June 16, 2004

Mr. Kenneth Putnam, Chairman
BWR Owners Group
Nuclear Management Company
Duane Arnold Energy Center
3277 DAEC Rd.
Palo, IA 52324

SUBJECT: SAFETY EVALUATION FOR LICENSING TOPICAL REPORT (LTR) NEDO-33091, "IMPROVED BPWS CONTROL ROD INSERTION PROCESS" (TAC NO. MB9642)

Dear Mr. Putnam:

On June 6, 2003, and supplemented on April 21, 2004, the Boiling Water Reactors Owners Group (BWROG) submitted LTR NEDO-33091, "Improved BPWS Control Rod Insertion Process," to the staff for review and approval. On May 10, 2004, an NRC draft safety evaluation (SE) regarding our approval of NEDO-33091 was provided for your review and comments. By telecon on June 3, 2004, the BWROG provided minor editorial comments. The staff has incorporated the BWROG's comments into the final SE enclosed with this letter.

The staff has found LTR NEDO-33091 acceptable for referencing in licensing applications for boiling water reactors to the extent specified and under the limitations delineated in the LTR and in the enclosed SE. The SE defines the basis for acceptance of the LTR.

Our acceptance applies only to matters approved in the subject LTR. We do not intend to repeat our review of the acceptable matters described in the LTR. When the LTR appears as a reference in license applications, our review will ensure that the material presented applies to the specific plant involved. License amendment requests that deviate from this LTR will be subject to a plant-specific review in accordance with applicable review standards.

In accordance with the guidance provided on the NRC web site, we request that the BWROG publish an accepted version of this LTR within three months of receipt of this letter. The accepted version shall incorporate this letter and the enclosed SE between the title page and the abstract. It must be well indexed such that information is readily located. Also, it must contain in appendices historical review information, such as questions and accepted responses, draft SE comments, and original report pages that were replaced. The accepted version shall include a "-A" (designated accepted) following the report identification symbol.

If the NRC's criteria or regulations change so that its conclusion in this letter, that the LTR is acceptable, are invalidated, the BWROG and/or the applicant referencing the LTR will be expected to revise and resubmit its respective documentation, or submit justification for the continued applicability of the LTR without revision of the respective documentation.

Sincerely,

/RA/

Herbert N. Berkow, Director
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 691

Enclosure: Safety Evaluation

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

LICENSING TOPICAL REPORT NEDO-33091, "IMPROVED BPWS CONTROL ROD INSERTION PROCESS"

BOILING WATER REACTOR OWNERS GROUP (BWROG)

PROJECT NO. 691

1.0 INTRODUCTION

By letter dated June 6, 2003, as supplemented by letter dated April 21, 2004, the BWROG requested the NRC to review its licensing topical report (TR) NEDO-33091, "Improved BPWS [Banked Position Withdraw Sequence] Control Rod Insertion Process." Both the original BPWS process previously approved by the staff and the proposed improved process, are designed to minimize reactivity insertion during a postulated design basis control rod drop accident (CRDA).

Throughout its operating cycle, a boiling water reactor (BWR) experiences various startup, normal, and shutdown operations. Control rods are also moved due to fuel burn-up, power maneuvers, and normal operational occurrences. This rod movement could potentially result in a decoupled control rod that's stuck in the core, followed by a subsequent control rod drop, which would lead to a high reactivity insertion in a small region of the core. For large loosely coupled cores, a significant shift in the spatial power generation could occur during the course of this excursion. Utilizing rod pattern control systems, i.e., rod worth minimizer, rod sequence control system or rod pattern controller, the BPWS was developed to reduce the maximum control rod worth during the startup and shutdown processes. The original/standard BPWS process currently requires control rods to be moved in banked positions, even during the shutdown process after the low power set point (LPSP) is reached. This requirement results in the control of rod movement through many steps, when there is an extremely low possibility for the control rod to drop out of the core. Therefore, the improved BPWS proposes the one-step full insertion of control rods without banking after the reactor power is below LPSP.

2.0 REGULATORY BASIS

CRDA is the design basis accident for the subject LTR. In order to minimize the impact of a CRDA, the BPWS process was developed to minimize control rod reactivity worth for BWR2-6. The proposed improved BPWS further simplifies the control rod insertion process, and in order to evaluate it, the staff followed the guidelines of Standard Review Plan Section 15.4.9, and referred to General Design Criterion 28 of Appendix A to 10 CFR Part 50 as its regulatory requirement.

3.0 TECHNICAL EVALUATION

The original/standard BPWS was developed to minimize the control rod worth and mitigate the consequences of a CRDA from occurring during startup. This procedure also directly applies to the control rod insertion sequence during the shutdown routine, after power is lower than the LPSP. The BWROG and GE Nuclear Energy (GENE) found that this approach, while conservative, requires unnecessary control rod movements during the shutdown process. The procedural requirements on the operator also increases the risk of incorrect control rod movement, and causes additional wear on the rod and rod drive hardware systems. Since the possibility of having a decoupled control rod is extremely low during the shutdown process, GENE is proposing the improved BPWS, which allows control rods to be fully inserted in a single step during the shutdown process.

The improved BPWS proposes the following changes to the operational procedures:

1. Before reducing power to the LPSP, operators shall confirm control rod coupling integrity for all rods that are fully withdrawn. Control rods that have not been confirmed coupled and are in intermediate positions must be fully inserted prior to power reduction to the LPSP. No action is required for fully-inserted control rods.

   If a shutdown is required and all rods, which are not confirmed coupled, cannot be fully inserted prior to the power dropping below the LPSP, then the original/standard BPWS must be adhered to.

2. After reactor power drops below the LPSP, rods may be inserted from notch position 48 to notch position 00 without stopping at intermediate positions. However, GENE recommends that operators should insert rods in the same order as specified for the original/standard BPWS as much as reasonably possible. If a plant is in the process of shutting down following improved BPWS with the power below the LPSP, no control rod shall be withdrawn unless the control rod pattern is in compliance with standard BPWS requirements.

All other control rod operational requirements are unchanged and continue to apply. The proposed changes may alter the technical specifications of certain plants; GENE has identified the potentially affected areas in the standard technical specifications. The specific changes for each plant implementing the improved BPWS will be determined on a case-by-case basis.

The basis of the improved BPWS is the assumption that a CRDA can only be caused by a stuck rod which is decoupled from the control rod drive (CRD). No single failure of a BWR CRD mechanical or hydraulic system can cause a control rod to drop completely out of the reactor core during the reactor shut-down process. In its April 21, 2004, response to the staff's request for additional information (RAI), the BWROG/GENE referred the staff to Final Safety Analysis Report (FSAR) sections, isometric drawings, and hydraulic schematics describing the CRD hydraulic unit design, control rod assembly configuration, and postulated CRD failure modes and effects scenarios from the FSARs for Oyster Creek (BWR/2), Monticello (BWR/3), Limerick (BWR/4), LaSalle (BWR/5), and Perry (BWR/6). The staff's review considered CRD hydraulic systems from plants of various BWR designs, and found that the CRD systems of BWR/2

through BWR/6 designs are very similar with respect to the mechanisms for rod insertion, withdrawal, and locking. The staff found that during a reactor shutdown process for all operating BWRs when each control rod is given an insert signal, there exists no single failure of the CRD hydraulic or mechanical system that could result in a control rod withdrawal out of the core of more than six inches (equivalent to one CRD index tube drive notch length). Therefore, the staff agrees with the BWROG/GENE's assessment regarding the possible cause of a CRDA during the shutdown process after reactor power is below the LPSP since the technical basis, as cited above, is sound and acceptable.

Implementation of the improved BPWS requires two major operating procedure changes. The requirement for operators to confirm control rod coupling integrity for all rods fully withdrawn will ensure proper coupling during the control rod insertion process and any possible rod withdrawal after reactor power drops below LPSP. The proposed procedure for the full insertion of all unconfirmed control rods prior to LPSP will prevent the possibility of a decoupled control rod dropping out during the control rod maneuvers. If all unconfirmed control rods cannot be fully inserted prior to the LPSP, the use of the standard BPWS will become the conservative fall back position, since the risk of a CRDA occurring using the improved BPWS will be no different than the original/standard BPWS using this procedure.

After reactor power drops below the LPSP, the improved BPWS allows the full insertion of each control rod without banking. This simplification of the control rod insertion process helps to reduce the number of control rod insertion steps. Since all unconfirmed control rods have been inserted, it is highly unlikely for a CRDA to occur while confirmed rods are being inserted without banking. Therefore, the improved BPWS will have the same level of safety assurance as the previously approved standard BPWS process. Should the operator decide to reverse the shutdown process, the improved BPWS does not allow for the withdrawal of any control rods, unless the control rod pattern meets the standard BPWS requirements. This ensures that all control rods are always banked for withdrawal.

The improved BPWS's single step full insertion also reduces the insertion time of each rod, which may induce a necessary increase in other procedures or processes to accommodate this rapid change. During telephone conferences, the staff requested additional information from the BWROG/GENE regarding the impact of the accelerated shut-down process on other procedures. The BWROG/GENE examined its process and requirements, and concluded in its RAI response on April 21, 2004, that the improved BPWS process does not adversely affect the normal shutdown processes, since the operating procedures will remain to be bounded by the most limiting (fastest negative reactivity) control rod insertion scenario (RAI #3). In addition, pressure-temperature effects, as in the cooldown process for example, are accounted for and controlled by controlling reactor dome pressure, coolant flow and coolant temperature.

4.0 CONCLUSIONS

The BWROG/GENE has proposed an improved BPWS process which allows for the single step full insertion of control rods during shutdown, when the reactor power is lower than the LPSP.

The staff has completed its review of the subject LTR, and concluded that the proposed change is acceptable and applicable to BWR/2-6 with original/standard BPWS already implemented. Plants electing to implement the improved BPWS must reflect the changes in their operating procedure. If the technical specification of a plant is impacted or needs to be updated, an amendment submittal to the NRC will be required.

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Date: June 16, 2004

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