UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
NORTHEAST NUCLEAR ENERGY CO.	)	Docket No. 50-336-OLA
	)	(Spent Fuel Pool Design)
(Millstone Nuclear Power Station, Unit No. 2)	)	
	)	

AFFIDAVIT OF GEORGE N. BETANCOURT

I, George N. Betancourt, being duly sworn, hereby state as follows:

1. I am employed by Northeast Utilities Service Company (NUSCo) as a Senior Mechanical Engineer for the Spent Fuel Storage Program.

2. My business address and phone number are:

Northeast Utilities Service Company
P.O. Box 270
Hartford, CT 06141
(203) 665-3784

3. I am responsible for the engineering associated with all spent fuel storage programs. My detailed resume showing my experience and qualifications is attached to this Affidavit.

4. I have reviewed Dr. Kaku's August 23, 1992, and March 31, 1993, affidavits ("declarations") related to the above-captioned proceeding. In addition, I have reviewed the four issues admitted by the Atomic Safety and Licensing Board (ASLB) under Contention 1 in this proceeding. The purpose of this Affidavit is to address the first of the four issues; i.e., the issue related to the actual scope of degradation of Boraflex panels at Millstone Unit No. 2 (Millstone 2) and the assumptions regarding Boraflex conditions in the Amendment 158 criticality analysis.

5. Based on my review of materials provided by the Cooperative Citizens Monitoring Network (CCMN), including Dr. Kaku's two affidavits, I conclude that CCMN and Dr. Kaku have presented no facts on which to base their assertions concerning Amendment 158 and the supporting criticality analyses. Based on Blackness testing results at Millstone 2, as described below, the Amendment 158 criticality analysis very conservatively bounds both present and anticipated Boraflex conditions. I conclude that no genuine dispute on a material issue of fact has been presented by CCMN or Dr. Kaku.

BORAFLEX

6. NUSCo has been aware of, and has been evaluating, Boraflex conditions at Millstone 2 for about seven years. Boraflex is a silicone-based polymeric material containing finely-divided

boron carbide in polydimethylsiloxane. Under irradiation, Boraflex becomes a hard, brittle material. If the Boraflex material is mechanically bound while under irradiation, it will be prone to the formation of gaps. Axial shrinkage of the Boraflex is the mechanism leading to the formation of gaps in the material.

7. Observations of irradiated Boraflex indicate that the change in physical properties reach saturation values beyond which there is no further change. Tests performed by the Electric Power Research Institute (EPRI) show that Boraflex will shrink under gamma irradiation and that this shrinkage will saturate at a maximum value of 3 to 4 percent at an accumulated gamma fluence of 5×10^{10} rads.

8. In this proceeding, the matter in issue related to Boraflex degradation, as set forth by the ASLB in its November 24, 1992, Memorandum and Order, is:

> **What is the actual state of the Boroflex [sic] box degradation, and what is the corresponding disposition of the water gaps? Id., ¶ 8. The Licensee examined approximately half of the poisoned rack cells with a defect rate of 16%.[2] If the sample is not representative, the gaps may be larger than expected, or locally concentrated. A concentration of gaps would cause local enhancement of the neutron distribution with an effect of increasing K_∞.**

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[2]Dr. Kaku incorrectly stated that only 16% of the Boroflex boxes were examined. Affidavit, ¶ 7. The NRC Staff caught this error and

> **noted that the defect rate is 16%. The sampling consisted of approximately half of the poisoned rack cells. . . .**

BLACKNESS TESTING

9. Two Blackness testing campaigns have been performed at Millstone 2. The Blackness testing technique is described by Dr. Stanley Turner in his Affidavit.

10. The targeted test population for the two Blackness test campaigns were those cells which were significantly irradiated (i.e., cells that have held recently discharged fuel) and as a result were most susceptible to gap formation (see ¶ 6 above). Of the 384 total Boraflex cells in the spent fuel pool (all in Regions A and B), we specifically identified 260 cells as most susceptible to Boraflex shrinkage and degradation. In the Blackness test campaigns to date, 176 individual cells have been characterized. This sample represents 46% of all storage cells with Boraflex panels (four panels per cell) and essentially 70% of the 260 cells that have been subjected to significant irradiation. Additionally, 70 of the 176 cells tested were tested in both Blackness testing campaigns to allow comparison over time.

11. Data on the results of the Blackness testing at Millstone 2 are summarized in Table 1 attached to this Affidavit.

12. The cumulative results of the two Blackness test campaigns show a maximum shrinkage of 2 percent (maximum gap size less than 3 inches) with defects in 13 percent of the panels. In fact, most of the measured gaps were considerably smaller than the maximum gap observed.

13. In Table 1, note that the overall panel defect rate observed for both test campaigns was 13 percent. The panel defect rate for the second campaign alone was 16 percent. The latter does not represent the overall defect rate because 32 panels with known gaps (from the first campaign) were selected for retesting, which skewed the rate. (Compare the footnote to issue 1 in the ASLB's November 24, 1992 Memorandum and Order.)

14. It is also important to note that in the Blackness testing no "clustering" of gaps was observed, in the sense of gaps in adjacent panels occurring at the same axial location. The gap distribution was observed to be essentially random throughout the axial length of the panels.

15. Northeast Nuclear Energy Company (NNECo) elected in 1991 to replace the two Boraflex boxes at Millstone 2 that were determined through the Blackness testing to contain gaps greater than two inches (D9 and J9); therefore, the maximum measured in service shrinkage after the replacement was 1.3 percent. The average gap size was approximately 0.8 inches.

16. Blackness testing results obtained at Millstone 2 are consistent with other utility test data and remain bounded and conservative relative to EPRI data relating to shrinkage. This EPRI data has been derived primarily from coupon programs. Coupon test programs -- like Blackness testing -- are used to characterize the physical properties of Boraflex in a radiation environment.

17. Currently, NNECo intends to continue Blackness testing in the Millstone 2 Spent Fuel Pool until saturation has been achieved and the gap growth in the Boraflex panels reaches its end point. This surveillance testing will, as with the previous campaign, overlap previously tested cells as well as expand the test population. We believe our program of Blackness testing, surveillance coupons, removal, replacement, and disassembly of Boraflex boxes, EPRI specialized test specimens, and dosimetry testing, to be one of the most comprehensive in the industry.

18. In his August 1992 affidavit at ¶ 7, Dr. Kaku alleges that no one knows precisely how much degradation has occurred within the Boraflex boxes and that only 16% of the Boraflex boxes actually have been examined. He argued that the sample "is too small to give an accurate picture of the true nature of the degradation." (Dr. Kaku acknowledges in his March 1993, affidavit, at ¶ 1, that the number 16% in his earlier

affidavit was in error.) As shown in Table 1 attached, 46% of the Boraflex boxes were tested. This information was provided directly to CCMN on January 15, 1993, in the discovery materials provided by NNECo. However, Dr. Kaku makes no mention of the actual number of cells tested in his March 1993 affidavit, nor does he dispute that the total number tested (46% overall and 70% of those most susceptible to gaps) is adequate. Dr. Kaku is simply in error when he states that no one knows the extent of Boraflex gapping in the pool.

19. As noted above, the Blackness testing technique is described in more detail in the Affidavit of Dr. Turner. NNECo specifically confirmed the accuracy, calibration and resolution of the equipment used to perform Blackness testing. A Blackness test was performed on cell D9 (the most degraded cell identified during the first Blackness testing campaign). Cell D9 then was removed from the rack and tested again to verify that movement did not caused shifting and realignment of any gaps. The Boraflex box for cell D9 was then disassembled and the Boraflex was measured to determine actual gap size, location and configuration. Correlation between the Blackness test results and actual measurements was very good: locations agreed within 1-2% and gap sizes agreed within 10%. This demonstrated that the Blackness testing equipment was accurate to within its calibration limits and demonstrated the credibility of the overall Blackness testing program.

CRITICALITY ANALYSIS

20. Based on my involvement on the Millstone 2 Blackness testing, I was also involved in selecting bounding assumptions to be used in the Amendment 158 criticality analysis. Although the maximum observed gap size was less than three inches, the gap size assumed for the Amendment 158 criticality analysis performed by HOLTEC is 5.65 inches (4%). This gap size bounds a 3 to 4% shrinkage as might occur at the saturation dose (see ¶ 7 above). Further, 5.65 inch gaps were assumed in every Boraflex panel, even though in most panels no gaps were observed. In addition, a 4% width shrinkage was assumed for analysis purposes. These conservative assumptions go well beyond the gap distributions observed in the Blackness testing programs at Millstone 2. With these assumptions, the criticality analysis conservatively models the actual observed condition of the Boraflex panels and bounds anticipated gaps in the Boraflex.

21. The assumed 5.65 inch gap also bounds the condition of the few panels observed that had more than one gap. The assumed gap is larger than the sum of all observed multiple gaps. Moreover, the total gap in any one panel is always limited to the 3 to 4 percent shrinkage expected at the saturation dose (see ¶ 7 above), regardless of whether in one or more gaps. The assumed 5.65 inch gap is also conservative from a

reactivity standpoint because the entire gap is assumed at one location on the panel.

SUMMARY AND CONCLUSION

22. The two Blackness tests, confirmed by actual benchmarking of the testing process, accurately measured the size, location and distribution of Boraflex panel gaps in the spent fuel pool. Testing demonstrated that no clustering of gaps has occurred, and that most panels have no gaps. However, to build additional conservatism into the criticality analyses supporting Amendment 158 and to bound anticipated degradation, gap sizes and numbers were assumed that were well in excess of those observed.

23. The information provided above is true and correct to the best of my knowledge and belief.

George N. Betancourt

Sworn and subscribed to before
me this 5 day of May, 1993

Kathleen I Gates
Notary Public

December 31, 1997
My commission expires:

RESUME

NAME: *GEORGE N. BETANCOURT*

EMPLOYER: Northeast Utilities Service Company

TITLE: Senior Mechanical Engineer
Spent Fuel Storage Program

BIRTH DATE: November 27, 1950

EDUCATION:

1971	Academy of Aeronautics - Associates Degree/Mechanical
1975	City College of New York - Bachelors Degree/Mechanical

WORK EXPERIENCE: *(Chronological past to present)*

FROM/TO YEARS	JOB TITLE	COMPANY	RESPONSIBILITIES
2/75 - 12/78	Engineer	Combustion Engineering	Design/Development/Fabrication/ Test of Reactor Refueling Mechanisms, Equipment and Spent Fuel Racks
12/78 - 6/82	Mechanical/ Nuclear Engineer	Ebasco Services	Technical support for the construction of several nuclear plants. Primary responsibilities centered around the reactor assembly and large bore piping installation.
7/82 - Present	Senior Mechanical Engineer	NUSCO	Responsible for the spent fuel storage programs on the Millstone Units 1, 2, 3 and Connecticut Yankee Nuclear Power Plants

OTHER JOB RELATED INFORMATION: ***(licenses, publications, etc.)***

Licensed by the Federal Aviation Administration (FAA)

Airframe and Power Plant Qualification for private and commercial propeller and turbine driven airplanes and helicopters.

United States Patent Office

Holder of several U. S. Patents for development of reactor refueling related mechanisms for Combustion Engineering System 80 Nuclear Supply Systems. Patents reduced to practice at Palo Verde Nuclear Stations (Arizona Public Power).

Millstone Unit 2

1346 Total Storage Cells in Pool, 384 Contain Boraflex

Test Date	Cells					Panels					Gaps		
	Irradiated	No. Tested	% Tested **	Defects	% Defects	Irradiated	No. Tested	% Tested**	Defects	% Defects	No.	Ave Siz	Max Size
Aug-90	384	105	27%	32	30%	1536	420	27%	46	11%	49	.76"	1.7"
Oct-91	384	141	37%	53	38%	1536	564	37%	89	16%	93	.83"	2.8" *
Total	384	176	46%	53	30%	1536	704	46%	89	13%	93	NA	2.8" *
T/S Analysis Assumes	384				100%		Random axial distribution			100%		5.65"	5.65"

* The two cells with >2" gaps had poison boxes replaced

** The second campaign tested 32 cells with gaps and 38 cells without gaps from the first campaign.

TABLE 1

BLACKNESS TESTING DATA