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

March 22, 1989

NRC INFORMATION NOTICE NO. 89-31: SWELLING AND CRACKING OF HAFNIUM CONTROL RODS

Addressees:

All holders of operating licenses or construction permits for pressurized water reactors (PWRs) with Hafnium control rods.

Purpose:

This information notice is being provided to alert addressees of swelling and cracking of Hafnium control rods at several PWRs. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances:

During eddy current and profilometry measurements of the control rods at the Wolf Creek Generating Station, abnormal wear and swelling were identified in 53 Hafnium rod cluster control assemblies (RCCAs). As a result, the Wolf Creek licensee informed the RCCA vendor, Westinghouse Electric Corporation, of their inspection results. Subsequently, Westinghouse examined previous inspection data from Union Electric Co.'s Callaway Plant and confirmed that Hafnium control rod swelling was also occurring at Callaway. In addition, there has been some foreign experience with these Hafnium control rods breaking due to either swelling or hydriding and fretting.

Discussion:

Westinghouse introduced Hafnium material in RCCAs as a replacement for silver-indium-cadmium (Ag-In-Cd) in the 1970s. Some control rod cladding wear was expected; however, the extent of swelling and cracking discovered at the Wolf Creek and Callaway reactors was not.

Westinghouse believes that the Hafnium control rod swelling and cracking are caused by hydriding of the Hafnium. Hydriding of the control rod occurs when hydrogen from the reactor coolant diffuses through the stainless steel cladding and reacts with Hafnium to form Hafnium hydride. The hydriding phenomenon was addressed by Westinghouse during the development of the Hafnium control rods

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and was not considered to be significant. During autoclave testing of the control rods in the 1970s, hydriding occurred uniformly over the entire length of the rod and resulted in only a very minor volumetric increase.

At the Wolf Creek and Callaway reactors, however, the abnormal wear and localized swelling of the control rods occurred at several locations, with the largest number of swollen sections located in the upper regions of the control rods. According to Westinghouse, Hafnium reacts with air during the fabrication process and quickly forms a protective oxide layer on the Hafnium rod surface that inhibits the hydriding process. It is postulated that initial misalignment of the Hafnium rods with the cladding during the assembly of the RCCAs can result in loose particles or spalling of the stainless steel cladding near the top of the inner diameter of the cladding. During thermal cycling, the differential thermal expansion between the Hafnium and the stainless steel cladding causes the particles to come in contact with the Hafnium and to penetrate or remove the protective oxide layer. After the oxide layer is penetrated, the diffusion of hydrogen into the Hafnium occurs. Because the Hafnium and the cladding have a constant interface at the bottom of the control rod, the greatest relative movement between the Hafnium and the stainless steel occurs at the top of the control rod and results in increased hydriding.

The principal safety concern associated with swelling and cracking caused by hydriding is the inability of a control rod to fully insert into the core because of interference between control rods and the guide cards. The safety analysis prepared by Westinghouse to evaluate the potential consequences of control rod swelling and end plug cracking indicates that there is no possibility of interference or locking of the control rods. The maximum theoretical diametrical increase of a control rod due to the hydriding mechanism has been calculated by Westinghouse to be 0.026 inches. In the safety analysis, the maximum increase was conservatively assumed to be 0.029 inches and resulted in a maximum control rod diameter of 0.410 inches. Since the passage way in the guide cards through which the control rods travel has a nominal inside diameter of 0.420 inches, Westinghouse has determined that a nominal clearance of at least 0.010 inches exists between the control rods and the guide cards when the maximum diametrical increase is assumed.

Westinghouse has also calculated that operating plants with Hafnium control rods will experience only a small increase in control rod drop times (less than 0.1 seconds) assuming that all 24 RCCA individual absorber rods are bent. In addition, no plant is expected to exceed its technical specification limits on rod drop time through the end of either a third 18-month cycle or a fourth 12-month cycle.

Although the current information does not suggest the need for immediate action, the NRC is concerned about the long-term continued operation of nuclear reactors with swollen or cracked Hafnium control rods. The NRC staff and Westinghouse personnel are continuing their evaluations on this issue. In the interim, it is important that addressees take whatever actions are necessary to ensure that similar problems, if they exist at their facilities, are detected early and corrective actions are taken to preclude any deterioration of the safety function of the control rods.

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

Charles E. Rossi

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contacts: S.L. Wu, NRR
(301) 492-1065

L. Phillips, NRR
(301) 492-3235

Attachment: List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
89-30	High Temperature Environments at Nuclear Power Plants	3/15/89	All holders of OLs or CPs for nuclear power reactors.
89-29	Potential Failure of ASEA Brown Boveri Circuit Breakers During Seismic Event	3/15/89	All holders of OLs or CPs for nuclear power reactors.
89-28	Weight and Center of Gravity Discrepancies for Copes-Vulcan Air-Operated Valves	3/14/89	All holders of OLs or CPs for nuclear power reactors.
89-27	Limitations on the Use of Waste Forms and High Integrity Containers for the Disposal of Low-Level Radioactive Waste	3/8/89	All holders of OLs or CPs for nuclear power reactors, fuel cycle licenses and certain by-product materials licenses.
89-26	Instrument Air Supply to Safety-Related Equipment	3/7/89	All holders of OLs or CPs for nuclear power reactors.
89-25	Unauthorized Transfer of Ownership or Control of Licensed Activities	3/7/89	All U.S. NRC source, byproduct, and special nuclear material licensees.
89-24	Nuclear Criticality Safety	3/6/89	All fuel cycle licensees and other licensees possessing more than critical mass quantities of special nuclear material.
89-23	Environmental Qualification of Litton-Veam CIR Series Electrical Connectors	3/3/89	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

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*SEE PREVIOUS PAGE FOR CONCURRENCE (I Comments included attached)

D/DOEA:NRR	*IP	*C/OGCB:DOEA:NRR	*RPB:ARM	*D/DEST:NRR
CERossi	RHauber	CHBerlinger	TechEd	LCShao
3/17/89	03/ /89	03/9/89	02/28/89	03/8/89
*OGCB:DOEA:NRR	*SRXB:DEST:NRR	*SRXB:DEST:NRR	*C/SRXB:DEST:NRR	*AD/SAD:DEST:NRR
JGuillen	SLWu	LPhillips	WHodges	AThadani
03/10/89	03/1/89	03/1/89	03/2/89	03/6/89

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	D/DOEA:NRR	C/OGCB:DOEA:NRR	RPB:ARM	D/DEST:NRR
	CERossi	CHBerlinger	Previously Concurred TechEd for Rdlue	LCShao
	03/ /89	03/9/89	02/28/89	03/8/89
OGCB:DOEA:NRR	SRXB:DEST:NRR	SRXB:DEST:NRR	C/SRXB:DEST:NRR	AD/SAD:DEST:NRR
JGuillen	SLWu	LPhillips	WHodges	AThadani
03/10/89	03/1 /89	03/1 /89	03/2 /89	03/ /89

IP RB
for RHauber
3/17/89

May Rot.

March 17, 1989

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