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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 OBJECTIONS AND NON-PROPRIETARY
RESPONSES TO STATE'S FIRST REQUESTS FOR DISCOVERY**

Applicant Private Fuel Storage L.L.C. ("Applicant" or "PFS") files this response to "State of Utah's First Set of Discovery Requests Directed to the Applicant ("State's First Discovery Requests"), an electronic copy of which was served on the Applicant on Friday, April 9, 1999.¹ The State and the Applicant have agreed that the party responding to Requests for Admissions and Interrogatories, during the formal discovery period, may have eight working days in which to timely file a response.²

¹ The Applicant is filing a separate response with respect to those portions of the State's First Discovery Requests which contain proprietary information, specifically requests concerning Utah Contention H.

² Attached to this response is an affidavit of John D. Parkyn, Chairman of PFS, verifying the truth of PFS's answers to the State's interrogatories and requests for admission. Applicant will shortly file similar verifications from the various individuals that were responsible for preparing the answers to each of the requests for admissions and interrogatories that are responded to in this response.

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GENERAL OBJECTIONS

These objections apply to the Applicant's responses to all of the State's First Discovery Requests.

1. The Applicant objects to the State's instructions and definitions on the grounds and to the extent that they request or purport to impose upon the Applicant any obligation to respond in manner or scope beyond the requirements set forth in 10 C.F.R. §§ 2.740, 2.741 and 2.742.

2. The Applicant objects to State's Request for Production of Documents to the extent that it requests discovery of information or documents protected under the attorney-client privilege, the attorney work product doctrine, and limitations on discovery of trial preparation materials and experts' knowledge or opinions set forth in 10 C.F.R. § 2.740 or other protection provided by law. The Applicant has provided the State with a Privilege Log which identifies documents subject to these privileges and protections, which the Applicant reserves the right to supplement.³

³ While not formally objecting, Applicant notes that the State may be abusing the limitation on quantity of interrogatories by its use of unnumbered subparts. See, for example, Interrogatories 1, 2, 6, 7 on Contention Utah O. In the interest of maintaining the hearing schedule, Applicant herein has sought to respond to all otherwise non-objectionable subparts of the State's Interrogatories, although we expect to object formally to any further use by the State of this subpart system subterfuge again in the proceeding.

I. GENERAL DISCOVERY REQUESTS

A. GENERAL REQUESTS FOR ADMISSIONS

REQUEST NO. 1. Do you admit that all commitments, representations, and statements made by the Applicant in response to the NRC Staff's past and future Requests for Additional Information, have the same effect as commitments, representations and statements made by the Applicant in its ISFSI Part 72 License Application?

APPLICANT'S RESPONSE: Applicant objects to this request as being overly broad, calling for legal conclusions and speculation. Without waiving these objections, Applicant admits that commitments, representations, and statements made by the Applicant in response to the NRC Staff Requests for Additional Information have the same effect as commitments, representations and statements made by the Applicant in its ISFSI Part 72 License Application.

REQUEST NO. 2. Do you admit that all commitments, representations, and statements made by the Applicant in response to the NRC Staff's past and future Requests for Additional Information, effectively amend the commitments, representations and statements made by the Applicant in its ISFSI Part 72 License Application?

APPLICANT'S RESPONSE: Applicant objects to this request as being overly broad, calling for legal conclusions and speculation. Without waiving these objections, Applicant admits that commitments, representations, and statements made by the Applicant in response to the NRC Staff Requests for Additional Information effectively amend the commitments, representations and statements made by the Applicant in its ISFSI Part 72 License Application.

REQUEST NO. 3. Do you admit that all commitments, representations, and statements made by the Applicant in response to the NRC Staff's past and future

Requests for Additional Information, are provisional commitments, representations, and statements to which the Applicant has not committed itself until it amends its ISFSI Part 72 License Application?

APPLICANT'S RESPONSE: Applicant objects to this request as being overly broad, calling for legal conclusions and speculation. Without waiving these objections, Applicant denies.

B. 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. 1. State the name, business address, and job title of each person who was consulted and/or who supplied information for responding to interrogatories, requests for admissions and requests for the production of documents. Specifically note for which interrogatories, requests for admissions and requests for production each such person was consulted and/or supplied information.

If the information or opinions of anyone who was consulted in connection with your response to an interrogatory or request for admission differs from your written answer to the discovery request, please describe in detail the differing information or opinions, and indicate why such differing information or opinions are not your official position as expressed in your written answer to the request.

APPLICANT'S RESPONSE: In addition to counsel for PFS, the following persons were consulted and/or supplied information in responding to the State's First Discovery Requests:

John Donnell
Project Director
Private Fuel Storage L.L.C.
7677 East Berry Ave
Englewood, CO 80111-2137
General Requests for Admission and
Utah Contentions B, L, O and DD

William Hennessy
Assistant Project Manager and Lead Licensing Engineer
Stone & Webster
7677 Berry Avenue
Denver, CO 80111-2137
General Requests for Admission and
Utah Contentions B, L, O and DD

Jerry Cooper
Project Engineer
Stone & Webster
7677 Berry Avenue
Denver, CO 80111-2137
Utah Contention O

Jeffrey Johns
Senior Licensing Engineer
Stone & Webster
7677 Berry Avenue
Denver, CO 80111-2137
Utah Contentions O

Donald W. Lewis
Lead Mechanical Engineer
Stone & Webster
7677 Berry Avenue
Denver, CO 80111-2137
Utah Contention B and O

Barbara Mohrman
Environmental Program Manager
Stone & Webster
245 Summer Street
Boston, Mass. 02210
Utah Contention DD

Sue Davis
Environmental Engineer
Stone & Webster
245 Summer Street
Boston, Mass. 02210
Utah Contention DD

John Clark
President
Bay Geophysical
868 Robinwood Court
Traverse City, MI 49686
Utah Contention L

Kevin Coppersmith
Vice-President
Geomatrix Consultants
2101 Webster Street
12th Floor
Oakland, CA 94612
Utah Contention L

Bert Swan
Principal Geologist
Geomatrix Consultants
2101 Webster Street
12th Floor
Oakland, CA 94612
Utah Contention L

John Vincent
Manager
Nuclear Fuel Resources
GPU Nuclear
1 Upper Pond Road
Parsippany, NJ 0754
Utah Contention B

In response to whether the information or opinions of anyone who was consulted in connection with PFS's response to an interrogatory or request for admission differs from the PFS's written answer to the discovery request, PFS is unaware of any such difference among those consulted.

GENERAL INTERROGATORY NO. 2. To the extent that PFS has not previously produced documents relevant to any Utah admitted contention, identify all such documents not previously produced. PFS may respond to this request by notifying

the State that PFS has updated its repository of documents relevant to admitted contentions at Parsons, Behle and Latimer.

APPLICANT'S RESPONSE: As jointly agreed to by the State and PFS, PFS will notify the State upon updating its repository of documents relevant to admitted Contentions maintained at Parsons, Behle and Latimer in Salt Lake City.

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: To date, the Applicant has identified the following persons whom it expects to call as witnesses at the hearing with respect to the State's admitted contentions.

Utah C – Radiation Doses

<u>Name and Address:</u>	William E. Kennedy, Jr. 1845 Terminal Drive, Suite 140 Richland, WA 99352
<u>Profession:</u>	Environmental Health Physicist
<u>Employer:</u>	Dade Moeller & Associates
<u>Professional Expertise:</u>	Environmental Health Physics
<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.

Subject matter of testimony:

PFS's calculation of radiation doses from hypothetical accident conditions. Mr. Kennedy will testify that PFS has properly analyzed radiation doses from the hypothetical design basis loss of confinement accident, including environmental pathways such as direct radiation and ingestion of food and soil, and has shown that the off-site dose from such hypothetical design basis loss of confinement accident would remain far below regulatory limits.

Documents reviewed and/or relied upon:

Mr. Kennedy will rely upon applicable portions of the PFS License Application (including SAR), RAI Response 7-1, and supporting calculations. In addition, Mr. Kennedy may review and rely upon responses to Requests for Additional Information, supporting calculations, documents produced by the State as well as any new information that may come into PFS's possession.

Name and Address:

Dr. Richard Wilson
(Witness on behalf of Skull Valley Band)
Harvard University
Cambridge, MA 02138

Profession:

Physicist and Educator

Employer:

Harvard University

Professional Expertise:

Physics and Risk Assessments

Educational, Scientific Experience, and Professional Qualifications:

See Attached Resume

Publications in the last ten years:

See Attached List

Testifying experience in last four years:

One case involving Bethlehem Steel, in San Francisco, concerning the attribution of mesothelioma (March 1999); one case involving the State of West Virginia, in Morgantown, West

Virginia, concerning liability for asbestos-related harm (February 1995)

Subject matter of testimony:

The validity of PFS's calculation of radiation doses under hypothetical accident conditions.

Documents reviewed
and/or relied upon:

Dr. Wilson will review and rely upon applicable portions of the PFS License Application (including SAR); PFS new dose calculation (submitted in RAI Response 7-1); the responses to contentions filed by the Scientists for Secure Waste Storage in February 1998 and all references therein; and other relevant documents and information as deemed appropriate.

Utah F and P – Training

Name and Address:

Michael Ladd
Northern States Power Company
Prairie Island Training Center
1660 Wakonade Drive West
Welch, MN 55089

Profession:

Nuclear Training Program Management

Employer:

Northern States Power Company

Professional Expertise:

Nuclear Training Programs

Educational, Scientific
Experience, and
Professional Qualifications:

See Attached Resume

Publications in the last ten years:

None

Testifying experience in last
four years:

None

Subject matter of testimony:

The adequacy of PFS's training program. Mr. Ladd will testify that in his professional opinion the PFS training program meets applicable NRC requirements.

Documents reviewed and
relied/or upon:

Mr. Ladd will rely upon the relevant portions of the PFS License Application (including the SAR). Mr. Ladd may review and rely upon responses to Requests for Additional Information, other training and education-related information as deemed appropriate, documents produced by the State as well as any new information that may come into PFS's possession.

Utah G – Quality Assurance

Name and Address:

John Gregory Thorgersen
Wisconsin Electric Power Company
NES Building
6590 Nuclear Road
Two Rivers, WI 54241

Profession:

Nuclear Engineer

Employer:

Wisconsin Electric Power Company

Professional Expertise:

Quality assurance; plant operations; nuclear
licensing

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:

In his testimony regarding the adequacy of PFS's QA program, Mr. Thorgersen will testify that in his professional opinion the PFS QA program provides the requisite level of detail and demonstrates

sufficient organizational independence to satisfy the NRC regulations.

Documents Reviewed and/or
Relied Upon:

Mr. Thorgersen will rely upon the PFS License Application, PFSLLC Quality Assurance Program Description, PFSLLC Quality Assurance Procedures and the NRC Regulations. In addition, Mr. Thorgersen may review and rely upon responses to Requests for Additional Information, documents produced by the State as well as any new information that may come into PFS' possession.

Utah K – Credible Accidents

Name and Address:

Dr. Carlton Britton

Profession:

Professor, Department of Range, Wildlife and Fisheries Management

Employer:

Texas Tech University

Professional Expertise:

Range improvement and management, fire ecology

Educational, Scientific
Experience, and
Professional Qualifications:

See Attached Resume

Publications in the last ten years:

See Attached List

Testifying experience in last
four years:

Lard Ranch v. Southwestern Public Service, deposition, Lubbock, Texas (1998); Federal Mediation Hearing, Lubbock, Texas (1998); Dalton v. Stuart, deposition, Lubbock, Texas (1996).

Subject matter of testimony:

Susceptibility of the PFS ISFSI to wildfires. The facts and opinions to which Dr. Britton will testify are set forth in his report, attached to RAI Response 8-3.

Documents reviewed
and/or relied upon:

The documents reviewed and relied upon by Dr. Britton include those specified and referred to in his report as well as: Wright, H.A. and Arthur W. Bailey, Fire Ecology: The United States and Southern Canada, Wiley Interscience, New York, 1982; Forest Service Database, Fire Effects on Plants, www.fs.fed.us/database/feis/; Sneva, F.A. and C.M. Britton, Adjusting and Forecasting Herbage Yields in the Intermountain Big Sagebrush Region of the Steppe Province, Ore. Agr. Exp. Sta. Bull. No. 659, 1983; Britton, C.M., R.G. Clark and F.A. Sneva, Will Your Sagebrush Burn?, Rangelands, 3:207-208, 1981. In addition, Dr. Britton may review and rely upon responses to Requests for Additional Information, documents produced by the State as well as any new information that may come into PFS's possession

Name and Address:

James L. Cole

Profession:

Consultant, retired Air Force Brigadier General

Employer:

National Air Traffic Controllers Association

Burdeshaw Associates, Ltd.

Professional Expertise:

Aircraft operations, Air Force weapons testing, air traffic control

Educational and Scientific
Experience, and
Professional Qualifications:

See Attached Resume

Publications in the last ten years:

FAA General Aviation Forecast Conference Proceedings, "Opportunities and Challenges for the 21st Century," March 24-25, 1998

Testifying experience in last
four years:

None

<u>Subject matter of testimony:</u>	Hazard posed to ISFSI by air operations and by weapon testing activities at Dugway Proving Ground and the UTTR. Gen. Cole will testify that aircraft flights from Hill Air Force Base, the UTTR, Dugway Proving Ground, and Salt Lake City International Airport will pose no significant hazard to the ISFSI. He will also testify that weapons tests, including tests of air-delivered weapons and missiles, on the UTTR and Dugway would also pose no significant hazard to the ISFSI.
<u>Documents reviewed and/or relied upon:</u>	Gen. Cole has reviewed the relevant portions of the PFS License Application (including the SAR) and pleadings concerning Utah Contention K. In addition, PFS is producing at its document repository at Parsons Behle and Latimer specific documents that Gen. Cole expects to rely upon in his testimony and has other documents that Gen. Cole has reviewed available for the State to review in Washington, DC at its request.
<u>Name and Address:</u>	George Carruth
<u>Profession:</u>	Consultant, retired Army Colonel
<u>Employer:</u>	Retired
<u>Professional Expertise:</u>	Chemical and biological agents and munitions, Army operations
<u>Educational, Scientific Experience, and Professional Qualifications:</u>	See Attached Resume
<u>Publications in the last ten years:</u>	None
<u>Testifying experience in last four years:</u>	None

Subject matter of testimony:

Hazard posed to ISFSI by military operations on Dugway Proving Ground. Col. Carruth will testify to the insignificant hazard that activities on Dugway Proving Grounds, including activities involving chemical and biological agents and military training activities, will pose to the ISFSI.

Documents reviewed
and/or relied upon:

Col. Carruth will rely upon relevant parts of the PFS License Application (SAR) and additional documents concerning Dugway Proving Ground, including those produced by the State.

Name and Address:

Dr. Richard Wilson
(Witness on behalf of Skull Valley Band)
See Contention Utah C for information

Subject matter of testimony:

Potential risks to the PFS ISFSI of credible accidents associated with activities at Dugway Proving Ground, the Utah Test and Training Range, Hill Air Force Base, Salt Lake City International Airport, and/or the Tekoi Rocket Engine Test Facility.

Documents reviewed
and/or relied upon:

Dr. Wilson will rely upon the PFS License Application (SAR), documents concerning risk assessment generally, and those specifically related to the facilities relevant to Contention K, including documents produced by the State; the responses to contentions filed by the Scientists for Secure Waste Storage in February 1998 and all references therein; and other documents and information as deemed appropriate.

Utah L – Geotechnical

Name and Address:

Dr. Kevin Coppersmith
Geomatrix Consulting, Inc.
2101 Webster Street, 12th Floor
Oakland, California 94612

<u>Profession:</u>	Geotechnical Consultant
<u>Employer:</u>	Geomatrix Consulting, Inc.
<u>Professional Expertise:</u>	See Attached Resume
<u>Educational and 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 concerning the geological conditions of the PFS site, Dr. Coppersmith will testify about the seismic studies, the methodology to confirm the site's design criteria and the suitability of the site for the proposed ISFSI. The specific facts and conclusions to which Dr. Coppersmith will testify, and their underlying basis, are set forth in the Geomatrix Final Report – Fault Evaluation Study and Seismic Hazard Assessment
<u>Documents reviewed and/or Relied Upon:</u>	Dr. Coppersmith will rely upon the Geomatrix Final Report – Fault Evaluation Study and Seismic Hazard Assessment as well as other documents and data referenced therein. In addition, Dr. Coppersmith may review and rely upon responses to Requests for Additional Information, studies performed by PFS or the State, and other documents produced by the State, as well as any new information that may come into the possession of PFS.

Utah M – Probable Maximum Flood

<u>Name and Address:</u>	Dr. George H. C. Liang 245 Summer Street Boston, MA 02210-2288
<u>Profession:</u>	Environmental Engineer
<u>Employer:</u>	Stone & Webster
<u>Professional Expertise:</u>	See attached resume.
<u>Educational and 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 accuracy of PFS's estimation of the Probable Maximum Flood, Dr. Liang will testify regarding the results and bases of the calculation of the flood volumes and levels that he has performed for the PFSF site.
<u>Documents reviewed and/or Relied Upon:</u>	Dr. Liang will rely upon the PFS License Application, Responses to Requests for Additional Information as well as the flood design calculations and materials referenced therein. In addition, Dr. Liang may rely upon materials produced by the State and any new information which comes into the possession of PFS.

Utah R – Emergency Plan

Name and Address: Dr. Carlton Britton
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.

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.

C. GENERAL DOCUMENT REQUESTS

The State requests the Applicant to produce the following documents directly or indirectly within its possession, custody or control to the extent not previously produced by the Applicant during informal discovery:

REQUEST NO. 1. All documents in your possession, custody or control that are identified, referred to or used in any way in responding to all of the above general interrogatories and the following interrogatories and requests for admissions relating to specific contentions.

APPLICANT'S RESPONSE: To the extent PFS has not previously produced such documents, PFS will forward them this week to its repository of documents maintained at Parsons, Behle and Latimer in Salt Lake City, except for certain documents that General Cole has reviewed which PFS will make available for review by the State in Washington, D.C at its request.

REQUEST NO. 2. To the extent that PFS has not already produced documents to date, all documents in your possession, custody or control relevant to each Utah admitted contention, and to the extent possible, segregated by contention and separated from already produced documents.

APPLICANT'S RESPONSE: PFS has produced to the State during informal discovery all relevant documents not privileged and will continue to identify and produce all such documents not previously produced. See Response to General Interrogatory No. 2. Additional relevant documents identified in response to the specific document

requests herein are being forwarded this week to PFS's document repository at Parsons, Behle and Latimer.

REQUEST NO. 3. All documents (including experts' opinions, workpapers, affidavits, and other materials used to render such opinion) supporting or otherwise relating to testimony or evidence that you intend to use at the hearings on each Utah admitted contention.

APPLICANT'S RESPONSE: Applicant objects to this request as being overly broad, vague and unduly burdensome. Applicant will produce such documents as agreed to by the State and PFS with respect to experts as provided for by General Interrogatory No. 5.

II. UTAH CONTENTION B (License Needed for Intermodal Transfer Facility)

A. INTERROGATORIES – Utah Contention B

INTERROGATORY NO. 1. Expand on your answer to the EIS RAI Response, question 1-2, by describing with specificity the actual design and specifications, including but not limited to, turning radius of the heavy haul tractor/trailers PFS or its agents may acquire for use at the ITF; the minimum and maximum number of tractor/trailers PFS or its agent may acquire; where specifically maintenance of the tractor/trailers will be conducted at the ITF; and the amount of time heavy haul transfer operations will take, commencing with the unloading of a cask from a rail car at the ITF to receipt and inspection at the ISFSI.

APPLICANT'S RESPONSE: The Applicant objects to this interrogatory based on the Board's ruling admitting Utah Contention B in part only. The Board rejected subparts 2 and 3 of the State's contention as originally submitted concerning, among other issues, the number and reliability of the heavy haul tractor trailers and the potential for queuing at the ITP. Private Fuel Storage, L.L.C. (Independent Spent Fuel Storage

Installation), LBP-98-7, 47 NRC 142, 184-85 (1998). Thus, the information sought in this interrogatory going to the reliability of the heavy haul tractor trailers (i.e. the trailers' design and specification) and the potential for queuing (number of tractor trailers to be acquired and length of time for heavy haul transfer operations) is beyond the scope of this Contention as admitted by the Board. Without waiving this objection, the Applicant responds as follows:

Actual design and specifications of the heavy haul tractor/trailers

The actual design of the heavy haul tractor/trailers has not been performed at this time, nor have any design specifications been prepared or any contracts for a design been awarded. However, the actual design will be an "off-the-shelf" design readily available from a qualified vendor such as the three vendors, Aspen, Talbert, and Trail King, that have previously provided trailer information. The procurement process of the trailers, which will lead to possession of the actual design of the trailer, will not occur until sometime around early 2001.

As noted in the subject RAI response, information (catalog data showing the side view, overall dimensions, and turning capability) from the referenced trailer manufacturers that has been previously provided to the State was acquired to provide the project with guidance for the preliminary layout of the Intermodal Transfer Point and Canister Transfer Building. Because the specific design has not been procured at this time, conservative assumptions (longest trailer length, widest turning radii, etc.) were used to ensure the design will accommodate the actual units.

As stated in the subject RAI response, the heavy haul trailers range from 150 ft to 180 ft in length and are typically 11 ft wide. The trailers will have about 100 tires to distribute the weight within typical highway limits. The trailers are articulated, that is they can pivot in several places and include steerable axles to accommodate tight radius turning. The turning radius ranges 75 ft to 150 ft, depending on whether steerable dollies are used.

The maximum travel speed is usually determined by state permit requirements, which consider the road condition, load weight and size, etc. The trailers are typically designed to travel normal highway speeds.

Number of tractor/trailers PFS may acquire

As stated in the subject RAI response, a minimum of 2 heavy haul tractor/trailer units would be required in order to move 100 to 200 casks per year if the casks were transported by highway from the ITP to the PFSF.

Location where maintenance of the tractor/trailers will be conducted at the ITF

The Intermodal Transfer Point is not designed to perform maintenance of the tractor/trailers. Rather, as noted in the subject RAI response, maintenance activities will be conducted at the PFSF Operation & Maintenance Building, except such maintenance duties that are complex enough in nature that they require off-site contracted major maintenance such as engine overhauls, etc.

Amount of time heavy haul transfer operations will take at the ITF

As stated in the response to RAI ITP-1(a), the rail car will be positioned under the ITP crane, which will lift the cask/transport cradle off the rail car, move over the heavy haul trailer, and lower the cask/transport cradle onto the trailer. Once road ready, the shipment will be transported, along Skull Valley Road to the ISFSI where the receipt inspection process for storage will occur.

The cask/transport cradle will be moved as a unit, complete with the impact limiters as required to maintain 10 CFR 71 requirements. This will minimize the time for transfer from the rail car to the heavy haul trailer since the shipment will not be dismantled and reassembled. The amount of time for this transfer is estimated to be up to 4 hours.

As stated in Section 4.3.7 of the Environmental Report the heavy haul tractor/trailers will travel at an estimated 20 mph when loaded with spent fuel. Since it is 26 miles from the ITP to the PFS, the trip will take approximately 2 hours with consideration of start/stop time. Therefore, the total amount of time for transferring the transportation cask from rail car to the PFS will be approximately 6 hours.

INTERROGATORY NO. 2. Expand on your answer to the EIS RAI Response, question 1-2, by describing with specificity the actual design and specifications, including but not limited to turning radius and maximum travel speed, of the rail cars PFS or its agents may acquire for cross country cask transportation; the date on which PFS or its agents expect to make a decision on the final rail car design; the date(s) on which rail car orders will be placed; the minimum and maximum number of rail cars PFS or its agents will acquire; where specifically the rail cars will be parked at the ITF or nearby area;

where specifically the rail cars and locomotives will be maintained at the ITF; and where diesel fuel will be stored.

APPLICANT'S RESPONSE: The Applicant objects to this interrogatory on the same grounds as set forth above with respect to Interrogatory No. 1 for Utah Contentions B, that is the Interrogatory requests information beyond the scope of Contention B as admitted by the Board. Without waiving this objection, Applicant answers as follows:

Actual design and specifications of the rail cars

The actual design of the rail cars has not been performed at this time, nor have any design specifications been prepared or any contracts for a design been awarded. As stated in the subject RAI response, the rail cars will be designed similar to a heavy duty 145 ton flatbed car with 3 axle-trucks or depressed center flatbed car with double bolsters (two sets of 2-axle trucks).

Since, the final design has not been performed on the rail car, the turning radius of the cask car has not been determined. However, the car will be approximately 75 feet in length and will be capable of turning a fairly tight radius. The minimum radius that the rail car can negotiate is dependent on various factors such as car length. The radius that the rail car will actually travel is dependent on the track configuration. The rail line for the PFSF shown in Figures 4.5-3 (Intermodal Transfer Point) and 4.5.6 (Low Corridor Rail Line) of the PFS Safety Analysis Report are designed with 3000 ft radii curves, which are unrestrictive.

The maximum speed at which the rail cars will travel has not been finally determined, although PFS's current objective is to design the rail cars such that they could travel at speeds up to 55 miles per hour.

Date of final rail car design and rail car order

The final rail car design will be determined when the PFS awards a contract for fabrication of the cars. The date for the award will be sometime in mid-2000.

Number of rail cars PFS will acquire

As stated in the subject RAI response, a minimum of 2 fleets would be used to transport the casks to the PFSF in order to move 100 to 200 casks per year. Each fleet would consist of 3 to 6 rail cars. It has not been determined at this time whether any more fleets would be required or purchased.

Location where the rail cars will be parked at the ITF or nearby area

As stated in the subject RAI response, If the intermodal transfer point is utilized, parking for the rail cars, when not in use, will either be provided on one of the intermodal transfer point siding tracks or at leased space.

Location where the rail cars and locomotives will be maintained at the ITF

The Intermodal Transfer Point is not designed to provide maintenance for the rail car and locomotive. As stated in the subject RAI response, overhauls and maintenance will be performed in a privately operated railroad equipment servicing shop.

Location where diesel fuel will be stored

As stated in the commitment resolution letter dated March 24, 1999 response, there will be a diesel fuel storage tank located near the restricted area fence approximately 200 ft northeast of the PFSF Canister Transfer Building. However, this tank will supply fuel oil only for the cask transporters. It has not been determined at this time whether to incorporate a second diesel storage tank nearer the rail tracks toward the west side of the facility or whether to utilize a mobile diesel tank truck that can use the perimeter road to access and refuel the locomotives from just outside the west side of the restricted area fences. There will be no diesel fuel stored at the ITP.

INTERROGATORY NO. 3. Expand on your answer to the Second Round RAI Safety Response, question Intermodal Transfer Point (designated by PFS as "PFSF Safety RAI No. 2, ITP-1") by describing with specificity the scope and coverage, including but not limited to inclusions and exclusions, of the proposed "transportation services agreement" PFS intends to enter into with utilities that may ship spent nuclear fuel to the proposed ISFSI for among other things rail car to heavy haul truck intermodal transfer operations; road transportation of casks from the ITF to the proposed ISFSI; rail services from the reactor site to the proposed ISFSI via the Low rail spur; continuous security and escort services of fuel shipments; communications with local emergency responders; and coordination with law enforcement.

APPLICANT'S RESPONSE: Applicant objects to this interrogatory to the extent that it requests information on rail services from the reactor site to the proposed ISFSI via the rail line from Low to the site as being beyond the scope of this contention. In response to the remainder of this interrogatory, Applicant states that it has not developed information beyond that set forth in response to PFSF Safety RAI No. 2, ITP-1

as to the specific scope and coverage of a “transportation services agreement” under which it would provide transportation services to utility reactor licensees.

B. DOCUMENT REQUESTS – Utah Contention B

The State requests the Applicant to produce the following documents directly or indirectly within its possession, custody or control to the extent not previously produced by the Applicant during informal discovery:

**APPLICANT’S OBJECTION
TO DOCUMENT REQUESTS 1 TO 7**

Applicant objects to Document Requests 1 to 7 below on the same basis as its objection to Interrogatories No. 1 and 2 for Utah Contention B above, in that they request information beyond the scope of Utah Contention B as admitted by the Board.

REQUEST NO. 1. All designs, specifications, drawings, reports, correspondence, including e-mails and telephone and meeting notes, and other documents that relate to the heavy haul tractor/trailers PFS may use to transport spent nuclear fuel casks from the ITF to the proposed ISFSI.

APPLICANT’S RESPONSE: Without waiving the above objection, Applicant states that it produced all relevant documents identified during informal discovery and that it has not currently identified any additional relevant documents to produce.

REQUEST NO. 2. All designs, specifications, drawings, reports, correspondence, including e-mails and telephone and meeting notes, and other documents, referring or relating to the present status and acquisition of the heavy haul tractor/trailers PFS may use to transport spent nuclear fuel casks from the ITF to the proposed ISFSI.

APPLICANT’S RESPONSE: Without waiving the above objection, Applicant states that no formal designs, specifications, drawings, reports, correspondence or

documents referring or relating to the present status and acquisition of the heavy haul tractor/trailers that PFS may use to transport spent nuclear fuel casks, have been prepared or produced as of this time.

REQUEST NO. 3. Any document, including but not limited to designs, specifications, drawings, reports, correspondence, e-mails, telephone and meeting notes, and other documents referring or relating to the rail cars PFS may use to transport spent nuclear fuel casks from the reactor sites to the proposed ISFSI.

APPLICANT'S RESPONSE: Without waiving the above objections, Applicant states that the detailed design, procurement specifications and drawings have not been prepared at this point in the project. In addition to reports, correspondence and other documents provided during informal discovery, Applicant has identified recently generated documents responsive to the above request which it will forward this week to its document repository at Parsons Behle and Latimer.

REQUEST NO. 4. Any document, including but not limited to designs, specifications, drawings, reports, correspondence, e-mails, telephone and meeting notes, and other documents, referring or relating to the present status and acquisition of the rail cars PFS may use to transport spent nuclear fuel casks from the reactor sites to the proposed ISFSI.

APPLICANT'S RESPONSE: Without waiving the above objection, Applicant states that the detailed design, procurement specifications and drawings have not been prepared at this point in the project. In addition to reports, correspondence and other documents provided during informal discovery, Applicant has identified recently generated documents responsive to the above request which it will forward this week to its document repository at Parsons Behle and Latimer.

REQUEST NO. 5. Any document, including but not limited to reports, correspondence, e-mails and telephone and meeting notes, between PFS and the U.S. Department of Transportation (“DOT”) or the American Association of Railroads (“AAR”) referring or relating to any type of required approvals or recommendations from DOT or AAR for the design and operation of the rail cars PFS may use to transport spent nuclear fuel casks from the reactor sites to the proposed ISFSI.

APPLICANT’S RESPONSE: Without waiving the above objections, Applicant states that in addition to documents previously provided during informal discovery, Applicant has identified recently generated documents between PFS and TTCI which it will forward this week to its document repository at Parsons Behle and Latimer.

REQUEST NO. 6. Any document, including but not limited to reports, correspondence, e-mails and telephone and meeting notes, referring or relating to regulatory approvals for and ownership, maintenance, and operation of the 32 miles rail line from the Union Pacific main line at Low to the proposed ISFSI.

APPLICANT’S RESPONSE: Without waiving the above objections, Applicant states that in addition to documents previously provided during informal discovery, Applicant has identified recently generated documents which it will forward this week to its document repository at Parsons Behle and Latimer.

REQUEST NO. 7. Any document, including but not limited to reports, correspondence, e-mails, telephone and meeting notes, or other documents referring or relating to Price-Anderson insurance coverage of shipments of spent fuel to the proposed ISFSI en route from: (a) for those reactor sites that do not have direct rail access, a reactor site to the main rail line; (b) the main rail line to the ITF; (c) the main line to the point at which the Low rail spur leaves the Union Pacific main line; and (d) the Low rail spur from the Union Pacific main line to the proposed ISFSI.

APPLICANT’S RESPONSE: Without waiving the above objection, Applicant states that it has identified no such documents.

REQUEST NO. 8 and NO. 9. Document Requests No. 8 and No. 9 relate to PFS's response to the Intermodal Transfer Point question in the Second Round Safety RAIs (designated by PFS as "PFSF Safety RAI No. 2, ITP-1). In its part (a) RAI response to the Intermodal Transfer question, PFS states it may perform intermodal transfer operations "as a common/contract carrier under a transportation services agreement with the utility customers or PFS may arrange for a third party to perform such services for the utility customers... [or PFS] may act as a broker."

REQUEST NO 8. Any draft, proposed or final contract, arrangement, or agreement, or any other document, including correspondence, e-mails and telephone and meeting notes, referring or relating in any way to: (a) a transportation services agreement with any utility customer for intermodal transfer operations at the ITF; (b) a third party performing intermodal transfer operations at the ITF; and (c) brokerage by PFS to perform intermodal transfer operations at the ITF.

APPLICANT'S RESPONSE: Applicant has not identified any such documents.

REQUEST NO. 9. In part (b) of its Second Round Safety RAIs Response to the Intermodal Transfer question, PFS refers to a rail choice option. Produce all documents referring or relating to contractual, formal or other arrangements PFS will provide for the rail transportation of spent nuclear fuel casks to the proposed ISFSI site.

APPLICANT'S RESPONSE: Applicant has not identified any such documents.

III. UTAH CONTENTION C (Failure to Demonstrate Compliance With NRC Dose Limits)

The following requests for admissions and interrogatories are based on revised accident dose calculations, included as an attachment, and submitted to NRC on February 11, 1999 under separate cover, to the Second Round Safety RAI Response. The accident dose calculations were prepared by Dade Moeller and Associates for Stone and Webster, and are presented in two reports: UR-010, "RESRAD Pathway Analysis Following Deposition of Radioactive Material From the Accident Plumes" (February 9, 1999); and UR-009, "Accident Dose Calculations at 500m and 3219m Downwind for Canister Leakage Under Hypothetical Accident Conditions for the Holtec MPC-68 and SNC TranStor Canisters" (February 9, 1999). The revised calculations make a number of assumptions whose bases are unexplained.

APPLICANT'S OBJECTION TO UTAH C DISCOVERY REQUESTS

Objection No. 1: The Applicant objects to this discovery request in its entirety on the grounds that it is beyond the scope of the admitted contention. “[T]he NRC Rules of Practice limit discovery to the boundaries of admitted contentions.”⁴ Moreover, the Appeal Board has emphasized that “the scope of a contention is determined by the ‘literal terms’ of the contention, coupled with its stated bases.”⁵ Here the boundaries and the stated bases of the Utah Contention C concern alleged deficiencies in the PFS’s original accident dose calculation based on alleged selective and inappropriate use of data and information from NUREG-1536 and SAND80-2124 and PFS’s failure to consider other applicable dose pathways in addition to inhalation from the passing cloud. The Applicant, however, has subsequently done a revised analyses – referred to in the introduction to the State’s requests for Utah C above – in which it no longer relies upon information or assumptions from NUREG-1536 and SAND80-2124 and further considers other applicable dose pathways in addition to inhalation from the passing cloud. Thus, the Applicant is now consistent with the specific points raised by the State in Utah C and the claims raised by that contention are now moot. The Applicant is filing today a motion for summary disposition with respect to Utah C on that basis.

⁴ Vermont Yankee Nuclear Power Corporation (Vermont Yankee Nuclear Power Station), LBP-88-25, 28 NRC 394, 396 (1988) (citing Public Service Company of New Hampshire (Seabrook Station, Units 1 and 2), ALAB-899, 28 NRC 93, 97 (1988); 10 C.F.R. § 2.740(b)(1)).

⁵ Id.

The State's discovery requests that follow do not seek information related to the specific claims raised in Utah C as admitted by the Board. Thus, the requests seek material outside that "reasonably calculated to lead to the discovery of admissible evidence" relevant to the Utah C as admitted by the Board and are therefore objectionable. See 10 C.F.R. § 2.740(b)(1).

Objection No. 2. The Applicant also objects to Requests for Admissions 8-11 and Interrogatory 9 below because they relate to subject matter outside the scope of this proceeding. NRC rules "only permit[] discovery of information or documents 'relevant to the subject matter involved in the proceeding.'"⁶ The Board has excluded from the proceeding the subject of nuclear sabotage, such as might be conducted with the anti-tank missiles that are the subject of the State's discovery request. See LBP-98-7, supra, 47 NRC at 227-28 (excluding consideration of attacks on spent fuel casks with anti-tank weapons); Private Fuel Storage, L.L.C. (Independent Spent Fuel Storage Installation), LBP-98-29, 48 NRC 286, 304 & n.22 (1998) (excluding consideration of sabotage); accord Private Fuel Storage, L.L.C. (Independent Spent Fuel Storage Installation) LBP-98-13, 47 NRC 360, 372 (1998). Because Requests for Admissions 8-11 and Interrogatory 9 relate to sabotage, Applicant objects on this basis as well to responding to these requests.

⁶ Allied-General Nuclear Services (Barnwell Fuel Receiving and Storage Station), LBP-77-13, 5 NRC 489, 492 (1977) (quoting 10 C.F.R. § 2.740(b)(1)).

A. REQUESTS FOR ADMISSIONS -- Utah Contention C

REQUEST NO. 1. Do you admit that in UR-010, PFS assumes a person stands 500 meters away from a canister for 2,000 hours/year?

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection No. 1 above.

REQUEST NO. 2. Do you admit that PFS assumes that the person standing 500 meters away from a canister for 2,000 hours is a worker?

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection No. 1 above.

REQUEST NO. 3. Do you admit that PFS assumes that there will not be any full time residents at or near the fence post of the controlled area?

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection No. 1 above.

REQUEST NO. 4. Do you admit that PFS assumes that it has control over the area beyond the fence post of the controlled area?

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection No. 1 above.

REQUEST NO. 5. Do you admit that PFS assumes the leak rate for the Holtec Hi-Storm storage cask is derived from NUREG-1617?

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection No. 1 above.

REQUEST NO. 6. Do you admit that PFS assumes that the leak rate for the Holtec Hi-Storm storage cask used at the PFS facility will be the same as is permitted by NRC regulations in 10 CFR 71.51 and Appendix A.

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection No. 1 above.

REQUEST NO. 7. Do you admit that PFS has done no independent analysis to justify the assumptions described in Admissions 1 and 2 above?

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection No. 1 above.

REQUEST NO. 8. Do you admit that a TOW-2 anti-tank missile can penetrate one meter of steel, and therefore could penetrate a HI-STAR 100 metal cask.?

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection Nos. 1 and 2 above.

REQUEST NO. 9. Do you admit that a MILAN anti-tank missile can penetrate one meter of steel, and therefore could penetrate a HI-STAR 100 metal cask?

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection Nos. 1 and 2 above.

REQUEST NO. 10. Do you admit that the leak rate A2, specified in 10 CFR Part 71, Appendix A for a type B transportation cask, could be exceeded by a direct strike of a TOW-2 or MILAN anti-tank missile?

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection Nos. 1 and 2 above.

REQUEST NO. 11. Do you admit that the hole diameter calculated in NUREG/CR-6487 could be exceeded by a direct strike of a TOW-2 or MILAN anti-tank missile?

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection Nos.

1 and 2 above.

B. INTERROGATORIES -- Utah Contention C

INTERROGATORY NO. 1. Describe the basis for PFS's assumption in UR-009 and UR-010 of a 30-day exposure duration. Your answer should include a description of whether people at the fence post, 500 meters from a canister, are assumed to remain in the area or to be notified and evacuated and why, what is expected to occur during the 30-day period and why, and what occurs at the expiration of the 30-day period and why.

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection No. 1

above.

INTERROGATORY NO. 2. Justify a 30-day exposure period for each of the different exposure pathways: direct gamma from deposited radionuclides; direct gamma from the passing cloud; inhalation of gases, particulates and volatiles; and ingestion of food (for example, milk, vegetation, meat).

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection No. 1

above.

INTERROGATORY NO. 3. To the extent that you answer Requests for Admissions numbered 1 through 4 in the affirmative, please explain the basis for your answer.

To the extent that you answer Requests for Admission numbered 1 through 4 in the negative, please explain the basis for your answer.

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection No. 1

above.

INTERROGATORY NO. 4. For a thyroid dose, PFS considers iodine-129, but ignores chlorine-36, which will also be present in irradiated fuel. Please justify your failure to include chlorine-36 in the thyroid dose analysis.

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection No. 1 above.

INTERROGATORY NO. 5. In UR-010, the RESRAD pathway analysis, particulates are assumed to be deposited downwind. The deposited radioactive material is then assumed to be mixed within the top one centimeter of soil. The standard code RESRAD is then employed to calculate direct gamma, food ingestion and inhalation of resuspended particulates. Rather than artificially mix radioactive material with soil, Moeller & Associates could have directly calculated a direct gamma dose from the surface density of deposited radionuclides (pCi/m²) using FGR #12 (EPA, "External Exposure To Radionuclides In Air, Water, And Soil," EPA 402-R-93-081, September 1993), an EPA report Moeller & Associates used in calculating an immersion dose. Explain why FGR # 12 was not used in this case to calculate the direct gamma dose from the surface concentrations.

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection No. 1 above.

INTERROGATORIES NO. 6 through 8. Interrogatories 6 through 8 are based on the following information. In UR-009, Dade Moeller & Associates changes the methodology used in PFS's SAR for estimating the release of particulates, gases, and volatiles from a storage cask. The methodology is now based on NUREG-1617, "Standard Review Plan Transportation Packages for Spent Nuclear Fuel" (March 1998). NUREG-1617 is in turn based on NUREG/CR-6487, a report by Lawrence Livermore National Laboratories ("LLNL") entitled "Containment Analysis for Type B Packages Use to Transport Various Contents" (November 1996). Please answer Interrogatories 6 through 8 regarding this analysis.

INTERROGATORY NO. 6. Justify the use of NUREG-1617, which relates to transportation casks, for an accident analysis involving storage casks. Your answer should include a discussion of the unique features of a storage cask compared to a transportation cask, such as the high temperature in a storage canister, the high pressure in a storage canister, the inability to apply ANSI standard N14.5 assumed in NUREG/CR-6487 (annual test of leak rate).

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection No. 1 above.

INTERROGATORY NO. 7. To the extent that you answer Requests for Admissions 5 through 7 in the negative, please explain the basis for your answers.

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection No. 1 above.

INTERROGATORY NO. 8. Describe how vibrations and heat during transport will affect the leak rate during storage. Your answer should include consideration of the effects of spalling of crud, degradation of fuel assemblies, and the effect of transportation vibrations on weld integrity.

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection No. 1 above.

INTERROGATORY NO. 9. Please explain why a sabotage accident, such as an anti-tank missile into a HI-STAR 100 cask, should not be considered a bounding accident, rather than the slight leakage considered by the NRC in NUREG-1617. Your answer should include a discussion of the expected leak hole diameter following a direct strike by a TOW-2 or MILAN missile, and a comparison with the leak hole diameter calculated in NUREG/CR-6487.

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection Nos. 1 and 2 above.

C. DOCUMENT REQUESTS – Utah Contention C

The State requests the Applicant to produce the following documents directly or indirectly within its possession, custody or control to the extent not previously produced by the Applicant during informal discovery:

REQUEST NO. 1. Any qualitative or quantitative information and documents that relate to assumptions, calculations, and methodologies for PFS's accident dose limits analyses, exposure duration, exposure pathways, and leak rate for the Holtec casks.

APPLICANT'S RESPONSE: The Applicant objects on the basis of Objection No. 1 above.

IV. UTAH CONTENTION H (Inadequate Thermal Design)

A. INTERROGATORIES – Utah Contention H

The following interrogatories are based on proprietary information prepared by Holtec for PFS and submitted to the NRC in "HI-STORM Thermal Analysis for PFS RAI," Holtec Report No. HI-9921234 (February 9, 1999) ("Thermal Analysis").

[Proprietary Information Deleted.]

APPLICANT'S GENERAL OBJECTION TO UTAH H DISCOVERY REQUESTS

Objection No. 1: The Applicant objects to the State's discovery requests for Utah H on the grounds that the information sought is outside the scope of the contention as admitted and is thus not "reasonably calculated to lead to the discovery of admissible evidence." See 10 C.F.R. § 2.740(b)(1). The State seeks to impermissibly expand the scope of the contention by seeking information which is independent from any of the seven admitted subparts of Utah H.

The State's apparent basis for its discovery requests is that the Holtec proprietary report⁷ with respect to which it seeks discovery in Interrogatories Nos. 1-3 analyzes the conditions in Subparts 3, 4 and 5 of Utah Contention H which the State contended therein that the Applicant should have considered, but did not, in its initial application. In making this request, as in Utah C above, the State fails to abide by the Appeal Board's admonition that "the scope of a contention is determined by the 'literal terms' of the contention, coupled with its stated bases."⁸ The boundary of Subparts 3, 4 and 5 is their allegation that the Applicant "failed to take into account" certain design conditions.⁹ In effect, the State seeks to inquire into the results and basis of calculations that the State contends were never performed. Because the Applicant has evaluated the conditions set forth in Subparts 3, 4 and 5 in Utah Contention H, the claims raised by those subparts are now moot. On this basis, Applicant intends to file a motion for partial summary disposition for Utah Contention H next week.

Objection No. 2: To the extent that the State requests information that that pertains to the general thermal design of the cask, and not site specific temperature related issues, the Applicant objects on the grounds that the request is overbroad and seeks material not reasonably calculated to lead to the discovery of admissible evidence. The

⁷ HI-STORM Thermal Analysis for PFS RAI, Holtec Report No. HI-992134 (February 9, 1999).

⁸ Vermont Yankee, 28 NRC at 396.

⁹ Utah Contention H, Subpart 3. See also Utah Contention H, Subpart 4 ("fails to take into consideration"); Utah Contention H, Subpart 5 ("fails to account for").

State's requests for documents concerning the general thermal design of the casks ignores this Panel's clear instruction that the scope of the contention is limited to site specific issues.¹⁰

INTERROGATORY NO. 1. [Proprietary Information Deleted.]

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection No. 1 above.

INTERROGATORY NO. 2. [Proprietary Information Deleted.]

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection No. 1 above.

INTERROGATORY NO. 3. [Proprietary Information Deleted.]

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection No. 1 above.

B. DOCUMENT REQUESTS – Contention H

The State requests the Applicant to produce the following documents directly or indirectly within its possession, custody or control to the extent not previously produced by the Applicant during informal discovery:

¹⁰ Memorandum and Order of May 18, 1998 Ruling on Motions for Reconsideration, Private Fuel Storage, L.L.C. (Independent Spent Fuel Storage Installation), LBP-98-10, 47 NRC at 288, 295 (1998). See also LBP-98-7, 47 NRC at 185-86 ("Commission's regulatory scheme . . . establish[es] a separate cask design approval process under rulemaking procedures"). It is obvious from the broad nature of the requests that the State is seeking information in this proceeding to use generally in the Holtec cask certification rulemakings before the Commission, in which at least one docket, the State has filed comments opposing certification on thermal design issues.

REQUEST NO. 1. In addition to any documents that have been produced to date in discovery, please produce any and all documents referring or relating in any way to the thermal design of the proposed ISFSI and/or the Holtec Hi-Storm cask, including all calculations, analyses, and assumptions used to determine the design temperature of the proposed ISFSI and the Hi-Storm cask.

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection Nos. 1 and 2 above. The Applicant notes that it has produced documents relevant to site specific temperature issues and will continue to do so as it identifies such documents.

REQUEST NO. 2. [Proprietary Information Deleted.]

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection Nos. 1 and 2 above.

REQUEST NO. 3. [Proprietary Information Deleted.]

APPLICANT'S RESPONSE: Applicant objects on the basis of Objection No. 1 above.

V. CONTENTION L (Geotechnical)

A. INTERROGATORIES – Utah Contention L

The following interrogatories refer to an attachment (submitted under separate cover to NRC on February 11, 1999) to PFS's Response to the Safety RAIs, dated February 10, 1999 and relate to the diagrams for the four seismic lines accompanying Bay Geophysical Associates, Inc.'s Final Report entitled *High Resolution Seismic Shear Wave Reflection Profiling for the Identification of Faults at the Private Fuel Storage Facility Skull Valley, Utah*, dated January 1999, specifically, Interpreted Time Sections PFSF-98-A (Fig. 20), PFSF-98-B (Fig. 21), PFSF-98-C (Fig. 22) and PFSF-98-D (Fig. 23). Interrogatories No. 1 through No. 3 relate to the following notations on the insert box for each figure:

(a) Last notation in the insert box, common to Figures 20 through 23: “Colour Data Type: Traces (Smoothed),” and

(b) Fourth notation in the insert box, common to:

(i) Figures 21 through 23: “Enhanced [or Enh]... Trim Statics”

(ii) Figure 20: “RMS...”

INTERROGATORY NO. 1. Describe the purpose of “smoothing” the data (*see* notation described in (a) above) and also describe what effect “smoothing” had on processing the data used to develop Figures 20 through 23.

RESPONSE: The note “Traces (Smoothed)” that appears in the last notation in the insert box common to Figures 20 through 23 of the Bay Geophysical report simply reflects the blending of adjacent color pixels (*i.e.*, the color squares that compose a color plot) to reduce the grainy appearance of the plot. That was its purpose and it had no effect on the processing and interpretation of the data.

INTERROGATORY NO. 2. Describe how valid data were not eliminated in the “trim” process; describe the purpose of using “statics,” which flattens the data to a common horizon and de-emphasizes shallow faulting or near surface displacements; describe how PFS guarded against or compensated for such flattening or de-emphasis; and describe what processing applied to line 4, where the notation on Figure 20 refers to “RMS” as contrasted to the notation “enhanced trim statics” on Figures 21 through 23.

RESPONSE: Typically, statics compensate for elevation changes across the line, assuming that the propagation velocity in the near surface materials is constant. The purpose of the trim static application referenced in the fourth notation in the insert box to Figures 21 through 23 of the Bay Geophysical report is to enhance the amplitudes of the reflections in the zone of interest for the purpose of mitigating noise in order to facilitate the identification of significant geologic features, such as faulting. The trim statics

compensate for trace- to- trace near surface velocity aberrations that create small travel time differences at each source or receiver location. This is particularly true for shear waves, which can have exceedingly low near surface velocities (<400 feet/sec.). The slow propagation velocities exhibited by shear (S-) waves are precisely the reason that they were chosen for this survey: they provide much higher resolution than P- waves of equivalent frequencies (approximately $\frac{1}{4}$ the wavelength of P- waves above the Qp). The trade off is dealing with more severe statics caused by station to station near surface (upper several feet) velocity variations. It is also Bay Geophysical's experience from previous high-resolution shear wave surveys that these near surface perturbations cannot be satisfactorily accounted for with refraction or datum statics alone.

The data acquisition and methodology employed at the PFS site yielded a stacked seismic trace every 1.5 ft. in the subsurface. Such a high spatial sampling density justifies lateral statistical enhancements such as the trim statics referenced. On this data set, the trim statics were calculated by averaging a set of stacked traces to form a pilot, or model. Each trace within a Common Depth Point (CDP) gather was cross correlated with the pilot trace to determine the amount of time shift to apply to each trace in within the CDP gather prior to stacking. In this case, a total of 61 traces were averaged to form the pilot. The implicit assumption in using this trim statics is that the stratigraphy, or relative stratigraphic column, is consistent over a lateral distance of approximately 45 feet (30 traces x 1.5 feet per trace) on either side of the CDP. This assumption was confirmed

with Geomatrix Consultants based on their subsurface investigations, i.e., bore holes and test pits.

The validity of the trim static process is confirmed by closely spaced bore holes. Specifically, bore holes were drilled in the field to confirm the graben feature on Figure 20 between shotpoints 3100 and 3200 (faults F1 and F3) identified by Bay Geophysical's seismic data. This feature and the overall geometry of the fault set was confirmed in the field by boreholes C7 – C15. Additionally, the amount of displacement of the Qp horizon identified by the Bay Geophysical seismic data was calibrated to the fault displacements measured between the bore holes. (Geomatrix Consultants Report, 1999, Section 5.2). Geomatrix applied this calibration factor to the other faults interpreted from the seismic data. Based on comparison to these borings and other boring and trenching data, the static and enhancement methods used for final display and interpretation were chosen because the methods as applied to line A (figure 14 and 20, Bay Geophysical Associates report, 1999) best fit the geology of the area. Similar methods were used for lines C and D which were acquired after processing was completed on lines A and B.

RMS scaling was applied to line A in addition to the trim static process described above because the seismic section exhibited amplitude banding (that is, alternating bright and dim vertical zones on the profile section). This scaling is applied by increasing or decreasing the amplitude of an entire trace by a fixed factor. This factor is calculated by finding the average RMS (root mean square) amplitude of that trace between

approximately 100 and 200 milliseconds and dividing this average into the desired average amplitude. This type of scaling does not affect relative amplitudes within a specific trace nor does it flatten the data.

INTERROGATORY NO. 3. Describe how Bay Geophysical arrived at the placement of the Q_p horizon (marked in yellow on Figure 20) and Q/T (Quaternary/Tertiary) horizon (marked in blue on Figure 20); describe the supporting evidence, criteria and controls used to determine the placement of horizons Q_p and Q/T on Figure 20; and describe where the top of Paleozoic or bedrock is located on Figure 20, including the rationale for determining its location.

RESPONSE: The identification and placement of the Q_p and Q_t horizons were based on geologic information provided by Geomatrix developed from borings and other aspects of Geomatrix's evaluation of the site geology described in their report. The specific geologic criteria used to identify and place the Q_p and Q_t horizons are described in section 6.1 entitled "Identification of reflections" on page 11, of Bay Geophysical Associates report, 1999.

This high resolution shear wave seismic survey was specifically designed to provide maximum resolution in the Quaternary and Tertiary near surface sediments. The top of Paleozoic or bedrock is not located or identified on Figure 20. It is probably below the 500 millisecond line at which Figure 20 ends. Although the recording time of the data was 1 second, the data were not interpretable below about 500 milliseconds.

B. DOCUMENT REQUESTS – Utah Contention L

The State requests the Applicant to produce the following documents directly or indirectly within its possession, custody or control to the extent not previously produced by the Applicant during informal discovery:

REQUEST NO. 1. Any documents, including but not limited to data, that were independently developed without “static” or “trim” processing.

RESPONSE: The data without trim statics or AGC can be found on the CD ROM identified by bates number 32,692 as standard SEG-Y format files: UTNOTR1.SGY, UTNOTR2.SGY, UTC1.SGY and UTD1.SGY for lines A, B, C, and D, respectively, which PFS is producing in response to this request.

REQUEST NO. 2. Any velocity profiles for any and all seismic lines.

RESPONSE: These can be found in standard SEG-Y format on the CD ROM identified by bates number 32,692, which PFS is producing in response to this request. They are labeled VELLINEA.SGY, VELLINEB.SGY, VELLINEC.SGY, VELLINED.SGY, for lines A,B,C, and D, respectively.

REQUEST NO. 3. All documents relating to the rationale for the use and application of static and trim processing and smoothing the data.

RESPONSE: No such documents exist.

VI. CONTENTION O (Hydrology)

A. INTERROGATORIES – Utah Contention O

INTERROGATORY NO. 1. Describe the sanitary systems, drains, sumps and other waste generating facilities that will be connected to the septic tank(s) and drainfields at the ISFSI site; the layout and design basis for the septic system(s),

including maximum daily flow rate in gallons per day for each system; and describe plans for how PFS will monitor and sample the septic tank sludge and effluent entering the drainfield system(s).

APPLICANT'S RESPONSE:

Sanitary systems, drains, sumps and other waste generating facilities

There are two sanitary systems at the PFSF. One will process wastes from the Canister Transfer and Security & Health Physics Buildings and the other will process wastes from the Administration and Operation & Maintenance Buildings. Wastes processed by the systems will originate only from the restrooms and lunchrooms. Each sanitary system is piped to a septic tank and onto a drain field.

Layout and design basis for the septic system(s)

PFS has sized the septic system in accordance with the Uniform Plumbing Code (UPC) to consist of two 3500 gallon septic tanks each having a leach field of 1400 square feet. This is based on the number of restroom and lunchroom fixtures within the buildings.

The maximum daily flow rate of sewage produced in gallons per day is based on the daily number of personnel located in these various buildings at the site. From Table 4.2-1 of the Environmental Report, there will be an estimated 42 workers at the site. In accordance with the UPC for a factory type work environment, the maximum daily flow rate in gallons per day is approximately 650 gpd for the Canister Transfer Building and

Security & Health Physics Building septic system and approximately 400 gpd for the Administration and Operation & Maintenance Building septic system.

Monitoring and sampling of septic tank sludge and effluents

PFS does not plan to monitor or test the septic system sludge and effluents. The design of the ISFSI and the spent fuel storage system and PFS administrative controls will preclude contaminants from entering the septic system. Sludge and effluents that will exist in the septic system will only be from normal restroom and lunchroom byproducts.

INTERROGATORY NO. 2. Describe the chemicals, by name, quantity and concentration, that may be stored at the proposed ISFSI site, including at the PFS laboratory; the chemicals that may be used and lab tests that may be performed at any location at the proposed ISFSI site; the waste characteristics of any liquid waste, including but not limited to effluent from washing equipment, trucks, and other vehicles, and where and how PFS will dispose of such liquid waste.

APPLICANT'S RESPONSE: Section 2.2 of the PFSF Emergency Plan states the following:

10 CFR 72.32(a)(13) refers to the Emergency Planning and Community Right-to-Know Act of 1986, Title III, Pub. L. 99-499 (EPCRA), with respect to hazardous materials at the PFSF. EPCRA stipulates that if a facility has an extremely hazardous substance in an amount greater than the appropriate threshold planning quantity, then the facility must designate a facility Emergency Coordinator to participate in the local planning process. The PFSF will not have extremely hazardous substances present in an amount equal to or greater than the threshold planning quantities of 40 CFR 355 Appendix A.

Since limited quantities of hazardous materials will be stored and used at the PFSF, spills or other accidents involving hazardous materials do not have the potential for posing a threat to onsite or offsite personnel and would not constitute an emergency condition. The requirements of EPCRA have therefore been met with respect to hazardous materials at the PFSF. The Emergency Plan implementing procedures will contain a list of all hazardous materials used at the PFSF, including quantities, locations, use and storage requirements.

It is premature at this time to provide a detailed list of the chemicals, along with their quantities and concentrations that may be stored at the PFSF. However, it is reasonable to assume that PFSF will have normal maintenance/cleaning related chemical substances, such as commercial cleaners and solvents.

In regards to potential radioactive liquid effluents, PFSF SAR Section 7.6.4 states the following:

There are no radioactive liquid effluents generated at the PFSF. As discussed in Section 7.5.2, any water collected in the Canister Transfer Building shipping cask load/unload bay drain sumps from potential moisture gathered on the outer surfaces of shipping casks during transport is sampled and analyzed to verify it is not radioactive prior to its release. In the event contaminated water is detected, it will be collected in a suitable container, solidified so that it qualifies as solid waste, staged in the LLW holding cell while awaiting shipment offsite, and transported to a LLW disposal facility, in accordance with Radiation Protection procedures.

Maintenance fluids, such as waste oil, will be transferred to an appropriate commercial facility for disposal. There are no vehicle wash down facilities at the PFSF,

and it is not planned to wash down vehicles at the PFSF such as the heavy-haul trailers or rail cars that transport shipping casks, or the cask transporter that transfers storage casks.

INTERROGATORY NO. 3. Describe the effluents that could potentially be disposed of via any drain, to include the sump system in the Canister Transfer Building, from *inter alia* routine activities, such as equipment and cask handling operations, from spills, and by failure of employees to follow waste routing procedures; and how PFS will monitor effluents from the facilities at the ISFSI site to the septic tank system(s), such facilities to include the laboratory, the Canister Transfer Building, and locations at which maintenance operations occur.

APPLICANT'S RESPONSE: The sumps in the cask load/unload bay of the Canister Transfer Building do not have a drain, but act as closed catch basins that collect liquid that could drip off of the rail car or heavy-haul vehicle used to transport shipping casks. There are no connections from the sumps to the sewage system. PFSF SAR Section 4.7.1 states as follows in this regard:

No floor drains are located in the Canister Transfer Building to preclude the possibility of contamination entering the septic system. Shallow floor sumps are located in the center of each shipping cask load/unload bay to collect water from rain and snow that may run off onto the floor from a spent fuel shipment. Collected water will be sampled to ensure no contamination is present prior to removal.

PFSF SAR Section 7.5.2 further describes the protections against radioactive contamination as follows:

Provisions for personnel decontamination are contained in the Security and Health Physics Building. Contamination of equipment or personnel is not expected to occur under normal conditions of operation. In accordance with the

PFSLLC's policy of preventing generation of liquid radioactive waste, any necessary decontamination of equipment and personnel will be conducted using methods that produce only solid radioactive waste. Decontamination methods would typically include wiping the contaminated item with rags or paper wipes. Drain sumps are provided in the cask load/unload bay of the Canister Transfer Building which catch and collect water that drips from shipping casks (e.g. from melting snow) onto the floor. Water collected in the cask load/unload bay drain sumps is sampled and analyzed to verify it is not contaminated prior to its release. In the event contaminated water is detected, it will be collected in a suitable container, solidified by the addition of an agent such as cement or "Aquaset" so that it qualifies as solid waste, staged in the LLW holding cell while awaiting shipment offsite, and transported to a LLW disposal facility, in accordance with Radiation Protection procedures.

Drains of sinks and toilets in the Canister Transfer and Security and Health

Physics Buildings are routed by sewage system piping to the septic tank located northeast of the Security and Health Physics Building. Personnel using the sinks and toilets in these buildings will not have radioactive contamination, and radioactivity will not enter the sewage system. Strict canister handling techniques, personnel training and health physics oversight will be implemented to minimize the likelihood of any worker contamination. Further, there will be step-off pads and frisking stations at the exit from each canister transfer cell to assure personnel leaving these areas are free of radioactive contamination. Facility procedures will not permit a contaminated person to enter the rest rooms in the Canister Transfer Building. Similarly, facility procedures will not permit a contaminated person to enter the restrooms in the security and health physics building, nor wash in the sinks of this building.

The laboratory in the Security and Health Physics Building will have the capability to handle liquid as well as dry samples. An example of a liquid sample that could be brought to the laboratory for analysis is water from a sump in the cask load/unload bay of the Canister Transfer Building. If analysis determines that a liquid sample has radioactive contamination, the contaminated liquid will not be disposed of in a sink or toilet that drains to the septic system. The contaminated liquid will be transferred to a suitable container, solidified by the addition of an agent so that it qualifies as solid waste, staged in the LLW holding cell while awaiting shipment offsite, and transported to a LLW disposal facility, in accordance with Radiation Protection procedures. Facility procedures will not permit disposal of contaminated or potentially contaminated liquids down drains into the septic system, and laboratory personnel will be trained and qualified on these procedures. In addition, the liquid sample analysis area in the laboratory will be physically removed from sinks to minimize the possibility of a technician mistakenly pouring a contaminated or potentially contaminated liquid sample down a drain.

PFS does not plan to monitor the sink and toilet drains of the Canister Transfer and Security and Health Physics Buildings given the protections described above. Likewise PFS does not plan to monitor drains in the Operations and Maintenance Building or the Administration Building, which are outside the restricted area and which are routed to a separate septic tank.

Spills of hazardous substances such as diesel fuel will be contained, and countermeasures applied to mitigate the effects. Soil contaminated with diesel fuel or other hazardous substance will be removed and hauled to an appropriate commercial facility for disposal. There are no drains in the Canister Transfer Building that would route hazardous liquids, such as diesel fuel, spilled onto the floor of the building to the septic system.

INTERROGATORY NO. 4. Describe how PFS will contain, treat and dispose of spills, storm water or any other effluents from construction activities (including sanitary waste disposal) and operational activities, including but not limited to the years the concrete batch plant and asphalt plant are expected to be located and operated at the ISFSI site; from runoff from the storage pads; from activities associated with vehicle, train and equipment maintenance; and from any spills or leakage from underground or above ground petroleum, chemical or other storage tanks.

APPLICANT'S RESPONSE:

Effluents from construction activities and operational activities

Sanitary waste will be collected in standard portable sanitary facilities that will be regularly pumped out by a contractor during construction and by the sanitary system that processes the waste through the septic tank and drain field during operation.

Although not defined at this time, measures will be implemented in accordance with EPA requirements to manage stormwater (NPDES) and to ensure proper control of hazardous materials (SPCC) during construction and operation, as stated in Section 9.1.3 of the PFS Environmental Report.

Runoff from the storage pads

Runoff from the storage pads will drain and collect in the stormwater detention basin located at the north side of the facility. As stated in Section 4.2.4 of the PFS Environmental Report, water that may collect in the detention basin will dissipate by evaporation and seepage into the subsoil.

Effluents from vehicle, train and equipment maintenance

As noted in EIS RAI Response 1-2, maintenance of the heavy haul tractor/trailer, locomotives and rail cars will be typically performed at appropriate offsite locations. Maintenance of onsite vehicles and light maintenance of the heavy haul trailers will be performed in the Operations & Maintenance Building. Any maintenance related effluents will be collected and disposed at an appropriate commercial facility for disposal. No maintenance effluents will be disposed into the sanitary system or in the environment.

Spills or leakage from underground or above ground petroleum, chemical or other storage tanks.

The PFS will include liquid petroleum (propane) tanks for building heating, a diesel tank to supply fuel for onsite vehicles, the emergency diesel generator fuel tank, and fire water storage tanks. All of the tanks will be located above ground. Any liquid propane that leaks would turn into a gaseous state once it is at atmospheric pressure and would escape into the atmosphere. The emergency diesel generator day tank will be a double wall tank located on the same skid as the diesel generator. The double wall design

ensures that any leakage through the inner wall is captured and detected so that no diesel fuel escapes to the environment. PFSF will be implementing the National Fire Protection Association code, NFPA-30, governing above ground tanks which requires that the diesel fuel storage tank be surrounded by a diked area to contain the fuel should a leak occur.

INTERROGATORY NO. 5. Describe any and all environmental barriers, including but not limited to synthetic and earthen liners, hydraulic pavements, and the foundation design for the hydraulic pavements, that will be emplaced under the storage pads, in the drainage areas at the edge of the concrete storage pads, and in any retention pond; and any and all monitoring systems, including monitoring parameters, for detecting seepage from the concrete storage pads, drainage areas at the edge of the pads, and the retention pond.

APPLICANT'S RESPONSE: As stated in PFS Safety Analysis Report and the response to RAI 17-1, the canister vessels are fully welded and leak-tight under all conditions such that there is no release of radioactive material to the environment and no need for environmental barriers or monitoring systems for the concrete storage pads, drainage areas at the edge of the pads, or the detention basin. In addition, the NRC has accepted that storage confinement casks of acceptable design and construction that are sealed by welding do not require monitoring for possible radiation release. Therefore, storm-water that passes over the pads, drains into the areas at the edge of the pads or into the detention basin, is not expected to be radiologically contaminated or require an environmental barrier.

Nevertheless, as also stated in the response to RAI 17-1, the PFS considers it prudent to obtain samples of water from the detention basin to verify that storm-water runoff is contamination-free.

INTERROGATORY NO. 6. Describe the number of water wells PFS intends to drill on the Reservation; the formal arrangements between PFS and the Band to drill each well; approval from other water users who may be affected by PFS's water wells; the specific location, depth, and artesian pressure of each well; the safe annual yield of the aquifer beneath the proposed PFS wells; the projected drawdown of the aquifer from PFS's use and consumption of well water; and details of how the wells will be constructed, including the material to be used for the casing, the depth at which the casing will be perforated and how the well will be grouted.

APPLICANT'S RESPONSE:

Number of water wells PFS intends to drill on the Reservation

It is not known at this time the number of wells that will be drilled on the reservation. The exact number will depend on how much water is obtained from the reservation water supply.

Formal arrangements between PFS and the Band to drill each well

There are no formal arrangements between PFS and the Band to drill wells at this time.

Approvals from other water users who may be affected by PFS's water wells

There have been no discussions with other water users regarding the use of water wells by the PFS at this time. PFS is not aware of any required approvals for wells on reservation land. As stated in EIS RAI 8-1 dated February 18, 1999, it is not anticipated that other water users will be affected.

Specific location, depth, and artesian pressure of each well

The specific location, depth, and pressure of each well have not been determined at this time.

Annual yield of the aquifer beneath the proposed PFS well(s);

As noted in the response to EIS RAI 8-1, dated February 18, 1999:

The maximum anticipated withdrawal rate for the proposed PFSF water well will be approximately 8500 gal/day (6 gpm or 9.5 ac-ft/yr) during the first nine months of operation and will decrease thereafter. Over a 20-year period (year 2002 through 2021), the average withdrawal rate from the well will be approximately 3850 gal/day (2.7 gpm or 4.3 ac-ft/yr). It should be noted that six existing wells within five miles of the site have water rights ranging from approximately 11 to 1600 ac-ft/yr. This information and additional details on these wells are included in the response to the previous safety RAI No.1, SAR Question 2-3.

Based on anticipated PFS projected water consumption rate and the characteristics of the ground water under the site above, it has been determined that PFS's water usage will not harm the aquifer or adversely affect the supplies of nearby water users.

Projected drawdown of the aquifer from PFS's use and consumption of well water

As stated in the response to the EIS RAI 8-1, dated February 18, 1999:

Past measurements of water levels in wells in Skull Valley indicate that, as a whole, the withdrawal of water from wells has not appreciably altered the natural balance. Limited well records indicate that water levels fluctuated no more than five feet from an average mean. Only in the immediate vicinity of the Town of Dugway (16 miles from the PFSF), where water has been pumped for public supply, have water levels declined appreciably in response to pumping, indicating changes in aquifer storage.

EIS RAI 8-1 (cites omitted).

Considering that the nearest well is approximately 9,500 feet away, operation of the PFSF water well will have no adverse impacts to private or Reservation groundwater users.

Details of how the wells will be constructed

The wells construction, including the material to be used for the casing, the depth at which the casing will be perforated and how the well will be grouted, has not been determined at this time however, the actual construction will use local requirements for typical well construction as guidance.

INTERROGATORY NO. 7. At or before termination of PFS's NRC license or at or before transfer or relinquishment of the site and any buildings or structures to the Skull Valley Band of Goshute Indians, describe the PFS closure and disposal plan for the septic tank system, the retention pond, the storage pads and surrounding areas, and any contingency plans PFS has or remedial measures PFS will take for areas that may be impacted by fuel spills or other contaminants.

APPLICANT'S RESPONSE:

Septic System

Under NRC regulations, termination of PFS's NRC license (decommissioning) pertains only to structures that are radiologically activated or contaminated. Thus, the ultimate removal of the PFSF septic system is not part of the decommissioning of the facility. Moreover, the disposition of the remaining structures on the site that are not decommissioned is up to the Skull Valley Band. Thus, it has not been decided if or how the PFSF septic system would be removed.

Detention Basin

The details of the removal of the detention basin have not yet been finalized, but it will probably be covered with soil, the surface of which will be revegetated, after the decommissioning of the facility. See ER § 4.6.4.

Storage Pads

A Preliminary Decommissioning Plan is provided in Appendix B of the License Application. As discussed in this plan, the concrete storage pads will only be used to support the storage casks and it is not anticipated that they will become activated or contaminated. Although the possibility of such an occurrence is remote, it is addressed for decommissioning purposes by assuming up to 10 percent of the storage pad area will require surface decontamination. The maximum number of storage pads is 500, with each having an area of 64 ft by 30 ft, for a total area of 960,000 square feet. Ten percent of this area is 96,000 square feet, which takes no credit for the area protected by the bottom of each storage cask. As stated in the response to safety RAI No. 1, question LA 1-6, the surface decontamination of 10 percent of the storage pad area would generate approximately 290 c.f. of low level waste.

Section 4.6.4 of the ER discusses two alternatives for final disposition of the storage pads; 1) following characterization of the storage pads, any necessary decontamination, and release of the storage pads for unrestricted use, storage pads can be excavated, cut into smaller sections, and trucked off-site for disposal at a local landfill, or 2) the storage pads could be left in place and the storage area covered with soil and

replanted with native vegetation. The preferred alternative for decommissioning of the concrete storage pads is to leave them in place and cover the cask storage area with soil and replant with native vegetation.

In the event the entire removal of the pads is performed, this would involve removal of 106,667 CY of material $[(64\text{-ft} \times 30\text{-ft} \times 3\text{-ft}) \times 500 \text{ pads} = 106,667 \text{ CY}]$. Using a 20 CY truck and a factor of 0.9 to allow for void spaces, yields approximately 5,926 truckloads $[106,667 / (20 \times 0.9) = 5,926]$. Since decommissioning will occur many years into the future, location of a suitable landfill cannot be determined at this time.

Surrounding Areas

Since the philosophy of designing and operating the PFSF is "start clean, stay clean", it is not anticipated that any areas surrounding the cask storage pads will become activated or contaminated. The intention is to maintain the facility free of radiological contamination at all times. In the unlikely event contamination occurs during the operational phase of the facility, all radioactive contamination will be removed upon its discovery. As discussed in the Preliminary Decommissioning Plan, at the end of facility operations, a radiological survey of the entire PFSF site will be performed in order to verify the absence of contamination and to identify any areas requiring decontamination.

Fuel Spills or Other Contaminants

The PFSF design as well as the procedures to be followed during operation will minimize the possibility of spills of fuel or other contaminants. In the unlikely event that spills do occur they will be cleaned up upon discovery.

B. DOCUMENT REQUESTS – Utah Contention O

The State requests the Applicant to produce the following documents directly or indirectly within its possession, custody or control to the extent not previously produced by the Applicant during informal discovery:

REQUEST NO. 1. All designs, drawings or other documents referring or relating to the sanitary and wastewater systems, drains, sumps and other waste generating facilities and all monitoring systems related thereto.

APPLICANT'S RESPONSE: In addition to documents previously produced during informal discovery, Applicant will be forwarding additional documents this week to its document repository at Parsons, Behle and Latimer.

REQUEST NO. 2. All designs, drawings or other documents referring or relating to the retention pond, the septic tank system(s) and the drain fields and all monitoring systems related thereto.

APPLICANT'S RESPONSE: The general layout and location of the detention basin are shown in Figures 2.1-2 and 2.6-2 of the PFSF SAR and ER. There are no drawings of the septic tank systems in the SAR or ER. PFS has not yet developed detail designs or drawings of the detention basin or the septic tank systems and associated leaching fields but will be forwarding this week to its document repository at Parsons, Behle and Latimer certain preliminary engineering drawings. PFS does not have plans for monitoring systems related to the detention basin or septic tank systems.

REQUEST NO.3. All designs, drawings or other documents referring or relating to equipment, truck or other vehicular washing facilities or systems, and documents, including plans and drawing, describing how PFS will handle effluent from those activities.

APPLICANT'S RESPONSE: There are no vehicle washing facilities at the PFSF. In addition, PFS does not have designs or drawings for equipment washing facilities. There are no plans or drawings for handling effluents from equipment washing facilities.

REQUEST NO. 4. All documents referring or relating to spill prevention measures and effluent containment, treatment and disposal from construction, operation and maintenance activities at the proposed ISFSI site.

APPLICANT'S RESPONSE: All documents referring or relating to spill prevention measures and effluent containment, treatment and disposal from construction, operation and maintenance activities at the proposed ISFSI site, have already been provided to the State. There are no additional documents to provide at this time.

REQUEST NO. 5. All documents, including detailed design and construction drawings, referring or relating to all environmental barriers for the storage pads, the drainage areas at the edge of the storage pads, and the retention pond, and all monitoring systems relating thereto.

APPLICANT'S RESPONSE: In addition to documents previously produced during informal discovery, Applicant will be forwarding additional documents this week to its document repository at Parsons, Behle and Latimer.

REQUEST NO. 6. All designs, drawings or other documents referring or relating to the construction of water wells, including but not limited to details about the materials that will be used in the construction and grouting of the well and the size and depth of the casing perforation.

APPLICANT'S RESPONSE: All documents referring or relating to the construction of water wells, including but not limited to details about the materials that will be used in the construction and grouting of the well and the size and depth of the casing perforation, have already been provided to the State. There are no additional documents to provide at this time.

REQUEST NO. 7. All documents referring or relating to the closure of the proposed ISFSI site, including but not limited to closure and disposal of the septic tank system(s), retention pond, storage pads, and contaminated areas from spill or other pollutants.

APPLICANT'S RESPONSE: All documents referring or relating to the closure of the proposed ISFSI site, including but not limited to closure and disposal of the septic tank system(s), detention basin, storage pads, and contaminated areas from spill or other pollutants have already been provided to the State. There are no additional documents to provide at this time.

VII. CONTENTION DD (Ecology and Species)

A. INTERROGATORIES – Utah Contention DD

INTERROGATORY NO. 1. In its EIS RAI Response to Question 2-1.a (Electrical Systems, SAR Section 4.3.2), PFS states that a “new electrical line will be constructed parallel to the site access road to furnish 12.5 kV to a 480 volt site transformer located at the site.” Describe the potential impact and mitigation measures that PFS will take during the construction, operation and use of the line on the following species: peregrine falcon, bald eagle, bobolink, burrowing owl, caspian tern, common yellowthroat, ferruginous hawk, long-billed curlew, short-eared owl, Swainson's hawk, Skull Valley pocket gopher, Pohl's milkvetch and spring parsley.

APPLICANT'S OBJECTIONS AND RESPONSE: Applicant objects to this interrogatory to the extent it requests information on species other than the peregrine falcon, pocket gopher, Pohl's milkvetch, and spring parsley, because such other species are beyond the scope of Contention DD as admitted by the Board, as was expressly clarified by the Board in its Memorandum and Order of May 18, 1998 Ruling on Motions for Reconsideration. LBP-98-10, 47 NRC at 296-97 (Board limited "paragraphs one and three simply to the specific species"). With respect to the peregrine falcon, pocket gopher, Pohl's milkvetch and spring parsley, Applicant answers as follows:

Due to the lack of suitable habitat along the access road to the PFSF, the construction of a new electrical line parallel to the access road will have no impact on the peregrine falcon, Skull Valley pocket gopher, or spring parsley. Pohl's milkvetch has not been located within the project or access road areas. Furthermore, because there is very limited suitable habitat in the project area, there is no anticipated impact to Pohl's milkvetch. Notwithstanding this lack of suitable habitat or any anticipated impact, PFS will perform surveys prior to construction to confirm the absence of these species.

INTERROGATORY NO. 2. Estimate the total acreage of the Skull Valley pocket gopher's habitat which may potentially be disturbed by the construction and operation of the proposed ISFSI; and describe PFS's intended efforts to minimize the area of potential disturbance and mitigate the potential impacts on the Skull Valley pocket gopher, a rare subspecies of the pocket gopher.

APPLICANT'S RESPONSE: As discussed in Section 2.3.1.4.2 and Section 4.1.2 of the ER, no pocket gopher habitat has been located within the project area. As a

result, no pocket gopher habitat will be disturbed. However, prior to construction, surveys will be conducted to confirm the continued absence of this species.

INTERROGATORY NO. 3. Describe the frequency of traffic associated with PFS's operations, including but not limited to heavy haul truck transportation, construction vehicles, and other vehicular traffic, to and from the intermodal transfer facility at Rowley Junction to the Skull Valley ISFSI site, and the impact that the traffic frequency, and associated noise and human activity, may have on the nesting, mating, breeding and hunting activities of the peregrine falcon, bald eagle, bobolink, burrowing owl, caspian tern, common yellowthroat, ferruginous hawk, long-billed curlew, short-eared owl, and Swainson's hawk.

APPLICANT'S RESPONSE: Applicant objects to this interrogatory to the extent it seeks information on species other than peregrine falcon, in that such other species are beyond the scope of the contention as admitted by the Board. With respect to the peregrine falcon, Applicant responds as follows:

Section 4.1.7 of the ER discusses the frequency of traffic associated with the construction and operation of the project. Section 4.1.2 discusses potential impacts of this traffic and noise on the peregrine falcon. For reasons noted in Section 4.1.2, peregrine falcons are not expected to be impacted by increased traffic associated with the construction and operation of the PFSF.

INTERROGATORY NO. 4. Describe the potential impacts and effects that the construction and operation of the Low rail spur transportation corridor, including but not limited to the alteration of drainage areas, may have on the least chub (a proposed endangered species since September 29, 1995), Columbia spotted frog, milk snake, Townsend's big-eared bat, Brazilian free-tailed bat, ringtail, sage grouse, burrowing owl, and Lewis' woodpecker.

APPLICANT'S OBJECTION AND RESPONSE: Applicant objects to this interrogatory because the Board has previously dismissed any and all contentions raised by the State with respect to the low rail line transportation corridor. LBP-98-29, supra, 48 NRC 286 (1998). Applicant further objects to this interrogatory on the grounds that none of the species for which information is requested falls within the scope as Contention DD as admitted by the Board.

B. DOCUMENT REQUESTS – Utah Contention DD

The State requests the Applicant to produce the following documents directly or indirectly within its possession, custody or control to the extent not previously produced by the Applicant during informal discovery:

REQUEST NO. 1. All documents that evaluate the impact to species from the construction, operation and use of above ground electrical lines and transformers at and near the proposed ISFSI site and documents that describe the measures PFS will take to mitigate the effect of electric power lines and transformers, and associated construction and maintenance activities, on plants, animals and other species.

APPLICANT'S RESPONSE: Applicant objects to this request with respect to species other than the peregrine falcon, the pocket gopher, Pohl's milkvetch and spring parsley as being beyond the scope of the contention as admitted by the Board. With respect to these four species, Applicant states that the ER, documents referenced in the ER, and all other supporting documentation have already been provided to the State.

REQUEST NO. 2. All documents, including but not limited to reports and evaluations, of how construction, operation and decommissioning of the proposed ISFSI and Low rail spur, and vehicular and train traffic to and from the proposed ISFSI, may impact the plants, animals and other species, including but not limited to the Skull Valley pocket gopher, and the ecological effects of such activities.

APPLICANT'S RESPONSE: Applicant objects to this document request to the extent it seeks documents related to impacts of the low rail line or to species other than the peregrine falcon, the pocket gopher, Pohl's milkvetch and spring parsley as being beyond the scope of Contention DD. With respect to these four species, the Applicant states that all documents referenced in and used for the preparation of the ER have previously been provided and no additional documents have been identified evaluating the impacts with respect to these species.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "Paul Gaukler". The signature is fluid and cursive, with the first name "Paul" being more prominent than the last name "Gaukler".

Jay E. Silberg

Ernest L. Blake, Jr.

Paul A. Gaukler

SHAW, PITTMAN, POTTS & TROWBRIDGE

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Counsel for Private Fuel Storage L.L.C.

Dated: April 21, 1999

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

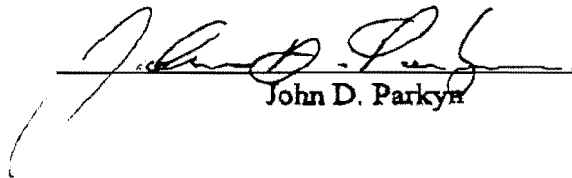
In the Matter of)	
)	
PRIVATE FUEL STORAGE L.L.C.)	Docket No. 72-22
)	
(Private Fuel Storage Facility))	ASLBP No. 97-732-02-ISFSI

AFFIDAVIT AND
VERIFICATION OF JOHN D. PARKYN

CITY OF LA CROSSE)	
)	SS:
STATE OF WISCONSIN)	


John D. Parkyn, being duly sworn, states as follows:

I am Chairman of the Board of Private Fuel Storage L.L.C. (PFS), a limited liability company organized and existing under the laws of the State of Delaware with its principal office currently located in La Crosse, Wisconsin. I have read the foregoing answers to the State's interrogatories and requests for admission and verify that the same are true to the best of my information and belief.

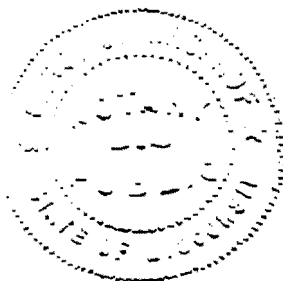


John D. Parkyn

Sworn to before me this
21st day of April, 1999



Notary Public, State of Wisconsin
My Commission Expires: June 6, 1999



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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))	

CERTIFICATE OF SERVICE

I hereby certify that copies of the Applicant's Objections and Non-Proprietary Responses to State's First Requests For Discovery and the Affidavit and Verification of John D. Parkyn 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 21st day of April 1999. The attached resumes of Applicant's witnesses are only being sent by first class mail.

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Paul A. Gaukler

RESUME OF
WILLIAM E. KENNEDY, JR.

WILLIAM E. KENNEDY, JR.

Associate

Dade Moeller & Associates

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(509) 946-0410 - Fax 946-4412*

EDUCATION/QUALIFICATIONS

M.S., Nuclear Engineering, Kansas State University, 1975.

B.S., Nuclear Engineering, Kansas State University, 1973.

Mr. Kennedy has 23 years of experience as an environmental health physicist.

POSITION

Associate, Dade Moeller & Associates, specializing in Occupational and Environmental Sciences

RELEVANT EXPERIENCE

Mr. Kennedy has extensive experience as a project manager, task leader, and individual contributor covering a broad range of health physics topics. He has experience with projects that required the practical application of information in the areas of radionuclide effluent characterization and environmental behavior, radiation dosimetry, safety assessment, radiation shielding, health physics, and statistical analysis. He has been involved with the development of the technical basis for revised standards and regulations, and has participated in evaluations and appraisals at operating nuclear facilities.

Mr. Kennedy has been involved in the development of environmental pathway and radiation dosimetry models used to assess the potential health and environmental impacts resulting from release of radionuclides to the environment. He has specialized in utilizing these models to evaluate alternatives in such areas as radioactive materials transport, radioactive waste disposal, decommissioning nuclear facilities, development of exemption or clearance levels, and evaluation of nuclear facility operating practices. Over the past 15 years, Mr. Kennedy has led and contributed to a variety of commercial low-level waste disposal projects for the U.S. Nuclear Regulatory Commission, the Electric Power Research Institute, and private industry. Mr. Kennedy was a charter member of the Low-Level Radioactive Waste Performance Assessment Peer Review Panel for the DOE representing the Hanford Site. As a member of this Panel, Mr. Kennedy served as acting chair for the review of the Savannah River Site Saltstone and E-Area Vault disposal facilities. Mr. Kennedy has served on or chaired numerous working groups and peer review panels associated with DOE high-level and low-level waste including serving on a DOE Headquarters working group to develop a technical basis for the DOE low-level waste disposal Order, chairing a DOE Headquarters working group to review the proposed U.S. Environmental Protection Agency (EPA) low-level waste regulations, serving on a Headquarters

working group to advise and review proposed revisions to the EPA high-level waste regulations, and numerous working groups to review low-level waste disposal options at the Hanford Site.

Mr. Kennedy served as the general chairman of the 26th HPS midyear symposium on Environmental Health Physics held on January 24-28, 1993, at Lake Coeur D'Alene, Idaho. He was elected to the board of directors of the Environmental Sciences Division of ANS. Mr. Kennedy has been the author or co-author of over 120 technical publications, presentations, and short courses. Mr. Kennedy served as a consultant to a National Cancer Institute committee to determine the thyroid doses that the American people may have received from ^{131}I fallout from the atmospheric testing of nuclear weapons at the Nevada Test Site. He served as a United States delegate to a special committee of the Nuclear Energy Agency (NEA) of the Organization of Economic Co-operation and Development (OECD) to determine international waste acceptance criteria for alpha emitters in low-level radioactive waste. Mr. Kennedy served as a consultant to the International Atomic Energy Agency (IAEA), Vienna, Austria, and was a member of the IAEA Advisory Groups to evaluate the "Derivation of Exempt Quantities for Application to Terrestrial Waste Disposal" and "Derivation of Exempt Quantities for Recycle of Materials from Nuclear Facilities." Mr. Kennedy has served as an invited lecturer for IAEA training courses on "Management of Radioactive Waste from Nuclear Power Plants" held in 1993 at Argonne National Laboratory and on "Safety Assessment Modeling for Low and Intermediate Radwastes" held in 1994 in Rio de Janeiro, Brazil, and in 1996 in Cairo, Egypt, and on "Environmental Monitoring" in 1997 in Kiev, Ukraine.

Mr. Kennedy served as a lecturer in low-level waste performance assessment and decommissioning standards and procedures at the 1991 Harvard University School of Public Health Continuing Education Program; as a lecturer at the 1992 HPS Summer School at Ohio State University; as an instructor at the 1992, 1994, and 1996 HPS Professional Enrichment Programs, and as a lecturer on *De Minimis* and associated Issues Related to Radioactive and Mixed Waste at the Harvard University School of Public Health Continuing Education Program. He is also a member of the National Council on Radiation Protection and Measurements Scientific Committee 87-3 on *Low-Level Radioactive Waste Performance Assessment*, and is serving as Chairman of Scientific Committee 64-21 on *Decommissioning*.

EMPLOYMENT HISTORY

1995 - Present *Dade Moeller & Associates, Inc.*

Mr. Kennedy recently joined Dade Moeller & Associates, Inc., and has been involved with the following technical areas:

- **Litigation Support** Mr. Kennedy has provided technical support on four litigation cases involving positions for both the defense and the plaintiffs. In 1985, Mr. Kennedy served on a team of experts to the defense in evaluating the doses that sheep received resulting from the 1953 nuclear test Nancy in Nevada. In 1995, he provided support during the

review of the plaintiff's scientific positions with regard to the principles of good science for the Three Mile Island Unit 2 nuclear reactor litigation. His evaluations were successfully used as part of the defense team strategy in that important litigation. Since 1995, Mr. Kennedy has been involved in a major environmental dose litigation regarding past operations of a defense nuclear facility. He also provided the health physics technical support to the defense in a litigation involving radiation exposures to workers at an in-situ uranium mining operation, and was scheduled to appear as an expert witness until the case was settled out of court in favor of the defense. In 1998, Mr. Kennedy provided technical support to the plaintiffs in a case involving radium contamination in a building. Again, he was scheduled to serve as an expert witness until the case was settled in favor of the plaintiffs out of court.

- **NCRP Scientific Committee 87-3** Mr. Kennedy is serving on the National Council on Radiation Protection and Measurements (NCRP) Scientific Committee 87-3 on Low-Level Radioactive Waste Performance Assessment. This committee is in the process of developing a document to provide a thorough review of currently acceptable national and international approaches and concepts for conducting performance assessments for-near-surface disposal of radioactive wastes.
- **Low-Level Radioactive Waste** Mr. Kennedy is involved in national and international projects and activities associated with low-level radioactive waste management. Mr. Kennedy was invited to serve on an international peer review panel to evaluate the Japan Nuclear Fuel Limited (JNFL) design for the Phase 2 low-level waste disposal facility at Rokkasho, Japan. The focus of this review was to evaluate the disposal system design and performance relative to gas generation issues, within the context of approaches taken in other countries. He was selected by Westinghouse Hanford Company as a member of a Peer Review Panel for Ground Water Recharge at the Hanford Site. This panel included members from academia and industry, and Mr. Kennedy was asked to develop the draft and final summary of the Peer Review Panel comments and conclusions. Mr. Kennedy is also a lecturer at Low-Level Radioactive Waste short courses presented to the U.S. Department of Energy Operations Offices as part of their continuing education requirements.
- **ANSI Standard N13.12** Mr. Kennedy is serving as the chairman of ANSI Standard N13.12 *Surface and Volume Radioactivity Standards for Unconditional Clearance*. This standard was initiated in 1964 and earlier drafts resulted in the development of Regulatory Guide 1.86 by the NRC. This standard continues to be one of the most highly needed and controversial standards considered for the nuclear industry.
- **Development of Authorized Limits** Mr. Kennedy provided support to contractors at the Hanford Site in the development of authorized limits for specific materials and waste streams. For Westinghouse Hanford Company, Mr. Kennedy evaluated the release of occupational and environmental samples for offsite analysis. For Waste Management Federal Services of Hanford, Inc., Mr. Kennedy evaluated the potential for application of

authorized limits to reduce mixed waste streams. The process of the development of authorized limits may have a major impact on DOE operations and the management of radioactive materials.

1975 - 1995 *Battelle, Pacific Northwest Laboratory*

As a Staff Scientist and Technical Group Leader for Environmental Health Physics, Mr. Kennedy led or contributed to a number of specific projects and tasks including:

- **Environmental Protection Support and Assistance.** From 1984 to 1995, Mr. Kennedy was project manager and a principal technical contributor for the Environmental Protection Support and Assistance project currently sponsored by the U.S. Department of Energy (DOE), Office of Environmental Guidance. This project provided DOE with a broad, flexible resource of technical expertise necessary to assist in fulfilling DOE's environmental protection responsibilities. The technical assistance was provided in three major areas: 1) research relating to key environmental protection or regulatory compliance issues, 2) technical review and assessment of proposed environmental standards, and 3) development of improvements for DOE environmental protection programs. Recent documents were published regarding the development of control levels for metal recycle and release of materials to regulated hazardous waste treatment and disposal facilities.
- **Residual Radioactive Contamination from Decommissioning.** In support of the development of a revised U.S. Nuclear Regulatory Commission (NRC) Policy concerning exemption of sources and practices from regulatory control, Mr. Kennedy managed an effort to develop a technical basis for translating contamination levels to annual dose. In October 1992, a final report (NUREG/CR-5512, Vol. 1) was released. The document contains a description of a generic radiation exposure scenario analysis for residual radioactive materials in buildings and soil. The analysis accounts for both volume and surface sources in buildings, and for both soil concentrations and the total inventory left at a site. The result of the analysis is an evaluation of the total effective dose equivalent (TEDE) to an average individual in a population group exposed to a unit concentration of residual radioactive material after decommissioning. The technical basis is being used by the NRC to develop screening values for determining license termination conditions that are consistent with their revised policy.
- **Biotic Transport.** Mr. Kennedy was a primary contributor to a project conducted for the NRC to determine the relevance of biotic pathways to the long-term regulation of radioactive waste disposal. He was a co-author of six documents and was the lead author of a journal article reporting the results of this work. His primary areas of involvement included the development of an "order-of-magnitude" model to describe the transport of radionuclides from low-level waste disposal sites by biotic processes, and the comparison of doses to man with doses resulting from human intrusion scenarios. These comparisons were made for the ecological communities specific to both arid and humid regions.

- **Dose Assessment for Sheep Exposed to Fallout from Nuclear Test Nancy.** Mr. Kennedy was a principal contributor in a study for DOE designed to estimate radiation doses received by sheep in Nevada from radioactive fallout resulting from a nuclear test conducted at the Nevada Test Site in the 1950's. His involvement included the modification of existing exposure pathway and dosimetry models and directing changes to the accompanying computer programs. Metabolic and physiological data for sheep were obtained from the literature and used where possible to develop internal dosimetry models specific to sheep. The types of doses estimated included: inhalation during plume passage, external exposure during plume passage, external exposure to deposited radionuclides, beta exposure of exposed skin, ingestion of contaminated vegetation and soil, localized exposure of the rumen wall, and doses to fetal lambs. The results were presented in the form of a "best estimate" of the doses.

PROFESSIONAL ACTIVITIES

Mr. Kennedy is a member of both the local and national chapters of the Health Physics Society (HPS), the American Nuclear Society (ANS), and the International Society of Exposure Assessment (ISEA). He is serving as a member of the Board of Directors of the HPS and he served on the State and Federal Legislation committee of the HPS in 1989, received the prestigious 1990 Elda E. Anderson Award, and was named "Health Physicist of the Year" for 1985 by the Columbia Chapter. Mr. Kennedy served as President of the Columbia Chapter of the Health Physics Society for 1995-1996.

PUBLICATIONS

Book Chapters

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Presentations

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Kennedy, W. E., Jr., and S. Y. Chen. 1998. Development of ANSI N13.12 Standards on Release of Surface or Volume Sources." Presented at the 43rd Annual Meeting of the Health Physics Society, July 12-16, 1998, Minneapolis, Minnesota.

Kennedy, W. E., Jr. 1997. "Environmental Transport I, II and III: Atmospheric, Surface and Ground Water, and Biological." Presented at the Third Summer School on Environmental Radiation Monitoring Techniques, August 25 - September 5, 1997, Ukrainian Radiation Training Centre, Kiev, Ukraine.

Kennedy, W. E., Jr. 1997. "Design of Surveillance Programs and Errors and Uncertainties in Sampling and Analysis." Presented at the Third Summer School on Environmental Radiation Monitoring Techniques, August 25 - September 5, 1997, Ukrainian Radiation Training Centre, Kiev, Ukraine.

Kennedy, W. E., Jr. 1997. "Pathway Analysis and Environmental Dosimetry and Dose Reconstruction." Presented at the Third Summer School on Environmental Radiation Monitoring Techniques, August 25 - September 5, 1997, Ukrainian Radiation Training Centre, Kiev, Ukraine.

Kennedy, W. E., Jr. 1997. "Performance Assessment and Modeling Low-Level Waste Facilities." Continuing Education Course presented at Harvard University, School of Public Health, June 19, 1997, Boston Massachusetts.

Kennedy, W. E., Jr. 1997. "General Perspective on Performance Assessment." Presented at the 18th Low-Level Radioactive Waste Management Conference, May 20-22, 1997, Salt Lake City, Utah.

Kennedy, W. E., Jr. 1997. "Realistic Risk Estimates vs Worst Case Scenarios in Developing ANSI N13.12 Release Criteria." Presented at WM Symposia on the Role of Risk Assessment in Developing Reasonable Policy and Regulation, April 16-17, 1997, Washington, D.C.

Kennedy, W. E., Jr. 1996. "*De Minimis* and Associated Issues Related to Radioactive and Mixed Wastes." Continuing Education Course presented at Harvard University, School of Public Health, June 12, 1996, Boston Massachusetts.

Kennedy, W. E., Jr. 1996. "Release Criteria: Where Have We Been, Where are We Going"? Presented as a Professional Enrichment Program at the 29th Midyear Meeting of the Health Physics Society, January 7, 1996, Scottsdale, Arizona.

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Kennedy, W.E., Jr. 1995. "Performance Assessment for DOE LLW." Presented at the Hanford Site Recharge Workshop, May 22-23, 1995, Richland, Washington.

Kennedy, W. E., Jr, R. L. Hill, R. L. Aaberg, and A. Wallo, III. 1994. "Radiological Control Criteria for Materials Considered for Recycle and Reuse." PNL-SA-22796. Presented at the Second Workshop on Residual Radioactivity and Recycling Criteria, jointly sponsored by the U.S. Environmental Protection Agency and the Japan Atomic Energy Research Institute, November 9-11, 1994, Tokai, Japan.

Kennedy, W. E., Jr. 1994. "How Clean is Clean Enough? The Evolution of Decommissioning Standards." Opening Address at the "How Clean is Clean?" Workshop at Waste Management '94, Tucson, Arizona.

Kennedy, W. E., Jr. 1994. "Low-Level Radioactive Waste Performance Assessment: Principles and Future Directions." PNL-SA-23684 A. Presented as a Continuing Education Course at the 27th Midyear Topical Meeting of the Health Physics Society, February 14-16, 1994, Albany, New York.

Kennedy, W. E., Jr. 1993. "Low-Level Radioactive Waste Disposal in the United States: An Overview of Current Commercial Regulations and Concepts." PNL-SA-22886. Presented at the International Atomic Energy Agency Training Course on Management of Radioactive Wastes from Nuclear Power Plants (Lecture 3.1), August 25, 1993, Argonne National Laboratory, Argonne, Illinois.

Kennedy, W. E., Jr., R. L. Hill, and R. L. Aaberg. 1993. "Control Levels for Residual Contamination in Materials Considered for Recycle and Reuse." PNL-SA-22796. Presented at the International Atomic Energy Agency Specialists Meeting on Experience in the Application of Exemption Principles, November 2-4, 1993, Vienna, Austria.

Hill, R. L., R. L. Aaberg, D. A. Baker, and W. E. Kennedy, Jr. 1993. "Control Levels for Residual Contamination in Materials Considered for Recycle and Reuse." PNL-SA-21839. Presented at the American Nuclear Society Topical Meeting on Environmental Transport and Dosimetry, September 1-3, 1993, Charleston, South Carolina.

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Wallo, A., H. T. Peterson, R. L. Aaberg, M. F. Jarvis, and W. E. Kennedy, Jr. 1993. "Radiation Control Criteria for Mixed Wastes Generated at Department of Energy Facilities." Poster presented at the 26th Midyear Topical Meeting of the Health Physics Society, January 24-28, 1993, Lake Coeur d'Alene, Idaho.

Kennedy, W. E., Jr. 1992. "Residual Radioactivity Criteria." PNL-SA-21061, presented at the Health Physics Society Summer School, Columbus, Ohio.

Kennedy, W. E., Jr. 1992. "Risk-Based Cleanup Standards." PNL-SA-21060, presented at the Health Physics Society Summer School, Columbus, Ohio.

Kennedy, W. E., Jr. 1992. "Translating Residual Radioactive Contamination Levels to Annual Dose." PNL-SA-20692, presented as a Professional Enrichment Program at the 37th Annual Meeting of the Health Physics Society, Columbus, Ohio.

Kennedy, W. E., Jr., and R. A. Meck. 1992. "Technical Basis for Establishing Residual Radioactive Concentrations." PNL-SA-18646, presented at the 25th Midyear Topical Symposium of the Health Physics Society, Dearborn, Michigan.

Kennedy, W. E., Jr. 1991. "Exemption from Regulatory Control." PNL-SA-19625A, presented at the Hanford Technical Exchange, Richland Washington.

Kennedy, W. E., Jr., and R. L. Aaberg. 1991. "Derivation of IAEA Exempt Quantities for Recycle and Reuse." PNL-SA-19004A, presented at the Annual Health Physics Society Meeting, Washington, D.C.

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Kennedy, W. E., Jr. 1991. "Decontamination and Decommissioning: Standards and Procedures." 1991. PNL-SA-19452A, presented at the Advanced Workshop on Occupational and Environmental Radiation Protection, Harvard School of Public Health, Boston, Massachusetts.

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Kennedy, W. E., Jr. 1990. "Residual Radioactivity Contamination Limits for Decommissioning." PNL-SA-18591A, presented at the Fuel Cycle Facilities Forum Meeting, Richland, Washington.

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Hickey, E. E., and W. E. Kennedy, Jr. 1989. "A Review of Environmental Radiological Data From U.S. Department of Energy Nuclear Sites." PNL-SA-16516A, presented at the Annual Meeting of the Health Physics Society, Albuquerque, New Mexico.

Kennedy, W. E., Jr. 1989. "Applied Modeling Studies to Develop Radiological Release Criteria." PNL-SA-16930A, presented at the U.S. Department of Energy Workshop on Offsite Release Criteria for Contaminated Materials, Oak Ridge, Tennessee.

Kennedy, W. E. Jr. 1989. "Practical Considerations in the Development, Distribution, and Reliance on Computer Software." PNL-SA-16732A, presented at the Columbia Chapter, Health Physics Society Symposium on Computer Applications in Health Physics: 1989 Update, Richland, Washington.

Kennedy, W. E., Jr. 1988. "Principles of Performance Assessment." PNL-SA-16083A, presented at the American Society of Mechanical Engineers (ASME) Hazardous Waste Conference, Tacoma, Washington.

Kennedy, W. E., Jr. 1988. "Pathway Analysis Models for Establishing Concentration Limits in Contaminated Soils." PNL-SA-16383A, presented at the U.S. Department of Energy Workshop on the Management of Contaminated Soils, Knoxville, Tennessee.

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Kennedy, W. E., Jr., and J. P. Corley. 1986. "Application of the ICRP Recommendations to Revised Secondary Radiation Protection Standards." PNL-SA-13965, presented at the Twenty-Fifth Hanford Life Sciences Symposium, Richland, Washington.

Kennedy, W. E., Jr., and B. A. Napier. 1986. "Allowable Residual Contamination Levels for Decommissioning: Revisions to the Method." PNL-SA-13399, presented at the Nineteenth Topical Symposium of the Health Physics Society, Knoxville, Tennessee.

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Kennedy, W. E., Jr., R. A. Peloquin, and B. A. Napier. 1985. "Intruder Dose Pathway Analysis for the Onsite Disposal of Radioactive Wastes." PNL-SA-12437, presented at the Eighteenth Topical Symposium of the Health Physics Society held in Colorado Springs, Colorado.

Kennedy, W. E., Jr., R. A. Peloquin, B. A. Napier, and S. M. Neuder. 1985. "Onsite Disposal of Commercial Radioactive Wastes: The ONSITE/MAXI1 Computer Program." PNL-SA-13265S, presented at the 1985 Winter Meeting of the American Nuclear Society, San Francisco, California.

Marks, S., F. T. Cross, D. H. Denham, and W. E. Kennedy, Jr. 1985. "Estimation of Health Effects Due to Elevated Radiation Exposure Levels in Structures." PNL-SA-11187, presented at the Seminar on Exposure to Enhanced Natural Radiation and Its Implications, Maastricht, The Netherlands.

Neuder, S. M., W. E. Kennedy, Jr., and C. Fasano. 1985. "Onsite Low-Level Waste Disposal." PNL-SA-133698S, presented at the 1985 Winter Meeting of the American Nuclear Society, San Francisco, California.

Kennedy, W. E., Jr., and B. A. Napier. 1984. "Allowable Residual Contamination Levels for Decommissioning: A Description of the Method." PNL-SA-12052, presented at the DOE Workshop on Remedial Action Criteria-I, Gaithersburg, Maryland.

Kennedy, W. E., Jr., and B. A. Napier. 1984. "Allowable Residual Contamination Levels for Decommissioning: A Summary of Example Results." PNL-SA-12053, presented at the DOE Workshop on Remedial Action Criteria-I, Gaithersburg, Maryland.

Kennedy, W. E., Jr., and B. A. Napier. 1984. "An Independent Derivation of the 10 CFR Part 61 Commercial Low-Level Waste Disposal Limits." PNL-SA-11938, presented at the 1983 Annual Meeting of the American Nuclear Society, New Orleans, Louisiana.

Marks, S., D. H. Denham, F. T. Cross, and W. E. Kennedy, Jr. 1984. "Health Effects Estimation for Contaminated Properties." In Proceedings of the 6th International Congress of the International Radiation Protection Association, Berlin (West), Germany.

Kennedy, W. E., Jr., and F. M. Mann. 1983. "Potential Low-Level Waste Disposal Limits for Fusion Radionuclides." PNL-SA-11441, presented at the 1983 American Nuclear Society Winter Meeting, San Francisco, California.

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Kennedy, W. E., Jr., D. H. McKenzie, and L. L. Cadwell. 1982. "Relevance of Biotic Pathways to the Regulation of Nuclear Waste Disposal." PNL-SA-10701, presented at the Fourth Annual Participants' Information Meeting, U.S. DOE Low-Level Waste Management Program (LLWMP), Denver, Colorado.

Kennedy, W. E., Jr., and B. A. Napier. 1982. "Allowable Residual Contamination Levels: Transuranic Advanced Disposal Systems for Defense Wastes." Presented at the 1982 American Nuclear Society Winter Meeting, Washington, D.C.

Kennedy, W. E., Jr., B. A. Napier, and J. K. Soldat. 1982. "Transuranic Advanced Disposal Systems: Preliminary ²³⁹Pu Waste Disposal Criteria for Hanford." PNL-SA-10624, presented at the Alpha-Contaminated Waste Management Workshop, Gaithersburg, Maryland.

Kennedy, W. E., Jr., J. K. Soldat, L. L. Cadwell, and D. H. McKenzie. 1982. "The Potential Role of Biotic Transport Models in Low-Level Waste Management." Presented at the 1982 American Nuclear Society Winter Meeting, Washington, D.C.

Kennedy, W. E., Jr., J. K. Soldat, L. B. Sasser, D. W. Murphy. 1982. "Dose Assessment for Sheep Exposed to Fallout from Nuclear Test Nancy." PNL-SA-10412, presented at the Fifth Dose Assessment Advisory Group Meeting, Las Vegas, Nevada.

Kennedy, W. E., Jr., J. K. Soldat, L. B. Sasser, D. W. Murphy. 1982. "Dose Assessment for Sheep Exposed to Fallout from Nuclear Test Nancy, March 24, 1953." PNL-SA-10412, presented at the Symposium on Radioecology and Ecology, Jackson Lake, Wyoming.

Napier, B. A., and W. E. Kennedy, Jr. 1982. "How Clean is Clean Enough?: Allowable Residual Contamination Levels." PNL-SA-10525, presented at the 1982 American Nuclear Society Winter Meeting, Washington, D.C.

Kennedy, W. E., Jr., D. W. Murphy, and E. C. Watson. 1981. "A Review of Removable Surface Contamination on Radioactive Materials Transportation Containers." PNL-SA-9711, presented at the 1981 American Nuclear Society Winter Meeting, San Francisco, California.

Kennedy, W. E., Jr., E. S. Murphy, and E. C. Watson. 1981. "Inhalation as an Occupational Exposure Pathway." PNL-SA-9155, presented at the Health Physics Society Annual Meeting, Louisville, Kentucky.

Kennedy, W. E., Jr., and E. C. Watson. 1981. "MPC and ALI: Their Basis and Their Comparison." PNL-SA-9349, presented at the Joint Meeting of the Northern California and Columbia Chapters of the Health Physics Society, Lake Tahoe, California.

Murphy, D. W., R. Harty, J. M. Aldrich, and W. E. Kennedy, Jr. 1981. "A Quantitative Review of Removable Surface Contamination on Radioactive Material Transportation Containers." PNL-SA-9271, presented at the Health Physics Society Annual Meeting, Louisville, Kentucky.

Kennedy, W. E., Jr., R. O. Gilbert, R. R. Kinnison, and E. C. Watson. 1980. "Statistical Aspects of Determining Compliance with Radiation Standards." PNL-SA-8320, presented at the Health Physics Society Annual Meeting, Seattle, Washington.

Kennedy, W. E., Jr., and G. M. Holter. 1979. "Public Radiation Exposure Considerations During Nuclear Facility Decommissioning." PNL-SA-7880, presented at the American Nuclear Society Winter Meeting, San Francisco, California.

Kennedy, W. E., Jr., R. B. McPherson, and E. C. Watson. 1979. "Acceptable Residual Radioactive Contamination Levels for Sites of Decommissioned Nuclear Facilities." EPA 520/3-79-002, presented at the Health Physics Society's Twelfth Midyear Topical Symposium on Low-Level Radioactive Waste Management, Williamsburg, Virginia.

Kennedy, W. E., Jr., E. C. Watson, G. R. Hoenes, and B. A. Napier. 1979. "A Method for Determining Acceptable Residual Radioactive Contamination Levels." PNL-SA-7495, presented at the Health Physics Society Annual Meeting, Philadelphia, Pennsylvania.

Napier, B. A., G. R. Hoenes, W. E. Kennedy, Jr., and E. C. Watson. 1979. "The Maximum Annual Dose Resulting from Residual Radioactive Contamination." PNL-SA-7496, presented at the Health Physics Society Annual Meeting, Philadelphia, Pennsylvania.

Watson, E. C., W. E. Kennedy, Jr., G. R. Hoenes, R. B. McPherson, and W. F. Sandusky. 1978. "Radiation Exposure Pathways of Primary Importance to Nuclear Facility Decommissioning Planners." PNL-SA-7048-S, presented at the 1978 American Nuclear Society Winter Meeting, Washington, D.C.

Watson, E. C., W. E. Kennedy, Jr., G. R. Hoenes, and D. A. Waite. 1978. "Methodology for Determining Acceptable Residual Radioactive Contamination Levels at Decommissioned Nuclear Facilities/Sites." IAEA-SM-234/16, presented at the IAEA International Symposium on the Decommissioning of Nuclear Facilities, Vienna, Austria.

Kabele, T. J., C. M. Heeb, K. J. Schneider, W. E. Kennedy, Jr., and M. A. Lewallen. 1977. "Effluents from the LWR Stowaway Fuel Cycle." Presented at the 1977 American Nuclear Society Winter Meeting, San Francisco, California.

Kennedy, W. E., Jr. 1976. "Short-Lived Fission-Product Gamma-Ray Spectra from the Thermal Fission of ^{235}U ." BN-SA-593, presented at the Twenty-First Annual Meeting of the Health Physics Society, San Francisco, California.

Streng, D. L., E. C. Watson, J. T. Bander, and W. E. Kennedy, Jr. 1976. "A Probabilistic Approach to External Cloud Dose Calculations Using Onsite Meteorological Data." BNWL-SA-5816, presented at the Twenty-First Annual Meeting of the Health Physics Society, San Francisco, California.

RESUME OF
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EDUCATION

St. Paul's School, London, England

Christ Church, Oxford University, Oxford, England:

Open Mathematical Scholar 1943

B.A. (Physics) 1946

M.A., D.Phil. (Physics) 1950

POSITIONS

Research Lecturer, Oxford University 1949-54

Research Associate, University of Rochester 1950-51

Research Associate, Stanford University 1951-52

Research Officer, Clarendon Laboratory, Oxford University 1952-55

Assistant Professor of Physics, Harvard University 1955-57

Associate Professor of Physics, Harvard University 1957-61

Professor of Physics, Harvard University 1961-83

Chairman, Dept. of Physics, Harvard University 1982-85

Chairman, Cyclotron Operating Committee, Harvard University 1961-81

Cyclotron Operating Committee, Harvard University, Member 1981-present

Acting Director, Energy and Environmental Policy Center, Harvard University 1977-79

Member, Advisory Committee, Energy and Environmental Policy Center, Harvard University 1979-90

Associate, Adams House, Harvard University 1971-present

Affiliate, Center for Middle Eastern Studies, Harvard University 1990-present

Affiliate, Center for Science and International Affairs, Harvard University 1990-present

Affiliate, Center for Risk Analysis, School of Public Health, Harvard University, 1992-present

Director, Regional Center for Global Environmental Change, (NIGEC) Harvard University 1990-1993

Mallinckrodt Professor of Physics, Harvard University 1983-present

SUMMER AND VISITING POSITIONS

Stanford University 1958

University of Paris-Sud (Orsay) (John Simon Guggenheim Fellow) 1961

Laboratori Nazionali di Frascati, Rome (Fulbright Fellow) 1969

Overseas Lecturer, U.S. Information Agency 1973-83

Lecturer on Energy and Environment, Lawrence Radiation Laboratory

Summer Institute, Berkeley, California 1973

Lecturer, Second Energy Symposium, Boulder, Colorado 1974

Lecturer, UK Summer School on Aspects of Energy Conversion 1975

Co-Director, International Schools on Energetics I, II, III, IV, Erice, Italy 1974-80

Visiting Professor, University of Grenoble, Grenoble, France 1981

Visiting Scientist, CERN, Geneva, Switzerland 1981

National Science Foundation Lecturer, Pakistan 1982

Visitor : Los Alamos National Laboratory: February 1998, January/February 1999

COMMITTEE, CONSULTANT, AND OTHER POSITIONS

Assistant Editor, Annals of Physics 1956-84

National Science Foundation, Physics Advisory Board 1967-70

Trustee, Universities Research Association 1968-73

Consultant to the Attorney General, State of Maine 1971-72

Transportation Advisory Committee, City of Newton 1973 - 78

Energy Research and Development Administration Breeder Reactor Safety Committee 1974-76

Consultant to the Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards 1974-77

Consultant to the Electric Power Research Institute 1975-77

Consultant to Los Alamos Scientific Laboratory 1976-77

Consultant to Oak Ridge National Laboratory 1977-82

Consultant to the U.S. General Accounting Office 1977-78

Consultant to Air Products and Chemicals 1977-80

Consultant to Lawrence Livermore Laboratory 1977-82

Visiting Committee, Engineering Physics Division, Oak Ridge National Laboratory 1978-82

Consultant to Clairol, Inc. 1979-83

Chairman, Governor's Panel on Reactor Safety Subsequent to the

Accident at Three Mile Island, Commonwealth of Massachusetts 1979-80

Consultant to the United Nations Council on Namibia 1980

Advisor, King Faisal International Prize, Riyadh, Saudi Arabia 1982-83

National Academy of Sciences Energy Engineering Board 1982-91

Chairman, American Physical Society Study Group on Radiological Consequences of Nuclear Power Plants 1983-85

Consultant to the Attorney General, State of Rhode Island 1983

U.S. Department of Energy Health and Environmental Safety Advisory Committee (HERAC) 1984-86

Visiting Committee, Nuclear Engineering Division, Brookhaven National Laboratory 1984-91

Chairman, Visiting Committee to Radiation Medicine Department , Massachusetts General Hospital 1984-present

Tobacco Smoking Committee, Health Advisory Council, City of Newton 1984-1988

Member, Nuclear Regulatory Commission, Research Advisory Committee 1986-91

Consultant, Los Alamos National Laboratory 1988-90

Intergovernmental Personnel Agreement with Food and Drug Administration 1988-90

Member, Advisory Council, Atomic Library & Technology Center 1988-present

Member, Committee on Future Nuclear Power, National Academy of Sciences 1989-92

Member, Organizing Committee, 1st International Sakharov Conference 1989-90

Member, Science Advisory Committee, Atlantic Legal Foundation 1990-present

Chairman, Expert group on nuclear reactor safety: Republic of China (Taiwan) 1990-1991

Member, Subcommittee on Electromagnetic Radiation, Science Advisory Board, EPA 1991

Chairman, International Advisory Committee, International Sakharov (Institute) College of Radioecology (Minsk) (1992- present)

General Accounting Office (US) Consultant 1977; 1992

Member, Board of Directors, Sakharov Foundation, New York 1992-

Member, Conseil Scientifique NBC, Nice, France 1992-1992

Consultant, University of Kuwait 1978, 1984, 1989, 1993

Consultant, Kuwait Institute of Scientific Research 1978, 1979, 1982, 1984, 1986

Consultant , Arab Fund for Economic and Social Development (1996, 1997)

Consultant, International Atomic Energy Agency (1997,1998,1999)

AWARDS

Forum Award, American Physical Society for Forum on Science and Society 1990

Society for Risk Analysis Distinguished Achievement Award 1993

SOCIETIES

Fellow, American Physical Society

Member, American Academy of Arts and Sciences

Fellow, New York Academy of Arts and Sciences

Life Member, Society for Physical Research (London)

Member, Massachusetts Group Against Smoking Pollution (GASP)

Member, Society for Risk Analysis

Member, Newton Conservators (Board of Directors, 1972-76)

Member, Appalachian Mountain Club

CLUB

United Oxford and Cambridge Club, Pall Mall, London

PUBLICATIONS:

Over 700 publications in various scientific journals.

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**LIST OF PUBLICATIONS OF
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PUBLICATION LIST

1947-1950 1951-1960 1961-1970 1971-1980 1981-1990 1991-1995 1996-NOW

1. "Photodisintegration of the deuteron," R. Wilson, C.H. Collie and H. Halban, Nature (letter) 162, 185 (1948).
- 1a. "Random selectors for ESP experiments," Richard Wilson, Proceedings of the Society for Psychical Research 48, 213 (1947).
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703. "Public Acceptance of Nuclear Energy: Regulatory Issues and a Critique of Accelerator Driven Reactors", R. Wilson, Energy, Environment and Economy Program (E3), 1998.
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709. "Measurement of the Branching Ratios for the Decays of $D_s^+ \rightarrow \eta\pi^+, \eta'\pi^+, \eta\rho^+$, and $\eta'\rho^+$ ", C.P. Jessop, et al., (CLEO Collaboration), Physical Review D 58 052002 (1998).
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711. "First Observation of the Decay $\tau^- \rightarrow K^{*-} \eta \nu_\tau$ ", M. Bishai et al., (CLEO Collaboration), Physical Review Letters, 82, 281 (1999).
712. "First Observation of $Y(1S) \rightarrow \gamma\pi^+\pi^-$ and $Y(1S) \rightarrow \gamma\pi^0\pi^0$ ", A. Anastossov et al., (CLEO Collaboration), Physical Review Letters, 82, 286 (1999).
713. "Observation of Two Narrow States Decaying into $\Xi_c^+\gamma$ and $\Xi_c^0\gamma$ ", C.P. Jessop, et al., (CLEO Collaboration), Physical Review Letters, 82, 492 (1999).
714. "Measurement of the Mass Splittings Between the $b\bar{b}$ $\chi_{bJ}(1P)$ States", K.W. Edwards, et al., (CLEO Collaboration), Physical Review D, 59, 032003 (1999).
715. " Y Dipion Transitions at Energies Near the $Y(4S)$ ", S. Glenn, et al., (CLEO Collaboration), Physical Review D 59, 052003 (1999).
716. "Measurement of the Neutral Weak Form Factors of the Proton", K.A. Aniol, et al., (HAPPEX Collaboration), Physical Review Letters 82, 1096-1100 (1999).
717. *Risk Benefit Analysis*, E.A.C. Crouch and R. Wilson
718. Comments on "Assessment of Health Effects from Exposure to Power Line Frequency Electric and Magnetic Fields". NIEHS working group report (1998). Richard Wilson, September 24th 1998

719. "Trends in Mesothelioma Incidence and Asbestos Exposure Evaluation", B. Price and R. Wilson, Canadian Mineralogist (in press).

Richard Wilson

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RESUME OF
MICHAEL J. LADD

RESUME

Michael J. Ladd
2008 Chestnut Drive
Hudson, Wisconsin 54016
Phone: (715)-381-1244 (Home)
(612)-386-1165 Ext. 4007 (Work)

EDUCATION

Completed MBA at Webster College, (July 1981), Management & Business

Completed a BS in Occupational Education at Southern Illinois University, (August 1980)

Anticipate completion of BS at Winona State University, (1999)

EXPERIENCE

November 1996 to Present - Training Process Manager Prairie Island:
I am responsible for maintaining the systematic approach to training and Institute of Nuclear Power Operations (INPO) accreditation in all Prairie Island training programs while integrating all training resources into the line organization. Prairie Island training was identified as one of the top nine training programs out of 238 with excellent training at the 1998 INPO CEO conference. Preparing all Training Programs for accreditation renewal in 2000. Represent PI on all NSP and Generation Training Committees and Process Reengineering teams.

February 1996 to November 1996 - Senior Nuclear Consultant:
I provided technical, operational, and administrative support to the CEO, President of Generation, the VP Nuclear, the Director Licensing and Management Issues on all issues related to Nuclear Generation BWR and PWR. I was the INPO, Nuclear Energy Institute, Investor Relations point of contact for all initiatives and emerging issues related to our nuclear plants. I also acted as the point of contact for most other NSP Depts. needing information on our nuclear plants such as communications and risk management. I wrote many presentations for the CEO, President Generation, VP Nuclear and the Director of Licensing on nuclear issues.

April 1991 to February 1996 - Technical Training Superintendent:
I provided direction, support and supervision 10 Instructors and Engineers, to administer & maintain 7 INPO accredited programs and SRO Certification program. Oversee the Emergency Preparedness Training & Scenario development process. Summer of 1993 Acting Training Manager for Prairie Island Nuclear Generating Site. Member of Minnesota Quality Award assessment team.
Training Representative for NSP on feasibility of becoming an Operating Company with Point Beach & Kewaunee summer of 1994. Assisted Corporate Training Dept. in the development of an apprenticeship training program for a new Multi Skilled Plant Mechanic. Team Leader for NSP Generation Training Process Improvement team 1995/6 T-6 Team. Completed 4 successful

INPO accreditation renewal visits for all Technical and Operations training programs.

Maintained SALP 1 in plant support for 2 SALP periods.

July 1985 to April 1991 - Administrator of Emergency Preparedness:
Coordinate and administer Emergency Planning for both NSP nuclear plants. Coordinate offsite planning with Minnesota and Wisconsin's Health Department and Division of Emergency Services, as well as various Wisconsin and Minnesota counties. Assist all agencies in identifying resources and staffing needs. Managed budget of 1.5 Million dollars, Supervised 4 personnel. Established an Emergency Preparedness(EP) resource sharing network for NRC Region 3 Utilities. Maintained SALP 1 in EP for 4 SALP periods. Wrote emergency plans, procedures and training for both NSP's Nuclear Facilities and assisted in writing State and County Emergency plans, procedures and training.

July 1981 to 1984 - Simulator/Operations Training Instructor:
Monticello Nuclear Generating Plant. Taught SRO classes, annual License Requalification, developing Licensing and Retraining programs, lesson plan development, writing, administering and grading RO/SRO exams; additionally managed the Acceptance Testing program for the Monticello Simulator, wrote and reviewed all Operations and Simulator curriculum. On-going project of INPO accreditation for all Operations training. Assisted in the development of the fuel shipping plan and provided three weeks fuel shipment training and public relations work in Wisconsin. Performed SRO and RO audit exams for various BWR and PWR Nuc Gen Stations across the US from 1982 to 1992.

Experience

March 1981 to July 1982 - Training Engineer
Westinghouse Electric Corporation. I Taught NSSS systems and power conversion systems within the classroom. Additionally, I provided in-plant tours at the Zion Nuclear Power Plant. My tasks also involved providing training on the SNUPPS simulator. I was also involved in writing lesson texts and lesson plans for all ECCS systems for Rochester Gas and Electric. An on-going objective was the writing and programming of lessons in Tutor language for computer assisted instruction.

November 1979 to March 1981 - Consultant employed by Westinghouse:
Responsibilities included curriculum development in the area of Heat Transfer and Thermodynamics. I wrote the first Heat Transfer Fluid flow & thermodynamics book for Westinghouse, post TMI. Additional responsibilities included nuclear fundamentals training for National and International

students. An additional task was writing of marketing brochures for newly developed instructional programs.

September 1970 to March 1981 - Active duty US Navy:
Highest rank attained while on active duty was E-7 Chief Petty Officer. In charge of Operations and Mechanical Maintenance for various nuclear and fossil fueled ships. Qualified all the senior operations watches on every ship I served on. Additional duties and responsibilities included training officer assigned to the apprentice training division, recruit training command, Great Lakes, Illinois. I was responsible for developing, administering and managing educational systems for the Fireman, Airman and Seaman programs. Additional responsibilities included acting as a technical advisor for the Instructional Program Development Center, Great Lakes, Illinois.
I also wrote power transfer courses for 600 & 1200 psi fossil fueled boilers.

TRAINING

The Seven Habits of Highly Effective People, 1998
Performance Improvement International, Reducing Human Error, 1998
Human Performance Improvement Techniques for Managers August - 1997
Improving Your Management Effectiveness - July 1997
Evaluating Training Programs - July 1997
Minn. Management Academy, Executive Development Center UofM - November 1995
Human Performance Evaluation System - November 1994
Error Reduction Techniques - November 1993
Celebrate Diversity - February 1993
Managing and Motivating Employees - November 1991
Leadership Development, NSP Course - February 1991
Join the Management Team, NSP Course - January 1990
Affirmative Action - January 1991
Ethics, NSP Course - November 1988
Project Management, University of Minnesota - December 1987
Managing for Productivity, NSP Course - September 1986
How to deal with the Media - June 1986
Information Management System - February 1985
Emergency Planning, Harvard University - June 1985
BWR SRO License, February 10, 1984, License #SOP-30323
SRO BWR Hot License Certification, Morris Simulator - November 1982
SRO/RO Retraining, Morris Simulator - December 1982
SRO/RO PWR Certification - March 1981 SNUPPS & Zion
Simulator Training, Westinghouse - August 1981
Systems Training, Westinghouse - July 1981
Instructor Training, Westinghouse, (Instructor Certified) - March 1981
Fundamentals Training, Westinghouse - January 1980
Company Commanders School, US Navy - September 1978
Class C School, Instructor Duty School - August 1978
Engineman Basics - December 1974
Class C School, Air Conditioning & Refrigeration School - Nov. 1973
Engineering Laboratory Technician School - November 1972

SIC Nuclear Submarine Prototype - August 1972
US Naval Nuclear Power School - February 1972
Class A School, Machinist Mate - April 1971
Basic Propulsion Engineering School - February 1971

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RESUME OF
JOHN GREGORY THORGERSEN

JOHN GREGORY THORGERSEN

EDUCATION: Bachelor of Science - Nuclear Engineering
University of Wisconsin - Madison (1980)

Coursework toward a Masters in Management
Cardinal Stritch College - Milwaukee (1984 - 1985)

EXPERIENCE: Wisconsin Electric Power Company

4/5/99 – Present Nuclear Power Business Unit
Operating Supervisor Trainee
Operations Section

Currently enrolled in a Senior Reactor Operator license training program
at the Point Beach Nuclear Plant.

6/1/98 – 4/5/99 Nuclear Power Business Unit
Manager - Quality Verification
Nuclear Assurance Section

Primary responsibilities include the internal and supplier QA assessment
programs, including QA oversight of major projects.

4/12/93 - 6/1/98 Nuclear Power Business Unit
Senior Project Engineer
Quality Assurance Section

Primary responsibilities included the internal and supplier QA assessment
programs, QA oversight of major projects and maintenance of the safety
classification list (Q-List) for QA scope structures, systems and
components.

Wisconsin Public Service Corporation

9/1/86 - 4/12/93 Nuclear Power Department
Quality Assurance Auditing Supervisor
Quality Assurance Auditing Group

Primary responsibilities included the internal QA assessment program.

7/1/81 - 9/1/86 Nuclear Power Department
Nuclear Engineer

Nuclear Licensing & Systems Group

1/26/81 - 7/1/81

Nuclear Power Department
Associate Engineer
Nuclear Licensing & Systems Group

Primary engineering responsibilities included the design, analysis, and operation of systems and equipment installed at an operating Nuclear Power Plant and associated licensing activities. Responsible Project Manager for Equipment Qualification Program, Pressurizer Safety/Relief Valve Qualification and Analysis of the Discharge Piping, and Upper Plenum Injection/Emergency Core Cooling System Analysis. Also served 4.5 years as a Certified Shift Technical Advisor.

MEMBER

American Nuclear Society
Tau Beta Pi
Phi Kappa Phi

CERTIFICATION

1. Certified Shift Technical Advisor at the Kewaunee Nuclear Power Plant, a PWR (1982 - 1986)
2. Certified Lead Auditor to ANSI N45.2.23-1978 (1987 - Present)

RESUME OF
CARLTON M. BRITTON

CURRICULUM VITA

Carlton M. Britton

Personal Data:

Social Security No.: 585-01-1292

Business Address: Dept. of Range, Wildlife, & Fisheries
Texas Tech University
Lubbock, Texas 79409-2125
Telephone: (806) 742-2842
E-mail: c7cmb@ttacs.ttu.edu

Home Address: 2822 22nd Street
Lubbock, Texas 79410-1620
Telephone: (806) 797-6954

Birth: August 13, 1944
Socorro, New Mexico

Marital Status: Married: Rebecca J. Wittenburg

Children: Gretchen Lee,
Born Nov. 3, 1969
Jennifer Rebecca,
Born Sept. 19, 1972
Matthew Carlton,
Born Sept. 29, 1975
Leah Suzanne,
Born Sept. 8, 1976

Health: Excellent, minimal disability

Specialty: Range Improvement and Management
Fire Ecology

Education:

1972-1975: Texas A&M University
PhD; December 1975
Range Science

1968-1970: Texas Tech University
MS; May 1970
Range Management

1962-1968: Texas Tech University
BS; May 1968
Range Management

Professional Experience:

Professor, Department of Range, Wildlife, and Fisheries Management, Texas Tech University, Lubbock, 1988-present.

Associate Professor, Department of Range and Wildlife Management, Texas Tech University, Lubbock, 1980-1988.

Associate Professor, Squaw Butte Experiment Station, Oregon State University, Burns, 1980.

Assistant Professor, Squaw Butte Experiment Station, Oregon State University, Burns, 1975-1980.

Tom Slick Fellow, Range Science Department, Texas A&M University, College Station, 1974-1975.

Research Assistant, Range Science Department, Texas A&M University, College Station, 1972-1974.

Research Associate, Department of Range and Wildlife Management, Texas Tech University, Lubbock, 1970-1971.

Research Assistant, Department of Range and Wildlife Management, Texas Tech University, Lubbock, 1968-1970.

University Service:

Forage-Livestock Task Force, Oregon State University, 1978-1980.

Editor, Progress in Rangeland Research, Oregon State University, 1979-1980.

Curriculum and Teaching Improvement Committee, Department of Range and Wildlife Management, Texas Tech University, 1980-1983, 1993-present.

Student Relations and Placement Committee, Department of Range and Wildlife Management, Texas Tech University, 1980-1985.

Graduate Programs and Research Committee, Department of Range and Wildlife Management, Texas Tech University, 1980-present; Chairman, 1993-present.

Bookstore Advisory Committee, Texas Tech University, 1981-1984.

Graduate Studies Coordination Committee, College of Agricultural Sciences, Texas Tech University, 1981-1983; 1993-1995.

Development Committee, College of Agricultural Sciences, Texas Tech University, 1985-1988; and 1997 to present.

Co-editor, Research Highlights--Noxious Brush and Weed Control, Texas Tech University, 1982-1989 and 1994 to present.

Tenure and Promotion Committee, College of Agricultural Sciences, Texas Tech University, 1987-1990.

Editor, Management Notes, Texas Tech University, 1983-present.

Curriculum Committee, College of Agricultural Sciences, Texas Tech University, 1990-1992.

Grievance Committee, Texas Tech University, 1997-present

Professional Service:

Manuscript Review, Journal of Range Management, U.S. Forest Service, BLM, and Agricultural Research Service, Southwestern Naturalist, Texas Journal of Agriculture and Natural Resources, etc.

Range Youth Camp Committee, PNW Section-SRM, 1977-1980.

Secretary-Treasurer, Texas Section-SRM, 1981.

Chairman, Scholarship Committee, Texas Section-SRM, 1982.

Co-chairman, Fire Ecology Session, Annual Meeting, Society for Range Management, 1985.

Co-chairman, Technical Papers, Summer Meeting, Society for Range Management, 1985.

Co-moderator, Range Ecology Session, Annual Meeting, Society for Range Management, 1986.

Moderator, Fire Ecology Session, 10th North American Prairie Conference, 1986.

Chairman, Outstanding Contribution to Range Management Committee, Texas Section-SRM, 1987.

Co-chairman, Poster Sessions, Annual Meeting, Society for Range Management, 1988.

Associate Editor, Journal of Range Management, 1988-1991.

Chairman, Outstanding Contribution to Range Management Committee, Texas Section-SRM, 1990.

Editor, Journal of Range Management, Handbook and Style Manual revision 1990-1991.

Associate Editor, Texas Journal of Agriculture and Natural Resources, 1995 to present.

Editor-in-Chief, Texas Journal of Agriculture and Natural Resources, 1998.

Societies and Professional Organizations:

Society for Range Management
Society of the Sigma Xi
Gamma Sigma Delta
Phi Sigma
Southwestern Association of Naturalist

Professional Meetings Attended:

Society for Range Management, National, 1975, 1976, 1977, 1979, 1980, 1981, 1982, 1984, 1987, 1988, 1990, 1993, 1998.

Section, 1978, 1980, 1981, 1982, 1983, 1985, 1987, 1990.

Community Service:

Board of Directors, Harney County Coordinated Child Care Center, Burns, 1975-1976.

Education Committee, Holy Family Catholic Church, Burns, 1976-1980.

Board of Directors, Harney County School District No. 1, 1976-1980, (Chairman, 1980).

Media Committee, St. John Neumann Catholic Church, Lubbock, 1981.

Honors, Awards, and Special Recognition:

Tom Slick Fellowship, Texas A&M University, 1974-1975.

Outstanding Young Men of America, 1979.

Excellence in Instruction, Advanced Fire Management, 1979.

College Research Award, College of Agricultural Sciences. Texas Tech University, 1985.

Outstanding Alumni, Department of Range, Wildlife, and Fisheries, Texas Tech University
1996

Teaching:

Courses Taught:

1. Principles of Range Management (non majors) (RWFM 3303), undergraduate, Texas Tech University.
2. Range Improvements (RWFM 3401), undergraduate, Texas Tech University
3. Principles of Range Management (RWFM 3304), undergraduate, Texas Tech University.
4. Fire Ecology and Management (RWFM 4313), undergraduate, Texas Tech University.
5. Range Analysis and Management Planning (RWFM 4303), undergraduate, Texas Tech University.
6. Internship, (RWFM 4000), undergraduate, Texas Tech University.
7. Fire Ecology (RWFM 5210), graduate, Texas Tech University.
8. Range Research Methods (R&WM 5302), graduate, Texas Tech University.
9. Seminar (R&WM 5100), graduate, Texas Tech University.
10. Teaching Practicum (R&WM 7210), graduate, Texas Tech University.

Graduate Students:

1. Master of Science - 9.
2. Doctor of Philosophy - 4.

Publications:

Major Manuscripts:

Britton, C. M., and H. A. Wright. 1971. Correlation of weather and fuel variables to mesquite damage by fire. J. Range Manage. 24:136-141.

Wright, H. A., C. M. Britton, R. L. Wink, and B. Beckham. 1972. A progress report on techniques to broadcast burn dozed juniper. Proc. Tall Timbers Fire Ecol. Conf.

12:169-174.

- Britton, C. M., C. M. Countryman, H. A. Wright, and A. G. Walveker. 1973. The effect of humidity, air temperature, and wind speed on fine fuel moisture content. *Fire Technology* 9:46-55.
- Waller, S. S., C. M. Britton, and J. D. Dodd. 1974. Soil fertility and production parameters of Andropogon scoparius tillers. *J. Range Manage.* 28:476-479.
- Britton, C. M., and J. D. Dodd. 1976. Relationships of photosynthetically active radiation and shortwave irradiance. *Agric. Meteorol.* 17:1-7.
- Britton, C. M., J. D. Dodd, and A. T. Weichert. 1976. Energy values of plant species and litter of an Andropogon-Paspalum grassland. *J. Biogeog.* 3:389-395.
- Wright, H. A., and C. M. Britton. 1976. Fire effects on vegetation in western rangeland communities. In, A symposium--Use of prescribed burning in western woodland and range ecosystems. Utah State Univ., Logan, Utah.
- Britton, C. M., B. L. Karr, and F. A. Sneva. 1977. A technique for measuring rate of fire spread. *J. Range Manage.* 30:395-397.
- Britton, C. M., J. D. Dodd, and A. T. Weichert. 1978. Net aerial primary production of an Andropogon-Paspalum grassland ecosystem. *J. Range Manage.* 31:381-386.
- Clark, R. G., and C. M. Britton. 1978. Vegetation sampling for prescribed burns. *Prairie Prescribed Burning Symposium*. Jamestown, North Dakota. 18p.
- Britton, C. M., and M. H. Ralphs. 1978. Use of fire as a management tool in sagebrush ecosystems. In, *The sagebrush ecosystem: A symposium*. Utah State Univ., Logan, Utah.
- Clark, R. G., and C. M. Britton. 1979. A bibliography of bitterbrush [Purshia tridentata (Pursh) DC.] annotated from 1967 to 1978. *Ore. Agr. Exp. Sta., Sta. Bull. No. 640*. 18p.
- Britton, C. M., and H. A. Wright. 1979. A portable burner for evaluating effects of fire on plants. *J. Range Manage.* 32:475-476.
- Daugherty, D. A., H. A. Turner, and C. M. Britton. 1979. Effects of grazing intensity on steer gains. *Proc. Western Sect., Amer. Soc. Anim. Sci.* 30:139-142.
- Wright, H. A., L. F. Neuenschwander, and C. M. Britton. 1979. The role and use of fire in sagebrush-grass and pinyon-juniper plant communities. A state-of-the-art review. *USDA For. Serv. Gen. Tech. Rep. INT-58*. 48p.

- Britton, C. M., and R. G. Clark. 1981. Evaluating prescribed burns. Prescribed Burning Workshop. Malheur National Wildlife Refuge. 25p.
- Britton, C. M., and F. A. Sneva. 1981. Effects of tebuthiuron on a western juniper community. J. Range Manage. 34:30-32.
- Britton, C. M., R. G. Clark, and F. A. Sneva. 1981. Will your sagebrush range burn? Rangelands 3:207-208.
- Clark, B., A. A. Steuter, and C. M. Britton. 1981. An inexpensive anemometer frame. Fire Manage. Notes 42(3):13-14.
- Daugherty, D. A., C. M. Britton, and H. A. Turner. 1982. Grazing management of crested wheatgrass range for yearling steers. J. Range Manage. 35:347-350.
- Sneva, F. A., C. M. Britton, H. F. Mayland, J. Buckhouse, R. A. Evans, J. A. Young, and M. Vavra. 1982. Mt. St. Helens ash: Considerations of its fallout on rangelands. Ore. Agr. Exp. Sta. Spec. Rep. 650. 27p.
- Clark, R. G., C. M. Britton, and F. A. Sneva. 1982. Response of bitterbrush to burning and clipping in eastern Oregon. J. Range Manage. 35:711-714.
- Cornely, J. E., C. M. Britton, and F. A. Sneva. 1982. Manipulation of flood meadow vegetation and observations on small mammal populations. Prairie Nat. 15:16-22.
- Waller, S. S., C. M. Britton, J. L. Stubbendieck, and F. A. Sneva. 1983. Germination of Kochia prostrata seed. J. Range Manage. 36:241-245.
- Steuter, A. A., and C. M. Britton. 1983. Fire induced mortality of redberry juniper (Juniperus pinchotii Sudw.). J. Range Manage. 36:343-345.
- Britton, C. M., and F. A. Sneva. 1983. Big sagebrush control with tebuthiuron. J. Range Manage. 36:707-708.
- Britton, C. M., and A. A. Steuter. 1983. Production and nutritional attributes of tobosagrass following burning. Southwest Nat. 28:347-352.
- Britton, C. M., R. G. Clark, and F. A. Sneva. 1983. Effects of soil moisture on burned and clipped Idaho fescue. J. Range Manage. 36:708-710.
- Britton, C. M., and H. A. Wright. 1983. Brush management with fire. Brush Manage. Symp., Soc. for Range Manage. Albuquerque, New Mexico.
- Kelsey, R. G., W. E. Wright, F. A. Sneva, A. Winward, and C. M. Britton. 1983. The concentration and composition of big sagebrush essential oils from Oregon. Biochem. Syst. and Ecol. 11:353-360.

- Sneva, F. A., and C. M. Britton. 1983. Adjusting and forecasting herbage yields in the intermountain big sagebrush region of the Steppe Province. Ore. Agr. Exp. Sta. Bull. No. 659. 61p.
- Sears, W. E., C. M. Britton, D. B. Wester, and R. D. Pettit. 1986. Herbicide conversion of a sand shinnery oak (Quercus havardii) community: Effects on biomass. J. Range Manage. 39:399-403.
- Sears, W. E., C. M. Britton, D. B. Wester, and R. D. Pettit. 1986. Herbicide conversion of a sand shinnery oak (Quercus havardii) community: Effects on nitrogen. J. Range Manage. 39:403-407.
- Dahl, B. E., P. F. Cotter, D. B. Wester, and C. M. Britton. 1987. Range plant establishment in the Southern Plains region. USDA For. Serv. Gen. Tech. Rep. RM-158:42-46.
- Hansmire, J. A., D. L. Drawe, D. B. Wester, and C. M. Britton. 1988. Effect of winter burns on forbs and grasses of the Texas Coastal Prairie. Southwest. Nat. 33:333-338.
- Masters, R. A., and C. M. Britton. 1988. Response of WW517 old world bluestem to fertilization, watering, and clipping. Texas J. Agr. and Nat. Resour. 2:48-53.
- Masters, R. A., K. L. Marietta, and C. M. Britton. 1988. Response of yucca (Yucca glauca) to fire, herbicide, and mechanical treatments. Texas J. Agr. and Nat. Resour. 2:4-7.
- Roberts, F. H., C. M. Britton, D. B. Wester, and R. G. Clark. 1988. Fire effects on tobosagrass and weeping lovegrass. J. Range Manage. 41:407-409.
- Bryant, F. C., B. E. Dahl, R. D. Pettit, and C. M. Britton. 1989. Does short-duration grazing work in arid and semiarid regions? J. Soil and Water Conserv. 44:290-296.
- Marietta, K. L., and C. M. Britton. 1989. Establishment of seven high yielding grasses on the Texas High Plains. J. Range Manage. 42:289-294.
- Weigel, J. R., G. R. McPherson, and C. M. Britton. 1989. Effect of short-duration grazing on winter annuals in the Texas Rolling Plains. J. Range Manage. 42:372-375.
- Weigel, J. R., C. M. Britton, and G. R. McPherson. 1990. Trampling effects from short-duration grazing on tobosagrass range. J. Range Manage. 43:92-95.
- McPherson, G. R., C. M. Britton, and H. A. Wright. 1990. Long-term effects of fire on mesquite mortality. Southwest. Nat. 35:235-237.
- Marietta, K. L., C. M. Britton, and P. F. Cotter. 1990. Nutritional parameters of seven improved grasses on the Texas High Plains. Texas J. Agr. Nat. Resour. 4:23-30.
- Masters, R. A., and C. M. Britton. 1990. Ermelo weeping lovegrass response to fertilization, clipping, and watering. J. Range Manage. 43:461-465.

- Britton, C. M., G. R. McPherson, and F. A. Sneva. 1990. Effects of burning and clipping on five bunchgrasses in eastern Oregon. *Great Basin Nat.* 50:115-120.
- Pitts, J. S., F. T. McCollum, and C. M. Britton. 1990. Relationships among protein supplementation, selected blood constituents, and performance of grazing steers. *Texas J. Agr. Nat. Resour.* 4:43-46.
- Pitts, J. S., F. T. McCollum, and C. M. Britton. 1992. Protein supplementation of steers grazing tobosagrass in spring and summer. *J. Range Manage.* 45:226-231.
- Sanden, E. M., C. M. Britton, and J. H. Everitt. 1992. Total ground cover estimates from corrected scene brightness measurements. *Proc. ACSM-ASPRS* 4:413-422.
- Sanden, E. M., C. M. Britton, and J. H. Everitt. 1992. Seasonal influences on total ground-cover estimates from scene brightness measurements. *Proc. ACSM-ASPRS* 5:332-342.
- Blair, B. K., C. M. Britton, and D. N. Ueckert. 1994. Pricklypear control with fire and herbicides on the Texas Rolling Plains. *Texas J. Agr. Nat. Resour.* 6:87-97.
- Britton, C.M., C. Villalobos, and J.S. Pitts. 1995. Protein supplementation of stockers on tobosagrass rangeland. Cattleman's College. TSCRA. San Antonio.
- Villalobos, C., C.M. Britton, and J.S. Pitts. 1995. Effects of protein levels fed during winter on subsequent performance of steers grazing tobosagrass. *Texas J. Agr. Nat. resources.* 10:1-14.
- Sanden, E.M., C.M. Britton, and J.H. Everitt. 1996. Total ground-cover estimates for corrected scene brightness measurements. *Photogrammetric Engineering and Remote Sensing* 62:147-150.
- Sanden, E.M., C.M. Britton, and J.H. Everitt. 1997. Scene brightness measurements to estimate senescent ground cover. *Photogrammetric Engineering and Remote Sensing.* (in press).
- Britton, C.M. 1997. Prescribed burning at Texas Tech. *Proc Texas A&M Univ. Juniper Symp.* p. 5-?-?.
- Mitchell, R.B., C.M. Britton, D.B. Wester, and S.J. Mullins. 1997. Current research on redberry juniper at Texas Tech University. *Proc Texas A&M Univ. Juniper Symp.* p. 5-41-44.
- Villalobos, J.C., C.M. Britton, and T. McCollum. 1998. Protein supplementation level effects on Steer performance while grazing tobosagrass. *J. Range Manage.* (In Press).

- Gerbolini, a., D. Ethridge, C.M. Britton, and D.N. Ueckert. 1998. Economics of redberry juniper control with burning in the Texas Rolling Plains. J. Range Manage. (in Press).
- Mitchell, R.B., and C.M. Britton. 1999. Managing weeds to establish and maintain warm-season grasses. In: B.E. Anderson and K.J. Moore (eds.), Warm-season Grasses: current trends and issues. ASA/CSSA/SSSA, Madison, WI. (In Press).
- Mitchell, R.B., and C.M. Britton. 1999. Redberry foliage moisture dynamics in the Texas Rolling Plains. Texas J. Agric. and Natural Res. (In Press).
- Villalobos, J.C., and C.M. Britton. 1999. Stocker performance. Texas J. Agric. and Natural Res. (In Press).

Minor Manuscripts:

- Wright, H. A., and C. M. Britton. 1970. Mesquite control by spraying and burning. Proc. Ann. Southern Weed Sci. Soc. 23:221-224.
- Britton, C. M., and F. A. Sneva. 1977. Production and chemical attributes of Kochia prostrata. Ore. Agr. Exp. Sta. Spec. Rep. No. 480. p. 9-12.
- Britton, C. M., and F. A. Sneva. 1979. Effects of tebuthiuron on a western juniper community. Ore. Agr. Exp. Sta., Spec. Rep. No. 534. p. 10-13.
- Daugherty, D. A., H. A. Turner, and C. M. Britton. 1979. Pasture management for increased gains. Ore. Agr. Exp. Sta., Spec. Rep. No. 534. p. 17-22.
- Britton, C. M., and F. A. Sneva. 1979. Effects of haying and non-use on flood meadow vegetation. Ore. Agr. Exp. Sta., Spec. Rep. No. 549. p. 5-7.
- Britton, C. M., F. A. Sneva, and R. G. Clark. 1979. Effect of harvest date on five bunchgrasses of eastern Oregon. Ore. Agr. Exp. Sta., Spec. Rep. No. 549. p. 16-19.
- Clark, R. G., and C. M. Britton. 1979. Seasonal response of bitterbrush to burning and clipping in eastern Oregon. Ore. Agr. Exp. Sta., Spec. Rep. No. 549. p. 35-36.
- Waller, S. S., D. K. Schmidt, J. L. Stubbendieck, C. M. Britton, and F. A. Sneva. 1979. Effects of harvest date and drying procedures on germination of Kochia prostrata (L.) Schrad. Ore. Agr. Exp. Sta., Spec. Rep. No. 549. p. 8-10.
- Britton, C. M., J. E. Cornely, and F. A. Sneva. 1980. Burning, haying, grazing, and non-use of flood meadow vegetation. Ore. Agr. Exp. Sta. Spec. Rep. No. 586. p. 7-9.
- Daugherty, D. A., C. M. Britton, and H. A. Turner. 1980. Grazing management of crested wheatgrass range for yearling steers. Ore. Agr. Exp. Sta. Spec. Rep. No. 586. p. 38-42.

- Hefner, P., R. G. Clark, and C. M. Britton. 1980. Seasonal flammability of big sagebrush and western juniper foliage. Ore. Agr. Exp. Sta. Spec. Rep. No. 586. p. 3-6.
- Britton, C. M., and F. A. Sneva. 1981. Effect of fire on herbaceous yield of sagebrush-bunchgrass range. Ore. Agr. Exp. Sta. Spec. Rep. No. 620. p. 1-3.
- Hansmire, J. A., C. M. Britton, and S. S. Waller. 1983. A simple sack holding frame. J. Range Manage. 36:800.
- Britton, C. M., and R. G. Clark. 1984. Effects of fire on sagebrush and bitterbrush. Rangeland Fire Effects Symposium. Boise.
- Weigel, J., and C. M. Britton. 1986. Use of a metal detector to locate permanent plots. J. Range Manage. 39:565.
- McPherson, G. R., G. A. Rasmussen, H. A. Wright, and C. M. Britton. 1986. Getting started in prescribed burning. Texas Tech Univ., Dept. Range and Wildl. Manage. Management Note No. 9.
- Britton, C. M., H. A. Wright, B. E. Dahl, and D. N. Ueckert. 1987. Management of tobosagrass rangeland with prescribed fire. Texas Tech Univ., Dept. Range and Wildl. Manage. Management Note No. 11.

Popular Manuscripts:

- Britton, C. M. 1974. Fallow riceland and livestock, can herbicides help? Rice Farming 8(4):22-23.
- Britton, C. M. 1974. A&M specialist take note of ranchers fuel problem. West Texas Livestock Weekly. 14 March:12.
- Britton, C. M. 1982. Burning becomes a popular tool. The Ranch Mag. 63(12):36.
- Britton, C. M., and J. S. Pitts. 1989. Capitan rancher finds way to keep troughs ice-free. Livestock Weekly. 44(34):17.
- Britton, C. M., and W. Meinzer. 1990. Fire and Wildlife. Texas Parks and Wildl. 49(1):28-31.
- Britton, J. R., and C. M. Britton. 1993. A shepherders assistant: Adventures in a hill country pasture. Ranch Mag. 74(6):18-19.
- Britton, R., and C. M. Britton. 1993. Adventures in snake hunting. Ranch Mag. 74(9):32-33.

Papers Presented:

- Britton, C. M., and J. D. Dodd. 1974. Correlation of selected environmental factors with net aerial primary productivity of a grassland ecosystem. Southwest. Nat. (Abstr.).
- Britton, C. M., and J. D. Dodd. 1975. Correlation of selected environmental parameters with net aerial primary production of a grassland ecosystem. Soc. for Range Manage. (Abstr.).
- Britton, C. M., and J. D. Dodd. 1976. Relationship of regrowth production to the environment in an Andropogon-Paspalum grassland ecosystem. Soc. for Range Manage. (Abstr.).
- Britton, C. M., and H. A. Wright. 1976. Effects of prescribed burning on vegetation. Use of prescribed burning in western woodland and range ecosystems--a symposium. Utah State Univ., Logan, Utah. (Abstr.).
- Britton, C. M., and F. A. Sneva. 1977. Production and chemical attributes of Kochia prostrata. Soc. for Range Manage. (Abstr.).
- Britton, C. M. 1977. Observed fire behavior in grassland communities. Cold Desert Fire Management Workshop. Boise, Idaho. (Abstr.).
- Britton, C. M. 1977. Fire effects in sagebrush-bunchgrass ecosystems. BLM District Fire Management Officer Training Session. Boise, Idaho. (Abstr.).
- Britton, C. M. 1977. Implications of prescribed burning in sagebrush-bunchgrass communities. Soc. for Range Manage., PNW Section, Corvallis. (Abstr.).
- Britton, C. M. 1978. Effects of season of burning on five bunchgrass species in eastern Oregon. Soc. for Range Manage. (Abstr.).
- Britton, C. M. 1978. Use of fire as a management tool in sagebrush ecosystems. Utah State Univ., Logan, Utah. (Abstr.).
- Britton, C. M. 1978. Prescribed fire in the Great Basin. BLM Fire Management Seminar. Denver, Colorado. (Abstr.).
- Britton, C. M. 1979. Fire in arid lands. Advanced Fire Management Course. National Interagency Resource Technology Center, Marana, Arizona. (Abstr.).
- Daugherty, D. A., H. A. Turner, and C. M. Britton. 1979. Effects of grazing intensity on steer gains. J. Anim. Sci. Suppl. 1,49:261. (Abstr.).
- Britton, C. M. 1980. Fire in sagebrush-grass. Managing fire effects. National Advanced Resource Technology Center. Marana, Arizona. (Abstr.).

- Britton, C. M. 1980. Fire in arid lands. Advanced fire management. National Advanced Resource Technology Center. Marana, Arizona. (Abstr.).
- Britton, C. M., and F. A. Sneva. 1980. Effects of haying and non-use on native flood meadow vegetation. Soc. for Range Manage. (Abstr.).
- Waller, S. S., D. K. Schmidt., J. Stubbendieck, C. M. Britton, and F. A. Sneva. 1980. Germination of Kochia prostrata (L.) Schrad. Soc. for Range Manage. (Abstr.).
- Britton, C. M. 1981. Fire in arid lands. Advanced fire management. National Advanced Resource Technology Center. Marana, Arizona. (Abstr.).
- Britton, C. M. 1981. Fire in sagebrush-bunchgrass. Univ. of Wyoming Prescribed Burning Symp. Riverton, WY. (Abstr.).
- Britton, C. M. 1981. Use of fire to rehabilitate western rangelands. USDI-USDA Rehabilitation Workshop. Twin Falls, ID. (Abstr.).
- Britton, C. M. 1981. Effects of fire in sagebrush-bunchgrass communities. Forest Service Workshop. Cody, WY. (Abstr.).
- Britton, C. M. 1981. Use and evaluation of fire on waterfowl habitat. U.S. Fish and Wildlife Service Workshop. Burns, OR. (Abstr.).
- Sneva, F. A., C. M. Britton, H. Mayland, J. Buckhouse, R. Evans, J. Young, and M. Vavra. 1981. St. Helen's ash: initial considerations of its fallout on rangelands. Soc. for Range Manage. (Abstr.).
- Sneva, F. A., J. Young, R. Evans, H. Mayland, J. Buckhouse, C. Britton, and M. Vavra. 1981. St. Helen's ash: rangeland impacts. Northwest Science Association. 54th Ann. Meeting. Corvallis, OR. (Abstr.).
- Britton, C. M. 1982. Fire effects on vegetation and range. USDI Workshop, Fire effects for Resource Specialist. Redmond, OR (Abstr.).
- Britton, C. M. 1982. Fire in arid lands. Advanced fire management. National Advanced Resource Technology Center. Marana, Arizona. (Abstr.).
- Britton, C. M. 1982. Range analysis and mapping. A Shortcourse in Range Management. Lima, Peru (Abstr.).
- Britton, C. M., and A. A. Steuter. 1982. Production and nutritional attributes of tobosagrass following burning. Soc. for Range Manage. (Abstr.).
- Steuter, A. A., and C. M. Britton. 1982. Fire induced mortality rates for redberry juniper. Soc. for Range Manage. (Abstr.).

- Sears, W. E., C. M. Britton, and R. D. Pettit. 1982. Biomass and nitrogen dynamics of a herbicide treated sand shinnery oak community. Soc. for Range Manage. (Abstr.).
- Britton, C. M. 1983. Fire in arid lands. Advanced fire management. National Advanced Resource Technology Center. Marana, Arizona. (Abstr.).
- Britton, C. M. 1983. Vegetation measurements for prescribed burns. U.S. Fish and Wildl. Serv. Workshop. Laguna-Atascosa Refuge, Texas. (Abstr.).
- Kelsey, R. G., W. E. Wright, F. A. Sneva, A. Winward, and C. M. Britton. 1983. Essential oils in Oregon big sagebrush. Soc. for Range Manage. (Abstr.).
- Marietta, K. L., and C. M. Britton. 1983. Forage alternatives for dryland agriculture on the Texas High Plains. Soc. for Range Manage. (Abstr.).
- Masters, R. A., C. M. Britton, and F. H. Roberts. 1983. Effect of season of burn on weeping lovegrass. Soc. for Range Manage. (Abstr.).
- Roberts, F. H., C. M. Britton, and R. G. Clark. 1983. Effect of fire intensity on grass yield in west Texas. Soc. for Range Manage. (Abstr.).
- Wright, H. A., and C. M. Britton. 1983. Brush management with fire. Soc. for Range Manage. (Abstr.).
- Sears, W. E., C. M. Britton, and R. D. Pettit. 1983. Biomass dynamics following oak death in a sand shinnery oak community. Soc. for Range Manage. (Abstr.).
- Britton, C. M. 1984. Effects of fire on sagebrush and bitterbrush. Rangeland Fire Effects Symp. Boise, Idaho. (Abstr.).
- Marietta, K. L., and C. M. Britton. 1984. Production, crude protein, and IVDOM levels of several native and introduced forage species on the Texas High Plains. Soc. for Range Manage. (Abstr.).
- Masters, R. A., and C. M. Britton. 1984. Effect of fertilization, irrigation, and defoliation on water use efficiency of weeping lovegrass and old world bluestem (WW517). Soc. for Range Manage. (Abstr.).
- Britton, C. M. 1985. Effects of fire on grazing management. Texas Section, Soc. for Range Manage. (Abstr.).
- Britton, C. M. 1985. Use of fire on tobosagrass rangeland. Soc. for Range Management. Summer meeting. (Abstr.).
- Marietta, K. L., and C. M. Britton. 1985. Establishment of several native and introduced forage species on the Texas High Plains. Soc. for Range Manage. (Abstr.).

- Masters, R. A., K. L. Marietta, and C. M. Britton. 1985. Response of yucca to fire, herbicide and mechanical treatments. Soc. for Range Manage. (Abstr.).
- Pitts, J. S., F. T. McCollum, and C. M. Britton. 1986. Physiological response of steers to different levels of supplementation. Soc. for Range Manage. (Abstr.).
- Britton, C. M. 1987. Fire and rangeland resources. Nat. Park Serv., Calif.
- Weigel, J. R., and C. M. Britton. 1987. Effects of short duration grazing trampling on seedling emergence and soil strength. Soc. for Range Manage. (Abstr.).
- Weigel, J. R., G. R. McPherson, and C. M. Britton. 1987. Effects of short duration grazing trampling on grass and forb seedling emergence. A.A.A.S. (Abstr.).
- Pitts, J., T. McCollum, and C. Britton. 1988. Effect of protein intake on several blood constituents and fecal nitrogen in grazing steers. Soc. for Range Manage. (Abstr.).
- Pitts, J., T. McCollum, and C. Britton. 1988. Effects of supplemental protein on average daily gain and several blood constituents of steers grazing spring and summer tobosagrass range. Soc. for Range Manage. (Abstr.).
- Blair, K., C. M. Britton, and D. N. Ueckert. 1988. Summer and fall physiological activity in Lindheimer prickly pear (*Opuntia lindheimeri*). Soc. for Range Manage. (Abstr.).
- Negrete, L. F., C. M. Britton, L. C. Fierro, and L. Mena. 1988. Response of six tropical grasses to prescribed burning in the west coast of Mexico. Soc. for Range Manage. (Abstr.).
- Britton, C. M. 1989. Fire and Rangeland. Nat. Park Serv. Calif.
- Britton, C. M. 1990. Effects of prescribed fire on rangelands. Range Brush and Weed Control Conf., Las Cruces.
- Britton, C. M. 1990. Fire Ecology. Cattle Growers Short Course. New Mexico State Univ.
- Britton, C. M. 1990. How to burn safely and effectively. Cattle Growers Short Course. New Mexico State Univ.
- Britton, C. M. 1990. The positives and negatives of prescribed burning. Range and Wildl. Field Day--2B Ranch.
- Britton, C. M., and D. B. Wester. 1993. Climatic patterns and weed populations. New Mexico Veg. Manage. Assoc. Albuquerque.
- Britton, C. M. 1993. Winter supplementation and compensatory gain of steers grazing tobosagrass range. Texas and Southwest. Cattle Raisers Assoc. Austin.

- Britton, C. M. 1993. Response of grasses and shrubs to prescribed fire. Prescribed Burning Seminar, TAES and SCS. Albany.
- Britton, C. M., and D. B. Wester. 1993. Correlation of fall precipitation and annual broomweed infestations. Soc. for Range Manage.
- Sanden, E. M., C. M. Britton, and J. H. Everitt. 1993. A remote sensing vegetation index to estimate total ground cover. Soc. for Range Manage. Albuquerque.
- Villalobos, C., and C. M. Britton. 1993. Protein supplementation effect on forage intake by steers grazing dormant tobosagrass. Soc. for Range Manage. Albuquerque.
- Villalobos, C., C. M. Britton, and J. S. Pitts. 1993. Effect of level of protein supplementation on steer performance grazing dormant tobosagrass. Soc. for Range Manage. Albuquerque.
- Wester, D. B., and C. M. Britton. 1993. Annual broomweed: Factors affecting a broomweed year. Rangeland Weed Control Workshop, TAES. Post.
- Britton, C.M. 1995. Use of fire to improve central Texas rangeland. TAES. San Saba County, Texas.
- Britton, C.M. 1995. Supplementation of stockers on rangeland. TSCRA Cattleman's College. San Antonio.
- Britton, C.M. 1995. Effect of plant morphology on plant response to prescribed fire. U.S. Fish and Wildlife Serv., Minot, ND.
- Britton, C.M. 1995. Prescribed burning CRP fields to control boll weeviles. Plains Cotton Growers. Lamesa and Seminole.
- Britton, C.M. 1995. Effect of prescribed burning on rangeland value. Soc. Farm and Real Estate Appraisers. Lubbock.
- Britton, C.M. 1995. Fire history on the Spade Ranch. TP&W Fire School. Colorado City.
- Villalobos, C., and C.M. Britton. 1995. Effect of protein levels fed during winter on subsequent performance of steers grazing tobosagrass. Soc. Range Manage.
- Britton, C.M.. 1996 Using fire to fight weevils in CRP. West Texas Cotton Conf. Levelland.
- Britton, C.M.. 1996. Range Survey Report – Pantex Plant. College of Agriculture Sciences and Natural Resources. Texas Tech University.
- Britton, C.M. 1996. Using fire to restore rangeland ecosystems. USDA Forest Service. Amarillo.

- Britton, C.M. 1996. Burning in Texas. Lubbock Christian University.
- Britton, C.M. 1996. Managing CRP grasslands. The Farm Show. Lubbock.
- Britton, C.M. 1996. Range research at Texas Tech. Houston Livestock Show Board. Lubbock.
- Britton, C. M. 1996. Prescribed burning in Texas. Southwest Fire Council. Annual Meeting. Lubbock.
- Britton, C.M. 1997. Juniper burning at Texas Tech. The Juniper Symposium. TAES. San Angelo.
- Mitchell, R., C.M. Britton, D. Wester, and S. Mullins. 1997. Current research on redberry juniper at Texas Tech University. The Juniper Symposium. TAES. San Angelo.
- Johnson, P.A., A. Gerbolini, D. Ethridge, C.M. Britton, and D.N. Ueckert. 1997. Economics of redberry juniper control in the rolling plains. The Juniper Symposium. TAES. San Angelo.
- Britton, C.M. 1997. Use of fire for brush management. TAES Workshop. Clarendon Junior College.
- Britton, C.M. 1997. Fire Management in west Texas. TP&W. Triangle Ranch Fire School.

Theses and Dissertations Directed:

- | | | |
|-----------------|-----|---|
| Robert G. Clark | MS | Seasonal response of bitterbrush to burning and clipping in eastern Oregon. |
| Weldon Sears | MS | Compartmental biomass and nitrogen dynamics on sand shinnery oak rangeland as affected by different ages of treatment with tebuthiuron. |
| Fred Roberts | MS | Effects of fire intensity on grass yields. |
| Loren Kronemann | MS | Fire effects on mule deer browse. |
| Kay Marietta | PhD | Forage alternatives to irrigated agriculture on the High Plains. (December 1984) |
| Robert Masters | PhD | Water use efficiency of selected high yielding grasses. (September 1985) |

Fernando Negrete	MS	Effect of fire on tropical grasses. (December 1986)
Jeff Weigel	MS	Effect of cattle trampling on seedling establishment and soil strength. (May 1987)
Keith Blair	MS	Photosynthesis and control of pricklypear. (Dec 1990)
Carlos Villalobos	PhD	Winter supplementation of steer grazing tobosagrass. (May 1992)
Eric Sanden	PhD	Determination of total ground cover by remote sensing. (May 1992)
Steve Brown	MS	Fire effects on Matagorda Island Vegetation. (May 1995)
Rodney Smith	MS	Control of shrubby vegetation on Attwater Prairie Chicken habitats. unfinished
Chuck Stanley	MS	Comparison of summer and winter burning of native vegetation on the High Plains of Texas. (May 1997)
Brent Racher	MS	Correlation of juniper canopy cover to forage yield in the rolling red plains of Texas. (December 1998)
Eve Warren	Ph.D	Germination and establishment characteristics of redberry juniper

Grant Monies Received at Texas Tech:

1. E. L. Lilly and Co. 1980. Biomass and nitrogen dynamics of a herbicide converted plant community. \$15,000.
2. U.S. Forest Service. 1982. Evaluation of fire effects model. \$5,000.
3. Eli Lilly and Co. 1983. Herbicidal control of flameleaf sumac. \$1,000.
4. Thornton Estate. 1983. Base funding for Texas Tech Experimental Ranch. \$340,000.
5. Various private individuals and companies. 1984. Material and supplies for Texas Tech Experimental Ranch. \$150,000.
6. Godbold Feed Co. 1986. Winter supplementation of steers. \$4,800.

7. Hemphill Wells Foundation. 1986. Ranch Research. \$7,500.
8. Mary Baker Rumsey Foundation. 1988. Research. \$51,000.
9. Mary Baker Rumsey Foundation. 1989. Research and Endowments. \$125,000.
10. Mary Baker Rumsey Foundation. 1990. Research. \$12,000.
11. Godbold Feed Co. 1990. Winter Supplementation. \$7,600.
12. J. F. Charitable Endowment. 1991. Winter Supplementation. \$10,000.
13. Bureau of Land Management. 1991. Fire Effects on Desert Grasslands. \$96,000 (Requested Proposal--Tentative).
14. U.S. Fish and Wildlife Service. 1991. Effects of Fire on Wildlife Habitat at Matagorda Island and Attwater's Prairie Chicken Refuges. \$159,000. (Requested Proposals--Approved).
15. J.F. Charitable Endowment. 1991. Publication and printing of one Management Note and one germination pamphlet. \$5,000.
16. Godbold Feed Co. 1991. Winter Supplementation. \$6,000.
17. Godbold Feed Co. 1991. Winter Supplementation. \$5,000.
18. Nature Conservancy. 1993. Fire History. \$1,400.
19. J. F. Charitable Endowment. 1993. Various. \$9,500.
20. Godbold Feed Co. 1994. Winter Supplementation. \$6,000.
21. J. F. Charitable Endowment. 1994. Various. \$5,000.
22. J. F. Charitable Endowment. 1995. Various. \$13,000.
23. J. F. Charitable Endowment. 1996. Various. \$5,000.
24. U.S. Army, IPA. 1996. \$48,000.
25. J. F. Charitable Endowment. 1997. Various. \$7,000.
26. U.S. Army, IPA. 1997. \$58,800.
27. Plains Cotton Growers. 1998. Fire Studies. \$10,000.
28. J.F. Charitable Endowment. 1998. Various. \$10,000.

29. Natural Resource Conservation Service. National Prescribed Fire School. 1997-1999. \$15,000.

RESUME OF
JAMES L. COLE

JAMES L. COLE • 7711 GRIFFIN POND COURT • SPRINGFIELD, VIRGINIA 22153

(703) 455-6630

SENIOR MANAGER

PROFESSIONAL PROFILE: Eighteen years top level executive decision-making experience in air transportation, association management, safety program management, risk analysis, and flight crew training. Seasoned and skilled in the U.S. Government interagency process and legislative liaison with Congress. Expert in policy formulation and strategy development. Accomplished public speaker with many keynote addresses and trips to Capitol Hill.

EDUCATION: Executive Development Program, Cornell University
MBA, Auburn University
MA, Ohio State University
BS, U.S. Air Force Academy

1996-Present, Chief of Staff, National Air Traffic Controllers Association (NATCA). Mission is the improvement of air traffic safety and working conditions for air traffic controllers. Manage full time staff of twenty-five, an annual budget of \$7 million, and maintain effective liaison with the U.S. Congress, the Federal Aviation Administration, the National Transportation Safety Board, and the aerospace and aviation communities.

Built effective coalitions with other associations and expanded NATCA's safety advocacy role
Prepared NATCA's input to the White House Commission on Aviation Safety and Security
Briefed members of Congress and GAO on aviation safety issues

1994-1996, President and CEO, National Aeronautic Association (NAA). Mission is the advancement and promotion of the art, sport, and science of aviation and space flight. NAA sanctions and certifies aviation and space records; awards major aviation trophies; and represents the U.S. internationally as the National Aero Club of the United States. Reorganized and reinvigorated NAA while achieving single greatest year of aggregate membership growth in over twenty years.

Doubled Corporate Memberships (added 23) and tripled Affiliate Memberships (added 33)
Doubled Individual Memberships (added 500)

1991-1994, Chief of Safety, U.S. Air Force. Directed entire U.S. Air Force Safety program with authority and accountability for accident prevention and investigations for 500,000 personnel and 9,000 aircraft in all aspects of ground and air operations. Managed all flight, ground, and weapons safety as well as nuclear surety of all USAF nuclear weapons. Achieved "Safest Year in USAF History."

Produced lowest number of aircraft mishaps and lowest aircraft mishap rate ever
Achieved lowest number of air and ground mishap fatalities ever

1990-1991, Assistant DCS Operations and Transportation, Military Airlift Command, U.S. Air Force. Directed all air operations and transportation functions for Military Airlift Command, including world-wide airlift, aeromedical evacuation, special operations and air rescue operations.

Managed training, qualification, standardization and evaluation of all aircrews
Maintained and managed world-wide positive command and control system
Worked DESERT SHIELD/DESERT STORM airlift of 482,000 troops and 513,000 tons of cargo

1989-1990, Inspector General, Military Airlift Command, U.S. Air Force. Led Inspection and Safety functions for Military Airlift Command. Set and enforced operational standards and inspection criteria for active and air reserve airlift units totalling 160,000 personnel and 1,400 aircraft.

Planned and administered all Operational Readiness and Management Effectiveness Inspections
Managed flight, ground, and weapons safety as well as nuclear weapons airlift surety
Investigated and resolved complaints and responded successfully to congressional inquiries

1986-1989, Senior Advisor for Joint Matters, Joint Staff, Joint Chiefs of Staff. Produced National Security papers and presentations for the Chairman, Joint Chiefs of Staff and the service Chiefs of Staff for their scheduled meetings three times each week and their weekly meeting with the Secretary of Defense.

Prepared Chairman for National Security Council meetings with the President
Orchestrated national policy and strategy issues in the U.S. Government Interagency Arena
Briefed Secretary of Defense, Joint Chiefs of Staff, and members of Congress many times

1985-1986, Commander, 89th Military Airlift Wing, Andrews AFB, Military Airlift Command, U.S. Air Force. Directed and operated worldwide VIP air transportation for U.S. President, Vice President, senior government officials and foreign dignitaries. Assets included three operational flying squadrons, a flying detachment overseas, a maintenance complex, an air passenger and cargo terminal, and a supply organization.

Recruited and trained 1,500 top quality flight crew and support personnel
Managed \$10 million annual operating budget
Earned OUTSTANDING ratings on all operational and management inspections
Won Flight Safety Achievement Award

SPECIAL SKILLS AND ACCOMPLISHMENTS:

AVIATOR - USAF Command Pilot with 6,500 total flying hours. Flight Examiner and Instructor qualified. Designed and taught Flight Instructor Orientation Course on quality training, risk management, and optimal instructing techniques which increased student throughput and decreased costs by 10%. Certificated Flight Instructor/Commercial Pilot with instrument rating and 1,500 flying hours as flight instructor in C-141 (L-300), C-47 (DC-3), and T-41 (Cessna 172).

HISTORIAN - Served as Assistant Professor of History on U.S. Air Force Academy faculty. Taught Modern European and U.S. Military History. Certified as Western European Area Specialist. Course Chairman for Modern European History Honors Course and History of Air Power Course. Extensive experience in course development and syllabus preparation. Won "Outstanding Instructor of the Year" Award. Contributing author to Flying Combat Aircraft, published by Iowa State University Press. Published several articles and many book reviews in professional journals. Member of PHI ALPHA THETA (History Scholarship).

BOARDS - Member, Advisory Committee to Safety and Surety Assessment Center, Sandia National Laboratories. Member, Board of Trustees, Air Force Historical Foundation. Member, Board of Directors, Air Force Academy Society of Washington D.C. Member, Board of Directors, National Aeronautic Association.

SECURITY CLEARANCE - TOP SECRET (SCI with SBI).

RESUME OF
GEORGE A. CARRUTH

George A. Carruth

6435 Alloway Court
Springfield, VA 22152

Home: (703) 569-7884
Office: (202) 488-6736

CURRENT POSITION:

Manager, System Integration

EDUCATION:

Tulane University, 1967-1969, Biology, PhD, 1973
University of Arkansas, 1956-1957, Animal Nutrition, MS, 1957
University of Arkansas, 1952-1956, Agriculture, BS, 1956
National War College, 1978
U.S. Army Command and General Staff College, 1971-1972
U.S. Army Chemical School, Radiological Safety, 1964

EXPERIENCE:

CRWMS M&O

System Integration

1991 - Present

Summary of Responsibilities and Major Accomplishments

Responsible for development, implementation and maintenance of CRWMS program-level management plans, policies and procedures; system level technical baseline requirements documentation and OCRWM and M&O change control plans and procedures. Manage the development of system interfaces and integrates engineering and other technical activities to ensure achievement of technical baseline.

TRW Command Support Division

Project Manager

1987 - 1991

Summary of Responsibilities and Major Accomplishments

Developed organization and concepts for the TRW team system engineering, development and management of the Nuclear Waste Management System for the Office of Civilian Radioactive Waste Management. Managed and developed Business Management Volume of the TRW Proposal. Researched and prepared business analysis of environmental services for TRW entry into market. Developed strategy, and directed technical and management sections of TRW's proposal for Program and Integration Support of the Army's Chemical Stockpile Disposal Program.

U.S. Department of the Army

Chief, Chemical and Nuclear Biological and Chemical

1985 - 1987

Defense Division, Office of the Deputy Chief of Staff for Operations and Plans

Summary of Responsibilities and Major Accomplishments

Developed and managed the Army's chemical warfare, nuclear, biological, and chemical defense policies, programs, and plans. Responsible for budget information and execution; doctrine; material requirement definition; and material life cycle management to include disposal of toxic chemical structure development; and material life cycle management to include disposal of toxic chemical munitions and agents. Maintained an annual program of \$1 billion during period of severe budget reductions. Provided leadership for the development of the first Joint Service Chemical Warfare and Chemical Biological Defense Research

CARRUTH, GEORGE A.

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Development and Acquisition Plan that provides prioritized material, science and technology, and data requirements supporting resource needs to all the armed services. Guided development of the congressionally-mandated concept plan for the destruction of the national stockpile of toxic chemical agents and munitions on a very constrained schedule. Conducted and planned three program alternatives within average cost of \$2 billion each. Briefed, and was a witness, before key congressional committees, members, and staffers on the Fiscal Year 1986 and 1987 Department of Defense Presidential Budget Requests. Gained congressional support/funding for the chemical warfare program including funding for production of binary chemical weapons.

Deputy Commander
U.S. Army Nuclear and Chemical Agency

1984 - 1985

Summary of Responsibilities and Major Accomplishments

Provided daily direct supervision to the Army Nuclear and Chemical Agency, the only organization dedicated to provide technical support on nuclear and chemical matters to the Army in a tactical area. Provide top-level guidance on policy for the safety, security, and reliability of three of the Army's nuclear and chemical weapons. Supervised preparation of employment manuals for all Army weapons and those of other services used to support the Army in the field.

Commander
Dugway Proving Ground

1981 - 1984

Summary of Responsibilities and Major Accomplishments

Managed the Army Dugway Proving Ground, DoD's only chemical warfare, chemical and biological defense and smoke major range and test facility. Planned, conducted, and reported on a wide variety of highly technical test projects representing over 45,000 man-hours of effort. Originated and guided to completion, a comprehensive plan for the modernization of the test facility to include increase in personnel and improved instrumentation, facilities, housing, utilities, and communications. Directly supervised the operation of an isolated 2,500-person community including housing, medical care, law enforcement, fire protection, utilities, and support facilities.

Chief, Nuclear and Chemical Office
U.S. Army Material Development Readiness Command

1978 - 1981

Summary of Responsibilities and Major Accomplishments

Directed development of environmental documentation for several major Army programs to include controversial projects such as movement of chemical weapons for Colorado to Utah and the chemical stockpile program. Exercised major headquarters responsibility for the safety and the security of the majority of the Army Material Development and Readiness Command's chemical weapons and two of the largest nuclear depots to include responsibility for accident/incident control, physical security site-upgrade program, and personnel reliability program.

Staff Engineer
Chemical Division, Office of the Deputy Chief of Staff
For Operations and Plans

1975 - 1977

Summary of Responsibilities and Major Accomplishments

Point of contact for all matters affecting nuclear, biological and chemical training, readiness, doctrine, equipment, and employment of chemical munitions for Headquarters, Department of the Army. Conducted joint service planning and coordination of program with Office of the Secretary of Defense and the other

CARRUTH, GEORGE A.**Page 3**

Services. Lead team that conducted detailed review of the U.S. Army's Chemical Warfare Posture and developed a comprehensive program plan for correcting identified deficiencies.

As Chief of the Trails Branch Staff Studies and Trails Wing (1972 - 1974), served as Exchange Officer to the British Defense NBC School responsible for planning, coordinating, and directing tests of British NBC defense equipment and doctrine.

As Chief of the Radiological Division (1970 - 1971), presented nuclear weapons employment and radiology safety to all students at the U.S. Army Chemical School.

As Chemical Officer and Deputy Operations Officer (1969 - 1970), planned and operated the control room for monitoring and directing military operations in the largest corps area in Vietnam.

Executive for Plans and Training (1964 - 1967), for all U.S. Army forces in Panama.

Instructor for Plans and Training (1962 - 1964), for the U.S. Army Chemical School.

Instructor and Company Executive Officer (1960 - 1962), prepared and presented instruction to combined officer and enlisted courses on jungle and amphibious small unit operations for the Ranger Department in the U.S. Infantry School.

Research Biochemist (1957 - 1959), for the U.S. Army Biological Warfare Laboratory.

Awards/Accomplishments/Publications/Patents/Other**Memberships**

National Science Foundation Fellowship (for MS)

National Science Fellowship (for PhD)

Sigma Xi

Awards

Legion of Merit (three awards)

Bronze Star

Army Commendation Metal (three awards)

RESUME OF
KEVIN J. COPPERSMITH

KEVIN J. COPPERSMITH

Performance Assessment
Hazard Analysis
Decision Analysis
Project Management

EDUCATION

University of California, Santa Cruz; Ph.D., Geology, 1979
Washington and Lee University, Lexington, Virginia: B.S., Geology, 1974

PROFESSIONAL HISTORY

Geomatrix consultants, Inc., Principal and Vice President, 1985 to date
Woodward-Clyde Consultants, Senior Project Geologist, 1978-1985
University of California, Regents Fellow, 1974-1978
Earth Sciences Board, University of California, Santa Cruz, Research Assistant and Teaching Assistant, 1974-1978

REPRESENTATIVE SKILLS AND EXPERIENCE

Dr. Coppersmith has 20 years of consulting experience, with primary emphasis in performance assessment and hazard analysis. Dr. Coppersmith has pioneered approaches to characterizing earth sciences data, and their associated uncertainties, into probabilistic hazard analyses through the process of formal expert elicitation. As manager of the Performance Assessment (PA) operating unit at Geomatrix, Dr. Coppersmith has helped develop capabilities within the firm that integrate the fields of earth sciences, hazard analysis, and risk assessment. As a result of increasing use of performance assessment for decision making, Dr. Coppersmith has identified new applications for PA in the engineering and environmental fields. Applications range from highway bridges to nuclear waste repositories.

Dr. Coppersmith's areas of expertise and representative project experience are identified briefly below:

Development of Hazard Methodologies and Uncertainty Treatment

- Seismic Hazard in the Eastern United States, Electric Power Research Institute (EPRI)
- Maximum Earthquakes in Eastern United States, EPRI
- Senior Seismic Hazard Analysis Committee, Department of Energy (DOE), Nuclear Regulatory Commission (NRC), and EPRI
- Seismic Hazard Analysis Methodology Topical Report for Yucca Mountain, DOE
- Expert Elicitation Methodology Demonstration for Yucca Mountain
- Performance Assessment, EPRI

Hazard Analysis for Performance Assessment of Built Structures and Pipelines

- Seismic hazard at San Francisco bay area bridges, California Department of Transportation (Caltrans)

Seismic hazard at Humboldt Bay bridges, Caltrans
Regional seismic hazard analysis for Oregon bridges and transportation structures, Oregon Department of Transportation
Seismic hazard and site response studies for K-reactor, Westinghouse Savannah River Company
Seismic hazard analysis for Portugues Dam, Puerto Rico, U.S. Army Corps of Engineers
Seismic hazard analysis of Southern Ontario, Atomic Energy Control Board, Canada.

Expert Elicitation for Performance Assessments

Demonstration of risk-based total system performance assessment, EPRI, DOE
Probabilistic volcanic hazard analysis for Yucca Mountain, TRW, DOE
Seismic hazard analysis for Yucca Mountain, USGS, DOE
Expert Elicitations for Total System Performance Assessment at Yucca Mountain:
Unsaturated zone flow; Near field/Altered Zone Coupled Effects; Waste Package Degradation; Waste Form Degradation Radionuclide Mobilization; Saturated Zone Flow and Transport, TRW, DOE

Hazard Analyses for Development of Design Criteria or Design Review

Seismic Hazard Assessment for the New Production Reactor of Savannah River Site and Idaho National Engineering Laboratory, DOE
WNP-1, 2, 4 Hanford and WNP-3,5 Satsop, WPPSS
Diablo Canyon Power Plant, PG&E
Trojan Nuclear Power Plant, PGE
San Onofre Nuclear Generating Station, SCE
Palo Verde Nuclear Power Plant, APS

Seismic Source Characterization for Hazard Analysis

Diablo Canyon Power Plant, PG&E
Hanford Reservation, Westinghouse Hanford Company
Darlington and Pickering Nuclear Generating Stations, AECB
Nuclear Power Plants in Eastern Europe: Bohunice, Slovakia; Kozloduy and Belene, Bulgaria; Paks, Hungary;
San Onofre Nuclear Generating Station, Southern California Edison

Geologic Field Studies

Humboldt Bay Nuclear Power Plant, Pacific Gas & Electric Company (PG&E)
Diablo Canyon Power Plant, PG&E
Savannah River Site, South Carolina, Westinghouse Savannah River Company
Rocky Flats Environmental Technology Site, EG&G

AFFILIATIONS

Geological Society of America
Seismological Society of America
American Geophysical Union
Earthquake Engineering Research Institute

APPOINTMENTS

National Research Council/National Academy of Sciences:
 Panel on Probabilistic Seismic Hazard Analysis (1987-1988)
 Panel on Geological Hazards, Committee on Solid Earth Sciences - A Critical Assessment (1989-1990)
 Committee on Seismology (1988-1993)
 Chairman, Task Group on Probabilistic Approaches to Geological Uncertainties Related to Seismic and Volcanic Hazards, International Lithosphere Program, Inter-Union Commission of the Lithosphere - Geodynamics of the Solid Earth (1991-1993)
 Chairman, Task Group on Probabilistic Approaches to Geological Uncertainties Related to Seismic and Volcanic Hazards, International Lithosphere Program, Inter-Union Commission on the Lithosphere - Geodynamics of the Solid Earth (1991-1993)
 Seismic Hazard Team Leader, Earthquake risk Reduction in the United States, An Assessment of Selected User Needs and Recommendations for the National Earthquake Hazards Reduction Program; conducted for Federal Emergency Management Agency (FEMA) (1994)
 Geosciences Team Leader, Governor's Executive Order on the Implications of the 1993 Northridge Earthquake to Building Codes and Land Use Planning, sponsored by California Seismic Safety Commission and FEMA (1994)
 Appendix A Expert Panel, providing advice to Department of Energy, Nuclear Regulatory Commission regarding revision to 10CFR100 Appendix A of Geologic Siting Criteria (1991-1996)
 Senior Seismic Hazard Analysis Committee, sponsored by the Department of Energy, Nuclear Regulatory Commission, and Electric Power Research Institute (1994-1996)
 Editorial Board, Earthquake Spectra, Professional Journal of the Earthquake Engineering Research Institute (1991-Present)
 Director, Seismological Society of America (1996-1999)

RECENT INVITED LECTURES AND PRESENTATIONS

Earthquake Engineering Research Institute Annual Seminary (February, 1986)
 University of South Carolina, Geology Seminar (September, 1986)
 Stanford University, Risk Analysis Seminar (March, 1987)
 University of California, Santa Cruz, Geology Seminar (March, 1987)
 National Earthquake Prediction Evaluation Council, Cascadia Subduction Zone (April, 1987)
 Earthquake Engineering Research Institute, Strong Ground Motion Seminar
 San Francisco, CA (April, 1987)
 Los Angeles, CA (April, 1987)
 Charleston, SC (January, 1988)
 American Society of Civil Engineer's Geotechnical Considerations in Hazardous Waste Management (June, 1987)
 National Center for Earthquake Engineering Research, Symposium on Seismic Hazards, Ground Motions, Soil-Liquefaction, and Engineering Practice in Eastern North America

(October, 1987)

Geological Society of America, Neotectonics in Earthquake Evaluation (October, 1987)

U.S. Geological Survey Workshop o Fault Segmentation (March, 1988)

Seismogenesis on The Eastern United States, NSF Workshop (April, 1988)

NATO Advanced Research Workshop on Causes and Effects on Earthquakes at Passive Margins and in Areas with Post-glacial Rebound on both Sides of the North Atlantic (May, 1988)

American Society of Civil Engineers, Earthquake Engineering and Soil Dynamics II Conference (June, 1988)

National Earthquake Hazards Reduction Program Workshop of the Cascadia Subduction Zone (March, 1989)

National Academy of Sciences/National Research Council, Symposium on Opportunities in Seismology (May, 1989)

International Geological Congress Symposium on Geological Hazards (July, 1989)

Department of Energy, Natural Phenomena Hazards Mitigation Conference (October, 1989)

International High-Level Radioactive Waste Management Conference (April, 1990)

Institute of Gas technology, Disaster Relief Planning Meeting (April, 1990)

Workshop on Probabilistic Seismic Hazard Methodology, California Department of Transportation (November, 1990)

Seismic Hazards in the Delta, San Francisco Bay Region, Association of California Water Agencies (November, 1990)

State-of-the-Art Lecture, International Conference on Seismic Zonation (August, 1991)

Conference on Seismic Vulnerabilities, Nuclear Waste Technical Review Board (January, 1992)

Seismic Hazard Methodologies, Building Seismic Safety Council (January, 1993)

Effects of the 1992 Nevada Earthquake, International High Level radioactive Waste Management Conference (April, 1993)

Use of Paleoseismic Data in Hazard Analysis, International Conference on the Implications of the 1988 Spitak, Armenia Earthquake (October, 1993)

New Directions in Geotechnical Engineering, American Society of Civil Engineers (April, 1994)

Emergency Response Planning for Gas Systems, Institute Gas Technology (May, 1994)

Experience Characterizing Earthquake Sources in the Central and Eastern United States; Canadian Atomic Energy Control Board (June, 1995)

Probabilistic and Deterministic Approaches to Seismic Hazard Analysis, Applied Technology Council (September, 1995)

Expert Elicitation of Probabilistic Volcanic Hazard at Yucca Mountain, Nevada, International High Level Radioactive Waste Management Conference (May, 1996)

Improved Guidance on the Use of Experts - Probabilistic Seismic Hazard Analysis and Other International Topical Meeting on Probabilistic Safety Assessment (October, 1996)

The Use of Expert Elicitation to Quantify Uncertainties in Inputs to Total System Performance Assessments at Yucca Mountain, Nevada (May, 1998)

Examples of Seismic Source Characterization for Probabilistic Seismic Hazard Analysis, Symposium on Geologic Interpretation of Earthquake Hazards, Camerino, Italy (June, 1998)

Use of Expert Judgments in Risk Analyses, Probabilistic Safety Analysis and Management

Conference, New York (September, 1998)

New Trends in the Use of Paleoseismic Data in Seismic Hazard Analyses, Keynote Speech

Latin American Geological Congress, Buenos Aires (November, 1998)

Incorporating Uncertainties in Seismic Hazard Analyses, Luncheon Address, Symposium on the Application of Geophysics to Environmental and Engineering Problems, Environmental and Engineering Geophysical Society (March, 1999)

PUBLICATIONS

“Use of Expert Elicitation to Quantify Uncertainties in Process Models for Total System Performance Assessment,” K.J. Coppersmith, R.C. Perman, R.R. Youngs, and M. Pendleton, International High Level Radioactive Waste Management Conference Proceedings, p. 318-320, 1998.

“Use of Expert Elicitation for Modeling Waste Package Degradation at the Potential Yucca Mountain Repository,” J.H. Lee, K.J. Coppersmith, D. Stahl, R. Andrews, M. Pendleton, International High Level Radioactive Waste Management Conference Proceedings, p. 414-416, 1998

“Characterizing seismic sources for design ground motions and fault displacement studies part of Los Angeles 2020 project,” L. S. Cluff, and K. J. Coppersmith, Port of Las Angeles 2020 Project Earthquake Symposium, p. 1-14, 1997.

“Performance Assessments for gas transmission systems,” Proceedings of the Disaster Relief Planning Symposium: Institute for Gas Technology (in press).

“Yucca Mountain Probabilistic Volcanic Hazard Analysis Project,” International High-Level Radioactive Waste Management Conference Proceedings, 1996.

“New empirical relationships among magnitude, rupture length, rupture width, rupture area, and surface displacement,” D.L. Wells, K.J. Coppersmith, Bulletin of the Seismological Society of America, v. 84 #4, p. 974-1002, 1994.

“Modeling fault rupture hazard for the proposed repository at Yucca Mountain, Nevada,” K.J. Coppersmith, R. Youngs, Proceedings Third International Conference High Level Radioactive Waste Management, April 12-16, 1992.

“Demonstration of a decision analysis methodology for assessing the performance of the Yucca Mountain site in southern Nevada,” F. Schwartz, R. McGuire, D. Bullen, N. Cook, K. J. Coppersmith, J. Kernendy, A. Long, F. Pearson Jr., M. Sheridan, and R. R. Youngs, Waste Management, v. II, p. 287-306, 1991.

“Seismic source characterization for engineering seismic hazard analyses,” K.J. Coppersmith, Proceedings of the Fourth International Conference on Seismic Zonation: Earthquake Engineering Research Institute, Oakland, California, v. 1, p. 1-60, 1991.

"Improved methods for seismic hazard analysis in the western United States," R.R. Youngs, Proceedings of the Fourth U.S. National Conference on Earthquake Engineering, v. 1, p. 723-731, 1990.

"Incorporating seismotectonic data into seismic hazards analyses," K.J. Coppersmith, Second International High-Level Radioactive Waste Management Conference Proceedings, 1990.

"Probabilistic Seismic hazard analysis using expert opinion: An example from the Pacific Northwest," K.J. Coppersmith, R. Youngs, Geological Society of America Memoir on Neotectonics in Earthquake Evaluation, E. Krinitsky, and D.B. Slemmons (eds.), v. 8, p.27-46.

"New earthquake magnitude and fault rupture parameters: Part I Surface rupture length and rupture area relationships" (abs.), D.L. Wells, K.J. Coppersmith, X. Chang, and D.B. Slemmons, Seismological Research Letters, 1989.

"Paleoseismic history of the Meers fault, southwestern Oklahoma, and its implications to evaluations of earthquake hazards in the central and eastern United States," F. H. Swan, and K. I. Kelson, Proceedings of the 17th Water Reactor Safety Information Meeting, 1989.

"Keeping pace with the science: seismic hazard analysis in the western United States," R.R. Youngs, K. J. Coppersmith, Proceedings of the Second DOE Natural Phenomena Hazards Mitigation Conference, 1989.

"Keeping pace with the science: seismic hazard analysis in the central and eastern United States," K. J. Coppersmith, R.R. Youngs, Proceedings of the Second DOE Natural Phenomena Hazards Mitigation Conference, 1989.

"The impact of fault segmentation on estimates of earthquake recurrence and seismic hazard," R.R. Youngs, Proceedings of the Fourth International Symposium on the Analysis of Seismicity and Seismic Risk, 1989.

"Estimating maximum earthquakes for seismic sources in the central and eastern United States: A progress report," K.J. Coppersmith, R.R. Youngs, A.C. Johnston, L.R. Kanter, J.F. Schneider, and W.J. Arabasz, Proceedings of the Fourth International Symposium on the Analysis of Seismicity and Seismic Risk, Bechyně Castle, Czechoslovakia, v.1, p.115-122, September 4-9, 1989.

"Issues regarding earthquake source characterization and seismic hazard analysis within passive margins and stable continental interiors," K.J.Coppersmith, R.R. Youngs, Earthquakes at North Atlantic Passive Margins: Neotectonics and Post-glacial Rebound, S. Gregerson and P.W. Basham (eds.), Kluwer Academic publishers, v. 266, p.601-631, 1989.

"Temporal and spatial clustering of earthquake activity in the central and eastern United States," K.J. Coppersmith, Seismological Research Letters, v. 59, p. no. 4, 299-304, 1988.

"Estimating future coseismic ruptures from fault segmentation data," (abs.) K.J. Coppersmith, R.R.

Youngs, Geological Society of America Abstracts with Programs, 20:151, 1988.

"The seismicity of stable continental interiors," A.C. Johnston, A.G. Metzger, Seismological Society of America, Annual Meeting, 1987.

"Characteristics of the boundaries of historical surface fault ruptures," P.L. Knuepfer and others, Seismological Society of America, Annual Meeting, 1987.

"Methods for assessing maximum earthquakes in the central and eastern United States," K.J. Coppersmith, R. Youngs, A.C. Johnston, and L. Kanter, Electric Power Research Institute Palo Alto, California, Research Project RP-2556-12, 1987.

"Seismic hazard methodology for the central and eastern United States, Volume 1: Methodology," with Risk Engineering, Woodward-Clyde Consultants, and Cygna Corporation, Electric Power Research Institute Publication NP-4726, 1986.

"Seismic hazard: new trends in analysis using geologic data," D.P. Schwartz, K.J. Coppersmith, Active Tectonics: National Academy of Sciences, National Academy Press, pgs. 215-230, 1986.

"Capturing uncertainty in probabilistic seismic hazard assessments within intraplate tectonic environments," K.J. Coppersmith, R.R. Youngs, Proceedings Third U.S. National Conference on Earthquake Engineering, v. 1, p.301-312, Charleston, South Carolina, Aug.24-28, 1986.

"Advance in tectonic and seismic hazard studies in the eastern United States," Earthquake Engineering Institute Annual Seminar, Seismic Hazard and Vulnerability, February 6, 1986.

"Seismic hazard assessment at the Hanford region, eastern Washington state," R.R. Youngs, K.J. Coppersmith, M.S. Power, and F. Swan, Proceedings of the DOE Natural Phenomena Hazards Mitigation Conference, p.169-176, 1985.

"Implications of Fault slip rates and earthquake recurrence models to probabilistic seismic hazard estimates," R.R. Youngs, K.J. Coppersmith, Bulletin of the Seismological society of America, #4 v. 75, p.939-964, August, 1985.

"Tectonic framework methodology for developing seismic source zones in the eastern United States," J.C. Stepp, K.J. Coppersmith, J.L. King, International ANS/ENS Topical Meeting on Probabilistic Safety Methods and Applications Proceedings, p.49-1 – 49-8, 1985.

"Methods for estimating maximum earthquake magnitude," D.P. Schwartz, K.J. Coppersmith, and F.H. Swan, III, Proceedings of the Eighth World Conference on Earthquake Engineering, v.1, p.279-286, 1984.

"Journal of Geophysical Research Special Issue on Fault Behavior and the Earthquake Generation Process," Associate Editor, v. 89, no. B7, 1984.

"Fault behavior and characteristic earthquakes: examples from the Wasatch and San Andreas fault zones," D. P. Schwartz, and K. J. Coppersmith, *Journal of Geophysical Research*, v. 89, no. B7, p.5681-5698, July 10, 1984.

"Assessment of confidence intervals for results of seismic exposure analysis," R.B. Kulkarni, R.R. Youngs, and K.J. Coppersmith, *Proceedings of the Eighth World Conference on Earthquake Engineering*, San Francisco, California, v. 1, p.263-270, 1984.

"Introduction to the Special Section on fault behavior and the earthquake generation process," K. J. Coppersmith, and D. P. Schwartz, *Journal of Geophysical Research*, v. 89, no. B7, p. 5669-5673, July 10, 1984.

"Source characterization for seismic hazards analyses within intraplate tectonic environments" (abs.), R.R. Youngs, *Earthquake Notes*, v. 54, no. 1, 1983.

"Probabilistic evaluation of earthquake hazards," California Division of Mines and Geology, Special Publication 62, 1982.

"Probabilistic earthquake source definition for seismic exposure analyses" (abs), R. R. Youngs, *Earthquake Notes*, v. 53, no. 1, 1982.

"Probabilities of earthquake occurrence on the San Andreas fault based on geologic data", (abs.) L. S. Cluff, *International association of Seismology and Physics of the Earth's Interior*, 21st General Assembly, A2.17, 1981.

"A new approach to seismic hazards analysis: Classifying faults based on their relative degree of activity," L.S. Cluff and P.L. Knuepfer, *Structural Engineers Association of California*, 50th Annual Convention Proceedings, v. 4, 1981.

"Near-surface behavior of thrust faults in the Humboldt Bay Area, California" (abs.), *Earthquake Notes*, *Seismological Society of America*, v. 52, no. 1, 1981.

"Estimating the probability of occurrence of surface faulting earthquakes on the Wasatch Fault Zone, Utah," L.S. Cluff, A.S. Patwardhan, K.J. Coppersmith, *Bulletin of the Seismological Society of America*, v. 70, no. 5, p.1463-1478, 1980.

"Morphology, recent activity, and seismicity of the San Gregorio fault zone," G.B. Griggs, *California Division of Mines and Geology*, Special Report 137, 1978.

RESUME OF
GEORGE H.C. LIANG

Experience Summary

Dr. Liang is a Senior Principal Environmental Engineer in the Environmental Sciences & Engineering Department. He has over 26 years of experience in siting, environmental assessment, developing and managing environmental protection programs, and licensing of power plants and industrial facilities. He also has extensive experience in mathematical modeling, numerical analysis, and computer applications in environmental engineering/design related problems. He is currently a Program Manager and has previously been a Lead Environmental Engineer on major projects in nuclear/fossil power plants and industrial projects, which involved environmental impact studies, federal/state/local permitting applications, managing engineering/design, procurement and installation of water and wastewater treatment systems, conceptual design of the heat dissipation/chemical discharge system, studies of alternative cooling systems, groundwater dispersion, hydrological analysis of power plant sites and thermal/water quality impact analysis of power plant discharge.

As Supervisor of Water Quality and Hydrology, Dr. Liang has supervised many water quality and hydrology related tasks for power plant projects. He established the technical guideline for flood analysis at power plant sites. He managed the environmental impact assessment of a fluidized bed power plant site and prepared its permit application. He established the exclusion criteria for siting a Low-Level Radioactive Waste disposal facility in Maine, to assure compliance with federal and state requirements. He evaluated existing permit requirements to determine the potential environmental impacts of rerating a nuclear power plant. Dr. Liang completed the conceptual design of a surface run-off detention pond for a proposed NPR site in Idaho, a cooling pond for a proposed power plant site in Florida, a multiport diffuser for a cogen plant in New York and a combined cycle power plant in England, U.K. He has developed the water quality monitoring program and conducted the hydrothermal/water quality modeling for numerous power plant projects.

Dr. Liang has been a lead environmental engineer on major projects in nuclear, fossil, and industrial plants.

Dr. Liang has been an expert in mathematical modeling of surface water, groundwater, water quality, hydrological and hydrothermal analysis.

Dr. Liang has been intimately familiar with EPA's National Pollution Discharge Elimination System (NPDES) permit application regulations and the requirements of section 401 of the Water Quality Act (WQA), which amended Clean Water Act (CWA) section 402(1)(2). He has assisted many major utility clients as well as independent power producers in obtaining the NPDES permit.

Dr. Liang has participated in numerous siting studies for various type of power generation projects and Low Level Radioactive Waste disposal facilities. He has designed and supervised many environmental monitoring programs for siting studies, and prepared permit applications and supporting documentations.

As a member of ICE team, Dr. Liang has participated in evaluating DOE's Environmental Restoration and Waste Management Five-Year plan. He has assisted DOE in environmental cleanup activities at Hanford site, and managed environmental studies for the U.S. AMTL research reactor decommissioning project.

Dr. Liang developed a comprehensive environmental protection program at a nuclear power plant construction site. He monitored project construction activities for regulatory compliance in air and water quality, noise, wetlands and wildlife refuge protection, and solid waste disposal. Dr. Liang integrated the environmental protection program with the quality assurance and safety/health programs to measure program performance. He provided the impetus to implement similar programs at other nuclear power plant sites.

Dr. Liang has performed a technical review of the existing environmental operating limit permits and supporting documentation (316a and 316b demonstrations) and assessed the impact of the power uprate on the plant's ultimate heat sink.

In 1994, Dr. Liang managed a consulting services project for improving the technical ability of 22 senior engineers from East China Electric Power Design Institute, dealing with the requirements for a Conventional Island design associated with a nuclear power plant.

Since 1995, Dr. Liang has been working as Lenders' engineer for several fossil power plant projects in China. Working as an Independent Technical Consultant (ITC), he has been responsible for the due diligence effort which includes technical review of engineering/design of the major plant systems, review and evaluation of fuel sources and cost, project performance parameters and guarantees, environmental parameters for compliance with PRC's regulations and World Bank guidelines; construction progress monitoring for funding drawdown certification, start-up/test procedure review, and witnessing the 72-hour and 24-hour test runs, and certification of completion of several fossil power plant projects in China.

Recently Dr. Liang has been in charge of developing EPC cost data base for fossil power plant in China.

Education

Ph.D., Civil Engineering - University of Connecticut, Storrs, Connecticut - 1972

M.S., Civil Engineering - University of Connecticut, Storrs, Connecticut - 1967

National Taiwan University, Taipei, Taiwan, Republic of China

Training

China Forum - since 1995, a lunch-time seminar series, meeting once every other month, covered the topics of information, challenges, strategies, recent development, and successful projects in marketing in China, sponsored by the Office of International Trade & Investment, the Commonwealth of Massachusetts, Foley, Hoag & Eliot LLP, and others.

The Princeton Course/Groundwater Pollution and Hydrology - 1993

Hazardous Materials Management, American Management Association - 1991

Site Selection and Design of Sediment and Detention Basins, Southern New England Environmental Regulation Course, Executive Enterprise, Inc. - 1987

MIT Video Course on Finite Element Methods, Massachusetts Institute of Technology - 1984

Water Resources Lecture Series - Rainfall/Run-off Modeling using HEC-1, Stone & Webster Engineering Corporation - 1982

Sediment Transport in Rivers and Estuaries, University of Southern California - 1974

Licenses, Registrations, and Certifications

Professional Engineer - Connecticut, 09789 - 1975 Active

Professional Affiliations

American Geophysical Union, Member
The Society of the Sigma Xi, Member

Publications

Liang, G.H.C., "New Technologies in Sulfur Removal in the Refining Process in a Refinery." National Conference for Environmental Managers of Petrochemical Plants, May 1995

Liang, G.H.C., "Use of Groundwater Analytical/Numerical Models for Evaluating Pollution Control Measures at Hazardous Waste Disposal Facilities." New England/Republic of China Technical Exchange Symposium, May 1990.

Liang, G.H.C., "Summary of Hydrographic and Hydrothermal Studies at Millstone Nuclear Power Station, 1969-1985." Millstone Ecological Advisory Committee Meeting, Waterford, Connecticut. 1986.

Liang, G.H.C.; Lee, V.M.; and Torbin, R.; "A Data Acquisition and Analysis Technique for a Sediment Transport Field Study Program." COASTAL ZONE 78, San Francisco, California, 1978.

Liang, G.H.C. and Lin, J.D., "Effect of Pressure Gradient on Wind-waves in a Laboratory Channel." 2nd U.S. National Conference in Wind Engineering Research, Colorado State University, Fort Collins, Colorado, 1975.

Liang, G.H.C., "Wind-generated Waves With and Without Pressure Gradients." University of Connecticut, Storrs, Connecticut, 1972.

Liang, G.H.C. and Lin, J.D., "Laboratory Win-waves Generated With and Without Pressure Gradients." American Geophysical Union Fall Annual Meeting, San Francisco, California, 1972.

Liang, G.H.C., "Numerical Calculation of the Source Term for a Vertical Line Source Under Linearized Free Surface." University of Connecticut, Storrs, Connecticut, 1967.