

October 8, 2004

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

SUBJECT: FINAL SAFETY EVALUATION OF NEDC-33046, "TECHNICAL JUSTIFICATION TO SUPPORT RISK-INFORMED PRIMARY CONTAINMENT ISOLATION VALVE AOT EXTENSIONS FOR BWR PLANTS" (TAC NO. MB4595)

Dear Mr. Putnam:

On May 3, 2002, and its supplement dated July 30, 2003, the Boiling Water Reactors Owners Group (BWROG) submitted Licensing Topical Report (LTR) NEDC-33046, "Technical Justification to Support Risk-Informed Primary Containment Isolation Valve AOT Extensions for BWR Plants," to the staff. On August 12, 2004, an NRC draft safety evaluation (SE) regarding our approval of NEDC-33046 was provided for your review and comments. By letter dated September 10, 2004, the BWROG commented on the draft SE. The staff's disposition of the BWROG's comments on the draft SE are discussed in the attachment to the final SE enclosed with this letter.

The staff has found that LTR NEDC-33046, "Technical Justification to Support Risk-Informed Primary Containment Isolation Valve AOT Extensions for BWR Plants," is acceptable for referencing in licensing applications for boiling water reactors to the extent specified and under the limitations delineated in the TR and in the enclosed SE. The SE defines the basis for acceptance of the TR.

Our acceptance applies only to matters approved in the subject TR. We do not intend to repeat our review of the acceptable matters described in the TR. When the TR 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 TR will be subject to a plant-specific review in accordance with applicable review standards.

In accordance with the guidance provided on the NRC website, we request that the BWROG publish an accepted version of this TR 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 historical review information, such as questions and accepted responses, draft SE comments, and original TR pages that were replaced. The accepted version shall include a "-A" (designated accepted) following the report identification symbol.

K. Putnam

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If future changes to the NRC's regulatory requirements affect the acceptability of this TR, the BWROG and/or licensees referencing it will be expected to revise the TR appropriately, or justify its continued applicability for subsequent referencing.

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

K. Putnam

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cc:

Mr. Joseph E. Conen
Vice Chairman, BWR Owners Group
DTE Energy – Fermi 2
200 TAC
6400 N. Dixie Highway
Newport, MI 48166

Mr. J. A. Gray, Jr.
Regulatory Response Group Chairman
BWR Owners Group
Entergy Nuclear Northeast
440 Hamilton Avenue Mail Stop 12C
White Plains, NY 10601-5029

Mr. H. Lewis Sumner
Executive Chairman, BWROG
Southern Nuclear Company
40 Inverness Center Parkway
P.O. Box 1295
Birmingham, AL 35242

Mr. William Holston
Manager, Engineering Services
Nine Mile Point - Station
OPS Building/2nd Floor
P.O. Box 63
Lycoming, NY 13093

Mr. Thomas G. Hurst
GE Nuclear Energy
M/C 782
3901 Castle Hayne Road
Wilmington, NC 28402

Mr. Thomas A. Green
GE Nuclear Energy
M/C 782
175 Curtner Avenue
San Jose, CA 95125

Mr. James Meister
Executive Vice Chairman, BWROG
Exelon
Cornerstone II at Cantera
4300 Winfield Road
Warrenville, IL 60555

Mr. William A. Eaton
ENTERGY
P.O. Box 31995
Jackson, MS 39286

Mr. Aloysius Wrape
General Manager, Perform
Mail Code GENPL4
Two North Ninth Street
Allentown, PA 18101

Mr. Richard Libra
DTE Energy
Fermi 2
M/C 280 OBA
6400 North Dixie Highway
Newport, MI 48166

Mr. James F. Klapproth
GE Nuclear Energy
M/C A-16
3901 Castle Hayne Road
Wilmington, NC 28402

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
NEDC-33046, "TECHNICAL JUSTIFICATION TO SUPPORT RISK-INFORMED PRIMARY
CONTAINMENT ISOLATION VALVE AOT EXTENSIONS FOR BWR PLANTS"
BOILING WATER REACTOR OWNERS GROUP
PROJECT NO. 691

1.0 INTRODUCTION AND BACKGROUND

By letter dated May 3, 2002, as supplemented by letter dated July 30, 2003, the Boiling Water Reactors Owners Group (BWROG) submitted Licensing Topical Report (LTR) NEDC-33046, "Technical Justification to Support Risk-Informed Primary Containment Isolation Valve AOT Extensions for BWR Plants," for staff review. This LTR would support licensees' requests for changes to their technical specifications' (TS) allowed outage times (AOT) for primary containment isolation valves (PCIV). The supplement dated July 30, 2003, provided responses to the staff's request for additional information (RAI) and other clarifications.

The LTR provides a risk-informed justification for extending the PCIV AOTs from 4 and 72 hours to 7 days. The BWROG analysis includes a generic bounding risk assessment of the impact of adopting the proposed AOTs. The BWROG states that the proposed AOTs were developed using the guidance of Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," dated November 2002 and RG 1.177, "An Approach for Plant-Specific Risk-Informed Decisionmaking: Technical Specifications," dated August 1998.

The LTR is intended to provide for the performance of on-line testing, maintenance, and repair of PCIVs declared inoperable during Modes 1, 2, and 3. The scope of the analysis included all PCIVs except the main steam isolation valves (MSIV) and the PCIVs in the feedwater system. The BWROG stated the proposed changes have merit based on the low risk associated with the extended AOTs and provide additional flexibility in the performance of preventive and corrective maintenance during power operation and reduce the potential for plant shutdown.

The proposed AOT revision is applicable to PCIVs associated with the standard technical specifications (STS) NUREG-1433, "Standard Technical Specifications General Electric Plants, BWR/4," Revision 2, dated June 2001, or Section 3.6, "Containment Systems," of NUREG-1434, "Standard Technical Specification General Electric Plants, BWR/6," Revision 2, dated June 2001. More specifically, the LTR applies to limiting condition for operation (LCO) 3.6.1.3, "Primary Containment Isolation Valves." NEDC-33046 did not include an evaluation to extend secondary containment isolation valves and dampers.

Of the conditions identified in LCO 3.6.1.3, only conditions A, C, and E were evaluated by NEDC-33046. The risk impact of two PCIVs inoperable in a penetration was not evaluated by the LTR (Condition B). The AOT for this configuration is generally limited by an LCO to an AOT of one hour and remains unchanged by topical report NEDC-33046. In addition, for some boiling water reactors (BWRs), LCO 3.6.1.3 may also include the containment pressure boundary functional requirements for valves that are also included in accident mitigation systems. Dual function PCIVs that function as containment pressure boundaries and serve in accident mitigation capacity were evaluated only with regard to the valve impact on loss of containment isolation. The impact of PCIV operability on other TS functions was not evaluated with respect to their affected systems in this LTR.

Based on the BWROG evaluation, PCIVs excluded from the analysis include valves associated with the main feedwater system and the MSIVs. The LTR concludes that low pressure core spray PCIVs for BWR 5/6 plants and the shutdown cooling suction PCIVs for all BWRs did not meet the extended AOT acceptance guidelines of RG 1.174 and 1.177 and therefore are not part of this LTR's request for PCIV AOT extension. In addition, based on responses to the staff's RAI and additional evaluation, the BWROG withdrew the proposed 7-day AOT extension request for TS 3.6.1.3 Condition E, "One or more penetration flow paths with one or more containment purge valves not within purge valve leakage limits." However, the BWROG's July 30, 2003, RAI response also noted that the analysis for Condition C, "One or more penetration flow paths with one PCIV inoperable [for reasons other than Condition[s] D [and E]]" supported an AOT extension for excess flow check valve (EFCV) PCIVs included in Condition D. Therefore Condition D EFCV PCIVs are included in the scope of this LTR. The completion times for other Condition D PCIVs are not revised.

Although NEDC-33046 references the term AOT as used in the STS, the LCO markups included in the LTR utilize the improved standard STS that incorporates the term completion time (CT). The AOT is a general reference to the time given to accomplish a TS required action. To have a more specific meaning, AOT can refer to additional time for repair, bypass, shutdown, etc. A CT as used in the improved STS has a broader meaning than an AOT, by also defining the time for other required actions such as equipment status or plant mode changes. The CT is intended to allow sufficient time to repair failed equipment while minimizing the risk associated with the loss of the component function. The term AOT appears to be used interchangeably with the term CT as applied by the LTR.

2.0 REGULATORY EVALUATION

PCIVs help ensure that adequate primary containment boundaries are maintained during and after accidents by minimizing potential paths to the environment, and that the primary containment function assumed in the safety analysis is maintained. Two barriers (one may be a closed system) in series are provided for each penetration so that no credible single failure of an active component can result in a loss of isolation or leakage that exceeds the limits assumed in the safety analysis. The associated LCO in the STS ensures that the PCIVs will perform their design safety functions to minimize the loss of reactor coolant inventory and establish a containment boundary during an accident.

NUREG-1433 and NUREG-1434 state that the function of the PCIVs, in combination with other accident mitigation systems, is to limit fission product release during and following design basis accidents (DBAs) to within limits. Primary containment isolation within the time limits specified for PCIVs designed to close automatically ensures that release of radioactive material to the environment is consistent with assumptions used in the DBA analysis.

NUREG-1433 and NUREG-1434 also list the DBAs that result in release of radioactive material for which consequences are mitigated by PCIVs: loss of coolant accident (LOCA), main steam line break (MSLB), and fuel handling accident inside primary containment. For each of these accidents, it is assumed that PCIVs are either closed or in transition to close within the required isolation time following accident initiation, which ensures that potential paths to the environment are minimized.

2.1 Applicable Regulations

Title 10, Section 50.36, of the *Code of Federal Regulations* (10 CFR 50.36) requires that all operating licenses for nuclear reactors must include the TS for the subject plant. The LCO, along with the required AOTs are specified for each system included in the TS.

Appendix A of 10 CFR Part 50 - General Design Criterion (GDC) 55, "Reactor Coolant Pressure Boundary Penetrating Containment," requires that each line that is part of the reactor coolant pressure boundary and that penetrates primary containment shall be provided with containment isolation valves.

Appendix A of 10 CFR Part 50 - GDC 56, "Primary Containment Isolation," requires that each line that connects directly to the containment atmosphere and penetrates primary reactor containment shall be provided with containment isolation valves.

Maintenance Rule, 10 CFR 50.65(a)(4), as it relates to the proposed PCIV AOT configuration, requires the assessment and management of the increase in risk that may result from the proposed maintenance activity.

2.2 Applicable Regulatory Criteria/Guidelines

General guidance for evaluating the technical basis of proposed risk-informed changes is provided in Chapter 19.0 of the NRC Standard Review Plan (SRP), NUREG-0800. More specific guidance related to risk-informed TS changes is provided in SRP Section 16.1, "Risk-Informed Decisionmaking: Technical Specifications," which includes AOT changes as part of risk-informed decisionmaking. Chapter 19.0 of the SRP states that a risk-informed application should be evaluated to ensure that the proposed changes meet the following key principles:

- The proposed change meets the current regulations, unless it explicitly relates to a requested exemption or rule change.
- The proposed change is consistent with the defense-in-depth philosophy.
- The proposed change maintains sufficient safety margins.

- When proposed changes increase core damage frequency or risk, the increase(s) should be small and consistent with the intent of the Commission's Safety Goal Policy Statement.
- The impact of the proposed change should be monitored using performance measurement strategies.

RG 1.174 and RG 1.177 provide specific guidance and acceptance guidelines for assessing the nature and impact of licensing-basis changes, including proposed permanent TS changes in AOTs by considering engineering issues and applying risk insights. RG 1.177 identifies an acceptable risk-informed approach including additional guidance specifically geared toward the assessment of proposed TS AOT changes. Specifically, RG 1.177 identifies a three-tiered approach for the evaluation of the risk associated with a proposed AOT TS change as identified below.

- Tier 1 is an evaluation of the plant-specific risk associated with the proposed TS change, as shown by the change in core damage frequency (CDF) and incremental conditional core damage probability (ICCDP). Where applicable, containment performance should be evaluated on the basis of an analysis of large early release frequency (LERF) and incremental conditional large early release frequency (ICLERP).
- Tier 2 identifies and evaluates, with respect to defense-in-depth, any potential risk-significant plant equipment outage configurations associated with the proposed change. The licensee should provide reasonable assurance the risk-significant plant equipment outage configurations will not occur when equipment associated with the proposed TS change is out-of-service.
- Tier 3 provides for the establishment of an overall configuration risk management program (CRMP) and confirmation that its insights are incorporated into the decisionmaking process before taking equipment out-of-service prior to or during the AOT. Compared with Tier 2, Tier 3 provides additional coverage based on any additional risk-significant configurations that may be encountered during maintenance scheduling over extended periods of plant operation. Tier 3 guidance can be satisfied by the Maintenance Rule (10 CFR 50.65(a)(4)), which requires a licensee to assess and manage the increase in risk that may result from activities such as surveillance, testing, and corrective and preventive maintenance.

3.0 TECHNICAL EVALUATION

3.1 Detailed Description of the Proposed Change

The LTR's assessment of the risk impact for the proposed changes to extend PCIV AOTS to 7 days during Modes 1, 2, and 3 follows the guidance of RGs 1.177 and 1.174, and includes the evaluation of the ICCDP and ICLERP for valves left in the open position during the proposed AOT. The BWROG's evaluation also includes interfacing system LOCA (ISLOCA) for valves connected to the reactor coolant system (RCS). The LTR evaluates the ICCDP for valves left in the closed position that have dual functions of containment isolation and accident consequences mitigation. The BWROG considered the risk impact of PCIVs installed in

systems with non-seismically qualified piping. In addition, since TS LCO 3.6.1.3 Note 2 allows separate condition entry for each penetration flow path, multiple LCO entries were considered in the LTR.

NEDC-33046 uses a process to assess plant risk that involved the grouping of PCIVs and the associated penetrations in generic classes. Each class was then further divided in subgroups of generic configurations. The BWROG did not perform a plant-specific AOT risk evaluation, but instead selected risk parameters identified as bounding. The risk parameters selected represent a composite plant and are considered bounding values based on data from 25 BWROG member utilities. The risk impact of each configuration was determined by applying the proposed seven day AOT and using the bounding risk parameters for each LCO. The evaluations determined the risk impact on CDF, ICCDP, LERF, and ICLERP with one PCIV inoperable within a penetration for the seven day AOT. The AOT risk is referred to as the single AOT risk and represents the probability of core damage while the PCIV is in the LCO configuration for the specified AOT. The resulting value represents the risk increase while in a seven day PCIV AOT.

The parameters used by the BWROG in the calculation of ICCDP and ICLERP are included in the table below.

| Risk Parameter Values Used for Calculation of ICCDP and ICLERP | | |
|---|---------|---|
| Parameter | Value | Comments |
| Plant core damage (per year) | 5.56E-5 | Bounding CDF value based on most limiting BWROG plant referenced in NEDC-33046 |
| LERF (per year) | 4.27E-6 | Bounding LERF value based on most limiting BWROG plant referenced in NEDC-33046 |
| Conditional core damage probability due to small LOCA | 9.00E-5 | Bounding value |
| Conditional core damage probability due to intermediate LOCA | 5.50E-3 | Bounding value |
| Conditional core damage probability due to a turbine trip | 8.93E-6 | Bounding value |
| CDF due to seismic event (per year) | 2.10E-5 | Bounding CDF value based on most limiting BWROG plant referenced in NEDC-33046 |
| CDF due to a seismic small LOCA event (per year) | 2.31E-7 | Bounding CDF value based on most limiting BWROG plant referenced in NEDC-33046 |
| CDF due to a seismic intermediate LOCA event (per year) | 1.0E-7 | Bounding CDF value based on most limiting BWROG plant referenced in NEDC-33046 |

The BWROG evaluation uses the maximum failure rate and failure probability regardless of valve type in an attempt to bound all valve types. The selected values are identified in bold, as seen in the table below.

| Valve Type | Failure to Close (/demand) | Failure to remain Closed (/hour) | Failure Probability During AOT |
|-----------------------|----------------------------|----------------------------------|--------------------------------|
| Air Operated Valve | 2.00E-3 | 1.40E-5 | 2.35E-3 |
| Motor Operated Valve | 2.70E-3 | 7.70E-7 | 1.29E-4 |
| Solenoid Valve | 1.10E-3 | 1.70E-5 | 2.86E-3 |
| Check Valve | 1.20E-3 | 2.20E-6 | 3.70E-4 |
| Pressure Relief Valve | N/A | 2.2E-6 | 3.70E-4 |

As stated above, the LTR grouped PCIVs and their associated penetrations into generic classes based on the type of containment flow path. The result was a list of five generic classes designated A through E which were broken down into smaller class types with a separate risk analysis performed for each.

The following PCIV flow paths were evaluated:

Class A

Penetration is connected directly to the containment atmosphere, or connected to non-seismically qualified piping that interfaces with the containment atmosphere.

- Penetrations connected directly to containment atmosphere and outside environment.
- Penetrations connected directly to containment atmosphere and a closed loop system outside containment.
- Penetrations connected directly to containment atmosphere and an open loop system outside containment.

Class B

Penetration is connected to the RCS but fluid flow is not generally required to accomplish or support safety functions.

- Penetrations used to obtain sample from the reactor coolant.

- Penetrations used to provide reactor water cleanup (RWCU) flow.

Class C

Penetration is connected to closed loop piping inside and outside containment.

- Penetrations connected to non-essential containment cooling units (PCIVs outside containment and closed loop inside containment).
- Penetrations connected to non-essential containment cooling units (PCIVs inside and outside containment).

Class D

Penetration is connected to containment atmosphere and a detector outside containment.

- Sample lines.
- Air and Instrumentation lines.

Class E

Penetration is designed to open during a design basis event.

- Penetrations used to support reactor coolant inventory control safety function.
- Penetrations used to support containment heat removal safety function.
- PCIVs in penetrations connected to the suppression pool.

With respect to Class E, the LTR states that low pressure core spray (LPCS) isolation valves for BWR5/6 and shutdown cooling suction valves for all BWRs do not meet the LTR's acceptability criteria and hence are not included in the BWROG PCIV AOT extension request. For the rest of the emergency core cooling system (ECCS) safety injection isolation valves (low pressure coolant injection/low pressure core spray/high pressure coolant injection/high pressure core spray), the unavailability of one safety injection flow path will not compromise the ability of the ECCS to mitigate a LOCA. While inoperability of one single train safety injection isolation valve to open may render the single train inoperable, the rest of the ECCS system remains capable of meeting the LOCA event mitigation.

NEDC-33046 includes general assumptions in estimating the risk impact for the proposed PCIV AOT extensions as shown below.

- The proposed AOT is assumed to be adequate to perform expected PCIV maintenance. The BWROG stated that as a result, the risk from a forced shutdown because of insufficient time to repair would be minimal.

- The BWROG also assumes that risk contribution of a failure of the penetration piping during the proposed AOT would be negligible based on the limited piping length involved.
- The analysis assumes that the CDF due to containment bypass events would be negligible in relation to the total CDF. For this evaluation, a value of zero was assumed which is conservative due to the BWROG methodology, i.e., in that the overall base CDF is used in the analysis.
- The BWROG data used in the analysis of extended PCIV AOT times uses a bounding input value that was selected from a population of 25 BWR plants.
- One PCIV is assumed inoperable for a penetration and is assumed to be detected during surveillance or valve operation. The inoperable PCIV is assumed to be in the open position and the unaffected PCIV (if the penetration is so equipped) is evaluated to ensure that it is operable.
- Failures (including failure to close on demand, failure to remain closed, and failure probability during the AOT) for different valve types were evaluated. The LTR selected the maximum value for each parameter regardless of valve type.
- Pipe failures not related to a seismic event were assumed to occur randomly. The frequency of a pipe break was selected based on a review of NUREG/CR-4407, "Pipe Break Frequency Estimation for Nuclear Power Plants," dated February 1989 and WASH-1400, "Reactor Safety Study." The BWROG also considered the probability of pipe failure (without ISLOCA) given in NUREG/CR-5124, "Interfacing Systems LOCA: Boiling Water Reactors." The BWROG assumed that there would be 100 pipe sections for the piping under consideration. The most conservative pipe failure probability of the three references was used in the analysis.
- Non-seismically qualified piping was assumed to fail with a probability of one.
- The BWROG states that because of the bounding nature of the seven day AOT evaluation, the impact on average CDF due to increased PCIV unavailability was not evaluated in the LTR.
- No credit was taken for scrubbing (suppression pool scrubbing) from the wetwell.
- In general, for open piping systems outside containment, it is assumed that there are multiple valves in the flow path that can be credited for isolating the pathway. Multiple valve failures were assumed to be a low probability event.
- The LTR assumes that the penetration remains intact and integrity is maintained.
- When maintenance is performed on a PCIV, the BWROG assumed that the pressure boundary would not be broken for more than the current AOT (4 or 72 hours) and is to be controlled by the maintenance rule (10 CFR 50.65(a)(4)).

3.2 Review of Methodology

The staff reviewed the BWROG's submittal using the three-tiered approach referenced in RG 1.174, RG 1.177, and SRP Chapter 16.1.

The first tier includes assessing the risk impact of the proposed change in accordance with acceptance guidelines consistent with the Commission's Safety Goal Policy Statement, as documented in RG 1.174 and RG 1.177. The first tier assesses the impact on operational plant risk based on the change in CDF (Δ CDF) and change in LERF (Δ LERF). It also evaluates plant risk while equipment covered by the proposed AOT is out of service, as represented by the ICCDP and ICLERP. In addition, Tier 1 should establish whether the quality of the PRA is compatible with the safety implications of the proposed TS change and that the scope and level of the PRA are adequate to fully support evaluation of the TS change. Cumulative risk of the present TS change in light of past applications or additional applications under review are also considered along with uncertainty/sensitivity analysis with respect to the assumptions related to the proposed TS change.

The second tier involves identifying potential high-risk configurations that may exist if other equipment or systems (in addition to the equipment associated with the proposed change) were also taken out-of-service simultaneously, or subjected to concurrent testing. The purpose of the Tier 2 evaluation is to ensure that appropriate restrictions will be in place to prevent the occurrence of such high-risk configurations.

The third tier establishes a risk management program for the overall configuration and confirms that risk insights are incorporated into the decisionmaking process before taking equipment out-of-service prior to or during the AOT. The third tier provides additional assurance over the second tier by identifying risk-significant configurations that may be encountered over extended periods of plant operation. Licensees can implement the overall configuration risk management program (as referenced in RG 1.177) through the maintenance rule of 10 CFR 50.65(a)(4). Specifically, the rule requires that, before performing any maintenance activity, the licensee must assess and manage the potential risk increase that may result from a proposed maintenance activity.

The subsections below describe each tier and the associated reviews.

3.3 Technical Evaluation

For the quantitative evaluation of the risk impact of extending the current PCIV AOT from 4, or 72 hours to a proposed duration of 7 days, the BWROG developed a methodology to group various containment penetrations into defined classes. For each defined class, the BWROG developed generic configurations of containment penetrations to assess the impact on the plant at power risk utilizing the proposed seven day AOT for the associated penetration PCIVs.

3.3.1 Tier 1: PRA Applicability and Insights

The analyses used in NEDC-33046 are generic, therefore, each licensee requesting PCIV AOT extensions will need to justify the applicability of the LTR results to their particular plant. A plant-specific analysis must be performed to ensure the applicability of NEDC-33046 conclusions with respect to the risk impact of extending the AOTs for inoperable PCIVs.

The licensee's analysis must be applied to penetrations analyzed in NEDC-33046. Any additional penetrations must be included in the licensee's analysis.

3.3.1.1 PRA Applicability

The objective of the PRA review is to determine whether the generic risk assessments used in evaluating the proposed PCIV extended AOTs were of sufficient scope and detail. The staff reviewed the information provided in NEDC-33046 and based on the above discussion, the staff concludes that the BWROG adequately addressed the issue of capability, and the risk analysis was of sufficient scope and detail to estimate the risk measures associated with the proposed PCIV extended AOTs on a generic basis.

To ensure the applicability of NEDC-33046 to a licensee's plant, additional information on PRA quality will be required by the staff in the following areas.

1. The plant-specific PRA reflects the as-built, as-operated plant.
2. Applicable PRA updates.
3. Conclusions of the peer review including facts and observations applicable to the proposed PCIV extended AOTs.
4. PRA quality assurance programs/procedures.
5. PRA adequacy and completeness with respect to evaluating the proposed PCIV AOT extension risk.
6. RG 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," for trial use. Although intended for trial use in a pilot program to finalize staff guidance on PRA quality, guidance is provided to address PRA technical adequacy that licensees may find useful in the application of NEDC-33046.

3.3.1.2 PRA Insights

One approach to demonstrate that the risk impact of the proposed change is acceptable is to show that the licensing basis meets the key principles set forth in RG 1.174 for the proposed change. One of these principles is to show that when the proposed change results in an increase in CDF or risk, the increased risk is small. In addition, the impact of the proposed change should be monitored using performance measurement strategies. RG 1.174 and RG 1.177 provide acceptance guidelines for meeting the above principles. Specifically, those guidelines include Δ CDF, Δ LERF, ICCDP, and ICLERP. The risk metrics ICCDP and ICLERP suggested by RG 1.177 are used in addition to the metrics outlined in RG 1.174 for the evaluation of AOTs because AOTs are entered infrequently and are temporary in nature.

The risk impact of extending PCIV AOTs is summarized in Table 6.3-3 of the LTR. The results show that the risk impact of the proposed PCIV AOTs are within the ICCDP and ICLERP acceptance guidelines of $5.0E-7$ and $5.0E-8$, respectively. As stated previously, because of the bounding nature of the seven day AOT evaluation, the impact on average CDF due to

increased PCIV unavailability was not specifically evaluated by NEDC-33046. Although the LTR results are stated as bounding, plant-specific analyses must be performed to ensure the applicability of NEDC-33046 with respect to Δ CDF, Δ LERF, ICCDP, and ICLERP for PCIV penetration flow paths. In addition, licensees must provide an evaluation of external event risk, either quantitative or qualitative, which demonstrates that external events will not have an adverse impact on the conclusions of the plant-specific analyses.

3.3.1.3 PRA Uncertainty

As discussed in RG 1.174 and NUREG/CR-6141, "Handbook of Methods for Risk-Based Analyses of Technical Specifications," a licensee can perform sensitivity studies to provide additional insights into the uncertainties related to the proposed AOT extension and demonstrate compliance with the guidelines and evaluate uncertainties related to modeling and completeness issues.

Based on the bounding values used in the analysis, the BWROG did not provide a discussion or provide sensitivity studies with respect to the AOT extension risk analysis. However, based on the LTR's use of bounding values for input parameters, a sensitivity analysis using an upper bound should be inherent in the results. As a further check, the staff reviewed NUREG-1715, "Component Performance Study-Motor-Driven Pumps, 1987-1998 Commercial Power Reactors," data for motor-operated and air-operated valve failures on demand. The data was based on operating experience from 1987 through 2002. Although limited to motor-operated valves and air-operated valves, the data presented in NUREG-1715 shows that the PCIV demand failure probability used by the LTR bounds the range of values given in NUREG-1715. NUREG-1715 also indicated a decreasing trend for failure on demand within the industry with regard to motor-operated valve and air-operated valves. Additionally, based on the LTR's results for ICLERP and ICCDP, a 10 percent change in any parameter should not adversely affect the results stated in the LTR, which are generally a magnitude lower than the RG 1.177 acceptance guidelines. Based on the above, the results obtained by the BWROG are expected to be bounding, though this must be confirmed by plant-specific analysis.

3.3.2 Tier 2: Avoidance of Risk-Significant Plant Configurations

For the Tier 2 analysis a licensee must provide reasonable assurance that risk significant plant equipment outage configurations will not occur when specific plant equipment is out-of-service in accordance with the proposed TS change. A Tier 2 program is intended to limit the degradation of plant mitigation capabilities with a PCIV out of service (LCO condition) such that defense-in-depth is maintained. The LTR evaluation identified no generic Tier 2 conditions as a result of the proposed AOT extension for PCIVs. For licensees adopting NEDC-33046, an evaluation should be performed to confirm that the conclusions of the LTR remain applicable to the licensee's plant.

The LTR notes that the STS allows multiple simultaneous entries (see Section 3.6.1.3) into the LCO, but not for multiple PCIVs associated with the same flow path. However, multiple entries for PCIVs associated with the proposed AOT change would result in increased CDF, LERF, ICCDP and ICLERP values from that assumed in the LTR. Simultaneous multiple entries and the subsequent impact on risk were not specifically evaluated by the BWROG, but the LTR did state that based on the low level of risk identified, a number of multiple simultaneous entries would not be expected to exceed the ICLERP guideline of 5E-8. The BWROG also stated that

plant implementation of the maintenance rule (10 CFR 50.65) would limit the overall risk associated with PCIV maintenance by controlling the cumulative risk of multiple PCIVs in an LCO and the associated boundary in maintenance. However, multiple simultaneous LCO entries for PCIVs must be evaluated on a plant-specific basis such that the risk impact assumptions of the LTR remain valid including CDF, LERF, ICCDP and ICLERP. BWROG member utilities have committed to assess the risk associated with PCIV maintenance, and to develop cumulative unavailability targets for PCIVs within the scope of the maintenance rule of 10 CFR 50.65(a)(4). However, in addition to cumulative availability targets, multiple simultaneous entries into the LCO must also confirm that CDF, LERF, ICCDP and ICLERP are less than the RG 1.174 and 1.177 guidelines and consistent with the guidance contained in NUMARC 93.01, "Industry Guidelines for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," Section 11, "Assessment of Risk Resulting from Performance of Maintenance Activities" as endorsed by RG 1.182, "Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants."

3.3.3 Tier 3: Risk-Informed Configuration Risk Management

RG 1.177 states that a licensee should develop a program to ensure that the risk impact of out-of-service equipment is appropriately evaluated before a maintenance activity is performed. RG 1.174 states that monitoring performed in conformance with the maintenance rule of 10 CFR 50.65 can be used when such monitoring is sufficient for the structures, systems and components affected by the risk-informed application. A licensee's submittal must include a discussion on the licensee's CRMP for assessing the risk associated with removal of PCIVs from service and their conformance to the requirements of 10 CFR 50.65(a)(4), as they relate to the proposed PCIV AOTs. The discussion must also include the subject of multiple PCIV AOTs while maintaining conformance to the assumptions outlined in NEDC-33046.

A Tier 3 program ensures that while a PCIV is in an LCO condition, additional activities will not be performed that could further degrade the capability of the plant to respond to a condition the inoperable PCIV or system was designed to mitigate, and as a result, increase plant risk beyond that assumed by the LTR analysis. Tier 3 programs, as implemented by the maintenance rule of 10 CFR 50.65(a)(4) during PCIV maintenance: (1) ensure that additional maintenance does not increase the likelihood of an initiating event intended to be mitigated by the out-of-service equipment, (2) evaluate the effects of additional equipment out-of-service during PCIV maintenance activities that would adversely impact PCIV AOT risk such as from redundant systems or components, and (3) evaluate the impact of maintenance on equipment or systems assumed to remain operable by the PCIV AOT analysis. Because NEDC-33046 was based on generic plant characteristics, each licensee adopting the LTR must furnish plant-specific Tier 3 information in their individual submittals.

3.4 Staff Findings and Conditions

The results presented in NEDC-33046 are consistent with the acceptance guidelines given in RG 1.177 and 1.174 and show a small increase in plant risk due to the extension of PCIV AOTs to 7 days. This conclusion is predicated on adopting the topical report in a manner consistent with the NRC staff safety evaluation findings and the guidelines and assumptions identified in NEDC-33046. In addition, the following conditions provide guidance for future submittals by licensees wishing to extend PCIV AOTs:

1. Because not all penetrations have the same impact on CDF, LERF, ICCDP, or ICLERP, a licensee's application verifies the applicability of NEDC-33046, including verification that the PCIV configurations for the specific plant match the LTR and the risk parameter values used in the LTR are bounding for the specific plant. Any additional PCIV configurations or non-bounding risk parameter values not evaluated by the LTR should be included in the licensee's plant-specific analysis. [Note that PCIV configurations or non-bounding risk parameter values outside the scope of the LTR will require staff review of the specific penetrations and related justifications for the proposed completion times.]
2. The licensee's application verifies that external event risk, either through quantitative or qualitative evaluation, will not have an adverse impact on the conclusions of the plant-specific analysis for extending the PCIV AOTs.
3. The licensee verifies conformance to the requirements of the maintenance rule (10 CFR 50.65(a)(4)), as they relate to the proposed PCIV AOTs and the guidance contained in NUMARC 93.01, Section 11, as endorsed by RG 1.182, including verification that the licensee's maintenance rule program includes a LERF assessment as part of the maintenance rule process.
4. The licensee's application verifies that a penetration remains intact during maintenance activities, including corrective maintenance activities. Regarding maintenance activities where the pressure boundary would be broken, the licensee confirms that the assumptions and results of the LTR remain valid. This includes the assumption that maintenance on a PCIV will not break the pressure boundary for more than the currently allowed AOT.
5. The licensee's application verifies the operability of the remaining PCIVs in the applicable penetration flow path before entering the AOT for the inoperable PCIV.
6. Since the STS allows separate condition entry for each penetration flow path, the licensee's application verifies that the potential for any cumulative risk impact of failed PCIVs and multiple PCIV LCO entries has been evaluated and is acceptable. The licensee's Tier 3 risk management program (10 CFR 50.65(a)(4)) confirms that multiple simultaneous entries into the LCO do not exceed the RG 1.174 and RG 1.177 guidelines and that defense-in-depth for safety systems is maintained.
7. The licensee shall verify that the plant specific PRA quality is acceptable for this application in accordance with the guidelines given in RG 1.174.

3.5 Topical Report Revisions

Based on the BWROG's July 30, 2003, RAI responses, the following revisions to NEDC-33046 have been implemented:

- RAI response, Question 5. Page 6-34, the first paragraph is revised to clarify the term "acceptable limit."
- RAI response, Question 9. On page 6-42 an editorial correction is made.

- RAI response, Question 10. Section 5.2.1 provides clarification that the risk evaluation is based on a single AOT of 168 hours per year.
- RAI response, Question 16. On page 6-9, Assumption n is deleted.
- RAI response, Question 17.a. Page 5-2, Section 5.1 provides clarification that the probability of failure of the closed loop piping system is deemed negligible.
- RAI response, Question 18. Page 6-1, Section 6.1, Section 6.3.2.1a, Abstract, Purpose, Section 2.1, Section 4.1, Section 6.3.2.4 provides additional clarification of the scope of the LTR.
- RAI response, Question 20. Page 6.2, ECCS isolation valves provide clarification on subsystem operability and ECCS operability with regard to an inoperable safety injection isolation valve.
- RAI response, Question 25. Clarification will be provided to have a licensee confirm that PCIV configurations and PRA results remain bounding for a licensee's submittal.
- RAI response, Question 26. A statement will be added that the proposed AOT changes do not apply to an open system with a single PCIV.
- RAI response, Question 27. Revises the LTR to withdraw the proposed 7-day AOT for TS 3.6.1.3 Condition E. In addition, Condition D with applicability to only EFCVs is added to the scope of the LTR.
- RAI response. Table 6.3-3, page 6-47 corrects the ICCDP and ICLERP risk ratios listed in the table.
- RAI response. On page 6-40, the last paragraph changes the wording "This configuration DOES NOT MEET either acceptance criteria" to "This configuration DOES NOT MEET the acceptance guideline for ICLERP."
- RAI response. Page 6-11, Figure 6.3-1 and page 6-20, Figure 6.3-4 are corrected to show normally closed valves.

3.6 Regulatory Commitment

The RG 1.177 Tier 3 program ensures that while a PCIV is in an LCO condition, additional activities will not be performed that could further degrade the capabilities of the plant to respond to a condition the inoperable PCIV or system was designed to mitigate, and as a result, increase plant risk beyond that assumed by the LTR analysis. A licensee's implementation of RG 1.177 Tier 3 guidelines generally implies the assessment of risk with respect to CDF. However, the proposed PCIV AOT impacts containment isolation and consequently LERF as well as CDF. Therefore, a licensee's CRMP, including those implemented under the maintenance rule of 10 CFR 50.65(a)(4), must be enhanced to include a LERF assessment and must be documented in a licensee's plant-specific submittal.

4.0 CONCLUSION

The risk impact of the proposed 7-day AOT for the PCIV as estimated by CDF, LERF, ICCDP, and ICLERP, is consistent with the acceptance guidelines specified in RG 1.174, RG 1.177, and staff guidance outlined in Chapter 16.1 of NUREG-0800. The staff finds that the risk analysis methodology and approach used by the BWROG to estimate the risk impacts were reasonable and of sufficient quality. The Tier 2 evaluation did not identify any risk-significant plant equipment configurations requiring TS, procedure, or compensatory measures on a generic basis, but a plant-specific analysis must be done for plants adopting NEDC-33046 to confirm or adjust this aspect of the evaluation, as appropriate. NEDC-33046 implements a configuration risk management program (Tier 3) using 10 CFR 50.65(a)(4) to manage plant risk when PCIVs are taken out-of-service. PCIV reliability and availability will also be monitored and assessed under the maintenance rule (10 CFR 50.65) to confirm that performance continues to be consistent with the analysis assumptions used to justify extended PCIVs AOTs. The conditions identified in Sections 3.4 and 3.6 must also be addressed by licensees adopting NEDC-33046. Based on the above, the staff finds that the proposed seven day AOT is acceptable for the PCIVs as described in NEDC-33046.

Attachment: Resolution of Comments

Principal Contributor: C. Doult

Date: October 8, 2004

RESOLUTION OF COMMENTS

ON DRAFT SAFETY EVALUATION FOR TOPICAL REPORT

NEDC-33046. "TECHNICAL JUSTIFICATION TO SUPPORT RISK-INFORMED PRIMARY CONTAINMENT ISOLATION VALVE AOT EXTENSIONS FOR BWR PLANTS"

By letter dated September 10, 2004, the Boiling Water Reactors Owners Group (BWROG) commented on the draft safety evaluation for Licensing Topical Report (LTR) NEDC-33046, "Technical Justification to Support Risk-Informed Primary Containment Isolation Valve AOT Extensions for BWR Plants." The following is the staff's resolution of those comments.

1. BWROG Comment: Page 13, Section 3.4, "Staff Findings and Conditions," Condition 1 – The BWROG stated that "licensees will assess 1) their plant valve configurations for compliance with those of the topical report, and 2) their plant specific risk values against Tables 6.3-1 and 6.3-2 of the topical report."

BWROG Proposed Resolution: Revise Condition 1 to read, "Because not all penetrations have the same impact on CDF, LERF, ICCDP, or ICLERP, a licensee's application verifies the applicability of NEDC 33046, including verification that the PCIV configurations for the specific plant match the LTR and the risk parameter values used in the LTR are bounding for the specific plant. Any additional PCIV configurations or non-bounding risk parameter values not evaluated by the LTR should be included in the licensee's plant specific analysis. (Note that PCIV configurations or non bounding risk parameter values outside the scope of the LTR will require staff review of the specific penetrations and related justifications for the proposed completion times)."

NRC Action: The comment was fully adopted into the final SE.

2. BWROG Comment: Page 13, Section 3.4, "Staff Findings and Conditions," Condition 3 – "The BWROG pointed out to the Staff during the conference call that no components could be taken out of service for maintenance without a specific risk evaluation as required by current regulation [10 CFR05.65 (a)(4)]. If the Staff desires a declarative statement regarding compliance to the maintenance rule and Regulatory Guide 1.182, licensees can accommodate such a statement. The BWROG understood as a result of the conference call that commitment to Regulatory Guide 1.182 was all that the Staff had in mind as a CRMP, and therefore, the concept of CRMP can be eliminated. It was also pointed out that PCIV AOT LERF assessments were not required of the CEOG."

BWROG Proposed Resolution: The BWROG suggests that the last sentence of bullet No. 3 be eliminated.

NRC Action: The staff agrees that implementation of 10 CFR 50.65(a)(4) provides for configuration risk management. The LTR states that no Tier 2 conditions were noted that were not already prohibited under TS 3.6.1.3. Based on this, the Tier 2 reference can be deleted.

However, the maintenance rule (10 CFR 50.65(a)(4)) states that a licensee shall assess and manage the increase in risk that may result from proposed maintenance activities. For PCIVs, the risk metric should include LERF which is consistent with NUMARC 93.01, Section 11 (RG 1.182). Based on this, the second part of Condition 3 should stay. This is consistent with the August 27, 2004, phone call with the BWROG. Wording for Condition 3 is revised as follows: "The licensee verifies conformance to the requirements of the maintenance rule (10 CFR 50.65(a)(4)), as they relate to the proposed PCIV AOTs and the guidance contained in NUMARC 93.01, Section 11, as endorsed by RG 1.182, including verification that the licensee's maintenance rule program includes a LERF assessment as part of the maintenance rule process."

3. BWROG Comment: Page 13, Section 3.4, "Staff Findings and Conditions," Condition 4 – The BWROG stated, "as discussed during the conference call, present Technical Specifications (3.6.1.1) already partially addresses this Staff request. The requirement is restated to be consistent with the CEOG requirement addressing Staff common cause concerns."

BWROG Proposed Resolution: Revise Condition 4 to read, "The licensee's application verifies the OPERABILITY of the remaining PCIV(s) in the applicable penetration flow path before entering the Completion Time for the inoperable PCIV."

NRC Action: The staff will split this condition into two parts (Condition 4 and Condition 5). The first part is consistent with the CEOG LTR SER Item c and Item n, page 6-9 of NEDC-33046. The second part can be modified as per the BWROG markup. Wording is revised as follows:

4. The licensee's application verifies that a penetration remains intact during maintenance activities, including corrective maintenance activities. Regarding maintenance activities where the pressure boundary would be broken, the licensee confirms that the assumptions and results of the LTR remain valid. This includes the assumption that maintenance on a PCIV will not break the pressure boundary for more than the currently allowed AOT.
 5. The licensee's application verifies the operability of the remaining PCIVs in the applicable penetration flow path before entering the AOT for the inoperable PCIV.
4. BWROG Comment: Page 13, Section 3.4, "Staff Findings and Conditions," Condition 5 – The BWROG stated, "The SE states that the BWROG committed to assess the risk associated with PCIV maintenance and to develop unavailability targets for PCIVs within the scope of the maintenance rule. In fact compliance with the

maintenance rule already requires this and the draft SE requirement for multiple valve assessments is already discussed in requirements [Conditions] #3 and #4. It appears to the BWROG that this requirement is redundant to existing requirements and the discussion of requirement #3 and #4. This was not required of the CEOG."

BWROG Proposed Resolution: Eliminate Condition 5.

NRC Action: The staff references CEOG LTR SE, item d for a similar condition to that of Condition 5 (revised in terms of the maintenance rule and not CRMP). However, the staff concurs with removing the condition regarding availability targets, as Section 6.7 of the LTR indicates these have been established. Wording is revised as follows:

Since the STS allows separate condition entry for each penetration flow path, the licensee's application verifies that the potential for any cumulative risk impact of failed PCIVs and multiple PCIV LCO entries has been evaluated and is acceptable. The licensee's tier 3 risk management program (10 CFR 50.65(a)(4)) confirms that multiple simultaneous entries in the LCO do not exceed the RG 1.174 and RG 1.177 guidelines and that defense-in-depth for safety systems is maintained.

Condition 5 in the draft SE now becomes Condition 6 in the final SE.

5. BWROG Comment: Page 14, Section 3.4, "Staff Findings and Conditions," Condition 6 – The BWROG stated, "As discussed during the conference call, uncertainty analysis is part of the topical report. An evaluation of uncertainties is part of the normal assessment done for risk by licensees. Based on the conversation during the conference call, the BWROG assumes that no new plant specific work is needed to accommodate this requirement. Also, this was not required of the CEOG."

BWROG Proposed Resolution: Eliminate Condition 6.

NRC Action: The comment was fully adopted into the final SE.

6. BWROG Comment: Page 14, Section 3.4, "Staff Findings and Conditions," Condition 7 – The BWROG stated, "During the conference call it was agreed that the draft SE could state that the licensee agreed to meet the requirements of Regulatory Guides 1.174 and 1.177."

BWROG Proposed Resolution: The BWROG suggests revising this requirement to read, "The licensee's shall verify the specific plant PRA quality is acceptable for this application."

NRC Action: The staff agrees with the BWROG assessment, except that RG 1.174 should be referenced in the revised wording as follows: "The licensee shall verify that the plant specific PRA quality is acceptable for this application in accordance with the guidelines given in RG 1.174."

7. BWROG Comment: Page 14, Section 3.4, "Staff Findings and Conditions," Condition 8 – The BWROG stated, "during the conference call, it was agreed that valves with specific ECCS functions other than containment isolation have Technical specifications associated with the ECCS functions."

BWROG Proposed Resolution: The BWROG suggests eliminating Condition 8.

NRC Action: The comment was fully adopted into the final SE.

8. BWROG Comment: Page 14, Section 3.4, "Staff Findings and Conditions," Condition 9 – The BWROG stated, "during the conference call, it was pointed out that open piping systems outside of containment are addressed as configurations required by requirement [Condition] #1 to be evaluated. There did not appear to be justification to call out these configurations for special mention."

BWROG Proposed Resolution: The BWROG suggests eliminating Condition 9.

NRC Action: The comment was fully adopted into the final SE.

9. BWROG Comment: Page 1, line 28 – "secondary containment PCIVs. . . ."

BWROG Proposed Resolution: "secondary containment isolation valves and dampers. . . ."

NRC Action: The comment was fully adopted into the final SE.

10. BWROG Comment: Page 2, line 11-23 – the BWROG states, "The restrictions on Purge/Vent valves (Condition E) and limiting Condition D to only EFCVs are not listed in Sections 3.4 or 3.6. Will the LTR be revised as part of the '-A' version to reflect the RAIs?"

BWROG Proposed Resolution: The BWROG requests documentation in SE where it states that the LTR does not allow the extension on these valves.

NRC Action: The staff assumes that the LTR would be revised by the BWROG to incorporate the RAI—the RAI response is mentioned in this paragraph and in Section 3.5, "Topical Report Revisions." Otherwise, the BWROG will need to provide a condition restricting the scope of the LTR to reflect the referenced RAI response.

11. BWROG Comment: Page 2, line 26-31 – the BWROG states, "The discussion of the differences between AOT and CT does not make sense, is not recognized by the TS community, and adds no value to the discussion and should be deleted."

BWROG Proposed Resolution: Retain only the first and last sentence in this paragraph.

NRC Action: This item discusses the difference between CT and AOT—since the BWROG used "AOT" in the LTR while using "CT" in the TS mark-ups. The paragraph remains unchanged.

12. BWROG Comment: Page 3, line 15-16 – the BWROG states, "The imbedded requirement for licensees to submit plant-specific information is not needed in this specific context and should be deleted."

BWROG Proposed Resolution: Remove, "the licensees will submit risk information to support the proposed license amendment to extend PCIV AOTs."

NRC Action: The comment was fully adopted into the final SE.

13. BWROG Comment: Page 8, line 31-33 – the BWROG states, "Last bullet implies an implementation requirement that is not specifically listed anywhere else in the SE, such as Section 3.4."

BWROG Proposed Resolution: Condition 4 is too vague and needs to be made specific to this issue.

NRC Action: This item is on pages 6 through 9 of the LTR. The comment was adopted into the final SE under a revision to Condition 4 and new Condition 5.