

Dr. Ram Srinivasan
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San Jose, CA 95120
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EDUCATION: BE in Civil Engineering (with honors), University of Madras
MS in Civil Engineering, University of Illinois
MS in Business and Taxation, San Jose State University
Ph.D. in Civil Engineering, University of Illinois

**PROFESSIONAL
ACTIVITIES:** Member, American Society of Civil Engineers

**PROFESSIONAL
REGISTRATION:** Professional Engineer, Illinois and California
Structural Engineer, State of Illinois

**PUBLICATIONS
AND REPORTS:** Several technical papers in ASCE and other technical societies on various topics, including Piping Analysis, Seismic Soil-Structure Interaction, Post-Earthquake Analysis, Blast Analysis, Inelastic Seismic Analysis of Fossil Fuel Boiler Structure, Limit Design, Fatigue Strength of High Strength Steel, etc. (See attached List of Publications.)

EXPERIENCE SUMMARY:

Dr. Ram Srinivasan is presently the Manager of Design Engineering at BNFL Fuel Solutions. He has participated in and coordinated the design and analysis of dry cask spent fuel storage and transportation systems. The systems include the TranStor™ and VSC-24 designs. He has also contributed to the various sections of the safety analysis reports of the TranStor™ and VSC-24 systems.

Dr. Srinivasan has a Ph.D. in Civil Engineering from the University of Illinois, Urbana – Champaign, Illinois. He has over 25 years of experience in the design of nuclear power plants. For ten years he has been a consultant to the Electric Power Research Institute, Palo Alto, California. He has actively participated in the various phases of the Advanced Light Water Reactor (ALWR) Program. This experience includes the preparation of the Utility Requirements Document (Evolutionary and Passive Plants), Design Certification of the various vendor designs, and Conformance Assessment of the vendor designs to the utility requirements. He has also participated in the Life Cycle Cost Reduction Programs, including Operation and Maintenance Costs.

Dr. Srinivasan has extensive experience in engineering and project management of power plant structures and components. He held positions as Head of Structural Engineering Specialist Section at Sargent and Lundy, Chicago (1972 – 1980); Project Manager of several piping projects at Quadrex Corporation, Campbell, CA (1980-1982); and Senior Consultant at S. Levy Inc. (1984-1994). Experience includes structural and engineering mechanics, structural dynamics including seismic analysis and design, piping and pipe supports, and application of ASME, ACI, ASCE, ANSI Codes and Standards.

Provided technical training and project management for a number of utility and industry clients. Assisted utilities in several costs saving projects; eliminating unnecessary requirements from procurement specifications, efficient design of small bore piping, snubber reduction programs, etc.

SPECIFIC PROJECTS

Dry Cask Storage and Transportation Casks Participated in and coordinated the design and analysis of dry cask spent fuel storage and transportation systems. The systems include the TranStor™ and VSC-24 designs. The design includes the consideration of pressure, thermal, handling and external loads (tornado, earthquake, flood, etc.). He has also contributed to the various sections of the safety analysis reports of the TranStor™ and VSC-24 systems.

EPRI Advanced Light Water Reactor Program. Key participant in the development of Utility Requirements Document (URD) and assessment of vendor designs (ABWR, SBWR, and AP600) for conformance to the URD.

Third Party Review of the Comanche Peak Steam Electric Station. As a Group Leader of the Civil/Structural discipline, reviewed the design of the various structures, seismic analysis, component (equipment, cable tray, conduit, etc.) supports. Also reviewed the structural design interfaces between the NSSS Vendor and Architect Engineer.

Pipe Support Reduction Program. Reviewed existing design of Small Bore Piping based on Architect Engineer Simplified Dynamic Analysis (SDA). Analyzed sample lines using the computer code NUPIPE and identified removal of those supports not required. Summarized conservatism and limitations of the SDA.

Review of ASME Class 1 Piping Stress Reports. Prepared detailed checklists based on ASME Code requirements (NA-3300) for Owner Review of Stress Reports. Reviewed all ASME Class 1 Piping Stress Reports using the checklists.

Independent Review of Mark 1 Containment Study: Reviewed Plant Unique Assessment Report (PUAR) for the Duane Arnold Energy Center. The review included comparison of the NRC requirements against utility commitments. The reports were then reviewed in light of the NRC requirements and the utility commitments.

Review of Seismic Qualification of Mechanical Equipment. Performed an independent review of seismic requalification of mechanical equipment (ECCS pumps, fuel racks, etc.).

Technical Training. Established and presented training courses to utility engineering staff. Several courses were presented to different utilities. The source material included (1) Introduction to the ASME Code; (2) Piping Design and Analysis; (3) Pressure Vessel and Component Design.

Litigation Record Review. Reviewed the litigation records for Houston Lighting and Power Company for identification of any deficiencies in the design and construction of the South Texas Plants.

In-depth technical Review of Piping Stress Analysis and Support Design performed by Brown & Root in connection with litigation of the South Texas Project (client: Houston Light and Power).

Technical assistance to Commonwealth Edison Co. on their Snubber Reduction Programs for LaSalle County Stations (BWR) and Byron Stations (PWR).

PUBLICATIONS

1. "On-Site Staffing Requirements for a Simplified Boiling Water Reactor (SBWR)," presented at the ICONE-4 Conference in New Orleans, Louisiana, March 1996.

2. "A Snubber Reduction Pilot Program," presented at the ASME Pressure Vessel and Piping Conference, Chicago, June 1986.
3. "Economic Application of Computer Analysis to Small Bore Piping Design." Presented at ASME Pressure Vessel and Piping Conference, Portland, Oregon, June 1983.
4. "Application of Frequency Response Method in Post-Earthquake Analysis." Presented at Sixth SMiRT Conference, Paris, August 1981.
5. "Blast Effects on Safety-related Structures." Presented at Second ASCE Specialty Conference on Structural Design of Nuclear Plant Facilities, New Orleans, Louisiana, December 1975.
6. "Response of Suspended Boilers to Earthquake Motions." Presented at ASCE, Power Division, Specialty Conference on Electric Power and the Civil Engineer, Boulder, Colorado, August 1974.
7. "Three-Dimensional Soil-Structure Seismic Analysis Using Finite Elements." Presented at ASCE Conference on Structural Design of Nuclear Plant Facilities, Chicago, December 1973.
8. "Inelastic Response of Steel Frames to Simulated Earthquake Motions." Ph.D. Doctoral Dissertation, Department of Civil Engineering, University of Illinois, Urbana, May 1972.
9. "Fatigue Strength of Bolted High Strength Structural Steel." *Journal of the Structural Division*, Proceedings of ASCE, March 1971.