UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

OFFICE OF THE
GENERAL COUNSEL

May 26, 2000

G. Paul Bollwerk, III, Chairman
Administrative Judge
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dr. Peter S. Lam
Administrative Judge
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dr. Jerry Kline
Administrative Judge
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, DC 20555

In the Matter of
Private Fuel Storage L.L.C.
(Independent Spent Fuel Storage Installation)
Docket No. 72-22-ISFSI

Dear Administrative Judges:

If I have not done so already, I wish to advise the Licensing Board and parties that the electronic files for the proposed NRC Staff ("Staff") exhibits in this proceeding, which the Staff has previously served by mail, may be located in the NRC ADAMS system, as follows:

1. Staff Exhibit A
Safety Evaluation Report of the Site-Related Aspects of the Private Fuel Storage Facility Independent Spent Fuel Storage Installation, dated December 15, 1999 (revised and reissued on January 4, 2000) -- ADAMS No. ML003714863; and

2. Staff Exhibit B
Certificate of Compliance for the Holtec International HI-STORM 100 Cask System, dated May 4, 2000, with Appendix B, "Approved Contents and Design Features For the HI-STORM 100 Cask System," p. 3-8, and Holtec International HI-STORM 100 Cask System Safety Evaluation Report, Chapter 4, "Thermal Evaluation" -- ADAMS No. ML003714897.

Since these documents are available electronically, additional copies are not being provided herewith. If difficulties arise in accessing these files, please call me at (301) 415-1575.

In addition, I wish to bring to your attention certain matters concerning Contention Utah H, as we prepare to go to hearing on that contention.

As the Licensing Board and parties are aware, the Staff's testimony concerning Contention Utah H, filed on May 15, 2000, presented the preliminary results of certain computer analyses that are being performed by the Staff's consultants at Pacific Northwest National Laboratory ("PNL"). These analyses evaluated the temperature of air entering the inlets of the hottest cask at the PFS site, assuming an ambient air temperature of 52°F, specifically considering the effect of airflow (convection) under normal conditions at the site -- a concern that was identified by the State's witnesses, for the first time, in connection with their continued depositions in April 2000. *See, e.g.*, Exh. 2 to State of Utah's Motion to Compel Applicant . . . ," dated May 24, 2000 (Memo from M. Resnikoff and M. Lamb to D. Curran, Esq., dated April 7, 2000, at 1 ("the purpose of this memo is to inform the Applicant of our analysis of Contention H before our deposition next week" (*id.*, emphasis added)).

The Staff considers this late identification of issues by the State's witnesses -- two and one-half years after Contention Utah H was filed, and just one month before testimony was due to be filed in this proceeding -- to be most unfair. Further, we believe that these issues exceed the proper scope of Contention Utah H, as admitted;[1] and that the other issues which the State had identified in this contention have already been withdrawn or resolved.[2]

Nonetheless, the Staff is prepared to address these matters, if necessary, at the hearings in June -- recognizing that our testimony will require some revision to reflect the final results of our analyses. In this regard, I wish to advise you that we expect the final results of the Staff's computer analyses to become available early next week. While Mr. Guttmann's pre-filed testimony indicated that the "preliminary results" of our TEMPEST computer analysis indicated that the calculated average air inlet temperature would be "less than 15°F higher" than the 52°F far-field ambient temperature, *i.e.*, "less than 67°F" (Guttmann

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[1] Prior to April 2000, Utah Contention H had been interpreted as raising other issues -- *i.e.*, (a) the ambient air temperatures in Skull Valley, (b) concrete temperature limits; (c) the effect of radiative heating by the concrete casks and pads; and (d) the adequacy of Holtec International's "EHT" model -- which only addressed the impact of heat transfer under off-normal conditions, relevant to the short-term temperature limits. In the Staff's view, the Applicant's filings (*e.g.*, its motion for partial summary disposition), the State's filings (*e.g.*, its June 25, 1999 response to the Applicant's motion for partial summary disposition), the Staff's filings (*e.g.*, its statement of position dated December 15, 1999), and the Licensing Board's decision on summary disposition, LBP-99-42, 50 NRC 295 (1999), all reflect this understanding.

[2] The State formally withdrew Bases 1-2 and 6-7 of the contention, and has now withdrawn or conceded the issue of radiative heating -- which was identified by the State and recognized by the Licensing Board to be the "crux," the "central concern" and the "central assertion" of the contention (LBP-99-42, 50 NRC 295, 302-04 (1999)); *see* Resnikoff Dep. of April 13, 2000, at Tr. 94-96. Similarly, while Contention Utah H has been interpreted to involve a challenge to the cask's performance under "off-normal" or "accident" conditions, for which only the short-term temperature limit applies, the State has now withdrawn that concern. *Id.*, Tr. 99-100 (the cited transcript pages are attached hereto).

at 8, 10), the final results are expected to predict a more precise value for this temperature, within the bounding value stated in Mr. Guttmann's pre-filed testimony. Similarly, while Mr. Guttmann's pre-filed testimony provided a preliminary value for the predicted peak cladding temperature (PCT) under normal conditions of 550°F, assuming ambient inlet air temperature of 67°F (*Id.* at 11), the final results of the Staff's analyses will provide a more precise prediction of the PCT. Mr. Guttmann will revise his testimony accordingly, with an appropriate errata sheet, upon his appearance as a witness.

In connection with Mr. Guttmann's testimony concerning these matters, on May 17, 2000, I received an E-mail request from Diane Curran, Counsel for the State, seeking documentation concerning the Staff's TEMPEST and COBRA-SFS computer analyses. The Staff has undertaken to respond fully and cooperatively to this request, as follows: (a) I have provided information to the State and PFS concerning the availability of the TEMPEST code, its cost, and the platforms on which it may be run; (b) I have provided the user manuals for the TEMPEST and COBRA codes; (c) I have arranged for the inputs and outputs of the Staff's analysis to be posted on PNL's website (ftp.pnl.gov/pub/outgoing/Utah_ISFSI), and provided instructions on how to access that information; (d) I have provided the node maps utilized by PNL in its TEMPEST and COBRA analyses; (e) I have identified the PNL sensitivity studies that were performed, and arranged for them to be posted on the PNL website, on request; (f) I have provided the professional qualifications of the Staff's consultants, Dr. Donald Trent and Thomas Michener; and (g) I will provide a report summarizing PNL's analyses, upon the Staff's receipt and review thereof.[3]

With the expected completion of the Staff's computer analyses, the Staff intends to proffer certain additional exhibits which were not available when we filed copies of our exhibits on May 15, 2000. At this time, I expect these additional exhibits to consist of the expected report summarizing PNL's computer analyses, and the professional qualifications of the Staff's consultants, Dr. Donald Trent and Thomas Michener. The Trent and Michener qualification statements are attached hereto, as Staff Exhibits C and D; the PNL report will be provided to the Licensing Board and parties upon its completion, as Staff Exhibit E.

The Staff recognizes that this information is being provided to the Licensing Board and parties only a few weeks before hearings commence. However, it must be recognized that the Staff did not commence its computer modeling of these matters until April 2000, after it had learned of the State's concerns in connection with the State's witnesses' continued deposition of April 13, 2000. Further, the preliminary results of the Staff's analyses only began to become available on May 12, 2000, one business day before testimony was due to be filed; and the final results will not be available until next week. By waiting to identify their new concerns regarding ambient temperature conditions until the resumption of their

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[3] The inputs and outputs for earlier runs of the Staff's analyses were provided to PFS and the State this week. As I informed the State and PFS today, we have discovered that an incorrect input value was utilized in the COBRA runs; we are therefore re-running the COBRA analyses with the correct input value, and will provide the results to PFS and the State when they become available early next week.

depositions in April 2000, just one month before testimony was due to be filed in the proceeding, the State and its witnesses put the Staff (and other parties) in the untenable position of having to develop new analyses under extremely rushed conditions, in order to be able to respond effectively to this surprise development. If the State had identified these issues sooner, the Staff would have had more time to address these concerns, and the State would have had more time to study the Staff's response. I believe the Staff acted commendably in hastening to analyze the State's new concerns under extremely tight time constraints, and in providing the results of its efforts to the Licensing Board and parties immediately upon receipt thereof.

Sincerely,

Sherwin E. Turk
Counsel for NRC Staff

Enclosures: As stated

cc w/encl.: Service List

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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In the Matter of:	:
PRIVATE FUEL STORAGE, L.L.C.	: Docket No.
	: 72-22-ISFSI
(Independent Spent Fuel	: ASLBP No.
	: 97-732-02-ISFSI
Storage Installation)	:

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DEPOSITION OF MARVIN RESNIKOFF AND MATTHEW LAMB

Washington, D.C. 20037-1128

Thursday, April 13, 2000

Deposition of MARVIN RESNIKOFF and MATTHEW LAMB, called for examination, pursuant to notice, at 9:45 a.m., at the law offices of Shaw Pittman, 2300 N Street, N.W., before Michael G. Paulus, a notary public in and for the District of Columbia, when were present on behalf of the respective parties:

contributions of various heat sources. I take it this calculation is following up on that issue.

A [Resnikoff] Yes, that's right.

A [Lamb] Yes.

Q One of the issues that you had last time, Dr. Resnikoff, with respect to the relative contribution of various heat sources was the contribution of radiant heat sources from adjacent casks. Did you do anything to evaluate that issue?

A [Resnikoff] I think in this we are in agreement that the contribution from adjacent casks can be taken into account by having a reflecting boundary.

Q So that is no longer an issue in this case; is that correct?

A [Resnikoff] I believe that's so.

MS. CURRAN: We need to take a break.

[Counsel and witnesses leave conference room.]

WITNESS RESNIKOFF: I've been taken to the woodshed again. The answer I gave wasn't really complete. If one is just looking at the radiated

heat transfer, that's what I was thinking in my head when you asked the question about the EHT model. But there are a whole range of other issues that aren't taken into account and that I tried to take into account in this memo which I wrote, more of which can be taken into account in what we call this extended EHT model, and even that doesn't take take into account some other factors which I've tried to discuss.

BY MR. GAUKLER:

Q I believe my question was limited to adjacent casks as a radiated heat source. You agree that that is no longer an issue? That was my question specifically.

A [Resnikoff] This is the issue involved in that. Your question is actually quite involved and there are various levels you can address it, but if you try to impose a more realistic model and want to take into account, for example, wind, meteorological conditions, that is, air moving past other casks, the system might look at lot like the modeling of the inside of a canister, fuel assemblies inside a

canister where you have heat moving up through the center and you have cool air coming through the sides. Similarly in a canister that was modeled you have heat coming up through the center and then within the canister you have the cooler air going down the sides of the canister and then going up the center. I think the model looked more like that.

That's a fuller explanation of what I meant.

We proposed this extended EHT model as a way to in a simple manner extend what has already been done and to do it rather rapidly so that one can get results which incorporate more of the features of the physical reality, but not all of them.

Q What thermodynamic studies of heat transfer inside a canister are you referring in your previous answer?

A [Resnikoff] I'm referring to the ANSIS calculations that involve the effective conductivity within the canister where one has to take into account convective currents and metal to metal

conduction.

Q You haven't proposed anything like that here?

A [Resnikoff] We haven't done that, no.

Q Do you know what would be involved in doing that?

A [Resnikoff] One would have to set up a 3D model to do this.

Q You make some recommendations for additional provisions to add to the 2D model in your April 7th memorandum, correct?

A [Resnikoff] Yes.

Q If you make those provisions, do you think that is sufficient to answer the question here?

A [Resnikoff] It answers part of the questions. It takes into account more of the heat in the system, namely, the heat that the fuel is generating; it takes into account the vents; it takes into account the heat that strikes that top of the cask. But it doesn't yet take into account a more global system where you would need a 3D model.

Q If we ran the 2D model, as you suggest,

and we come up within the limits, does that end the dispute between us?

A [Resnikoff] If the results show that you are close to the limits, then I would want a 3D model to be run. If the results were still far from the limits -- I have to say this is also another issue that we are looking into, as to which limits, whether it's the DCCG limit or another limit. If they were far from the limits where there would be fuel degradation, I would be satisfied. This is something the state has to look over as a policy issue.

Q What limits are you concerned with? First of all, we are talking, I think, just about the peak cladding temperature.

A [Resnikoff] The peak cladding temperature, not the concrete temperature here. I'm referring to the peak cladding temperature.

Q We're not talking about the canister temperature limits, correct?

A [Resnikoff] I'm more concerned about the peak cladding temperature than I am about concrete

temperature limits.

Q But concrete is no longer an issue. You've agreed with that.

Going back to peak cladding temperatures, there are three cases that we have run or that we have limits for. We have the normal case, the off-normal, which is the 100 degree case, and the extreme ambient case.

A [Resnikoff] The normal, off-normal and the what?

Q Extreme ambient.

Do you have concerns with respect to all three of those limits or just one of those limits?

A [Resnikoff] I'm concerned with the normal case and with the 51 or 52 degree site average ambient temperatures.

Q Do you understand that the 52 degree site average ambient temperature is the PFS case that is analogous to the Holtec 80 degree normal case?

A [Resnikoff] Yes.

Q As a practical matter, for us 52 degrees is the normal limit for the PFS site?

A [Resnikoff] Yes.
Q So it's the normal case that you are concerned with?
A [Resnikoff] Yes.
Q The extreme ambient and the off-normal ambient are not issues in this case any longer?
A [Resnikoff] That's right.
Q You were saying before that if the extended EHT model as you proposed was close to the limits you would have a concern. Do you have any idea what you mean by close to the limits?
MS. CURRAN: Off the record for just a second.
MR. GAUKLER: Yes.
[Discussion off the record.]
BY MR. GAUKLER:
Q I was asking what you consider to be close to the limit in terms of the normal limit which we agreed is the sole issue now in the case.
A [Resnikoff] I'm not sure I have an exact number, but if you are within 20 degrees Fahrenheit, I would be concerned because of the uncertainties in

STAFF EXH. C

DONALD S. TRENT

Consultant, Numerical Thermal Fluid Engineering
Senior Staff Scientist Emeritus, Pacific Northwest National Laboratory
Hall of Fame: Oregon State University School of Engineering

Education

BS	Agricultural Engineering, Power Machinery, Oregon State University	1962
MS	Mechanical Engineering, Thermal Fluid Sciences, Oregon State University	1964
PhD	Mechanical Engineering, Thermal Fluid Sciences, Oregon State University First Minor - Physical Oceanography Second Minor - Applied Mathematics	1972

Positions Held

- 1964-1996 Battelle Pacific Northwest Laboratories, Richland, WA. Retired 1/31/96
- 1976-1986 Manager, Fluid and Thermal Engineering Section
- 1986-1996 Chief Scientist, Analytical Sciences Department, Applied Physics Center
- 1987-1988 Visiting Professor of Mechanical Engineering, Oregon State University, Corvallis, Oregon
- 1989-present Courtesy Professor Department of Mechanical Engineering, Oregon State University, Corvallis, Oregon
- 1989-1997 Research Affiliate, Department of Nuclear Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts.
- 1990-1991 Lecturer in Mechanical Engineering, Washington State University, Tri-Cities Campus
- 1995-1997 Board of Visitors. Department of Materials and Nuclear Engineering, University of Maryland, College Park, Maryland
- 1996-present Senior Staff Scientist Emeritus, Battelle Pacific Northwest Laboratories
- 1997-1998 Consultant. Korea Power Engineering Company, Sujee office, Korea

- 1997 Consultant. Lead Practitioner, DOE Technical Leadership Development Program. ATL, Germantown, Maryland

- 1997-present Consultant. Pacific Northwest National Laboratory. Nuclear Waste Tank Mitigation Program (DOE), and Spent Fuel Storage Cask Program (NRC)

General Experience

The majority of Dr. Trent's experience has been in the area of computational fluid mechanics and heat and mass transfer. He has developed and/or directed the development of several major computer codes for reactor core and system safety thermal-hydraulic analysis. These code development efforts have dealt with light water, liquid metal, and gas-cooled reactors, as well as advanced reactors for both space and terrestrial applications. In the nuclear waste management area he has developed computational tools to analyze the dynamics of molten glass and nuclear waste tank mixing.

Outside of the nuclear area, Dr. Trent has developed computational tools for predicting the behavior of cooling tower flows (both internal and external), solar ponds, and solar receivers. He has developed Computational tools for the study of air flow in buildings and ducts and for drilling in the oil production industry.

Dr. Trent has been extensively involved in computational marine hydrodynamics. He has developed several computer codes for simulating flow in lakes, estuaries, bays, and oceans. Results from work in this area appeared on national public television (NOVA-PBS). Work has also involved simulating once-through discharge systems for the San Onofre and Diablo Canyon nuclear power stations.

Beginning in 1990, Dr. Trent became heavily involved in flammable waste tank technical issues at the Hanford site. For 3 years he served on the Waste Tank Science Panel, reviewing research and making recommendations to DOE and the Hanford site Operations Manager regarding matters of nuclear waste tank safety research. He developed an extended version of the TEMPEST code that is capable of simulating the non-Newtonian hydrodynamic behavior and gas release during roll-over events and engineering mitigation operation. This code continues to be used to simulate tank waste hydrodynamics and heat transfer.

In addition to his technical experience, Dr. Trent managed the Fluid and Thermal Engineering Section for 10 years. During this time he developed a nationally and internationally recognized staff in computational thermal hydraulics. Computer codes developed by this group include the COBRA series, (COBRA-IV, COBRA-TRAC, COBRA-WC, COBRA-SFS, and COBRA-NC), VIPRE-01, VIPRE-02, and TEMPEST.

In his current position as Chief Scientist Emeritus (retired), Dr. Trent interacts on a variety of technical/administrative issues across the Pacific Northwest National Laboratory and the Battelle Memorial Institute. This interaction extends to universities, national laboratories, and other

industrial firms. Areas include supercomputers and computational fluid mechanics. Technical work includes computational fluid mechanics research in generalized coordinates, grid generation, turbulence, Non-Newtonian Flows, algorithm development, and vector/parallel processing on supercomputers.

Example research efforts in which Dr. Trent has played a key role include:

- Dr. Trent's work includes thermodynamic design analysis of the NASA tungsten-core propulsion reactor and an ex-core thermionic, fast compact space power reactor. He has also conducted feasibility studies of small liquid-metal-cooled isotopic power Sources for both military and civilian applications.

- As principal investigator for Battelle's initial efforts in heat pipe application, Dr. Trent was responsible for detailed analysis, design, and testing of high-temperature liquid metal heat pipes. He holds one heat pipe patent.

- Dr. Trent performed extensive analytical studies on similarity requirements for physical modeling of the Fast Flux Test Facility (FFTF) thermal-hydraulic behavior. This work guided the design of the FFTF Hydraulic Core Mockup (HCM).

- While a part-time employee for the EPA (1967-1970), Dr. Trent developed Plume models based on similarity theory for ocean outfalls and lumped-parameter models for lake systems flushing. These models were used for several years by various governmental agencies.

- Dr. Trent's PhD research at Oregon State University led to development of the SYMJET computer code used for simulating thermal discharges in shallow coastal water. This code has since been used to simulate the plume behavior of a large number of the existing single port vertical dischargers along the Pacific coast and is still being used by the government of Mexico. This work led to development of the VECTRA computer code used for two-dimensional hydrodynamics and heat transfer in water bodies and other engineering applications.

- During the period 1977 to 1980, Dr. Trent developed the TEMPEST computer code at the request of the DOE's Base Technology Program Office. Dr. Trent, along with a number of colleagues, is continuing to develop the TEMPEST code for a broad base of applications. TEMPEST is currently being used by a large number of government agencies, industrial firms, and universities.

- Dr. Trent developed a computation procedure for simulating the transient, three-dimensional flow of molten glass in a Joule-heated furnace. The methodology has been used internationally. This procedure has also been extended to molten glass canister filling.

- Dr. Trent's activity and interest in computational marine hydrodynamics has been extensive. He has developed a marine version of the TEMPEST code capable of simulating transient, three-dimensional hydrodynamics using either shallow-water or deep-water theory. He has participated on projects using the marine version of TEMPEST for the Hudson River, Sequim Bay, Prudhoe Bay, Buzzards Bay, New Bedford harbor, San Onofre, Huntington Beach, and Diablo Canyon.

- Dr. Trent has managed numerous computer code development and application programs for various governmental and industrial organizations including DOE, NRC, EPRI, nuclear utilities, utilities, and energy production companies.

- Dr. Trent developed the ARIEL computer code which predicts transient, three-dimensional turbulent flows in generalized orthogonal coordinates with heat and constituent transport. Flow physics includes turbulence, non-Newtonian fluid behavior, and flow in porous media. Methodology will be extended to the marine environment. This code is now called TEMPEST T2.

- Dr. Trent is currently conducting technical work in several areas of applied computational fluid mechanics including:

    - methodologies for generalized coordinates in three-dimensional turbulent flows

    - marine hydrodynamics and heat and mass transport

    - natural convection in highly viscous liquids (glass and volcanic magma chambers)

    - hydrodynamics of nuclear waste slurries

    - supercomputer vector/parallel processing in computational fluid mechanics

Dr. Trent is currently a member of the Oregon State University staff in the capacity Of Courtesy professor of Mechanical Engineering. He is a past member of the OSU Graduate Council and served as major professor for graduate students at OSU. Dr. Trent is also a past member of the MIT staff in the capacity of Research Affiliate and is a past member of the Board of Visitors at the University of Maryland. Dr. Trent has taught courses in Mechanical Engineering at Washington State University/Tri-Cities. Dr. Trent spent 1987 and 1988 on sabbatical to Oregon State University as a visiting professor in Mechanical Engineering. This assignment included teaching graduate level Computational Fluid Mechanics and Heat Transfer, Engineering Analysis (Numerical Mathematics), and working with the Mechanical Engineering staff and graduate Students in related areas.

Professional Activities

- Technical coordinator and lecturer on numerical hydrodynamics. Five-day short Course "Heat Disposal in Power Plant Siting," Joint Center for Graduate Study, Richland, Washington, 1973, 1974.

- ERDA Regional Transport Study Group. Surface Water Transport Writing Group Chairman. 1975. ANSI Standard (N-231) "Discharge of Thermal Effluents Into Surface Waters." Writing Group Chairman.

- Former consultant to the Advisory Committee on Reactor Safeguards (ACRS).

- Core Components Working Group. DOE/Reactor Research and Technology National Working Group for Advanced LMFBR Technology. Thermal hydraulics representative. 1980-1982.

- Technical paper reviewer for ASCE, ASME, ANS technical journals.

- Battelle Memorial Institute Task Force Member. Commercialization of intellectual property-computer software.

- Battelle Memorial Institute University Grant Monitor. Washington State University (1979-1980) and Oregon State University (1980-1983) grants.

- WSU Advisory Council (ME Department).

- Technical Coordinator and Meeting Chairman, National Core Thermal Hydraulics Information Meeting, Seattle, Washington, May 1979.

- Department of Energy/Research and Technology Thermal Hydraulics Working Group Chairman, 1979-1981.

- Chairman, National Core Thermal Hydraulics Information Meeting, Monterey, California. April 1980.

- Pacific Northwest National Laboratory's representative to Hanford Site Scientific and Engineering Computing Committee.

- Laboratory consultant/representative on matters involving supercomputers.

- Promoted and developed Integrated Computing Environment (ICE) concept at the Pacific Northwest National Laboratory.

- Nuclear Waste Storage Tank Science Panel.

- New Production Reactor Safety Review Panel, Ebasco Services.

- Dr. Trent has presented numerous invited lectures/seminars at universities including University of Washington, Washington State University, Oregon State University, Whitman College, Joint Center for Graduate Studies, Massachusetts Institute of Technology, Rensselaer Polytechnic Institute, and Texas A&M.

- Additional information about Dr. Trent may be found in American Men and Women of Science, Marquis Who's Who in America (Western Edition), Who's Who in Science, Men of Achievement, Marquis Who's Who in Science and Engineering, Marquis Who's Who in America , Marquis Who's Who in Business and Industry and Marquis Who's Who in the World.

Professional Affiliations

American Society of Mechanical Engineers
Sigma Xi

Honors

Phi Kappa Phi, National Academic Honor Society
Federal Laboratory Consortium Award. 1992
Charter member Oregon State School of Engineering Hall of Fame. 1998

Patents, Copyrights

Patent - A Heat Pipe (1970)
Copyright - TEMPEST Computer Software (1990)
Copyright - TEMPEST Computer Software (1997)

Dr. Trent has authored or coauthored a number of technical reports and refereed journal articles in the area of Computational heat transfer and fluid flow.

Formal Publications

Trent, D.S. 1964. Control of Moisture Condensed from Water Saturated Air Flowing Through Cooled Porous Media. Master's Thesis, Oregon State University.

Trent, D.S. 1967. Applications of Geometric Models for the FFTF Hydraulic Core Mockup. BNWL-575.

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Trent, D. S., and J. R. Welty. 1972. Numerical Computation of Convection Currents Induced by Fires and Other Sources of Buoyancy. Conference of the Combustion Institute, Seattle, WA, Paper No. WSCI 72-18, 19, April 1972.

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Trent, D. S. 1975. Mathematical Modeling of Transport Processes in Aquatic Systems. Proceedings, Computational Methods in Nuclear Engineering, CONF-750413:1, Charleston, SC, April 1975 (also BNWL-SA-5379).

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Invited Lectures

1973. Offshore Discharge of Thermal Effluents. University of Washington, Seattle, WA.

1973. Field Surveys and Numerical Computation of the Heated Water Discharge at San Onofre Unit 1. Washington State University, Pullman, WA.

1974. Environmental Heat Sinks. Presented at Twenty-First Annual Meeting, Pacific Northwest Regional Section, AGU, Richland, WA, October 1974.

1974. Review Fundamentals of Fluid Dynamics and Heat Transfer, Session 4; Hydrodynamic Theory, Reynolds Equations, Transport Theory, Session 8; Two-and Three-Dimensional Hydrodynamic and Transport Models, Session 9; Similarity Theory--Principles and Application to Submerged Discharge, Session 10; Numerical Techniques in Hydrodynamics and Heat Transport, Session 13, "Application of Numerical Techniques; Discharge/Intake Systems; Regional Flows and Heat Transport, Session 18. In: Heat Disposal in Power Plant Siting, (D. S. Trent, Course Developer and Technical Coordinator), Joint Center for Graduate Study, Richland, WA, November 1974.

1974. Environmental Transport Processes Related to Siting. Presented at Joint Center for Graduate Study, Richland, WA, November 1974.

1974. Heat Rejection to the Environment. Presented at Whitman College, Walla Walla, WA.

1980. Methods in Computational Fluid Mechanics. Presented at Massachusetts Institute of Technology, Cambridge, MA.

1987. Methods in CFM. Presented at Texas A&M and Washington State University.

1987-1988. Computational Fluid Mechanics--What's It All About. Presented at Oregon State University, Washington State University, and Massachusetts Institute of Technology.

1988. Computational Fluid Mechanics and Heat Transfer - A Lecture Series. Massachusetts Institute of Technology, Cambridge.

1992. Computational Fluid Mechanics and Heat Transfer - A Lecture Series. Massachusetts Institute of Technology, Cambridge.

1995. Computational Fluid Mechanics and Heat Transfer - A Lecture Series. Massachusetts Institute of Technology, Cambridge.

1995. Computational Fluid Mechanics and Heat Transfer in Non Newtonian Radioactive Waste Tank Slurries - A Lecture. University of Maryland.

Various others.

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EDUCATION

B.S.	Mechanical Engineering, Washington State University (Cum Laude)	1982
M.S.	Mechanical Engineering, Washington State University	1984

EXPERIENCE

Since joining Battelle-Northwest in October 1983, Mr. Michener has participated in programs involving spent fuel storage thermal analyses, parallel code development, thermal modeling of glass waste canisters, non-Newtonian flow modeling, gas-fluid-particle mixture modeling, Deep Ocean flow modeling, wind energy research and thermal-hydraulic experimentation and analyses using advanced computer codes. The specific programs that Mr. Michener has been involved with include:

Mr. Michener is the Project Manager/Technical Lead on four Nuclear Regulatory Commission (NRC) projects. The projects involve providing the NRC with expert technical assistance in the area of thermal/fluid analysis for various scenarios involving spent nuclear fuel storage systems.

Mr. Michener led the Heat Transfer Code Evaluation & Qualification (HTCEQ) Project for the US DOE. This project was tasked with the validation/verification of the COBRA-SFS and HYDRA-II computer codes, for use in licensing of spent fuel storage systems. In this role he led the development of the COBRA-SFS transient 3-dimensional CFD software program and multiple modeling efforts of spent fuel storage systems. He performed in this capacity since 1989. The project was completed September 1996.

Mr. Michener has been modeling the thermal performance of spent nuclear fuel storage systems for 15 years. Mr. Michener and his PNNL team have performed thermal hydraulic analyses of the following spent nuclear storage systems:

REA 2023 Metal Storage Cask *
Castor V 21 Metal Storage Cask *
Transnuclear TN-24P Metal Storage Cask *
Transnuclear TN-32 Metal Storage Cask
Transnuclear TN-68 Metal Storage Cask
Transnuclear TN-68 Metal Transportation Cask

Westinghouse MC-10 Metal Storage Cask *
Nuhoms Storage Modules
Pacific Sierra Nuclear VSC 17 Concrete Ventilated Cask *
Westinghouse/BFS Westflex W21 Ventilated Concrete Cask
Holtec HiStorm Ventilated Concrete Cask

* performed and reported COBRA-SFS thermal analyses results prior to receiving experimental data from these instrumented casks, which contained actual spent fuel. "Blind" predictions were compared with data and reported in EPRI/PNNL documents.

Mr. Michener had the lead in training NRC staff in the use of the COBRA-SFS thermal Spent Fuel Storage analysis computer code. Mr. Michener also lead separate efforts to train Ukrainian and Hungarian regulators in the use of COBRA-SFS.

Mr. Michener was the task leader on a project to perform thermal analyses on a proposed multi-purpose Spent Fuel Storage Cask. The COBRA-SFS simulations were used to direct a redesign of the cask to correct the poor thermal performance of the cask.

Mr. Michener was the Principle Investigator on a Laboratory Directed Research and Development Project to develop a parallel version of a reactive Chemistry version of the TEMPEST computer code. He has the lead in converting the chemistry to run in a message passing mode.

Mr. Michener was the project manager for the Computational Support task for the Hanford Tank Waste Mitigation Project. This work focuses on computational modeling of the high level radioactive waste tanks using the TEMPEST computer program to determine the best methods for mitigation of the periodic hydrogen gas releases. Technical issues involved Non-Newtonian fluids, particle/fluid interaction, and turbulent mixing.

Mr. Michener is the manager of the Computational Fluid Dynamics (CFD) Group's Computational Environment. In this role he is responsible for investment decisions and, research projects, as well as being involved in the many computer/network related pilot programs.

Mr. Michener has provided thermal hydraulic modeling support of free surface flow problems in support of the Hanford mission to clean up the high level radioactive waste tanks. For this effort Mr. Michener received training on the Star-CD Computational Fluid Dynamic Computer software and then applied the code to various mixing scenarios.

Mr. Michener provides technical guidance on numerous Computational Modeling efforts performed at PNNL. He is also the technical representative/lead for the COBRA-SFS and TEMPEST computer codes for PNNL.

Mr. Michener has worked on the transient analyses of different liquid metal power loops using the TEMPEST computer code, in support of the SP-100 research program. The

SP-100 is a space reactor concept capable of producing 100 kWe using advanced heat transfer and energy conversion techniques.

Mr. Michener participated in a series of experiments designed to investigate the effect of zero gravity on two-phase flow phenomena. The experiments, carried out on the NASA KC-135 "K BIRD" Aircraft, involved the study of boiling and condensing flow in zero gravity.

Mr. Michener was responsible for the design, implementation, and data analyses from an onsite experiment characterizing wind energy as seen from a rotating turbine blade. The work scope included microcomputer data acquisition from an array of two-dimensional hot film sensors, followed by spectral analyses of velocity information.

HONORS

Member of Tau Beta Pi, National Engineering Honor Society
Member of Phi Kappa Phi, National Honor Society

PUBLICATIONS

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Lombardo, N.J., T.E. Michener, C.L. Wheeler, and D. R. Rector. 1986. COBRA-SFS Predictions of Single-Assembly Spent Fuel Heat Transfer Data. Pacific Northwest Laboratory, Richland, Washington.

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REPORTS

Provided upon request