Enclosure

Battelle
Pacific Northwest Laboratories
Battelle Boulevard
P.O. Box 999
Richland, Washington 99352
Telephone (509) 376-2382

December 23, 1991

Dr. S. L. Wu
Reactor Systems Branch
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Mail Stop 8E23
Washington, DC 20555

Dear Shih-Liang:

This letter is intended to summarize the status and the open issues that remain with the Vermont Yankee Nuclear Power Corporation (VYNPC) submittal of the FROSSTEY code. The open issue that remains in this review is in the conservatisms that need to be applied in FROSSTEY2 code licensing analyses. This issue was first raised in NRC's letter dated March 9, 1990 (Reference 1) requesting further information. The licensee provided a written response to Reference 1 in a letter dated March 6, 1991 (Reference 2) that was found to not adequately address the issue of conservatisms for FROSSTEY2 licensing analyses. A letter was prepared by PNL dated August 19, 1991 that addressed the conservatisms that need to be included in fuel performance code licensing analyses. This letter was forwarded to the licensee for their information.

Discussed during a conference call on October 28, 1991, among VYNPC, NRC, and PNL consultants was how VYNPC intended to address the open issue; however, the VYNPC verbal response has been found to be inadequate for the reasons cited in this letter. As noted in my August 19, 1991 letter to you, industry LOCA analyses have traditionally included the uncertainties in the fuel performance code input, e.g., dimensional uncertainties in fabrication of fuel rods, uncertainties in the fuel performance code calculation itself, and any biases that may exist in the code. Also noted in my previous letter, the conservatisms used by industry for LOCA analyses in the recent past have been such that there has been a 95% probability at a 95% confidence level that the predicted LOCA stored energy will be bounding.

VYNPC staff suggested in the last conference call held on October 28, 1991, that based on their sample calculation for a boiling-water reactor (BWR) design, provided in their March 1991 response to questions, the FROSSTEY2 code input uncertainties for commercially-fabricated fuel rods for licensing analyses such as LOCA are equal to or greater than the code calculational uncertainties. VYNPC staff appear to be suggesting that the FROSSTEY2 licensing input for the code satisfactorily covers the conservatisms necessary for LOCA stored energy and that the uncertainties in the FROSSTEY2 code

calculations do not need to be considered. I have evaluated this claim by the VYNPC staff and have concluded that there are several problems with their claim.

First, the translation of code input uncertainties to the uncertainties in fuel stored energy is of different magnitudes for different fuel designs. The greatest differences exist between pressurized-water reactor (PWR) and BWR fuel designs. VYNPC staff have indicated that they intend to apply FROSSTEY2 to both PWR and BWR designs. Therefore, the calculated uncertainties in BWR fuel stored energy as induced by BWR fuel input uncertainties are not applicable to input-induced uncertainties in PWR fuel stored energy.

Second, my own assessment of the uncertainties in the FROSSTEY2 code comparisons to experimental data suggests that the standard deviation, σ, of this comparison, in terms of stored energy, is approximately equal to the increase in stored energy (above the best estimate value) induced by the BWR commercial rod input uncertainties to FROSSTEY2. Therefore, the conservatism in the FROSSTEY2 calculated stored energy resulting from the VYNPC proposed licensing input of BWR commercial rod dimensional uncertainties is significantly less than the conservatism currently used by industry. The level of conservatism currently used by industry is such that the LOCA stored energy will be bounding based on a 95% probability at a 95% confidence level including both input and code calculational uncertainties.

Third, the LOCA uncertainties for stored energy should ideally include both the uncertainties in the commercial fuel rod dimensions, i.e., σ^2 (commercial fuel rod input), plus the uncertainties in the FROSSTEY2 code calculation, i.e., σ^2 (FROSSTEY2 code). The latter uncertainty is difficult to determine because the uncertainties in the FROSSTEY2 code comparisons to experimental data inherently includes the uncertainties in the fabrication of the experimental fuel rods [σ^2(experimental rod input)], uncertainties induced by the experiment [σ^2(experiment)], and FROSSTEY2 calculational uncertainties [σ^2(FROSSTEY2 code)].

VYNPC staff have assumed that the dimensional uncertainties of the experimental fuel rods plus the other experimental uncertainties are much greater than the FROSSTEY2 calculational uncertainties [i.e., σ^2(experimental rod input) + σ^2(experiment) $>>\sigma^2$(FROSSTEY2 code)] and, therefore, they can ignore the FROSSTEY2 calculational uncertainties. It is more likely that σ^2(FROSSTEY2 code) $\geq\sigma^2$(experimental rod input) + σ^2(experiment). The VYNPC assumption also assumes the commercial rod input (fabrication) uncertainties are equal to those for the experimental fuel rods plus the other experimental uncertainties. I do not believe the VYNPC assumption is valid because the input dimensional uncertainties for the experimental rods are significantly lower than for commercially-fabricated rods because the former input, in most cases, is based on the actual mean measured dimensions and fabrication characteristics of the experimental rods following fabrication. Therefore, the input uncertainties for the experimental rods are significantly less than for commercially-fabricated rods. In addition, experimentally-induced uncertainties are hard to determine.

For your background information, the only instance in the past where NRC approval was provided for a fuel vendor's fuel performance code for calculating LOCA stored energy using only code input uncertainties as proposed by VYNPC staff, was for a code that had a large conservative bias in calculated stored energy that bounded the uncertainty in the code's prediction. This is not the case for the FROSSTEY2 code because its thermal predictions are considered to be best estimate although the code appears to provide a somewhat conservative prediction of fission gas release.

Based on the above discussions, I continue to recommend that FROSSTEY2 include the conservative approach for LOCA stored energy as discussed in my August 19, 1991 letter to you.

Licensing analyses of end-of-life rod internal pressures should normally include uncertainties in input due to variabilities in fabrication, but also the uncertainties in the FROSSTEY2 predictions of fission gas release. The uncertainties in the code's thermal predictions does not need to be included because this is incorporated in the fission gas release prediction uncertainties. The rod internal pressure calculations should also include transients up to the linear heat generation rate technical specification limits. The transients should be included throughout the life of the fuel rod and their number should bound those possible during normal operation and anticipated operational occurrences.

The fuel melting calculation should not only include fabrication uncertainties but should also include those transients from anticipated operational occurrences and include the effects of fission gas release during these transients on the code thermal predictions.

It is anticipated that additional review will be required once we receive VYNPC's response on how they intend to handle FROSSTEY2 code input and calculational uncertainties for licensing analyses.

If you have questions on the above, please feel free to call me.

Sincerely,

Carl E Beyer

Carl E. Beyer
Reactor Systems and Fuel
Performance Section

CEB:dsc

cc: BE Thomas, NRC

REFERENCES

1. Letter, U.S. Nuclear Regulatory Commission to Vermont Yankee Nuclear Power Corporation (NVY 90-051) dated March 9, 1990.

2. Letter, Vermont Yankee Nuclear Power Corporation to U.S. Nuclear Regulatory Commission (BVY 91-024) dated March 6, 1991.

Docket No. 50-271 January 28, 1992

Mr. L. A. Tremblay
Licensing Engineer
Vermont Yankee Nuclear
Power Corporation
580 Main Street
Bolton, Massachusetts 01740-1398

Dear Mr. Tremblay:

SUBJECT: OPEN ISSUES ON FROSSTEY2 CODE (TAC NO. M68216)

Enclosed is a summary report from our consultant Battelle Pacific Northwest Laboratories (PNL) concerning the open issues of the FROSSTEY2 code review following a conference call between Vermont Yankee Nuclear Power Corporation and NRC on October 28, 1991. We endorse our consultant's findings, and this summary report constitutes our position on FROSSTEY2.

Sincerely,

Original signed by:

Patrick Sears, Project Manager
Project Directorate I-3
Division of Reactor Projects I/II
Office of Reactor Regulation

cc w/enclosure:
See next page

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cc:
Mr. J. Gary Weigand
President & Chief Executive Officer
Vermont Yankee Nuclear Power Corp.
R.D. 5, Box 169
Ferry Road
Brattleboro, Vermont 05301

Mr. John DeVincentis, Vice President
Yankee Atomic Electric Company
580 Main Street
Bolton, Massachusetts 01740-1398

Regional Administrator, Region I
U. S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, Pennsylvania 19406

R. K. Gad, III
Ropes & Gray
One International Place
Boston, Massachusetts 02110-2624

Mr. W. P. Murphy, Senior Vice President, Operations
Vermont Yankee Nuclear Power Corporation
R.D. 5, Box 169
Ferry Road
Brattleboro, Vermont 05301

Mr. Richard P. Cedano, Commissioner
Vermont Department of Public Service
120 State Street, 3rd Floor
Montpelier, Vermont 05602

Public Service Board
State of Vermont
120 State Street
Montpelier, Vermont 05602

Chairman, Board of Selectmen
Town of Vernon
Post Office Box 116
Vernon, Vermont 05354-0116

Mr. Raymond N. McCandless
Vermont Division of Occupational and Radiological Health
Administration Building
Montpelier, Vermont 05602

G. Dana Bisbee, Esq.
Office of the Attorney General
Environmental Protection Bureau
State House Annex
25 Capitol Street
Concord, New Hampshire 03301-6937

Mr. James Pelletier
Vice President - Engineering
Vermont Yankee Nuclear Power Corp.
P. O. Box 169, Ferry Road
Brattleboro, Vermont 05301

Resident Inspector
Vermont Yankee Nuclear Power Station
U.S. Nuclear Regulatory Commission
P. O. Box 176
Vernon, Vermont 05354

Chief, Safety Unit
Office of the Attorney General
One Ashburton Place, 19th Floor
Boston, Massachusetts 02108

Mr. David Rodham, Director
Massachusetts Civil Defense Agency
400 Worcester Road
P.O. Box 1496
Framingham, Massachusetts 01701-0317
ATTN: James Muckerheide

Enclosure

Battelle
Pacific Northwest Laboratories
Battelle Boulevard
P.O. Box 999
Richland, Washington 99352
Telephone (509) 376-2332

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Carl E. Beyer

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Reactor Systems and Fuel
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