Progress Energy

Crystal River Nuclear Plant
Docket No. 50-302
Operating License No. DPR-72

January 19, 2012
3F0112-06

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Subject: Crystal River Unit 3 – Response to Request for Additional Information to Support NRC Piping and NDE Branch Technical Review of the CR-3 Extended Power Uprate LAR (TAC No. ME6527)

References:
1. CR-3 to NRC letter dated June 15, 2011, "Crystal River Unit 3 – License Amendment Request #309, Revision 0, Extended Power Uprate" (Accession No. ML112070659)
2. NRC to CR-3 letter dated December 7, 2011, "Crystal River Unit 3 Nuclear Generating Plant - Request for Additional Information for Extended Power Uprate License Amendment Request (TAC No. ME6527)" (Accession No. ML11326A231)

Dear Sir:

By letter dated June 15, 2011, Florida Power Corporation, doing business as Progress Energy Florida, Inc., requested a license amendment to increase the rated thermal power level of Crystal River Unit 3 (CR-3) from 2609 megawatts (MWt) to 3014 MWt. On December 7, 2011, the NRC provided a request for additional information (RAI) required to complete its evaluation of the CR-3 Extended Power Uprate (EPU) License Amendment Request (LAR).

The attachment, "Response to Request for Additional Information to Support NRC Piping and NDE Branch Technical Review of the CR-3 EPU LAR," provides the CR-3 formal response to the RAI needed to support the Piping and NDE Branch technical review of the CR-3 EPU LAR.

This correspondence contains no new regulatory commitments.

If you have any questions regarding this submittal, please contact Mr. Dan Westcott, Superintendent, Licensing and Regulatory Programs at (352) 563-4796.

Sincerely,

Jon A. Franke
Vice President
Crystal River Nuclear Plant

JAF/gwe

Attachment: Response to Request for Additional Information to Support NRC Piping and NDE Branch Technical Review of the CR-3 EPU LAR

xc: NRR Project Manager
Regional Administrator, Region II
Senior Resident Inspector
State Contact

A001
NRR

Progress Energy Florida, Inc.
Crystal River Nuclear Plant
15760 W. Powerline Street
Crystal River, FL 34428

STATE OF FLORIDA

COUNTY OF CITRUS

Jon A. Franke states that he is the Vice President, Crystal River Nuclear Plant for Florida Power Corporation, doing business as Progress Energy Florida, Inc.; that he is authorized on the part of said company to sign and file with the Nuclear Regulatory Commission the information attached hereto; and that all such statements made and matters set forth therein are true and correct to the best of his knowledge, information, and belief.

Jon A. Franke
Vice President
Crystal River Nuclear Plant

The foregoing document was acknowledged before me this 19 day of January, 2012, by Jon A. Franke.

Carolyn E Portmann

Signature of Notary Public
State of Florida

CAROLYN E. PORTMANN
Commission # DD 937553
Expires March 1, 2014
Bonded Thru Troy Fain Insurance 800-385-7019

(Print, type, or stamp Commissioned Name of Notary Public)

Personally Known ✓ -OR- Produced Identification ______

FLORIDA POWER CORPORATION

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50-302 /LICENSE NUMBER DPR-72

ATTACHMENT

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION TO SUPPORT NRC PIPING AND NDE BRANCH TECHNICAL REVIEW OF THE CR-3 EPU LAR

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION TO SUPPORT NRC PIPING AND NDE BRANCH TECHNICAL REVIEW OF THE CR-3 EPU LAR

By letter dated June 15, 2011, Florida Power Corporation (FPC), doing business as Progress Energy Florida, Inc., requested a license amendment to increase the rated thermal power level of Crystal River Unit 3 (CR-3) from 2609 megawatts (MWt) to 3014 MWt. On December 7, 2011, the NRC provided a request for additional information (RAI) required to complete its evaluation of the CR-3 Extended Power Uprate (EPU) License Amendment Request (LAR). The following provides the CR-3 formal response to the RAI needed to support the Piping and NDE Branch (EPNB) technical review of the CR-3 EPU LAR. For tracking purposes, each item related to this RAI is uniquely identified as EPNB X-Y, with X indicating the RAI set and Y indicating the sequential item number.

Piping and NDE Branch (EPNB)

Applicable Application Section, 2.1.5, "Reactor Coolant Pressure Boundary (RCPB) Materials."

Section 2.1.5 RAI Background

The following discussion related to CR-3 EPU conditions is provided to support the response to the RAI regarding Section 2.1.5, "Reactor Coolant Pressure Boundary Materials." The CR-3 EPU does not involve significant changes to Reactor Coolant System (RCS) parameters that affect corrosion of the RCPB materials. The RCS thermal hydraulic (T-H) condition changes as a result of EPU are as follows:

RCS Temperature

At CR-3, the RCS T_{AVG} is maintained at a constant value during plant operation and slightly increases at EPU conditions. As summarized in Section 1.1, "Nuclear Steam Supply System Parameters," of the EPU Technical Report (TR) (Reference 1, Attachments 5 and 7), T_{HOT} increases a maximum of 6.6°F, T_{COLD} decreases < 1°F, and T_{AVG} increases 3°F at EPU conditions.

RCS Pressure

As indicated in Section 1.1 of the EPU TR (Reference 1, Attachments 5 and 7), the RCS pressure is unchanged at EPU conditions.

RCS Flow

Total RCS flow does not increase as a result of EPU. As indicated in Section 1.1 of the EPU TR (Reference 1, Attachments 5 and 7), the total RCS flow slightly decreases; < 1%.

RCS Boron Concentration

At EPU conditions, RCS boron concentration increases at the beginning of core life, assuming hot zero power and equilibrium xenon conditions, from approximately 1500 ppm to approximately 1700 ppm. The average deviation of RCS boron concentration during a 24-month operating cycle at EPU conditions is approximately 100 ppm. Also, Electric

Power Research Institute (EPRI) studies have concluded that the influence that lithium and boron have on primary water stress corrosion cracking (PWSCC) is much less than the overall pH effect.

The CR-3 Boric Acid Corrosion (BAC) Control Program monitors piping outside diameter corrosion, including RCPB piping. The BAC Control Program ensures a rigorous response to leak sites that could result in boric acid corrosion of plant piping and other structures, systems, and components (SSCs). Corrosion is tracked and trended via CR-3 work control and plant corrective action processes. Evaluations associated with these processes use appropriate system conditions (e.g., chemistry, temperature, etc.). Although parameters used in these evaluations may change as a result of EPU, the monitoring programs to assess and manage corrosion are not fundamentally changed and evaluations associated with these programs will continue to use appropriate conditions following EPU implementation. In addition, routine system and Mode 3 walkdowns aid in leakage identification.

At CR-3, internal RCS corrosion is managed in accordance with the CR-3 Strategic Water Chemistry Plan (SWCP). The SWCP includes the guidance and requirements of EPRI Report 1014986, "Pressurized Water Reactor Primary Water Chemistry Guidelines," (Reference 2). Operation at EPU conditions does not alter compliance with the requirements of the SWCP. The EPRI guideline limits and requirements are not altered as a result of EPU. Additionally, RCS pH is cycle specific and an RCS supplemental chemistry guideline is developed by the fuel vendor, which includes pH requirements for the operating cycle consistent with the SWCP.

Boron concentration is maintained for reactivity management over core life. Lithium concentration is coordinated with the boron concentration over the entire cycle to achieve the required RCS pH. The resulting pH program precludes general corrosion and adverse impacts on fuel cladding. Thus, the higher boron concentrations required for EPU operation will necessitate changes to lithium concentrations to maintain pH per the fuel vendor established program. Nevertheless, the fundamental program requirements are not altered as a result of EPU conditions. The fuel vendor prescribed pH program for any plant condition, including EPU, ensures that the principles for a pH program defined in the EPRI pressurized water reactor (PWR) primary water chemistry guidelines (Reference 2) are followed.

11. (EPNB 1-1)

Under the heading, General Corrosion/Wastage of Carbon Steel Components, Section 2.1.5.2 discusses the boric acid corrosion (BAC) program at Crystal River Unit 3 (CR-3). (1) Discuss how often the visual inspection will be performed under the BAC program. (2) Clarify whether all reactor coolant pressure boundary (RCPB) components (piping and vessels) will be inspected and managed under the BAC program. Identify and justify any RCPB components that will not be inspected under the BAC program. (3) Explain why the BAC program will not be affected by the EPU. (4) Discuss the impact of EPU on general corrosion/wastage of RCPB components because the licensee discussed mainly the BAC program and Electric Power Research Institute (EPRI) water chemistry guidelines without addressing the impact of EPU on general corrosion/wastage of RCPB components.

Response:

(1) Visual inspections as part of the BAC Control Program are routinely performed but not conducted on a specific interval. Specific boric acid awareness training is provided to plant personnel that are likely to come into contact with potential boric acid leakage and includes engineering, maintenance, health physics, and operations personnel. During the normal course of their duties, plant personnel traverse accessible areas of the plant at a frequency that promotes early detection of boric acid leakage and are required to initiate a plant corrective action when boric acid residue is detected. In addition to routine walkdowns, visual inspections of borated water systems are conducted by systems engineers during system walkdowns and Mode 3 walkdowns such that the entire system is completely walked down within one operating cycle. Portions of the borated systems not accessible due to reactor operation are scheduled at least once per operating cycle during outages. Also, CR-3 maintains a BAC control monitoring log consisting of a list of boric acid system components that have a history of leakage. This log identifies the required inspection and monitoring interval for each component to ensure they are inspected at a frequency commensurate with their risk.

(2) RCPB components (piping and vessels) are managed under the CR-3 BAC Control Program and are inspected based on the program procedural guidance.

(3) As noted above in the Section 2.1.5 RAI Background, there are no changes to the BAC Control Program requirements. The range of parameter changes associated with the EPU does not unduly challenge management of the BAC Control Program.

(4) CR-3 EPU analyses indicate, as summarized in Section 1.1 of the EPU TR (Reference 1, Attachments 5 and 7), T_{HOT} increases a maximum of 6.6°F, T_{COLD} decreases < 1°F, T_{AVG} increases 3°F, and the total RCS flow decreases < 1%. As described in EPRI Report 1000975, "Boric Acid Corrosion Guidebook, Revision 1, Managing Boric Acid Corrosion Issues at PWR Power Stations," (Reference 3), extensive testing indicates that the general corrosion rate of carbon and low alloy steel in borated water peaks at approximately 220°F. The general corrosion rate decreases approximately one order of magnitude as the temperature increases to 600°F. Since the RCS normal operating temperature is approximately 580°F, small changes in RCS temperature (i.e., 6.6°F) will have a negligible impact on the general corrosion rate of the RCPB components at EPU conditions.

As described above in the Section 2.1.5 RAI Background, the changes in RCS T-H conditions and chemical conditions as a result of EPU do not impact the CR-3 BAC Control Program and SWCP requirements and any changes will continue to be managed by these programs. The vast majority of leaks are mechanical in nature, such as valve packing leakage, and the relatively minor change in RCS T-H and chemistry conditions will not affect crack generation; rarely a source of leakage. Per the BAC Control Program, corrosion rate determinations assume the maximum boric acid concentration due to the effect of evaporative distillation; ≥ 2500 ppm, which is greater than projected EPU boric acid concentrations. In addition, operation at EPU conditions does not alter compliance with the requirements of the SWCP. The SWCP will continue to implement the EPRI PWR primary water chemistry guideline requirements following EPU implementation. Thus, operation at EPU conditions will not have an adverse impact on general corrosion or wastage of the RCPB components.

12. (EPNB 1-2)

Under the heading, SCC [Stress Corrosion Cracking] of Austenitic Stainless Steels, Section 2.1.5.2 focuses on the treatment of the reactor coolant inside the pipe. NRC Information Notice 2011-04, "Contaminants and Stagnant Conditions Affecting Stress Corrosion Cracking in Stainless Steel Piping in Pressurized-Water Reactors [PWRs]," discusses stress corrosion cracking initiated from the outside diameter of austenitic stainless steel piping. The EPU conditions may cause higher stresses in the piping and can affect SCC. Therefore, discuss the impact of EPU on the potential of outside diameter SCC (ODSCC) on RCPB piping and the program to monitor the ODSCC on stainless steel piping.

Response:

Progress Energy has evaluated NRC Information Notice 2011-04 and determined that the existing monitoring and inspection requirements at CR-3 adequately assess ODSCC of austenitic stainless steel piping. Routine plant system walkdowns and Mode 3 walkdowns are performed such that the RCPB piping is walked down within one operating cycle and includes monitoring ODSCC of austenitic stainless steel piping. Temperature is the only parameter altered by EPU that could potentially affect ODSCC susceptibility. CR-3 EPU analyses indicate, as summarized in Section 1.1, of the EPU TR (Reference 1, Attachments 5 and 7), T_{HOT} increases a maximum of 6.6°F, T_{COLD} decreases < 1°F, and T_{AVG} increases 3°F. RCS temperatures are well above the temperature at which moisture can exist on the outside surface of the RCS primary loop piping. As such, EPU will not impact the potential of ODSCC on RCPB piping that operates above 250°F. For RCPB stainless steel piping that operates below 250°F, the small increase in RCS temperature is not expected to impact ODSCC susceptibility. Therefore, the current CR-3 strategy for assessing and monitoring ODSCC continues to be acceptable at EPU conditions.

13. (EPNB 1-3)

Under the heading "Alloy 600/82/182 Components at CR-3," Section 2.1.5.2 discusses impact of EPU on primary water stress corrosion cracking (PWSCC) of Alloy 82/182 dissimilar welds. (1) Identify any RCPB piping that have unmitigated Alloy 82/182 dissimilar butt welds. (2) Discuss the impact of EPU on the integrity of those pipes with unmitigated Alloy 82/182 welds and how the unmitigated pipes will be monitored to minimize potential PWSCC. (3) Section 2.1.5.2 states that the pressurizer surge line was mitigated in 2009. The NRC staff understands that the licensee installed a weld overlay on the surge line. Based on the NRC-approved weld overlay relief request, a flaw growth calculation must be performed for the surge line. Discuss whether the flaw growth calculation has been updated to include the EPU conditions. If not, provide justification. (4) Discuss whether the safety, relief, and spray nozzles of the pressurizer have been mitigated. If yes, subquestion (3) above applies. (5) Discuss whether an Alloy 600 Program has been implemented to monitor and manage PWSCC of Alloy 600/82/182 material. If not, provide justification. (6) Discuss whether EPU will increase the potential of PWSCC at the bottom-mounted instrument nozzles of reactor pressure vessel.

Response:

(1) As noted in Section 2.1.5, "Reactor Coolant Pressure Boundary Materials," of the EPU TR (Reference 1, Attachments 5 and 7), RCPB Alloy 600/82/182 locations most susceptible to PWSCC have been replaced or mitigated with Alloy 690/52/152. The following remaining

RCPB locations have unmitigated Alloy 82/182 dissimilar metal welds; cold leg butt welds, cold leg instrument nozzle welds, the bottom-mounted instrument (BMI) nozzle welds, core flood nozzle welds, High Pressure Injection and Makeup System (HPI/MU) nozzle welds, and HPI nozzle safe end welds.

(2) RCPB locations with unmitigated Alloy 82/182 welds are exposed to RCS cold leg temperature, which decreases < 1°F due to EPU. This small temperature change will have no affect on PWSCC susceptibility. Therefore, the EPU will not impact the integrity of RCPB piping with unmitigated Alloy 82/182 welds. Additionally, an Alloy 600 Program has been implemented for CR-3 as part of a Progress Energy fleet program. This program implements the mandatory recommendations of NEI 03-08, "Guideline for the Management of Materials Issues," (Reference 4) and includes monitoring and managing the effects of PWSCC for Alloy 600/82/182.

As indicated in the EPRI PWR primary water chemistry guidelines (Reference 2), pH is the primary chemistry parameter that contributes to PWSCC. Although RCS water chemistry requirements will change as a result of EPU (e.g., boron and lithium concentration), the CR-3 SWCP will continue to maintain the parameters within the EPRI guideline limits, including RCS pH. As such, existing monitoring requirements to minimize the susceptibility to PWSCC on unmitigated RCPB piping welds continue to be acceptable following EPU implementation.

(3) A full structural weld overlay has been installed at the pressurizer surge line nozzle location. The associated flaw growth calculation has been updated to reflect a higher RCS hot leg temperature of 609°F at EPU conditions.

(4) The pressurizer safety valve nozzles, pressurizer power operated relief valve nozzle, and pressurizer spray nozzle have been mitigated with Alloy 52 structural weld overlay. The associated flaw growth calculations consider a pressurizer design temperature of 650°F which is unchanged at EPU conditions.

(5) An Alloy 600 Program has been implemented for CR-3 as part of a Progress Energy fleet program. This program implements the mandatory recommendations of NEI 03-08 (Reference 4) and includes monitoring and managing the effects of PWSCC for Alloy 600/82/182.

(6) The effective temperature of the BMI nozzles is T_{COLD}. CR-3 EPU analyses indicate T_{COLD} decreases < 1°F. Additionally, RCS water chemistry parameters that can affect PWSCC, including pH, will continue to be maintained within the limits of the CR-3 SWCP and EPRI PWR primary water chemistry guidelines. Therefore, operation at EPU conditions will not increase the susceptibility of PWSCC at the BMI nozzles.

14. (EPNB 1-4)

Under the heading "Alloy 600/82/182 Components at CR-3," Section 2.1.5.2 states that " ... [a] review of operating experience regarding effects of lithium and pH on PWSCC by EPRI PWR Water Chemistry Guidelines suggests that there are no adverse effects on PWSCC from the lithium/boron concentration range. Therefore, there is no PWSCC impact from the EPU water chemistry...."

The licensee's statements are not clear regarding the impact of EPU on the potential for PWSCC on RCPB piping. (1) Clarify whether EPU will change the lithium and boron concentration. If yes, discuss whether the change will increase the potential for PWSCC in the RCPB piping. (2) Discuss whether EPU will cause unfavorable changes in reactor coolant system (RCS) water chemistry that would lead to the RCPB piping being more susceptible to PWSCC. For example, EPU may cause chemicals to be added or oxygen and hydrogen concentration to be changed. (3) If EPU causes an unfavorable change in RCS water chemistry, discuss how CR-3 will manage the unfavorable changes to minimize degradation.

Response:

As noted above in the Section 2.1.5 RAI Background, the CR-3 EPU does not involve significant changes to RCS parameters that affect corrosion of the RCPB materials. As indicated in the EPRI PWR primary water chemistry guidelines (Reference 2), pH is the primary chemistry parameter that contributes to PWSCC. Although boron concentration will increase as a result of EPU, equivalent changes in lithium concentrations will maintain RCS pH within limits. Additionally, other RCS water chemistry parameters that can have an impact on corrosion are fluoride, chloride, sulfate, dissolved hydrogen, and dissolved oxygen. The CR-3 chemistry limits of these parameters, which are consistent with the EPRI PWR primary water chemistry guidelines (Reference 2), are not affected by EPU and the CR-3 SWCP will continue to maintain the parameters within these required limits. Therefore, the potential for PWSCC in the RCPB piping will not increase and there are no unfavorable changes in the RCS water chemistry that would lead to the RCPB piping being more susceptible to PWSCC as a result of EPU.

15. (EPNB 1-5)

(a) Address the impact of EPU on other degradation mechanisms in the RCPB piping that were not discussed in Section 2.1.5, such as water hammer, flow accelerated corrosion, high cycle fatigue, and environmentally assisted fatigue of the RCPB piping (e.g., thermal stratification in the pressurizer surge line). (b) Discuss the impact of EPU on the fatigue cumulative usage factors of the RCPB piping. Discuss whether the cumulative usage factors have been updated due to EPU. If not, provide justification.

Response:

(a) The effects of waterhammer on the CR-3 RCPB components due to the EPU were not specifically analyzed. However, changes in primary system parameters important to fluid transient loads are not expected to increase the susceptibility of RCPB component damage as a result of waterhammer at EPU conditions. For example, primary system pressure distribution does not change as a result of EPU therefore; hydraulic loads on the pressurizer spray line due to spray valve actuation will not increase.

Secondary side steam and feedwater flows increase approximately 17% as a result of EPU. However, the attendant increases in secondary system piping loads resulting from secondary side fluid transients do not significantly increase the risk to the RCPB integrity (i.e., steam generator tubes) because of the infrequent occurrence of relevant transients and the degree of attenuation that occurs at the steam or feedwater nozzles/annuli of the steam generators. These conclusions are supported by the results of an EPRI review of waterhammer mechanisms in the nuclear industry. EPRI Report TR-106438 2856-03, "Water Hammer

Handbook for Nuclear Plant Engineers and Operators," (Reference 5) provides a list of waterhammer mechanisms in PWRs, including frequency of occurrence. The vast majority of severe events reported occurred via the inadvertent interaction of two-phase mixtures: this type of waterhammer event is not created or aggravated by the EPU. Several events were flow related, however, these events were limited to localized effects (e.g., snubber or support damage).

CR-3 EPU analyses indicate, as noted in Section 1.1 of the EPU TR (Reference 1, Attachments 5 and 7), total RCS flow decreases < 1%. Therefore, flow accelerated corrosion is not expected to increase in the RCPB piping.

High cycle fatigue in the RCS piping is not expected to change as a result of EPU since the volumetric flow rate decreases < 1%.

Environmentally assisted fatigue evaluations were not specifically performed for the CR-3 EPU consistent with the CR-3 current licensing basis (CLB). However, as noted in Section 2.2.2.1, "NSSS Piping, Components, and Supports," of the EPU TR (Reference 1, Attachments 5 and 7), the environmental effects of fatigue on the pressurizer surge line have been previously evaluated and the results of those evaluations remain valid for EPU. Additionally, environmentally assisted fatigue evaluations were required for CR-3 license renewal. A separate independent LAR regarding CR-3 license renewal was submitted in December 2008 (Reference 6). To avoid duplication of NRC reviews regarding CR-3 license renewal, FPC proposes to not address environmentally assisted fatigue evaluations further as part of the CR-3 EPU LAR review.

(b) The RCPB piping fatigue usage factors have been updated for EPU conditions. Refer to Section 2.2.2.1 of the EPU TR (Reference 1, Attachments 5 and 7) for a summary of the structural analyses performed for the RCPB piping considering EPU conditions which includes a discussion related to the fatigue cumulative usage factors.

16. (EPNB 1-6)

In Section 2.1.5.2, under the heading "Thermal Aging," the licensee stated that "A review of the RCS pressure boundary components shows no CASS [cast austenitic stainless steel] material in the RCS pressure boundary exposed to the T_{HOT}. Therefore, there will be no impact on thermal aging by the EPU." However, reactor coolant pump (RCP) casing is made of CASS material as discussed in Section 2.1.6. RCP experiences T_{COLD} temperature, not T_{HOT}. Discuss whether EPU affects the thermal aging of the cold leg piping. If yes, discuss how thermal aging of the RCP casing will be monitored.

Response:

As indicated in Section 1.1 of the EPU TR (Reference 1, Attachments 5 and 7), T_{COLD} will decrease < 1°F at EPU conditions. Therefore, operation at EPU conditions will not further alter the thermal aging effect of the RCS cold leg piping, including the CASS material in the RCP casing exposed to the primary coolant. The ASME Section XI inspection requirements will continue to manage the effects of loss of fracture toughness due to thermal aging embrittlement of the CASS material in the RCP casings.

Applicable Application Section 2.1.6, "Leak-Before-Break."

17. (EPNB 1-7)

(a) Confirm that the only piping that CR-3 has been approved for leak-before-break (LBB) is the primary loop, and no branch lines. (b) Discuss whether the primary loop piping contains nickel-based Alloy 82/182 welds and discuss whether the primary loop piping has been mitigated to minimize PWSCC. Discuss the mitigation method. (c) If the primary loop piping has not been mitigated, discuss the measures to minimize its potential of PWSCC under EPU. (d) If the primary loop piping has been mitigated with a weld overlay discuss whether the original LBB evaluation has been updated per NRC Regulatory Issue Summary 2010-07.

Response:

(a) Consistent with the Babcock and Wilcox (B&W) Topical Report BAW-1847, Revision 1, "Leak-Before-Break Evaluation of Margin Against Full Break for RCS Primary Piping of B&W Designed NSS," (Reference 7), the only CR-3 RCS piping that has been approved for LBB is the RCS primary loop piping. For CR-3, none of the RCS branch lines have been approved for LBB.

(b) As noted in Section 2.1.5 of the EPU TR (Reference 1, Attachments 5 and 7), RCPB Alloy 600/82/182 locations most susceptible to PWSCC have been replaced or mitigated with Alloy 690/52/152. The following remaining RCPB locations have unmitigated Alloy 82/182 dissimilar metal welds; cold leg butt welds, cold leg instrument nozzle welds, BMI nozzle welds, core flood nozzle welds, HPI/MU nozzle welds, and HPI nozzle safe end welds.

(c) RCPB locations with unmitigated Alloy 82/182 dissimilar metal welds are exposed to RCS cold leg temperature, which decreases < 1°F due to EPU. This small temperature decrease will have no affect on PWSCC susceptibility. An Alloy 600 Program has been implemented for CR-3 as part of a Progress Energy fleet program. This program implements the mandatory recommendations of NEI 03-08 (Reference 4) and includes monitoring and managing the effects of PWSCC for Alloy 600/82/182.

(d) The RCS primary loop piping system has not been mitigated with weld overlay or other mitigation techniques. As noted in Section 2.1.6 of the EPU TR (Reference 1, Attachments 5 and 7), the CR-3 LBB analyses were performed in accordance with the CR-3 CLB and the LBB methodology described in BAW-1847, Revision 1 (Reference 7). The LBB analysis was re-performed considering EPU conditions for the RCS hot leg location to confirm that the LBB margins are met and that they remain bounded by the minimum LBB margins of the cold leg piping cited in BAW-1847, Revision 1 (Reference 7). The LBB analyses do not need to be updated to consider the guidance of Regulatory Issue Summary 2010-07, "Regulatory Requirements for Application of Weld Overlays and Other Mitigation Techniques in Piping Systems Approved for Leak-Before-Break," (Reference 8) since as stated above, the RCS primary loop piping has not been mitigated with weld overlay or other mitigation techniques.

18. (EPNB 1-8)

Section 2.1.6.2 specifies an acceptance criterion that requires the "Minimum Moment" loads calculated for the EPU be *greater* than the "Minimum Moment" loads in the original LBB analysis (BAW-1847). Note (2) to Table 2.1.6-2 (minimum moment loads) states that the minimum moment load calculated using EPU conditions for the 36-inch inside diameter hot leg straight pipe is less than the minimum moment load in the original LBB analysis. This implies that the 36-inch hot leg pipe does not satisfy the above acceptance criterion. However, Note (2) explains that Table 2.1.6-1 (maximum moment loads) shows that the EPU maximum bending moment at this location is much smaller than the maximum moment load in the original LBB analysis, meaning that the flaw size required for a flow rate of 10 gallons per minute is stable enough to not experience growth under the EPU maximum moment loading. Discuss whether the 36-inch hot leg pipe under the EPU conditions will satisfy the margin of 2 for crack size and margin of 10 for the leakage as specified in Standard Review Plan 3.6.3. If not, provide justification for the proposed EPU.

Response:

As noted in Section 2.1.6 of the EPU TR (Reference 1, Attachments 5 and 7), the CR-3 LBB analyses, considering EPU conditions, were performed in accordance with the CR-3 CLB and the LBB methodology described in B&W Topical Report BAW-1847, Revision 1 (Reference 7). A detailed LBB analysis has now been performed to address the hot and cold leg piping at EPU conditions, in lieu of the qualitative assessment previously cited in Note (2) to Table 2.1.6-2 of the EPU TR (Reference 1, Attachments 5 and 7). The detailed LBB analysis for the CR-3 EPU includes the 36-inch inside diameter hot leg straight pipe location and demonstrates that the required LBB margins are met at this location as well; a predicted leakage rate margin of 10 was used to determine the leakage size crack assuming normal operating conditions and flaw stability margin of at least 2 was demonstrated assuming normal plus faulted conditions. The calculated flaw stability margin between a leakage size crack and a critical size crack at this hot leg piping location is 5.4; greater than the required margin of 2.

References

1. CR-3 to NRC letter dated June 15, 2011, "Crystal River Unit 3 – License Amendment Request #309, Revision 0, Extended Power Uprate." (Accession No. ML112070659)

2. EPRI Report 1014986, "Pressurized Water Reactor Primary Water Chemistry Guidelines," Volume 1, Revision 6, December 2007.

3. EPRI Report 1000975, "Boric Acid Corrosion Guidebook, Revision 1, Managing Boric Acid Corrosion Issues at PWR Power Stations," Final Report, November 2001.

4. NEI 03-08, "Guideline for the Management of Materials Issues," Revision 2, January 2010.

5. EPRI Report TR-106438 2856-03, "Water Hammer Handbook for Nuclear Plant Engineers and Operators," May 1996.

6. CR-3 to NRC letter dated December 16, 2008, "Crystal River Unit 3 – Application for Renewal of Operating License." (Accession No. ML090080054)

7. B&W Topical Report BAW-1847, Revision 1, "Leak-Before-Break Evaluation of Margin Against Full Break for RCS Primary Piping of B&W Designed NSS," September 1985.

8. Regulatory Issue Summary 2010-07, "Regulatory Requirements for Application of Weld Overlays and Other Mitigation Techniques in Piping Systems Approved for Leak-Before-Break," June 8, 2010.