

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

November 21, 1989

**NRC BULLETIN NO. 89-03: POTENTIAL LOSS OF REQUIRED SHUTDOWN MARGIN DURING REFUELING OPERATIONS**

Addressees:

All holders of operating licenses or construction permits for pressurized water reactors.

Purpose:

This bulletin is being provided to alert addressees to the potential loss of required shutdown margin during the movement and placement of highly reactive fuel during refueling operations. It is expected that recipients will take the actions in this bulletin to prevent potential violations of required shutdown margin and, in extreme cases, inadvertent criticality during refueling.

Description of Circumstances:

Baltimore Gas and Electric Company (BG&E) submitted a 10 CFR Part 21 report to the NRC on March 15, 1989, regarding the potential loss of shutdown margin during refueling operations at its Calvert Cliffs Nuclear Power Plant, Units 1 and 2. BG&E reported that it had increased the fuel enrichment during the last several fuel cycles. In the current cycle, 4.3 weight percent U-235 fuel was loaded into the core. During a review of NRC Information Notice No. 88-21, "Inadvertent Criticality Events at Oskarshamn and U.S. Nuclear Power Plants," BG&E discovered that the Calvert Cliffs refueling procedures allowed the placement of fuel assemblies in intermediate positions during core alterations. In addition, BG&E determined that the potential existed for losing some of the shutdown margin required by the plant technical specifications, even if several fresh reload assemblies with enrichments as low as 4.1 weight percent were grouped together. Calculations also showed that under extreme conditions an inadvertent criticality could occur if a number of highly reactive assemblies were grouped together. In response to the BG&E notification, the NRC issued Information Notice No. 89-51, "Potential Loss of Required Shutdown Margin During Refueling Operations," dated May 31, 1989.

BG&E has revised the Calvert Cliffs refueling procedures to ensure that fuel assemblies will not be placed in intermediate positions during core alterations without first verifying their potential reactivity. The revised procedures

allow fuel to be positioned only in intermediate core locations that will contain fuel of equal or greater reactivity in the final core configuration.

Discussion:

As a result of longer fuel operating cycles, utilities have been increasing the enrichment of reload fuel. Some of these fresh reload assemblies may be highly reactive under certain refueling conditions. Although analyses are performed for PWRs to confirm that the refueling boron concentration is sufficient to maintain the required shutdown margin (subcriticality) for the final core configuration, these analyses may not be sufficient to assure that the shutdown margin will be maintained for all intermediate fuel assembly positions. In addition, explicit procedural controls may not exist to control the location and movement of highly reactive fuel assemblies during refueling. Because a significant amount of reactivity can be added to subcritical configurations by the addition of a single highly reactive assembly, it is possible that an inadvertent criticality could occur if a number of such assemblies are grouped together. With this highly reactive fuel, subcritical multiplication (inverse count rate) may not provide adequate warning of an approach to criticality. An inadvertent criticality could result in fuel failures, system damage, and potentially high radiological doses to onsite workers.

Combustion Engineering, Inc. (CE), the nuclear fuel design consultant for Calvert Cliffs, recognized this potential problem and issued an information bulletin regarding shutdown margin during refueling to all utilities with CE-designed plants. These utilities have been advised to review their fuel shuffle procedures that control the location of highly reactive fuel and to be aware that the refueling boron concentration necessary to maintain the required shutdown margin, which is based on the final core configuration, may not be sufficient to assure that their required shutdown margin will be maintained for all intermediate fuel assembly positions. In circumstances in which explicit analyses are not available for each intermediate fuel assembly position, CE recommends positioning fuel only in intermediate core locations that will contain fuel of equal or greater reactivity in the final core configuration.

Requested Actions:

Operating Reactors:

All PWR licensees are requested to assure that adequate shutdown margin is maintained during all refueling operations. This should be accomplished through the following actions:

1. Assure that any intermediate fuel assembly configuration (including control rods) intended to be used during refueling is identified and evaluated to maintain sufficient refueling boron concentration to result in a minimum shutdown margin of approximately 5%.
2. Assure that fuel loading procedures only allow those intermediate fuel assembly configurations that do not violate the allowable shutdown margin and that these procedures are strictly adhered to.

3. Assure that the staff responsible for refueling operations is trained in the procedures recommended in Item 2 above and understand the potential consequences of violating these procedures. This training should include the fundamental aspects of criticality control with higher enriched fuel assemblies.

**Construction Permit Holders:**

All PWR construction permit holders are requested to complete the above-listed actions before the date scheduled for fuel loading.

**Reporting Requirements:**

Within 60 days of receipt of this bulletin, pursuant to 10 CFR 50.54(f), all holders of OLs for PWRs shall notify the NRC by letter whether they have taken, or will take, the actions requested above. Prior to initial fuel loading, CP holders shall advise the NRC by letter whether the requested actions have been implemented.

The written reports required above shall be addressed to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, D.C. 20555, and shall be submitted under oath or affirmation pursuant to the provisions of Section 182a, Atomic Energy Act of 1954, as amended and 10 CFR 50.54(f). In addition, a copy shall be submitted to the appropriate Regional Administrator.

**Backfit Discussion**


The objective of the actions requested in this bulletin is to ensure that an adequate shutdown margin is maintained during the movement and placement of fuel during refueling operations.

The issuance of the bulletin is justified on the basis of the need to provide adequate protection to the health and safety of the public and is consistent with the provisions of 10 CFR 50.109a(4)(ii). The actions proposed by the bulletin will ensure that an adequate shutdown margin is maintained. Failure to take these actions may result in an inadequate shutdown margin during refueling operations. In extreme cases this could result in inadvertent criticality with potential for fuel failures, reactor damage, and relatively high radiological doses to onsite workers.

This request is covered by Office of Management and Budget Clearance Number 3150-0011 which expires December 31, 1989. The estimated average burden hours are 100 person-hours per licensee response, including assessment of the new recommendations, searching data sources, gathering and analyzing the data, and preparing the required letters. These estimated average burden hours pertain only to these identified response-related matters and do not include the time for actual implementation of the requested actions. Send comments regarding this burden estimate or any other aspect of this collection of information,

including suggestions for reducing this burden, to the Information and Records Management Branch, Division of Information Support Services, Office of Information Resources Management, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555; and to the Paperwork Reduction Project (3150-0011), Office of Management and Budget, Washington D.C. 20503.

If you have any questions about this matter, please contact one of the technical contacts listed below or the appropriate NRR project manager.

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

Technical Contacts: Laurence I. Kopp, NRR  
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Attachment: List of Recently Issued NRC Bulletins

NRC BULLETIN NO. 89-03: SHUTDOWN MARGIN LOSS

<u>PLANT</u>	<u>DOCKET NO.</u>	<u>PM</u>			
Arkansas 1	05000313	Harbuck	Palo Verde 2	05000529	Chan
Arkansas 2	05000368	Poslusny	Palo Verde 3	05000530	Davis
Beaver Valley 1	05000334	Tam	Point Beach 1	05000266	Swenson
Beaver Valley 2	05000412	Tam	Point Beach 2	05000301	Swenson
Bellefonte 1	05000438	Cortland	Prairie Island 1	05000282	DiIanni
Bellefonte 2	05000439	Cortland	Prairie Island 2	05000306	DiIanni
Braidwood 1	05000456	Sands	Rancho Seco 1	05000312	Kalman
Braidwood 2	05000457	Sands	Robinson 2	05000261	Lo
Byron 1	05000454	Olshan	Salem 1	05000272	Stone
Byron 2	05000455	Olshan	Salem 2	05000311	Stone
Callaway 1	05000483	Alexion	San Onofre 1	05000206	Trammell
Calvert Cliffs 1	05000317	McNeil	San Onofre 2	05000361	Kokajko
Calvert Cliffs 2	05000318	McNeil	San Onofre 3	05000362	Kokajko
Catawba 1	05000413	Jabbour	Seabrook 1	05000443	Nerses
Catawba 2	05000414	Jabbour	Sequoyah 1	05000443	Donohew
Comanche Peak 1	05000445	Malloy	Sequoyah 2	05000328	Donohew
Comanche Peak 2	05000446	Malloy	Shearon Harris	05000400	Becker
Cook 1	05000315	Giitter	South Texas 1	05000498	Dick
Cook 2	05000316	Giitter	South Texas 2	05000499	Dick
Crystal River 3	05000302	Silver	St Lucie 1	05000335	Norris
Davis-Besse 1	05000346	Wambach	St Lucie 2	05000389	Norris
Diablo Canyon 1	05000275	Rood	Summer 1	05000395	Hayes
Diablo Canyon 2	05000323	Rood	Surry 1	05000280	Buckley
Farley 1	05000348	Reeves	Surry 2	05000281	Buckley
Farley 2	05000364	Reeves	Three Mile	05000289	Hernan
Fort Calhoun 1	05000285	Bourmia	Trojan	05000344	Bevan
Ginna	05000244	Johnson	Turkey Point 3	05000250	Edison
Maddam Neck	05000213	Wang	Turkey Point 4	05000251	Edison
Indian Point 2	05000247	Brinkman	Vogtle 1	05000424	Hopkins
Indian Point 3	05000286	Neighbors	Vogtle 2	05000425	Hopkins
Kewaunee	05000305	Gody	Waterford 3	05000382	Wigginton
Maine Yankee	05000309	Leeds	Watts Bar 1	05000390	Auluck
McGuire 1	05000369	Hood	Watts Bar 2	05000391	Auluck
McGuire 2	05000370	Hood	Wolf Creek 1	05000482	Pickett
Millstone 2	05000336	Vissing	Yankee Rowe	05000029	Sears
Millstone 3	05000423	Jaffe	Zion 1	05000295	Patel
North Anna 1	05000338	Engle	Zion 2	05000304	Patel
North Anna 2	05000339	Engle			
Oconee 1	05000269	Wiens			
Oconee 2	05000270	Wiens			
Oconee 3	05000287	Wiens			
Palisades	05000255	DeAgazio			
Palo Verde 1	05000528	Chan			

LIST OF RECENTLY ISSUED  
 NRC BULLETINS

Bulletin No.	Subject	Date of Issuance	Issued to
88-10, Supplement 1	Nonconforming Molded-Case Circuit Breakers	8/3/89	All holders of OLs or CPs for nuclear power reactors.
89-02	Stress Corrosion Cracking of High-Hardness Type 410 Stainless Steel Internal Preloaded Bolting in Anchor Darling Model S350W Swing Check Valves or Valves of Similar Design	7/19/89	All holders of OLs or CPs for nuclear power reactors.
89-01	Failure of Westinghouse Steam Generator Tube Mechanical Plugs	5/15/89	All holders of OLs or CPs for PWRs.
88-08, Supplement 3	Thermal Stresses in Piping Connected to Reactor Coolant Systems	4/11/89	All holders of OLs or CPs for light- water-cooled nuclear power reactors.
88-07, Supplement 1	Power Oscillations in Boiling Water Reactors	12/30/88	All holders of OLs or CPs for BWRs.
88-11	Pressurizer Surge Line Thermal Stratification	12/20/88	All holders of OLs or CPs for PWRs.
88-10	Nonconforming Molded-Case Circuit Breakers	11/22/88	All holders of OLs or CPs for nuclear power reactors.
88-05, Supplement 2	Nonconforming Materials Supplied by Piping Supplies, Inc. at Folsom, New Jersey and West Jersey Manufacturing Company at Williamstown, New Jersey	8/3/88	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License  
 CP = Construction Permit