Attachment-One

to

March 11th, 2014

2.206 Enforcement Petition

# The Federal Register

## The Daily Journal of the United States Government

Notice

# St. Lucie Nuclear Power Plant, Unit 2; Notice of Consideration of Issuance of Amendment to Facility Operating License, Proposed No Significant Hazards Consideration Determination, and Opportunity for a Hearing

A Notice by the **Nuclear Regulatory Commission** on **11/24/2004**

The U.S. Nuclear Regulatory Commission (the Commission) is considering issuance of an amendment to Facility Operating License No. NPF-16, issued to Florida Power and Light Company (FPL, the licensee) for operation of the St. Lucie Nuclear Plant, Unit No. 2, located in St. Lucie County, Florida.

The proposed amendment would revise Technical Specification (TS) Section 4.4.5.4 to modify the definitions of steam generator tube "Plugging Limit" and "Tube Inspection," as contained in the St. Lucie Unit 2 TS Items 4.4.5.4.a.6 and 4.4.5.4.a.8, respectively. The purpose of these modifications is to define the depth of the required tube inspections and to clarify the plugging criteria within the tubesheet. The proposed amendment was submitted in response to the Commission Generic Letter 2004-01 and in support of the steam generator inspections planned during the upcoming St. Lucie Unit 2 refueling outage.

Show citation box

Before issuance of the proposed license amendment, the Commission will have made findings required by the Atomic Energy Act of 1954, as amended (the Act) and the Commission's regulations.

The Commission has made a proposed determination that the amendment request involves no significant hazards consideration. Under the Commission's regulations in Title 10 of the Code of Federal Regulations (10 CFR), Section 50.92, this means that operation of the facility in accordance with the proposed amendment would not (1) involve a significant increase in the probability or consequences of an accident previously evaluated; or (2) create the possibility of a new or different kind of accident from any accident previously evaluated; or (3) involve a significant reduction in a margin of safety. As required by **10 CFR 50.91**(a), the licensee has provided its analysis of the issue of no significant hazards consideration, which is presented below:

1. Operation of the facility in accordance with the proposed amendment would not involve a significant increase in the probability or consequences of an accident previously evaluated.

FPL proposes to modify the definitions of steam generator "Plugging Limit" and "Tube Inspection," as contained in the St. Lucie Unit 2 Technical Specification (TS) Items 4.4.5.4.a.6 and 4.4.5.4.a.8, respectively. These modifications maintain existing design limits and would not increase the probability or consequences of an accident involving tube burst or primary to secondary accident-induced leakage, as previously analyzed in the UFSAR [Updated Final Safety Analysis Report]. Also, the tube burst criteria of NRC Regulatory Guide 1.121 (Basis for Plugging Degraded PWR [Pressurized Water Reactor] Steam Generator Tubes) would continue to be satisfied.

Tube burst is precluded for a tube with defects within the tubesheet region because of the constraint provided by the tubesheet. As such, tube pullout resulting from the axial forces induced by primary to secondary differential pressures would be a prerequisite for tube burst to occur. A joint industry test program (WCAP-16208-P) has defined the non-degraded tube to tubesheet joint length required to preclude tube pullout (C*) and maintain acceptable primary to secondary accident-induced leakage, assuming a 360° circumferential through wall crack existed immediately below this length. For St. Lucie Unit 2, C* is 10.1 inches. Any degradation below C* is shown by empirical test results and analyses to be acceptable, thereby precluding an event with consequences similar to a postulated tube rupture event. WCAP-16208-P incorporates an assumed primary to secondary accident-induced leakage value of 0.1 gpm/steam generator. Inspection to the C* length will ensure that the postulated accident induced leakage will remain below the current and future primary to secondary LCO leakage limits of 0.5 and 0.15 gpm/steam generator, respectively, imposed by the St. Lucie Unit 2 Technical Specifications (Section 3.4.6.2) and utilized in the UFSAR accident analyses (Chapter 15).

In summary, the proposed modifications to the St. Lucie Unit 2 Technical Specifications maintain existing design limits and do not involve a significant increase in the probability or consequences of an accident previously evaluated in the UFSAR.

2. Operation of the facility in accordance with the proposed amendments would not create the possibility of a new or different kind of accident from any previously evaluated.

Steam generator tube leakage and structural integrity will be maintained during all plant conditions upon implementation of the proposed inspection scope and plugging limit modifications to the St. Lucie Unit 2 Technical Specifications. These modifications do not introduce any new mechanisms that might result in a different kind of accident from those previously evaluated. Even with the limiting circumstances of a complete circumferential separation (360° through wall crack) of a tube below the C* length, tube pullout is precluded and leakage is predicted to be maintained within the Technical Specification limits during all plant conditions.

3. Operation of the facility in accordance with the proposed amendments would not involve a significant reduction in a margin of safety.

Upon implementation of the proposed inspection scope and plugging limit modifications to the St. Lucie Unit 2 Technical Specifications, operation with potential tube degradation below the C* inspection length within the tubesheet region of the steam generator tubing meets the margin of safety as defined by RG 1.121 (Basis for Plugging Degraded PWR Steam Generator Tubes) and RG 1.83 (Inservice Inspection of Pressurized Water Reactor Steam Generator Tubes), and the requirements of General Design Criteria 14, 15, 31 and 32 of **10 CFR 50**. Therefore, the proposed modifications do not involve a significant reduction in a margin of safety.

The NRC staff has reviewed the licensee's analysis and, based on this review, it appears that the three standards of **10 CFR 50.92**(c) are satisfied. Therefore, the NRC staff proposes to determine that the amendment request involves no significant hazards consideration.

The Commission is seeking public comments on this proposed determination. Any comments received within 30 days after the date of publication of this notice will be considered in making any final determination.

Normally, the Commission will not issue the amendment until the expiration of 60 days after the date of publication of this notice. The Commission may issue the license amendment before expiration of the 60-day period provided that its final determination is that the amendment involves no significant hazards consideration. In addition, the Commission may issue the amendment prior to the expiration of the 30-day comment period should circumstances change during the 30-day comment period such that failure to act in a timely way would result, for example in derating or shutdown of the facility. Should the Commission take action prior to the expiration of either the comment period or the notice period, it will publish in the Federal Register a notice of issuance. Should the Commission make a final No Significant Hazards Consideration Determination, any hearing will take place after issuance. The Commission expects that the need to take this action will occur very infrequently.

Written comments may be submitted by mail to the Chief, Rules and Directives Branch, Division of Administrative Services, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC

20555-0001, and should cite the publication date and page number of this Federal Register notice. Written comments may also be delivered to Room 6D59, Two White Flint North, 11545 Rockville Pike, Rockville, Maryland, from 7:30 a.m. to 4:15 p.m. Federal workdays. Documents may be examined, and/or copied for a fee, at the NRC's Public Document Room, located at One White Flint North, Public File Area O1 F21, 11555 Rockville Pike (first floor), Rockville, Maryland.

The filing of requests for hearing and petitions for leave to intervene is discussed below.

Within 60 days after the date of publication of this notice, the licensee may file a request for a hearing with respect to issuance of the amendment to the subject facility operating license and any person whose interest may be affected by this proceeding and who wishes to participate as a party in the proceeding must file a written request for a hearing and a petition for leave to intervene. Requests for a hearing and a petition for leave to intervene shall be filed in accordance with the Commission's “Rules of Practice for Domestic Licensing Proceedings” in **10 CFR Part 2**. Interested persons should consult a current copy of **10 CFR 2.309**, which is available at the Commission's PDR, located at One White Flint North, Public File Area 01F21, 11555 Rockville Pike (first floor), Rockville, Maryland. Publicly available records will be accessible from the Agencywide Documents Access and Management System's (ADAMS) Public Electronic Reading Room on the Internet at the NRC Web site, ***http://www.nrc.gov/reading-rm/doc-collections/cfr/***. (Note: Public access to ADAMS has been temporarily suspended so that security reviews of publicly available documents may be performed and potentially sensitive information removed. Please check the NRC Web site for updates on the resumption of ADAMS access.)If a request for a hearing or petition for leave to intervene is filed by the above date, the Commission or a presiding officer designated by the Commission or by the Chief Administrative Judge of the Atomic Safety and Licensing Board Panel, will rule on the request and/or petition; and the Secretary or the Chief Administrative Judge of the Atomic Safety and Licensing Board will issue a notice of a hearing or an appropriate order.

As required by **10 CFR 2.309**, a petition for leave to intervene shall set forth with particularity the interest of the petitioner in the proceeding, and how that interest may be affected by the results of the proceeding. The petition should specifically explain the reasons why intervention should be permitted with particular reference to the following general requirements: (1) The name, address and telephone number of the requestor or petitioner; (2) the nature of the requestor's/petitioner's right under the Act to be made a party to the proceeding; (3) the nature and extent of the requestor's/petitioner's property, financial, or other interest in the proceeding; and (4) the possible effect of any decision or order which may be entered in the proceeding on the requestors/petitioner's interest. The petition must also identify the specific contentions which the petitioner/requestor seeks to have litigated at the proceeding.

Each contention must consist of a specific statement of the issue of law or fact to be raised or controverted. In addition, the petitioner/requestor shall provide a brief explanation of the bases for the contention and a concise statement of the alleged facts or expert opinion which support the contention and on which the petitioner intends to rely in proving the contention at the hearing. The petitioner/requestor must also provide references to those specific sources and documents of which the petitioner is aware and on which the petitioner intends to rely to establish those facts or expert opinion. The petition must include sufficient information to show that a genuine dispute exists with the applicant on a material issue of law or fact. Contentions shall be limited to matters within the scope of the amendment under consideration. The contention must be one which, if proven, would entitle the petitioner to relief. A petitioner/requestor who fails to satisfy these requirements with respect to at least one contention will not be permitted to participate as a party.

Those permitted to intervene become parties to the proceeding, subject to any limitations in the order granting leave to intervene, and have the opportunity to participate fully in the conduct of the hearing.

If a hearing is requested, the Commission will make a final determination on the issue of no significant hazards consideration. The final determination will serve to decide when the hearing is held. If the final determination is that the amendment request involves no significant hazards consideration, the Commission may issue the amendment and make it immediately effective, notwithstanding the request for a hearing. Any hearing held would take place after issuance of the amendment. If the final determination is that the amendment request involves a significant hazards consideration, any hearing held would take place before the issuance of any amendment.

Nontimely requests and/or petitions and contentions will not be entertained absent a determination by the Commission or the presiding officer of the Atomic Safety and Licensing Board that the petition, request and/or the contentions should be granted based on a balancing of the factors specified in **10 CFR 2.309**(a)(1)(i)-(viii).

A request for a hearing or a petition for leave to intervene must be filed by: (1) First class mail addressed to the Office of the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, Attention: Rulemaking and Adjudications Staff; (2) courier, express mail, and expedited delivery services: Office of the Secretary, Sixteenth Floor, One White Flint North, 11555 Rockville Pike, Rockville, Maryland, 20852, Attention: Rulemaking and Adjudications Staff; (3) E-mail addressed to the Office of the Secretary, U.S. Nuclear Regulatory Commission, ***HEARINGDOCKET@NRC.GOV***; or (4) facsimile transmission addressed to the Office of the Secretary, U.S. Nuclear Regulatory Commission, Washington, DC, Attention: Rulemakings and Adjudications Staff at (301) 415-1101, verification number is (301) 415-1966. A copy of the request for hearing and petition for leave to intervene should also be sent to the Office of the General Counsel, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, and it is requested that copies be transmitted either by means of facsimile transmission to 301-415-3725 or by email to ***OGCMailCenter@nrc.gov***. A copy of the request for hearing and petition for leave to intervene should also be sent to the M.S. Ross, Attorney, Florida Power and Light, P.O. Box 14000, Juno Beach, Florida 33408-0420, attorney for the licensee.

For further details with respect to this action, see the application for amendment dated November 8, 2004, which is available for public inspection at the Commission's PDR, located at One White Flint North, File Public Area O1 F21, 11555 Rockville Pike (first floor), Rockville, Maryland. Publicly available records will be accessible from the Agencywide Documents Access and Management System's (ADAMS) Public Electronic Reading Room on the Internet at the NRC Web site, ***http://www.nrc.gov/reading-rm/adams.html***. (Note: Public access to ADAMS has been temporarily suspended so that security reviews of publicly available documents may be performed and potentially sensitive information removed. Please check the NRC Web site for updates on the resumption of ADAMS access.)Persons who do not have access to ADAMS or who encounter problems in accessing the documents located in ADAMS, should contact the NRC PDR Reference staff by telephone at 1-800-397-4209, 301-415-4737, or by e-mail to ***pdr@nrc.gov***.

Dated at Rockville, Maryland, this 18th day of November 2004.

For the Nuclear Regulatory Commission.

Brendan T. Moroney,

Project Manager, Section 2, Project Directorate II, Division of Licensing Project Management, Office of Nuclear Reactor Regulation.

[FR Doc. **04-26007** Filed 11-23-04; 8:45 am]

BILLING CODE 7590-01-P

Attachment-Two

to

March 11th, 2014

2.206 Enforcement Petition

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

November 30, 2010

Mr. Mano Nazar
Executive Vice President and
Chief Nuclear Officer
Florida Power & Light Co.
P. O. Box 14000
700 Universe Boulevard
Juno Beach, FL 33408-0420

SUBJECT: ST. LUCIE UNIT 2 - SUMMARY OF THE STAFF'S REVIEW OF THE 2009 STEAM GENERATOR TUBE INSERVICE INSPECTIONS (TAC NO. ME2969)

Dear Mr. Nazar:

By letter dated November 9, 2009 (Agencywide Documents Access and Management System (ADAMS) Accession Number ML093230226), Florida Power & Light Company (the licensee) submitted information summarizing the results of the 2009 steam generator tube inspections at St. Lucie Unit 2. These inspections were performed during Refueling Outage 18. In addition, the licensee provided some clarifying information concerning the 2009 inspections in a letter dated October 1, 2010 (ML102870115).

The U. S. Nuclear Regulatory Commission staff has completed its review of this report and concludes that the licensee provided the information required by their technical specifications and that no additional follow-up is required at this time. The staff's review of the report is enclosed.

Should you have any questions you can contact me at 301-415-2788.

Sincerely,

Tracy J. Orf

Tracy J. Orf, Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-389

Enclosure:
Summary of the 2009 Steam Generator Tube Inspections

cc w/ encl: Distribution via Listserv

SUMMARY OF THE U. S. NUCLEAR REGULATORY COMMISSION STAFF'S REVIEW

ST. LUCIE UNIT 2

2009 STEAM GENERATOR TUBE INSPECTIONS

DOCKET NUMBER 50-389

By letter dated November 9, 2009 (Agencywide Documents Access and Management System (ADAMS) Accession Number ML093230226), Florida Power & Light Company (the licensee) submitted information summarizing the results of the 2009 steam generator (SG) tube inspections at St. Lucie Unit 2. These inspections were performed during Refueling Outage 18 (SL2-18). In addition, the licensee provided some clarifying information concerning the 2009 inspections in a letter dated October 1, 2010 (ML102870115).

St. Lucie Unit 2 has two replacement SGs manufactured by AREVA. Each SG has 8999 thermally treated Alloy 690 tubes with an outside diameter of 0.75 inches and a wall thickness of 0.043 inches. During manufacturing, all tubes were hydraulically expanded at both ends over the full depth of the tubesheet. The tubesheet was drilled on a triangular pitch with 1.0-inch spacing, center-to-center. The radius of the row 1 U-bends is 4.134 inches. The U-bends in rows 1 through 15 were stress relieved after bending. Seven Type 410 stainless steel support plates (each 1.181-inches thick), which have broached trefoil holes, support the vertical section of the tubes, and four sets of antivibration bars (each 0.112 inches thick) made from Type 405 stainless steel support the U-bend section of the tubes.

This was the first inservice inspection for the AREVA-NP Model 86/19TI replacement steam generators since they were installed in December 2007. At the end of SL2-18 in 2009, the replacement SGs had accumulated 15.01 effective full-power months of operation.

The licensee provided the scope, extent, methods, and results of their SG tube inspections in the documents referenced above. In addition, the licensee described corrective actions, such as tube plugging, taken in response to the inspection findings. The tubes in both SGs were inspected during this refueling outage.

Based on its review of the reports submitted, the Nuclear Regulatory Commission (NRC) staff has the following observations and comments:

- The licensee reported primary and secondary side inspections performed in accordance with Technical Specification 6.9.1.12.

- The hot-leg tubesheet bore located at row 76, column 103 in SG B has a zone of slightly enlarged hole diameter. The zone starts approximately 4 inches above the primary face of the tubesheet, is 7.5-inches long, and is locally oversized from 0.002 to 0.005 inches. The location was examined with a rotating probe and no degradation was detected.

ENCLOSURE

- A "tube shaving signal," was reported in the tube located at row 88, column 93 in SG B above the cold-leg tubesheet during the preservice rotating probe examination in 2007. The attributes of the shaving signal were consistent with a similar signal observed in another AREVA domestic replacement SG, where visual examination confirmed the presence of a narrow shaving of tubing that had been "shaved" off the tube wall during tube insertion. This location was re-examined with a rotating probe, and no degradation was detected and the shaving signal was no longer present.

- The only service induced indications detected were wear at the antivibration bars, tube support plates, and the support/positioning device. The support/positioning device supports the antivibration bar structure, is located on the outer periphery of the tube bundle, and it contacts numerous tubes on the extrados. A similar support/positioning device is used in SGs at Salem Unit 2. One tube was plugged due to two indications located at the antivibration bar support/positioning device.

- Approximately 5800 indications of wear at the antivibration bars were detected (3700 in SG A and 2157 in SG B). Only a small fraction of the wear scars were inspected with a rotating probe (only 75 wear scars focusing on those that measured greater than 20-percent through-wall as measured by the bobbin coil).

- Ten indications of wear at the tube support plates were detected. All of these indications were inspected with a rotating probe (thereby confirming the nature of the degradation).

- Secondary side inspections were performed in each of the SGs. Loose nuts (bolts not fully engaged) were identified on the feedring inspection port covers in SGs A and B. Similar findings were observed at Salem Unit 2. At St. Lucie Unit 2, the fasteners were re-torqued to manufacturer's specifications. At Salem Unit 2, all feedring inspection port hardware (cover, gasket, bolts, and locking washers) were replaced with an improved design.

Based on a review of the information provided, the NRC staff concludes that the licensee provided the information required by their technical specifications. In addition, the staff concludes that there are no technical issues that warrant follow-up action at this time since the inspections appear to be consistent with the objective of detecting potential tube degradation and that inspection results appear to be consistent with industry operating experience at similarly designed and operated units (although the number of wear indications is much greater than that at other units with AREVA SGs).

November 30, 2010

Mr. Mano Nazar
Executive Vice President and
Chief Nuclear Officer
Florida Power & Light Co.
P. O. Box 14000
700 Universe Boulevard
Juno Beach, FL 33408-0420

SUBJECT: ST. LUCIE UNIT 2 - SUMMARY OF THE STAFF'S REVIEW OF THE 2009 STEAM GENERATOR TUBE INSERVICE INSPECTIONS (TAC NO. ME2969)

Dear Mr. Nazar:

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The U. S. Nuclear Regulatory Commission staff has completed its review of this report and concludes that the licensee provided the information required by their technical specifications and that no additional follow-up is required at this time. The staffs review of the report is enclosed.

Should you have any questions you can contact me at 301-415-2788.

Sincerely,

*/RA/*

Tracy J. Orf, Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-389

Enclosure:
Summary of the 2009 Steam Generator
Tube Inspections

cc w/ encl: Distribution via Listserv

Distribution:
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LPL2-2 r/f
RidsNrrDrlLpl2-2
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AObodoako, NRR
RidsNrrDorlDpr
RidsNrrLABClayton
RidsAcrsAcnw_MailCtr
RidsOgcRp

ADAMS Accession No. ML103340040

| OFFICE | LPL2-2/PM | LPL2-2/LA | CSGB/BC | LPL2-2/BC |
|---|---|---|---|---|
| NAME | TOrf | BClayton | RTaylor* | DBroaddus |
| DATE | 11/30/10 | 11/30/10 | 11/8/10 | 11/30/10 |

*by memo

OFFICIAL RECORD COPY

Attachment-Three

to

March 11th, 2014

2.206 Enforcement Petition

**UNITED STATES OF AMERICA**
**BEFORE THE NUCLEAR REGULATORY COMMISSION**

| | | |
|---|---|---|
| In the Matter of: | ) | |
| *Florida Power & Light Co.* | ) | Docket No. 50-389 |
| St. Lucie Plant, Unit 2 | ) | |

## DECLARATION OF ARNOLD GUNDERSEN

Under penalty of perjury, I, Arnold Gundersen, hereby declare as follows:

## I. INTRODUCTION

1. My name is Arnold Gundersen. I am Chief Engineer for Fairewinds Associates, a paralegal services and expert witness firm. I have been retained by Southern Alliance for Clean Energy (SACE) to evaluate safety and licensing issues related to the replacement steam generators (RSGs) that Florida Power & Light Co. (FPL) installed in the Unit 2 St. Lucie nuclear reactor in 2007.

2. As discussed below and demonstrated in my attached Curriculum Vitae (Exhibit 1), I am qualified by training and experience in the field of nuclear reactor engineering.

3. I earned my Bachelor Degree in Nuclear Engineering from Rensselaer Polytechnic Institute (RPI) cum laude. I earned my Master Degree in Nuclear Engineering from RPI via an Atomic Energy Commission Fellowship. Cooling tower operation and cooling tower plume theory were my area of study for my Master Degree in Nuclear Engineering.

4. I began my career as a reactor operator and instructor in 1971 and progressed to the position of Senior Vice President for a nuclear licensee prior to becoming a nuclear engineering consultant and expert witness.

5. I have testified before the Nuclear Regulatory Commission (NRC) Atomic Safety and Licensing Board (ASLB) and Advisory Committee on Reactor Safeguards (ACRS), the State of Vermont Public Service Board, the State of Vermont Environmental Court, the Florida Public Service Commission, the State of New York Department of Environmental

Conservation, and in Federal Court. I have also testified before the NRC's 2.206 Petition Review Board.

6. I am a chapter author of the first edition of the Department of Energy (DOE) Decommissioning Handbook, and the book entitled *Fukushima Daiichi: The Truth and the Way Forward*, Shueisha Publishing, 2012-2-17, Japan.

7. I have more than 40 years of professional nuclear experience in nuclear engineering, including but not limited to: Nuclear Plant Operation, Nuclear Management, Nuclear Safety Assessments, Reliability Engineering, In-service Inspection, Criticality Analysis, Licensing, Engineering Management, Thermohydraulics, Structural Engineering Assessments, Nuclear Fuel Rack Design and Manufacturing, Nuclear Equipment Design and Manufacturing, Cooling Tower Operation, Cooling Tower Plumes, Consumptive Water Loss, Radioactive Waste Processes, Decommissioning, Waste Disposal, Prudency Defense, Employee Awareness Programs, Public Relations, Contract Administration, Technical Patents, Archival Storage and Document Control, Source Term Reconstruction, Dose Assessment, Whistleblower Protection, and NRC Regulations and Enforcement.

8. I have extensive experience in the design and operation of nuclear power plant steam generators. In the 1970s, while I was the Lead Engineer for the procurement of two nuclear steam supply systems (NSSS) for New York State Electric & Gas Co., I reviewed all of the major steam generator designs that were being developed at that time, and ultimately procured two Combustion Engineering NSSS. My work as a Senior Vice President at Nuclear Energy Services included co-invention of the "nozzle dam," a component used for modern steam generator inspections during refueling. I also evaluated the faulty steam generators in the San Onofre Units 2 and 3 nuclear reactors as an expert witness retained by Friends of the Earth (FOE). I prepared several declarations and expert reports that FOE used in adjudicatory proceedings regarding the San Onofre steam generators. They are listed in my attached C.V.

9. I have reviewed FPL and NRC documents that discuss the safety of the St. Lucie Unit 2 steam generators with respect to modifications that were made from the original steam generator (OSG) designs to the replacement steam generator (RSG) designs.

## II. PURPOSE OF MY DECLARATION

10. My declaration has several purposes. First, I will explain the reasons for my expert opinion that FPL's replacement of the St. Lucie Unit 2 steam generators in 2007 changed the steam generator safety design for Unit 2 in fundamental ways that were not contemplated in the original license, and that in one respect was explicitly forbidden by the original license. Taken together, these design changes altered basic features of the reactor pressure boundary, which constitutes an essential fission product boundary protecting the public from accidental releases of radioactivity. Therefore these design changes required an amendment to FPL's operating license under 10 C.F.R. § 50.59.

11. Second, I will explain how the NRC Staff effectively granted the required license amendment by repeatedly allowing FPL to restart Unit 2 after each of the three refueling and inspection outages that have occurred since the RSGs were installed, despite knowing that FPL had fundamentally altered the design basis for the RSGs, and despite immediate and ongoing inspection results showing that the altered RSG design was causing significant wear on the steam generator tubes. Currently, the NRC Staff is in the process of amending the Unit 2 license with respect to the design changes to the RSGs once again, because it is about to conduct an inservice inspection of safety components that are included in the Unit 2 technical specifications but that were removed or altered by FPL when it replaced the steam generators. The NRC Staff must either approve a change to the technical specifications or require FPL to change the RSG design.

12. Third, I will discuss the reasons for my expert opinion that FPL's design changes to the steam generators have compromised the safety of the operation of Unit 2 and pose an unacceptable risk to public health and safety. Therefore these changes warrant thorough review in a license amendment proceeding and public hearing before Unit 2 can be restarted.

## III. BACKGROUND INFORMATION REGARDING STEAM GENERATORS

13. Steam generators play an important safety role at St. Lucie and at all nuclear reactors, by transferring heat out of the reactor and thereby maintaining temperature levels inside the reactor at a safe level in order to avoid core meltdown. The 2013 License Renewal GEIS (NUREG-1437, Rev. 1) (ML003762754) describes the role of steam generators in pressurized water reactors like St. Lucie as follows:

> In PWRs [pressurized water reactors], water is heated to a high temperature under pressure inside the reactor. (Figure 3.1-2) The water is then pumped in the primary circulation loop to the steam generator. Within the steam generator, water in the secondary circulation loop is converted to steam that drives the turbines. The turbines turn the generator to produce electricity. The steam leaving the turbines is condensed by water in the tertiary loop and returned to the steam generator. The tertiary loop water flows to cooling towers where it is cooled by evaporation, or it is discharged directly to a body of water, such as a river, lake, or other heat sink. … The tertiary loop is open to the atmosphere, but the primary and secondary cooling loops are not.

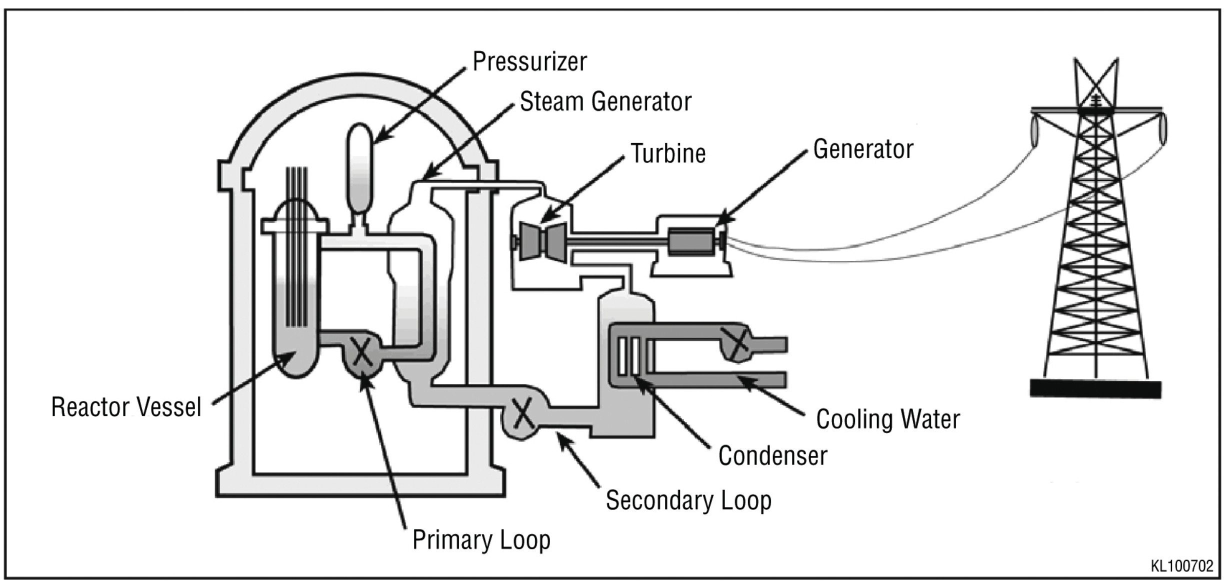



**Figure 3.1-2.** Pressurized Water Reactor (NRC 2002a)

*Id.* at 3-11. Thus, not only do the steam generators produce the steam that drives a reactor's turbines, but also they perform two essential safety functions: removing heat from the reactor and serving as a barrier to prevent radiation from being released.

14. A steam generator has a large lower-pressure upper chamber that is not radioactive, and tubes entering and leaving a smaller higher-pressure chamber at the bottom that contains radioactive high-pressure water. The stay cylinder and divider plate vertically partition the bottom chamber of the steam generator. In this bottom chamber, also known as the plenum, high-pressure radioactive reactor coolant enters the steam generator on one side via the "hot leg" and leaves it on the other side via two "cold legs." Before exiting the plenum via the "cold legs," this radioactive water is circulated into the upper chamber through thousands of U shaped heat transfer tubes, where the heat of the tubes is transferred to water in the steam generator, creating non-radioactive steam. The non-radioactive steam that ultimately is transferred to the turbines that generate electricity. As long at the tubes and tube sheet retain their structural integrity, the radioactive water remains isolated within the lower chamber and within the tubes.

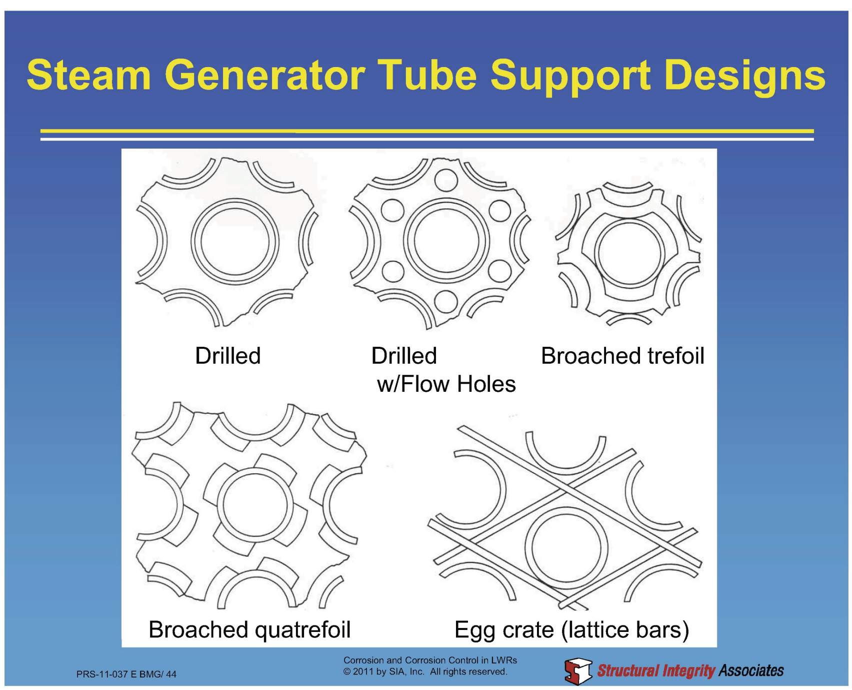
15. The radioactive plenum at the bottom of the steam generator is separated from the nonradioactive chamber above it by the tubesheet, a metal disc approximately 12 feet in diameter and slightly less than two feet thick. This metal disk serves as an anchor into which both sides of the heat transfer tubes are inserted. The heat transfer tubes are in the shape of a U, and hence the steam generator at St. Lucie 2 is called a "U-Tube" steam generator. One end of the U-tube connects to the hot leg side of the plenum, while the opposite side of the tube connects to the cold leg of the plenum. Not only is the tubesheet extraordinarily heavy, but in addition it is subject to a pressure difference of as much as 2,000 pounds per square inch (psi) between the radioactive water in the plenum beneath it and the non-radioactive water in the upper chamber of the steam generator. While the weight of the tubesheet could cause it to collapse, the high pressure from beneath could also cause it to flex upward. Because the tube sheet separates the radioactive and nonradioactive chambers of the steam generator, and because it is under high pressure, the tubesheet is considered to be a safety-related component that is part of the reactor pressure boundary.

16. In Combustion Engineering (CE) steam generators (including the original St. Lucie steam generators), the tubesheet is supported by a stay cylinder that is located in the plenum. The stay cylinder is attached to the bottom of the steam generator and the underside of the tube

sheet. Because the stay cylinder is designed to relieve the weight in the middle of the tubesheet and to prevent the tubesheet from flexing upward in the event of an accident, the stay cylinder serves a passive safety-related role. As described by the NRC, the stay cylinder in a steam generator serves an important safety function in the event of a major accident as it "supports the tubesheet in the event of a steam line break and, therefore, lowers the tubesheet flexure." Letter from Alan B. Wang to Harold B. Ray, re San Onofre Nuclear Generating Station, Unit 2 (Sept. 23, 2002) (ML022540872).

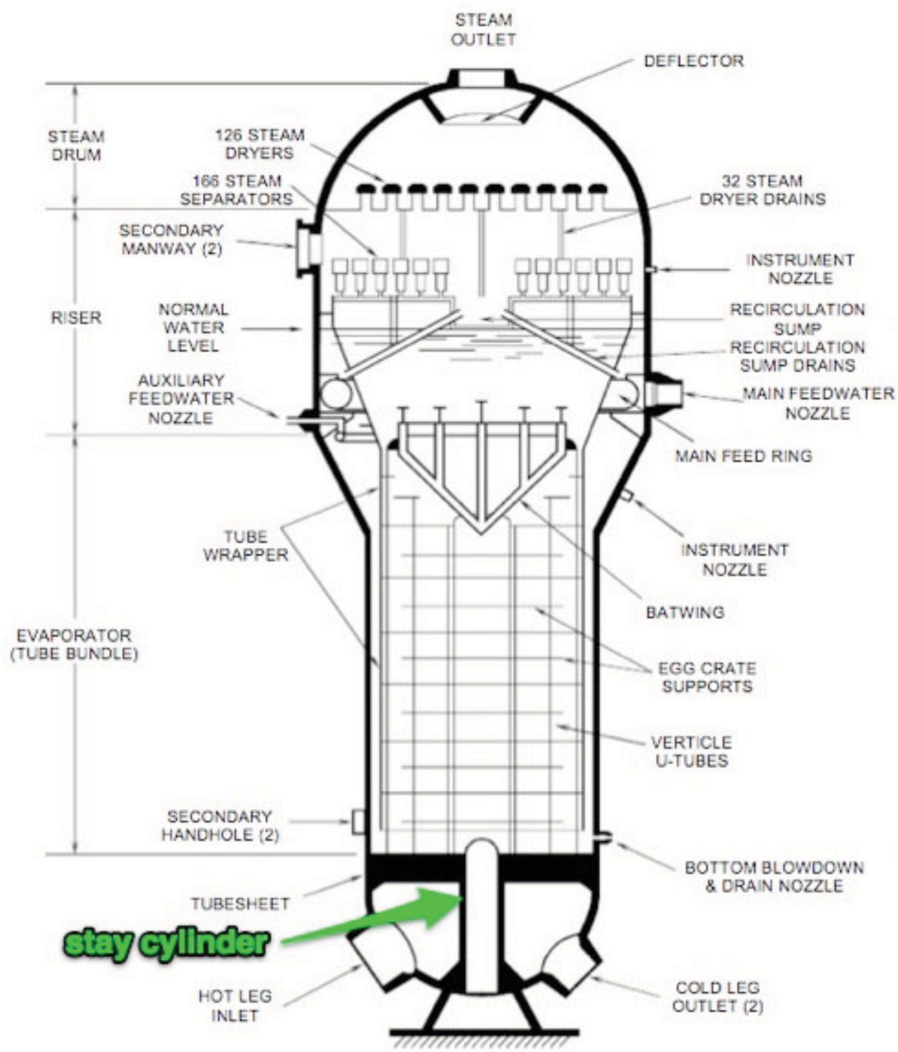
The stay cylinder is unique to the CE design because the CE steam generators are twice as large as the Westinghouse design. The larger diameter of the CE steam generator would cause the tube sheet to flex more in the event of a steam line break accident at St. Lucie Unit 2 than at other reactors with smaller steam generators.

17. In order to protect against wear and vibration, steam generator heat transfer tubes must be supported. St. Lucie's OSGs used an egg crate or lattice design for support of the steam generator tubes. St. Lucie's RSGs have broached plates. Other designs are also used. The following NRC diagram illustrates the principal tube support designs:



NRC slides, Crevice Corrosion, Pitting Corrosion IGA (2011) (ML11229A050).

18. The following diagram illustrates the design of a typical CE PWR steam generator with a stay cylinder and egg crate supports:




19. Steam generator tubes are susceptible to the stresses of corrosion and vibration, and nationwide, they have a long history of wearing thin or cracking. As discussed below, steam generator tube degradation causes a significant nuclear safety risk by substantially increasing the likelihood of an accident that releases radioactivity into the environment.

20. Unfortunately, a leak or disintegration of one or more tubes would cause the radioactive water to escape the containment. Because there is at least a 1,000-pound-per-square-inch (psi) pressure difference between the high-pressure radioactive side of the tubes and the lower pressure steam that then leaves the containment, a leak will inevitably release radioactivity to the environment.

21. Additionally, gross failure of one or more of the steam generator tubes could create a nuclear design basis accident and cause the nuclear reactor core to lose a portion of its cooling water. However, the unique concern regarding degraded steam generator tubes is that uncontrolled radiation releases from a tube break will not remain inside the containment building and instead leak out of the facility and into public areas because it has a path to the environment via atmospheric dump valves and steam generator blowdown.

22. If a steam line break accident were to occur, the depressurization of the steam generator caused by the steam line break -- coupled with the lack of water at the top of the steam generators -- would cause cascading tube failures, involving dozens of tubes. The cascading tube failures would pop like popcorn and cause excessive offsite radiation exposures. Operators are not trained on procedures to mitigate multiple tube failures, and emergency cooling systems lack the capacity to mitigate an accident if more than one tube were to fail. Hence, maintaining tube integrity is of the utmost importance.

## IV. BACKGROUND INFORMATION REGARDING ST. LUCIE

### A. Original Licensing of St. Lucie

23. The NRC licensed St. Lucie Unit 1 in 1976 and St. Lucie Unit 2 in 1983. Originally, both reactors had steam generators that were designed and built by Combustion Engineering (CE). Both Units had two essentially identical steam generators.

24. A stay cylinder was installed in each of the original St. Lucie steam generators. *See* FSAR at 5.2-29, which lists the "tubesheet stay" as a Class 2 component.[1] The stay cylinder

[1] The FSAR for St. Lucie Unit 2 is not posted on ADAMS. Therefore a relevant excerpt is

supported the tube sheet and thereby allowed it to be thinner than it would be without support. As described by the NRC in a 1987 license amendment safety evaluation: "A stay cylinder is installed at the central portion of the tubesheet to permit reduction of tubesheet thickness." Safety Evaluation by the Office of Nuclear Reactor Regulation, Related to Amendment No. 24 to Facility Operating License No. NPF-16, Florida Power & Light Company, et al., St. Lucie Plant, Unit No. 2, Docket No. 50-389 (Oct. 15, 1987) (ML013600133).

25. The OSGs at Unit 2 also employed an egg crate or lattice design to support the heat transfer tubes. FPL chose the egg crate design for the specific purpose of reducing the potential for tube vibration. As discussed in the FSAR:

> The potential for tube denting has been reduced in the St. Lucie Unit 2 steam generators by the installation of an antivibration support system that does not use drilled support plates. Supports of the name type, "egg crates", have been utilized to some extent in all CE supplied commercial steam generators within the United States.
>
> The egg crate system reduces susceptibility to tube denting by providing large clearances and increased flow area around the tubes, so that the clearances between the tubes and their supports are less likely to become plugged by corrosion products.
>
> St. Lucie Unit 2 has a full egg crate support system (all support plates have been eliminated.)

FSAR at 5.4-13. (Exhibit 3)

## B. License Renewal

26. FPL applied for renewal of both St. Lucie operating licenses in 2001. FPL's license renewal application listed the tubesheets, stay cylinders, divider plates, U-tubes, and lattice tube supports among the reactor coolant system (RCS) components that are subject to aging management review. *See* Application for Renewed Operating License, Table 3.1-1 at 3.1-65

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attached as Exhibit 2.

(Nov. 29, 2001) (ML013400221). The application specifically noted that St. Lucie Unit 1 and 2 designs "do not include" tube support plates. *Id.* at 3.1-32. The intended function of the tubesheets, stay cylinders, and u-tubes was listed as "pressure boundary." *Id.,* Table 3.1-1.

27. The NRC Staff's Safety Evaluation Report (SER) for renewal of the St. Lucie operating license evaluates FPL's program for managing aging of the safety-related components of the steam generators, including tubesheets, stay cylinders u-tubes, tube supports, and other steam generator components as follows:

> The component/commodity groups and their intended functions, material, environment, and aging effects requiring management and programs/activities for the steam generators are listed in Table 3.1-1 of the LRA. The component/commodity groups identified in the table include primary heads, <u>stay cylinders</u>, primary manway covers, primary inlet and outlet nozzles, primary inlet and outlet nozzle safe ends, <u>tubesheets</u>, primary instrument nozzles, U-tubes, tube plugs, divider plates, upper and lower shells, transition cones, secondary heads, Feedwater nozzles and safe ends, steam outlet nozzle safe ends, Unit 2 steam outlet nozzles, Unit 1 steam outlet nozzles with integral flow orifices, blowdown nozzles, secondary instrument nozzles, secondary manway and handhole closure covers, tube bundle wrappers and wrapper supports, <u>tube support lattice bars</u>, conical skirts, upper vessel clevises, and shear keys and boltings. The intended functions identified were pressure boundary, heat transfer, flow distribution, throttling, and structural support.

Safety Evaluation Report Related to the License Renewal of St. Lucie Nuclear Power Plant, Units 1 and 2 at 2-35 – 2-36 (July 2003) (ML031890095) (emphasis added). Based on FPL's representations, the Staff concluded that "there is reasonable assurance that the applicant has appropriately identified the steam generator components subject to an AMR [aging management review] in accordance with the requirements stated in 10 CFR 54.21(a)(1)." *Id.* at 2-36.

28. In the License Renewal SER, the NRC Staff evaluated FPL's Aging Management Program (AMP) and related Steam Generator Integrity Program. The SER describes the AMP as follows:

> In Section 3.1.6. of the LRA, the applicant identifies that aging management of SG tubes

> will be managed by the Steam Generator Integrity Program which is discussed in Section 3.2.13 of Appendix B to the LRA.
>
> The applicant states that the Steam Generator Integrity Program is consistent with the 10 attributes of the AMP, XI.M19, "Steam Generator Tube Integrity," in the GALL Report. In addition, the program scope includes the Unit 2 SG tube support lattice bars. The Steam Generator Integrity Program also credits sludge lancing as a preventive action for secondary side SG tube degradation and tube bundle flushing to minimize FAC of the Unit 2 carbon steel tube support lattice bars.
>
> The applicant states that the Steam Generator Integrity Program has been effective in ensuring detection of the aging effects of cracking and loss of material in SG tubes. The program is structured to meet NEI 97-06, "Steam Generator Program Guidelines," which references several EPRI guidelines. These EPRI guidelines include SG examination, tube integrity assessments, primary and secondary water chemistry, primary-to-secondary leakage, in-situ pressure testing, and tube plug assessment. <u>Although the applicant did not explicitly discuss this in the LRA, the Steam Generator Integrity Program must also satisfy the SG surveillance requirements in the St. Lucie Units 1 and 2 technical specifications.</u>

SER at 3-64 (emphasis added). Based on this information, the Staff concluded that the AMP is adequate. The NRC's conclusion was based in part on a determination that the technical specifications for St. Lucie will address the components that are subject to the AMP – *i.e.,* the tubesheet, stay cylinder, U-tubes, and tube supports:

> The staff reviewed the Steam Generator Integrity Program to determine whether the applicant has demonstrated that the effects of aging on the SG components will be adequately managed during the period of extended operation, as required by 10 CFR 54.21(a)(3). The 10 program elements in the GALL Report, AMP XI.M19, "Steam Generator Tube Integrity," provide detailed programmatic characteristics and criteria that the staff considers to be necessary to manage aging effects on SG components.
>
> The applicant evaluated the current SG inspection activities against industry recommendations provided by EPRI via NEI 97-06 and the SG suppliers. The applicant states that the effectiveness of the program is demonstrated by the operating experience and inspection results. The Steam Generator Integrity Program provides assurance that tube wear, pitting corrosion, general corrosion, crevice corrosion, PWSCC, intergranular attack (IGA), and intergranular stress-corrosion cracking (IGSCC) of components are managed and that the intended functions of the SG will be maintained consistent with the CLB during the period of extended operation. The applicant retains the program description of the Steam Generator Integrity Program, and the descriptions of the program's 10 elements, on record at the St. Lucie nuclear station.

> The staff inspected the Steam Generator Integrity Program for acceptability and compared the program's 10 elements to those described in the GALL Report, AMP XI.M19. The inspection findings are documented in Inspection Report 50-335/2003-03 and 50-389/2003-03, dated March 7, 2003. On the basis of these considerations, the staff finds that the Steam Generator Integrity Program will provide an acceptable means of managing the aging effects of SG components.
>
> On the basis of its AMP evaluations, the staff concludes that the AMP is acceptable for managing the pertinent aging effects and providing assurance that the intended functions of the SG components will be maintained consistent with the CLB during the period of extended operation, as required by 10 CFR 54.21(a)(3).

SER at 3-65. Inspection Report 2003-03, referred to in the above quoted, further explains the relationship between the AMP and the St. Lucie technical specifications:

> The ISI [In-Service Inspection] Program, an existing program, is credited in the LRA as an aging management program. The existing program has been monitoring Class 1, 2 and 3 piping, components, and integral attachment conditions via their inservice inspections since plant construction. <u>These various subsections' documents that constitute the program are required by the applicant's technical specifications and 10 CFR 55a.</u> Specific details of the Alloy 600, reactor vessel, vessel internal components, and steam generator tube special programs are addressed elsewhere in this report.
>
> The program for Class 1, 2 and 3 components consists of performing surface and volumetric nondestructive examinations of piping and components at various intervals in accordance with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code and other augmented requirements such as NUREGs, Generic Letters, etc. The ISI Program is controlled by procedure maintained and updated by engineering as various exemptions and addenda are changed or adopted and approved by the NRC. The program document is updated each 10-year interval and submitted to the NRC for approval of any relief requests. The inspectors determined that the applicant's program for Subsections IWB, IWC, and IWD met the GALL Criteria Section XI.M1.
>
> For ASME Section XI IWF, the applicant has an existing inspection program and separate basis document that had been inspecting Class 1, 2, and 3 component supports. The applicant took credit for the program and that program met GALL Criteria Section XI.S3. During system walkdowns, the inspectors in general looked at the equipment supports finding them acceptable or problems were identified in the applicant's corrective action documentation. Although the GALL criteria have no preventive actions specified, in the site's coastal salt-laden atmosphere, the applicant has had to aggressively monitor, paint, and repair supports in a pro active manner. The inspectors examined inspection program output, finding the reports acceptable per the site's program requirements.

> The inspectors reviewed: the applicable AMP basis documents; site procedures; and selected system LRAMRs as listed in Attachment 1. In addition to review of the above program documents and discussion of the program with responsible applicant personnel, the inspectors reviewed the final ISI inspection results reports for the last outage, the ISI inspection plans for the next outages, and audit/self assessments generated by the applicant over the last several years. This review determined that the plan was in place and being implemented.
>
> Also, periodic inspections of ISI activities have been performed by NRC ISI inspectors during outages. Recent inspections have found activities to be performed in accordance with program and plan requirements in an acceptable manner.
>
> The inspectors concluded that ISI activities are being conducted as described in the ISI Program. The program includes the systems and components listed in the LRA, for which the LRA credited the ISI Program for aging management. Adequate historic reviews to determine aging effects had been conducted, and adequate guidance had been provided to reasonably ensure that aging effects will be appropriately managed.

Letter from Harold O. Christensen to FPL re: St. Lucie Nuclear Plant - NRC Inspection Report 50-335/2003-03 AND 50-389/2003-03 at 9-10 (March 7, 2003) (ML030710192) (emphasis added). Thus, the AMP and the Steam Generator Integrity Program and the specific components they cover – including the stay cylinder, the tube sheet, and the lattice tube supports -- are incorporated into the technical specifications for St. Lucie Unit 2.

### C. Steam Generator Replacements

29. In 1998, FPL replaced the Unit 1 OSGs with new replacement steam generators RSGs manufactured by Babcock & Wilcox (B&W). To my knowledge, the RSGs were almost identical in design to the CE OSGs.[2] FPL did not seek a license amendment, but rather claimed to be exempt from filing a license amendment application under 10 C.F.R. § 50.59. The design of the RSGs included a stay cylinder and the central region of the tube sheet directly above the stay cylinder was solid steel with no additional tubes added. The only

[2] The UFSAR including the installation of the Unit 1 RSG is not publicly available. Thus, my opinion is based on general information gleaned from various St. Lucie licensing and enforcement documents and information provided by the NRC during the San Onofre Confirmatory Action Letter Proceedings.

significant difference between the OSGs and the RSGs appears to be the replacement of Alloy 600 with Alloy 690 in the manufacture of the tubes.

30. In 2007, FPL replaced the Unit 2 CE OSGs with new ones manufactured by AREVA. As it had done in 1998 on Unit 1, FPL again did not seek a license amendment, but rather claimed to be exempt from filing a license amendment application under 10 C.F.R. § 50.59. In June of 2008, FPL filed a report with the NRC that summarized the characteristics of the new RSGs as follows:

> The RSGs are approximately the same physical size as the original steam generators (OSGs). There are no changes to interfaces with the reactor coolant (RC), main feedwater (MFW), or main steam systems (MSS), and no significant changes to major component supports or piping supports. RSG design differences compared to the OSG design include (1) a small operating weight decrease and a small change in the center of gravity (CG) location, (2) an addition of an integral flow restrictor in the main steam nozzle (3) increased heat transfer area, (4) use of ¾ inch thermally treated Alloy 690 tube material, (5) reduced tube wall thickness, (6) a 3.8% increase in secondary side liquid inventory at hot full power (HFP) conditions and a 3.9% decrease in secondary inventory at hot zero power (HZP) conditions, (7) a higher circulation ratio, and (8) reduced moisture carryover. Evaluations of the differences between the RSGs and OSGs are presented in this report. These evaluations confirm that the use of the RSGs meets the existing UFSAR design basis acceptance criteria.

St. Lucie Unit 2, Docket No. 50-389, Changes, Tests, and Experiments Made as Allowed by 10 C.F.R. 50.59 for the Period of June 12, 2006 through April 4, 2008 at 8 (attached to letter from Gordon L. Johnston, FPL, to NRC re: St. Lucie Unit 2 Docket No. 50-389 Report of 10 CFR 50.59 Plant Changes (June 26, 2008)) (ML081840111).

31. A careful review of subsequently issued documents reveals, however, that in fact the Unit 2 RSGs employed significant design changes. While FPL claimed in its Section 50.59 report that it had made " no changes to interfaces with the reactor coolant (RC) … system … and no significant changes to major component supports or piping supports," it is now clear from correspondence related to the San Onofre steam generators that the RSGs no longer contained the stay cylinders that were part of the OSG design discussed in the FSAR as structural support for the reactor coolant system and included in the Aging Management Program (AMP). *See, e.g.,* E-mail from Kenneth Karwoski to Greg Werner and Art Howell

re: thanks and a question (Jan. 31, 2013) (attached as Exhibit 4). Second, documents related to subsequent inspections of the St. Lucie Unit 2 steam generators show that AREVA added 588 new tubes to the original 8,411 tubes, now totaling 8,999 tubes. *See, e.g.,* Letter from Tracy J. Orf, NRC, to Mano Nazar, FPL, re: St. Lucie Unit 2 – Summary of the Staff's Review of the 2009 Steam Generator Tube Inservice Inspections (TAC No. ME2969), Enclosure at 1 (Nov. 30, 2010) ("11/30/10 NRC Letter"). Third, inspection-related documents refer to "Seven (7) Trefoil Broached Plates" in the RSGs, despite the fact that "plates" were specifically excluded from the original steam generator design. *See, e.g.,* Letter from Eric S. Katzman, FPL, to NRC, re: St. Lucie Unit 2, Docket No. 50-389, RAI Reply for Refueling Outage SL2-18, Steam Generator Tube Inspection Report at 2 (Oct. 1, 2010) (ML102870115). Finally, in order to accommodate the 588 new tubes, it is reasonable to infer that the region of the tubesheet that had been directly above the stay cylinder was now perforated with 588 new holes. As discussed in more detail below, the purpose of the stay cylinder was to prevent tubesheet flexing. The RSG in St. Lucie Unit 2 has a tubesheet with more holes in its center precisely where more flexing is more likely to occur. The failure by the NRC to address this weakened tubesheet raises concerns about the safety and integrity of Unit 2's pressure boundary in the event of a steam line break accident. In addition, the substitution of broached plates for egg crate tube supports creates potential for greater vibration of tubes. *See* pars. 44, 45, and 61.

32. FPL also submitted an Updated Final Safety Analysis Report (UFSAR) to the NRC. The UFSAR is likely to contain more details about the RSGs. But the UFSAR was withheld from public disclosure. Although SACE has requested a copy, the NRC is still reviewing whether or not to release it and how much of the document it should actually release.

## D. Extended Power Uprates

33. In 2010 and 2011, FPL applied to the NRC for Extended Power Uprates (EPUs) for St. Lucie Units 1 and 2, respectively. St. Lucie Unit 1 EPU License Amendment Request

(LAR), Attachment 5 (Nov. 22, 2010) (ML101160143); St. Lucie Unit 2 EPU LAR, Attachment 5 (Feb. 25, 2011) (ML110730299). The NRC approved these analyses in separate SERs. 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 (July 9, 2012) (ML12156A208) ("Unit 1 EPU SER"); Safety Evaluation by the Office Of Nuclear Reactor Regulation Related to Amendment No. 163 to Facility Operating License No. NPF-16, Florida Power and Light Company, St. Lucie Plant, Unit No. 1, Docket No. 50-389 (Sept. 24, 2012) (12235A463) ("Unit 2 EPU SER").

34. FPL conducted a safety analysis to determine whether the power uprate for each unit would compromise the reactor pressure boundary. The scope of the analysis for Unit 1 covered components that had been in the OSGs and were also included in the RSGs, *i.e.,* the stay cylinders and lattice supports for the steam generator tubes. *See* Unit 1 License Amendment Request, Attachment 5 at 2.2.2-66:

> The scope of the reconciliation was the entire SG pressure boundary, internal and external pressure boundary attachments, and all internal components. Specifically, reconciliations were performed for the tubesheet, stay-cylinder, U-tubes, primary head and vessel support skirt, secondary shell and internal/external attachments, primary and secondary nozzles, primary and secondary manways, handholes, inspection ports, studs and covers on all bolted openings, lattice grid and U-bend tube supports, shroud, and steam drum internals.

35. In contrast, in describing the "entire pressure boundary" that was subject to the safety analysis for the Unit 2 EPU, FPL made no mention of the stay cylinder or lattice supports that had been removed from the Unit 2 RSGs; nor did it analyze the effect of their removal. Instead, FPL wrote the analysis as if those components had never existed:

> The scope of the stress reconciliation reanalysis was the entire SG pressure boundary and all internal and external pressure boundary attachments. Formal analyses were performed for the tubesheet, tube bundle, primary divider plate, primary head and internal attachments, secondary shell and internal/external attachments, primary and secondary nozzles, primary and secondary manways, handholes, inspection ports, and studs and covers on all bolted openings.
>
> License Amendment Request, Attachment 5 at 2.2.2-65.

36. After FPL applied for its St. Lucie EPUs, and prior to NRC approval of those EPUs, the San Onofre RSGs – whose design is similar to the St. Lucie Unit 2 RSGs -- were found to be critically flawed and were removed from service. Despite the NRC knowledge of the significant safety failure at San Onofre and the similarity of the St. Lucie steam generators, the NRC went forward with the approval of the St. Lucie Unit 2 EPU.

### E. Steam Generator Tube Inspections at St. Lucie Unit 2

37. While the RSG tubes at St. Lucie Unit 1 showed nominal wear over the past decade, an unusually high number of tubes in the Unit 2 RSGs exhibited wear in 2009 during the very first inspection after the RSGs were installed. *See* 11/30/10 NRC Letter, Enclosure at 2 (noting that "the number of wear indications is much greater than at other units with AREVA SGs"). Demonstrations of tube wear continued to increase in subsequent inspections in 2011 and 2012. In the latest inspection in September 2012, an astonishing 2,211 steam generator tubes in SG A showed 7,646 wear indications and 1,503 steam generator tubes in SG B showed 3,988 wear indications. The following table shows the increasing amount of wear in these tubes in St. Lucie Unit 2. Of equal concern is the fact that the total tubes exhibiting wear increased from 2,046 in 2009 to 3,714 in 2012 for an increase of 81%, even before the EPU increase was implemented. For each year, the table shows the total number of tube wear indications and the number of tubes exhibiting the wear indications.

| History of wear indications/affected number of tubes (cumulative) | | | |
|---|---|---|---|
| | **Inspection Year** | | |
| | **2009** | **2011** | **2012** |
| **SG A** | **3,700/1,231** | **5,864/1,862** | **7,646/2,211** |
| **SG B** | **2,157/815** | **2,963/1,125** | **3,988/1,503** |
| | | | |

Record of NRC Conference Call, St. Lucie Unit 2 Steam Generator Inspection (Sept. 13, 2012) (ML12258A080) ("09/13/12 Conference Call Record").

38. Almost all of the wear indications occurred at the antivibration bars and at the tube support plates that had been installed for the first time with the RSGs. *See, e.g.,* 11/30/10 NRC Letter, attachment at 2; 09/13/12 Conference Call Record. Despite these indications that the altered design of the RSGs was creating an unacceptable degree of vibration in the steam generators, the NRC allowed the reactor to resume operation after each outage and conducted no evaluation of how the unusual level of damage to the steam generators could be related to the 2007 design changes.

39. St. Lucie was shut down for a scheduled maintenance outage on March 3, 2014. FPL has committed to inspect 100% of the steam generators, as the NRC explained in a recent Steam Generator Update conference call. This will be the first outage following a complete operating cycle under Unit 2's extended power uprate. FPL has not committed to provide the results of the inspection before starting the reactor again. Restart is scheduled for April 2, 2014.

## V. DISCUSSION

### A. Replacement of the Steam Generators Required a License Amendment Under 10 C.F.R. § 50.59.

40. NRC regulation 10 C.F.R. § 50.59(c)(1) provides:

> A licensee may make changes in the facility as described in the final safety analysis report (as updated), make changes in the procedures as described in the final safety analysis report (as updated), and conduct tests or experiments not described in the final safety analysis report (as updated) without obtaining a license amendment pursuant to § 50.59 only if:
> (i) A change to the technical specifications incorporated in the license is not required, and
> (ii) The change, test or experiment does not meet any of the criteria in paragraph (c)(2) of this section.

Paragraph (c)(2) provides, in turn, that a nuclear reactor licensee must seek a license amendment before implementing a "proposed change, test, or experiment" if the change, test, or experiment would:

(i) Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the final safety analysis report (as updated);
(ii) Result in more than a minimal increase in the likelihood of occurrence of a malfunction of a structure, system, or component (SSC) important to safety previously evaluated in the final safety analysis report (as updated);
(iii) Result in more than a minimal increase in the consequences of an accident previously evaluated in the final safety analysis report (as updated);
(iv) Result in more than a minimal increase in the consequences of a malfunction of an SSC important to safety previously evaluated in the final safety analysis report (as updated);
(v) Create a possibility for an accident of a different type than any previously evaluated in the final safety analysis report (as updated);
(vi) Create a possibility for a malfunction of an SSC important to safety with a different result than any previously evaluated in the final safety analysis report (as updated);
(vii) Result in a design basis limit for a fission product barrier as described in the FSAR (as updated) being exceeded or altered; or
(viii) Result in a departure from a method of evaluation described in the FSAR (as updated) used in establishing the design bases or in the safety analyses."

41. As summarized by the ASLB in the San Onofre case, three questions must be answered to determine whether the NRC Staff's actions constitute a *de facto* amendment of FPL's operating license for St. Lucie Unit 2 : whether FPL is being allowed to operate (1) in a manner "that deviates from a technical specification in its existing license;" (2) "beyond the ambit, or outside the restrictions of its existing license;" or (3) "in a manner that is neither delineated nor reasonably encompassed within the prescriptive terms" of FPL's existing license. *Southern California Edison Co.* (San Onofre Nuclear Generating Station, Units 2 and 3), LBP-13-07, 77 NRC 307, 333 (2013) (vacated, CLI-13-09, __ NRC __ (Dec. 5, 2013)). *See also* 77 NRC at 335.

42. FPL's replacement of the Unit 2 steam generators does not comply with 10 C.F.R. § 50.59 in any of these respects. First, as discussed above in pars. 28 and 31, the components that have been altered, added, or removed from the RSGs – the new tubes, punctured tube sheets, removed stay cylinders, and changed tube supports -- are all covered by the technical specifications for Unit 2. For example, the technical specifications include inspections of all

components covered by FPL's AMP. The regulations do not permit FPL to remove equipment covered by the AMP or alter its characteristics without a license amendment.

43. In addition, the changes to the St. Lucie Unit 2 RSGs allow FPL to operate outside the scope or restrictions of its existing license, "[c]reat[ing] a possibility for a malfunction of an SSC important to safety with a different result than any previously evaluated in the final safety analysis report (as updated)." 10 C.F.R. § 50.59(c)(2)(vi). For instance, the original FSAR for St. Lucie Unit 2 specifically provided for support of the tubesheet by the stay cylinder, in order to prevent flexing of the tubesheet. To remove the stay cylinder would create the potential for a malfunction of the tubesheet that was not anticipated in the original FSAR.

44. Similarly, the RSG changes allow FPL to operate outside the scope of its existing license with respect to steam generator tube supports. As discussed above, the original license for St. Lucie Unit 2 relied specifically on the egg crate support structure for the steam generator tubes to limit vibration of the tubes, and explicitly asserted that plates would not be used. Thus, not only are those changes not contemplated by the original license, they are forbidden.

45. The unreviewed 10 C.F.R. § 50.59 changes in the St. Lucie Unit 2 RSG increased the number of tubes in the center of the RSG. Thus, heat that had been applied on the periphery of the OSG was moved to the center of the RSG. Furthermore, by replacing the egg crate tube supports with the broached tube support plates in the RSG the flow resistance was increased from the OSG egg crate design. The net effect of additional tubes at the center of the RSG increased resistance to flow on the secondary side of the tubes. This change has created vibrational problems due to increased steam bubble production. Those problems should have reasonably been identified as causative factors in the tube damage that St. Lucie Unit 2 has experienced since its RSGs were installed.

46. In addition, it is clear that the stay cylinder, lattice tube supports, and tubesheet were considered essential elements of the reactor pressure boundary throughout the licensing and re-licensing of St. Lucie, and even in the EPU analysis for Unit 1. *See* pars. 24, 26, 27, 28,

31, and 34 above. Consistent with FPL's License Renewal application and with the NRC Staff's License Renewal SER, FPL's EPU application for St. Lucie Unit 1 treats the stay cylinders as safety components that must be addressed in the safety analysis for the EPU. Thus, for instance, the St. Lucie Unit 1 EPU application states:

> To quantify the range of stress occurring during each postulated design transient for the EPU conditions, ratios were determined between the EPU and design basis pressure and temperature variations and the design basis range of stresses were prorated by these ratios. Acceptance of the results for EPU conditions was based on demonstrating continued compliance with the structural criteria in the ASME B&PV Code Section III, Subsection NB (Reference 1). These acceptance criteria are the same as those used for the design basis analyses of the Replacement SGs.
>
> The internal components, which are not part of the pressure boundary, are not governed by the ASME B&PV Code (Reference 1). However, ASME B&PV Code, Section III, Subsections NB and NF were adopted as guidelines for performing the structural analysis of these components.
>
> The scope of the reconciliation was the entire SG pressure boundary, internal and external pressure boundary attachments, and all internal components. Specifically, reconciliations were performed for the tubesheet, <u>stay-cylinder</u>, U-tubes, primary head and vessel support skirt, secondary shell and internal/external attachments, primary and secondary nozzles, primary and secondary manways, handholes, inspection ports, studs and covers on all bolted openings, <u>lattice grid and U-bend tube supports</u>, shroud, and steam drum internals.

*Id.* at 2.2.2-66 (emphasis added). FPL describes the reconciliation analysis as follows:

> From a structural standpoint, the increased pressure and temperature variations specified in the revised design transients during EPU normal and upset operating conditions impact the SG. Both the primary and secondary side SG components are affected, resulting in an increase in stress intensity and fatigue usage factors. SG to balance of plant interface locations, such as at nozzles to pipe and external supports, are impacted by changes to the interface loads. The EPU structural evaluation was performed by reconciling the existing SG design basis analyses against the revised design transient conditions and the revised interface loads. The scope of the reconciliation included all of the SG pressure boundary, as well as internal components. Specifically, reconciliations were performed for the <u>tubesheet, stay-cylinder, U-tubes</u>, primary head and vessel support skirt, secondary shell and internal/external attachments, primary and secondary nozzles, primary and secondary manways, handholes, inspection ports, studs and covers on all bolted openings, lattice grid and U-bend tube supports, shroud, and steam drum internals. The

> reconciliation analyses used both classical and finite element methods to determine the stresses, stress intensity ranges, and fatigue usage factors for the EPU conditions.
>
> *Id.* at 2.2.2-68 (emphasis added).

47. Thus, prior to the Unit 2 steam generator replacement and prior to the approval of the EPU on Unit 2, FPL's licensing documents acknowledged that the stay cylinder was a safety component that was part of the reactor pressure boundary: first in the FSAR for the OSGs, second in the license renewal proceeding, and later in the extended power uprate license amendment proceeding for Unit 1 the stay cylinder was included as an essential element of the stress analysis of the tubesheet pressure boundary in the RSGs. In the St. Lucie Unit 2 RSG 10 C.F.R. § 50.59 letter, FPL neglects to mention the safety role of the stay cylinder, and misrepresents the changes by stating that "[t]here are no changes to interfaces with the reactor coolant … system(s), and no significant changes to major component supports or piping supports." In fact, the stay cylinder was a part of the reactor coolant system, and was a "major component support" to the tubesheet. [3]

48. Finally, in a number of important respects, the design changes have allowed Unit 2 to operate in a manner not reasonably anticipated by the original St. Lucie license. The interrelationship of the altered or removed components creates fundamental changes to the reactor pressure boundary that were never previously analyzed. For instance, the tube sheet has been weakened by adding hundreds of holes for the 588 new tubes in the location where the stay cylinder had been previously located in the OSG. Furthermore, adding hundreds of tubes to the center of the tube sheet would change the heat transfer rate, moving more heat to the center of the bundle and increasing the likelihood of tube vibration and tube damage.

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[3] Given that the stay cylinder is a part of the reactor coolant system that supports a major safety component (the tubesheet), FPL's statement raises the serious concern that FPL has materially misrepresented the nature of the actions that it took in replacing the Unit 2 steam generators. The statement should be evaluated in connection with any other documents FPL submitted to the NRC with the 10 C.F.R. § 50.59 letter (including the non-public FSAR), to determine whether FPL fully and accurately disclosed to the NRC the nature of its design changes to the Unit 2 RSGs. There is no doubt, however, that in the single document made available to the public, FPL misrepresented the scope of the changes it made to the steam generators.

49. In addition, the absence of the stay cylinder coupled with a weakened tubesheet containing more drilled holes to flex and possibly of a tubesheet failure in the event of a steam line break accident; such an omission of a critical safety component should have been identified as reportable under 10 C.F.R. § 50.59.

50. The Unit 2 EPU stress analysis is entirely different than the stress analysis for Unit 1. Unit 1's EPU analysis identifies the safety significance of the stay cylinder in its RSG while Unit 2's EPU analysis simply ignores the proven safety significance of the stay cylinder despite the fact that the Unit 2 RSG has a weaker tubesheet with more holes at its center and the EPU would have increased uplift forces on the tubesheet. The Unit 2 EPU analysis also fails to acknowledge that adding more tubes to the center of the steam generator changes the heat load on the Unit 2 RSG compared to Unit 1, and would also increase steam and vibration in the tubes, thus hastening their damage and failure.

### B. The NRC Has Amended FPL's Operating License to Accept the Unit 2 Design Changes and Continues to Conduct a License Amendment Proceeding.

51. Six years have passed since December 2007, when FPL installed the two RSGs in St. Lucie Unit 2. During that time period, the NRC Staff repeatedly has made regulatory decisions to allow FPL to operate the reactor in spite of the fact that the new design of the RSGs put the reactor's operation outside of both the original design basis and the license renewal design basis. At the same time, the Staff has continued to use FPL's outage inspections as an opportunity to gather information about the reasons for the poor performance of the RSGs since they were installed. For instance, in a meeting on February 19, 2014 (in which I participated by telephone), a member of the NRC Staff referred to "extensive" discussions between the Staff and FPL over the past several years. The Staff has established an alternating pattern of seeking information about the RSGs and making decisions to allow the continued operation of Unit 2 with the altered, severely damaged RSGs.

52. This process began in 2008, when FPL submitted a report regarding the changes it had made in the previous two years without seeking a license amendment under 10 C.F.R. § 50.59. As discussed above in par. 30, 31, 43, 45, and 47, the report provided vague summary information about the replacement of the Unit 2 steam generators. The NRC's ADAMS collection contains no NRC response to that report. But after FPL 2009 inspection during the first outage after the RSGs were installed, when a surprisingly high number of tubes showed wear, the NRC Staff used the inspection to gather more information about the design of the RSGs. In an August 2010 RAI, for instance, the NRC Staff sought the following fundamental design information about the RSGs "in order to better understand the design of your replacement SGs:"

    a. A tubesheet map depicting the row and column numbers,
    b. Tube material and manufacturer,
    c. Outside diameter and wall thickness of the tubes,
    d. Number of tubes in each SG,
    e. Tube pitch (e.g., triangular, 1.00-inch center-to-center),
    f. Expansion method and extent (e.g., hydraulic expansion for the full length of the tubesheet),
    g. Tube support plate material and design,
    h. Flow distribution baffle design, if applicable,
    i. Whether tubes were stress relieved after bending, and if so, the rows that were stress relieved,
    j. The smallest U-bend radius, and
    k. Heat transfer surface area.

E-mail from Brenda Mozafari, NRC, to Ken Frehafer and Eric Katzman re: Request for Additional Information re SG inspection 2009 (Aug. 24, 2010) (ML102370210). FPL provided the information in a letter from Eric S. Katzman dated October 1, 2010 (ML102870115). FPL's letter revealed a number of design changes that were not included in the original FSAR for Unit 2, including the presence of 8,999 tubes (increased by 588 from the original number of 8,411), the presence of seven "Trefoil Broached Plates," and the presence of tubes throughout the entire tubesheet instead of around the edge of the stay cylinder (now removed).

53. This information exchange between the NRC and FPL highlights the lack of regulatory scrutiny provided by the NRC during the RSG replacement, and demonstrates that the NRC relied upon the assurances of FPL in the 10 C.F.R. § 50.59 processes rather than perform its own adequate analysis. Despite FPL's clear departure from its design basis, and despite the disturbing number of wear indications revealed by the inspection, the NRC decided not to take further regulatory action:

> Based on a review of the information provided, the NRC staff concludes that the licensee provided the information required by their technical specifications. In addition, the staff concludes that there are no technical issues that warrant follow-up action at this time since the inspections appear to be consistent with the objective of detecting potential tube degradation and that inspection results appear to be consistent with industry operating experience at similarly designed and operated units (although the number of wear indications is much greater than that at other units with AREVA SGs).

Letter from Tracy J. Orf, NRC, to Mano Nazar, FPL, re: St. Lucie Unit 2 – Summary of the Staff's Review of the 2009 Steam Generator Tube Inservice Inspections (TAC No. ME2969) (Nov. 30, 2010) (ML103340040). In this letter, the NRC acknowledged significant deficiencies in St. Lucie's RSGs, yet opted for more inspections rather than address the significant design and fabrications differences made to the RSG in the transition from the OSG. The significant underlying changes made to the St. Lucie RSGs should have been identified by FPL through the 10 C.F.R. § 50.59 processes.

54. In evaluating FPL's 2010 EPU license amendment applications for Units 1 and 2, the Staff also implicitly acknowledged the design differences between the Unit 1 RSGs (which kept the stay cylinders and lattice tube supports) and the Unit 2 RSGs (which eliminated those components), by conducting a different type of safety analysis for each unit's steam generators. *See* pars. 34 and 35 above. In its EPU review, the Staff also took into account the results of the 2011 outage inspection, in which increased wear of steam generator tubes was observed. Letter from Tracy J. Orf, NRC, to Florida Power & Light Co. re: Summary of July 27, 2011, Conference Call with Florida Power & Light Company Regarding the Findings of the Spring 2011 Steam Generator Tube Inspections at St. Lucie Unit No. 2 (TAC No. ME6757), Enclosure 2 at 1 (March 27, 2013) (ML13077A448). Again, despite the

design changes to St. Lucie Unit 2, the continuing occurrence of wear on the steam generators, and the similar problems identified on San Onofre Units 2 and 3, the NRC Staff approved the power uprate for St. Lucie Unit 2 on September 24, 2012. *See* par. 36 above.

55. In November 2012, FPL conducted its third inspection following installation of the Unit 2 steam generators, and found even more tubes with signs of wear: 7,646 wear indications in 8,999 tubes in the Steam Generator A and 3,988 wear indications in 8,999 tubes in Steam Generator B. This discovery led to an RAI and several meetings between NRC and FPL. *See* Letter from Eric S. Katzman to NRC re: St. Lucie Unit 2, Docket No. 50-389, Refueling Outage SL2-20 Steam Generator Tube Inspection Report (May 6, 2013) (ML13141A479). E-mail from Siva P. Lingam to Ken Frehafer (Nov. 6, 2012) (ML13310B664); Letter from Eric S. Katzman to NRC re: St. Lucie Unit 2, Docket No. 50-389, Refueling Outage SL2-20 Steam Generator Tube Inspection Report RAI Reply (Nov. 26, 2013) (ML13338A582); Letter from Siva P. Lingam, NRC, to Florida Power & Light Co., re: Summary of March 14, 2013, Meeting with Florida Power & Light Company to Discuss Insights About the Performance of the Steam Generators at St. Lucie Plant, Unit No. 2 After Three Operating Cycles (TAC No. ME9534 (April 11, 2013); Letter from Siva P. Lingam to Florida Power & Light Company re: Summary of September 13, 2013, Conference Call with Florida Power & Light Company Regarding the Findings of the Fall 2012 Steam Generator Tube Inspections at St. Lucie Plant, Unit No. 2 (TAC No. ME9534 (April 4, 2013).

56. The NRC did not conclude its review of all of this information until January 2014, more than one year after the inspection had taken place. The conclusion repeated, virtually verbatim, the same language of the NRC's report of its evaluation of the 2009 inspection:

> Based on a review of the information provided, the NRC staff concludes that the licensee provided the information required by their technical specifications. In addition, the staff concludes that there are no technical issues that warrant follow-up action at this time, since the inspections appear to be consistent with the objective of detecting potential tube degradation, and inspection results appear to be consistent with industry operating experience at similarly designed and operated units. The NRC notes, however, that the number of wear indications is much greater than that at other AREVA SGs of similar age.

Letter from Siva P. Lingam, NRC, to Mano Nazar, FPL, re: St. Lucie Plant, Unit 2 – Review of the 2012 Refueling Outage Steam Generator Tube Inservice Inspection Report (TAC No. MF1786) (Jan. 27, 2014) (ML14103A247). Thus, once again the NRC implicitly amended FPL's operating license for Unit 2 by approving continued operation in spite of the known differences between the OSG and RSG designs, and in spite of the growing problem of tube generator wear.

57. The NRC's process for amending FPL's operating license for St. Lucie Unit 2 is ongoing. Once again, the NRC plans close oversight of steam generator inspections during the current outage at Unit 2. In a February 19, 2014, meeting between the NRC Staff and the Steam Generator Task Force, the NRC Staff stated that FPL had committed to inspect 100% of the steam generator tubes. The NRC Staff has also sent FPL a request for information about the inspection and a notice of its plan to conduct a "baseline inservice inspection ("ISI") at Unit 2 during the refueling outage. Letter from Omar R. López-Santiago, NRC, to Mano Nazar, FPL, re: St. Lucie Nuclear Plant, Unit 2 – Notification of Inspection and Request for Information (Feb. 24, 2014) (ML14056A110).[4] As discussed above in paragraph 28, under FPL's renewed license, the ISI will cover components that are listed in FPL's AMP. Thus, the inspection will cover the stay cylinder and lattice tube supports, components that have been removed in the RSGs. Therefore, if the NRC approves the results of the ISI, once again it will implicitly be approving the operation of Unit 2 outside its design basis.

58. This alternating pattern of information-gathering and regulatory decision-making by the NRC shows not only that the NRC has informally amended FPL's operating license on multiple occasions by approving continued operation with equipment that is clearly outside the reactor's design basis; and that the approval process continues as the Staff continues to gather and assess information about the faulty RSGs.

[4] Although the NRC asked for information about the steam generator inspections by March 3, 2014, no response by FPL had been posted on ADAMS as of March 8, 2014.

## C. FPL's Design Changes Pose an Unacceptable Risk to the Safety of the St. Lucie Nuclear Reactor That Should Be Addressed in a Formal License Amendment Proceeding and Public Hearing Before Operation of Unit 2 Resumes.

59. FPL has made at least four major design changes to the basic components of the reactor coolant pressure boundary (RCPB), an essential safety system in the Unit 2 reactor. Those changes are: the removal of the stay cylinder, the perforation of the central region of the tubesheet, the addition of 588 tubes in that central region, and the substitution of broached trefoil plates for a lattice or egg crate support system for the thousands of tubes in each steam generator. As discussed above with respect to 10 C.F.R. § 50.59, neither FPL nor the NRC Staff has analyzed how the newly altered RCPB components will interact and change the behavior of the entire system. In my professional opinion, the existence of an unanalyzed condition in such an important safety system poses an unacceptable risk to public health and safety.

60. In order to adequately analyze the safety implications of the design alterations to the Unit 2 steam generators, it would be necessary to have a complete description of those changes and an analysis by FPL in a license amendment application. With the limited information that is available now, however, it is possible to identify several unanalyzed safety risks that should be resolved before FPL is allowed to restart Unit 2.

61. For instance, as discussed above in pars. 16, 31, 43, and 49, the stay cylinder was originally installed to support the tubesheet and keep it from flexing. FPL has now created a risk in Unit 2 (but not in Unit 1) that the tube sheet will not be strong enough to withstand the forces of heat and pressure in the steam generator. This risk is of particular concern for the unusually large steam generators and tube sheets installed at St. Lucie. The risk is compounded by the punching of holes in the central region of the tubesheet to accommodate 588 additional tubes. As a result, the central region of the tubesheet is the area most vulnerable to flexing, and now less solid. If the tube sheet were to flex and fail, radiation within the reactor would bypass the containment and pass directly into the environment.

62. Another change with significant safety implications in Unit 2 (but not in Unit 1) is the addition of 588 tubes to the central region of the tubesheet. Not only does this increase the risk of tubesheet flexing, but the addition of new tubes changes the pattern of circulation of hot water and steam. As secondary side, non-radioactive water moves vertically up in a steam generator, more steam is created and the relative volume of water decreases. When the volume of steam becomes much greater than the volume of water, the degree to which the steam generator vibrates increases significantly. This vibration is a major cause of steam generator tube wear and degradation. Even if the new tubes damaged in Unit 2's RSG are not actively leaking or have not ruptured, the tubesheet and tubes in a main steam line accident scenario are at risk of bursting and spewing radiation into the atmosphere. These tube wear problems are unique to St. Lucie Unit 2, as tube wear in Unit 1 is nominal and the Unit 1 RSG is quite similar to the OSG.

63. There is an immediate danger that the tubes in the St. Lucie Unit 2 RSGs could suddenly fail in a manner similar to the failure of the tubes in San Onofre Unit 3. Moreover, the NRC and FPL have not analyzed the likelihood of the tube-to-tube wear failures occurring in St. Lucie Unit 2. Specifically, the increasing wear gaps between the tubes and the Anti-Vibration Bars (AVBs) caused by growth in the denting of the tubes and by poor thermal hydraulic conditions will over time create the very same type of tube-to-tube wear failures that occurred in San Onofre Unit 3. As was shown in San Onofre Unit 3, this damage can occur in less than one refueling cycle and hence will be undetected until tube failure actually occurs.

64. FPL has dealt with some of the tube wear problems by plugging tubes. In my professional opinion, plugging the tubes in Unit 2 is not an effective solution, because it fails to deal with the root causes of this failed design. Continuing to plug the tubes will never solve the underlying problem at St. Lucie Unit 2 because vibration of the tubes is a result of the unanalyzed RSG design and is not the root cause of the steam generator problems at St. Lucie Unit 2. The actual problem is the plethora of Unit 2 RSG design changes that have created unanalyzed safety problems that were not part of the Unit 1 RSGs and were not part of either St. Lucie Unit 1 or 2 OSGs. Plugging tubes cannot repair these design changes that

are causing damage to the tubes.

## VI. CONCLUSION

65. The NRC Staff has effectively amended the operating license for St. Lucie Unit 2, by repeatedly making decisions to allow FPL to operate with troubled steam generators that are far outside the scope of the safety design that the NRC approved in 1981 and renewed in 2003. Although FPL changed fundamental features of the reactor coolant pressure boundary system and the fission barrier that protects the public from accidental releases of radiation, neither FPL nor the NRC performed the in-depth analyses that such changes require. Instead, during the six years that followed replacement of the steam generators, the NRC has continued to gather, in correspondence and meetings with FPL, the information it should have demanded at the outset.

66. Now the NRC has informed FPL that it will conduct a major safety inspection of St. Lucie Unit 2 during the current refueling outage. This inspection, the ISI, is designed to confirm that all passive safety equipment (such as the steam generators and their components) is operating safely and without undue aging effects. Ironically, under Unit 2's technical specifications and AMP, the inspection must include safety components that no longer exist at St. Lucie Unit 2 – the stay cylinders and the lattice or egg crate support structures for thousands of steam generator cooling tubes. The inspection will also cover thousands of steam generator tubes that have dented at an unusually high and unanticipated rate, thus raising fundamental questions about the root causes of the steam generator failures.

67. Under the circumstances, it is time for the NRC to address the significant changes made by FPL to its Unit 2 steam generators in a formal licensing proceeding. This proceeding should include disclosure by FPL of all of the design changes it has made, public release of a safety analysis of why FPL should be allowed to operate Unit 2 with the design changes it has made, and a full public hearing.

Under penalty of perjury, I declare that the foregoing statements of fact are true and correct to the best of my knowledge and that the foregoing statements of my opinion are based on my best professional judgment.

(Electronically signed pursuant to 10 C.F.R. §304(d)(1))

Arnold Gundersen, MENE, RO
Fairewinds Associates, Inc
Burlington, Vermont 05401
Date: March 9, 2014

**CURRICULUM VITAE**
**Arnold Gundersen**
**Chief Engineer, Fairewinds Associates, Inc**
March 9, 2014

## Education and Training

ME NE Master of Engineering Nuclear Engineering
Rensselaer Polytechnic Institute, 1972
U.S. Atomic Energy Commission Fellowship
Thesis: Cooling Tower Plume Rise

BS NE Bachelor of Science Nuclear Engineering
Rensselaer Polytechnic Institute, Cum Laude, 1971
James J. Kerrigan Scholar

RO Licensed Reactor Operator, U.S. Atomic Energy Commission,
License # OP-3014

## ***Qualifications – including and not limited to:***

- Chief Engineer, Fairewinds Associates, Inc
- Nuclear Engineering, Safety, and Reliability Expert
- Federal and Congressional hearing testimony and Expert Witness testimony
- Former Senior Vice President Nuclear Licensee
- Former Licensed Reactor Operator
- Atomic Energy Commission Fellow
- 44-years of nuclear industry experience and oversight
    - Nuclear engineering management assessment and prudency assessment
    - Nuclear power plant licensing and permitting – assessment and review
    - Nuclear safety assessments, source term reconstructions, dose assessments, criticality analysis, and thermohydraulics
    - Contract administration, assessment and review
    - Systems engineering and structural engineering assessments
    - Cooling tower operation, cooling tower plumes, thermal discharge assessment, and consumptive water use
    - Technical patents, nuclear fuel rack design and manufacturing, and nuclear equipment design and manufacturing
    - Radioactive waste processes, storage issue assessment, waste disposal and decommissioning experience
    - Reliability engineering and aging plant management assessments, in-service inspection
    - Employee awareness programs, whistleblower protection, and public communications
    - Quality Assurance (QA) & records

## Publications

Published Lecture — *The Lessons of the Fukushima Daiichi Nuclear Accident* published in the *International Symposium on the Truth of Fukushima Nuclear Accident and the Myth of Nuclear Safety,* August 30, 2012 University of Tokyo, Iwanami Shoten Publishers, Tokyo, Japan

Author — *The Echo Chamber: Regulatory Capture and the Fukushima Daiichi Disaster, Lessons From Fukushima,* February 27, 2012, Greenpeace International

Co-author — *Fukushima Daiichi: Truth And The Way Forward,* Shueisha Publishing, February 17, 2012, Tokyo, Japan.

Co-author — *Fairewinds Associates 2009-2010 Summary to JFC, July 26, 2010* State of Vermont, Joint Fiscal Office, (http://www.leg.state.vt.us/jfo/envy.aspx).

Co-author — *Supplemental Report of the Public Oversight Panel Regarding the Comprehensive Reliability Assessment of the Vermont Yankee Nuclear Power Plant July 20, 2010,* to the Vermont State Legislature by the Vermont Yankee Public Oversight Panel.

Co-author — The Second Quarterly Report by Fairewinds Associates, Inc to the Joint Legislative Committee regarding buried pipe and tank issues at Entergy Nuclear Vermont Yankee and Entergy proposed Enexus spinoff. See two reports: *Fairewinds Associates 2nd Quarterly Report to JFC* and *Enexus Review by Fairewinds Associates.*

Author — Fairewinds Associates, Inc *First Quarterly Report to the Joint Legislative Committee*, October 19, 2009.

Co-author — *Report of the Public Oversight Panel Regarding the Comprehensive Reliability Assessment of the Vermont Yankee Nuclear Power Plant*, March 17, 2009, to the Vermont State Legislature by the Vermont Yankee Public Oversight Panel.

Co-author — *Vermont Yankee Comprehensive Vertical Audit – VYCVA – Recommended Methodology to Thoroughly Assess Reliability and Safety Issues at Entergy Nuclear Vermont Yankee, January 30, 2008 Testimony to Finance Committee Vermont Senate.*

Co-author — *Decommissioning Vermont Yankee – Stage 2 Analysis of the Vermont Yankee Decommissioning Fund – The Decommissioning Fund Gap*, December 2007, Fairewinds Associates, Inc. Presented to Vermont State Senators and Legislators.

Co-author — *Decommissioning the Vermont Yankee Nuclear Power Plant: An Analysis of Vermont Yankee's Decommissioning Fund and Its Projected Decommissioning Costs*, November 2007, Fairewinds Associates, Inc.

Co-author — *DOE Decommissioning Handbook, First Edition*, 1981-1982, invited author.

## Patents

Energy Absorbing Turbine Missile Shield – U.S. Patent # 4,397,608 – 8/9/1983

## Honors

U.S. Atomic Energy Commission Fellowship, 1972

B.S. Degree, Cum Laude, RPI, 1971, 1st in nuclear engineering class

Tau Beta Pi (Engineering Honor Society), RPI, 1969 – 1 of 5 in sophomore class of 700

James J. Kerrigan Scholar 1967–1971

Teacher of the Year – 2000, Marvelwood School

Publicly commended to U.S. Senate by NRC Chairman, Ivan Selin, in May 1993 – "It is true...everything Mr. Gundersen said was absolutely right; he performed quite a service."

## Committee Memberships

Member Board of Directors of Fairewinds Energy Education Corp, 501(c)3

Vermont Yankee Public Oversight Panel, appointed 2008 by President Pro-Tem Vermont Senate

National Nuclear Safety Network – Founding Board Member

Three Rivers Community College – Nuclear Academic Advisory Board

Connecticut Low Level Radioactive Waste Advisory Committee – 10 years, founding member

Radiation Safety Committee, NRC Licensee – founding member

ANSI N-198, Solid Radioactive Waste Processing Systems

**Expert Witness Testimony and Nuclear Engineering Analysis and Consulting**
NRC ASLB Proceeding Fermi Unit 3 52-033-COL – October 30, 2013 – Retained by Don't Waste Michigan, Beyond Nuclear et al, Oral Expert Witness Testimony regarding Contention 15: Quality Assurance.

State of Utah Seventh District Court of Emory County – September 25, 2013 – Retained by HEAL Utah et al as an expert witness testifying on cooling tower consumptive use of water for a proposed nuclear power plant owned by Blue Castle Holdings and located on the Green River. Defendants were Kane County Water Conservancy District.

Canadian Nuclear Safety Commission – May 29-30, 2013 – Retained by Durham Nuclear Awareness to present expert witness testimony in hearings regarding the proposed life extension for the Pickering Nuclear Station owned Ontario Power Generation.

Nuclear Regulatory Commission – May 30, 2013 – Expert witness report Before The Secretary NRC *In the Matter of Detroit Edison Nuclear Power Station: Rebuttal Testimony Of Arnold Gundersen Supporting Of Intervenors' Contention 15: DTE COLA Lacks Statutorily Required Cohesive QA Program.* Retained by Don't Waste Michigan, Beyond Nuclear et al.

Nuclear Regulatory Commission – May 20, 2013 – Expert witness report Before The Secretary NRC *In the Matter of Davis Besse Nuclear Power Station: Expert Witness Report Of Arnold Gundersen To Support The Petition For Leave To Intervene And Request For Hearing By Beyond Nuclear, Citizens Environment Alliance Southwest Ontario Canada, Don't Waste Michigan, and The Sierra Club.* Retained by Beyond Nuclear, Citizens Environment Alliance Southwest Ontario Canada, Don't Waste Michigan, and The Sierra Club.

Nuclear Regulatory Commission – May 6, 2013 – Expert witness report Before The Secretary NRC: *Expert Witness Report Of Arnold Gundersen To Support The Petition For Leave To Intervene And Request For Hearing By The Blue Ridge Environmental Defense League, Bellefonte Efficiency And Sustainability Team, And Mothers Against Tennessee River Radiation.* Retained by BREDL et al.

Nuclear Regulatory Commission – April 30, 2013 – Expert witness report to Atomic Safety and Licensing Board: *Testimony Of Arnold Gundersen Supporting Of Intervenors Contention 15: DTE Cola Lacks Statutorily Required Cohesive QA Program.* Retained by Don't Waste Michigan, Beyond Nuclear et al.

Canadian Nuclear Safety Commission (CNSC) – April 29, 2013 – Expert witness report to Canadian Nuclear Safety Commission (CNSC): *Analysis Of The Relicensing Application For Pickering Nuclear Generating Station*. Retained by Durham Nuclear Awareness.

Nuclear Regulatory Commission – January 16, 2013 – Expert witness presentation to NRC Petition Review Board: 2.206 Presentation San Onofre Units 2 and 3 Replacement Steam Generators Meeting With Petitioner Friends Of The Earth, Requesting Enforcement Action Against Southern California Edison Under 10 CFR 2.206

Expert Witness Report For Friends Of The Earth – July 11, 2012 – San Onofre's Steam Generators: Significantly Worse Thank All Others Nationwide, Fairewinds Associates, Inc

Expert Witness Report For Friends Of The Earth – May 15, 2012 – *San Onofre's Steam Generator Failures Could Have Been Prevented*, Fairewinds Associates, Inc

Expert Witness Report For Friends Of The Earth – April 10, 2012 – *San Onofre Cascading Steam Generator Failures Created By Edison: Imprudent Design And Fabrication Decisions Caused Leaks,* Fairewinds Associates, Inc

Expert Witness Report For Friends Of The Earth – March 27, 2012 – *Steam Generator Failures At San Onofre: The Need For A Thorough Root Cause Analysis Requires No Early Restart,* Fairewinds Associates, Inc

Expert Witness Report For Greenpeace – February 27, 2012 – *Lessons From Fukushima: The Echo Chamber Effect,* Fairewinds Associates, Inc

Nuclear Regulatory Commission – December 21, 2011 – Expert witness report to Atomic Safety and Licensing Board: *Prefiled Direct Testimony of Arnold Gundersen Regarding Consolidated Contention RK-EC-3/CW-EC-1 (Spent Fuel Pool Leaks)*

New York State Department Of Environmental Conservation – November 15-16, 2011 – Expert witness report for Riverkeeper: hearing testimony regarding license extension application for Indian Point Units 2 and 3 – contention: tritium in the groundwater.

Nuclear Regulatory Commission – November 10, 2011 – Expert witness report entitled: *Fukushima and the Westinghouse-Toshiba AP1000, A Report for the AP1000 Oversight Group by Fairewinds Associates, Inc,* and Video. Submitted to NRC by the AP1000 Oversight Group.

Nuclear Regulatory Commission – October 7, 2011 – *Testimony to the NRC Petition Review Board Re: Mark 1 Boiling Water Reactors*, Petition for NRC to shut down all BWR Mark 1 nuclear power plants due to problems in containment integrity in the Mark 1 design.

New York State Department Of Environmental Conservation – October 4, 2011 – *Prefiled Rebuttal Testimony Of Arnold Gundersen On Behalf Of Petitioners Riverkeeper, Inc., Scenic Hudson, Inc., And Natural Resources Defense Council, Inc. To The Direct Testimony Of Matthew J. Barvenik (Senior Principal GZA Geoenvironmental, Inc.) Regarding Radiological Materials*

Southern Alliance for Clean Energy (SACE) submission to TVA Board of Directors – August 3, 2011– Expert witness report entitled: *The Risks of Reviving TVA's Bellefonte Project,* and Video prepared for the Southern Alliance for Clean Energy (SACE).

New York State Department Of Environmental Conservation, July 22, 2011 – Prefiled Direct Testimony Of Arnold Gundersen On Behalf Of Petitioners Riverkeeper, Inc., Scenic Hudson, Inc., And Natural Resources Defense Council, Inc. Regarding Radiological Materials

Nuclear Regulatory Commission – May 10, 2011 – *Comment to the proposed rule on the AP1000 Design Certification Amendment Docket ID NRC-2010-0131 As noticed in the Federal Register on February 24, 2011* Retained by Friends of the Earth as Expert Witness.

Nuclear Regulatory Commission – May 10, 2011 – *Comment to the proposed rule on the AP1000 Design Certification Amendment Docket ID NRC-2010-0131 As noticed in the Federal Register on February 24, 2011* Retained by Friends of the Earth as Expert Witness.

NRC Advisory Committee on Reactor Safeguards (ACRS) – May 26, 2011 – Lessons learned from Fukushima and Containment Integrity on the AP1000.

Vermont Energy Cooperative (VEC) – April 26, 2011 – Presentation to the Vermont Energy Cooperative Board of Directors, *Vermont Yankee – Is It Reliable for 20 more years?*

Vermont State Nuclear Advisory Panel (VSNAP) – February 22, 2011 – Testimony and presentation entitled the *Vermont Yankee Public Oversight Panel Supplemental Report* regarding management issues at the Vermont Yankee Nuclear Power Plant to the reconvened Vermont State Nuclear Advisory Panel.

Vermont State Legislature Senate Committee On Natural Resources And Energy – February 8, 2011. Testimony: *Vermont Yankee Leaks and Implications*. (http://www.leg.state.vt.us/jfo/envy.aspx)

Vermont State Legislature – January 26, 2011 – House Committee On Natural Resources And Energy, and Senate Committee On Natural Resources And Energy – Testimony regarding Fairewinds Associates, Inc's report: *Decommissioning the Vermont Yankee Nuclear Power Plant and Storing Its Radioactive Waste* (http://www.leg.state.vt.us/jfo/envy.aspx). Additional testimony was also given regarding the newest radioactive isotopic leak at the Vermont Yankee nuclear power plant.

Vermont State Legislature Joint Fiscal Committee Legislative Consultant Regarding Entergy Nuclear Vermont Yankee – *Decommissioning the Vermont Yankee Nuclear Power Plant and Storing Its Radioactive Waste* January 2011. (http://www.leg.state.vt.us/jfo/envy.aspx).

U.S. Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards (NRC-ACRS) AP1000 Sub-Committee – *Nuclear Containment Failures: Ramifications for the AP1000 Containment Design,* Supplemental Report submitted December 21, 2010. (http://fairewinds.com/reports)

Vermont State Legislature Joint Fiscal Committee Legislative Consultant Regarding Entergy Nuclear Vermont Yankee – *Reliability Oversight Entergy Nuclear Vermont Yankee, December 6, 2010.* Discussion regarding the leaks at Vermont Yankee and the ongoing monitoring of those leaks and ENVY's progress addressing the 90-items identified in Act 189 that require remediation. (http://www.leg.state.vt.us/jfo/envy.aspx).

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB) – *Declaration Of Arnold Gundersen Supporting Blue Ridge Environmental Defense League's Contention Regarding Consumptive Water Use At Dominion Power's Newly Proposed North Anna Unit 3 Pressurized Water Reactor* in the matter of Dominion Virginia Power North Anna Power Station Unit 3 Docket No. 52-017 Combined License Application ASLBP#08-863-01-COL, October 2, 2010.

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB) – *Declaration Of Arnold Gundersen Supporting Blue Ridge Environmental Defense League's New Contention Regarding AP1000 Containment Integrity On The Vogtle Nuclear Power Plant Units 3 And 4* in the matter of the Southern Nuclear Operating Company Vogtle Electric Generating Plant, Units 3&4 Combined License Application, Docket Nos. 52-025-COL and 52-026-COL and ASLB No. 09-873-01-COL-BD01, August 13, 2010.

Vermont State Legislature Joint Fiscal Committee Legislative Consultant Regarding Entergy Nuclear Vermont Yankee – July 26, 2010 – Summation for 2009 to 2010 Legislative Year For the Joint Fiscal Committee Reliability Oversight Entergy Nuclear Vermont Yankee (ENVY) Fairewinds Associates 2009-2010. This summary includes an assessment of ENVY's progress (as of July 1, 2010) toward meeting the milestones outlined by the Act 189 Vermont Yankee Public Oversight Panel in its March 2009 report to the Legislature, the new milestones that have been added since the incident with the tritium leak and buried underground pipes, and the new reliability challenges facing ENVY, Entergy, and the State of Vermont. (http://www.leg.state.vt.us/jfo/envy.aspx)

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB) – *Declaration Of Arnold Gundersen Supporting Blue Ridge Environmental Defense League's Contentions* in the matter of Dominion Virginia Power North Anna Station Unit 3 Combined License Application, Docket No. 52-017, ASLBP#08-863-01-COL, July 23, 2010.

Florida Public Service Commission (FPSC)
Licensing and construction delays due to problems with the newly designed Westinghouse AP1000 reactors in *Direct Testimony In Re: Nuclear Plant Cost Recovery Clause By The Southern Alliance For Clean Energy (SACE)*, FPSC Docket No. 100009-EI, July 8, 2010.

U.S. Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards (NRC-ACRS) AP1000 Sub-Committee – Presentation to ACRS regarding design flaw in AP1000 Containment – June 25, 2010 Power Point Presentation: http://fairewinds.com/content/ap1000-nuclear-design-flaw-addressed-to-nrc-acrs.

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB) – *Second Declaration Of Arnold Gundersen Supporting Supplemental Petition Of Intervenors Contention 15: DTE COLA Lacks Statutorily Required Cohesive QA Program* – June 8, 2010.

NRC Chairman Gregory Jaczko, ACRS, Secretary of Energy Chu, and the White House Office of Management and Budget – *AP1000 Containment Leakage Report Fairewinds Associates - Gundersen, Hausler, 4-21-2010.* This report, commissioned by the AP1000 Oversight Group, analyzes a potential flaw in the containment of the AP1000 reactor design.

Vermont State Legislature House Committee On Natural Resources And Energy – April 5, 2010 – Testified to the House Committee On Natural Resources And Energy – regarding discrepancies in Entergy's TLG Services decommissioning analysis. See *Fairewinds Cost Comparison TLG Decommissioning* (http://www.leg.state.vt.us/jfo/envy.aspx).

Vermont State Legislature Joint Fiscal Committee Legislative Consultant Regarding Entergy Nuclear Vermont Yankee – February 22, 2010 – The Second Quarterly Report by Fairewinds Associates, Inc to the Joint Legislative Committee regarding buried pipe and tank issues at Entergy Nuclear Vermont Yankee and Entergy proposed Enexus spinoff. See two reports: *Fairewinds Associates 2nd Quarterly Report to JFC* and *Enexus Review by Fairewinds Associates*. (http://www.leg.state.vt.us/jfo/envy.aspx).

Vermont State Legislature Senate Natural Resources – February 16, 2010 – Testified to Senate Natural Resources Committee regarding causes and severity of tritium leak in unreported buried underground pipes, status of Enexus spinoff proposal, and health effects of tritium.

Vermont State Legislature Senate Natural Resources – February 10, 2010 – Testified to Senate Natural Resources Committee regarding causes and severity of tritium leak in unreported buried underground pipes. http://www.youtube.com/watch?v=36HJiBrJSxE

Vermont State Legislature Senate Finance – February 10, 2010 – Testified to Senate Finance Committee regarding *A Chronicle of Issues Regarding Buried Tanks and Underground Piping at VT Yankee.* (http://www.leg.state.vt.us/jfo/envy.aspx).

Vermont State Legislature House Committee On Natural Resources And Energy – January 27, 2010 *A Chronicle of Issues Regarding Buried Tanks and Underground Piping at VT Yankee*. (http://www.leg.state.vt.us/jfo/envy.aspx).

Submittal to Susquehanna River Basin Commission, by Eric Epstein – January 5, 2010 – *Expert Witness Report Of Arnold Gundersen Regarding Consumptive Water Use Of The Susquehanna River By The Proposed PPL Bell Bend Nuclear Power Plant* In the Matter of RE: Bell Bend Nuclear Power Plant Application for Groundwater Withdrawal Application for Consumptive Use BNP-2009-073.

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB) – *Declaration of Arnold Gundersen Supporting Supplemental Petition of Intervenors Contention 15: Detroit Edison COLA Lacks Statutorily Required Cohesive QA Program*, December 8, 2009.

U.S. NRC Region III Allegation Filed by Missouri Coalition for the Environment – Expert Witness Report entitled: *Comments on the Callaway Special Inspection by NRC Regarding the May 25, 2009 Failure of its Auxiliary Feedwater System,* November 9, 2009.

Vermont State Legislature Joint Fiscal Committee Legislative Consultant Regarding Entergy Nuclear Vermont Yankee – Oral testimony given to the Vermont State Legislature Joint Fiscal Committee October 28, 2009. See report: *Quarterly Status Report - ENVY Reliability Oversight for JFO* (http://www.leg.state.vt.us/jfo/envy.aspx).

Vermont State Legislature Joint Fiscal Committee Legislative Consultant Regarding Entergy Nuclear Vermont Yankee – The First Quarterly Report by Fairewinds Associates, Inc to the Joint Legislative Committee regarding reliability issues at Entergy Nuclear Vermont Yankee, issued October 19, 2009. See report: *Quarterly Status Report - ENVY Reliability Oversight for JFO* (http://www.leg.state.vt.us/jfo/envy.aspx).

Florida Public Service Commission (FPSC) – Gave direct oral testimony to the FPSC in hearings in Tallahassee, FL, September 8 and 10, 2009 in support of Southern Alliance for Clean Energy (SACE) contention of anticipated licensing and construction delays in newly designed Westinghouse AP 1000 reactors proposed by Progress Energy Florida and Florida Power and Light (FPL).

Florida Public Service Commission (FPSC) – NRC announced delays confirming my original testimony to FPSC detailed below. My supplemental testimony alerted FPSC to NRC confirmation of my original testimony regarding licensing and construction delays due to problems with the newly designed Westinghouse AP 1000 reactors in *Supplemental Testimony In Re: Nuclear Plant Cost Recovery Clause By The Southern Alliance For Clean Energy*, FPSC Docket No. 090009-EI, August 12, 2009.

Florida Public Service Commission (FPSC) – Licensing and construction delays due to problems with the newly designed Westinghouse AP 1000 reactors in *Direct Testimony In Re: Nuclear Plant Cost Recovery Clause By The Southern Alliance For Clean Energy (SACE)*, FPSC Docket No. 090009-EI, July 15, 2009.

Vermont State Legislature Joint Fiscal Committee Expert Witness Oversight Role for Entergy Nuclear Vermont Yankee (ENVY) – Appointment from July 2009 to May 2010. Contracted by the Joint Fiscal Committee of the Vermont State Legislature as an expert witness to oversee the compliance of ENVY to reliability issues uncovered during the 2009 legislative session by the Vermont Yankee Public Oversight Panel of which I was appointed a member along with former NRC Commissioner Peter Bradford for one year from July 2008 to 2009. At the time, Entergy Nuclear Vermont Yankee (ENVY) was under review by Vermont State Legislature to determine if it should receive a Certificate for Public Good (CPG) to extend its operational license for another 20-years. Vermont was the only state in the country that had legislatively created the CPG authorization for a nuclear power plant. Act 160 was passed to ascertain ENVY's ability to run reliably for an additional 20 years.

U.S. Nuclear Regulatory Commission – Expert Witness Declaration regarding Combined Operating License Application (COLA) at North Anna Unit 3 *Declaration of Arnold Gundersen Supporting Blue Ridge Environmental Defense League's Contentions* (June 26, 2009).

U.S. Nuclear Regulatory Commission – Expert Witness Declaration regarding Through-wall Penetration of Containment Liner and Inspection Techniques of the Containment Liner at Beaver Valley Unit 1 Nuclear Power Plant *Declaration of Arnold Gundersen Supporting Citizen Power's Petition* (May 25, 2009).

U.S. Nuclear Regulatory Commission – Expert Witness Declaration regarding Quality Assurance and Configuration Management at Bellefonte Nuclear Plant *Declaration of Arnold Gundersen Supporting Blue Ridge Environmental Defense League's Contentions in their Petition for Intervention and Request for Hearing*, May 6, 2009.

Pennsylvania Statehouse – Expert Witness Analysis presented in formal presentation at the Pennsylvania Statehouse, March 26, 2009 regarding actual releases from Three Mile Island Nuclear Accident. Presentation may be found at: http://www.tmia.com/march26

Vermont Legislative Testimony and Formal Report for 2009 Legislative Session – As a member of the Vermont Yankee Public Oversight Panel, I spent almost eight months examining the Vermont Yankee Nuclear Power Plant and the legislatively ordered Comprehensive Vertical Audit. Panel submitted Act 189 Public Oversight Panel Report March 17, 2009 and oral testimony to a joint hearing of the Senate Finance and House Committee On Natural Resources And Energy March 19, 2009. http://www.leg.state.vt.us/JFO/Vermont%20Yankee.htm

Finestone v Florida Power & Light Company (FPL) (11/2003 to 12/2008) Federal Court – Plaintiffs' Expert Witness in United States District Court for the Southern District of Florida. Retained by Plaintiffs' Attorney Nancy LaVista, from Lytal, Reiter, Fountain, Clark, Williams, West Palm Beach, FL. Case#06-11132-E. This case involved two plaintiffs in cancer cluster of 42 families alleging that illegal radiation releases from nearby nuclear power plant caused children's cancers. Production request, discovery review, preparation of deposition questions and attendance at Defendant's experts for deposition, preparation of expert witness testimony, preparation for Daubert Hearings, ongoing technical oversight, source term reconstruction and appeal to Circuit Court.

U.S. Nuclear Regulatory Commission Advisory Committee Reactor Safeguards (NRC-ACRS) – Expert Witness providing oral testimony regarding Millstone Point Unit 3 (MP3) Containment issues in hearings regarding the Application to Uprate Power at MP3 by Dominion Nuclear, Washington, and DC. (July 8-9, 2008).

Appointed by President Pro-Tem of Vermont Senate Shumlin (now Vermont Governor Shumlin) to Legislatively Authorized Nuclear Reliability Public Oversight Panel – To oversee Comprehensive Vertical Audit of Entergy Nuclear Vermont Yankee (Act 189) and testify to State Legislature during 2009 session regarding operational reliability of ENVY in relation to its 20-year license extension application. (July 2, 2008 to present).

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB) – Expert Witness providing testimony regarding *Pilgrim Watch's Petition for Contention 1 Underground Pipes* (April 10, 2008).

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB) – Expert Witness supporting *Connecticut Coalition Against Millstone In Its Petition For Leave To Intervene, Request For Hearing, And Contentions Against Dominion Nuclear Connecticut Inc.'s Millstone Power Station Unit 3 License Amendment Request For Stretch Power Uprate* (March 15, 2008).

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB) – Expert Witness supporting *Pilgrim Watch's Petition For Contention 1*: *specific to issues regarding the integrity of Pilgrim Nuclear Power Station's underground pipes and the ability of Pilgrim's Aging Management Program to determine their integrity*. (January 26, 2008).

Vermont State House – 2008 Legislative Session –

- House Committee on Natural Resources and Energy – Comprehensive Vertical Audit: *Why NRC Recommends a Vertical Audit for Aging Plants Like Entergy Nuclear Vermont Yankee (ENVY)*
- House Committee on Commerce – Decommissioning Testimony

Vermont State Senate – 2008 Legislative Session –

- Senate Finance – testimony regarding Entergy Nuclear Vermont Yankee Decommissioning Fund
- Senate Finance – testimony on the necessity for a Comprehensive Vertical Audit (CVA) of Entergy Nuclear Vermont Yankee
- House Committee on Natural Resources and Energy – testimony regarding the placement of high-level nuclear fuel on the banks of the Connecticut River in Vernon, VT

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB) – MOX Limited Appearance Statement to Judges Michael C. Farrar (Chairman), Lawrence G. McDade, and Nicholas G. Trikouros for the "Petitioners": Nuclear Watch South, the Blue Ridge Environmental Defense League, and Nuclear Information & Resource Service in support of *Contention 2: Accidental Release of Radionuclides, requesting a hearing concerning faulty accident consequence assessments made for the MOX plutonium fuel factory proposed for the Savannah River Site*. (September 14, 2007).

Appeal to the Vermont Supreme Court (March 2006 to 2007) – Expert Witness Testimony in support of *New England Coalition's Appeal to the Vermont Supreme Court Concerning: Degraded Reliability at Entergy Nuclear Vermont Yankee as a Result of the Power Uprate*. New England Coalition represented by Attorney Ron Shems of Burlington, VT.

State of Vermont Environmental Court (Docket 89-4-06-vtec 2007) – Expert witness retained by New England Coalition to review Entergy and Vermont Yankee's analysis of alternative methods to reduce the heat discharged by Vermont Yankee into the Connecticut River. Provided Vermont's Environmental Court with analysis of alternative methods systematically applied throughout the nuclear industry to reduce the heat discharged by nuclear power plants into nearby bodies of water and avoid consumptive water use. This report included a review of the condenser and cooling tower modifications.

U.S. Senator Bernie Sanders and Congressman Peter Welch (2007) – Briefed Senator Sanders, Congressman Welch and their staff members regarding technical and engineering issues, reliability and aging management concerns, regulatory compliance, waste storage, and nuclear power reactor safety issues confronting the U.S. nuclear energy industry.

State of Vermont Legislative Testimony to Senate Finance Committee (2006) – Testimony to the Senate Finance Committee regarding Vermont Yankee decommissioning costs, reliability issues, design life of the plant, and emergency planning issues.

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB) – Expert witness retained by New England Coalition to provide Atomic Safety and Licensing Board with an independent analysis of the integrity of the Vermont Yankee Nuclear Power Plant condenser (2006).

U.S. Senators Jeffords and Leahy (2003 to 2005) – Provided the Senators and their staffs with periodic overview regarding technical, reliability, compliance, and safety issues at Entergy Nuclear Vermont Yankee (ENVY).

10CFR 2.206 filed with the Nuclear Regulatory Commission (July 2004) – Filed 10CFR 2.206 petition with NRC requesting confirmation of Vermont Yankee's compliance with General Design Criteria.

State of Vermont Public Service Board (April 2003 to May 2004) – Expert witness retained by New England Coalition to testify to the Public Service Board on the reliability, safety, technical, and financial ramifications of a proposed increase in power (called an uprate) to 120% at Entergy's 31-year-old Vermont Yankee Nuclear Power Plant.

International Nuclear Safety Testimony – Ten Days advising the President of the Czech Republic (Vaclav Havel) and the Czech Parliament on their energy policy for the 21st century.

Nuclear Regulatory Commission (NRC) Inspector General (IG) – Assisted the NRC Inspector General in investigating illegal gratuities paid to NRC Officials by Nuclear Energy Services (NES) Corporate Officers. In a second investigation, assisted the Inspector General in showing that material false statements (lies) by NES corporate president caused the NRC to overlook important violations by this licensee.

State of Connecticut Legislature – Assisted in the creation of State of Connecticut Whistleblower Protection legal statutes.

Federal Congressional Testimony –

- Publicly recognized by NRC Chairman, Ivan Selin, in May 1993 in his comments to U.S. Senate, "It is true...everything Mr. Gundersen said was absolutely right; he performed quite a service."
- Commended by U.S. Senator John Glenn, Chair NRC Oversight Committee for public – for testimony to NRC Oversight Committee

PennCentral Litigation – Evaluated NRC license violations and material false statements made by management of this nuclear engineering and materials licensee.

Three Mile Island Litigation – Evaluated unmonitored releases to the environment after accident, including containment breach, letdown system and blowout. Proved releases were 15 times higher than government estimate and subsequent government report.

Western Atlas Litigation – Evaluated neutron exposure to employees and license violations at this nuclear materials licensee.

Commonwealth Edison – In depth review and analysis for Commonwealth Edison to analyze the efficiency and effectiveness of all Commonwealth Edison engineering organizations, which support the operation of all of its nuclear power plants.

Peach Bottom Reactor Litigation – Evaluated extended 28-month outage caused by management breakdown and deteriorating condition of plant.

**Presentations & Media**

- *The Nuclear Renaissance? Is It Too Big To Fail?* November 20, 2013, University North Carolina, Chapel Hill, NC.
- *Speaking Truth to Power,* October 22, 1913 – Clarkson University, Potsdam, NY.
- *The United States At A Crossroads: Two Futures* – October 17 2013, Global Forum, Waitsfield, Vermont
- *A Road Less Taken*: *Energy Choices for the Future* – October 16, 2013, Johnson State College, Johnson, Vermont.
- *Fukushima: Ongoing Lessons for Boston* – October 9, 2013 – Boston, Massachusetts State House. Speakers were Arnie Gundersen, Former Japanese Prime Minister Naoto Kan, Former NRC Chair Gregory Jaczko, Former NRC Commissioner Peter Bradford, and Massachusetts State Senator Dan Wolf.
- *Fukushima: Ongoing Lessons for New York* – October 8, 2013 – New York City 82nd Street YMCA. Speakers were Arnie Gundersen, Riverkeeper President Paul Galley, Former Japanese Prime Minister Naoto Kan, Former NRC Chair Gregory Jaczko, Former NRC Commissioner Peter Bradford, and Ralph Nader.
- *Fukushima: Ongoing Lessons for California* – June 4, 2013 – New York City 82nd Street YMCA. Speakers were Arnie Gundersen, Riverkeeper President Paul Galley, Former Japanese Prime Minister Naoto Kan, Former NRC Chair Gregory Jaczko, Former NRC Commissioner Peter Bradford, and Friends of the Earth Nuclear Campaigner Kendra Ulrich.
- *What Did They Know And When? Fukushima Daiichi Before And After The Meltdowns,* Symposium: The Medical and Ecological Consequences of the Fukushima Nuclear Accident, The New York Academy of Medicine, New York City, NY, March 11, 2013
- *A Mountain of Waste 70 Years High,* Presentation: Old *and New Reactors*, University of Chicago, December 1, 2012
- Congressional Briefing September 20, 2012; invited by Representative Dennis Kucinich
- Presentations in Japan August/September 2012: Presentation at University of Tokyo (August 30, 2012), Presentation at Japanese Diet Building (members of the Japanese Legislature - August 31, 2012), Presentation to citizen groups in Niigata (September 1, 2012), Presentations to citizen groups in Kyoto (September 4 , 2012), Presentation to Japanese Bar Association (September 2, 2012), and Presentation at the Tokyo Olympic Center (September 6, 2012)

- Multi-media Opera: *Curtain of Smoke,* by Filmmaker Karl Hoffman, Composer Andrea Molino, and Dramatist Guido Barbieri, Rome, Italy (2012-5-21,22)
- Curtain of Smoke Symposium (2012-5-21), with Dr. Sherri Ebadi 2004 Nobel Laureate
- The Italian National Press Club Rome (2012-5-21) with Dr. Sherri Ebadi 2004 Nobel Laureate: the relationship between nuclear power and nuclear weapons
- Radio 3 Rome (2012-5-21) Discussion of Three Mile Island and the triple meltdown at Fukushima Daiichi (Japan),
- Sierra Club Panel Discussions (2012-5-5): Consequences of Fukushima Daiichi with Paul Gunter and Waste Disposal with Mary Olson,
- Physicians for Social Responsibility Seattle (2012-3-17),
- Fukushima Daiichi Forum with Chiho Kaneko, Brattleboro, VT (2012-3-11),
- Physicians for Global Responsibility Vancouver (2012-3-11) Skype Video Lecture, University of Vermont (2 – 2011),
- Boston Nuclear Forum, Boston Library (6/16/11),
- Duxbury Emergency Management (6/15/11),
- Vermont State Nuclear Advisory Panel (VSNAP), Elder Education Enrichment,
- New Jersey Environmental Federation (5/14/11),
- Quaker Meeting House,
- Press Conference for Physicians for Social Responsibility (5/19/11),
- St. Johnsbury Academy – Nuclear Power 101.

Educational videos on nuclear safety, reliability and engineering particularly Fukushima issues. Videos may be viewed @ fairewinds.org (501c3 non-profit)

Expert commentary (many more unnamed): CNN (8), The John King Show (16), BBC, CBC, Russia Today, Democracy Now, Al Jazeera America, KPBS (Radio & TV) VPR, WPTZ, WCAX, WBAI, CCTV, NECN, Pacifica Radio, CBC (radio & TV) (4), Rachel Maddow Show, *Washington Post*, *New York Times*, *Tampa Bay Times, The Guardian*, *Bloomberg* (print & TV), *Reuters*, *Associated Press*, *The Global Post*, *Miami Herald*, *Orange County Times, LA Times, Al Jazeera* (print)*, The Tennessean*, The Chris Martinson Show, *Mainichi News*, TBS Japan, *Gendai Magazine*, NHK television, *Scientific American*. *Huffington Post* (Paris) named Fairewinds.com the best go to site for information about the Fukushima Daiichi accident (5/9/11).

**Special Remediation Expertise:**

Director of Engineering, Vice President of Site Engineering, and the Senior Vice President of Engineering at Nuclear Energy Services (NES) Division of Penn Central Corporation (PCC)

- NES was a nuclear licensee that specialized in dismantlement and remediation of nuclear facilities and nuclear sites. Member of the radiation safety committee for this licensee.
- Department of Energy chose NES to write *DOE Decommissioning Handbook* because NES had a unique breadth and depth of nuclear engineers and nuclear physicists on staff.
- Personally wrote the "Small Bore Piping" chapter of the DOE's first edition Decommissioning Handbook, personnel on my staff authored other sections, and I reviewed the entire Decommissioning Handbook.
- Served on the Connecticut Low Level Radioactive Waste Advisory Committee for 10 years from its inception.

- Managed groups performing analyses on dozens of dismantlement sites to thoroughly remove radioactive material from nuclear plants and their surrounding environment.
- Managed groups assisting in decommissioning the Shippingport nuclear power reactor. Shippingport was the first large nuclear power plant ever decommissioned. The decommissioning of Shippingport included remediation of the site after decommissioning.
- Managed groups conducting site characterizations (preliminary radiation surveys prior to commencement of removal of radiation) at the radioactively contaminated West Valley site in upstate New York.
- Personnel reporting to me assessed dismantlement of the Princeton Avenue Plutonium Lab in New Brunswick, NJ. The lab's dismantlement assessment was stopped when we uncovered extremely toxic and carcinogenic underground radioactive contamination.
- Personnel reporting to me worked on decontaminating radioactive thorium at the Cleveland Avenue nuclear licensee in Ohio. The thorium had been used as an alloy in turbine blades. During that project, previously undetected extremely toxic and carcinogenic radioactive contamination was discovered below ground after an aboveground gamma survey had purported that no residual radiation remained on site.

**Additional Education**

Basic Mediation Certificate    Champlain College, Woodbury Institute
28-hour Basic Mediation Training September 2010

**Teaching and Academic Administration Experience**

Rensselaer Polytechnic Institute (RPI) – Advanced Nuclear Reactor Physics Lab
Community College of Vermont – Mathematics Professor – 2007 through Spring 2013
Burlington High School
Mathematics Teacher – 2001 to June 2008
Physics Teacher – 2004 to 2006
The Marvelwood School – 1996 to 2000
*Awarded Teacher of the Year – June 2000*
Chairperson: Physics and Math Department
Mathematics and Physics Teacher, Faculty Council Member
Director of Marvelwood Residential Summer School
Director of Residential Life
The Forman School & St. Margaret's School – 1993 to 1995
Physics and Mathematics Teacher, Tennis Coach, Residential Living Faculty Member

**Nuclear Engineering** 1970 to Present

Expert witness testimony in nuclear litigation and administrative hearings in federal, international, and state court and to Nuclear Regulatory Commission, including but not limited to: Three Mile Island, US Federal Court, US NRC, NRC ASLB, ACRS, and Petition Review Board, Canadian Nuclear Safety Commission, Diet (Parliament) Japan, Vermont State Legislature, Vermont State Public Service Board, Florida Public Service Board, Czech Senate, Connecticut State Legislature, Western Atlas Nuclear Litigation, U.S. Senate Nuclear Safety Hearings, Peach Bottom Nuclear Power Plant Litigation, and Office of the Inspector General NRC, and numerous Congressional Briefings and Hearings.

Nuclear Engineering, Safety, and Reliability Expert Witness 1990 to Present

- Fairewinds Associates, Inc – Chief Engineer, 2005 to Present
- Arnold Gundersen, Nuclear Safety Consultant and Energy Advisor, 1995 to 2005
- GMA – 1990 to 1995, including expert witness testimony regarding the accident at Three Mile Island.

Nuclear Energy Services, Division of PCC (Fortune 500 company) 1979 to 1990

Corporate Officer and Senior Vice President - Technical Services – Responsible for overall performance of the company's Inservice Inspection (ASME XI), Quality Assurance (SNTC 1A), and Staff Augmentation Business Units – up to 300 employees at various nuclear sites.

Senior Vice President of Engineering – Responsible for the overall performance of the company's Site Engineering, Boston Design Engineering and Engineered Products Business Units. Integrated the Danbury based, Boston based and site engineering functions to provide products such as fuel racks, nozzle dams, and transfer mechanisms and services such as materials management and procedure development.

Vice President of Engineering Services – Responsible for the overall performance of the company's field engineering, operations engineering, and engineered products services. Integrated the Danbury-based and field-based engineering functions to provide numerous products and services required by nuclear utilities, including patents for engineered products.

General Manager of Field Engineering – Managed and directed NES' multi-disciplined field engineering staff on location at various nuclear plant sites. Site activities included structural analysis, procedure development, technical specifications and training. Have personally applied for and received one patent.

Director of General Engineering – Managed and directed the Danbury based engineering staff. Staff disciplines included structural, nuclear, mechanical and systems engineering. Responsible for assignment of personnel as well as scheduling, cost performance, and technical assessment by staff on assigned projects. This staff provided major engineering support to the company's nuclear waste management, spent fuel storage racks, and engineering consulting programs.

New York State Electric and Gas Corporation (NYSE&G) — 1976 to 1979

Reliability Engineering Supervisor – Organized and supervised reliability engineers to upgrade performance levels on seven operating coal units and one that was under construction. Applied analytical techniques and good engineering judgments to improve capacity factors by reducing mean time to repair and by increasing mean time between failures.

Lead Power Systems Engineer – Supervised the preparation of proposals, bid evaluation, negotiation and administration of contracts for two 1300 MW NSSS Units including nuclear fuel, and solid-state control rooms. Represented corporation at numerous public forums including TV and radio on sensitive utility issues. Responsible for all nuclear and BOP portions of a PSAR, Environmental Report, and Early Site Review.

Northeast Utilities Service Corporation (NU) — 1972 to 1976

Engineer – Nuclear Engineer assigned to Millstone Unit 2 during start-up phase. Lead the high velocity flush and chemical cleaning of condensate and feedwater systems and obtained discharge permit for chemicals. Developed Quality Assurance Category 1 Material, Equipment and Parts List. Modified fuel pool cooling system at Connecticut Yankee, steam generator blowdown system and diesel generator lube oil system for Millstone. Evaluated Technical Specification Change Requests.

Associate Engineer – Nuclear Engineer assigned to Montague Units 1 & 2. Interface Engineer with NSSS vendor, performed containment leak rate analysis, assisted in preparation of PSAR and performed radiological health analysis of plant. Performed environmental radiation survey of Connecticut Yankee. Performed chloride intrusion transient analysis for Millstone Unit 1 feedwater system. Prepared Millstone Unit 1 off-gas modification licensing document and Environmental Report Amendments 1 & 2.

Rensselaer Polytechnic Institute (RPI) — 1971 to 1972

Critical Facility Reactor Operator, Instructor – Licensed AEC Reactor Operator instructing students and utility reactor operator trainees in start-up through full power operation of a reactor.

Public Service Electric and Gas (PSE&G) — 1970

Assistant Engineer – Performed shielding design of radwaste and auxiliary buildings for Newbold Island Units 1 & 2, including development of computer codes.

**Media**

Featured Nuclear Safety and Reliability Expert (1990 to present) for Television, Newspaper, Radio, & Internet – Including, and not limited to: CNN: JohnKingUSA, CNN News, Earth Matters; DemocracyNow, NECN, WPTZ VT, WTNH, VPTV, WCAX, RT, CTV (Canada), CCTV Burlington, VT, ABC, TBS/Japan, Bloomberg: EnergyNow, KPBS, Japan National Press Club (Tokyo), Italy National Press Club (Rome), The Crusaders, Front Page, Five O'Clock Shadow: Robert Knight, Mark Johnson Show, Steve West Show, Anthony Polina Show, WKVT, WDEV, WVPR, WZBG CT, Seven Days, AP News Service, Houston Chronicle, Christian Science Monitor, Reuters, The Global Post, International Herald, The Guardian, New York Times, Washington Post, LA Times, Miami Herald, St. Petersburg Times, Brattleboro Reformer, Rutland Herald, Times-Argus, Burlington Free Press, Litchfield County Times, The News Times, The New Milford Times, Hartford Current, New London Day, Vermont Daily Briefing, Green Mountain Daily, EcoReview, Huffington Post, DailyKos, Voice of Orange County, AlterNet, Common Dreams, and numerous other national and international blogs

**Public Service, Cultural, and Community Activities**

2009 to Present –Fairewinds Energy Education Corp 501(C)3 non-profit board member

2005 to Present – Public presentations and panel discussions on nuclear safety and reliability at University of Vermont, Vermont Law School, NRC hearings, Town and City Select Boards, Legal Panels, Local Schools, Television, and Radio.

2007-2008 – Created Concept of Solar Panels on Burlington High School; worked with Burlington Electric Department and Burlington Board of Education Technology Committee on Grant for installation of solar collectors for Burlington Electric peak summer use

Vermont State Legislature – Public Testimony to Legislative Committees
Certified Foster Parent State of Vermont – 2004 to 2007
Mentoring former students – 2000 to present – college application and employment application questions and encouragement
Tutoring Refugee Students – 2002 to 2006 – Lost Boys of the Sudan and others from educationally disadvantaged immigrant groups
Designed and Taught Special High School Math Course for ESOL Students – 2007 to 2008
NNSN – National Nuclear Safety Network, Founding Advisory Board Member, meetings with and testimony to the Nuclear Regulatory Commission Inspector General (NRC IG)
Berkshire School Parents Association, Co-Founder
Berkshire School Annual Appeal, Co-Chair
Sunday School Teacher, Christ Church, Roxbury, CT
Washington Montessori School Parents Association Member
Marriage Encounter National Presenting Team with wife Margaret
Provided weekend communication and dialogue workshops weekend retreats/seminars
Connecticut Marriage Encounter Administrative Team – 5 years
Northeast Utilities Representative Conducting Public Lectures on Nuclear Safety Issues

**Personal**

Married to Maggie Gundersen 1979. Two children: Eric, 34, president and founder of MapBox and Development Seed, and Elida, 31, paramedic in Florida. Enjoy sailing, walking, swimming, yoga, and reading.

*End*

Exhibit 2 (FSAR Excerpt #1)



TABLE 5.2-3 (Cont'd)

| Component | Material Specification |
| --- | --- |
| Pressurizer (Cont'd) | |
| Forged nozzles | SA-508 Class 2 |
| Instrument nozzles[a] | SB-166 |
| Surge and PORV nozzle safe ends[a] | SA-351, Gr CF8M |
| Spray and instrument nozzle safe ends[a] | SA-182, Type 316 |
| Studs and nuts | SA-540-B24 |
| Steam generator | |
| Primary head (plate and forging) | SA-533 Grade B, Class 1 (plate)<br>SA-508 Class 2 (forging) |
| Safe ends | SA-508 Class 1 (forging) |
| Primary head cladding[a] | Weld deposited austenitic stainless steel with greater than 5% delta ferrite |
| Tubesheet | SA-508 Class 2 (forging) |
| Tubesheet stay | SA-508 Class 2 (forging) |
| Tubesheet cladding[a] | Weld deposited NiCrFe alloy (equivalent to SB-166) |
| Tube[a] | NiCrFe alloy (SB-163) |
| Secondary shell and head | SA-533 Grades A, and B Class 1<br>SA-516 Grade 70 |
| Secondary nozzles | SA-508 Class 1 or Class 2 |
| Secondary nozzle safe ends | SA-508 Class 1 |
| Secondary instrument nozzles | SA-106 Class B |
| Studs and nuts | SA-540 Grade B24 and SA-193 Grade B7 |
| Sliding base support | A533 Class 2 Grade B<br>Key - A291 Class 3A<br>Charpy V-notch 15 mils internal expansion at 50°F |

 **Exhibit 3 (FSAR Excerpt #1)**

Upon leaving the vertical U-tube heat transfer surface, the steam-water mixture enters the centrifugal-type separators. These impart a centrifugal motion to the mixture and separate the water particles from the steam. The water exits from the perforated separator housing and combines with the feedwater to repeat the cycle. Final drying of the steam is accomplished by passage of the steam through the corrugated plate dryers.

The steam generators are mounted on bearing plates which allow controlled lateral motion due to thermal expansion of the reactor coolant piping. Key stops embedded in the concrete base limit this motion in case of a reactor coolant pipe rupture. The top of each unit is restrained from sudden lateral movement by keys and hydraulic snubbers mounted rigidly to the concrete structure.

The steam generators are located at a higher elevation than the reactor vessel. The elevation difference creates natural circulation capability sufficient to remove core decay heat following coast down of all reactor coolant pumps.

Overpressure protection for the shell side of the steam generators and the main steam line up to the inlet of the turbine stop valve is provided by 16 flanged spring loaded ASME Code safety valves which discharge to atmosphere. Overpressure protection is discussed in Subsection 5.2.2.

5.4.2.1.3 Steam Generator Tubes

The steam generators are tubed with 0.750 inch OD by .048 wall tubes. The tubes are fabricated from Inconel 600 to insure compatibility with both the primary and secondary waters. The design incorporates a general corrosion allowance that provides for reliable operation over the plant design lifetime.

Localized corrosion has led to steam generator tube leakage in some operating reactor plants. Examination of tube defects that have resulted in leakage has shown that two mechanisms are primarily responsible. These localized corrosion mechanisms are referred to as (1) stress assisted caustic cracking, and (2) wastage or beavering. Both of these types of corrosion have been related to steam generators that have operated on phosphate chemistry. The caustic stress corrosion type of failure is precluded by controlling feedwater chemistry to the specification limits shown in Subsection 10.3.5. Removal of solids from the secondary side of the steam generator is discussed in Subsection 10.4.8. Localized wastage or beavering has been eliminated by removing phosphates from the chemistry control system.

Volatile chemistry (discussed in Subsection 10.3.5) has been successfully used in all CE steam generators that have gone into operation since 1972.

a) Tube Wall Thinning

The design steady state and transient conditions specified in the design of the steam generator tubes are discussed in Subsection 3.9.1.1. At least 0.012 inches of excess material is intentionally

Exhibit 3 (FSAR Excerpt #1)



provided to accommodate degradation of tubes due to normal uniform corrosion that may occur during the service lifetime.

b) Denting

A number of operating plants have experienced a corrosion phenomenon known as "denting".

Denting is caused by the uncontrolled corrosion of carbon steel support structure surfaces surrounding a tube. As the uncontrolled corrosion of carbon steel takes place, the original base metal (iron) is converted to nonprotective magnetite ($Fe_3O_4$) resulting in a doubling of volume (ie, twice the volume of the original base metal is occupied by the metal oxide). Because the magnetite is nonprotective, the base metal continues to corrode, producing large localized concentrations of metal oxide. The expanded metal oxide exerts pressure on the steam generator tube and the support. When pressure in the tube/tube support annulus becomes sufficient to produce yielding in the tube wall, denting results.

Experience from operating steam generators and laboratory testing has demonstrated that two conditions are required to initiate denting:

1) The original clearance between the tube and the support must have become blocked with a porous deposit in which bulk water can be concentrated.

2) The bulk water being concentrated must have condenser leakage impurities that produce acid solutions, which in corroding the carbon steel of the support result in the formation of a nonprotective form of magnetite.

The potential for tube denting has been reduced in the St. Lucie Unit 2 steam generators by the installation of an antivibration support system that does not use drilled support plates. Supports of the same type, "egg crates", have been utilized to some extent in all CE supplied commercial steam generators within the United States.

The egg crate system reduces susceptibility to tube denting by providing larger clearances and increased flow area around the tubes, so that the clearances between the tubes and their supports are less likely to become plugged by corrosion products.

St. Lucie Unit 2 has a full egg crate support system (all support plates have been eliminated).

c) Potential Effects of Tube Rupture

The steam generator tube rupture incident is a penetration of the barrier between the RCS and the Main Steam System. The integrity of this barrier is significant from the standpoint of radiological safety in that a leaking steam generator tube allows the transfer of reactor coolant into the Main Steam System. Radioactivity contained in the reactor coolant would mix with water in the shell side of the affected steam generator. This radioactivity would be transported by steam to the turbine and then to the condenser or directly to the condenser via the Steam Dump and Bypass System. Noncondensible radioactive gases in the condenser are removed by the Main Condenser Evacuation System and discharged to the plant vent. Analysis of a steam generator tube rupture incident, assuming complete severance of a tube, is presented in Section 15.6.

Experience with nuclear steam generators indicates that the probability of complete severance of a tube is remote. The material used to fabricate the vertical U-tube is a Ni-Cr-Fe alloy. A double-ended rupture has never occurred in a steam generator of this design. The more probable modes of failure, which result in smaller penetrations, are those involving the occurrence of pinholes or small cracks in the tubes, and of cracks in the seal welds between the tubes and tube sheet. Detection and control of steam generator tube leakage is described in Subsection 5.2.5.

d) Composition of Secondary Fluid and Radiological Considerations

Radioactivity connection in the secondary side of the steam generator is dependent upon the activity level of the Reactor Coolant System, the primary to secondary leak rate, and the operation of the Steam Generator Blowdown System. An evaluation of shell side radioactivity concentration is given in Section 11.1.

The recirculation water within the steam generators contains volatile additives necessary for proper chemistry control. These and other chemistry considerations of the Main Steam System are discussed in Subsection 10.3.5.

Materials used in fabrication of the steam generator are not affected by the radiation levels and doses resulting from operation. Although radiation levels are significant for any internal maintenance operations, procedures and equipment have been developed to minimize individual personnel exposure during these operations by allowing rapid completion of individual maintenance operations.

5.4.2.2 Steam Generator In-service Inspection

a) The preservice and in-service inspection programs are developed to comply with the ASME Code, Section XI requirements as appropriate, to permit examinations of the steam generator Code Class 1 and 2 component parts, including the steam generator tubes (refer to Subsection 5.2.4 and Section 6.6).

Exhibit 3 (FSAR Excerpt #1)

b) The in-service inspection program of the steam generator tubes is developed to comply with Appendix IV of the ASME Code, Section XI.

1) The program parameters comply with the guidelines recommended in Regulatory Guide 1.83, "In-service Inspection of Pressurized Water Reactor Steam Generator Tubes", July 1975 (R1).

2) The program examination method, equipment and reporting requirements comply to Appendix IV of the ASME Code, Section XI. The program parameters governing the criteria used for tube inspection, inspection intervals, and acceptance criteria (including plugging limits) are included in Technical Specifications.

## 5.4.3 REACTOR COOLANT PIPING

### 5.4.3.1 Design Basis

The reactor coolant piping is designed and analyzed for normal operation and all transients discussed in Subsection 3.9.1. Loading combinations and stress criteria associated with faulted conditions are presented in Subsection 3.9.1. In addition, certain nozzles are subjected to local transients that are included in the design and analysis of the areas affected. Thermal sleeves are installed in the surge nozzle, safety injection nozzles, and charging nozzles to accommodate these additional transients. Principal parameters are listed in Table 5.4-3. The ASME Code and Addenda the piping is designed to is specified in Subsection 5.2.1.

In addition to being specified as seismic Category I, the following additional vibratory requirement is specified in the engineering specification. The various piping assemblies are designed so that no damage to the equipment is caused by the frequency ranges of 14 to 15 Hz and 70 to 75 Hz. The frequency ranges account for mechanical vibratory excitation of the reactor coolant pump and impeller vane passing pressure variations.

### 5.4.3.2 Description

Each of the two heat transfer loops contains five sections of pipe; one 42 inch internal diameter pipe between the reactor vessel outlet nozzle and steam generator inlet nozzle, two 30 inch internal diameter pipes from the steam generator's two outlet nozzles to the two reactor coolant pump suction nozzles, and two 30 inch internal diameter pipes from the reactor coolant pump discharge nozzles to the reactor vessel inlet nozzles. These pipes are referred to as the hot leg, the suction legs, and the cold legs, respectively. The other major section of reactor coolant piping is the surge line, a 12 inch schedule 160 pipe between the pressurizer and the hot leg in Loop 2B, and the spray line, a 4 inch Schedule 160 pipe at the pressurizer reduced to two 3 inch schedule 160 pipes between the 4 inch pipe and each cold leg in Loops 2B1 and 2B2. Arrangement of this piping is further described in Subsection 5.1.1.

---

**From**: Karwoski, Kenneth
**To**: Werner, Greg; Howell, Art
**Sent**: Thu Jan 31 06:07:00 2013
**Subject**: RE: thanks & question

Only CE units have stay cylinders.

The only ones that removed the stay cylinders (to my knowledge) are ANO-2, SONGS 2 and 3, St. Lucie 2, and Waterford (and Fort Calhoun never had a stay cylinder). All of these units, except Waterford, added tubes.

ANO-2 - Trifoil
SONGS 2 and 3 - Trifoil
St. Lucie 2 - Trifoil
Waterford – broached plate (shape of hole (e.g., trefoil/quatrefoil) not specified)
Fort Calhoun - Trifoil

Let me know if you need anything else.

Ken

**From:** Werner, Greg
**Sent:** Wednesday, January 30, 2013 1:29 PM
**To:** Howell, Art
**Cc:** Karwoski, Kenneth
**Subject:** RE: thanks & question

I do not know. I do know that W3 has trefoil broached TSPs and did NOT put tubes where the stay cylinder was removed. According to unconfirmed reports, Palo Verde added tubes, but it was done at the periphery. Ken Karwoski might know. I will copy him on this.

Greg

**From:** Howell, Art
**Sent:** Wednesday, January 30, 2013 12:14 PM
**To:** Werner, Greg
**Subject:** Fw: thanks & question

Greg,

Do you know the answer?

---

**From**: Daniel O Hirsch <dhirsch1@cruzio.com>
**To**: Howell, Art
**Sent**: Wed Jan 30 12:55:05 2013
**Subject**: thanks & question

Art,

Thanks for talking with my students yesterday; it was a good experience for them, and the work they did, which I oversaw and confirmed, I think came up with interesting results.

Quick question: of the replacement steam generators which removed stay cylinders, which had tubes added and which changed from egg crate to broached?

I understand ANO Unit 2, St. Lucie 2, and Waterford 3 had stay cylinders removed. Fort Calhoun doesn't have a stay cylinder, but their original SG also didn't.

Thanks,

Dan

Attachment-Four

to

March 11th, 2014

2.206 Enforcement Petition

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

January 27, 2014

Mr. Mano Nazar
Executive Vice President and
Chief Nuclear Officer
Florida Power and Light Company
P.O. Box 14000
Juno Beach, Florida 33408-0420

SUBJECT: ST. LUCIE PLANT, UNIT 2 – REVIEW OF THE 2012 REFUELING OUTAGE STEAM GENERATOR TUBE INSERVICE INSPECTION REPORT (TAC NO. MF1786)

Dear Mr. Nazar:

By letter dated May 6, 2013, as supplemented by letter dated November 26, 2013, Florida Power and Light Company (the licensee) submitted information summarizing the results of the fall 2012 steam generator tube inspection report, for the twentieth Refueling Outage (fall 2012) in accordance with Technical Specification (TS) Section 6.9.1.12 for St. Lucie Plant, Unit 2. In addition to the above report, additional information concerning the fall 2012 inspections was summarized by the Nuclear Regulatory Commission (NRC) staff in documents dated April 4 and April 11, 2013.

The NRC staff has completed its review of these reports and concludes that the licensee provided the information required by its TSs and that no additional followup is required at this time. The NRC staff's review of the report is enclosed.

Sincerely,

Siva P. Lingam

Siva P. Lingam, Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-389

Enclosure:
Inspection Summary Report

cc w/encl: Distribution via ListServ

REVIEW OF THE FALL 2012 REFUELING OUTAGE

STEAM GENERATOR TUBE INSPECTION REPORT

FLORIDA POWER AND LIGHT COMPANY

ST. LUCIE PLANT, UNIT 2

DOCKET NO. 50-389

By letter dated May 6, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML13141A479), as supplemented by letter dated November 26, 2013 (ADAMS Accession No. ML13338A582), Florida Power and Light Company (the licensee) submitted information summarizing the results of the fall 2012 steam generator (SG) tube inspections at St. Lucie Plant (St. Lucie), Unit 2. These inspections were performed during the twentieth refueling outage (RFO). In addition to the above report, additional information concerning the fall 2012 inspections was summarized by the Nuclear Regulatory Commission (NRC) staff in documents dated April 4, 2013 (ADAMS Accession No. ML13084A030), and April 11, 2013 (ADAMS Accession No. ML13094A174).

St. Lucie, Unit 2 has two Model 86/19TI replacement SGs that were manufactured by AREVA and installed in December 2007. Each SG has 8,999 thermally treated Alloy 690 tubes with a nominal outside diameter of 0.75 inches and a nominal wall thickness of 0.043 inches. During manufacturing, all tubes were hydraulically expanded at both ends over the full depth of the tubesheet. The tubesheet was drilled on a triangular pitch with 1.0-inch spacing, center-to-center. The radius of the row 1 U-bends is 4.134 inches. The U-bends in rows 1 through 15 were stress relieved after bending. Seven Type 410 stainless steel support plates (each 1.181 inches thick with broached trefoil holes) support the vertical section of the tubes. Four sets of anti-vibration bars (AVBs) (each 0.112 inches thick and made from Type 405 stainless steel) support the U-bend section of the tubes.

This was the third inservice inspection for the replacement SGs. At the end of RFO 20 in fall 2012, the replacement SGs had accumulated 46.40 effective full power months of operation.

The licensee provided the scope, extent, methods, and results of their SG tube inspections in the documents referenced above. In addition, the licensee described corrective actions, such as tube plugging, taken in response to the inspection findings. The tubes in both SGs were inspected during this refueling outage.

Based on its review of the reports submitted, the NRC staff has the following observations and comments:

- The only service induced indications detected were wear at the AVBs (including at the tips of the AVBs in row 69), tube support plates, and the support/positioning device. The support/positioning device supports the AVB structure, is located on the outer periphery of the tube bundle, and it contacts numerous tubes on the extrados. All tubes with indications at the support/positioning device were plugged.

Enclosure

- Approximately 11,518 indications of wear at the AVBs were detected (7,485 in SG A and 4,033 in SG B). Of these indications, the number of new indications was 1,623 in SG A and 1,070 in SG B. The average growth rate per effective full power year (2.2 percent in SG A and 0.6 percent in SG B) continues to decline.

- The licensee is implementing a power uprate in the next cycle of operation (Cycle 20) and incorporated a wear rate increase of 24 percent in their operational assessment to account for the effects of the power uprate.

Based on a review of the information provided, the NRC staff concludes that the licensee provided the information required by their technical specifications. In addition, the NRC staff concludes there are no technical issues that warrant follow-up action at this time, since the inspections appear to be consistent with the objective of detecting potential tube degradation, and inspection results appear to be consistent with industry operating experience at similarly designed and operated units. The NRC staff notes, however, that the number of wear indications is much greater than the number of wear indications found at other AREVA SGs of similar age.

January 27, 2014

Mr. Mano Nazar
Executive Vice President and
Chief Nuclear Officer
Florida Power and Light Company
P.O. Box 14000
Juno Beach, Florida 33408-0420

SUBJECT: ST. LUCIE PLANT, UNIT 2 – REVIEW OF THE 2012 REFUELING OUTAGE STEAM GENERATOR TUBE INSERVICE INSPECTION REPORT (TAC NO. MF1786)

Dear Mr. Nazar:

By letter dated May 6, 2013, as supplemented by letter dated November 26, 2013, Florida Power and Light Company (the licensee) submitted information summarizing the results of the fall 2012 steam generator tube inspection report, for the twentieth Refueling Outage (fall 2012) in accordance with Technical Specification (TS) Section 6.9.1.12 for St. Lucie Plant, Unit 2. In addition to the above report, additional information concerning the fall 2012 inspections was summarized by the Nuclear Regulatory Commission (NRC) staff in documents dated April 4 and April 11, 2013.

The NRC staff has completed its review of these reports and concludes that the licensee provided the information required by its TSs and that no additional followup is required at this time. The NRC staff's review of the report is enclosed.

Sincerely,

*/RA/*

Siva P. Lingam, Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-389

Enclosure:
Inspection Summary Report

cc w/encl: Distribution via ListServ

DISTRIBUTION:
PUBLIC LPL2-2 R/F
RidsNrrPMStLucie Resource
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RidsNrrDeEsgb Resource
AJohnson, NRR
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ADAMS Accession No.: ML14013A247 ***by memo**

| OFFICE | LPL2-2/PM | LPL2-2/LA | ESGB/BC* | LPL2-2/BC |
|---|---|---|---|---|
| NAME | SLingam | BClayton | GKulesa | JQuichocho |
| DATE | 1/15/14 | 1/15/14 | 12/18/13 | 1/27/14 |

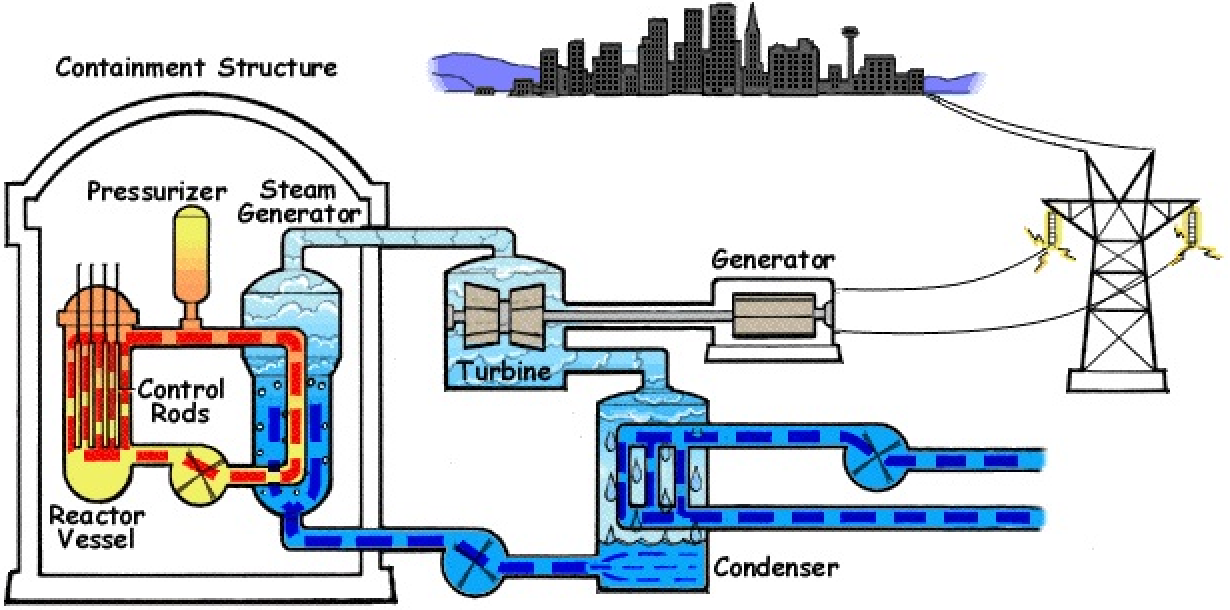
**OFFICIAL AGENCY COPY**

Attachment-Five

to

March 11$^{th}$, 2014

2.206 Enforcement Petition


Containment Structure
Pressurizer
Steam Generator
Generator
Turbine
Control Rods
Reactor Vessel
Condenser

Attachment-Six

to

March 11th, 2014

2.206 Enforcement Petition

**Subject:** St. Lucie 2.206 Petition Immediate Action Response + Proposed Date for Presentation to the PRB

**From:** "Regner, Lisa" <Lisa.Regner@nrc.gov>

**Sent:** 4/8/2014 5:17:10 PM

**To:** "saprodani@gmail.com" <saprodani@gmail.com>

**CC:** "Banic, Merrilee" <Merrilee.Banic@nrc.gov>

Mr. Saporito,

Below are the reasons that the NRC staff has decided to not take the immediate actions requested in your 10 CFR 2.206 Petition:

1. The staff is not aware of any safety issue relating to the design and operation of the St. Lucie 2 replacement steam generators (RSGs). The pressure boundary components of the RSGs, including the tubesheets, were designed in accordance with 10 CFR 50, including the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section III, thus ensuring their structural integrity. The broached-hole support plates for the RSGs are fabricated from stainless steel, significantly reducing any potential for denting compared to carbon steel support plates. Concerns for denting were the motivating factor cited in the Final Safety Analysis Report for the use of the “egg-crate” design of the carbon steel supports in the original steam generators (SGs). Both broached-hole supports and egg-crate designs have been used successfully in both original and replacement SGs.

2. The Reactor Oversight Process verifies that St. Lucie Unit 2 is operated in accordance with the technical specifications. The technical specifications require implementation of a Steam Generator Program (inspections, tube wear limits for removing tubes from service, tube integrity assessments) to ensure tube integrity is maintained.

3. The SG Program requires the licensee to perform inspections to evaluate tube safety margins for all tubes against regulatory requirements to confirm that the SGs continue to be operated safely. These inspections also are used to determine what tubes need to be removed from service and what other actions may be needed to ensure continued safe operation of St. Lucie 2 until the next scheduled inspection. Resident inspectors are on-site to verify compliance with the inservice inspection (ISI) program (the SG Program inspections are part of the licensee’s ISI).

4. The plant has been operating acceptably for 7 years since the SGs were replaced in 2007. There have been no findings of significance in the past three NRC inspections conducted to provide oversight of the licensee’s shutdown ISI inspections. Only a very small percentage of tubes have needed to be plugged. There is no measurable primary to secondary side leakage.

5. There is no indication that the licensee used the 10 CFR 50.59 process improperly. The Region II Resident Inspectors reviewed the 2007 Unit 2 steam generator replacement project, including the Florida Power and Light 10 CFR 50.59 evaluations; the NRC inspectors identified no findings of significance.

6. In February 2011, FPL submitted a license amendment request for a power uprate. The amendment request provided evaluations of the SG replacements with respect to thermal-hydraulics, structural integrity, and tube wear. The NRC staff reviewed the amendment, including the effects on the replacement SGs, and ultimately approved the amendment.

Feel Free to give me a call if you'd like to discuss further.

Also, I could not get the entire Petition Review Board together this week, unfortunately. Can you support Tuesday, April 15, from 1 – 2 pm for your presentation to the PRB?
Thanks,
Lisa

**Lisa M Regner**, Senior Project Manager
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
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