UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON D.C. 20555

September 8, 1987

NRC INFORMATION NOTICE NO. 87-43: GAPS IN NEUTRON-ABSORBING MATERIAL IN HIGH-DENSITY SPENT FUEL STORAGE RACKS

Addressees:

All nuclear power reactor facilities holding an operating license or a construction permit.

Purpose:

This notice is to alert recipients to a potentially significant problem pertaining to gaps identified in the neutron absorber component of the high-density spent fuel storage racks at Quad Cities Unit 1. The safety concern is that certain gaps might excessively reduce the margin of nuclear subcriticality in the fuel pool. The NRC expects that recipients will review this notice for applicability to their facilities and consider actions, if appropriate, to preclude a similar problem occurring at their facilities. However, suggestions in this notice do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances:

On May 1, 1987, Commonwealth Edison Company (CECO), the licensee at Quad Cities 1 and 2, presented data to the NRC regarding gaps measured in Boraflex, a neutron-absorbing material used in the high-density fuel storage racks manufactured by the Joseph Oat Corporation (OAT). Boraflex is a trade name for a boron carbide dispersion in an elastomeric silicone matrix manufactured by Bisco Products, Inc. (BISCO). Data pertaining to the gap size and distribution had been obtained by National Nuclear Corporation (NNC) under contract to CECO.

The licensee had retained Northeast Technology Corporation (NETCO) to interpret the data. NETCO prefaced their assessment as preliminary, noting that available data was limited, but concluded that the gap formation mechanism may be related to large local stresses in the Boraflex from fabrication-induced restraint within the rack and to tearing and shrinkage of the material.

The average gap size is 1-1/2 inches, with the largest 4 inches. The gaps occur in the upper two-thirds of the cell length.

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These gaps are inferred from anomalies in "blackness" testing results by NNC. The existence of a gap in the Quad Cities neutron absorber panel has been confirmed by underwater neutron radiography conducted by Nusurtec, Inc.

CECO also discussed the effects these gaps might have on the approved safety analysis for the spent fuel storage racks. CECO used conservative assumptions for gap size, gap location, and fuel burnup. Considerable margin in k-eff appears to be available before the licensing limit of 0.95 would be approached.

In July 1986, Wisconsin Electric Company, the licensee at Point Beach 1 and 2, reported to the NRC that test coupons of Boraflex material had shown considerable degradation under high radiation. However, the licensee asserted that this result did not represent the actual condition of Boraflex used in its spent fuel storage racks because of differences in methods of encapsulation, sample geometry, and handling frequency. Additionally, the coupons had been subjected to about 5 times more radiation than is associated with the average fuel rack position. Subsequent examination of full-length panels disclosed two results: in one panel examined for effects of the water environment but exposed to negligible gamma radiation, there was no degradation of the Boraflex. In another panel exposed to significant gamma radiation, 1-2 percent of the surface showed a gray discoloration at the edges, similar to the degradation of the coupons.

Discussion:

The concern is that separation of the neutron-absorbing material used in high density fuel storage racks might compromise safety. Although Quad Cities reports that its racks, even with gaps in the Boraflex as large as 4 inches, can meet the criticality criterion of k-eff less than or equal to 0.95, this may not be the case for larger gaps or for other plants. A list of the 31 sites using Boraflex is given in Attachment 1. Related information is given in "Behavior of High-Density Spent-Fuel Storage Racks," EPRI NP-4724, Electric Power Research Institute, August 1986.

Efforts to understand the gap formation have revealed several topics on which information is needed. Accordingly, the material supplier (BISCO) and the Electric Power Research Institute (EPRI) have undertaken research programs to collect this information. Some of their objectives are described below.

The BISCO program aims to establish with increased accuracy the relationship between radiation dose and size changes. The program also evaluates the potential effects of handling and restraint, during and subsequent to the fuel rack fabrication, on gap formation.

The EPRI program will correlate data from utilities' neutron absorber coupon surveillance programs. EPRI will further examine data obtained from CECO, as well as from BISCO and other sources, to improve the understanding of possible or actual gap formation models, including the effects of rack fabrication methods and irradiation damage mechanisms. The EPRI Program will also attempt

to model the specific Quad Cities experience considering absorbed gamma dose as a function of axial elevation, neutron absorbing sheet restraint, and fractional change in length.

The effect of rack design and manufacturing methods on the consequences of stress, temperature, and chemical environment to irradiated Boraflex is uncertain. Recent blackness test results at Turkey Point, who uses a Westinghouse spent fuel storage rack, did not indicate the presence of gaps in the Boraflex. The research programs are designed to evaluate each consequence and, in particular, to improve the understanding of stress caused by method of attachment of the Boraflex panel to the stainless steel wall of the cell.

Together, these programs are designed to improve the industry understanding of the safety implications of the observed gaps in the Boraflex neutron absorber component of the OAT high-density spent-fuel storage racks at Quad Cities.

No specific action or written response is required by this information notice. If you have any questions about this matter, please contact the Regional Administrator of the appropriate regional office or this office.

Charles E. Rossi

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Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

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Albert D. Morrongiello
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Attachments:
1. List of Plants Using Boraflex Structures in the Spent Fuel Pool
2. List of Recently Issued NRC Information Notices

LIST OF PLANTS WITH BORAFLEX
STRUCTURES IN THE SPENT FUEL POOL

1. Arkansas 1,2
2. Beaver Valley 1
3. Diablo Canyon 1,2
4. Calvert Cliffs 2
5. Farley 1,2
6. Fermi 2*
7. Ft. Calhoun
8. Ginna
9. Grand Gulf 1,2*
10. McGuire 1,2
11. Millstone 1,2,3
12. Nine Mi. Pt. 1,2
13. North Anna 1,2
14. Oconee 1,2,3
15. Oyster Creek*
16. Peach Bottom 2,3
17. Pilgrim
18. Pt. Beach 1,2
19. Pr. Island 1,2
20. Quad Cities 1,2*
21. Rancho Seco*
22. River Bend
23. Robinson 2
24. Summer*
25. Trojan
26. Turkey Pt. 3,4
27. Waterford 3
28. Seabrook 1,2
29. Watts Bar 1,2
30. Comanche Peak 1,2
31. Harris

*Plants having spent fuel storage racks fabricated by Joseph Oat Corporation.

LIST OF RECENTLY ISSUED
INFORMATION NOTICES 1987

Information Notice No.	Subject	Date of Issuance	Issued to
87-42	Diesel Generator Fuse Contacts	9/4/87	All nuclear power reactor facilities holding an OL or CP.
87-41	Failures of Certain Brown Boveri Electric Circuit Breakers	8/31/87	All nuclear power reactor facilities holding an OL or CP.
87-40	Backseating Valves Routinely to Prevent Packing Leakage	8/31/87	All nuclear power reactor facilities holding an OL or CP.
87-39	Control of Hot Particle Contamination at Nuclear Power Plants	8/21/87	All nuclear power reactor facilities and spent fuel storage facilities holding an NRC license or CP.
87-38	Inadequate or Inadvertent Blocking of Valve Movement	8/17/87	All nuclear power reactor facilities holding an OL or CP.
87-37	Compliance with the General License Provisions of 10 CFR Part 31	8/10/87	All persons specifically licensed to manufacture or to initially transfer devices containing radioactive material to general licensees, as defined in 10 CFR Part 31.
87-36	Significant Unexpected Erosion of Feedwater Lines	8/4/87	All nuclear power reactor facilities holding an OL or CP.
87-35	Reactor Trip Breaker, Westinghouse Model DS-416, Failed to Open on Manual Initiation from the Control Room	7/30/87	All nuclear power reactor facilities holding an OL or CP employing W DS-416 reactor trip breakers.

OL = Operating License
CP = Construction Permit

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to model the specific Quad Cities experience considering absorbed gamma dose as a function of axial elevation, neutron absorbing sheet restraint, and fractional change in length.

The effect of rack design and manufacturing methods on the consequences of stress, temperature, and chemical environment to irradiated Boraflex is uncertain. Recent blackness test results at Turkey Point, who uses a Westinghouse spent fuel storage rack, did not indicate the presence of gaps in the Boraflex. The research programs are designed to evaluate each consequence and, in particular, to improve the understanding of stress caused by method of attachment of the Boraflex panel to the stainless steel wall of the cell.

Together, these programs are designed to improve the industry understanding of the safety implications of the observed gaps in the Boraflex neutron absorber component of the OAT high-density spent-fuel storage racks at Quad Cities.

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Attachments:
1. List of Plants Using Boraflex Structures in the Spent Fuel Pool
2. List of Recently Issued NRC Information Notices

*SEE PREVIOUS CONCURRENCES

				D/DOEA:NRR
				CERossi
				08/ /87
*OGCB:DOEA:NRR	*AC/ECEB:DEST:NRR	*RI:QUAD	*PPMB:ARM	*C/OGCB:DOEA:NRR
CVHodge	CMcCracken	AMorrongiello	TechEd	CHBerlinger
08/20/87	08/26/87	08/25/87	07/17/87	08/24/87

to model the specific Quad Cities experience utilizing absorbed gamma dose as a function of axial elevation, fractional change in length and neutron absorbing sheet restraint.

The effect of rack design and manufacturing methods on the consequences of stress, temperature, and chemical environment to irradiated Boraflex is uncertain. Recent blackness test results at Turkey Point, who uses a Westinghouse spent fuel storage rack, did not indicate the presence of gaps in the Boraflex. The research programs are designed to evaluate each consequence and, in particular, to improve the understanding of stress caused by method of attachment or entrapment of the Boraflex panel to the stainless steel wall of the cell.

Together, these programs are designed to improve the industry understanding of the safety implications of the observed gaps in the Boraflex neutron absorber component of the OAT high-density spent-fuel storage racks at Quad Cities. To date, the NRC has not received information to prompt a more immediate addressing of this issue.

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*SEE PREVIOUS CONCURRENCES

OGCB:DOEA:NRR	AC/ECEB:DEST:NRR	RI:QUAD	*PPMB:ARM	D/DOEA:NRR	C/OGCB:DOEA:NRR
CVHodge	CMcCracken	AMorrongiello	TechEd	CERossi	CHBerlinger
08/20/87	08/26/87	08/25/87	07/17/87	08/ /87	08/24/87
vh	by phone	By Telephone			CHB

of maximum gap size, on which the determination of k-eff rests. Major uncertainties in this picture include isotropy of volume changes, damage mechanism, and influence of stress, temperature, and chemical environment.

Volume changes are assumed isotropic. If untrue, the presently estimated maximum gap size would be significantly affected.

The radiation damage mechanism is uncertain. Crosslinking leads to shrinkage, whereas scissioning leads to increased friability of the material. In the absence of low dose data, it is presently assumed that crosslinking damage is proportional to dose; thus it is thought that crosslinking is about complete at 1-2 E 10 rads. The degraded Point Beach coupons were given a dose of this magnitude, however the essentially nondegraded Point Beach panels and Quad Cities panels and representative positions in spent fuel pool storage racks are associated with doses from 3 to 6 times smaller than this range of values.

Stress, temperature, and chemical environment may influence the estimate of maximum gap size and hence pool criticality. In particular, to improve the understanding of stress, the EPRI program will determine the dependence of gap formation on the method of attaching the Boraflex panel to the stainless steel wall of the storage rack cell.

Together, these programs are designed to improve the industry's understanding of the safety implications of the observed degradation of Boraflex.

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Attachments:
1. List of Potentially Affected Plants
2. List of Recently Issued Information Notices

OGCB:DOEA:NRR	RI:QUAD	PPMB:ARM	C/OGCB:DOEA:NRR	D/DOEA:NRR
CVHodge	AMorrongiello	TechEd	CHBerlinger	CERossi
07/ /87	07/ /87	07/17/87	07/ /87	07/ /87

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