Florida Power & Light Company, 6501 S. Ocean Drive, Jensen Beach, FL 34957

FPL

April 23, 2003

L-2003-108
10 CFR 2.790(a)(4)
10 CFR 50.55a

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

Re: St. Lucie Units 1 and 2
Docket Nos. 50-335 and 50-389
Inservice Inspection Plan
Unit 1 Third and Unit 2 Second Ten-Year Intervals
Request for Additional Information Response
Unit 1 Relief Request 23 and Unit 2 Relief Request 33

By Letter L-2002-247 dated January 8, 2003 and pursuant to 10 CFR 50.55a (a)(3)(ii), Florida Power & Light Company (FPL) requested approval of Unit 1 Relief Request 23 and Unit 2 Relief Request 33. FPL requested an alternative to the requirements of paragraph IWB-3132.3 "Acceptance by Replacements" that states "As an alternative to the repair requirement of IWB-3132.2, the component or the portion of the component containing the flaw shall be replaced." FPL determined, pursuant to 10 CFR 50.55a (a)(3)(ii), that compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Approval of the subject relief requests was requested to support the St. Lucie Unit 2 refueling outage (SL2-14) that began on April 21, 2003.

By letter dated April 9, 2003, NRC requested additional information (RAI) necessary for the NRC to complete the review. Attachment 1 provides the FPL responses to questions 14 and 18. Attachment 2 provides the responses to NRC questions 1 through 13 and 15 through 17 on the referenced Westinghouse proprietary design reports. Attachment 3 provides nonproprietary and proprietary copies of the Westinghouse Report CR-9417-CSE95-1102, *Structural Analysis of Replacement Instrument Nozzles and Heater Sleeves for Florida Power & Light – St. Lucie Units 1 & 2 Pressurizer, #1 and 2 Piping, and #2 Steam Generator,* reference 7 of the relief requests.

As Attachments 2B and 3B contain information proprietary to Westinghouse Electric Company, they are supported by affidavits signed by Westinghouse, the owner of the information. The affidavits set forth the basis on which the Commission may withhold the information from public disclosure and addresses, with specificity, the considerations listed in 10 CFR 2.790(b)(4).

This document contains 2.790 Proprietary Information
When Attachments 2B and 3B are removed this document is decontrolled

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Accordingly, it is requested that Attachments 2B and 3B, the information that is proprietary to Westinghouse, be withheld from public disclosure in accordance with 10 CFR 2.790(a)(4).

In addition, Attachments 2A and 3A provide Westinghouse affidavits and copies of the nonproprietary versions of the Westinghouse responses to the RAI and Westinghouse Report CR-9417-CSE95-1102.

Correspondence with respect to the copyright or proprietary aspects of the Westinghouse responses to the RAI, Westinghouse Report CR-9417-CSE95-1102-P, or the supporting Westinghouse affidavits should be addressed to H. A. Sepp, Manager of Regulatory and Licensing Engineering, Westinghouse Electric Company, P. O. Box 355, Pittsburgh, Pennsylvania 15230-0355. Please contact George Madden at 772-467-7155 if there are any additional questions about this submittal.

Very truly yours,

William Jefferson, Jr.
Vice President
St. Lucie Plant

Attachments

WJ/GRM

Attachment 1

St. Lucie Units 1 and 2

FPL Responses to Questions 14 and 18

Question 14:

In section 6.2.3, an alternate pressure/temperature (P/T) profile was developed for the cooldown transient. This P/T profile was developed because the ASME section XI flaw stability criterion is exceeded when using the profile based on design specification transients.

Confirm/discuss that the P/T transient profile, utilized for analysis of the normal pressurizer cooldown, is consistent with the P/T limits specified in the Technical Specifications of Saint Lucie Units 1 and 2. Also, discuss what measures the licensee will implement to ensure that in the operation of the referenced units, the assumed pressure and temperature cooldown profiles in the pressurizer, will not be exceeded.

FPL Response:

The technical specification (TS) requirements for St. Lucie Units 1 and 2 show that the pressurizer temperature shall be limited to a maximum cooldown of 200°F in any 1-hour period.

Section 6.2.3 of CN-CI-02-69 states, "In studying the sensitivity of the thermal stress to various cooldown rates, it was seen that for this problem the results are not affected by the choice of the cooldown rate from 653°F to 200°F. One only needs to be concerned with the rate below the 200°F threshold, which is when the material toughness starts decreasing. Figure A in Section 3.2 shows the modified pressure and temperature transient, which forms the basis for the evaluation of flaw stability in this calculation." The cooling rate between 200°F and ambient is shown as 135°F/hr.

The pressurizer has an administrative maximum cooldown limit of 75°F per hour, which is well below the 135°F rate used in the analysis. In addition, when the reactor coolant system (RCS) temperature is below 200°F and cooldown requirements for steam generator and/or RCS cleanup are met, the last reactor coolant pump is secured. At this point the pressurizer cooldown is significantly limited. Cooldown is via auxiliary spray. The rate of auxiliary spray is controlled to no more than one charging pump running to cool the pressurizer metal.

Question 18:

"Attachment 1, Section 4 of the submittal states "(t)o remove all possible leak paths requires accessing the internal surface of the reactor coolant piping or pressurizer and grinding out the attachment weld and any remaining nozzle base metal. Such an activity results in high radiation exposure to the personnel involved. Grinding within the pipe or pressurizer also exposes personnel to safety hazards."

"Quantify the dose that would be received if required to remove the flaw. This should include a description of the area dose rates, proposed stay times, and proposed measures to maintain personnel dose as low as reasonably achievable. Provide the dose that would be received if the alternative was authorized. Additionally identify what safety hazards personnel would be exposed to and how those hazards constitute a hardship or unusual difficulty."

FPL RESPONSE

The following information is provided in response to the request:

- Dose rate data and assumptions.
- Task breakdown and dose estimates for both repair methods.
- Personnel safety challenges for the ID repair method.

Dose Rate Data and Assumptions

The following radiological exposure data was applied in the preparation of both exposure estimates. Note that all dose rates are in R/hr. (Note a)

AREA DESCRIPTION	AREA #	DOSE RATE (R/HR)
Containment General Area	1	0.001
OD Hot Leg Scaffold	2	0.060
Hot Leg General Area	3	0.045
Hot Leg at Boss Opening	4	0.060
Steam Generator Platform	5	0.017
Interior (ID) of Hot Leg	6	(Note b)

Assumptions/notes:

a. All dose rates derived from 2001 outage survey data.

b. This value was determined by calculation utilizing applicable data from St. Lucie Unit 1 and 2 quantitative survey data. From the Unit 1 steam generator replacement project (SGRP), hot leg dose rate data is available as measured at the midpoint ID of the pipe, following the removal of the steam generator (S/G). This value indicates an average of 0.700 R/hr. Unit 2 steam generator bowl surveys from April 2000 for 2A S/G, and November 2001 for 2B S/G indicates an average dose rate of 4.950 R/hr at the plane of the hot leg. Given this data, the dose rate at the nozzle location was determined to be 1.525 R/hr at the hot leg ID. This dose rate assumed the 0.700 R/hr from the RCS piping without a S/G in place, and a calculated value of an additional 0.825 R/hr due to shine from the S/G. The 0.825 R/hr assumed a linear decrease at six feet from the S/G hot leg plane at 4.950 R/hr. Additionally, it is recognized that the individual who would access the hot leg would transit the S/G bowl in full protective clothing and an airline respirator. To account for this task dose gradient, effective dose rates were calculated assuming 30 second access and egress times in the S/G bowl. Applying a S/G bowl dose rate of 4.950 R/hr and a hot leg ID dose rate of 1.525 R/hr, an effective dose rate was calculated for each planned hot leg entry. This was calculated as a weighted average given one minute for access/egress with the remainder of the time applied to the hot leg ID dose rate. This yielded the following values for the time periods identified:

STAY TIME (MINUTES)	EFFECTIVE DOSE RATE (R/hr)
10	1.868
15	1.753
20	1.696

These effective dose rates were applied in the development of the exposure estimate as applicable for the estimated task duration.

TASK BREAKDOWN/EXPOSURE ESTIMATE

In-Kind Repair

The in-kind repair involves the OD removal of five resistance temperature detector (RTD) nozzles, the ID removal of five RTD nozzles, followed by the ID weld-up of the 10 replacement nozzles and the associated non-destructive testing. This series of tasks and the associated exposure estimates are provided in the following table. All values reflect the activity performed 10 times.

STEP	DESCRIPTION	OD PIPE MAN-HOURS Note 1	ID PIPE MAN-HOURS Note 1	PLATFORM MAN-HOURS	DOSE (REM) Note 2
1	Set Equipment	16@3	0	12@3	0.924
2	Install OD FME	3.33@3	0	0	0.149
3	Cut Nozzle Flush - OD	10@2	0	0	0.600
4	Rmv OD FME/Inst ID FME	1.66@2	1.66@6	20@5	3.539
5	Install Cutting Tool	20@2	1.66@6	10@5	4.471
6	Rmv Nozzle Machining	20@2	0	0	1.200
7	Rmv Nozzle Remnant	20@2	0	0	1.200
8	Change ID Cutters	10@2	1.66@6	20@5	4.040
9	Machine Weld Prep	20@2	0	0	1.200
10	Rmv FME/Mach Equip	10@2	1.66@6	20@5	4.040
11	Measure Penetration	2.5@2	0	0	0.150
12	PT Weld Prep	0	3.33@6	20@5	6.034
13	Fit/Tack Nozzle	10@2	1.66@6	20@5	4.040
14	Weld Nozzle ½ T	0	2.5@6	20@5	4.723
15	PT ½ T Weld	0	3.33@6	20@5	5.989
16	Weld Nozzle Full T	0	2.5@6	20@5	4.723
17	PT Final Weld	0	3.33@6	20@5	5.989
18	Demobilization	8@5	0	8@5	0.272
-	**TOTALS Note 3**	**8.167**	**41.210**	**3.906**	**53.283**

Note 1 – Data convention is number of man-hours @ location. Location identifiers and associated dose rates are reflected in the table below.

AREA DESCRIPTION	AREA #	DOSE RATE (R/HR)
Containment General Area	1	0.001
OD Hot Leg Scaffold	2	0.060
Hot Leg General Area	3	0.045
Hot Leg at Boss Opening	4	0.060
Steam Generator Platform	5	0.017
Interior (ID) of Hot Leg	6	Note b above

Note 2 – Dose is the summation of man-hours multiplied by the dose rate corresponding to the area for the three columns.
Note 3 – Totals include ALARA action for OD shielding of the hot legs.

Given a total exposure of 53.283 person-rem, additional ALARA applications were postulated. The focus of this initiative was to reduce the hot leg ID dose rate, as the hot leg ID activities contribute to 81% of the exposure. The following actions were postulated with the dose reduction factor (DRF) experienced during the St. Lucie Unit 1 steam generator replacement project (SGRP):

ID sponge decontamination – the Unit 1 SGRP realized an average dose reduction factor (DRF) of 1.42 for the hot legs, via sponge decontamination. The performance of the pipe end decontamination expended 4.103 person-rem.

ID pipe shielding – application of pipe end shielding in the Unit 1 SGRP achieved an average DRF of 18.5 at a cost of 1.438 person-rem. This value of DRF would not be achieved for this application as the S/G would remain in place and shielding could not be applied as this would prevent egress for the confined space of the hot leg. Therefore, the shield plug could only be applied to the reactor vessel side of the hot leg nozzle, which was not considered as a dose source for this projection. Thus, no ALARA benefit would be recognized relative to this projection.

Sponge blast decontamination of the interior of the piping is credible. It is estimated that decontamination of each hot leg would generate 16 55-gallon drums of high activity spent media. St. Lucie Unit 1 and industry experience in SGRP indicate that each drum would indicate four to six R/hr contact.

Performing the decontamination and applying the St. Lucie Unit 1 achieved DRF of 1.42, would reduce the ID pipe activities to 23.902 person-rem for a dose reduction of 17.308. The dose expenditure is estimated to be 10.257 person-rem based on the St. Lucie Unit 1 experience during the SGRP and an increased scope factor of 2.5. Thus, the final dose saving of the pipe decontamination would be 7.051 person-rem.

Therefore, the final project dose estimate, assuming sponge blast decontamination is implemented, is **46.232 PERSON-REM**

Planned Replacement

The planned replacement involves the removal and replacement of five previously replaced nozzles and five original design nozzles. The previously replaced nozzles will be removed at the pipe OD weld, as the ID J-weld had been previously severed and a weld external to the pipe was applied. A complete nozzle assembly will be reinstalled and an OD weld applied. The five original design nozzles will be replaced by the half-nozzle concept. The upper portion of the nozzle is removed and replaced by a machined, matching segment. The original J-weld is left in place and an OD weld is applied similar to the previously replaced nozzles. Neither method requires an individual to access the internal volume of the hot leg.

The dose estimate for the nozzle replacement is as follows:

TOTAL ESTIMATED EXPOSURE FOR THIS TASK =					12.567	MAN-REM		
							TOTAL EXPOSURE	
				DOSE RATE			IN AREA	
CONTAINMENT AREA DESCRIPTION		AREA #		(R/hr)			(manRem)	
Containment General Area		1		0.001			1.572	
Scaffolding General Area		2		0.060			0.000	
Primary Loop General Area Around Loops		3		0.045			4.770	
Primary Loop General Area At Boss Opening		4		0.060			6.225	
PROCESS OR TASK DESCRIPTION	TIME		NUMBER	TIMES	TOTAL	AREA	DOSE	PROCESS
	hours	minutes	PEOPLE	REPEAT	HOURS	#	RATE	DOSE
Equipment Staging and Set-up								
Move and Equipment Staging	2.00	120	6	1	12.0	1	0.001	0.012
Firewatch	257.00	15420	6	1	1542.0	1	0.001	1.542
Prepare and Equipment Set-up	2.00	120	2	2	8.0	3	0.045	0.360
Repair Previously Repaired Location								
Grind to Remove Structural Weld	2.00	120	1	5	10.0	4	0.060	0.600
Pull Nozzle	0.17	10	1	5	0.8	4	0.060	0.050
Install FME Device	0.17	10	1	5	0.8	4	0.060	0.050
Complete Grinding J-Groove	1.00	60	1	5	5.0	4	0.060	0.300
PT J-Groove	0.25	15	1	5	1.3	3	0.045	0.056
Setup and Pre-Heat	2.00	120	1	5	10.0	3	0.045	0.450
Install Replacement Nozzle	0.50	30	1	5	2.5	4	0.060	0.150
Weld to 1/2T	1.00	60	1	5	5.0	4	0.060	0.300
PT 1/2T	0.25	15	1	5	1.3	3	0.045	0.056
Weld Final	0.75	45	1	5	3.8	4	0.060	0.225
PT Final	0.25	15	1	5	1.3	3	0.045	0.056
Install Thermal Well	1.00	60	1	5	5.0	4	0.060	0.300
PT Weld	0.25	15	1	5	1.3	3	0.045	0.056
Support for Above	6.00	360	1	5	30.0	3	0.045	1.350
Repair of Original Plant Equipment								
Grind to Remove Thermal Well	0.75	45	1	5	3.8	4	0.060	0.225
Install FME Device	0.17	10	1	5	0.8	4	0.060	0.050
Cut Nozzle Flush with Pipe OD	0.25	15	1	5	1.3	4	0.060	0.075
Install Machining Equipment	0.75	45	2	5	7.5	4	0.060	0.450
Counterbore Nozzle	1.00	60	2	5	10.0	4	0.060	0.600
Machine Weld Prep	1.00	60	2	5	10.0	4	0.060	0.600
Remove Machine Tool	0.25	15	2	5	2.5	4	0.060	0.150
PT Weld Prep	0.25	15	1	5	1.3	3	0.045	0.056
Setup and Pre-Heat	2.00	120	1	5	10.0	3	0.045	0.450
Setup and Preheat Piping	2.00	120	1	5	10.0	4	0.060	0.600
Install and Align Replacement 1/2 Nozzle	1.00	60	1	5	5.0	4	0.060	0.300
Weld to 1/2T	2.00	120	1	5	10.0	4	0.060	0.600
PT 1/2T	0.25	15	1	5	1.3	3	0.045	0.056
Weld Final	1.00	60	1	5	5.0	4	0.060	0.300
PT Final	0.25	15	1	5	1.3	3	0.045	0.056
Install and Weld Thermal Well	1.00	60	1	5	5.0	4	0.060	0.300
PT Weld	0.25	15	1	5	1.3	3	0.045	0.056
Support for Above	6.00	360	1	5	30.0	3	0.045	1.350
Equipment Removal and Packout								
Demob Equipment from Area	2.00	120	2	2	8.0	3	0.045	0.360
Demob Equipment from RB	3.00	180	6	1	18.0	1	0.001	0.018
Totals					1782			12.567

BREAKDOWN OF EXPOSURE ESTIMATES				EXPOSURE (manRem)				
Equipment Staging and Set-up				1.914				
Repair Previously Repaired Location				4.000				
Repair of Original Plant Equipment				6.275				
Equipment Removal and Packout				0.378				
TOTAL EXPOSURE =12.567 manRem								
Contingency Plan for Pulling RTD	1 hr/noz.	2 pers.	0.045	0.900	manRem			
TOTAL EXPOSURE =13.467 manRem								
Notes and Assumptions:								
1.) Dose rate provided by Utility Radiological Group and FRA-ANP Radiological Engineering.								
2.) Proper Radiological Engineering controls have been employed for Exposure Reduction								
3.) Estimate does not include Station Support Personnel, Radiation Protection or Decon Support.								
4.) Estimate may change depending on actual dose rates, and effectiveness of shielding.								
5.) This estimate is based on task steps and times provided by the process Engineer.								
6.) Contingency Plan - FRA-ANP pulling RTDs instead of Utility Personnel. Require 2 personnel at 1 hour per nozzle with a dose rate if 0.045 REM. Total 0.900 REM								
7.) Dose rates based on application of shielding in the work area.								

ALARA Comparison

The ALARA estimates above yield the following:

In-kind replacement = 46.232 Person-rem
Planned replacement = 12.567 Person-rem

As can be seen, the planned replacement is the preferred method from an ALARA perspective, resulting in a dose savings of **33.665 person-rem**.

PERSONNEL SAFETY CONSIDERATIONS

Relative to the planned replacement of the hot leg nozzles, there are no exceptional safety concerns. Beyond routine safety awareness, the only unique concern for the task is that associated with welding and grinding.

Relative to the in-kind replacement, the following safety concerns must be considered:

> Entry to the hot legs will satisfy the criteria for a permit required confined space. This will require additional attendants on the steam generator platform, which is accounted for in the ALARA estimate.
>
> The confined space concern is further complicated by the limited confines of the pipe and the welding evolution required. The increased risk to personnel while working in confined spaces, are well documented in operating experience. Specifically, SEN-160, OE-8317, OE3302, and SER 36-85 identify worker fatalities, loss of consciousness and near miss injuries are identified.

The confined space issue is further complicated by heat stress considerations. While conditions in the reactor containment do not normally pose a heat stress concern, conditions within the limited confines of the hot leg are postulated to present a concern. This consideration is founded in the understanding that:

Machining and welding activities will occur, providing a heat source.

Ventilation of the area is limited.

Personnel will be wearing heavy protective clothing to support radiological contamination control as well as hot work protection.

Personnel will be wearing airline respiratory protection for both radiological and confined space protections.

Personnel will be wearing full harness as required for confined space rescue.

Therefore, the full extent of the radiological and industrial safety precautions associated with work within the confines of hot leg piping presents physical and psychological stress to those performing the work. The additional stress to personnel presents a human error precursor to a threatening situation.

Attachment 2A

St. Lucie Units 1and 2

Non-Proprietary Responses to RAI

Questions 1-13 and 15-17

Prepared by Westinghouse

and

Westinghouse Proprietary Affidavit

34 Pages Total

CAW-03-1622

AFFIDAVIT

STATE OF CONNECTICUT:

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COUNTY OF HARTFORD:

Before me, the undersigned authority, personally appeared I. C. Rickard, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Company LLC ("Westinghouse"), and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

I. C. Rickard, Licensing Project Manager
Regulatory Compliance and Plant Licensing

Sworn to and subscribed
before me this 10th day
of April, 2003

Notary Public

LINDA A. SCATA
NOTARY PUBLIC
MY COMMISSION EXPIRES MAY 31, 2003

(1) I am the Licensing Project Manager, Regulatory Compliance and Plant Licensing, in Nuclear Services, Westinghouse Electric Company LLC ("Westinghouse"), and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rule making proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse Electric Company LLC.

(2) I am making this Affidavit in conformance with the provisions of 10 CFR Section 2.790 of the Commission's regulations and in conjunction with the Westinghouse application for withholding accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by the Westinghouse Electric Company LLC in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.790 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse.

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitute Westinghouse policy and provide the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information that is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by a competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon success in obtaining and maintaining a competitive advantage.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10 CFR Section 2.790, it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked Proprietary Class 2 in Enclosure 1 to Westinghouse letter FPL-03-50, for Florida Power and Light Company, being transmitted to the NRC by Florida Power and Light Company's letter and Application for Withholding Proprietary Information from Public Disclosure, to the Document Control Desk.

This information is part of that which will enable Westinghouse to:

(a) Implement Alloy 690 half nozzles without flaw removal as a nozzle repair technique.

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to sell the use of similar information to its customers for purposes of Alloy 690 nozzle repair without flaw removal.

(b) Westinghouse can sell support and defense of the Alloy 690 half nozzle repair without flaw removal.

(c) The information requested to be withheld reveals the distinguishing aspects of a methodology which was developed by Westinghouse.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar nozzle repair and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended.

Further the deponent sayeth not.

PROPRIETARY INFORMATION NOTICE

Transmitted herewith are proprietary and/or non-proprietary versions of documents furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

In order to conform to the requirements of 10 CFR 2.790 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted).

COPYRIGHT NOTICE

Non-Proprietary Responses to RAIs transmitted by:

NRC letter dated April 9, 2003, from B. Moroney (NRC) to J. Stall (FPL), "Saint Lucie Plant, Units 1 and 2 – Request for Additional Information Regarding Requests for Relief for Repair of Alloy 600 Small Bore Nozzles Without Flaw Removal (TAC Nos. MB7199 and MB7200)"

Westinghouse Electric Company LLC
P.O. Box 355
Pittsburgh, PA 15230-0355

Question 1

The submittal is for application of Alloy 690 half-nozzles. The analysis in Reference 7[‡] is applicable to nozzles and heater sleeves that are replaced by full alloy 690 nozzles and alloy corrosion liners.

Provide justification showing that this analysis is also applicable to replacements with alloy 690 half-nozzles.

Response

The only significant difference between the half nozzle and full nozzle designs is the length of the nozzle that extends into the bore below the partial penetration weld. The full nozzle extends approximately to the inside surface of the component wall, while the half nozzle extends roughly 1 inch beyond the weld. The length of the nozzle within the wall penetration can affect its stiffness, which would also affect the stresses. The effect of length on the stiffness of a cylindrical shell, such as the nozzle, is dependent on the attenuation length of the cylinder. The stiffness increases with length for lengths less than the attenuation length, but remains essentially constant for greater lengths. The ASME Code (see NB-3213.10 for example) uses $2.5\sqrt{RT}$ to estimate attenuation lengths cylindrical shells, where R is the mid-surface radius of the shell and T is the wall thickness. For the nozzles considered in the Report, the attenuation lengths are less than 1.0 inch. Consequently, the difference in length between the full and half nozzles has negligible effect on the stiffness of the nozzle and on the calculated stresses. Thus, it is reasonable to use the results from the full nozzle evaluations as justification for the half nozzle designs.

[‡] Reference 7 to the submittal cited in these questions is "CR-9417-CSE95-1102, Rev. 02, Structural Analysis of Replacement Nozzles and Heater Sleeves for Florida Power & Light – St. Lucie #1&2 Pressurizer, #1&2 Piping, and #2 Steam Generator." For convenience, this document is identified as the "Report" in the responses provided herein.

Question 2

The submittal states that the maximum cumulative usage factor (CUF) at the outside surface of the nozzle repair is [ ]. This value is taken from Reference 7, page D14. This CUF is applicable to the Piping Measurement or Sampling Nozzles. For Pressurizer Unit 1 Lower Level Nozzle Inside Surface the CUF at the inside surface is [ ] as shown on page D9. However, Table 4-9, on page 25 of Reference 7, indicates CUFs of [ ] for piping nozzles and [ ] for pressurizer nozzles.

Clarify what is meant by "inside surface" and indicate whether [ ] is the highest CUF for all nozzle locations, as currently stated.

Response

The CUF and Primary plus Secondary Stress Intensity Ranges stated in Appendix D of the Report are the correct values. The values shown in Table 4-9 were inadvertently retained from an earlier draft of the Report. The correct values were confirmed by review of the computer files used to make the calculations reported in Appendices C and D in the Report.

For the pressurizer nozzles, the correct maximum CUF's are [ ] at the inside surface of the Unit 1 Pressurizer Lower Level Nozzle and 0.454 at the outside surface of the Unit 1 Upper Level & Pressure Tap Nozzle. The correct maximum CUF's for the piping nozzles are [ ] at the outside surface and [ ] at the inside surface of the Measurement and Sampling Nozzles. As a result of conservative assumptions made in the Report, which are discussed at the end of this response, the actual CUF's are significantly less than the values stated in the Report.

The CUF's in the Report are calculated on the surfaces of the nozzle wall at a section through the nozzle at the toe of the partial penetration weld. The toe of the weld is defined in the response to Question 8. The inside surface is on the inside on the nozzle wall. The outside surface is on the outside of the nozzle wall at the toe of fillet radius between the OD of the nozzle and that of the vessel or pipe.

Conservative Assumptions in the CUF Evaluations:

In order to simplify the CUF evaluations, several extremely conservative assumptions were made in the Report. Some of these assumptions are described on page D1, while others are unstated. These assumptions and their impact on the most critical calculated CUF, at the inside surface of the Unit 1 Pressurizer Lower Level Nozzle (page D9), are discussed below. The impact on the CUF for other nozzles and locations would be similar in relative magnitude.

- As noted on page D1, the maximum alternating stress range due to pressure and thermal transients is assumed to occur in all [ ] stress cycles used in the CUF calculation. As shown on page D2, this alternating stress range of [ ] is partially defined by the cooldown transient (B1), which is specified for [ ] occurrences. The next most critical alternating stress range, [ ], can occur [ ] times. The largest alternating stress range that can apply for as many as [ ]. As a result of this assumption, the alternating stresses are increased by

[ ] stress cycles used in the CUF calculation. It is estimated that a [ ] reduction would reduce the partial usage factor attributed to these stress cycles [ ] on page D9) by about 50%.

- Page D8 states the CUF calculations include [ ] cycles of the alternating stress resulting from the combined dead weight (DW), thermal (TH) and seismic (OBE) pipe loads. This number of cycles is based on the [ ] occurrences specified for OBE. However, thermal and seismic stress cycles can combine only once for every other occurrence of an OBE event. Realistically, this limits thermal plus seismic stress cycles to [ ] or less. The remaining [ ] seismic stress cycles would include the alternating stress due to OBE pipe loads only. Elimination of this assumption would reduce the partial usage factor attributed to the [ ] cycles of OBE ([ ] on page D9) by 80% or more.

- The CUF calculation considers the thermal pipe load stresses to be fully reversible and applies them for all [ ] stress cycles. The full range of thermal pipe load stress occurs in conjunction with heatup and cooldown, which are specified for only [ ] cycles. Normally, thermal pipe load stresses vary from zero at plant shutdown to maximum value at normal operation for each heatup-cooldown cycle. Variations in thermal pipe loads associated with other operating transients are a small percentage of the full range and are neglected. Thus, normal procedure results in [ ] cycles of thermal pipe load stress at one-half the magnitude used in this calculation.

- Stresses due to dead weight (DW) pipe loads are assumed to be fully reversible and to cycle with each stress cycle. Dead weight loads on these nozzles are primarily due to the dead weight of the components and attached pipes and would not vary significantly during operation.

It should also be noted that the above assumptions introduce conservatism over and above that inherent in the design inputs that were used. In particular, there is ample conservatism in the specified pressure and thermal transients, which represent the most severe pressure and thermal excursions expected for each event as well as a conservative estimate for the lifetime occurrences of each. Also, the specified pipe loads used in this evaluation are unsigned, maximum values enveloping as many as 9 different nozzles in the two plants. It is likely that this process resulted in loads that are significantly more conservative than the loads on any particular nozzle.

Question 3

Provide justification why the fatigue analysis does not include stress cycling due to pump vibration, as stated on page 2 of the submittal.

Response

The nozzles considered in the Report and addressed in the submittal are located in the hot leg pipes and the pressurizer. These components are distant from the primary pumps in the cold leg pipes and, therefore, experience negligible mechanical excitation from pump vibration. The hot leg pipes are isolated from the primary coolant pumps by the steam generator on one end and the reactor vessel on the other. The pressurizer is separated from the primary coolant pumps by a 12 inch diameter surge line, which runs from the hot leg, and 2 to 3" spray lines, which run from the cold legs.

Question 4

Provide justification for not including, in the fatigue analysis, the effects of the operating pressure transients acting on the nozzles (i.e., end cap loads), the bore hole surfaces, and the weld surfaces.

Response

End Cap Loads:

As explained on page D1 of the Report, the stresses in the welds due to pressure and thermal transients in the component (pressurizer, piping or steam generator) were taken from the analyses of record cited as Reference 11 to the Report. The effect of end cap loads due to internal pressure in the nozzle was considered in these analyses and, therefore, the stresses resulting from end caps loads are included in the Report.

It should be noted that the finite element analyses in the Report were used only to determine the stresses resulting from external pipe loads on the nozzles. There was no intent to use finite element analysis to evaluate stresses resulting from pressure and thermal transients.

Pressure in Annulus:

The effect of pressure in the annulus between the nozzle and the bore hole in the vessel wall was neglected in the calculations in the Report. Pressure in this annulus increases the "pressure mismatch interaction loadings", as explained in the response to Question 10, and would result in increased pressure stresses from the pressure transients. Pressure in the annulus results in a greater dilation of the bore and a reduced dilation of the portion of the nozzle inside the wall. For the most critical nozzle in the Report, the Unit 1 Pressurizer Lower Level Nozzle, the most conservative assessment of this effect indicates the pressure stresses would approximately [ ] [ ].

The consequences of this stress correction on the CUF of the Pressurizer Unit 1 Upper Level Nozzle (page D10), most critical value calculated at a weld, is assessed in the response to the following question.

Pressure on Weld Surface:

The weld surface area exposed to pressure is small; the net force from this load has a negligible effect on the stresses in the nozzle and weld.

Question 5

American Society of Mechanical Engineers (ASME) Section III, Paragraph NB-3338.2, stipulates increases in stress indices as a result of "hillside" connections. The finite element model of the pressurizer nozzles does not model the inclination of the innermost and outermost pressure nozzles with respect to the normal direction of the wall.

Show how this effect was considered in the stress and fatigue calculations.

Response

Although NB-3338.2 applies to integral nozzles only, it does provide a procedure to account for the effect of a non-radial hole in a cylindrical vessel or spherical head.

NB-3338.2 stipulates increased stress indices for "hillside" connections to account of the elliptical shape of the hole in the component wall. The stress concentration effect on the major axis of the elliptical hole is greater than that for a circular hole of the same diameter. Consequently, the code requires that the stress circumferential to the hole from internal pressure in the component be increased to account for this effect.

The nozzle most affected by this adjustment is the lower level nozzle in the pressurizer, which is at an angle Φ = [ ] from normal to the bottom head. The required adjustment factor for a "hillside" connection according to NB-3338.2 is

$$1 + 2 \cdot \sin^2\Phi = 1 + 2 \cdot \sin^2([\quad]) = [\quad]$$

This indicates a 43% increase in the hoop stress component due to pressure.

As explained in response to the previous question, the pressure and thermal stresses in the nozzle were taken from the analyses of record for the original nozzle. The stresses for the lower level nozzle are listed on pages D2 and D5 for Units 1 and 2, respectively. Review of these analyses indicates that these stresses do not include the "hillside" correction. The impact of this correction on these stresses is estimated in the following paragraph.

The combined pressure and thermal stresses are listed on both pages, so the pressure stress portion is not readily identifiable. However, the hydrostatic test condition listed for Unit 1 on page D2 includes only pressure stress and can be used to estimate the stress increment resulting from the "hillside" effect. For the outside surface of the nozzle, the reported hoop stress (ST) for the hydro test condition is [ ]. Adjusted for the ratio of normal operating pressure to hydro test pressure, this is equivalent to a stress of [ ] at normal operation. Thus, the "hillside" effect results in an increment of about [ ] in the hoop stress during normal operation.

The effect of this correction in conjunction with the effect of pressure in the bore from the previous question on the CUF at the weld in on the Unit 1 Pressurizer Upper Level Nozzle is evaluated in tables on the following pages. All conservative assumptions used in the Report are maintained in this calculation. The pressure and thermal transient stresses shown on page D2 of the Report are recalculated with a correction factor of [ ] on the longitudinal and hoop components and a second factor of [ ] on the hoop component. The corrected stresses are shown on Table 1. The CUF evaluation for this location, shown on page D10 in the Report, is revised in Table 2 using the corrected stresses. The resulting CUF of [ ] is essentially unchanged from the [ ] value in the Report.

In consideration of the gross conservatism included in the fatigue analyses in the Report, as discussed in the response to Question 2, these corrections to the pressure stresses do not have a significant effect on the calculated CUFs.

The finite element analyses in the Report were used to calculate stresses in the nozzle and weld from pipe loads applied to the end of the nozzle. The "hillside" connection was considered to have negligible effect on these stresses and was not considered.

Table 1
Corrected Stresses for Unit 1 Pressurizer Upper Level Nozzle – Outside Surface

Trn	P	N	Pressure Stresses			Thermal Stresses		
			Sxp	Shp	Srp	Sxt	Sht	Srt
					Pressure Stress Factors			
					Hillside		[ ]	
					Annulus		[ ]	

Trn	Combined Stresses			Stress Differences			Concentrated Stress Diff.		
	Sx	Sh	Sr	Sx-Sh	Sx-Sr	Sh-Sr	K*Sx-Sh	K*Sx-Sr	Sh-Sr

			[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
K=	[ ]		[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

Table 2
Fatigue Evaluation of Unit 1 Pressurizer Upper Level Nozzle – Weld-Toe With Corrected Pressure Stresses

Outside	Press + Therm	Pipe DW+OBEinert	Total	3Sm	Ke

[ ]

Outside	Press + Therm	Pipe TH+DW+OBE	Total	Ke	Salt	N	nall	U

[ ]

Outside	Press + Therm	Pipe TH	Total	Ke	Salt	N	nall	U

[ ]

Outside	CUF
1.35Sx-Sh	[ ]
1.35Sx-Sr	[ ]
Sh-Sr	[ ]

Question 6

On page C2, provide a detailed explanation of the "0.1Sy" analysis.

Response

The "0.1Sy" analysis was performed by loading the inside end of the nozzle (the top end of the nozzle in the finite element model shown on Figure C-1 in the Report) with an axial load equivalent to a uniform axial stress of 0.1Sy in the nozzle wall. This was confirmed by a review of the input files for the ANSYS computer runs used in the Report.

The ANSYS computer output listed on pages C37 and C53 also provide verification of this. These outputs show the stresses at the section of the nozzles identified as "Cut 1" in Tables C-2 and C-3. For both nozzles, this cut is located as shown in Figure C-4 on page C11. On both pages C37 and C53, it can be seen that the membrane longitudinal stress (SY) at the cut is 2759 psi. As explained on page C2, the yield strength for the nozzle material is approximately 27.6 ksi, so that the nominal stress in the nozzle wall for the "0.1Sy" load condition is 2.76 ksi or 2760 psi.

Figures C-5d and C-10d show stress contour plots of the stress intensity in the nozzles for the "0.1Sy" load condition. It can be noted from the plots that the stresses in the nozzle on the root side of the weld are significantly higher than on the toe side. In Figures C-5a-c and C-10a-c, the opposite is true, since the specified pipe loads are applied on the toe side of the weld. This fact further verifies that the load was applied to the inside end of the nozzle.

The stress intensities at the root of the weld from the "0.1Sy" loading provide a benchmark that can be used to evaluate the stress intensities from the specified loads relative to the 0.1Sy and 0.2Sy criteria for "substantially no piping reactions". More detailed discussion of this evaluation is provided in response to Questions 7 and 8.

Question 7

Page D1 states, "However, all instrument nozzles on the pressurizer, the measurement and sampling nozzle on the piping, and the primary instrument nozzles were specified to have significant applied external pipe loadings." Based on the stress intensity values shown in tables C-1, C-2 and C-3, some of which exceed the yield strength of the material, the piping reactions also appear to be substantial.

Provide clarification how the "0.1Sy" analysis shows that the applied external loads on the replacement instrument nozzles meet the intent of Paragraph NB-3337.3 of ASME Section III, which limits the use of partial penetration welds to nozzles having "substantially no piping reactions."

Response

The criteria used by ABB-CE for "substantially no piping reactions" (SNPR) per NB-3337.3 is discussed in detail in response to Question 8. Briefly restated, it is that the applied pipe loads excluding earthquake shall cause a nominal stress in the nozzle wall at the weld root that is less than 0.2Sy. According to the SNPR criteria, pipe loads that result in a nominal stress less than 0.1Sy are not "significant" and need not be considered in the nozzle fatigue analysis. If the nominal stress exceeds 0.1Sy but is less than 0.2Sy, the loads are "significant" and must be evaluated in the fatigue analysis of the nozzle.

As noted in the response to Question 6, the "0.1Sy" analysis provides a benchmark that is used to evaluate the stresses at the root of the partial penetration weld from the specified loads relative to the stresses from a load condition which by definition satisfies the "SNPR" criteria. Consequently, if the specified loads result in a lesser stress intensity at the weld root, they are not significant and need not be evaluated. If the resulting stress intensity is less than twice the "0.1Sy" value, the loads are significant and must be evaluated. If the resulting stress intensity is more than twice the "0.1Sy" value, the loads are unacceptable and must be reduced.

Tables C-2 and C-3 list the stresses at 4 cuts through the nozzle wall. The locations of these cuts relative to the partial penetration welds are shown on Figure C-4. Cuts 1 and 2 are at the weld root and Cuts 3 and 4 are at the weld toe. The cuts of interest with regard to the SNPR criteria are Cuts 1 and 2, located at the root of the partial penetration weld. Cuts 3 and 4, located at the weld toe, are considered for fatigue evaluation, but are not subject to the SNPR criteria. Consequently, the SNPR evaluation presented in Table C-1 considers only the stresses at Cuts 1 and 2.

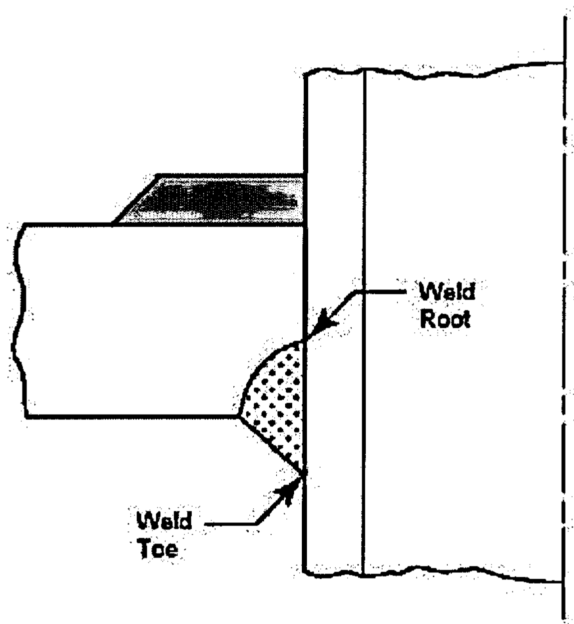
Question 8

Provide the basis for the ABB/CE interpretation that the requirement in ASME Section III, Paragraph NB-3337.3, is for limiting the stress intensity at the root of the weld only.

Define what is meant by "the root of the weld."

Response

The locations of interest in a partial penetration weld are the root and toe as identified in the sketch below:



Note, in this sketch the weld may be on the inside or outside of the component wall.

ABB-CE's position regarding the intent of the requirements in ASME Section III Paragraph NB-3337.3 was first articulated about 20 years ago. The origin and evolution of this position is explained in detail in the following discussion.

ASME Section III Paragraph NB-3337.3 allows nozzle attachment by partial penetration welds "...only for nozzles on which there are substantially no piping reactions...." It further states, "Earthquake loadings need not be considered in determining whether piping reactions are substantial." Clearly, the latter statement, in the absence of any definitive limit on piping reactions, indicates that the code intents for the component or piping designer to make the determination of whether or not piping reactions are substantial.

In the early 1980s, CE learned that the magnitude of the piping reactions imposed on some nozzles attached by partial penetration welds was questionable relative to the code requirement of "substantially no piping reactions." At that time CE developed a criteria that could be used to determine whether piping reactions on these nozzles met the intent of the code. For nozzles in Class 1 components, this criteria is paraphrased below:

> The calculated nominal stresses due to normal operating pipe loads at the nozzle section located adjacent to the weld attaching the nozzle to the pipe or component should be reviewed to verify that the joint is in full compliance with the code requirements using the following acceptance criteria.

A. If the calculated stress is no greater than 10% of yield, the piping reactions are acceptable and no further evaluation is required.

B. If the calculated stress is no greater than 20% of yield, the piping reactions are acceptable if justified in a fatigue evaluation in accordance with the code.

C. If the calculated stress is greater than 20% of yield or if the fatigue evaluation shows a usage factor exceeding 1, hardware modifications to limit the stress may be required.

At the time this criteria was formulated, the subject nozzles had the partial penetration weld on the inside of the pipe or component wall. Consequently, the piping reactions were applied to the nozzle on the root-side of the partial penetration weld, and the "nozzle section located adjacent to the weld" was at the weld root. Thus, the criteria permitted nominal stresses equal to 20% of yield in the nozzle wall at the weld root, where the potential for a "crack-like discontinuity" and a high fatigue strength reduction factor exists.

Subsequent to the discovery of the PWSCC problem with the Alloy 600 nozzle and weld materials used in these instrument nozzles, nozzle replacement designs employing Alloy 690 with the partial penetration welds on the outside of the pipe or component wall were developed. In these designs the piping reactions are applied to the nozzle on the toe-side of the partial penetration weld, so the criteria, applied as stated above, would limit the nominal stresses to 20% of yield in the nozzle wall at the weld toe. Since the discontinuity at the weld-toe is relatively benign compared to the weld-root, ABB-CE concluded that literal application of the criteria to these designs was overly restrictive. This was confirmed by comparative finite element analyses of both designs that indicated piping reactions meeting the criteria produced significantly lower stresses with the weld on the outside surface of the component wall.

In order to equalize the treatment of the two weld locations with respect to the "substantially no piping reactions" evaluation, ABB-CE elected to retain the previously established criteria, but to use a more liberal interpretation to evaluate outside wall weld locations. In particular, for the outside weld case, finite element analysis may be used to assess the magnitude of the applied pipe load stresses in the nozzle wall at the weld-root relative to the 10% and 20% of yield stress levels that the criteria would allow for an inside weld location. This assessment is performed by calculating the stresses in the nozzle wall at the weld-root from the specified pipe loads and comparing them against stresses from a hypothetical benchmark case with a known nominal stress in the nozzle wall at a section through the weld-root. The hypothetical benchmark case is loaded on the inside end of the nozzle by an axial load or bending moment calibrated to produce a unit nominal stress in the nozzle at the weld-root. For convenience, the unit nominal stress is usually chosen as 10% or 20% of yield stress.

For an outside weld location, this procedure allows somewhat higher stresses in the nozzle wall at a section through the weld-toe. Consequently, nominal stresses in the section at the weld-toe that exceed the 10%, or even the 20%, of yield limit are allowed. In this case, a code fatigue evaluation of the weld-toe with an appropriate stress concentration factor is required. If the 10% yield limit is exceeded at the weld-root, fatigue evaluation of the weld-root according to the provisions of ASME Section III, including the requirements of NB-3352.4(d)(5), is required regardless of weld location.

Question 9

Provide an explanation of the terms "SI", "Smn", "Smx" found on the stress contour plots.

Response

"SI" indicates that the plotted contours represent stress intensity values in the region of the model shown in the plots. Stress intensity, as defined per ASME Section III Paragraph NB-3213.1, is the algebraic difference between the maximum and minimum principal stresses a point.

"Smn" is the minimum value of the plotted variable, in this case stress intensity (SI), at any point in the model, which may extend beyond the region included in the plot.

"Smx" is the maximum value of the plotted variable, in this case stress intensity (SI), at any point in the model, which may extend beyond the region included in the plot.

Question 10

On page D1, provide an explanation of the term "pressure mismatch interaction loadings."

Response

The analyses of record cited for these nozzles (Reference 11 to the Report) were performed by the structural analysis method commonly called "interaction analysis." In this method, the component parts of the structure are treated as independent bodies loaded by applied external loads, such as internal pressure, pipe loads and thermal gradients, and by internal forces and moments, called redundants, acting at the interfaces between the bodies. The deformations of the independent bodies under the applied external loads induce discontinuities at the interfaces between the bodies. The redundants required to maintain continuity are then calculated. Once the redundants are determined, stresses in the bodies can be calculated from the external and internal loads. Classical structural analysis methods, such as theory of elasticity, strength of materials and theory of plates and shells, are used in the deformation and stress calculations.

The interaction analyses of record for these nozzles divided the structure into two bodies: the nozzle and the vessel or pipe wall. The interface between these bodies is the partial penetration weld. The term "pressure mismatch interaction loadings" refers to the internal loads (forces and moments) that the partial penetration weld sustains as a result of the deformation mismatch between the nozzle and vessel or pipe wall from internal pressure loads. Similarly "temperature mismatch interaction loadings" refers to the internal loads in the weld that arise from differential thermal deformations of the two bodies. Along with the applied external loads, these forces and moments are used to calculate the stresses in the partial penetration weld and the nozzle wall.

Question 11

Provide the basis for the stress concentration factor on page D8. Why should this value not be applied to all stress components?

Response

The stress concentration factor (SCF) on page D8 is based on Section A.7, pages 91-96, in Reference 12 cited in the Report:

> Tentative Structural Design Basis for Reactor Pressure Vessels and Directly Associated Components (Pressurized Water – Cooled Systems), PB151987, U. S. Department of Commerce, December 1958.

This document has long been a standard reference for the calculation of stress concentration factors in the nuclear power industry.

The value Ko, the stress concentration factor for a square shoulder, was obtained from Figure A.7-1 in the cited reference. It was adapted to the inclined shoulder with the equation given in Paragraph A.7.2.4 included in the Report. The notation used in the calculation is consistent with Reference 12, except that the angle β is represented by B.

Paragraphs A.7.4 – A7.6 in the reference cited above provide guidance on the use of the stress concentration factor in a nozzle vessel intersection. It is stated that the stress concentration factor is applied to the stress component that is perpendicular to the change in section, not to all stress components at the discontinuity. At the toe of the weld, the longitudinal stress component (SX) in the nozzle is perpendicular to the change in section, so according to this reference the SCF is properly applied to this component of stress only.

Question 12

Provide the cumulative usage factors in the component walls at the location of the new weld prior to the nozzle replacements (at the surface of the pipe or pressurizer).

Response

Cumulative usage factors on the outside surface of the pipe or vessel wall were not calculated in the analyses of record for these nozzles.

Instrument nozzles that are to be replaced on the primary piping incorporate a J-prep on the surface of the pipe that completely surrounds the existing bore. As shown in Westinghouse drawing 10011E05, the J-prep is nominally [ ] inches in depth and extends at least [ ] inches radially out from the edge of the existing bore. As a result, material on the outside surface of the component wall that may have experienced fatigue damage from prior operation has been removed.

Instrument nozzles that are to be replaced on the pressurizer incorporate an Alloy 690 weld buildup pad on the OD of the component to facilitate welding the new nozzle. Consequently, the new nozzles are not welded directly to material that was previously subjected to cyclic loading and possible fatigue damage.

Cumulative usage factors were calculated in the analyses of record for the partial penetration weld on the inside of the vessel wall. These calculations were done with a fatigue strength reduction factor of 5 and are expected to be bounding for the outside surface of the wall. The maximum calculated CUF was [ ] for the Unit 1 Pressurizer Upper Level Nozzle.

Question 13

ASME Section III, Paragraph NB-3352.4(d), outlines requirements for fatigue analysis of partial penetration welds. The paragraph states: A fatigue strength reduction factor of not less than 4 shall be used in the fatigue analysis.

Provide a discussion on the extent to which the finite element analyses, of the nozzle replacement welds, comply with the requirements of this paragraph.

Response

As noted in the response to Question 8, the SNPR criteria stipulates a code fatigue evaluation at the root of the weld if the pipe load stresses exceed the 0.1Sy limit. This evaluation would be done with a fatigue strength reduction factor of 4 per NB-3352.4(d)(5). However, in the cases considered in the Report, the magnitude of the pipe load stresses at the weld toe as well as the previously discussed conservative assumptions used in the stress and fatigue evaluations caused the weld-toe to be more critical than the weld root. Consequently the analyst chose not to include the fatigue evaluation for the weld-root in the Report.

The assumptions that the thermal and seismic pipe loads combine for [ ] cycles and that the thermal pipe loads are fully reversible and apply for [ ] cycles cause the fatigue evaluation to be highly dependent on the magnitude of the pipe load stresses. As seen in Tables C-2 and C-3 in the Report, the magnitude of the nominal pipe load stresses at the weld-toe is 3 to 4 times those at the weld-root; thus, the nominal stresses at the weld-toe are comparable in magnitude to the concentrated stresses at the weld-root. The unconcentrated stresses at the weld-toe result in primary plus secondary stress ranges that require an elastic-plastic correction factor be applied in the fatigue evaluation in addition to the stress concentration factor of 1.35 identified in the Report. These factors together with the magnitude of the pipe load stresses result in alternating stresses that are essentially due to pipe loads only. This is demonstrated in the last two tables on page D10 in the Report where it can be seen that the alternating stress (Salt) is only slightly larger than the applied pipe load stresses (Pipe TH+DW+OBE and Pipe TH+DW) shown.

In order to confirm that the CUF at the weld-root is acceptable, a fatigue evaluation including a fatigue strength reduction factor of 4 in accordance with NB-3352.4(d)(5) is presented in Tables 3 and 4. The evaluation is done for the Unit 1 Pressurizer Upper Level nozzle. This evaluation is performed with the same assumptions used in the Report except that the stress ranges from the pressure plus thermal transient conditions are varied as the transient occurrences are used. Assuming the maximum stress range for all cycles is too conservative with the fatigue strength reduction factor of 4. In addition, factors to account for the effect of pressure in the annulus between the bore and the nozzle [ ] and for the maximum hillside effect per NB-3338.2 [ ] are included. Conservatively, the nominal pipe load stresses are assumed to equivalent to [ ] for dead weight plus thermal (DW+TH) and [ ] for OBE seismic. The calculated CUF of [ ] is less than the most critical values calculated for the weld-toe in the Report.

Table 3
Corrected Stresses for Unit 1 Pressurizer Upper Level Nozzle – Weld Root

Trn	P	N	Pressure Stresses			Thermal Stresses		
			Sxp	Shp	Srp	Sxt	Sht	Srt
		Pressure Stress Factors			Hillside	[ ]		
					Annulus	[ ]		

Trn	Combined Stresses			Stress Differences			Concentrated Stress Diff.		
	Sx	Sh	Sr	Sx-Sh	Sx-Sr	Sh-Sr	K*(Sx-Sh)	K*(Sx-Sr)	K*(Sh-Sr)

			Max	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
K=	4.00		Min	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
			Range	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

Table 4
Fatigue Evaluation of Unit 1 Pressurizer Upper Level Nozzle – Weld Root
With Corrected Pressure Stresses and Fatigue Strength Reduction Factor = 4

[

Sorted Str. Intensity		
Cond	N	K*(Sh-Sr)

]

[

Cumulative Usage Factor Calculation							
Max	Max SI	Min	Min SI	Salt*	n	N	UF

]

CUF= [ ]

* Salt includes a fatigue strength reduction factor of 4 on DW+TH+OBE pipe load stress for the first [ ] cycles. DW+TH pipe load stress for all remaining cycles.

Pipe Load Stresses	DW+TH	[ ]
	OBE	[ ]

The following questions pertain to Reference (2) of the subject relief requests,"CN-CI-02-69, Revision 0, Evaluation of Fatigue Crack Growth associated with Small Diameter Nozzles for St. Lucie 1 & 2, dated October 9, 2002."

Question 15:

The U.S. Nuclear Regulatory Commission staff's safety evaluation (SE) for the topical report CE NPSD-1198-P, Revision 00, "Low-Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement Programs," was issued on February 8, 2002. The subject SE, currently under revision, requires the performance of plant specific thermal fatigue crack growth calculations for the worst-case existing flaw in the nozzles being assessed including a comparison to the maximum allowed crack size (length and depth).

Based on the thermal fatigue crack growth calculations for Saint Lucie Units 1 and 2, provide a comparison of the final crack size (length and depth), at the end of the evaluation period, to the maximum allowable crack size for the pressurizer nozzle locations and the hot leg piping nozzle locations.

Response:

Westinghouse has generated the requested information and summarized it in the table below. These results were developed using the same methods and analysis techniques used in the subject calculation.

Location	Initial Flaw Size (Depth/Length - in)	Final Flaw Size (Depth/Length - in)	Max Allowable Flaw Size(1) (Depth/Length - in)
[ ] [ ]	[ ] [ ]	[ ] [ ]	[ ] [ ]
[ ] [ ]	[ ] [ ]	[ ] [ ]	[ ] [ ] [ ]

Note: (1) [ ]

(2) [ ]

Question 16:

Confirm/discuss that the methods used in your thermal fatigue crack growth calculations are more appropriate than what is specified in Appendix A to Section XI of the ASME Code. Identify any deviations and provide the justification for each deviation.

Response:

As stated in the subject calculation, the fracture mechanics evaluation is performed using the guidance found in ASME Code, Section XI, Appendix A (Code). This guidance outlines a process to assess a flaw left in service considering postulated operating conditions over the life of the plant. As part of this guidance, the Code offers material limits and suggested methods of analysis. In this evaluation, the Code aspects associated with material properties specified in Article A-4000 were used as directed, as was the analysis guidance specified in Article A-5000. The only modification to the Code guidance was to use a more technically appropriate formulation to calculate the Stress Intensity Factor (SIF) as is allowed by Article A-3000.

The technique used to calculate SIF in the subject calculation is based on a Newman-Raju paper "*Stress Intensity Factor Equations for Cracks in Three-Dimensional Finite Bodies Subjected to Tension and Bending Loads*," NASA Technical Memorandum 85793, April 1984. Specifically, this paper presents solutions for several flaw configurations including flaws adjacent to holes such as the one presented for a "Corner Elliptical Corner Crack at a Hole." Considering the actual geometry of the problem under evaluation, which is essentially a hole through a specified thickness, it was concluded that the formulation offered by this paper was more applicable to the problem than that presented in Article A-3000.

From the discussion presented in the paper, the "Corner Elliptical Corner Crack at a Hole" formulation is based on results from a three-dimensional finite element model subjected to remote tension and bending loads. It further states that for ratios of crack depth to thickness less than 0.80, the equations are generally within 5% of the finite element results, except where the crack front intersects a free surface, where the equations give higher SIF than the finite element results. The paper concludes that the equations provided should be useful for correlating and predicting fatigue crack growth rate as well as in computing fracture toughness and fracture loads for these types of crack configurations.

In conclusion, based on our study of this paper, Westinghouse believes that this is an appropriate alternative to calculating the stress intensity factor for this problem than what is provided in ASME Code, Section XI, Appendix A.

Question 17:

In Section 6.3.4.2 for the evaluation of pressurizer lower shell axial flaws, it was stated that the Elastic-Plastic Fracture Mechanics (EPFM) analysis was used for the reactor/turbine trip transient because the subject transient does not meet the acceptance criteria based on Linear Elastic Fracture Mechanics (LEFM) analysis.

Provide a discussion describing the method and material properties used in this evaluation; and confirm that they are consistent with ASME Code or regulatory guidelines.

Response:

The Elastic-Plastic Fracture Mechanics (EPFM) evaluation performed in Section 6.3.4.2 of the subject calculation is based on methods specified in Appendix K of 1992 ASME Code Section XI, which are also the analysis methods found in Regulatory Guide (RG) 1.161. Since, Appendix K did not exist in 1989 ASME Code Section XI, which is the Code year specified in the plant submittal, the discussion below demonstrates the relationship of the various elements of the Appendix K analysis to the corresponding elements in RG 1.161.

Briefly, the method specified in RG 1.161 requires that the flaw meet the following acceptance criteria:

1. The crack driving force must be shown to be less than the material toughness as giving in following equation:

$$J_{applied} < J_{0.1} \qquad \text{(1) of RG 1.161}$$

where $J_{0.1}$ is the J-integral of the material's resistance to ductile tearing at a crack extension of 0.1 inch.

2. The flaw must be stable under ductile crack growth as given below:

$$\frac{\partial J_{applied}}{\partial a} < \frac{\partial J_{material}}{\partial a} \qquad \text{(2) of RG 1.161}$$

(with load held constant)

at

$$J_{applied} = J_{material}$$

where $J_{applied}$ is calculated for the postulated flaw under the applicable loading.

[

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[

Figure removed

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Attachment 3A

St. Lucie Units 1 and 2

Westinghouse Report CR-9417-CSE95-1102-NP

Structural Analysis of Replacement Instrument Nozzles
and Heater Sleeves for Florida Power & Light – St. Lucie Units 1 & 2
Pressurizer, #1 and 2 Piping, and #2 Steam Generator

And

Westinghouse Proprietary Affidavit

12 Pages Total

I, Ian C. Rickard, depose and say that I am the Licensing Project Manager of Westinghouse Electric Company LLC (WEC), duly authorized to make this affidavit, and have reviewed or caused to have reviewed the information which is identified as proprietary and described below. I have personal knowledge of the criteria and procedures utilized by WEC in designating information as a trade secret, privileged, or as confidential commercial or financial information.

This affidavit is submitted in conformance with the provisions of 10 CFR 2.790 of the Commission's regulations for withholding proprietary information and in conjunction with the application of Florida Power and Light Company for withholding this information. The information for which proprietary treatment is sought is contained in the following documents which have been appropriately designated proprietary:

- CR-9417-CSE95-1102, Rev. 02, Structural Analysis of Replacement Instrument Nozzles and Heater Sleeves for Florida Power & Light – St. Lucie #1 & 2 Pressurizer, #1 & 2 Piping, and #2 Steam Generator, January 1996

Pursuant to 10 CFR 2.790(b)(4) of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information included in the document identified above should be withheld from public disclosure.

1. The information sought to be withheld from public disclosure is owned and has been held in confidence by WEC. It consists of analyses demonstrating the structural integrity of a standard repair design for various St. Lucie Unit 1 and 2 partial penetration nozzles.
2. The information consists of analyses or other similar data concerning a process, method or component, the application of which results in substantial competitive advantage to WEC.
3. The information is of a type customarily held in confidence by WEC and not customarily disclosed to the public.
4. The information is being transmitted to the Commission in confidence under the provisions of 10 CFR 2.790 with the understanding that it is to be received in confidence by the Commission.
5. The information, to the best of my knowledge and belief, is not available in public sources, and any disclosure to third parties has been made pursuant to regulatory provisions or proprietary agreements that provide for maintenance of the information in confidence.
6. Public disclosure of the information is likely to cause substantial harm to the competitive position of WEC because:
   a. A similar product or service is provided by major competitors of WEC.
   b. WEC has invested substantial funds and engineering resources in the development of this information. A competitor would have to undergo similar expense in generating equivalent information.
   c. The information consists of analyses demonstrating the structural integrity of a standard repair design for various St. Lucie Unit 1 and 2 partial penetration nozzles, the application of which provides a competitive economic advantage. The availability of such information to competitors would enable them to design their product or service to

better compete with WEC, take marketing or other actions to improve their product's position or impair the position of WEC's product, and avoid developing similar technical analysis in support of their processes, methods or apparatus.

d. Significant research, development, engineering, analytical, manufacturing, licensing, quality assurance and other costs and expenses must be included in pricing WEC's products and services. The ability of WEC's competitors to utilize such information without similar expenditure of resources may enable them to sell at prices reflecting significantly lower costs.

e. Use of the information by competitors in the international marketplace would increase their ability to market comparable products or services by reducing the costs associated with their technology development. In addition, disclosure would have an adverse economic impact on WEC's potential for obtaining or maintaining foreign licenses.

Ian C. Rickard
Licensing Project Manager
Westinghouse Electric Company LLC

Sworn to before me this 13th day of March, 2003

Linda A. Sotta
Notary Public
My commission expires: May 31, 2003

Westinghouse Non-Proprietary Class 3

WESTINGHOUSE ELECTRIC COMPANY LLC

Calculation Note Number		Revision	Charge Number	Page
CR-9417-CSE95-1102-NP		02	111766	1
Project	Releasable (Y/N)	Shop Order Number	Microfiche Attached (Y/N)	Total No. Pages
	Y		N	10

Title: Structural Analysis of Replacement Instrument Nozzles and Heater Sleeves for Florida Power & Light - St. Lucie #1 & 2 Pressurizer, #1 & 2 Piping, and #2 Steam Generator

Prepared by: J.E. ROBERTS J.E. Roberts Date: 1-19-96

Approved By: D.P. SISKA DP Siska Date: 1-19-96

VERIFICATION STATUS: COMPLETE

The Safety-Related design information contained in this document has been verified to be correct by means of Design Review using Checklist(s) 2 of QAM-101.

Name J.W. Bass Independent Reviewer Signature JWBass Date 1-19-96

ASME CODE CERTIFICATION

This Design Report is certified to be correct and complete and in compliance with the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Division I, Nuclear Power Plant Components 1971 Edition and Addenda through Summer 1972.

Certified by: J.H. Sodergren Registration No. 8790
State of: ALABAMA Date: 1-19-96

ALABAMA REGISTERED No. 8790 PROFESSIONAL ENGINEER J. H. SODERGREN

Westinghouse

Record of Revisions

NUMBER	DATE	PARAGRAPH(s) INVOLVED	PREPARED BY	INDEPENDENT REVIEWER	APPROVED BY
0	3/5/95	Original Issue	J. E. Roberts 3/10/95	J. W. Bass 3/17/95	D. P. Siska 3/21/95
1	9/19/95	pages 22 and 28	J. E. Roberts 9/19/95	J. W. Bass 9/19/95	D. P. Siska 9/19/95
2	1/19/96	pages 1 & 2 App. B,C,D,E	J. E. Roberts J.E. Roberts 1/19/96	J. W. Bass JWBass 1/19/96	D. P. Siska DP Siska 1-19-96

Table Of Contents

1.0 Abstract

This report documents the structural integrity of a standard repair design for the FP&L St. Lucie partial penetration nozzles. The scope of coverage will allow modification of all Unit 1 and Unit 2 pressurizer instrument nozzles and heater sleeves, al Unit 1 and Unit 2 hot and cold leg RTD and sampling or flow measurement nozzles, and the primary instrument nozzle in the Unit 2 steam generator. (This report uses the terminology "**nozzles**" to cover this scope.)

The repair will include enlarging the existing penetration to accommodate the repair nozzle and a thin wall corrosion liner. The nozzle/liner is welded to either the external surface of the pressure boundary or to an external temper bead weld build-up pad which is added, as a part of the repair scope, on the exterior surface of the pressure shell.

This analysis considers maximum enveloping applied pipe loads in conjunction with pressure and thermal stresses conservatively calculated in the original stress analyses of record.

Results of the analyses show the standard repair design for the partial penetration weld nozzles to be acceptable for use with the aforementioned FP&L scope. ASME Code requirements are satisfied for all stress and fatigue allowables.

2.0 Description of Modification

Information for Section 2.0 is proprietary to Westinghouse Electric Company.

3.0 Method of Analysis

Information for Section 3.0 is proprietary to Westinghouse Electric Company.

4.0 Significant Results

Information for Section 4.0 A – E is proprietary to Westinghouse Electric Company.

5.0 References

1. ASME Boiler and Pressure Vessel Code, Section III for Nuclear Vessels, 1971 edition and Addenda through Summer 1972.
2. ASME Boiler and Pressure Vessel Code, Section III for Nuclear Vessels, Code Case N-474-1, "Design Stress Intensities and Yield Strength Values of UNS N06690 with a Minimum Specified Yield Strength of 35 ksi, Class 1 Components," March 5, 1990.
3. "Machinery's Handbook: A Reference book for the Mechanical Engineer, Draftsman, Toolmaker and Machinist," Nineteenth Edition, 1974, Oberg and Jones.
4. [ ]
5. [ ]
6. ANSYS Engineering Analysis System User's Manual, Revision 4.4A, Swanson Analysis Systems, Inc., June, 1985.
7. [ ]
8. [ ]
9. [ ]
10. [ ]
11. [ ]
12. Tentative Structural Design Basis for Reactor Pressure Vessels and Directly Associated Components (Pressurized Water – Cooled Systems), PB151987, US Dept. of Commerce, December 1958.
13. "Formulas for Stress and Strain," Fifth Edition, January 1976, Roark & Young.

APPENDIX A

Reinforcement, Spacing and Thickness Reqiurements

Information for Appendix A is proprietary to Westinghouse Electric Company.

APPENDIX B

Primary Stress Evaluation

Information for Appendix B is proprietary to Westinghouse Electric Company.

APPENDIX C

Substantial Load Evaluation

Information for Appendix C is proprietary to Westinghouse Electric Company.

APPENDIX D

Fatigue Usage Factor Evaluation

Information for Appendix D is proprietary to Westinghouse Electric Company.

APPENDIX E

Heater Removal and Insertion Force Evaluation

Information for Appendix E is proprietary to Westinghouse Electric Company.