EC-0441 EC Closeout Package

REV.0

Report Date: 10/30/2009

EC Number: 0000015044 Revision: 000

Engineering Change

EC Number :	0000015044	000	**Facility** :	PI	
Status/Date :	CLOSED	10/24/2009	**Type/Sub-type** :	EVAL /	

EC Title: EVALUATION OF THE IMPACT OF CONTINUING REFUELING CAVITY LEAKAGE DURING 1R26/2R26 ON CONCLUSIONS OF EC 14139 THAT CONSIDERED THE EFFECTS THROUGH 25 REFUELING OUTAGES. DOMINION ENG. R-4448-00-01

Mod Nbr:	**KW1:**	**KW2:**	**KW3:**	**KW4:**	**KW5:**

Master EC :		**Work Group** :		**Temporary** :	
Outage :		**Alert Group** :	E-PRGM MGR	**Aprd Req. Dt.** :	10/30/2009
WO Required :	N	**Image Addr** :		**Exp Insvc Date** :	
Adv Wk Appvd :		**Alt Ref.** :		**Expires On** :	
Auto-Advance :		**Priority** :		**Auto-Asbuild** :	
Caveat Outst :		**Resp Engr** :	DWNT01		

Units and Systems

Facility	Unit	System	System Description
PI	0	ZC	CONTAINMENT VENT

Attributes

Attribute Name	Value	Updated By	Last Updated	Notes
SCRN NO	NOT REQUIRED	DWNT01	10/11/2009	This evaluation is an extrapolation of a previous evaluation to show the co□□ nclusions remain valid. The evaluation does not support a change to any st□□ ructure, system, component, procedure, design basis, or technical specifica□□ tion and is not used as a basis for operability. Screening is not required□□ .
SIMULATOR				
SYSTEM HEALTH				
EVAL NO				
PORC DTE				
PRIORITY RANKING				

Topic Notes

Topic	Notes
DESCRIPTION	An engineering evaluation EC# 14139 was performed by Dominion Engineering to assess the potential for degradation of containment concrete, reinforcing bar, and containment vessels due to refueling cavity leakage through 25 refueling cycles. Evaluation EC# 15044 assesses the impact of continued leakage through 1R26 and 2R26 on the conclusions of the original evaluation. The original evaluation was performed in conjunction with RCE01160372 and was procured safety related under the vendor appendix B program as specified in contract 00026901.
JUSTIFICATION	The original evaluation was procured to support RCE01160372. The new evaluation extrapolates the original results for an additional outage to show the conclusions remain valid. Both the evaluation and the referenced Dominion evaluation are attached in sharepoint under the EC Pkg folder.
REVIEWER COMMENTS	Reviewer comments were included within the engineering evaluation. All comments were resolved.

Cross References

XRef	Number	Sub	Status	Date	Reference Description
AR	01160372		APPROVED	12/02/2008	Refueling Cavity Leakage Corrective Actions and the LRA
AR	01201071		APPROVED	10/05/2009	Leakage from Ceiling in Regen HX Room
EC	0000014139		CLOSED	05/11/2009	EVALUATION OF EFFECT OF BORATED WATER LEAKS ON CONCRETE, REINFORCING BAR

Affected Documents

Milestone

Milestone	Date	ID	Name	Req By
APPROVED BY	10/13/2009	WTRS02	Myers, Sonja K	APPROVED

Notes: Tom Downey is qualified to prepare EC-Evaluations. Lora Drenth □□
is qualified to prepare and review EC-evaluations. □□
I concur no 50.59 screening is required. □□
I approve this EC.

Milestone

Milestone	Date	ID	Name	Req By
CLOSE	10/24/2009	LDWHIP01	Whipple, Linda D	CLOSED
DSGN VERIFY	10/12/2009	N111195	Drenth, Lora D	
Notes: Comments on form QF-0528 attached to evaluation under ECPkg folder in share□□ point.				
PREPARED (EVL)	10/11/2009	DWNT01	Downing, Thomas R	H/APPR

Document References

Facilty	Doc-Type	Sub-Type	Doc #	Sheet	Rev	Minor Rev	Date
PI	EC		0000015044		000		10/24/2009

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Design Review Comment Form

Sheet 1 of 1

DOCUMENT NUMBER/ TITLE: EC 15044

REVISION: 0 DATE: 10/11/09

ITEM #	REVIEWER'S COMMENTS	PREPARER'S RESOLUTION	REVIEWER'S DISPOSITION
1	In the purpose section, the impression given was that the contact of the borated water with the containment vessel was not to continue beyond refueling outage 1R26. I believe that the actual intent of this evaluation is to evaluate conditions through the 27th cycle of operation (until shutdown for 1R27). Please clarify purpose section.	Adopted suggested language that references the 27th fuel cycle.	Purpose section has been clarified. LKD
2	The Dominion evaluation did not consider 5 mils as a conservative corrosion rate. It gave 5 mils as an example of a corrosion rate from a particular test. I suggest that if you choose to use a less conservative corrosion rate than the 7 mils per year assumed in the Dominion evaluation, you will need to more assertively make your point as to why a less conservative corrosion rate remains acceptable. The 7 mils per year assumption was not added as a margin of conservatism, but was a value taken from the Boric Acid Corrosion Guidebook	Revised evaluation to reference 7 mils as a conservative corrosion rate and added quote from Dominion report that states range of .002 to .007.	Revised evaluation uses the Dominion evaluation corrosion rate and explains why increased wall loss will not affect conclusions of the Dominion report. LKD
3	There should be some discussion in the corrosion portion as to how this affects margin management. It should be clear to the reader what type of margin has been lost by a possible 0.19 inch of wall thickness loss.	Added paragraph to demonstrate that margin was significant based on the pressure stress < ½ the yield strength and the change in margin is < 1%.	Discussion on available margin and the impact on ASME code design thickness has been explained.
4	Please page number the evaluation, page x of y, to allow verification that all pages are included.	Page numbers added to header.	Page numbers have been added.
	The evaluation has been reviewed per the requirements of FP-E-EVL-01 Rev. 3 Section 5.3.		No additional comments.

Reviewer: Lora Drenth Date: 10/12/09

Preparer: Tom Downing Date: 10/13/2009

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Design Review Checklist

EC Number or Document Number / Title / Revision Number: EC 15044 / EVALUATION OF THE IMPACT OF CONTINUING REFUELING CAVITY LEAKAGE DURING 1R26/2R26 ON CONCLUSIONS OF EC 14139 THAT CONSIDERED THE EFFECTS THROUGH 25 REFUELING OUTAGES. DOMINION ENG. R-4448-00-01

Verifier's Name / Discipline: Lora Drenth / Boric Acid Corrosion Program Owner

DESIGN REVIEW CONSIDERATIONS:		Yes	No	N/A
1.	Were the inputs correctly selected and incorporated into design?	☒	☐	☐
2.	Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?	☒	☐	☐
3.	Are the appropriate quality and quality assurance requirements specified?	☒	☐	☐
4.	Are the applicable codes, standards, and regulatory requirements including issue and addends properly identified and are their requirements for design met?	☐	☐	☒
5.	Have applicable construction and operating experience been considered?	☒	☐	☐
6.	Have the design interface requirements been satisfied?	☐	☐	☒
7.	Was an appropriate design method used?	☐	☐	☒
8.	Is the output reasonable compared to inputs?	☒	☐	☐
9.	Are the specified parts, equipment and processes suitable for the required application?	☐	☐	☒
10.	Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?	☐	☐	☒
11.	Have adequate maintenance features and requirements been specified?	☐	☐	☒
12.	Are accessibility and other design provisions adequate for performance of needed maintenance and repair?	☐	☐	☒
13.	Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?	☐	☐	☒
14.	Has the design properly considered radiation exposure to the public and plant personnel?	☐	☐	☒
15.	Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?	☐	☐	☒
16.	Have adequate pre-operational, subsequent periodic test and inspection requirements been appropriately specified, including acceptance criteria?	☐	☐	☒
17.	Are adequate handling, storage, cleaning, and shipping requirements specified?	☐	☐	☒
18.	Are adequate identification requirements specified?	☐	☐	☒
19.	Are requirements for record preparation, review, approval, and retention adequately specified?	☐	☐	☒
20.	Have Design and Operational Margins been considered and documented?	☒	☐	☐

COMMENTS: ☐ None ☒ Attached (Use Form QF-0528) ☐ In EC Topic Notes

Form retained in accordance with record retention schedule identified in FP-G-RM-01.

Evaluation of Potential Impact of Continued Refueling Cavity Leakage in 1R26

1. Purpose

This evaluation will review the impact of the continuance of refueling cavity leakage through the unit 1 twenty-seventh cycle of operation, which is estimated to begin fall 2009 and continue to spring 2011. This evaluation is based on the conclusions of EC# 14139, which considered the effects through 26 cycles of operation and/or 36 years of plant operation. The evaluation is also applicable to unit 2 as the Dominion evaluation was generic to both units.

2. Methodology

As per EC# 14139 and Dominion Engineering Evaluation R-4448-00-01 Rev. 0

3. Acceptance Criteria

As per EC# 14139 and Dominion Engineering Evaluation R-4448-00-01 Rev. 0

4. Inputs

As per EC# 14139 and Dominion Engineering Evaluation R-4448-00-01 Rev. 0

5. References

As per EC# 14139 and Dominion Engineering Evaluation R-4448-00-01 Rev. 0

6. Assumptions

As per EC# 14139 and Dominion Engineering Evaluation R-4448-00-01 Rev. 0

7. Analysis

The evaluation performed by Dominion Engineering considered the effects of degradation in four discrete areas: first, a bounding computation of the maximum credible corrosion of the containment lower ellipsoidal shell; second, a computation of the worst case depth of attack of the concrete by dissolution of the cement; third, a check that the effects of carbonation will not have rendered any rebar more susceptible to corrosion; and fourth, a computation of the maximum credible rebar corrosion for bars that are exposed to borated water flowing through cracks in the concrete.

The Dominion Engineering evaluation considered that a conservative corrosion rate to apply for determining the maximum credible wall loss of the containment shell would be 7 mils per year, and when considered to apply over 36 years, would have a resultant 0.25 inch of wall loss. From section 4.2 of the evaluation "Tests at ambient temperature indicate that the rates of corrosion of steel in aerated, concentrated (and in one case saturated) boric acid solutions range between 0.002 to 0.007 inch per year (Section 4.4.1 and page 4-35 of the

Boric Acid Corrosion Guidebook, Rev. 1 [16]). These rates are probably conservative for the current application since the pH of solution in contact with the steel containment vessel will be buffered by alkalinity from the cement in the concrete,"

Dominion Engineering then proceeded to determine a margin of conservatism and evaluation of a possible 0.25 inch of wall loss on the safety function of the containment. The evaluation concluded that 0.25 inch of wall loss would not impact the safety function of the containment vessel, with the caveat that any actual corrosion discovered in the field would need to be compared to the requirements of the ASME Section XI Code for acceptability.

By extrapolating the evaluation to account for an additional fuel cycle of exposure to the assumed conditions, the 36 year exposure time is increased to 37.5 years, and the calculated maximum credible wall loss increases from 0.25 inch to 0.26 inch. The conclusions of the evaluation, which considered 0.25 inch of wall loss remain valid as the 0.01 inch change is small compared to the nominal 1.5 inch wall thickness and does not significantly change the impact on the safety function of the containment vessel which was based on a comparison of the 11.6ksi pressure stress to the 34ksi yield stress of the material. From section 4.2 of the Dominion evaluation "For example, using a remaining thickness of 1.25 inches, the axial tensile stress at the thinned area is given by PR/2t (page 298 in [20]) where R is the radius (105 ′ /2 = 52.5′ = 630″), P is the accident design pressure of 46 psig, and t is the remaining thickness, taken as 1.25 in. This indicates an axial tensile stress of ~11,600 psi, which is far below the yield stress of 34.0 ksi (Table 1-8 in Chapter (I)1-12 of [21]) at the accident design temperature of 268°F (Sheet I2 in [12]), let alone the tensile strength of about 70 ksi.".

The Dominion evaluation noted that there is significant margin as the 11.6ksi pressure stress is less than half the material yield stress, and less than 20% of the material minimum tensile strength. As pressure stress is proportional to the shell thickness of 1.5", a change from an assumed thinning from .25 inch to .26 inch would change the available margin by less than 1% and does not change the conclusions of the evaluation. As noted above, any wall loss below the 1.5" design thickness would need to be evaluated in accordance with ASME section IX under the site IWE program for acceptability.

The Dominion Engineering evaluation of the worst case depth of attack on exposed concrete due to dissolution of the cement considered the exposure time to be 25 refueling outage pool-flood periods of 15 days each. The computed depth of attack was 0.31 inches. The correlation is a function of t to the 0.5 power. Adding an additional 15 day exposure period increases the calculated depth of attack to 0.32 inches. The Dominion evaluation then compared this depth of attack against the various thicknesses of grout or concrete cover used in the design of Prairie Island's containment concrete structures. The conclusion that this loss of concrete section in a wall that varies from 4 to 5 feet thick may be considered insignificant is not affected by the increase of one 1/100th of an inch. The Dominion Engineering evaluation noted that at one specific point around the fuel transfer tube, the design concrete thickness may be less than a foot, in which

case the loss of 0.31 or 0.32 inches should be specifically evaluated. If such an evaluation is subsequently performed elsewhere, then the change from 0.31" to 0.32" should be addressed. Otherwise, such a change may be deemed insignificant compared to the conservatisms employed in the calculation of the original value, such as the somewhat arbitrary doubling of the Salem corrosion rate proportional constant to account for uncertainties in the Prairie-Island-specific behavior from chemistry differences in the concrete aggregates.

The Dominion Engineering evaluation of the protection afforded the rebar by the hydroxides and the loss of said protection due to carbonation (reaction with carbon dioxide in the air over time), determined that carbonation may have penetrated approximately 1.2 inches into the concrete over the course of 36 years. This was based on a curve fit and extrapolation of data from NUREG/CR-6924, which covered 25 years. By repeating the same exercise, using 37.5 years instead of 36 years, we find that the calculated penetration goes from 1.18 inch to 1.21 inch, which does not change the value in the Dominion Engineering evaluation, which rounded to two significant figures. Thus, the conclusions are unaffected.

The Dominion Engineering evaluation considered the corrosion of rebar that is exposed to boric acid leakage through cracks in the concrete. It used a corrosion rate of 0.007 inch per year and an exposure of 30 days per refueling outage for each of 25 outages, for a total time of 750 days or 2.05 years. Thus the calculated upper limit of rebar corrosion was found to be 0.014". Extrapolating this value to 26 refueling outages worth of exposure results in an increase in corrosion depth from 0.014" to 0.015". The Dominion evaluation judged 0.014" of rebar corrosion to be insignificant without detailed analysis. Therefore, 0.015" would be similarly insignificant, in light of the supporting data of no visible signs of rebar corrosion such as concrete spalling or rust staining at the leakage locations in containment.

8. Conclusions

The conclusions reached in the Dominion Engineering evaluation (EC# 14139), when results are extrapolated for an additional refueling cycle of exposure, remain valid.