

August 12, 2004

Mr. Kenneth Putnam, Chairman
BWR Owners Group
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Duane Arnold Energy Center
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Palo, IA 52324

SUBJECT: DRAFT SAFETY EVALUATION FOR BOILING WATER REACTOR OWNERS GROUP (BWROG) LICENSING TOPICAL REPORT (LTR) 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 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 for review. Enclosed for the BWROG's review and comment is a copy of the staff's draft safety evaluation (SE) for the LTR.

Twenty working days are provided to you to comment on any factual errors or clarity concerns contained in the SE. The final SE will be issued after making any necessary changes and will be made publicly available. The staff's disposition of your comments on the draft SE will be discussed in the final SE.

To facilitate the staff's review of your comments, please provide a marked-up copy of the draft SE showing proposed changes and provide a summary table of the proposed changes.

If you have any questions, please contact Bo Pham at (301) 415-8450.

Sincerely,
/RA/

Stephen Dembek, Chief, Section 2
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 691

Enclosure: Draft Safety Evaluation

cc w/encl: See next page

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DRAFT 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 1.0 INTRODUCTION AND BACKGROUND

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

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

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

22 The proposed AOT revision is applicable to PCIVs associated with the standard technical
23 specifications (STS) NUREG-1433, "Standard Technical Specifications General Electric
24 Plants, BWR/4," Revision 2, dated June 2001, or Section 3.6, "Containment Systems," of
25 NUREG-1434, "Standard Technical Specification General Electric Plants, BWR/6," Revision 2,
26 dated June 2001. More specifically, the LTR applies to limiting condition for operation (LCO)
27 3.6.1.3, "Primary Containment Isolation Valves." NEDC-33046 did not include an evaluation to
28 extend secondary containment PCIV AOTs.

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

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

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

33 2.0 REGULATORY EVALUATION

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

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

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

12 2.1 Applicable Regulations

13 Title 10, Section 50.36, of the *Code of Federal Regulations* (10 CFR 50.36) requires that all
14 operating licenses for nuclear reactors must include the TS for the subject plant. The LCO,
15 along with the required AOTs are specified for each system included in the TS. The licensees
16 will submit risk information to support the proposed license amendment to extend PCIV AOTs.

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

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

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

27 2.2 Applicable Regulatory Criteria/Guidelines

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

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

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

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

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

32 3.0 TECHNICAL EVALUATION

33 3.1 Detailed Description of the Proposed Change

34 The LTR's assessment of the risk impact for the proposed changes to extend PCIV AOTS to 7
35 days during Modes 1, 2, and 3 follows the guidance of RGs 1.177 and 1.174, and includes the
36 evaluation of the ICCDP and ICLERP for valves left in the open position during the proposed
37 AOT. The BWROG's evaluation also includes interfacing system LOCA (ISLOCA) for valves
38 connected to the reactor coolant system (RCS). The LTR evaluates the ICCDP for valves left in
39 the closed position that have dual functions of containment isolation and accident
40 consequences mitigation. The BWROG considered the risk impact of PCIVs installed in
41 systems with non-seismically qualified piping. In addition, since TS LCO 3.6.1.3 Note 2 allows

1 separate condition entry for each penetration flow path, multiple LCO entries were considered
 2 in the LTR.

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

15 The parameters used by the BWROG in the calculation of ICCDP and ICLERP are included in
 16 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

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

1 seen in the table below.

2	Valve Type	Failure to Close (/demand)	Failure to remain Closed (/hour)	Failure Probability During AOT
3	Air Operated Valve	2.00E-3	1.40E-5	2.35E-3
4				
5	Motor Operated Valve	2.70E-3	7.70E-7	1.29E-4
6				
7	Solenoid Valve	1.10E-3	1.70E-5	2.86E-3
8	Check Valve	1.20E-3	2.20E-6	3.70E-4
9	Pressure Relief Valve	N/A	2.2E-6	3.70E-4
10				

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

15 The following PCIV flow paths were evaluated:

16 **Class A**

17
18 Penetration is connected directly to the containment atmosphere, or connected to
19 non-seismically qualified piping that interfaces with the containment atmosphere.

- 20 ● Penetrations connected directly to containment atmosphere and outside environment.
- 21 ● Penetrations connected directly to containment atmosphere and a closed loop system
22 outside containment.
- 23 ● Penetrations connected directly to containment atmosphere and an open loop system
24 outside containment.

25 **Class B**

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

- 28 ● Penetrations used to obtain sample from the reactor coolant.
- 29 ● Penetrations used to provide reactor water cleanup (RWCU) flow.

1 **Class C**

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

- 3 ● Penetrations connected to non-essential containment cooling units (PCIVs outside
4 containment and closed loop inside containment).
- 5 ● Penetrations connected to non-essential containment cooling units (PCIVs inside and
6 outside containment).

7 **Class D**

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

- 9 ● Sample lines.
- 10 ● Air and Instrumentation lines.

11 **Class E**

12 Penetration is designed to open during a design basis event.

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

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

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

- 27 ● The proposed AOT is assumed to be adequate to perform expected PCIV maintenance.
28 The BWROG stated that as a result, the risk from a forced shutdown because of
29 insufficient time to repair would be minimal.
- 30 ● The BWROG also assumes that risk contribution of a failure of the penetration piping
31 during the proposed AOT would be negligible based on the limited piping length
32 involved.

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

1 3.2 Review of Methodology

2 The staff reviewed the BWROG's submittal using the three-tiered approach referenced in RG
3 1.174, RG 1.177, and SRP Chapter 16.1.

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

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

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

29 The subsections below describe each tier and the associated reviews.

30 3.3 Technical Evaluation

31 For the quantitative evaluation of the risk impact of extending the current PCIV AOT from 4, or
32 72 hours to a proposed duration of 7 days, the BWROG developed a methodology to group
33 various containment penetrations into defined classes. For each defined class, the BWROG
34 developed generic configurations of containment penetrations to assess the impact on the plant
35 at power risk utilizing the proposed seven day AOT for the associated penetration PCIVs.

36 3.3.1 Tier 1: PRA Applicability and Insights

37 The analyses used in NEDC-33046 are generic, therefore, each licensee requesting PCIV AOT
38 extensions will need to justify the applicability of the LTR results to their particular plant. A
39 plant-specific analysis must be performed to ensure the applicability of NEDC-33046

1 conclusions with respect to the risk impact of extending the AOTs for inoperable PCIVs. The
2 licensee's analysis must be applied to penetrations analyzed in NEDC-33046. Any additional
3 penetrations must be included in the licensee's analysis.

4 3.3.1.1 PRA Applicability

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

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

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

25 3.3.1.2 PRA Insights

26 One approach to demonstrate that the risk impact of the proposed change is acceptable is to
27 show that the licensing basis meets the key principles set forth in RG 1.174 for the proposed
28 change. One of these principles is to show that when the proposed change results in an
29 increase in CDF or risk, the increased risk is small. In addition, the impact of the proposed
30 change should be monitored using performance measurement strategies. RG 1.174 and RG
31 1.177 provide acceptance guidelines for meeting the above principles. Specifically, those
32 guidelines include Δ CDF, Δ LERF, ICCDP, and ICLERP. The risk metrics ICCDP and ICLERP
33 suggested by RG 1.177 are used in addition to the metrics outlined in RG 1.174 for the
34 evaluation of AOTs because AOTs are entered infrequently and are temporary in nature.

35 The risk impact of extending PCIV AOTs is summarized in Table 6.3-3 of the LTR. The results
36 show that the risk impact of the proposed PCIV AOTs are within the ICCDP and ICLERP

1 acceptance guidelines of 5.0E-7 and 5.0E-8, respectively. As stated previously, because of the
2 bounding nature of the seven day AOT evaluation, the impact on average CDF due to
3 increased PCIV unavailability was not specifically evaluated by NEDC-33046. Although the
4 LTR results are stated as bounding, plant-specific analyses must be performed to ensure the
5 applicability of NEDC-33046 with respect to Δ CDF, Δ LERF, ICCDP, and ICLERP for PCIV
6 penetration flow paths. In addition, licensees must provide an evaluation of external event risk,
7 either quantitative or qualitative, which demonstrates that external events will not have an
8 adverse impact on the conclusions of the plant-specific analyses.

9 3.3.1.3 PRA Uncertainty

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

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

30 3.3.2 Tier 2: Avoidance of Risk-Significant Plant Configurations

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

39 The LTR notes that the STS allows multiple simultaneous entries (see Section 3.6.1.3) into the
40 LCO, but not for multiple PCIVs associated with the same flow path. However, multiple entries
41 for PCIVs associated with the proposed AOT change would result in increased CDF, LERF,
42 ICCDP and ICLERP values from that assumed in the LTR. Simultaneous multiple entries and

1 the subsequent impact on risk were not specifically evaluated by the BWROG, but the LTR did
2 state that based on the low level of risk identified, a number of multiple simultaneous entries
3 would not be expected to exceed the ICLERP guideline of 5E-8. The BWROG also stated that
4 plant implementation of the maintenance rule (10 CFR 50.65) would limit the overall risk
5 associated with PCIV maintenance by controlling the cumulative risk of multiple PCIVs in an
6 LCO and the associated boundary in maintenance. However, multiple simultaneous LCO
7 entries for PCIVs must be evaluated on a plant-specific basis such that the risk impact
8 assumptions of the LTR remain valid including CDF, LERF, ICCDP and ICLERP. BWROG
9 member utilities have committed to assess the risk associated with PCIV maintenance, and to
10 develop cumulative unavailability targets for PCIVs within the scope of the maintenance rule of
11 10 CFR 50.65(a)(4). However, in addition to cumulative availability targets, multiple
12 simultaneous entries into the LCO must also confirm that CDF, LERF, ICCDP and ICLERP are
13 less than the RG 1.174 and 1.177 guidelines and consistent with the guidance contained in
14 NUMARC 93.01, "Industry Guidelines for Monitoring the Effectiveness of Maintenance at
15 Nuclear Power Plants," Section 11, "Assessment of Risk Resulting from Performance of
16 Maintenance Activities" as endorsed by RG 1.182, "Assessing and Managing Risk Before
17 Maintenance Activities at Nuclear Power Plants."

18 3.3.3 Tier 3: Risk-Informed Configuration Risk Management

19 RG 1.177 states that a licensee should develop a program to ensure that the risk impact of
20 out-of-service equipment is appropriately evaluated before a maintenance activity is performed.
21 RG 1.174 states that monitoring performed in conformance with the maintenance rule of
22 10 CFR 50.65 can be used when such monitoring is sufficient for the structures, systems and
23 components affected by the risk-informed application. A licensee's submittal must include a
24 discussion on the licensee's CRMP for assessing the risk associated with removal of PCIVs
25 from service and their conformance to the requirements of 10 CFR 50.65(a)(4), as they relate
26 to the proposed PCIV AOTs. The discussion must also include the subject of multiple PCIV
27 AOTs while maintaining conformance to the assumptions outlined in NEDC-33046.

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

40 3.4 Staff Findings and Conditions

41 The results presented in NEDC-33046 are consistent with the acceptance guidelines given in
42 RG 1.177 and 1.174 and show a small increase in plant risk due to the extension of PCIV AOTs

1 to 7 days. This conclusion is predicated on adopting the topical report in a manner consistent
2 with the NRC staff safety evaluation findings and the guidelines and assumptions identified in
3 NEDC-33046. In addition, the following conditions provide guidance for future submittals by
4 licensees wishing to extend PCIV AOTs:

- 5 1. Because not all penetrations have the same impact on CDF, LERF, ICCDP, or ICLERP,
6 a licensee's application verifies the applicability of NEDC-33046, including verification
7 that the PCIV configurations for the specific plant match the LTR and meet the risk
8 guidelines of RGs 1.174 and 1.177 (including CDF, LERF, ICCDP and ICLERP). Any
9 additional PCIV configurations not evaluated by the LTR should be included in the
10 licensee's plant-specific analysis. [Note that PCIV configurations outside the scope of
11 the LTR will require staff review of the specific penetrations and related justifications for
12 the proposed completion times.]
- 13 2. The licensee's application verifies that external event risk, either through quantitative or
14 qualitative evaluation, will not have an adverse impact on the conclusions of the plant-
15 specific analysis for extending the PCIV AOTs.
- 16 3. The licensee's application verifies that procedures are in place to control PCIV AOT
17 entry to avoid possible risk-significant plant configurations (Tier 2) and that during the
18 PCIV AOT, procedures are in place for assessing the risk associated with removal of
19 other equipment from service (Tier 3). The licensee also verifies conformance to the
20 requirements of the maintenance rule (10 CFR 50.65(a)(4)), as they relate to the
21 proposed PCIV AOTs and the guidance contained in NUMARC 93.01, Section 11, as
22 endorsed by RG 1.182. In addition, if a CRMP does not explicitly include a LERF
23 assessment as part of the maintenance rule (10 CFR 50.65(a)(4)) process, the licensee
24 verifies that their CRMP has been enhanced to include LERF assessment within the
25 CRMP.
26
- 27 4. The licensee's application verifies that a penetration remains intact during maintenance
28 activities, including corrective maintenance activities. Regarding maintenance activities
29 where the pressure boundary would be broken, a licensee confirms that the
30 assumptions and results of the LTR remain valid. Regarding corrective maintenance,
31 the licensee's application verifies that common cause failure has been addressed and
32 states that the operability of the remaining PCIVs in a penetration will be verified before
33 entering the extended AOT, to ensure that defense-in-depth is maintained.
- 34 5. Since the STS allows separate condition entry for each penetration flow path, the
35 licensee's application (which is based on NEDC-33046) verifies that the potential for any
36 cumulative risk impact of failed PCIVs and multiple PCIV LCO entries has been
37 evaluated and is acceptable. The BWROG member utilities committed to assess the
38 risk associated with PCIV maintenance and to develop cumulative unavailability targets
39 for PCIVs within the scope of the maintenance rule (10 CFR 50.65(a)(4)). However, in
40 addition to cumulative availability targets, the licensee's Tier 3 CRMP (utilized to satisfy
41 10 CFR 50.65(a)(4)) confirms that multiple simultaneous entries into the LCO do not
42 exceed the RG 1.174 and RG 1.177 guidelines for CDF, LERF, ICCDP and ICLERP.

- 1 6. The licensee's application verifies that a quantitative or qualitative uncertainty analysis
2 has been performed and that the results are acceptable. This verification includes, as
3 appropriate, any sensitivity studies to address PRA peer review findings or areas of the
4 PRA that are not fully analyzed with respect to PCIVs.
- 5 7. The licensee's application shall include additional information on PRA quality, as
6 discussed in Section 3.3.1.1.
- 7 8. As stated in the LTR, some PCIVs categorized as Class E provide containment isolation
8 and are also required to open for accident mitigation. Therefore, an inoperable PCIV in
9 either the open or closed position will impact CDF and LERF. The LTR evaluates the
10 containment isolation function (inoperable valve in the open position). Therefore, a
11 licensee's application should verify that no AOT extensions have been requested for
12 Class E valves in the closed position.
- 13 9. For open piping systems outside containment, NEDC-33046 assumed that there are
14 multiple valves in the flow path that can be credited for isolating the pathway. Multiple
15 valve failures were assumed to be a low probability event. Therefore, a licensee's
16 application should confirm this for the plant under consideration.

17 3.5 Topical Report Revisions

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

- 20 ● RAI response, Question 5. Page 6-34, the first paragraph is revised to clarify the term
21 "acceptable limit."
- 22 ● RAI response, Question 9. On page 6-42 an editorial correction is made.
- 23 ● RAI response, Question 10. Section 5.2.1 provides clarification that the risk evaluation
24 is based on a single AOT of 168 hours per year.
- 25 ● RAI response, Question 16. On page 6-9, Assumption n is deleted.
- 26 ● RAI response, Question 17.a. Page 5-2, Section 5.1 provides clarification that the
27 probability of failure of the closed loop piping system is deemed negligible.
- 28 ● RAI response, Question 18. Page 6-1, Section 6.1, Section 6.3.2.1a, Abstract, Purpose,
29 Section 2.1, Section 4.1, Section 6.3.2.4 provides additional clarification of the scope of
30 the LTR.
- 31 ● RAI response, Question 20. Page 6.2, ECCS isolation valves provide clarification on
32 subsystem operability and ECCS operability with regard to an inoperable safety injection
33 isolation valve.
- 34 ● RAI response, Question 25. Clarification will be provided to have a licensee confirm that
35 PCIV configurations and PRA results remain bounding for a licensee's submittal.

- 1 ● RAI response, Question 26. A statement will be added that the proposed AOT changes
2 do not apply to an open system with a single PCIV.

- 3 ● RAI response, Question 27. Revises the LTR to withdraw the proposed 7-day AOT for
4 TS 3.6.1.3 Condition E. In addition, Condition D with applicability to only EFCVs is
5 added to the scope of the LTR.

- 6 ● RAI response. Table 6.3-3, page 6-47 corrects the ICCDP and ICLERP risk ratios listed
7 in the table.

- 8 ● RAI response. On page 6-40, the last paragraph changes the wording "This
9 configuration DOES NOT MEET either acceptance criteria" to "This configuration DOES
10 NOT MEET the acceptance guideline for ICLERP."

- 11 ● RAI response. Page 6-11, Figure 6.3-1 and page 6-20, Figure 6.3-4 are corrected to
12 show normally closed valves.

13 3.6 Regulatory Commitment

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

23 4.0 CONCLUSION

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

39 Principal Contributor: C. Doutt

40 Date: August 12, 2004