Sengupta, Abhijit

From: Williams, Charles R. [Charles.Williams@pgnmail.com]
Sent: Tuesday, December 01, 2009 3:01 PM
To: Lake, Louis; Thomas, George; nausdj@ornl.gov; Carrion, Robert
Subject: Draft Refute 8.3 for your Review
Attachments: FM 8.3.pptx; SP-178 Rev 28 (tmp) 205.pdf; Pages from SP-178 Rev 28 (tmp) 1.pdf; SP-178 Rev 28 - 50.59 Screen.pdf; EC-ED 62366RO.doc

Mr Lake and others,

Attached for your review is draft of refute 8.3 and its exhibits. If you have any questions, please call me.

Thanks you,
Charles Williams
919-516-7417

P/178

FM 8.3 Exhibit 2

REG-NGGC-0010 Rev. 8, Attachment 1 - Screen

Identification Number(s)					
Applicable Plant(s):		171865			**Revision Number:** 0
	BNP	**CR3**	**HNP**	**RNP**	

Implementing Document No: SP-178 Revision No: 28

Also FSAR Change Package 2005-0020, Appendix J Program Manual

Implementing Activity Description:

SP-178 is being revised to bring it up-to-date with industry practices regarding the performance of containment integrated leak rate tests. The significant changes are the lack of operation of the containment fans and the increase in maximum allowable pressurization/depressurization rates to 15 psi/hr. The changes also include the incorporation of PT-125, Integrated Leak Rate Instrument Pre-Test Verification, into this procedure, general formatting changes, and the use of vendor-provided equipment (instruments, driers, etc.) instead of installed plant equipment. The change in fan operation is the result of industry experience that has shown that fan operation actually introduces some instability and prolongs the testing. The change in pressurization/depressurization rates will reduce critical path time in the outage. The rate of change is still much less than accident conditions and is consistent with other plants, including BNP.

SECTION 1: Predetermination

		Yes	No
1a	Is a change to the Technical Specifications or Operating License necessary to implement the proposed activity?	☐ Initiate a change in accordance with applicable procedure and go to Section 2	☒ Continue to the next question
1b Or 1c	Is the proposed activity fully bounded by a previously completed Screen or Evaluation performed in accordance with REG-NGGC-0010? Has the proposed activity been formally approved by the NRC?	☐ Enter the Reference below and go to Section 4	☒ Go to Section 2

Previous Screen/Evaluation and/or NRC Approval Reference: N./A

SECTION 2: Applicability of Regulatory Processes Other Than 10 CFR 50.59

Address the questions below for all aspects of the activity. **Refer to Attachment 11 and contact the responsible program owner, as appropriate, to assure the effect of the activity is accurately and thoroughly addressed.** If the answer is "Yes" for any portion of the activity, complete the associated attachment (e.g. Question 3 and Attachment 3). Note that it is not unusual to have more than one process apply to a given activity.

		Yes	No
2	Does the proposed activity involve a change to the Emergency Plan or an Emergency Plan implementing procedure needed to comply with the requirements of 10 CFR 50 Appendix E? (Attachment 2)	☐	☒
3	Does the proposed activity involve a change to the Physical Security Plan, the Safeguards Contingency Plan or the Guard Training and Qualification Plan or the implementing procedures for these plans? (Attachment 3)	☐	☒
4	Does the proposed activity involve a change to the Quality Assurance Program Description? (Attachment 4)	☐	☒

REG-NGGC-0010 Rev. 8, Attachment 1 - Screen					
Applicable Plant(s):	BNP	CR3	HNP	RNP	Revision Number: 0
		171865			
Implementing Document No: SP-178			Revision No: 28		

		Yes	No
5	Does the proposed activity involve a change to the Fire Protection Program (including safe shutdown and Appendix R requirements for example)? (Attachment 5)	☐	☒
6	Does the proposed activity involve a change to the licensed operator requalification program? (Attachment 6)	☐	☒
7	Does the proposed activity involve a change in thermal or chemical effluents, involve a change to the Environmental Protection Plan, or involve a significant change to land use that could impact the environment? (Attachment 7)	☐	☒
8	Does the proposed activity involve a change to the Emergency Response Data System? (Attachment 8)	☐	☒
9	**[RNP Only - A response to this question is not to be provided by Evaluators at BNP, CR3, and HNP]** Does the implementing activity affect a dry fuel storage facility or associated activities? (Attachment 9)	☐	☐
	Applicability Conclusion Are all aspects of the activity controlled by one or more of the Regulatory Processes identified in question 1a and questions 2 through 9 above?	☐ Complete the required attachments and go to Section 4	☒ Complete the required attachments and go to Section 3

SECTION 3: 10 CFR 50.59 Screen

		Yes	No
10a	Does the proposed activity involve a change to an SSC that adversely affects any FSAR-described design function?	☐	☒ Enter Justification

Justification: Procedure SP-178 provides instructions for performing the integrated leak rate test on the CR-3 containment building. The changes to the procedure do not affect the function of the containment building, which is to provide one of the three fission product barriers. Neither the test acceptance criteria, nor the design conditions (i.e., pressure), are being changed by this procedure revision.

		Yes	No
10b	Does the proposed activity involve a change to a procedure that adversely affects how any FSAR-described SSC design function is performed or controlled?	☒	☐ Enter Justification

REG-NGGC-0010 Rev. 8, Attachment 1 - Screen

Applicable Plant(s):	BNP	CR3	HNP	RNP	Revision Number: 0
Identification Number(s)		171865			

Implementing Document No: SP-178 Revision No: 28

Justification: The design function of the containment building is to provide a fission product barrier in the event of a loss of coolant accident. This procedure ensures that the containment building can perform this function by measuring actual leakage rates at design pressure and comparing it to established allowable leakage criteria. The design pressure and acceptance criteria are not changing in this procedure revision. However, the FSAR does describe some of the specifics of the test, such as the use of fans and the number of instruments used. While not using the fans and changing (increasing) the number of instruments will not adversely affect how the fission barrier function of the containment building is performed or controlled, this question will conservatively be answered "yes" to invoke a full 50.59 evaluation.

		Yes	No
10c	Does the proposed activity involve revising or replacing any FSAR-described evaluation methodology that is used in establishing the design bases or used in the safety analyses?	☐	☒ Enter Justification

Justification: The evaluation methodology is not changing in the revision to SP-178. Some of the details of what equipment is used during the test is changing, but the methodology is unaffected. The absence of running fans will allow the RB atmosphere to stabilize quicker, and the use of additional instrumentation will provide more accurate results. The testing will continue to be performed in accordance with Appendix J to 10CFR50.

		Yes	No
10d	Does the proposed activity involve a test or experiment not described in the FSAR, where an SSC is utilized or controlled in a manner that is outside the reference bounds of the design for that SSC or is inconsistent with analyses or descriptions in the FSAR?	☐	☒ Enter Justification

Justification: The ILRT is described in the FSAR and is in accordance with Appendix J requirements. The procedure revision does not put any SSC in any condition that is inconsistent with its design.

	Yes	No
Are any of these questions (10a, 10b, 10c, or 10d) answered "Yes?"	☒ Complete and attach Attachment 10 and go to Section 4	☐ Enter References below and go to Section 4

References:
FSAR Rev. 29, Sections 5.6.3, 5.6.4, 5.6.5
ITS 3.6.1
ITS 5.6.2.20

SECTION 4: Signatures and Distribution

Evaluator:	C.L. Miller	**Date:**
Reviewer:	B. Foster	**Date:**
Supervisor:	T. Howard	**Date:**

After Approval, the Evaluator shall ensure proper distribution of the forms.

Additional Reviews (if required)

Reviewer:	**Date:**

REG-NGGC-0010 Rev. 8, Attachment 1 - Screen					
	Identification Number(s)				
Applicable Plant(s):		171865			Revision Number: 0
	BNP	CR3	HNP	RNP	
Implementing Document No: SP-178			Revision No: 28		
Reviewer:				Date:	
Reviewer:				Date:	

Progress Energy

C
Continuous
Use

PROGRESS ENERGY

CRYSTAL RIVER UNIT 3

PLANT OPERATING MANUAL

SP-178

CONTAINMENT LEAKAGE TEST-TYPE "A" INCLUDING LINER PLATE

REVISION SUMMARY

SECTION	DESCRIPTION
Entire Procedure	This revision to SP-178 is a total re-write. It is being revised to bring it up-to-date with industry practices regarding the performance of containment integrated leak rate tests. The significant changes being made are listed below: • The Reactor Building Cooling Units will be modified such that they are considered available for AI-504 Shutdown Condition 4; however, they will not be in operation during any phase of the ILRT. Industry experience is that stabilization time is minimized with the units secured. ED 62366 • The maximum allowable pressurization/depressurization rates have been changed to 15 psi/hr. This change in pressurization/depressurization rates will reduce critical path time in the outage. ED 62366 • PT-125, Integrated Leak Rate Instrument Pre-Test Verification, has been incorporated into this procedure. • Rented test instruments will be used in lieu of installed plant instruments. This will allow use of modern and more reliable instrumentation. • All pressurization equipment will be rented and the plant LR system will be bypassed. The rented equipment is more reliable and allows greater air flow capacity allowing for a shortened ILRT duration. • Added/Reformatted sections in accordance with AI-402B. • Updated position titles and procedure references.

Title	REACTOR BUILDING COOLING UNIT AVAILABILITY DURING ILRT
RE	C.L. Miller

A.1 EC Folder Contents

ED template 7/05/05

File	Rev	Section	ext	Chp	Subject	Page	of
A00	0	Contents	doc	A.1	EC Folder Contents	1	5
				A.2	List of Hard Copy Only Pages	1	5
				A.3	Revision Summary	1	5
				A.4	Problem Statement	1	5
				A.5	Solution Statement	2	5
				A.6	Evaluation	2	5
				A.7	References	5	5
B00	0	Review	doc	B.1	Engineering Review / Design Verification	1	1
Z00	0	Attach 1	xls		Info Spreadsheet – Time to Boil	1	2
Z01	0	Attach 2	pdf		Sketch – ILRT Equipment Layout	1	1
Z02	0	Attach 3	pdf		Email from ILRT Contractor (B. Carey)	1	1

EC FOLDER UTILITIES (Rev 4)	
Open selected doc files from the folder	Administrative Review Report
Print selected doc files from the folder	Close & save changes to all doc files opened from the folder
Close & discard changes to all doc files opened from the folder	Update "EC Folder Contents" table and update headers, footers, & chapters of doc files
Save all EC Folder doc files as read-only	Allow change to all EC Folder doc files
Select an open doc and insert an 11x8.5 page following its current page	Select an open doc and insert a 17x11 page following its current page

Instructions: Click in the appropriate cell; hit F2 to execute

A.2 List of Hard Copy Only Pages

N/A

A.3 Revision Summary

This is the original version.

A.4 Problem Statement

An RB fan is required to be available during AI-504 Shutdown Condition 4, which is when the ILRT will be performed in 14R. Since air is denser than steam at a given pressure, it is desired to know how much the RB will need to be depressurized to allow an RB fan to operate if a loss of decay heat is experienced. This evaluation will determine the maximum RB pressure to operate the fans with no change to the current configuration (baffles, overloads), as well as for larger overloads without baffles. These values will be compared to the estimated time to boil for the RCS and a recommendation will be made regarding configuration during 14R.

This EC-ED will also evaluate the ability to depressurize the RB at 15 psi/hr.

A.5 Solution Statement

The pressure at which the density of air equals the post-accident containment steam/air density of 0.19 lb_m/ft^3 is approximately 24 psig. If the RB fan motor overloads are replaced with 129 amp overloads, the allowable pressure can be increased to approximately 29 psig. This means the RB fans would not be considered "available" above these pressures. If decay heat removal was lost while the ILRT was in progress and at the maximum potential pressure of 55 psig, it would take approximately 2 hours to depressurize at 15 psi/hr, plus the time required to perform the necessary valve and equipment manipulations. The entire evolution would need to be completed prior to reaching the time to boil (estimated at approximately 3 hours).

The alternative to depressurizing the RB is to install baffles and change the fan motor overloads, similar to previous ILRTs. This would result in the fan being available during the entire duration of the ILRT. **This is the recommended option.** The baffles are stored in the oil tank warehouse (CATID 52700753). Details regarding their installation are included on drawing 311-725.

The installed ILRT depressurization line and two 8" temporary lines have adequate capacity to initially depressurize containment at 15 psi per hour. The containment pressure will eventually decrease to the point that there is insufficient ΔP to continue at 15 psi/hr and a slower rate will result.

A.6 Evaluation

During previous performances of the containment integrated leak rate tests (ILRT), the RB fans operated while the RB was pressurized. Since air is denser than steam at a given pressure, baffles were installed in the intake plenums of the fans and the motor overloads were replaced with overloads with higher ratings to prevent the fans from tripping. During 14R, the RB fans will not be operating during the ILRT. One fan, however, must still be available per AI-504, Enclosure 4. This ED will evaluate how much RB pressure would need to be reduced to allow the fans to operate, and also determine if a 15 psi/hr depressurization rate is feasible.

The following items will be included in this evaluation:

1. Determine the RB pressure that will allow a RB fan to operate in low speed if the ILRT baffles are not installed and the motor overloads <u>are not</u> changed.
2. Determine the RB pressure that will allow a RB fan to operate in low speed if the ILRT baffles are not installed and the motor overloads <u>are</u> changed
3. Determine the time to boil for the RCS during the ILRT.
4. Determine if the RB can be depressurized at a rate of 15 psi/hr.

Design Inputs:

Design Accident Ratings for AHF-1A/B/C [References 1 and 4]

Volumetric Flow Rate = Q = 50,000 ft^3/min

Density = ρ_{RB} = 0.19 lb_m/ft^3

Full Load Motor Current = FLA = 114 A

Volume of Containment is 2,060,000 ft^3 [Reference 10]

Assumptions:

1. The average air temperature inside containment during the ILRT is 90°F (the average air temperature during the ILRT in 6R was ~89°F with mixing/cooling [Ref. 3]. This is conservative because air temperature is expected to be higher without mixing/cooling (higher temperature = lower density).
2. Pressure drop in the suction ductwork is neglected (low velocity).

1. Determine the RB pressure that will allow a RB fan to operate in low speed if the ILRT baffles are not installed and the motor overloads <u>are not</u> changed

Per the RB fan vendor manual [Ref. 1], the design density of the air/steam mixture inside containment during accident conditions is 0.19 lb_m/ft^3. The pressure of air that corresponds to this density can be approximated from the following equation (ignores humidity and losses):

$$P = [\rho * R * (t + 460)/144] - 14.7$$

where R = 53.3 $ft\text{-}lb_f/lb_m$°R for air and t = °F

For ρ = 0.19 lb_m/ft^3 and t = 90°F,

$$P = [0.19 * 53.3 * (90 + 460)/144] - 14.7$$

$$\mathbf{P_{max} \approx 24\ psig}$$

2. Determine the RB pressure that will allow a RB fan to operate in low speed if the ILRT baffles are not installed and the motor overloads <u>are</u> changed

Fans are constant volume devices, i.e., the volume of gas being transferred does not significantly change as temperature and pressure are varied. What does change is the mass flow rate, which is equal to the volumetric flow rate times the density. The change in mass flow rate has a direct impact on the motor current. The relationship of power input (H) and air density (ρ) can be approximated by the following equation [Reference 2]:

$$H_1 / H_2 = \rho_1 / \rho_2$$

If the motor overloads are replaced with higher-rated overloads, as was done during the previous ILRTs, the fans will be able to operate at higher containment pressure (density). The density of air that will result in the higher overload current rating of 129 amps is

$$\rho_2 = \rho_1 * (H_2 / H_1)$$

$$= 0.19\ lb_m/ft^3 * (129/114)$$

$$= 0.215\ lb_m/ft^3$$

The corresponding RB pressure is

$$P = [0.215 * 53.3 * (90 + 460)/144] - 14.7$$

$$\mathbf{P_{max} \approx 29\ psig}$$

3. Determine the time to boil for the RCS during the ILRT for the containment pressures determined above

The spreadsheet included in Attachment 1 calculates time to boil for CR-3's core configuration in 14R at 20 days after shutdown with a RB pressure of 24 psig. The time to boil varies with RCS level and initial temperature, but will be approximately 3 hours if the RCS is above 141 feet and initially controlled at 120°F. The time can be extended about 12 minutes if RB pressure is 29 psig. *Note: this is an unverified spreadsheet, but the results are considered reasonable based on comparison to previous time to boil calculations.*

4. Determine if the RB can be depressurized at a rate of 15 psi/hr

The depressurization of the RB will be performed utilizing the ILRT depressurization line as well as two 8" temporary lines that will also be used for pressurization.

Assuming a maximum RB pressure of 55 psig, the mass of air in the containment building is

$$M = PV/RT$$

$$= (55\ lb_f/in^2 + 14.7\ lb_f/in^2)(144\ in^2/ft^2)(2{,}060{,}000\ ft^3)/(53.3\ ft\text{-}lb_f/lb_m{}^\circ R)(90 + 460^\circ R)$$

$$\approx 705{,}300\ lb_m$$

Similarly, the mass of air in containment at 40 psig is

$$= (40\ lb_f/in^2 + 14.7\ lb_f/in^2)(144\ in^2/ft^2)(2{,}060{,}000\ ft^3)/(53.3\ ft\text{-}lb_f/lb_m{}^\circ R)(90 + 460^\circ R)$$

$$\approx 553{,}500\ lb_m$$

Therefore, the mass flow required to reduce RB pressure 15 psi/hr at 55 psig is

$$705{,}300\ lb_m - 553{,}500\ lb_m = 151{,}800\ lb_m/hr$$

The volumetric flow rate, in terms of standard cubic feet per minute (scfm),would be

$$Q = m/\rho$$

$$= (151{,}800\ lb_m/hr)(1\ hr/60\ min)/0.0764\ lb_m/ft^3$$

$$Q \approx 33{,}115\ scfm$$

The installed ILRT depressurization line (from Penetrations 305 and 306 through LRV-122 to RB Purge Exhaust ductwork [Ref. 7]) has been analyzed to pass 12,000 scfm (55,008 lb_m/hr) at an RB pressure of 60 psig [References 5 and 6]. Although the flow rate will be slightly less when considering 55 psig vs 60 psig RB pressure, there is sufficient pressure drop across the control valve (LRV-122) in the calculation (35 psi) to increase the flow rate by opening the valve further.

If 12,000 scfm passes through the ILRT depressurization line, the remaining 21,115 scfm will need to exhaust through the two temporary 8" lines. These lines are a combination of carbon steel pipe and flexible hose, and are approximately 225' long each from the RB penetration to the exhaust muffler. The exact configuration is not presently known, as they will be field-run during the outage, but the general arrangement is shown on Attachment 2. Conservatively assuming each line is 1000' long to account for bends, fittings and valves, and using 11,000 scfm per line, the pressure drop is [Reference 8]:

$$\Delta P = \Delta P_{100\ psig,\ 60°F} * [(100 + 14.7)/(P + 14.7)] * [(460 + t)/520] * L\ ft$$

$$\Delta P = 0.633\ psi/100\ ft * [(114.7)/(55 + 14.7)] * [550/520] * 1000\ ft$$

$$\Delta P = 11\ psi$$

As long as the flow is not limited due to the velocity becoming sonic, the 8" lines (in conjunction with the ILRT depressurization line) will pass sufficient air flow to reduce RB pressure at 15 psi/hr. From Reference 9 Equation 9-23, the critical pressure (where velocity becomes sonic) is 52.8% of initial pressure. For a starting pressure of 55 psig (69.7 psia), the flow will become sonic if pressure drops below 22 psig. Therefore, since 55 psig – 11 psi = 44 psig (> 22 psig), sonic flow is not reached in the pipe line, and **15 psi/hr is achievable.**

From a structural standpoint, depressurizing (or pressurizing) the RB at 15 psi/hr is not challenging, as accident conditions are much more severe. The concern with the ILRT pressure change rates is with the impact on insulation, paint, electrical boxes, etc. There is no analysis that evaluates the 15 psi/hr. However, industry experience has demonstrated its acceptability. Brunswick Nuclear Plant currently uses this limit in BNP Procedure 0PT-20.5, and the ILRT vendor contracted for 14R provided a listing of plants that had previously depressurized at this rate (Attachment 3). One station did experience some insulation being displaced from a penetration, but this is considered minor and unusual. Containment inspections after the ILRT will identify any damage and evaluations or corrective actions will be performed as necessary.

A.7 References

1. Vendor Manual 0002, Reactor Containment Fan Cooler, Rev. 11
2. Marks' Standard Handbook for Mechanical Engineers, Ninth Edition
3. SP-178, Rev. 10 (completed 1987, Refuel Outage 6)
4. EDBD 8/11, Reactor Building Air Handling System, Rev 13
5. Calculation M92-0056, H2 Purge Pressure Loss Calculation, Rev. 0
6. MAR 91-05-03-01, Hydrogen Purge Redundancy Restoration
7. Drawing 302-723, Post-Accident Venting System, Rev. 15
8. Crane Technical Paper No. 410, Flow of Fluids Through Valves, Fittings, and Pipes, 1969
9. Essentials of Engineering Fluid Mechanics, Second Edition
10. Calculation M98-0010, Containment Free Volume, Rev. 0
11. Drawing 311-725, Reactor Building Plan at Floor Elev. 95'-0", Rev. 9

8.3 Effect of Faster Pressurization/Depressurization Rates During Last ILRT

Description:

The procedure for conducting the containment Integrated Leak Rate Test (ILRT) (SP-178) was changed before the last ILRT, which was performed in 1995. That change (2005) included a provision to allow the rate of change in internal pressure to 15 psi/hr, a higher rate than was used in previous ILRTs.

Data to be collected and Analyzed:

1. ILRT procedure. (FM 8.3 Exhibit 1)
2. 10 CFR 50.59 Evaluation of the ILRT procedure change relative to the pressurization/depressurization rate of 15 psi/hr. (FM 8.3 Exhibit 2)
3. Engineering disposition to and engineering change (ECED 62366RO) included an evaluation to depressurize containment at 15psi/hr. (FM 8.3 Exhibit 3)

Verified Refuting Evidence:

a. The ILRT procedure was appropriately changed and evaluated in accordance with Progress Energy procedures and 10 CFR 50.59. (FM 8.3 Exhibits 1 and 2)
b. ECDC 62366RO evaluated the 15 psi/hr change of containment pressurization/depressurization and concluded that "From a structural standpoint, depressurizing (or pressurizing) the RB at 15 psi/hr is not challenging, as accident conditions are much more severe" . Although other issues may result from this change, they are not considered relevant to the structural integrity of the containment and therefore not contributors to the delamination issue. (FM 8.3 Exhibit 3, pg 5 of 5)
c. In addition, Impulse Response scans of the exterior containment surface revealed no delamination in any sections between buttresses beyond the panel where the SGR hole was cut

Conclusion: There was no effect on the containment structure from changing the ILRT procedure that had not already been bounded by its design.

Verified Supporting Evidence:

Not applicable

May identify additional perspective on this issue as RCA related efforts proceeds