UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 2, 2018

Mr. Mano Nazar
President and Chief Nuclear Officer
Nuclear Division
Florida Power & Light Company
Mail Stop EX/JB
700 Universe Blvd.
Juno Beach, FL 33408

SUBJECT: ST. LUCIE PLANT, UNIT NOS. 1 AND 2 - REVIEW OF LICENSE RENEWAL COMMITMENT FOR REACTOR VESSEL INTERNALS AGING MANAGEMENT PLAN (CAC NOS. MF6777 AND MF6778, EPID L-2015-LRO-0001)

Dear Mr. Nazar:

By letter to the U.S. Nuclear Regulatory Commission (NRC) dated September 28, 2015, as supplemented by letters dated February 26, 2016, March 7, 2017, July 3, 2017, and December 19, 2017, Florida Power & Light Company (FPL or the licensee) submitted to the NRC staff a document titled, "St. Lucie Units 1 and 2 Reactor Vessel Internals [RVI] Aging Management Plan [AMP]." This RVI AMP was submitted to address Commitment No. 12 from the extended power uprate (EPU) safety evaluation report (SER) for St. Lucie Unit 1, and Commitment 4 from the SER related to the EPU for St. Lucie Unit 2. Both EPU commitments stated FPL would adopt MRP-227-A in place of its previously accepted RVI Inspection Program.

The enclosure to this letter documents the NRC staff's review and assessment of the licensee's submittal. The NRC staff finds that the licensee's RVI AMP and RVI Inspection Plan are acceptable and that the licensee has fulfilled EPU Commitment 12 for St. Lucie Unit 1, and EPU Commitment 4 for St. Lucie Unit 2.

Please contact Perry Buckberg at (301) 415-1383 if you have any questions.

Sincerely,

Perry H. Buckberg, Senior Project Manager
Plant Licensing Branch II-2
Division of Operator Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-335 and 50-389

Enclosure: Staff Assessment

cc: Listserv

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REACTOR VESSEL INTERNALS AGING MANAGEMENT PLAN

FLORIDA POWER AND LIGHT COMPANY, ET AL.

ST. LUCIE PLANT, UNIT NOS. 1 AND 2

DOCKET NOS. 50-335 AND 50-389

CAC NOS. MF6777 AND MF6778, EPID L-2015-LRO-0001

1.0 INTRODUCTION

By letter dated September 28, 2015 (Reference 1), as supplemented by letters dated February 26, 2016 (Reference 2), March 7, 2017 (Reference 3), July 3, 2017 (Reference 4), and December 19, 2017 (Reference 5), Florida Power & Light (FPL or the licensee) submitted a document titled "St. Lucie Units 1 and 2 Reactor Vessel Internals [RVI] Aging Management Plan [AMP]." The RVI AMP was submitted to address Commitment No. 12 from the extended power uprate (EPU) safety evaluation report (SER) for St. Lucie Unit 1 (References 6 and 7), and Commitment 4 from the St. Lucie Unit 2 EPU SER (Reference 8). FPL stated in both EPU commitments that it would adopt Material Reliability Program (MRP)-227-A, "Pressurized Water Reactor [PWR] Internals Inspection and Evaluation Guidelines," in place of its previously accepted RVI Inspection Program. The commitments made in the EPU SERs superseded Commitment 4 from NUREG-1779, "Safety Evaluation Report Related to the License Renewal of St. Lucie Units 1 and 2 (Reference 9)," which required that FPL submit a report summarizing the aging effects applicable to the RVI, including a description of the inspection plan, prior to the end of the initial period of operation for St. Lucie Unit 1.

In its September 28, 2015, letter, FPL states that, as discussed in its letter dated June 25, 2014 (Reference 10), the RVI inspection plan for St. Lucie Unit 1 is scheduled for submittal to the U.S. Nuclear Regulatory Commission (NRC), by September 30, 2015, and the RVI inspection plan for St. Lucie Unit 2 would be submitted at a later date. FPL further stated that the attached RVI AMP summarizes the St. Lucie Units 1 and 2 RVI Inspection Program and provides the age related degradation effects applicable to the RVI components, the schedule of inspections to be performed and the acceptance criteria.

Commitment No. 5 of NUREG-1779 required that FPL perform a one-time inspection of the reactor vessel internals. In its letter dated September 28, 2015, FPL stated that its letter dated June 25, 2014, discussed and reaffirmed FPL's adoption of MRP-227-A, which requires the implementation of periodic inspections for both St. Lucie Unit 1 and St. Lucie Unit 2, and supersedes the prior commitment for a one-time inspection. FPL further stated that in its letter dated June 25, 2014, it was stated that the first inspection of St. Lucie Unit 1 RVIs is currently

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scheduled for the spring outage of 2018, and that the first inspection of St. Lucie Unit 2 RVIs will be scheduled within 3 years after the period of extended operation (PEO) commences. Commitment No. 12 of the St. Lucie Unit 1 EPU SER, and the fourth in a series of commitments of the St. Lucie Unit 2 EPU SER require that FPL adopt MRP-227-A in place of its previously approved RVI Inspection Program.

In its letter dated September 28, 2015, FPL stated that the RVI AMP attached to the letter summarizes the revised St. Lucie Units 1 and 2 RVI Inspection Program, which is based on MRP-227-A.

2.0 REGULATORY EVALUATION

Title 10 of the *Code of Federal Regulations* (10 CFR) Part 54 addresses the requirements for plant license renewal. The regulation at 10 CFR Section 54.21 requires that each application for license renewal contain an integrated plant assessment (IPA) and an evaluation of time limited aging analyses (TLAAs). The plant-specific IPA shall identify and list those structures and components subject to an aging management review and demonstrate that the effects of aging (e.g., cracking, loss of material, loss of fracture toughness, dimensional changes, and loss of preload) will be adequately managed so that their intended functions will be maintained consistent with the current licensing basis (CLB) for the PEO as required by 10 CFR 54.29(a). In addition, 10 CFR 54.22 requires that a license renewal application (LRA) include any technical specification changes or additions necessary to manage the effects of aging during the PEO as part of the LRA.

Structures and components subject to an AMP shall encompass those structures and components that (1) perform an intended function as described in 10 CFR 54.4, without moving parts or without a change in configuration or properties (passive) and (2) are not subject to replacement based on a qualified life or specified time period (long-lived). The scope of components considered for inspection under MRP-227-A includes core support structures (typically denoted as Examination Category B-N-3 by the American Society of Mechanical Engineers (ASME) Code, Section XI) and those RVI components that serve an intended License Renewal (LR) safety function pursuant to criteria in 10 CFR 54.4(a)(1). The scope of the program does not include non-long-lived components such as fuel assemblies or reactivity control assemblies, or active components such as nuclear instrumentation because these components are not typically within the scope of the components that are required to be subject to an aging management review, as defined by the criteria set in 10 CFR 54.21(a)(1).

On January 12, 2009, Electric Power Research Institute (EPRI) submitted for NRC staff review and approval the Materials Reliability Program (MRP) Report 1016596 (MRP-227), Revision 0, "PWR Internals Inspection and Evaluation Guidelines" (Reference 11), which was intended as guidance for the use of applicants in developing their plant-specific AMP for RVI components.

Subsequent to the submittal of MRP-227 and prior to the issuance of the safety evaluation (SE) on MRP-227, NUREG-1801, "Generic Aging Lessons Learned Report," Revision 2 (the GALL Report, Revision 2) (Reference 12) was issued, providing new aging management review line items and aging management guidance in AMP XI.M16A, "PWR Vessel Internals." This GALL AMP was based on staff expectations for the guidance to be provided in the final NRC-approved version of MRP-227, which would be referred to as MRP-227-A.

Revision 1 to the staff's final SE regarding MRP-227, Revision 0, was issued on December 16, 2011 (Reference 13), with seven conditions and eight applicant/licensee action items (A/LAIs). The topical report conditions were specified to ensure that certain information was revised generically in MPR-227-A and the A/LAIs were specified for applicant/licensees to address plant-specific issues that could not be resolved generically in Revision 1 of the final SE on MRP-227-A. On January 9, 2012, EPRI published MRP-227-A, "Materials Reliability Program: PWR Internals Inspection and Evaluation Guidelines" (Reference 14). MRP-227-A contains a discussion of the technical basis for the development of plant-specific AMPs for RVI components in PWR vessels and also provides inspection and evaluation guidelines for PWR applicants to use in their plant-specific AMPs. MRP-227-A provides the basis for renewed license holders to develop plant-specific inspection plans to manage aging effects on RVI components, as described in the licensees' commitments in their Updated Final Safety Analysis Reports (UFSARs).

Since the GALL Report, Revision 2 was published prior to the issuance of the final MRP-227-A SE, the staff published License Renewal Interim Staff Guidance (LR-ISG) document LR-ISG-2011-04 (Reference 15), which modifies the guidance of AMP XI.M16A to be consistent with MRP-227-A.

<u>Overview of the MRP-227-A Process</u>

As the initial step in the process for developing the inspection recommendations of MRP-227-A, components were screened for eight different aging mechanisms: stress corrosion cracking (SCC), irradiation-assisted stress corrosion cracking (IASCC), wear, fatigue, thermal aging embrittlement (TE), irradiation embrittlement (IE), irradiation-enhanced stress relaxation and creep, and void swelling. Screening inputs included chemical composition (material grade), neutron fluence, temperature history, and representative stress levels. Components determined to be below the screening criteria for all aging mechanisms were designated category "A" while those exceeding the criteria for at least one mechanism were designated "non A." For the "non A" components, Failure Modes, Effects, and Criticality Analyses (FMECA) were then performed to categorize each component as category A, B, or C, with "A" being the least affected and C being the most affected. The components determined to be "A" in the initial screening were also reviewed by the FMECA expert panel to confirm their Category "A" status. Category B and C components were determined to need further evaluation and were subject to a functionality assessment using irradiated and aged material properties to determine the effects of the degradation mechanisms on functionality. As a result of the functionality assessment, each RVI component was assigned to one of four functional groups:

- **Primary**: those PWR internals that are highly susceptible to the effects of at least one of the eight aging mechanisms were placed in the "Primary" group. The Primary group also includes components that have shown a degree of tolerance to a specific aging degradation effect, but for which no highly susceptible component exists or for which no highly susceptible component is accessible. MRP-227-A specifies the scope, methods, coverage and schedule of inspections of Primary components. Initial inspection of most Primary components is required within two refueling outages of the start of the PEO. For a few components, actions other than inspections are specified for aging management, such as analysis.

- **Expansion**: those PWR internals that are highly or moderately susceptible to the effects of at least one of the eight aging mechanisms, but for which functionality assessment has shown a degree of tolerance to those effects, were placed in the "Expansion" group.

The schedule for implementation of inspections or other aging management requirements for Expansion components will depend on the findings from the examinations of the Primary components at individual plants.

- **Existing Programs**: those PWR internals that are susceptible to the effects of at least one of the eight aging mechanisms and for which generic and plant-specific existing AMP elements are capable of managing those effects, were placed in the "Existing Programs" group.

- **No Additional Measures**: those PWR internals for which the effects of all eight aging mechanisms are below the screening criteria were placed in the "No Additional Measures" group. Additional components were placed in the "No Additional Measures" group as a result of FMECA and the functionality assessment. No further action is required by these guidelines for managing the aging of the "No Additional Measures" components.

Aging management strategy development combined the results of functionality assessment with component accessibility, operating experience, existing evaluations, and prior examination results to determine the appropriate aging management methodology, baseline examination timing, and the need for and the timing of subsequent inspections.

Augmented inspections recommendations are identified for each Primary and Expansion category component. The recommendations for the Primary components also identify timelines for the inspection. The inspection strategy generally employs VT-3 level visual examinations to evaluate general component condition, enhanced visual (EVT-1) level visual examinations to identify surface breaking flaws, and VT-1 level visual examination to identify surface discontinuities such as gaps. Cracking in baffle-former bolts and core shroud bolts is monitored with ultrasonic techniques.

3.0 TECHNICAL EVALUATION

The staff reviewed the RVI AMP included as Attachment 1 to the licensee's September 28, 2015, letter to determine if it demonstrated that the effects of aging on the subject RVI components covered by the report would be adequately managed so that the components' intended functions would be maintained consistent with the CLB for the PEO, in accordance with 10 CFR 54.21(a)(3). The staff's final SE for MRP-227, Revision 0, concluded that the MRP-227, Revision 0, report, as modified by the conditions and limitation and A/LAIs of the SE, provides for the development of an acceptable AMP for PWR RVI components. Therefore, the staff's technical evaluation of the RVI AMP, documented in this Safety Assessment (SA), focused on program consistency with the recommendations of MRP-227-A (SA Section 3.1), consistency of the AMP elements with LR-ISG-2011-04 (SA Section 3.2), and determining whether the program adequately addresses the plant-specific A/LAIs (SA Section 3.3). Information in the licensee's submittal considered not relevant for this review is not discussed in this SA.

3.1 RVI Program Implementation

This subsection of the SA focuses on the consistency of the implementation of the St. Lucie Units 1 and 2 RVI Program with the MRP-227-A topical report, including the inspections to be performed (scope, schedule, methods, and acceptance criteria), TLAAs, and handling of operating experience.

3.1.1 Consistency of the RVI Program Inspections with MRP-227-A

In Section 1.3 of the RVI Program Description, the licensee referred to Table 1, "CE [Combustion Engineering] Plants Primary Components," Table 2, "CE Plants Expansion Components," and Table 3, "CE Plants Existing Program Components," of the RVI AMP for the Primary, Expansion, and Existing Programs component inspections. The licensee noted that inspection of "Expansion" items is only required if invoked by the expansion criteria for the "Primary" items. The licensee further referred to Table 4, "CE Plants Examination Acceptance and Expansion Criteria," of the RVI AMP for the acceptance criteria for the Primary and Expansion components.

The staff reviewed the licensee's RVI AMP Tables 1, 2, 3 and 4 for consistency with the corresponding information in the following MRP-227-A tables: Table 4-2, "CE Plants Primary Components," Table 4-5, "CE Plants Expansion Components," Table 4-8, CE Plants existing Programs Components, and Table 5-2, "CE Plants Examination Acceptance and Expansion Criteria." The staff notes that all ASME Section XI, Inservice Inspection requirements continue to apply in addition to the MRP-227-A requirements, unless a relief request is submitted and approved by the staff in accordance with 10 CFR 50.55a.

The staff found that Tables 1, 2, and 3 implement all the recommended inspections for Primary, Expansion, and Existing Programs components applicable to St. Lucie Units 1 and 2 (i.e., CE-design RVI with welded core shroud assembled in two vertical sections), and that these inspections are consistent with respect to schedule, frequency, examination method, and coverage, with Tables 4-2, 4-5 and 4-8 of MRP-227-A. The staff found the acceptance and expansion criteria listed in Table 4 of the RVI Program are consistent with the corresponding information of Table 5-2 of MRP-227-A.

In addition, one plant-specific Primary component exists for St. Lucie Unit 1. This is the Core Support Barrel Assembly - Expandable plugs and patches.

3.1.2 Time-Limited Aging Analyses

The St. Lucie Units 1 and 2 LRA and NUREG-1779 identify two TLAAs related to RVI: (1) Unit 1 core support barrel (CSB) repair fatigue analysis (2) Unit 1 CSB repair plug preload relaxation. Table 1 of the RVI AMP notes in the "Applicability" column for the Core Support Barrel Assembly - Lower flange weld, and the Lower Support Structure - Core support plate, that no inspections are required for St. Lucie Units 1 and 2 as TLAA exists. The staff notes that for these components, MRP-227-A Table 4-2 states under "Examination Method/Frequency" that if fatigue life cannot be demonstrated by TLAA, EVT-1 examination, shall be performed no later than two refueling outages from the beginning of the LR period, with subsequent examination on a 10-year interval. However, the LRA and NUREG do not identify TLAAs related to fatigue of the lower support structure – lower flange weld and lower support structure - core support plate. Therefore, in request for additional information (RAI) RAI-MF6777/MF6778-EVIB-01, the staff requested that the licensee, 1) clarify whether these analyses were previously part of the CLB for St. Lucie Units 1 and 2, or whether they are new analyses; 2) describe the methodology and results, including the cumulative usage factor (CUF) obtained from these calculations; 3) describe if the effects of the reactor water environment were considered in these analyses, and if so, how?; 4) describe how the fatigue analyses are documented at St. Lucie.

The licensee's February 26, 2016, RAI response letter included a response to RAI-MF6777/MF6778-EVIB-01 in which FPL stated that they credit the Metal Fatigue section, which incorporates analysis for ASME Section III, Class 1 Components, as the applicable TLAA Category for the subject components. Metal Fatigue is identified in Section 4.3 of the St. Lucie LRA, of NUREG-1779, and Chapter 18 of the UFSAR. To address the methodology and results, including the CUF, the licensee stated that the RVI fatigue evaluation was conducted in accordance with Paragraph NG-3228.3 of ASME Section III, which requires a simplified elastic-plastic analysis for any component in which the primary-plus-secondary stress intensity exceeds ASME code maximum primary-plus-secondary stress intensity range of 3Sm. This condition occurs in the core shroud and the instrument tube supports. CUFs of less than 1 were calculated for both of these components. For the remaining RVI components, a general scoping fatigue evaluation was performed using the same simplified elastic-plastic analysis with the maximum primary-plus-secondary stress intensity range set at 3Sm. The calculated CUF for the remaining RVI was also less than 1.

As clarified in the licensee's letter dated December 19, 2017, the fatigue evaluations of the reactor vessel internal components are included as Attachment 5, "Licensing Report," to the December 15, 2010, St. Lucie Unit 1 EPU License Amendment Request (Reference 16) and the February 25, 2011, St. Lucie Unit 2 EPU License Amendment Request (Reference 17). Attachment 5 of both submittals lists the core support barrel, core support plate, lower support structure beams and columns, core shroud, upper guide structure, fuel alignment plate, control element assembly shrouds, instrument tube supports, reactor vessel level monitoring system support tube and thimble support plate as the RVI components evaluated. The results demonstrated that these components were structurally adequate for the EPU conditions and the fatigue usage factors were all less than 1. The fatigue analyses remain valid for the PEO.

The NRC staff found that the licensee's response to RAI-MF6777/MF6778-EVIB-01 satisfactorily addressed staff concerns, considering that the fatigue analyses were conducted in accordance with paragraph NG-3228.3 of ASME Section III, the calculated CUFs of the RVI components were less than 1, the fatigue analyses are part of the CLB and were identified as a TLAA in the LRA, NUREG-1779 and Chapter 18 of the UFSAR; therefore RAI-MF6777/MF6778-EVIB-01 is resolved.

3.1.3 Operating Experience

In its description of the Operating Experience AMP element, FPL stated that they actively participate in joint industry programs addressing RVI issues including EPRI and the Pressurized Water Reactor Owner's Group (PWROG), and that in accordance with FPL procedure 0-ADM-17.29, operating experience gained from these groups as well as the Institute of Nuclear Power Operations, World Association of Nuclear Operators and international sites will be incorporated into the St. Lucie RVI Inspection Program in a timely manner.

In addition, the licensee discussed plant-specific operating experience related to degradation of the thermal shield attachment to the core support barrel for St. Lucie Unit 1, which resulted in removal of the thermal shield and the installation of expandable core barrel plugs and patches. This event is discussed in more detail in LRA Section 4.6.3.

3.1.4 Updated Final Safety Analysis Report (UFSAR) Revision

The licensee provided proposed revisions to the RVI AMP description in UFSAR Sections 18.1.4 (for St. Lucie Unit 1) and 18.1.3 (for St. Lucie Unit 2), as Attachment 2 to its letter dated September 28, 2015. The staff reviewed the revised descriptions and finds them to be acceptable because the descriptions accurately reflect the RVI AMP as described in Attachment 1 to the same letter. The revised descriptions reference MRP-227-A as the basis for the program.

3.2 RVI Aging Management Program Evaluation

Licensee Evaluation

The licensee stated in Section 2 of the RVI AMP that the attributes of the St. Lucie RVI Inspection Program and compliance with the GALL Report, Section XI.M16, "PWR Vessel Internals," are described in this section. The GALL identifies 10 attributes for successful component aging management. The framework for assessing the effectiveness of the projected program is established by the use of the 10 elements of the GALL.

The licensee provided a table in Section 2 of the RVI AMP containing a description of each of the 10 program elements – Scope of Program, Preventive Measures, Parameters Monitored/Inspected, Detection of Aging Effects, Monitoring and Trending, Acceptance Criteria, Corrective Actions, Confirmation Process, Administrative Controls, and Operating Experience.

NRC Staff Evaluation

The staff found that the licensee's description of the 10 elements of its RVI AMP is consistent with the criteria of LR-ISG-2011-04, which represents the most current NRC guidance on aging management of RVI, with the exception of a few items. Therefore, in RAI-MF6777/MF6778-EVIB-02, the staff requested:

1. Confirmation that the Administrative Controls element of the RVI AMP is governed by the site's 10 CFR 50, Appendix B quality assurance program.

2. With respect to the Confirmation Process, Administrative Controls, and Operating Experience elements of the AMP, that FPL discuss how the RVI AMP meets the NEI [Nuclear Energy Institute] 03-08 implementation requirements for MRP-227-A.

In its February 26, 2016, response to RAI-MF6777/MF6778-EVIB-02, the licensee stated that the St. Lucie RVI Inspection Program Confirmation Process, Administrative Controls, and Operating Experience elements have been revised to better align with LR-ISG-2011-04. The licensee also provided the staff the aforementioned elements' associated revisions, confirming that the implementation of these sections will be performed in accordance with NEI 03-08 in conjunction with MRP-227-A and that the Administrative Controls element is governed under the site 10 CFR Part 50 Appendix B, Quality Assurance Program. Therefore, the staff finds that RAI-MF6777/MF6778-EVIB-02 has been resolved.

LR-ISG-2011-04 states under the Monitoring and Trending program element, that the program applies applicable fracture toughness properties, including reductions for thermal aging or neutron embrittlement, in the flaw evaluations of the components in cases where cracking is detected in a RVI component and is extensive enough to warrant a supplemental flaw growth or flaw tolerance evaluation. The licensee did not address this under its description of the Monitoring and Trending AMP element. However, in Section 1.3 of the RVI AMP, the licensee stated that engineering evaluations for continued service shall be conducted in accordance with NRC-approved methodologies, described in Westinghouse report WCAP-17096-NP-A

(Reference 18), and that the potential loss of fracture toughness must be considered in any flaw evaluations. The staff considers the use of WCAP-17096-NP-A will adequately address applicable fracture toughness properties since WCAP-17096-NP-A specifies models for fracture toughness properties to be used for such evaluations.

LR-ISG-2011-04 also states under the Monitoring and Trending element that for singly represented components, the program includes criteria to evaluate the aging effects in the inaccessible portions of the components and the resulting impact on the intended function(s) of the components. LR-ISG-2011-04 further states that for redundant components (such as redundant bolts, screws, pins, keys, or fasteners, some of which are accessible to inspection and some of which are not accessible to inspection), the program includes criteria to evaluate the aging effects in the population of components that are inaccessible to the applicable inspection technique and the resulting impact on the intended function(s) of the assembly containing the components. Although the licensee did not address this recommendation under the Monitoring and Trending AMP element, the licensee's inspections incorporate the required minimum inspection coverage requirements (generally 75 percent of the total area or length (accessible plus inaccessible) for single component and 75 percent of the accessible plus inaccessible population for redundant components) of MRP-227-A. In addition, Section 1.3 of the RVI AMP, states that the required inspection coverage for Primary and Expansion Components is specified in Tables 1 and 2, respectively, and that if the specified coverage cannot be obtained, the condition shall be addressed in the Corrective Action Program. Therefore, based on the RVI AMP requirement to meet the MRP-227-A minimum coverage requirements, the staff finds that the licensee's RVI AMP meets the requirements of LR-ISG-2011-04 for inaccessible portions of components.

Therefore, the staff finds the 10 elements of the licensee's RVI AMP are acceptable.

3.3 Applicant/Licensee Action Items (A/LAIs) from Safety Evaluation of MRP-227, Revision 0

The staff's final SE of MRP-227, Revision 0 contained eight plant-specific A/LAIs. The staff determined that A/LAIs 1, 2, 3, 5, 7, and 8 are applicable to St. Lucie Units 1 and 2 and A/LAIs 4 and 6 are not applicable to St. Lucie Units 1 and 2 because these A/LAIs are applicable only to Babcock & Wilcox (B&W)–design RVI.

3.3.1 A/LAI No. 1 – Applicability of FMECA and Functionality Analysis Assumptions (Plant-Specific Applicability Verification of MRP-227-A)

This A/LAI requires that each applicant/licensee is responsible for assessing its plant's design and operating history and demonstrating that the approved version of MRP-227 is applicable to the facility. Each applicant/licensee shall refer, in particular, to the assumptions regarding plant design and operating history made in the FMECA and functionality analyses for reactors of their design (i.e., Westinghouse, CE, or B&W), which support MRP-227 and describe the process used for determining plant-specific differences in the design of their RVI components or plant operating conditions, which result in different component inspection categories. The applicant/licensee shall submit this evaluation for NRC review and approval as part of its application to implement the approved version of MRP-227.

Licensee Evaluation

The licensee stated:

> The process used to provide reasonable assurance that St. Lucie Units 1 and 2 are reasonably represented by the generic industry program assumptions (with regard to neutron fluence, temperature, stress values, and materials used in the development of MRP-227-A), is:
>
> 1. Identification of typical Combustion Engineering (CE)-designed [PWR RVI] components [in accordance with] (Table 4-5 of MRP-191 [Reference 19]).
> 2. Identification of St. Lucie Units 1 and 2 PWR components.
> 3. Comparison of the typical CE-designed PWR RVI components to the St. Lucie Units 1 and 2 RVI components:
>   a. Confirmation that no additional items were identified by this comparison (primarily supports Applicant/Licensee Action Item 2).
>   b. Confirmation that the materials from Table 4-5 of MRP-191 are consistent with St. Lucie Units 1 and 2 RVI component materials.
>   c. Confirmation that the design and fabrication of St. Lucie Units 1 and 2 RVI components are the same as, or equivalent to, the typical CE-designed PWR RVI components.
> 4. Confirmation that the St. Lucie Units 1 and 2 operating history is consistent with the assumptions in MRP-227-A regarding core loading patterns and base load operation.
> 5. Confirmation that the St. Lucie Units 1 and 2 RVI materials operated at temperatures within the original design basis parameters.
> 6. Determination of stress values based on design basis documents.
> 7. Confirmation that any changes to the St. Lucie Units 1 and 2 RVI components do not impact the application of the MRP-227-A generic aging management strategy.

The licensee further stated:

> The St. Lucie Units 1 and 2 RVI components are reasonably represented by the design and operating history assumptions regarding neutron fluence, temperature, materials, and stress values in the MRP-191 generic FMECA and in the MRP-232 functionality analysis based on the following:
>
> 1. St. Lucie Units 1 and 2 operating history is consistent with the assumptions in MRP-227-A with regard to neutron fluence and fuel management.
>   a. FMECA and functionality analysis for MRP-227-A made the following assumption of 30 years of operation with high-leakage core loading patterns followed by 30 years of low-leakage core fuel management strategy. The St. Lucie Units 1 and 2 fuel management program changed from a high to a low leakage core loading pattern prior to 30 years of operation. Therefore, St. Lucie Units 1 and 2 meet the fluence and fuel management assumptions in MRP-191 and requirements for MRP-227-A application.

b. St. Lucie Units 1 and 2 have operated under base load conditions over the life of the plant, therefore, St. Lucie Units 1 and 2 satisfy the assumptions in Materials Reliability Program (MRP) documents regarding operational parameters affecting fluence.

2. The St. Lucie Units 1 and 2 reactor coolant system operates between T_{cold} and T_{hot}. T_{cold} is not less than 532°F and there were no changes to T_{cold} due to extended power uprate (EPU). T_{hot} was no higher than 594°F prior to EPU and no higher than 608.2°F after EPU for Unit 1. T_{hot} was no higher than 598°F prior to EPU and no higher than 607.9°F after EPU for Unit 2. The design temperature for the vessel is 650°F. Therefore, St. Lucie Units 1 and 2 operating history is within original design basis parameters and is consistent with the assumptions used to develop the MRP-227-A aging management strategy with regard to temperature operational parameters.

3. With the exceptions discussed below, the St. Lucie Units 1 and 2 RVI components and materials are comparable to the typical CE-designed PWR RVI components (MRP-191, Table 4-5).

   a. There are two additional components for St. Lucie Unit 1 and one component for Unit 2 that are not included in MRP-191. In Unit 1, core support barrel patches and core support barrel expandable plugs were installed following the discovery of damage to the core barrel caused by fatigue of the thermal shield attachment points. CE developed and analyzed the repair method. For Unit 2, there are four specialized control element assembly (CEA) shroud assemblies that are fitted with flow bypass inserts. Other than the core support barrel patches, core support barrel expandable plugs, and flow bypass inserts, the components required for inclusion in the St. Lucie Units 1 and 2 program are consistent with those contained in MRP-191.

   b. St. Lucie Units 1 and 2 RVI component materials are consistent with, or nearly equivalent to, those materials identified in Table 4-5 of MRP-191 for CE-designed plants. Where differences exist, there is no impact on the St. Lucie Units 1 and 2 RVI program or the component is already credited as being managed under an alternate St. Lucie Units 1 and 2 aging management program.

   c. Design and fabrication of St. Lucie Units 1 and 2 RVI components are the same as, or equivalent to, the typical CE-designed PWR RVI components.

4. An 11.85% EPU was performed on St. Lucie Units 1 and 2. Evaluations performed by Westinghouse determined that the associated changes in temperature, fluence and loading on the RVI components did not affect the bounding assumptions or applicability of MRP-227-A. With the exception of the thermal shield removal for Unit 1, the modifications to the St. Lucie Units 1 and 2 RVI made over the lifetime of the plants are those identified in general industry practice or specifically directed by the original equipment manufacturer (OEM). The Unit 1 thermal shield removal was analyzed to be acceptable. Repairs to the core barrel, as a result of the thermal shield removal, were in accordance with recommendations and guidance of the OEM. Therefore, the design has been maintained over the lifetime of the plant as specified by the OEM and operational parameters with regard to fluence and temperature are compliant with MRP-227-A requirements. With the exception of two components for Unit 1 and one for Unit 2, the components are consistent with those considered in MRP-191. The

> materials for those components are also consistent with MRP-191, or where differences exist, there is no impact. The additional three components have no impact on the assumptions summarized above; therefore, the St. Lucie Units 1 and 2 RVI are represented by the assumptions in MRP-191, MRP-227-A, and MRP-232, confirming the applicability of the generic FMECA.

The licensee concluded that the St. Lucie Units 1 and 2 comply with A/LAI No. 1 of the NRC staff's final SER on MRP-227, Revision 0, and that therefore, the requirement is met for application of MRP-227-A as a strategy for managing age-related material degradation in the RVI components.

<u>NRC Staff Evaluation</u>

The staff notes that Items 1-3 of the licensee's process, and item 3 of the licensee's conclusions above, overlap with A/LAI No. 2, and will be evaluated by the staff under its evaluation of A/LAI No. 2.

The information provided by the licensee confirmed that St. Lucie Units 1 and 2 switched to a low-leakage core loading pattern prior to 30-calendar years of operation, have always operated as base-loaded units, and have no plant-unique modifications, making them consistent with the three assumptions of the FMECA and functionality analyses supporting MRP-227-A, listed in Section 2.4 of MRP-227-A.

As a result of technical discussions with the NRC staff, the basis for a plant to respond to the NRC's RAI to demonstrate compliance with MRP-227-A for originally licensed and uprated conditions was determined to be satisfied with plant-specific responses to the following two questions from the NRC memorandum dated March 15, 2013 (Reference 20):

1. Does the plant have non-weld or bolting austenitic stainless steel (SS) components with 20 percent cold work or greater, and, if so, do the affected components have operating stresses greater than 30 ksi [kilo pound per square inch]? (If both conditions are true, additional components may need to be screened in for stress corrosion cracking, SCC.)

2. Does the plant have atypical fuel design or fuel management that could render the assumptions of MRP-227-A, regarding core loading/core design, non-representative for that plant? [the March 15, 2013, NRC memorandum indicated this question covers power uprates as well as other core design and fuel management aspects].

In MRP Letter 2013-025 dated October 14, 2013 (Reference 21), EPRI provided to licensees a non-proprietary document containing guidance for responding to the two questions above. With respect to Question 1, MRP Letter 2013-025 provides guidance for licensees to assess whether RVI components at their plants, other than those identified in the generic evaluation, have the potential for cold work greater than 20 percent. With respect to Question 2, MRP Letter 2013-025 provides quantitative criteria based on RVI geometry and core power density to allow a licensee to assess whether a particular plant has atypical fuel design or fuel management, in lieu of performing a detailed RVI neutron fluence analysis.

The staff's review of MRP 2013-025, and the supporting technical information in Westinghouse June 2013, Report WCAP-17780-P titled, "Reactor Internals Aging Management MRP-227-A Applicability for Combustion Engineering and Westinghouse Pressurized Water Reactor Designs," are documented in the staff's November 7, 2014, WCAP-17780-P evaluation (Reference 22). In this WCAP evaluation, the staff concluded that the information provided on evaluation of cold work in WCAP-17780-P provides an adequate technical basis for the guidance in MRP Letter 2013-025 for responding to Question 1. The staff further concluded in the WCAP evaluation that the sensitivity studies of variations in neutron fluence, RVI geometry and temperature, and the information on power uprate effects on fluence and temperature, documented in WCAP-17780-P, provide an acceptable technical basis for the guidance in MRP Letter 2013-025 for responding to Question 2.

With respect to SCC of austenitic stainless steels, a screening criterion of cold work greater than or equal to 20 percent combined with stress greater than or equal to 30 ksi was applied to the screening of the generic components for CE RVI in MRP-191. Therefore, in RAI-MF6777/MF6778-EVIB-03, the staff asked the licensee if St. Lucie Units 1 and 2 have non-weld or bolting austenitic stainless steel components with 20 percent cold work or greater, and, if so, do the affected components have operating stresses greater than 30 ksi? If such components were identified, RAI-MF6777/MF6778-EVIB-03 also asked the licensee to provide a plant-specific aging management recommendation for SCC of these components.

In the February 26, 2016, initial response, the licensee stated that St. Lucie is actively taking part in a joint industry program under the PWROG, which is addressing the 20 percent cold work issue for non-weld or bolting austenitic stainless steel components on a generic rather than plant-specific basis. At the time, plant-specific component manufacturing records had been obtained for over 50 percent of all domestic PWRs to date. The licensee addressed four points that were shown in these records:

1. Twenty percent cold work limitation was already recognized at the time of plant construction (i.e. from 1970s),
2. Plant fabricators quality programs were in place to adhere to limitations in cold work austenitic stainless steels in these times,
3. Plant specific assessments conducted to date confirm that no non-fastener materials contain cold work greater than 20 percent, and
4. Correlation of data based on searches to date demonstrates consistency across the PWR fleet-B&W, CE, and Westinghouse show no cold worked non-fastener materials used in reactor vessel internals.

In April 2016 the PWROG issued PA-MSC-1288 PWR RV Internals Cold-Work Assessment (Reference 23) to leverage all of the data responses to this cold-work question and develop a response that the entire domestic PWR fleet can obtain credit for. The staff completed its review of PA-MSC-1288 in its staff assessment dated April, 21, 2017 (Reference 24). Forty-three percent of CE plants were addressed in the report covering early, median and later plant designs in order to obtain a significant sample of plants. Design data, including materials allowables for all internal components, were searched and assessed for potential material of fabrication and inclusion of cold-work to produce assurance of no cold-work on a plant specific basis. To date, no materials with 20-percent cold work or greater have been identified outside of fastener applications in RVIs; therefore, an additional plant-specific aging management recommendation is not necessary and the staff considers RAI-MF6777/MF6778-EVIB-03 resolved.

For the St. Lucie Unit 1 EPU, FPL stated in the May 17, 2011, response to RAI CVIB-5 (Reference 25) that a detailed fluence analysis of the reactor pressure vessel (from the interior of the core shroud plates through the vessel wall around the mid-plane) was used to determine fluence through the various RVI components, and that the fluence calculation adhered to the requirements of Regulatory Guide 1.190 with regard to method and uncertainty. For the materials evaluation, the fluence values in the detailed map were used to evaluate potential fluence conditions at other locations within the RVI. For temperature, the gamma heating rates (based on fluence) were evaluated to find the areas of highest temperature within the internals. These temperatures were inputs to the environmental conditions considered in the materials evaluation. The response to RAI CVIB-5 indicates the licensee used the screening criteria from MRP-175 in conjunction with the fluence and temperature analysis results to evaluate the susceptibility of RVI components to various age-related degradation mechanisms. The overall conclusion of the licensee's evaluation of the effects of the EPU on the susceptibility of RVI components to known degradation mechanisms was that it has identified appropriate degradation management program to address the effects of changes in operating temperature and neutron fluence on the integrity of the reactor internal and core support materials.

For St. Lucie Unit 2, the EPU Licensing Report also implies that a detailed neutron fluence analysis was performed similar to that for St. Lucie Unit 1. In RAI-MF6777/MF6778-EVIB-05, the staff requested the licensee describe how the fluence analysis of the St. Lucie Unit 2 RVI was performed in support of the EPU, or confirm the methodology used was the same as for St. Lucie Unit 1.

According to the licensee's March 7, 2017, RAI response, the fluence analysis methodology performed in support of the St. Lucie Unit 2 EPU was the same as that previously described for St. Lucie Unit 1, therefore the staff considers RAI-MF6777/MF6778-EVIB-05 resolved.

Since the licensee performed a detailed neutron fluence analysis of the RVI for St. Lucie Units 1 and 2 in support of the EPU, the staff did not consider it necessary to ask generic Question 2 from Reference 19 regarding atypical fuel management.

In the staff's safety evaluation related to the EPU for St. Lucie Unit 1, the staff concluded that it has reviewed the licensee's evaluation of the effects of the proposed EPU on the susceptibility of RVI to known degradation mechanisms and concludes that the licensee has identified appropriate degradation management programs to address the effects of changes in operating temperature and neutron fluence on the integrity of these components. The staff reached a similar conclusion in its SE related to the EPU for St. Lucie Unit 2. However, the staff notes that in its evaluation of RVI aging considering EPU, the licensee determined that some components are susceptible to certain aging mechanisms, which were screened out in the development process of MRP-227-A. For example, the EPU Licensing Reports for St. Lucie Unit 1 and St. Lucie Unit 2 list the fuel alignment plate, upper guide structure support plate, CEA shroud tubes, and CEA shroud bolts and locking bars as susceptible to loss of fracture toughness due to IE, while MRP-191 screened out these components for IE. The EPU licensing reports also identified the CEA flow channel parts as susceptible to IE. There is no equivalent generic component in MRP-191. Similarly, the EPU Licensing Reports for St. Lucie Unit 1, and St. Lucie Unit 2, list the fuel alignment plate, upper guide structure support plate, CEA shrouds (lower part), and CEA shroud bolts and locking bars as components susceptible to IASCC, while MRP-91 screened out these components for IASCC. Therefore, in MF6777/MF6778-EVIB-06, the staff requested the licensee provide the estimated fluence for EPU for these components at the end of life, confirm the fluence screening criteria it used for IE and IASCC, and confirm whether these components actually exceed the MRP-191 screening criteria. If the components do exceed the screening criteria, in RAI-MF6777/MF6778-EVIB-06 the staff further requested the licensee explain how MRP-227-A is bounding for St. Lucie Units 1 and 2, considering that these components exceed the MRP-191 screening limits. Finally, if MRP-227-A is not bounding for any specific components, RAI-MF6777/MF6778-EVIB-06 requested the licensee to provide a plant-specific aging management recommendation for such components.

In the licensee's March 7, 2017, response letter, the licensee provided a table comparing the fluence screening criteria for wrought austenitic stainless steel reported in the EPU Licensing Reports and MRP-175, "Materials Reliability Program: PWR Internals Material Aging Degradation Mechanism Screening and Threshold Values" (Reference 26), on which the screening criteria in MRP-191 Revision 0 and MRP-227-A are based, for IE and IASCC. The EPU reports have fluence screening limits of greater than or equal to 1×10^{20} n/cm^2 and 1×10^{21} n/cm^2 for IE and IASCC, respectively, which are more conservative than the MRP-175 values of greater than or equal to 1×10^{21} n/cm^2 for IE and a range of fluence values greater than or equal to 2×10^{21} n/cm^2 for IASCC which are dependent upon minimum stress. Subsequent to submitting the St. Lucie Units 1 and 2 EPU reports, the licensee committed to adopt MRP-227-A instead of the previously approved RVI Inspection Program for Units 1 and 2. Therefore, the licensee plans to utilize the fluence thresholds in MRP-175 for the development of the AMPs.

In Table 2, "Cumulative Fluence at 60 Years of Operation," of the March 7, 2017, response, the licensee provided the estimated 60-year cumulative fluences considering the EPU at end of life of the components listed in the NRC staff's RAI-MF6777/MF6778-EVIB-06. Additionally, it provides the fluence screening criteria for MRP-191, Revision 0, MRP-191, Revision 1, and MRP-175 for IE. All of the 60-year cumulative fluences for the components exceed the MRP-191 estimated fluences, and the fuel alignment plate, CEA shroud tubes, CEA flow channel parts and CEA shroud bolts and lock bars also exceed the MRP-175 fluence screening criteria for IE. The CEA shroud tubes are equivalent to CEA shrouds in MRP-191 and the highest fluences are found at the CEA shroud (shroud tube) bases.

Though the fuel alignment plates will exceed the estimated fluence ranges in MRP-191, Revision 0, it will not exceed the estimated fluence ranges in MRP-191, Revision 1. The estimated fluences for the fuel alignment plates introduce IE as an age-related degradation mechanism that is not considered in MRP-191, Revision 0. However, the elevated fluence estimates for the fuel alignment plates in MRP-191, Revision 1 also exceed the screening value for IE and bound the St. Lucie Units 1 and 2 estimated fluences for these components. Since MRP-191 Revision 1 did not dictate any changes to the aging management methodology of MRP-227-A, the fuel alignment plates are considered to be bounded by MRP-227-A. The upper guide structure support plates are assumed to be bounded by MRP-227-A since they fall below the fluence screening criteria in MRP-175 for all age-related degradation mechanisms involving fluence. The CEA shroud tubes, CEA flow channel parts and CEA shroud bolts and lock bars exceed the estimated fluence ranges of MRP-191, Revisions 0 and 1, and introduce IE as an additional age related degradation mechanism not included in MRP-191, Revision 0 or 1. The aging management methodology for the St. Lucie Units 1 and 2 CEA Shroud Assembly subcomponents is discussed in the FPL Response to Item 5 of RAI-MAF6777/MF6778-EVIB-06.

Item 5 of the licensee's response to RAI-MAF6777/MF6778-EVIB-06 addresses the plant-specific aging management recommendations for those components that exceed the MRP-175 criteria and are not bounded by MRP-227-A. These include the CEA shroud tube (bases), CEA shroud bolts/lock bars, CEA flow channel parts, guide lugs, guide lug inserts, guide lug insert bolts, guide lug bolts (grouped in with guide lug insert bolts under LAI 2), core shroud tie rods and nuts, CEA instrument guide tubes, CSB upper cylinder, core support plate, and fuel alignment pins. The guide lug bolt and tie rods and nuts are only applicable to St. Lucie Unit 1, since the Unit 2 sections are welded. The licensee discussed the elevated fluence levels of these components, their relation to the age-related degradation mechanisms recognized in both revisions of MRP-191, and the components' current category listing in MRP-227-A. The following were proposed by FPL for the components:

1. FPL currently inspects the accessible CEA shroud tubes (bases), bolts/lock bars, and flow channel parts under its ASME Section XI program and proposes to add them to the Existing Programs Components Table of the St. Lucie Units 1 and 2 RVI AMP. IE will be considered in any future flaw evaluations.
2. FPL proposes to add IE as an Effect (Mechanism) for the guide lugs, guide lug inserts and Bolts in the Existing Programs Components Table of the St. Lucie Units 1 and 2 RVI AMP. IE will be considered in any future flaw evaluations.
3. FPL proposes to add IASCC as an Effect (Mechanism) for the guide lugs in the Existing Program Components Table of the St. Lucie Units 1 and 2 RVI AMP.
4. FPL currently inspects the visible portions of the core shroud tie rods and nuts under its ASME Section XI Program and proposes to add them to the Existing Programs Components Table in the St. Lucie Units 1 and 2 RVI AMP.
5. FPL proposes to add IE as an Effect (Mechanism) for the CEA instrument guide tubes in the Primary Components Table of the St. Lucie Units 1 and 2 RVI AMP and will consider IE should any future flaw evaluations be performed.
6. FPL proposes to add IASCC as an Effect (Mechanism) for the CSB upper cylinder in the Expansion Components Table of the St. Lucie Units 1 and 2 AMP; IE is already included. No change to the CSB Upper Flange Weld in the Primary Components Table is required since the additional age-related degradation mechanisms (IE and IASCC) are not applicable.
7. To address this increased risk for IASCC, FPL proposes to add IASCC as an Effect (Mechanism) for the Fuel Alignment Pins in the Existing Programs Component Table in the St. Lucie Units 1 and 2 RVI AMP.

In the response to RAI-MAF6777/MF6778-EVIB-06, the licensee included Table 4, "Summary Table," which provides a summary of plant-specific aging management for the components not bounded by MRP-227-A.

Table-4, Summary Table

Group	Component	Fluence (n/cm^2)(E>1.0Mev)		Aging Management Approach Changes
		St. Lucie Units 1 and 2 Fluence	External Screening Threshold	
Core Shroud Assembly	Guide Lug	$\geq 2 \times 10^{21}$ n/cm^2 to $< 1.3 \times 10^{22}$ n/cm^2	$\geq 1.0 \times 10^{21}$ n/cm^2 (IE) $\geq 2.0 \times 10^{21}$ n/cm^2 (IASCC)	Add IE and IASCC as DM [Degradation Mechanism] in Existing Program Components Table
	Guide Lug Insert	$\geq 1 \times 10^{21}$ n/cm^2 to $< 2 \times 10^{21}$ n/cm^2	$\geq 1.0 \times 10^{21}$ n/cm^2 (IE)	Add IE as DM in Existing Program Components Table
	Guide Lug Insert Bolt	$\geq 1 \times 10^{21}$ n/cm^2 to $< 2 \times 10^{21}$ n/cm^2	$\geq 1.0 \times 10^{21}$ n/cm^2 (IE)	Add IE as DM in Existing Program Components Table

	Tie Rods and Nuts	$\geq 1.3 \times 10^{22}$ n/cm^2	$\geq 1.3 \times 10^{22}$ n/cm^2 (VS) $\geq 2.0 \times 10^{21}$ n/cm^2 (IASCC)	Add Tie Rods and Nuts in Existing Program Components Table with wear, fatigue, IE, ISR [Irradiation Stress Relaxation], VS [Void Swelling] and IASCC as the DMs
CEA Shroud Assembly	CEA Shroud Tubes (bases)	$\geq 1 \times 10^{21}$ n/cm^2 to $< 2 \times 10^{21}$ n/cm^2	$\geq 1.0 \times 10^{21}$ n/cm^2 (IE)	Add CEA Shroud Bases in Existing Program Components Table with SCC and IE as the DMs
	CEA Shroud Bolts/Lock Bars	$\geq 1 \times 10^{21}$ n/cm^2 to $< 2 \times 10^{21}$ n/cm^2	$\geq 1.0 \times 10^{21}$ n/cm^2 (IE)	Add CEA Bolts/Lock Bars in Existing Program Components Table with wear, fatigue, ISR and IE as the DMs
	CEA Flow Channel Parts	$\geq 1 \times 10^{21}$ n/cm^2 to $< 2 \times 10^{21}$ n/cm^2	$\geq 1.0 \times 10^{21}$ n/cm^2 (IE)	Add CEA Flow Channel Parts in Existing Program Components Table with SCC and IE as the DMs
	CEA Instrument Tube	$\geq 1 \times 10^{21}$ n/cm^2 to $< 2 \times 10^{21}$ n/cm^2	$\geq 1.0 \times 10^{21}$ n/cm^2 (IE)	Add IE as DM in Primary Program Components and Expansion Components Table
Core Support Barrel	Upper Cylinder	$\geq 2 \times 10^{21}$ n/cm^2 to $< 1.3 \times 10^{22}$ n/cm^2	$\geq 1.0 \times 10^{21}$ n/cm^2 (IE) $\geq 2.0 \times 10^{21}$ n/cm^2 (IASCC)	Add IASCC as DM in Expansion Components Table
Lower Support Structure	Fuel Alignment Pins	$\geq 1.3 \times 10^{22}$ n/cm^2	$\geq 2.0 \times 10^{21}$ n/cm^2 (IASCC)	Add IASCC as DM in Existing Program Component Table

To determine the adequacy of the proposed changes to aging management, the staff considered the consequences of failure and existing categorization of the components in MRP-191, Revision 0. The staff also considered whether the examination method proposed for St. Lucie is adequate to manage the additional degradation mechanism (DM).

The core shroud assembly, guide lugs, guide lug inserts, and guide lug insert bolts are already existing programs components, crediting visual VT-3 examinations performed under the ASME Code Section XI program. The only change to aging management was to add IE as a DM for all three components, and IASCC for the guide lugs. The guide lugs already had SCC of welds as a screened in DM. IE will not cause cracking by itself without another cracking mechanism, such as SCC or fatigue. However, neither cracking mechanism was considered significant in these components, since the effect/mechanism in MRP-227-A, Table 4-8 is loss of material due to wear and aging management of ISR. In the response to RAI-MAF6777/MF6778-EVIB-06 the licensee indicated that IASCC screened in for the guide lugs based on fluence for St. Lucie, but that the stresses would likely be too low for IASCC except at the welds. Also, MRP-191, Revision 0 classifies the guide lugs as low consequence of failure. Therefore, the staff finds that the VT-3 examinations performed under the ASME Code, Section XI program remain adequate for the guide lugs, inserts and guide lug insert bolts.

The licensee proposed adding several components previously categorized as "no additional measures" to the "existing programs category," including the core shroud assembly, tie rods and nuts, and the CEA shroud assembly, CEA shroud tube bases and CEA shroud bolts/lock bars.

The existing ASME Code, Section XI program visual VT-3 examinations would be credited for managing the new DMs for these components. For the core shroud assembly – tie rods and nuts, the additional DMs for St. Lucie are IASCC and void swelling. The staff does not generally consider visual VT-3 examination to be adequate to detect cracking, such as that due to IASCC, except in the case of redundant populations of components or highly flaw-tolerant components. There are multiple tie rods holding the two core shroud sections together, so these are redundant components. Also, the FMECA results for the tie rods and nuts in MRP-191, Revision 0 indicate a low likelihood of core damage associated with degradation of these components. Therefore, the staff finds VT-3 examination adequate for these components. For the CEA shroud tube bases and CE shroud bolts/lock bars, the additional DM for St. Lucie is IE. In MRP-191, Revision 0, these components screened in for cracking mechanism of SCC at welds for the CEA shroud tube bases, and fatigue for the CEA shroud bolts/lock bars. Despite the screened-in cracking mechanisms, these components were categorized as no additional measures in MRP-227-A. IE alone would not cause failure of these components. Therefore, the staff finds VT-3 examination under the existing ASME Code, Section XI program to be adequate to manage aging of these components.

The CEA shroud assembly, CEA flow channel parts are a subcomponent of the CEA shrouds that are not specifically included in MRP-191, Revision 0. The licensee assumed the CEA flow channel parts have the same fluence as the CEA shroud bases, and both components are Type 304 stainless steel, so have the same DMs. The licensee proposed to add the CEA flow channel parts to the "existing programs" category crediting the ASME Code, Section XI program. Consistent with the CEA shroud tube bases, the staff finds the VT-3 visual examinations under the ASME Code, Section XI program will provide adequate aging management for these components.

The CEA shroud assembly, CEA instrument guide tubes in peripheral locations are categorized as "primary" in MRP-227-A, which specifies visual VT-3 examination for cracking due to SCC and fatigue. The linked expansion component is the remaining CEA instrument guide tubes. Due to the higher fluence, the licensee added IE as a DM for these components. Since IE alone cannot cause failure, and the components are already being inspected for cracking, the staff finds the proposed aging management program adequate for the CEA instrument tubes.

The core support barrel, upper cylinder is an "expansion" component for which the higher plant-specific fluence for St. Lucie caused IASCC to be added as a DM. The upper cylinder already screened in for SCC at welds. The linked "primary" component for the upper cylinder welds is the core support barrel assembly, upper (core support barrel) flange weld, which has SCC but not IASCC as a DM. Therefore, the upper cylinder welds would be examined for cracking if cracking were found in the upper (core support barrel) flange weld. MRP-227-A specifies enhanced visual testing (EVT-1) examination for the upper cylinder weld. EVT-1 is an appropriate examination technique for the detection of IASCC cracking. It is likely that the upper cylinder would remain bounded by the lower cylinder girth weld and lower cylinder axial welds in terms of susceptibility to IASCC. However, there was no "primary" link for IASCC for the upper cylinder. Therefore, in the letter dated December 19, 2017, the licensee added the CSB upper cylinder as an Expansion Link to the Core Shroud Plate-Former Plate Weld in the Primary Components Table. Degradation meeting Expansion Criteria of the Core Shroud Plate-Former Plate will trigger an Expansion Component inspection of the CSB upper cylinder.

The staff finds this change acceptable because it provides an expansion link for the CSB upper cylinder to a Primary component susceptible to IASCC, which will provide a leading indicator for the potential for IASCC in the CSB upper cylinder.

IASCC was added as a DM for the lower support structure, fuel alignment pins, which are an "existing programs" component. The fuel alignment pins are subject to a visual VT-3 examination under the existing ASME Code, Section XI program. Although the staff normally does not consider VT-3 examination adequate to manage cracking, the FMECA in MRP-191 determined the fuel alignment pins are low consequence of failure components. Therefore, the staff finds the use of VT-3 examination provides adequate aging management for this component.

In addition to the above, for all the components for which IE was added as a new DM, the licensee stated that IE would be considered in all flaw evaluations.

Based on the above, the staff finds that the changes to the aging management programs to address the components identified as not bounded by the MRP-227-A guidance, are adequate to manage aging of these components. RAI-MAF6777/MF6778-EVIB-06 is thus resolved. Additionally, the staff notes that St. Lucie Units 1 and 2 are consistent with the three assumptions of the FMECA and functionality analyses and the staff has determined that the licensee provided an adequate justification that MRP-227-A is applicable to the facility, therefore A/LAI No. 1 is resolved.

3.3.2 A/LAI No. 2 PWR Vessel Internal Components Within the Scope of License Renewal

This A/LAI requires that, consistent with the requirements addressed in 10 CFR 54.4, each applicant/licensee is responsible for identifying which RVI components are within the scope of LR for its facility. Applicants/licensees shall review the information in Tables 4-1 and 4-2 in MRP-189, Revision 1, and Tables 4-4 and 4-5 in MRP-191 and identify whether these tables contain all of the RVI components that are within the scope of LR for their facilities in accordance with 10 CFR 54.4. (Note: Table 4-4 of MRP-191 is the applicable table for Westinghouse-design RVI.) If the tables do not identify all the RVI components that are within the scope of LR for its facility, the applicant or licensee shall identify the missing component(s) and propose any necessary modifications to the program defined in MRP-227, as modified by this SE, when submitting its plant-specific AMP. The AMP shall provide assurance that the effects of aging on the missing component(s) will be managed for the PEO.

Licensee Evaluation

The licensee stated that there are two additional components for St. Lucie Unit 1 and one component for Unit 2 identified in the plant-specific aging management review that are not included in MRP-191. The licensee stated that in Unit 1, core support barrel patches and core support barrel expandable plugs were installed following the discovery of damage to the core barrel caused by fatigue at the thermal shield attachment points, and for Unit 2, there are four specialized CEA shroud assemblies that are fitted with flow bypass inserts, and that, other than the core support barrel patches, core support barrel expandable plugs, and flow bypass inserts, all components in the St. Lucie Units 1 and 2 license renewal program are consistent with those contained in MRP-191.

The licensee stated that the in-core instrumentation (ICI) guide tubes for both units have a different material than that specified in MRP-191, but the difference has no effect on the recommended MRP aging strategy or is already managed by an alternate St. Lucie Units 1 and 2 program; therefore, no modifications to the program details in MRP-227-A need to be proposed.

The licensee stated that the generic scoping and screening of the RVI, as summarized in MRP-191 and MRP-232, to support the inspection sampling approach for aging management of the RVI specified in MRP-227-A are applicable to St. Lucie Units 1 and 2 with no modifications for the St. Lucie components that are consistent with those contained in MRP-191. The licensee stated that for the three components that are not included in MRP-191, the aging management strategy has been determined on a plant-specific basis, and that it has conservatively categorized the Unit 1 core support barrel patches and core support barrel expandable plugs as Primary components for aging management during the PEO. The licensee stated that plant-specific augmented inspections are required on a periodic basis to manage the associated aging effects on Primary components. The licensee indicated that it categorized the St. Lucie Unit 2 CEA shroud flow bypass inserts consistently with the categorization of the generic CEA shroud components in MRP-191 as Category A, making them No Additional Measures components. Thus, the licensee stated no further action is required for managing aging of these RVI components.

The licensee concluded that St. Lucie Units 1 and 2 comply with LAI #2 of the staff's final SE on MRP-227, Revision 0. The licensee concluded that the assessment performed identified three additional components that are not identified in MRP-191, and that the aging management strategy for these additional components has been included in the plant-specific program to ensure aging is managed for components that are not included within the scope of MRP-227-A. Therefore, the licensee concluded that St. Lucie Units 1 and 2 meet the requirement for application of MRP-227-A as a strategy for managing age-related material degradation in reactor internals components.

<u>NRC Staff Evaluation</u>

The staff reviewed the licensee's resolution of A/LAI No. 2, and notes that the licensee identified plant-specific RVI components for both units. For St. Lucie Unit 1, the licensee identified the core support barrel patches and expandable plugs as plant-specific components. The licensee noted that it categorized the core support barrel patches and expandable plugs as Primary category components. Table 1 of the RVI AMP calls for inspection of the plugs and patches due to cracking from IASCC, SCC, or fatigue, using EVT-1 enhanced visual examination, within two refueling outages of the start of the PEO, and every 10 years thereafter. The staff finds the categorization of the patches and plugs as Primary, as appropriately conservative. The staff finds the specified inspection method to be acceptable because EVT-1 is appropriated for detecting cracking. The frequency of the inspection is consistent with other RVI components. Further, Section 4.6.3 of the LRA for St. Lucie Units 1 and 2 indicates that the licensee inspected the patches and plugs at least twice after installation (in 1986 and 1996) and observed no abnormal degradation.

The licensee stated that St. Lucie Plant RVI component materials are consistent, or nearly equivalent to the materials identified in MRP-191, Table 4-5. The licensee also stated that where differences exist, either there is no impact due to the differences, or the components are being managed by an alternate AMP. Therefore, staff requested in RAI-MF6777/MF6778-EVIB-04 that the licensee identify the components fabricated from different materials than assumed in MRP-191, Table 4-5, identify the material type/grade used for these components, provide a justification for the determination that there is no impact on the categorization of these components and identify the alternative AMP(s) that will be used to manage aging of these components.

The licensee's February 26, 2016, response to RAI-MF6777/MF6778-EVIB-04 identified St. Lucie Units 1 and 2 ICI guide tubes, which are constructed of 304 SS, as the only components fabricated from different materials than what are assumed in MRP-191 (316 SS). The justification for claiming that there is no impact on the categorization of these components was that both 304 SS and 316 SS are wrought austenitic stainless steels and the screening criteria for all eight of the age related DMs addressed in MRP-227-A and MRP-191 are the same. Therefore, there need not be any change to the categorization of the 304 SS ICI guide tubes and, resultantly, an alternate AMP is not required to manage the aging of St. Lucie Units 1 and 2. The staff agrees with the licensee's responses to RAI-MF6777/MF6778-EVIB-04 and considers it resolved.

With respect to the St. Lucie Unit 2 CEA flow bypass inserts, the staff reviewed the FMECA results for the generic CEA shroud components in MRP-191, and notes that the consequence of failure of these components is economic only. The generic CEA shroud components were placed in Category A in MRP-191 based on being FMECA group 1, as a result of having a low likelihood of failure and a conditional core damage likelihood of "medium." Per MRP-191, the initial set of Category A components consisted of items for which all DMs were initially screened out. A review by the FMECA panel endorsed this initial screening. In addition, MRP-191 states the FMECA results identified additional components for which age-related DMs have minimal likelihood to cause failure, and that these components are also assigned to Category A. MRP-191 further states this action essentially screens these components out of further consideration as the process proceeds into the functionality assessments. The staff notes that those components assigned to Category A in MRP-191 typically became no additional measures components in MRP-227-A. The only component associated with the CEA shrouds that is not a no additional measures component is the instrument tubes. These were screened in for both SCC and fatigue, thus have a medium likelihood of failure. The instrument tubes (peripheral only) are categorized as Primary category components, with the remaining instrument tubes as the linked Expansion component.

To enable the staff to verify the CEA flow inserts should be categorized consistently with the generic CEA shroud components, in RAI-MF6777/MF6778-EVIB-07, the staff requested that the licensee provide details on the FMECA of the CEA flow bypass inserts, including the component functions, material, screened-in DMs, consequences of failure, likelihood of failure, and likelihood of damage (conditional core damage likelihood). In the response dated February 26, 2016, the licensee responded that FMECA results for CE nuclear steam supply system RVI components were summarized in MRP-191. The licensee rescinded their initial response to A/LAI No. 2 where they stated that CEA flow bypass inserts were excluded from MRP-191. Further investigation by FPL and Westinghouse determined that the CEA flow bypass inserts were indeed included as part of the CEA in the MRP-191 generic industry activity and appropriately assigned a "No Additional Measures" categorization. Since the CEA flow inserts are categorized with the generic CEA shroud components, RAI-MF6777/MF6778-EVIB-07 is resolved. The licensee has noted that the RVI components within the scope of LR are generally consistent with MRP-191 and, for those components that were not consistent, provided all of the necessary modifications to the AMP to ensure that their aging effects would be monitored throughout the PEO; therefore A/LAI No. 2 is resolved.

3.3.3 A/LAI No. 3 - Evaluation of the Adequacy of Plant-Specific Existing Programs

This A/LAI states that applicants/licensees of CE and Westinghouse are required to perform plant-specific analysis either to justify the acceptability of an applicant/licensee existing programs, or to identify changes to the programs that should be implemented to manage the aging of these components for the PEO. The A/LAI further states that the results of this plant-specific analysis and a description of the plant-specific programs being relied on to manage aging of these components shall be submitted as part of the applicant/licensee AMP application, and that the CE and Westinghouse components identified for this type of plant-specific evaluation include: CE thermal shield positioning pins and CE in-core instrumentation thimble tubes (Section 4.3.2 in MRP-227-A), and Westinghouse guide tube support pins (split pins) (Section 4.3.3 in MRP-227-A).

Licensee Evaluation

The licensee stated in the St. Lucie Units 1 and 2 EPU License Amendment Requests that there are no thermal shields or thermal shield positioning pins installed on the core barrels of St. Lucie Units 1 and 2. The licensee also stated that the St. Lucie Units 1 and 2 in-core instrumentation flux thimble tubes are considered out-of-scope for license renewal based upon the component screening performed in accordance with the Nuclear License Renewal Rule (10 CFR 54). The licensee additionally stated that all in-core instrumentation flux thimble tubes for St. Lucie Unit 1 were replaced during the Cycle 21 outage (spring 2007) (Work Order (WO) 35010464), and those for St. Lucie Unit 2 were replaced during the Cycle 19 outage (spring 2011) (WO 35010467), and that the replacement thimbles have been designed with sufficient margin to accommodate growth of thimbles' zircalloy sections during the PEO. Based on the foregoing, the licensee concluded A/LAI No. 3 is not applicable to St. Lucie Units 1 and 2.

NRC Staff Evaluation

The staff reviewed the LRA and the license renewal SER for St. Lucie Units 1 and 2, and confirmed that flux thimble tubes are not within the scope of license renewal. Review of these documents also confirms there are no thermal shield or thermal shield positioning pins. Therefore, the staff agrees that A/LAI No. 3 is not applicable to St. Lucie Units 1 and 2.

3.3.4 A/LAI No. 4 – B&W Core Support Structure Upper Flange Stress Relief

A/LAI No. 4 is applicable only to B&W-design RVI, therefore is not applicable to CE-design RVI such as St. Lucie Units 1 and 2.

3.3.5 A/LAI No. 5 – Application of Physical Measurements as Part of Instrumentation & Electrical Guidelines for B&W, CE, and Westinghouse RVI

This A/LAI requires applicants/licensees to identify plant-specific acceptance criteria to be applied when performing the physical measurements required by MRP-227-A for loss of compressibility for Westinghouse hold down springs, and for distortion in the gap between the top and bottom core shroud segments in CE units with core barrel shrouds assembled in two vertical sections. The applicant/licensee shall include its proposed acceptance criteria and an explanation of how the proposed acceptance criteria are consistent with the plants' licensing basis and the need to maintain the functionality of the component being inspected under all licensing basis conditions of operation as part of their submittal to apply MRP-227-A.

Licensee Evaluation

The licensee stated in the St. Lucie Units 1 and 2 EPU License Amendment Requests that the response to A/LAI No. 5 is based directly upon Westinghouse Letter LTR-RIAM-13-147, Revision 0, Transmittal of Final Summary Letter for Acceptance Criteria for Visual Examination of Gaps between Upper and Lower Core Shroud Subassemblies at Calvert Cliffs Units 1 and 2 and St. Lucie Units 1 and 2.

The licensee also stated that FPL participated in a PWROG Project Authorization (PA) to justify a gap size for the St. Lucie Units 1 and 2 core shrouds, and that the basic assumptions of the PA were that the gap be measurable using the specified VT-1 inspection resolution and that it satisfy functionality requirements. The licensee further stated that the Units 1 and 2 core shrouds differ slightly in design - Unit 1 uses a mechanical attachment (via tie rods) between the upper and lower core shroud sections, whereas Unit 2 uses a welded attachment, and that the postulated gap would include both thermal and void swelling contributions.

The licensee stated that the thermal contribution would be present only during power operation, and that the void swelling contribution would be present under all conditions including plant shutdown, during which the physical examination of the core shroud will be performed.

The licensee stated that core shroud gap acceptance criteria have been developed for St. Lucie Units 1 and 2 that are resolvable using the specified VT-1 inspection method of MRP-227-A. The licensee stated that plant-specific details are proprietary and not typically released publicly, but If the NRC requests additional details, the calculation can be made available for review. The licensee concluded that this satisfies the requirements of A/LAI No. 5.

NRC Staff Evaluation

The licensee's response to A/LAI No. 5 indicates that it has developed acceptance criteria for this examination, but provided no detail on the methodology or results of the analysis used to develop these criteria. Therefore, in RAI-MF6777/MF6778-EVIB-08, the staff requested the licensee make the calculation available for review by the staff, either by submitting it for information, or making it available for an audit.

For St. Lucie 1 and 2, A/LAI No. 5 is applicable only to the gap between the top and bottom core shroud segments. The licensee's evaluation supporting its response to A/LAI No. 5 is in PWROG Technical Report PWROG-16012-NP, Revision 0 (Reference 27), and was docketed as Attachment 2 to Reference 2 of this staff assessment.

The licensee performed an analysis of the acceptable gap width between the lower plate of the upper core shroud segment, and the upper plate of the lower core shroud segment. During operation, thermal expansion, distortion due to void swelling, plus the as-fabricated gap contribute to the total gap. During shutdown, when the physical measurement will be performed, the observable gap will be only due to void swelling plus the as-fabricated gap. The analysis includes a finite element analysis of the temperatures in the plates during operation, which was used as a basis to calculate maximum gap due to thermal expansion.

St. Lucie Unit 1 and 2 both have a core shroud assembled from two vertical sections. In Unit 1, the two sections are held together by tie rods and pins, while for Unit 2, the two vertical sections are connected via a full penetration weld at the outboard edge of the two interfacing plates. This design difference resulted in some differences in how the acceptable gap was evaluated.

The report states that maximum values for the void swelling portions of these gaps would be very difficult to predict, and were not explicitly calculated. The report further indicated that a maximum void swelling gap was selected based on the ability to readily detect the presence of gaps during the physical examinations of the core shroud assembly. Therefore, the licensee based the maximum allowable gap during plant shutdown (which is the sum of the void swelling and fabrication gap) on the capability of the VT-1 visual examination to detect a gap. The licensee determined that a reasonable detectable gap size for EVT-1 or VT-1 visual examination was equal to one-half of the required character resolution size for these examination techniques. The report indicates that the inspection standard for PWR internals (MRP-228) requires a character 0.044 inches in height to be resolvable for EVT-1 or VT-1 remote visual examination. Therefore, the licensee determined a reasonable detectable gap size is one-half this value, or 0.022 inches. Therefore, the allowable maximum gap size due to void swelling must be greater than or equal to 0.022 inches.

The licensee then postulated a void swelling gap of 0.125 inches as a starting point, and evaluated all the potential adverse effects on the RVI that could result from this void swelling gap, plus the calculated thermal expansion gap. The adverse effects evaluated for St. Lucie, Unit 1 are:

1. structural effect on interfacing core shroud (CS) horizontal plates
2. coolant flow jetting through the gap and impinging on the fuel assemblies
3. coolant flow jetting through the gap and impinging on the core support barrel (CSB)
4. increased *gamma* heating of the CSB directly adjacent to the gaps
5. increased fluence applied to the CSB and the reactor vessel directly adjacent to the gaps
6. turbulence in the main coolant flow adjacent to the gap
7. effect on CS-to-CSB bypass coolant flow
8. peripheral fuel assembly grid hanging up on the gap during insertion or withdrawal
9. inward deflection of interfacing CS horizontal plates encroaching on fuel space

For St. Lucie 2, due to the welded design, adverse effects #2, 3, 4, 5, and 7 were eliminated from consideration.

For St. Lucie Unit 1, the licensee determined the acceptable value of the gap during shutdown, due to both void swelling and the allowable fabrication gap, is 0.070 inches (the initial postulated gap of 0.125 inches was unacceptable for St. Lucie Unit 1 because the bypass flow was too high). However, 0.070 inches is greater than the minimum detectable gap of 0.022 inches, so the licensee determined it to be acceptable.

For St. Lucie Unit 2, the licensee determined the acceptable value of the gap during shutdown (due to void swelling and the allowable fabrication gap) is 0.125 inches.

The staff finds the licensee's evaluation of A/LAI No. 5 to be acceptable because the licensee considered the applicable aging mechanism (void swelling) in its evaluation, because the licensee's evaluation demonstrates that the acceptance criteria are adequate to ensure functionality of the RVI, considering the applicable aging mechanism, and because the specified examination method can readily detect gaps exceeding these acceptance criteria, therefore RAI-MF6777/MF6778-EVIB-08 is resolved.

3.3.6 A/LAI No. 6 Evaluation of Inaccessible B&W Components

This A/LAI is applicable only to B&W-design RVI, therefore is not applicable to CE-design RVI such as at St. Lucie Units 1 and 2.

3.3.7 A/LAI No. 7 Plant-Specific Evaluation of Cast Austenitic Stainless Steel (CASS) Materials

This A/LAI requires the applicants/licensees of B&W, CE, and Westinghouse reactors to develop plant-specific analyses to be applied for their facilities to demonstrate that B&W IMI guide tube assembly spiders control rod guide tube assembly spacer castings, CE lower support columns (LSCs), and Westinghouse LSC bodies, or additional RVI components that may be fabricated from CASS, martensitic or precipitation hardened stainless steel (PH-SS), will maintain their functionality during the PEO. These analyses should also consider the possible loss of fracture toughness in these components due to TE and IE. The plant-specific analysis shall be consistent with the plant's licensing basis and the need to maintain the functionality of the components being evaluated under all licensing basis conditions of operation. The applicant/licensee shall include the plant-specific analysis as part of their submittal to apply the approved version of MRP-227.

Licensee Evaluation

The licensee provided the following assessment of the St. Lucie Units 1 and 2 RVI CASS components and the assessment of their susceptibility to TE:

- The St. Lucie Unit 1 core support columns are low molybdenum, static cast. A certified material test report [(CMTR)] was located for one two-legged column. Its calculated ferrite content is less than 20%; thus, it is not susceptible to TE. The remaining St. Lucie Unit 1 core support columns are potentially susceptible to TE. The support columns were previously screened in for the age-related degradation mechanism of TE, along with stress corrosion cracking (SCC) of the weld, irradiation-assisted stress corrosion cracking (IASCC), fatigue, and IE in MRP-191, Table 4-7 and the inspection and evaluation guidelines for this Primary component are in MRP-227-A . The St. Lucie Unit 2 core support columns are 304 SS; thus, A/LAI No. 7 is not applicable to the St. Lucie Unit 2 core support columns.
- The St. Lucie Units 1 and 2 control element assembly [(CEA)] shroud tubes are low molybdenum, centrifugal cast CASS; thus they are not susceptible to TE. The CEA shroud tubes were also previously screened in for the age-related degradation mechanism of SCC of the weld in MRP-191, Table 4-7.
- The St. Lucie Unit 2 flow bypass inserts are low molybdenum, static cast, and have ferrite content ≤ 20%; thus they are not susceptible to TE. The flow bypass inserts were not identified in MRP-191. FPL has categorized the St. Lucie Unit 2 flow bypass inserts as No Additional Measures Components.

The licensee also stated, "[t]he St. Lucie Units 1 and 2 martensitic stainless steel (SS) RVI components include only a 403 SS Hold-down Ring in each unit. There are no martensitic PH-SS RVI components in St. Lucie Units 1 and 2."

The licensee finally concluded that the results of this evaluation do not conflict with strategy for aging management of RVI provided in MRP-227-A. The licensee stated that it is concluded that continued application of the strategies in MRP-227-A and the St. Lucie Units 1 and 2 RVI Inspection Program will meet the requirements for managing age-related degradation of the St. Lucie Units 1 and 2 CASS and martensitic SS RVI components.

NRC Staff Evaluation

In its response to A/LAI No. 7, the licensee identified the RVI components that are fabricated from CASS as the St. Lucie Unit 1 core support columns, the CEA shroud tubes for both units, and the St. Lucie Unit 2 flow bypass inserts. The licensee indicated that all but one of the Unit 1 core support columns screen in for TE based on the assumption that the ferrite content of the columns is greater than 20 percent, since CMTRs could not be located for these columns.

Since the St. Lucie Unit 1 core support columns (except one) screened in for TE, and are also susceptible to IE and several cracking mechanisms, in RAI-MF6777/MF6778-EVIB-09 the staff requested that the licensee provide an evaluation demonstrating that the columns will remain functional during the PEO considering the potential combined loss of fracture toughness due to TE plus IE along with the potential for cracking in the columns.

The licensee notified the NRC staff that they were participating in two joint industry programs under the PWROG addressing CASS RVI components during the PEO, considering the loss of fracture toughness due to both TE and IE, on a generic basis. Westinghouse completed the functionality analysis in Report No. PWROG-14048-P, Revision 1 (Proprietary) and the PRWOG submitted the report to the NRC via Owners Group Letter No. OG-17-62 dated March 1, 2017 (Reference 28). This report demonstrates the functionality of St. Lucie Unit 1 CASS core support columns (on a generic basis), during the PEO, considering the loss of fracture toughness due to both TE and IE.

In their July 3, 2017, response to RAI-MF6777/MF6778-EVIB-09, FPL notified the NRC staff that they have reviewed PWROG-14048-P, Revision 1 and concurred that the conclusions noted in the Executive Summary and Section 7 are applicable to St. Lucie Nuclear Plant, Unit 1. No changes to the St. Lucie Units 1 and 2 RVI AMP, as submitted to the NRC in the licensee's letter dated March 7, 2017, are needed.

The NRC staff issued a staff assessment (Reference 29) of PWROG-14048-P, Revision 1. In the assessment, the NRC staff made the same conclusions about LSC functionality as in its staff assessment for PWROG-14048-P, Revision 0 (Reference 30), but extended to all Westinghouse LSC and CE core support column designs of participating members of the PWROG. However, one of the conclusions in the staff assessment of PWROG-14048-P, Revision 1 is that the redundancy analysis in the report did not address the effect of the bending moment in LSC buckling. In the section titled "Assessment of Change 4" in the staff assessment of PWROG-14048-P, Revision 1, the NRC staff noted the high bending stresses for the faulted conditions, which could lead to failure of the LCSs due to compressive yielding, but further observed that the faulted condition analyzed in the report is very conservative and an unlikely condition since loss-of-coolant accident and seismic events are assumed to occur at the same time. Furthermore, the NRC staff determined that the flaw tolerance evaluation in the report demonstrated that the likelihood of full-section failure of the LSCs is low. This means that the likelihood of having an LSC configuration with broken LSCs is low. Since high bending stresses occur under faulted loads for cases with broken LSCs, the likelihood of having LSCs subject to high bending stresses is low.

The NRC staff verified that St. Lucie Unit 1 is an active participant in the PWROG program to address the functionality analysis of core support columns. Therefore, the NRC staff determined that the core support column design of St. Lucie Unit 1 were considered in the bounding LSC functionality analyses in PWROG-14048-P, Revision 1. Accordingly, the NRC staff determined that the core support columns will be adequately managed during the PEO and no additional change to the licensee's AMP. Therefore, the NRC staff determined that RAI-MF6777/MF6778-EVIB-09 has been resolved.

The licensee identified the St. Lucie Unit 2 flow bypass inserts as statically-cast CASS with ferrite content of at least 20 percent; thus the licensee concluded they are not susceptible to TE. The licensee also stated that the flow bypass inserts were not identified in MRP-191, and that it has categorized the St. Lucie Unit 2 flow bypass inserts as "No Additional Measures Components." Since the flow bypass inserts are no additional measures, the staff considers a response to A/LAI-7 unnecessary for this component, since no aging management activities would be required for this component.

The staff notes that St. Lucie Units 1 and 2 have one martensitic stainless steel component, the hold-down ring. However, the hold-down ring is a "No Additional Measures Component" for CE-design RVI. Therefore, since no aging management activities are required by MRP-227-A for the hold-down ring, the staff considers a response to A/LAI No. 7 unnecessary for this component. The staff finds the licensee's evaluation of A/LAI No. 7 to be acceptable considering that the licensee addressed the components fabricated from CASS and martensitic stainless steel at St. Lucie Unit 1 and Unit 2 and determined that they were either bounded by the LSC functionality analyses in PWROG-14048-P, Revision 1 or did not require further aging management activities.

3.3.8 A/LAI No. 8 – Submittal of Information for Staff Review and Approval

This action item requires applicants/licensees to make a submittal for NRC review and approval to credit their implementation of MRP-227, as amended by this SE, as an AMP for the RVI components at their facility. This submittal shall include the information identified in Section 3.5.1 of staff's final SE of MRP-227, Revision 0.

Section 3.5.1 of the staff's final SE of MRP-227, Revision 0, states that in addition to the implementation of MRP-227, Revision 0 in accordance with NEI 03-08, applicants/licensees whose licensing basis contains a commitment to submit a PWR RVI AMP and/or inspection program shall also make a submittal for NRC review and approval to credit their implementation of MRP-227, as amended by [the staff's final SE]. Section 3.5.1 of the staff's final SE further states that an applicant/licensee's application to implement MRP-227, as amended by this SE shall include the following items (1) and (2):

1. An AMP for the facility that addresses the 10 program elements as defined in NUREG-1801, Revision 2, AMP XI.M16A.

2. To ensure the MRP-227, Revision 0 program and the plant-specific action items will be carried out by applicants/licensees, applicants/licensees are to submit an inspection plan which addresses the identified plant-specific action items for staff review and approval consistent with the licensing basis for the plant. If an applicant/licensee plans to implement an AMP which deviates from the guidance provided in MRP-227, as approved by the NRC, the applicant/applicant shall identify where their program deviates from the recommendations of MRP-227, as approved by the NRC, and shall provide a justification for any deviation which includes a consideration of how the deviation affects both "Primary" and "Expansion" inspection category components.

Applicants that submitted applications for LR after the issuance of the MRP-227, Revision 0 final SE are required to submit additional information items. The staff notes that since the St. Lucie

Units 1 and 2 LRA was submitted prior to the issuance of the staff's final MRP-227 SE, the licensee is only required to submit the above two information items.

Licensee Evaluation

In response to A/LAI No. 8, the licensee stated that during the license renewal process, St. Lucie Units 1 and 2 prepared and gained approval for RVI Inspection Program from the NRC, as documented in NUREG-1759. Subsequently, during the review of the EPU License Amendment Requests, St. Lucie Units 1 and 2 committed to revise the RVI Inspection Program to align with MRP-227-A.

The licensee further stated that the St. Lucie RVI Inspection Program is summarized in Sections 1 and 2, and that it provides the following items: 1) components to be inspected; 2) the degradation mechanisms of concern; 3) the inspection methods; 4) the examination coverage; and 5) the examination acceptance criteria. And the responses to the eight Licensee Action Items of MRP-227-A are provided in Section 3. The licensee stated that these sections satisfy the requirements of A/LAI No. 8.

NRC Staff Evaluation

In Section 2 of the RVI AMP, the licensee provided a description of the 10 elements of its revised RVI AMP and compliance with NUREG-1801, AMP XI.M16A. Since the staff has determined that the licensee's AMP is consistent with AMP XI.M16A, as modified by LR-ISG-2011-04, the staff finds the licensee has complied with Item 1 of A/LAI No. 8.

In Section 2 of the RVI AMP the licensee also provided its RVI Inspection Plan, and in Section 3 of the RVI AMP, the licensee provided responses to the applicable A/LAI's for St. Lucie Units 1 and 2. The staff has approved the licensee's response to the applicable A/LAI's, as amended by responses to staff RAIs. Therefore, the staff finds the licensee has complied with Item 2 of A/LAI No. 8.

Based on the above, the staff finds A/LAI No. 8 is resolved for St. Lucie Units 1 and 2.

3.3.9 Conclusion of Applicant/Licensee Action Item Evaluation

The staff finds the licensee has adequately addressed those A/LAIs applicable to the design of St. Lucie Units 1 and 2; specifically, A/LAIs 1, 2, 3, 5, 7, and 8.

7.0 CONCLUSION

The NRC staff has reviewed St. Lucie Units 1 and 2 RVI AMP, and concludes that there is reasonable assurance that the RVI AMP will adequately manage aging of the RVI components at St. Lucie Units 1 and 2. The basis for the staff's conclusion is that the RVI Inspection Plan is consistent with the I&E guidelines of MRP-227-A, and because all A/LAIs specified in MRP-227-A applicable to the design of St. Lucie Units 1 and 2 have been addressed in a manner acceptable to the staff. Therefore, the NRC staff approves the St. Lucie Units 1 and 2 RVI AMP and RVI Inspection Plan.

Consequently, Commitment No. 12 from the St. Lucie Unit 1 EPU SER and Commitment #4 from the St. Lucie Unit 2 EPU SER are considered fulfilled. The NRC staff's approval of the St. Lucie Units 1 and 2 RVI Inspection Plan does not reduce, alter, or otherwise affect current ASME Code, *Section* XI ISI requirements, or any St. Lucie Units 1 and 2 specific licensing requirements related to ISI. The licensee must follow the implementation requirements as defined in Section 7.0 of MRP-227-A, which require that the NRC be notified of any deviations from the "Needed" requirements.

8.0 REFERENCES

1. Costanzo, C., Florida Power & Light Company, letter to U.S. Nuclear Regulatory Commission, "St. Lucie Units 1 and 2, Docket Nos. 50-335 and 50-389, License Renewal Commitments, Reactor Vessel Internals Aging Management Plan," dated September 28, 2015 (ADAMS Accession No. ML15300A574).
2. Costanzo, C., Florida Power & Light Company, letter to U.S. Nuclear Regulatory Commission, "St. Lucie Units 1 and 2, Docket Nos. 50-335 and 50-389, License Renewal Commitments, Reactor Vessel Internals Aging Management Plan, Response to Request for Additional Information," dated February 26, 2016 (ADAMS Accession No. ML16063A006).
3. DeBoer, D., Florida Power & Light Company, letter to U.S. Nuclear Regulatory Commission, "St. Lucie Units 1 and 2, Docket Nos. 50-335 and 50-389, License Renewal Commitments, Reactor Vessel Internals Aging Management Plan, Response to Request for Additional Information," dated March 7, 2017 (ADAMS Accession No. ML17075A194).
4. DeBoer, D., Florida Power & Light Company, letter to U.S. Nuclear Regulatory Commission, "St. Lucie Units 1 and 2, Docket Nos. 50-335 and 50-389, License Renewal Commitments, Reactor Vessel Internals Aging Management Plan," dated July 3, 2017 (ADAMS Accession No. ML17186A044).
5. DeBoer, D., Florida Power & Light Company, letter to U.S. Nuclear Regulatory Commission, "St. Lucie Units 1 and 2, Docket Nos. 50-335 and 50-389, License Renewal Commitments, Reactor Vessel Internals Aging Management Plan, Clarification of Responses to RAI 1 and RAI 6," dated December 19, 2017 (ADAMS Accession No. ML17354A061).
6. "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Amendment No. 213 to Facility Operating License No. DPR-67, Florida Power and Light Company, St. Lucie Plant, Unit No. 1, Docket No. 50-335," (Proprietary), dated July 9, 2012.
7. Orf, Tracy J., U.S. Nuclear Regulatory Commission, letter to Mano Nazar, Florida Power and Light Company, "St. Lucie Nuclear Plant, Unit 1 - Issuance of Amendment Regarding Extended Power Uprate (TAC No. ME5091)," (Redacted), dated July 9, 2012 (ADAMS Accession No. ML12181A019).
8. Orf, Tracy J., U.S. Nuclear Regulatory Commission, letter to Mano Nazar, Florida Power and Light Company, "St. Lucie Plant, Unit 2 - Issuance of Amendment Regarding Extended Power Uprate (TAC No. ME5843)," dated September 24, 2012 (ADAMS Accession No. ML12235A463).
9. NUREG-1779, "Safety Evaluation Report Related to License Renewal of St. Lucie Nuclear Plant, Units 1 and 2," dated September 30, 2003 (ADAMS Accession. No. ML032940205).

10. Jensen, J., Florida Power & Light Company, letter to U.S. Nuclear Regulatory Commission, "St. Lucie Units 1 and 2, Docket Nos. 50-335 and 50-389, Reactor Vessel Internals Inspection Program Plans and Inspection Dates," dated June 25, 2014 (ADAMS Accession No. ML14205A442).

11. EPRI Final Report Titled, "Materials Reliability Program: Pressurized Water Reactor Internals Inspection and Evaluation Guidelines, (MRP-227-Revision 0)," December 2008, (ADAMS Accession No. ML090160205) - Transmitted to NRC by MRP letter number MRP 2009-04 dated January 12, 2009.

12. NUREG-1801, Revision 2, "Generic Aging Lessons Learned (GALL) Report Final Report," dated December 31, 2010 (ADAMS Accession No. ML103490041).

13. Nelson, Robert A., NRC, letter to Neil Wilmshurst, EPRI, "Revision 1 of the Final Safety Evaluation of Electric Power Research Institute (EPRI) Report, Materials Reliability Program (MRP) Report 1016596 (MRP-227), Revision 0, "Pressurized Water Reactor (PWR) Internals Inspection and Evaluation Guidelines" (TAC NO. ME0680)," dated December 16, 2011 (ADAMS Accession No. ML11308A770).

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SUBJECT: ST. LUCIE PLANT, UNIT NOS. 1 AND 2 - REVIEW OF LICENSE RENEWAL COMMITMENT FOR REACTOR VESSEL INTERNALS AGING MANAGEMENT PLAN (CAC NOS MF6777 AND MF6778, EPID L-2015-LRO-0001) DATED MAY 2, 2018

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