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10 CFR 54

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D. C. 2055-0001

Re: Turkey Point Units 3 and 4
Docket Nos. 50-250 and 50-251
License Renewal Commitment
Submittal of Pressurizer Surge Line Welds Inspection Program

Turkey Point Nuclear Plant has a license renewal commitment to address the concern of environmentally assisted fatigue for the pressurizer surge line welds during the period of extended operation using one or more of the following approaches:

1. Further refinement of the fatigue analysis to lower the cumulative usage factor (CUF) to below 1.0, or
2. Repair of the affected locations, or
3. Replacement of the affected locations, or
4. Management of the effects of fatigue by an inspection program that has been reviewed and approved by the NRC.

The commitment was documented in Section 4.3.2 of the Safety Evaluation Report Related to the License Renewal of Turkey Point Nuclear Plant, NUREG 1759, dated April 2002.

The purpose of this letter is to notify the NRC Staff that FPL has selected the approach to manage the effects of environmentally assisted fatigue of the pressurizer surge line welds for Turkey Point Units 3 and 4 by inspection, i.e., option 4 above. Accordingly, prior to entering the period of extended operation, FPL submits herein in Attachment 1 details of the inspection program for NRC Staff review and approval. The technical basis of the inspection program is presented in Attachment 2.

Should you have any questions, please contact Mr. Robert J. Tomonto, Licensing Manager, at 305-246-7327.

Very truly yours,

Michael Kiley
Vice President
Turkey Point Nuclear Plant

Attachments
cc: USNRC Regional Administrator, Region II
USNRC Project Manager, Turkey Point Nuclear Plant
USNRC Senior Resident Inspector, Turkey Point Nuclear Plant

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FPL Letter L-2012-214

ATTACHMENT 1

Turkey Point Units 3 and 4

**Description of the Proposed Aging Management Program
For Pressurizer Surge Line Welds
Inspection Program**

1.0 Background

Florida Power & Light Company (FPL) has a license renewal commitment for Turkey Point Units 3 and 4, to address the effects of environmentally assisted fatigue for the pressurizer surge line welds during the period of extended operation using one or more of the following approaches:

1. Further refinement of the fatigue analysis to lower the cumulative usage factor (CUF) to below 1.0, or
2. Repair of the affected locations, or
3. Replacement of the affected locations, or
4. Management of the effects of fatigue by an inspection program that has been reviewed and approved by the NRC.

At Turkey Point Units 3 and 4, there are twelve pressurizer surge line weld locations subject to the effects of environmentally assisted fatigue (i.e., five welds in Unit 3, and seven welds in Unit 4). The critical weld locations of concern are the pressurizer surge nozzle-to-safe-end weld and the hot leg surge nozzle-to-pipe weld, where the calculated CUF was determined to exceed the ASME Code allowable usage factor of 1.0, when environmentally assisted fatigue (EAF) is considered during the period of extended operation.

By letter L-2001-075, dated April 19, 2001, (Reference 1), FPL committed to provide the NRC with inspection program details prior to entering the period of extended operation, should FPL select option 4 (i.e., inspection) to manage environmentally assisted fatigue during the period of extended operation.

FPL has selected to age manage the effects of the environmentally assisted fatigue on the pressurizer surge line welds by an inspection program and flaw tolerance evaluation. As noted in the Safety Evaluation Report Related to the License Renewal of Turkey Point Units 3 and 4, NUREG 1759, Section 4.3.2, pages 4-16, and 4-17, the use of an Aging Management Program to manage fatigue will require prior staff review and approval. Accordingly, Sections 2, 3 and 4 of this attachment provide the Proposed Aging Management Program Basis for the Turkey Point Units 3 and 4 Pressurizer Surge Line Welds Inspection Program, the Aging Management Program Attributes, and the Implementation of the Inspection Program, respectively, for NRC review and approval.

2.0 Proposed Aging Management Program Basis for Turkey Point Units 3 and 4 Pressurizer Surge Line Welds Inspection Program

The proposed Aging Management Program (AMP) for fatigue assessment is based on the approach documented in the ASME Boiler and Pressure Vessel Code, Section XI - Rules for Inservice Inspection of Nuclear Power Plant Components, Non-Mandatory Appendix L Operating Plant Fatigue Assessment.

A flaw tolerance evaluation was performed specifically for Turkey Point Units 3 and 4 in order to assess the operability of the surge line by using ASME Section XI Appendix L methodology

and to determine the successive inspection schedule for the surge line welds with a postulated surface flaw. Two bounding weld locations were evaluated in detail. The two bounding weld locations of concern are the pressurizer surge nozzle-to-safe-end weld and the hot leg surge nozzle-to-pipe weld. Based on a comparison of geometry, material properties and applicable loads, the results of the detailed evaluation of the two bounding locations are also applicable to all other in-between pipe weld locations on the surge line. The results of the crack growth for the pressurizer surge nozzle welds and hot leg surge nozzle welds are presented in Tables 1 and 2, respectively. The technical analysis of the postulated flaw tolerance evaluation is provided in Attachment 2 of this submittal.

Table 1

Pressurizer Surge Nozzle Crack Growth Results

Flaw Type (1) (2)	**Max. Flaw Length**(3)			**Allowable Flaw Depth**		**Final Flaw Depth**	**Final Flaw Length** (2)	**Allowable Operating Period**	**Successive Inspection Schedule** (5)
	l/πD	**(Deg.)**	**(in.)**	**a/t**	**(in.)**	**(in.)**	**(in.)**	**(months)**	**(years)**
Circumferential	0.1	36	3.91	0.75	0.96	0.650	3.900	> 564(4)	10
Axial	NA	NA	2.96	0.70	0.90	0.492	2.952	324(4)	10

Table 2

Hot Leg Surge Nozzle Crack Growth Results

Flaw Type (1) (2)	**Max. Flaw Length**(3)			**Allowable Flaw Depth**		**Final Flaw Depth**	**Final Flaw Length** (2)	**Allowable Operating Period**	**Successive Inspection Schedule** (5)
	l/πD	**(Deg.)**	**(in.)**	**a/t**	**(in.)**	**(in.)**	**(in.)**	**(months)**	**(years)**
Circumferential	0.1	36	3.37	0.42	0.422	0.386	2.316	> 720	10
Axial	NA	NA	1.94	0.75	0.76	0.323	1.938	624(4)	10

Notes for Tables 1 and 2:

1. The postulated initial flaw depth is 20% of the weld thickness (i.e., 0.201 inches) and the initial flaw length is 6 times its depth (i.e., 1.206 inches) per Appendix L guidelines.
2. A constant aspect ratio (a/l) of 1/6 is used in the crack growth analysis.
3. Flaw length based on Inner Diameter (ID)
4. Maximum flaw length is reached before the allowable flaw depth.
5. Per Appendix L, if allowable operating period is equal or greater than 10 years, the successive inspection schedule shall be equal to the examination interval listed in the Turkey Point ASME Section XI schedule of Inservice Inspection (ISI) program of the component.

Per the guidelines of Appendix L, Table L-3420-1, for the allowable operating periods listed in Tables 1 and 2, the successive inspection schedule for pressurizer surge line welds is determined to be ten years for either an axial or a circumferential postulated flaw. This inspection interval will be used for all pressurizer surge line welds as noted in Table 3.

3.0 Aging Management Program Attributes

The key attributes of the Turkey Point Units 3 and 4 Pressurizer Surge Line Weld Inspection Program that are used to describe the aging management program, are discussed below:

1. Scope of the Program
   All pressurizer surge line welds listed in Table 3 will be examined in accordance with Risk Informed In-service Inspection (RI-ISI) Programs for Class 1 piping welds. This alternative to the requirements of ASME Section XI was approved by the NRC during the fourth 10-year interval as Relief Request 3 and 4 for Units 3 and 4 respectively (Safety Evaluation dated December 9, 2008 TAC Nos. MD7740. MD8875). The aging effect managed with these inspections is cracking due to environmentally assisted fatigue. In each 10-year ISI interval during the period of extended operation, all surge line welds in scope will be inspected in accordance with the Turkey Point ISI Program.

   Based on postulated flaw tolerance analysis (Attachment 2), and per the guidelines of ASME Code, Section XI, Appendix L, Table L-3420-1, the successive inspection schedule is determined to be ten years. This inspection interval will be used for all surge line piping welds in scope.

   Examination methods are determined in accordance with the requirements of the Risk Informed In-service Inspection (RI-ISI) Programs for Class 1 piping welds. The examination method for this Class 1 piping welds are found within the ASME Code Case N-577-1, Category R-A, Item R1.11 as volumetric only. The Risk Informed Program does not require a surface examination to be performed for these category welds. Examination results are evaluated by qualified individuals in accordance with ASME Section XI acceptance criteria. Components with indications that do not exceed the acceptance criteria are considered acceptable for continued service.

2. Preventive Actions
   There are no specific preventive actions under this program to prevent the effects of aging.

3. Parameter(s) Monitored or Inspected
   Inservice examinations for the surge line welds will be volumetric examinations as indicated in Table 3.

4. Detection of Aging Effects
   The degradation of surge line welds is determined by volumetric examination in accordance with the requirements of Turkey Point ISI Program. The frequency and scope of examination are sufficient to ensure that the aging effects are detected before the integrity of the surge line welds would be compromised.

5. Monitoring and Trending
The frequency and scope of the examinations are sufficient to ensure that the environmentally assisted fatigue aging effect is detected before the intended function of these welds would be compromised. Examinations will be performed in accordance with the inspection intervals based on the results of the postulated flaw evaluation performed in accordance to the ASME Code Section XI, Appendix L methodology.

If flaws are identified in the pressurizer surge line welds, they will be evaluated by engineering to assess the effect of environmentally assisted fatigue (EAF), and to determine its impact on the EAF analysis (Attachment 2).

Records of the examination procedures, results of activities, examination datasheets, and corrective actions taken or recommended will be maintained in accordance with the requirements of Turkey Point Unit 3 and 4 ISI Program for ASME Section XI requirements.

6. Acceptance Criteria
Acceptance standards for the inservice inspections are identified in Subsection IWB for Class 1 components. Table IWB-2500-1 identifies references to acceptance standards listed in IWB-3500. Relevant indications found in the surge line welds that are revealed by the inservice inspections, may require additional evaluation per the requirements of ASME Section XI, Appendix L.

Indications that exceed the acceptance criteria are documented and evaluated in accordance with the Turkey Point Corrective Action Program. Operability of the surge line welds will require an IWB-3600 evaluation for acceptance based on engineering evaluation, repair, replacement or analytical evaluation. Repairs or replacements will be performed in accordance with ASME Section XI, Subsection IWA-4000 and IWA-6000, as described by administrative procedure 0-ADM-532, ASME Section XI Repair/Replacement Program.

7. Corrective Actions
Action Requests (ARs) are generated in accordance with the Turkey Point Corrective Action Program for any relevant indications of degradation. Items with examination results that do not meet the acceptance criteria are subject to acceptance by evaluation and/or acceptance by repair or replacement in accordance with Subsection IWB-3600.

8. Confirmation Process
When degradation is identified in the pressurizer surge line welds, an engineering evaluation is performed to determine if the weld is acceptable for continued service or if repair or replacement is required. The engineering evaluation includes probable cause, the extent of degradation, the nature and frequency of additional examinations, and, whether repair or replacement is required.

Repair and/or replacement are performed in accordance with the requirements of ASME Section XI, Subsections IWA-4000 and IWA- 6000, and as implemented by the Turkey Point Units 3 and 4 ISI Program and by the associated administrative procedure 0-ADM-532, ASME Section XI Repair/Replacement Program.

9. Administrative Controls
   Turkey Point ISI Program will document the EAF inspection requirements for the Turkey Point Units 3 and 4 pressurizer surge line welds.

10. Operating Experience
   A sample of the surge line welds have been examined ultrasonically during the first three inservice inspection intervals in accordance with the requirements of the ASME Section XI, Subsection IWB. All surge line welds were volumetrically inspected during the fourth ISI interval and prior to entering period of extended operation. To date, no reportable indications have been found in the subject pressurizer surge line welds.

The proposed aging management program will examine all pressurizer surge line welds listed in Table 3, every 10 years (every ISI interval), provide reasonable assurance that potential environmental effects of fatigue will be managed such that all the pressurizer surge line welds within the scope of license renewal will continue to perform their intended functions for the extended period of operation.

4.0 Implementation of Pressurizer Surge Line Welds Inspection Program

Upon approval of the proposed inspection program, related aging management program basis and implementing documents and the associated Updated Final Safety Analysis Report (UFSAR) sections will be updated accordingly.

5.0 References

1. Florida Power and Light letter to the NRC, L-2001-075, Response to Request for Additional Information for the Review of the Turkey Point Units 3 and 4 License Renewal Application, dated April 19, 2001.
2. Structural Integrity Associates Engineering Report No. 1100756.401, Rev. 1, "Flaw Tolerance Evaluation of Turkey Point Surge Line Welds Using ASME Code Section XI, Appendix L," dated May 2012.

TABLE 3
Turkey Point Units 3 and 4
Pressurizer Surge Line Welds Subject to Environmental Assisted Fatigue Inspection Program

	Unit	Weld Number	Last Examination Performed and Results	Allowable Operating Period per ASME Appendix L Analysis (See Note 1)	Proposed AMP Inspections Type & Frequency
1	Unit 3	**12”-RC-1301-1** RCS Hot Leg Nozzle	2004 Satisfactory	Greater than 10 Yrs	Volumetric Once in 10-Year
2		**12”-RC-1301-5** Surge Pipe to pipe weld	2012 Satisfactory	Greater than 10 Yrs	Volumetric Once in 10-Year
3		**12”-RC-1301-8** Pipe to reducer at Pressurizer	2006 Satisfactory	Greater than 10 Yrs	Volumetric Once in 10-Year
4		**14”-RC-1301-8A** reducer to safe end at pressurizer Surge Nozzle	2006 Satisfactory	Greater than 10 Yrs	Volumetric Once in 10-Year
5		**14”-** RC-1301-9 Safe End to Nozzle	2010 Satisfactory	Greater than 10 Yrs	Volumetric Once in 10-Year
1	Unit 4	**12”-RC-1401-1** At RCS Hot Leg Nozzle to pipe	2008 Satisfactory	Greater than 10 Yrs	Volumetric Once in 10-Year
2		**12”-RC-1401-2** Surge Pipe to pipe weld	2008 Satisfactory	Greater than 10 Yrs	Volumetric Once in 10-Year
3		**12”-RC-1401-4** Surge Pipe to pipe weld	2008 Satisfactory	Greater than 10 Yrs	Volumetric Once in 10 Year
4		**12”-RC-1401-7** Surge Pipe to pipe weld	2006 Satisfactory	Greater than 10 Yrs	Volumetric Once in 10-Year
5		**12”-RC-1401-8** Pipe to nozzle at Pressurizer	2006 Satisfactory	Greater than 10 Yrs	Volumetric Once in 10-Year
6		**14”-RC-1401-8A** Reducer to safe end at Pressurizer Surge Nozzle	2006 Satisfactory	Greater than 10 Yrs	Volumetric Once in 10-Year
7		**14”-** RC-1401-9 Safe End to Nozzle	2009 Satisfactory	Greater than 10 Yrs	Volumetric Once in 10-Year

Note 1: The inspection frequency as determined by ASME Code Section XI, Appendix L analysis is more than 10 years. In accordance to the requirements of Appendix L Table L-3420-1, the surge line welds will be examined once per 10 years, at the frequency of the Turkey Point Inservice Inspection Interval.

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ATTACHMENT 2

Turkey Point Nuclear Plant Units 3 and 4

Structural Integrity Associates

Engineering Report No. 1100756.401, Rev. 1,
"Flaw Tolerance Evaluation of
Turkey Point Surge Line Welds
Using ASME Code Section XI, Appendix L"

Report No. 1100756.401
Revision 1
Project No. 1100756
May 2012

Flaw Tolerance Evaluation of Turkey Point Surge Line Welds Using ASME Code Section XI, Appendix L

Prepared for:

Turkey Point Nuclear Station, Units 3 & 4
Florida Power & Light
Florida City, FL
Contract Number 02293658

Prepared by:

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Structural Integrity Associates, Inc.®

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1.0 INTRODUCTION

A flaw tolerance evaluation in accordance with ASME Code, Section XI, Appendix L [1] has been performed to manage fatigue at critical locations of the Turkey Point Units 3 & 4 pressurizer surge line locations by inspection and flaw tolerance evaluations. Specifically, the critical locations of concern are the nozzle-to-piping welds at the pressurizer surge nozzle and hot leg surge nozzle at the other end of the surge line where the calculated fatigue cumulative usage factor was determined to exceed the ASME Code allowable usage factor when environmentally assisted fatigue (EAF) is considered. When this occurs, an alternative ASME Section XI Appendix L flaw tolerance evaluation can be performed. The ultimate objective of the evaluation was to determine the required successive examination interval for the pressurizer surge and hot leg surge nozzle welds.

The flaw tolerance evaluation was performed to assess the operability of all the welds on the entire surge line from the pressurizer surge nozzle-to-safe-end weld to the hot leg surge nozzle-to-pipe weld. Based on a comparison of geometry, material properties and applicable loads, the results of the detailed evaluation of the two bounding locations are applicable to the other weld locations on the surge line (3 additional welds on Unit 3 and 5 additional welds on Unit 4).

2.0 TECHNICAL APPROACH

The evaluation was performed in accordance with the requirements of ASME Code, Section XI, Appendix L. The methodology used to determine the successive inspection schedule consists of the following principal tasks:

- Determine the stresses at the critical locations of the surge line
- Postulate hypothetical axial and circumferential flaws at the critical location of the nozzle welds. Select appropriate crack models to use to simulate the postulated flaws.
- Use the stresses determined at the critical locations and the selected crack models to compute stress intensity factors for all the applicable normal and upset condition loads.
- Perform fatigue crack growth analyses with the resulting stress intensity factors to determine the end-of-evaluation-period flaw size and, determine the time (allowable operating period) necessary for the postulated initial flaw to grow to the maximum allowable flaw depth.
- Determine the required successive inspection schedule in accordance with the procedures of Appendix L based on the calculated allowable operating period.

3.0 EVALUATION

3.1 Stress Analysis

Finite element stress analyses were performed using ANSYS [2] to determine the stresses at the welds of the 14" pressurizer surge nozzle and 12" hot leg surge nozzle at Turkey Point Nuclear Plant (PTN) Units 3 and 4. The dimensions of each nozzle assembly used in developing the representative finite element models were obtained from Reference 3 and 4, and are presented in Figure 1 and Figure 2 for the pressurizer surge and hot leg surge nozzles, respectively. The detailed finite element models of the nozzle assemblies are shown in Figure 3 for the pressurizer surge nozzle and Figure 4 for the hot leg surge nozzle.

Loads due to internal pressure, applicable thermal transients and piping interface loads such as deadweight and seismic loads were included in the finite element analyses of the nozzle welds. The bounding thermal transients and piping interface loads applied to the pressurizer surge nozzle, which were derived from References 5 and 6, are listed in Table 1 and Table 4, respectively. Similarly, the bounding thermal transients, insurge/outsurge transients and, piping interface loads applied to the hot leg surge nozzle, which were derived from References 5 and 7, are listed in Table 2, Table 3 and Table 5, respectively.

Through-wall hoop and axial stresses were extracted from the finite element stress analyses at the critical locations of the surge nozzle welds for use in the fatigue crack growth.

3.2 Allowable Flaw Evaluation

Per the recommendations of Appendix L of Section XI of the ASME Code, the analytical procedures of Appendix C of the Code are used to determine the critical flaw sizes for the postulated axial and circumferential flaws in the pressurizer surge and hot leg surge nozzle welds. The allowable surface flaws were then determined based on the critical size with consideration of structural margins for different plant operating conditions.

The results of the allowable flaw evaluation are summarized in Table 6 and Table 7 for the pressurizer surge and hot leg surge nozzle welds, respectively.

Circumferential Flaw: For all service levels, for a postulated flaw length of 36°(10% of the total pipe circumference), the bounding allowable flaw depth at the pressurizer nozzle weld is 75% (0.96 inch) of the original wall thickness for the surge nozzle and 42% (0.422 inch) of the original wall thickness for the hot leg surge nozzle.

Axial Flaw: For all service levels, the bounding allowable flaw depth was calculated to be 75% of the weld thickness for an axial flaw with a postulated length up to 2.96" for the pressurizer surge nozzle weld and 1.94" for the hot leg surge nozzle weld.

3.3 Fatigue Crack Growth Analyses

For crack growth prediction, representative fracture mechanics models of internal surface flaws in a cylinder were used to determine stress intensity factors (K) due to cyclic loading. The stress intensity factors for each type of load are computed as a function of postulated crack depth in the weld and superimposed for the various operating states. These stress intensity factors were computed for primary loads such as internal pressure and external piping loads, and secondary loads such as thermal gradient stresses (due to thermal transient events), and weld residual stresses.

Crack growth in the Type 316 and Type 304 stainless steel welds was calculated using the austenitic steel fatigue crack growth law in pressurized water reactor (PWR) environment from Reference 8, expressed as follows:

$$da/dN = C_0(\Delta K)^n \text{, units of in/cycle}$$

where:

$C_0 \quad = C\ S_R\ S_T\ S_{ENV}$

C $= 3.54 \times 10^{-7}$ for Type 316 (hot leg surge nozzle weld)

$= 4.43 \times 10^{-7}$ for Type 304 (pressurizer surge nozzle weld)

n $= 2.25$

$S_R = 1 + e^{8.02(R-0.748)}$

= parameter defining the effect of *R* ratio on crack growth rate,

$S_T = e^{-2516/T_K}$ $\quad 300\ °F \leq T \leq 650\ °F$

$S_T = 3.39 \times 10^5 e^{(-2516/T_K - 0.0301 T_K)}$ $\quad 70\ °F \leq T \leq 300\ °F$

= parameter defining the effect of temperature on crack growth rate,

$S_{ENV} = T_R^{0.3}$

= parameter defining the environmental effects on crack growth rate

da/dN = growth rate

ΔK = stress intensity factor range, ksi in$^{1/2}$

$T_K = [(T-32)/1.8+273.15]$, °K

T = metal temperature, °F

T_R = rise time, secs

$\Delta K_{th} = 1.0$ ksi in$^{1/2}$

Initial axial and circumferential flaws of depths equal to 20% of the weld thickness and a 1/6 aspect ratio (depth/length) were postulated per Appendix L guidelines. The times it takes the postulated initial flaw to reach the allowable flaw depths were determined with the crack growth analyses and reported as the allowable operating periods for each of the nozzle welds.

The crack growth results for the pressurizer surge nozzle weld and hot leg surge nozzle weld are shown in Table 8 and Table 9, respectively.

Circumferential Flaws: For a circumferential flaw with a postulated initial flaw depth of 20% of the weld thickness at the critical section, it takes 720 months (60 years) for the pressurizer surge nozzle to reach the allowable flaw depth calculated using a 36° maximum flaw length in the circumferential direction, and more than 720 months for the hot leg surge nozzle to reach the

allowable flaw depth calculated using a 36° maximum flaw length in the circumferential direction. However, based on the 1/6 aspect ratio, the flaw length reaches the maximum postulated flaw length (3.91") in 564 months (47 years) for the pressurizer surge nozzle.

Axial Flaws: For a postulated axial flaw with a postulated initial flaw depth of 20% of the weld thickness at the critical section, it takes more than 720 months to reach the allowable flaw depth for both surge nozzles. However, based on the 1/6 aspect ratio, the flaw length reaches the maximum postulated flaw length (2.96") in 324 months (27 years) for the pressurizer surge nozzle. Similarly, for the hot leg surge nozzle, based on the 1/6 aspect ratio, the flaw length reaches the maximum postulated flaw length (1.94") in 624 months (52 years).

3.4 Successive Inspection Schedule Requirements

The allowable operating periods reported above were used to calculate the required successive inspection schedule, based on the ASME Code, Section XI, Appendix L procedures. Table 8 and Table 9 show the successive inspection intervals applicable to the pressurizer surge nozzle and hot leg surge nozzle, respectively. For a postulated circumferential flaw with a depth of 20% wall thickness, the required examination interval is ten years for both the pressurizer surge and hot leg surge nozzles if a maximum flaw length of 36° is postulated. Similarly, for an axial flaw, the successive inspection schedule is 10 years for the pressurizer surge and hot leg surge nozzles.

Table 1: Bounding Transients for the Pressurizer Surge Nozzle

Description	Min T, °F	Max T, °F	Max P, psia	Cycles
Plant Heatup	333	653	2250	600
Plant Cooldown	333	653	2250	600
Plant Loading	551	653	2250	14500
Unit Unloading	605	653	2250	14500
Step Load Increase	602	653	2250	2000
Step Load Decrease	601	653	2250	2000
Large Step Load Decrease	605	653	2250	200
Steady State Fluctuations, Initial	553	653	2250	150000
Steady State Fluctuations, Random	555	653	2250	3000000
Feedwater Cycling	520	653	2250	2000
Loss of Load	605	653	2250	80
Loss of Power	571	653	2250	40
Partial Loss of Flow	547	653	2250	80
Reactor Trip from Full Power	555	653	2250	400
Inadvertent Auxiliary Spray	549	653	2250	20
Primary Side Hydro Test	44	282	3122	6
Primary Side Leak Test, Up	44	282	2450	165
Primary Side Leak Test, Down	44	282	2450	165

Table 2: Bounding Transients for Hot Leg Surge Nozzle

Transient	T_{HL} (°F)(1)		T_{Nozzle} (°F)(1)		Max P, psia(1)	Cycles
	Min	Max	Min	Max		
Plant Heatup	70	547	70	70	2250	200
Plant Cooldown	70	547	70	547	2250	200
Plant Loading	547	617	547	617	2288	14500
Plant Unloading	545	617	549	652	2287	14500
Large Load Rejection Large Step Load w. Steam Dump	564	625	617	647	2355	200
Loss of Load	567	657	567	657	2600	80
Loss of Power	565	627	565	654	2450	40
Loss of Flow	544	622	544	619	2280	80
Reactor Trip	517	617	598	621	2250	400
Primary Side Leak Test Up	44	282	44	282	2332	165
Primary Side Leak Test Down	44	282	44	282	2332	165
Primary Side Hydro Test	44	282	44	282	3122	6

Table 3: Insurge/Outsurge Transients for Hot Leg Surge Nozzle

Transient	Time, sec	T_{HL} (°F)	T_{NOZ} (°F)	P (psia)	Q_{SL}, gpm	Cycles
PIO320H	0	225	225	1003	0	43
	960	225	545	1003	200	
	1960	225	545	1003	200	
	2920	225	225	1003	0	
PIO300H	0	245	245	1003	0	69
	900	245	545	1003	200	
	1900	245	545	1003	200	
	2800	245	245	1003	0	
PIO270H	0	275	275	1003	0	73
	810	275	545	1003	200	
	1810	275	545	1003	200	
	2620	275	275	1003	0	
PIO250H	0	295	295	1003	0	19
	750	295	545	1003	200	
	1750	295	545	1003	200	
	2500	295	295	1003	0	
PIO320	0	125	125	402	0	29
	960	125	445	402	200	
	1960	125	445	402	200	
	2920	125	125	402	0	
PIO300	0	145	145	402	0	67
	900	145	445	402	200	
	1900	145	445	402	200	
	2800	145	145	402	0	
PIO270	0	175	175	402	0	67
	810	175	445	402	200	
	1810	175	445	402	200	
	2620	175	175	402	0	
PIO250	0	195	195	402	0	41
	750	195	445	402	200	
	1750	195	445	402	200	
	2500	195	195	402	0	

Table 4: Piping Interface Loads for Pressurizer Surge Nozzle

Load Case	Forces, lb			Moments, lb-in		
	Fx	Fy	Fz	Mx	My	Mz
Deadweight	-14	-2510	28	38004	-540	1500
Thermal	-95	2204	-14293	-1538170	1078440	175702
OBE	215	365	346	55536	8376	15108
SSE	560	1171	922	174732	22056	41436
ΔT=36°F	-907	1960	-13974	-1509860	820395	144860
ΔT=70°F	-457	3709	-8628	-732911	103940	98284
ΔT=103°F	-2132	2223	-13367	-1411870	322741	101056
ΔT=150°F	2196	3905	-8260	-665993	-330990	-598876
ΔT=250°F	5511	4150	-7799	-582345	-874652	-1470327
ΔT=304°F	7302	4282	-7551	-537175	-1168230	-1940910
ΔT=320°F	9607	-126	-8733	-570539	-1104820	-2507480

Table 5: Piping Interface Loads for Hot Leg Surge Nozzle

Load Case	Forces, lb			Moments, lb-in		
	Fx(2)	Fy	Fz	Mx(2)	My	Mz
Deadweight	-19	-2300	25	21830	-5400	98030
Thermal	14176	95	2858	-18284	393181	-81723
OBE	285	368	-28	37511	13656	39762
SSE	749	1179	-95	120062	39156	127305
ΔT=36°F	13759	907	2964	-67203	344917	-529660
ΔT=70°F	9378	457	-508	-5013	649850	-743009
ΔT=103°F	13314	2132	2521	-132813	382369	-1320742
ΔT=150°F	9100	6446	-819	-754856	676986	-2100962
ΔT=250°F (1)	8752	13934	-1207	-1692158	710907	-3798403
ΔT=304°F	8564	17977	-1417	-2198302	729224	-4715021
ΔT=320°F	4311	18860	-5176	-2351685	750839	-5057570

Notes: (1) Based on interpolation between the ΔT=70°F and ΔT=304°F. The number of cycles are 972 (81%) for ΔT=150°F and 228 (19%) for ΔT=250°F

(2) Fx is axial to the hot leg surge nozzle and Mx is torsion.

Table 6: Allowable Part Through-Wall Circumferential Flaw Size for Pressurizer Surge Nozzle Weld

Service Level[1]	Ratio of Flaw Length to Pipe Circumference, $l/\pi D$					
	0	0.1	0.2	0.3	0.4	0.5
	Flaw Length, l(degree)					
	0	36	72	108	144	180
A	0.75	0.75	0.75	0.60	0.49	0.43
B	0.75	0.75	0.75	0.64	0.52	0.45
C	0.75	0.75	0.75	0.66	0.52	0.46
D	0.75	0.75	0.75	0.70	0.58	0.50

Notes:

1) Service Level A = Normal Condition; Service Level B = Upset Condition; Service Level C = Emergency Condition; and Service Level D = Faulted Condition.

Table 7: Allowable Part Through-Wall Circumferential Flaw Size for Hot Leg Surge Nozzle Weld

Service Level[1]	Ratio of Flaw Length to Pipe Circumference, $l/\pi D$					
	0	0.1	0.2	0.3	0.4	0.5
	Flaw Length, l (degree)					
	0	36	72	108	144	180
A	0.75	0.42	0.22	0.16	0.13	0.12
B	0.75	0.75	0.75	0.75	0.75	0.69
C	0.75	0.75	0.75	0.75	0.73	0.67
D	0.75	0.75	0.75	0.75	0.75	0.70

Notes:

1) Service Level A = Normal Condition; Service Level B = Upset Condition; Service Level C = Emergency Condition; and Service Level D = Faulted Condition.

Table 8: Pressurizer Surge Nozzle Crack Growth Results

Flaw Type [1][2]	Max. Flaw Length[3]			Allowable Flaw Depth		Final Flaw Depth	Final Flaw Length [2]	Allowable Operating Period	Successive Inspection Schedule [5]
	l/πD	(Deg.)	(in.)	a/t	(in.)	(in.)	(in.)	(months)	(years)
Circumferential	0.1	36	3.91	0.75	0.96	0.650	3.900	> 564[4]	10
Axial	NA	NA	2.96	0.70	0.90	0.492	2.952	324[4]	10

Notes:

1) The postulated initial flaw depth is 20% of the weld thickness (i.e., 0.256") and the initial flaw length is 6 times its depth (i.e., 1.536") per Appendix L guidelines.
2) A constant aspect ratio (a/l) of 1/6 is used in the crack growth analysis.
3) Flaw length based on ID
4) Maximum flaw length is reached before the allowable flaw depth.
5) Per Appendix L, if allowable operating period is equal or greater than 20 years, the successive inspection schedule shall be equal to the examination interval listed in the PTN Section XI schedule of Inservice Inspection (ISI) program of the component.

Table 9: Hot Leg Surge Nozzle Crack Growth Results

Flaw Type [1][2]	Max. Flaw Length[3]			Allowable Flaw Depth		Final Flaw Depth	Final Flaw Length [2]	Allowable Operating Period	Successive Inspection Schedule [5]
	l/πD	(Deg.)	(in.)	a/t	(in.)	(in.)	(in.)	(months)	(years)
Circumferential	0.1	36	3.37	0.42	0.422	0.386	2.316	> 720	10
Axial	NA	NA	1.94	0.75	0.76	0.323	1.938	624[4]	10

Notes:

1) The postulated initial flaw depth is 20% of the weld thickness (i.e., 0.201") and the initial flaw length is 6 times its depth (i.e., 1.206") per Appendix L guidelines.
2) A constant aspect ratio (a/l) of 1/6 is used in the crack growth analysis.
3) Flaw length based on ID
4) Maximum flaw length is reached before the allowable flaw depth.
5) Per Appendix L, if allowable operating period is equal or greater than 20 years, the successive inspection schedule shall be equal to the examination interval listed in the PTN Section XI schedule of Inservice Inspection (ISI) program of the component.

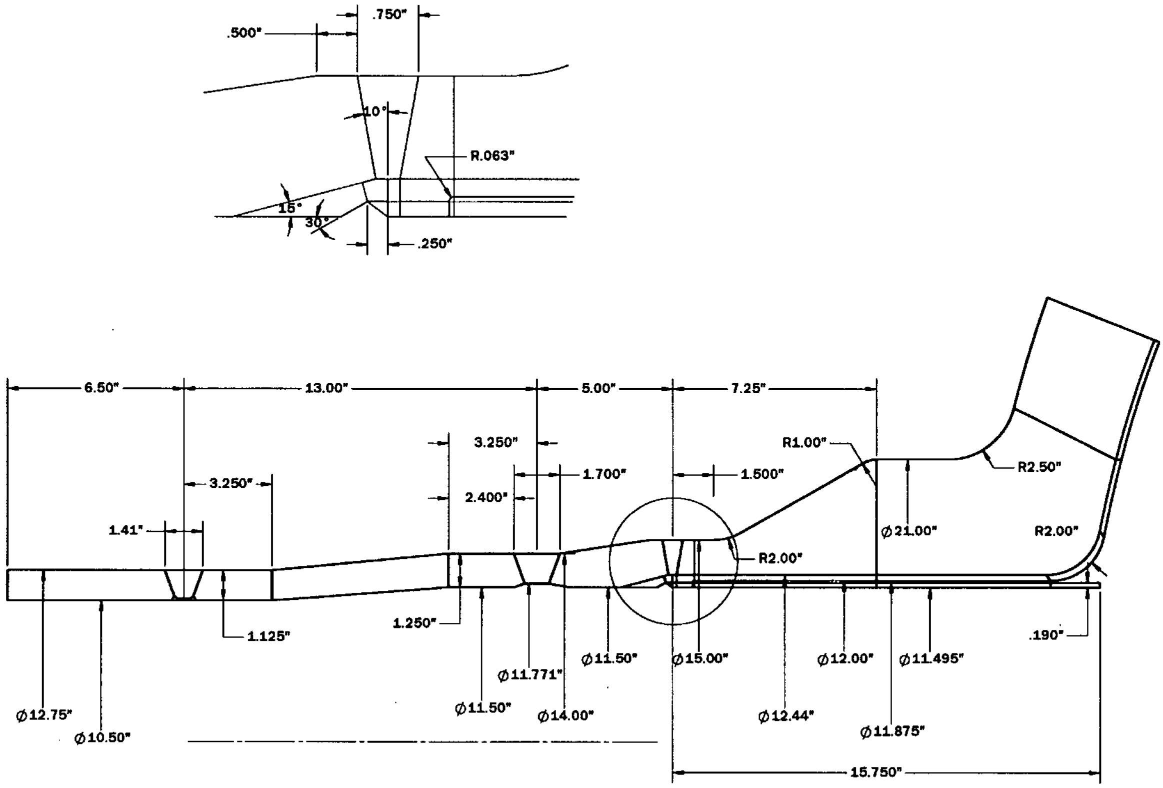

Figure 1: Pressurizer Surge Nozzle Dimensions

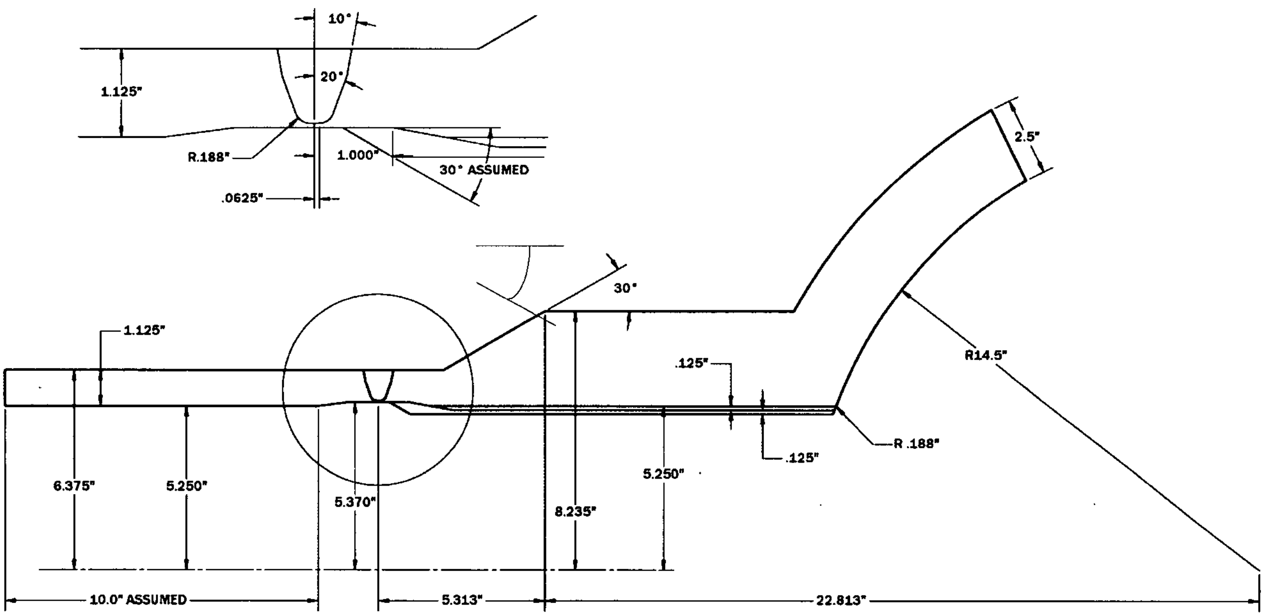

Figure 2: Hot Leg Surge Nozzle Dimensions

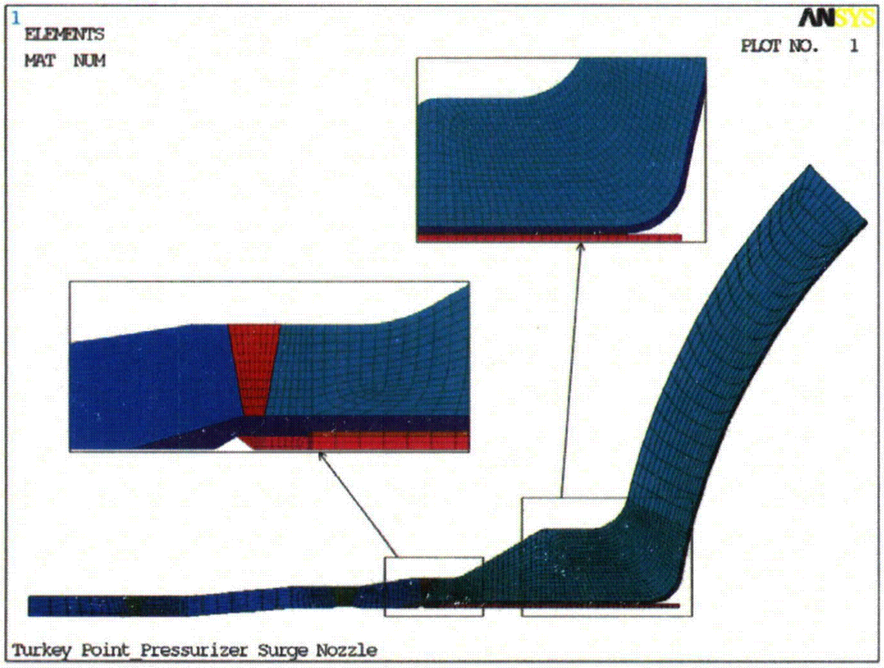

Figure 3: Finite Element Model of Pressurizer Surge Nozzle

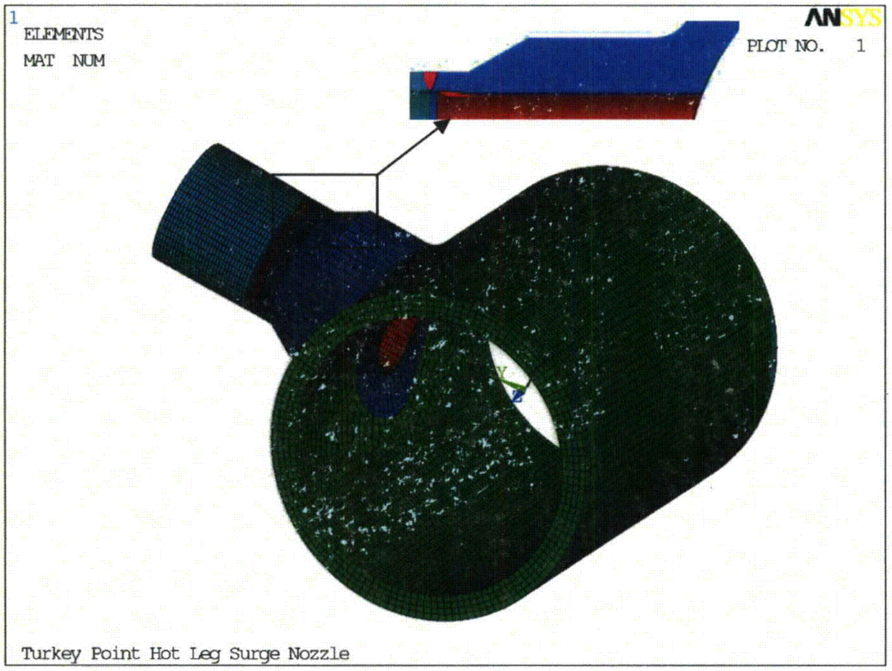

Figure 4: Finite Element Model of Hot Leg Surge Nozzle

4.0 CONCLUSIONS

The flaw tolerance of the pressurizer surge and hot leg surge nozzle welds at Turkey Point Units 3 and 4 has been evaluated and the required successive inspection schedule has been determined for a postulated 20% deep flaw with a 1/6 aspect ratio per the requirements of ASME Code, Section XI, Appendix L. The required examination interval for both surge nozzle welds is ten (10) years for either an axial or a circumferential postulated flaw. Therefore, the 10-year examination interval of the PTN ISI program for both surge nozzles remains unchanged. Based on a comparison of geometry, material properties and applicable loads, the results of the detailed evaluation of the two bounding locations are applicable to the other weld locations on the surge line (3 additional welds on Unit 3 and 5 additional welds on Unit 4). Hence, the 10-year examination interval of the PTN ISI program remains unchanged for the all the surge line welds considered in this evaluation.

5.0 REFERENCES

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2. ANSYS Mechanical APDL and PrePost, Release 12.1 x64, ANSYS, Inc., November 2009.
3. Geometry Data for Turkey Point Units 3 & 4 Pressurizer Surge Nozzle
   - 3a. Westinghouse Electric Co., Dwg. No. SK-10003631, Sheets 1 and 2, Rev. 0, "Series 84 Pressurizer."
   - 3b. Pressurizer Drawings:
     - i. Westinghouse Electric Corporation, Dwg. No. 681 J252, "Pressurizer Lower Head Assy. & Details."
     - ii. Florida Power and Light Co., Dwg. No. CIS-A-10, "Codes & Inspections Section Turkey Point Unit 3."
     - iii. Florida Power and Light Co., Dwg. No. MCI-A-10, "Codes & Inspections Section Turkey Point Unit 4."
   - 3c. FPL Dissimilar Metal Weld Checklist, PTN Unit 3, Pressurizer Surge Line Nozzle (12"-RC-1301-9).
   - 3c. Westinghouse Electric Corp., Technical Manual for Pressurizer (JPE), VTM No. Z313, JPN Issue No. 004.
   - 3d. Teledyne Engineering Services, Technical Report TR-5322-135, Rev. 1, "USNRC I&E Bulletin 79-14 Analysis, Turkey Point Unit 3 & 4 Nuclear Power Plant, Pressurizer Surge Line (Inside Containment) Stress Problem 041."
   - 3e. Crane Company, Technical Paper No. 410, "Flow of Fluids through Valves, Fittings and Pipe," 1976.
   - 3f. FPL official transmittal letter FPL-11-276 for the Westinghouse letter report number LTR-PAFM-11-138, "Surge Line Pressurizer Nozzle Reducer Information."
4. Geometry Data for Turkey Point Units 3 & 4Hot Leg Surge Nozzle
   - 4a. Westinghouse Document No. LTR-PAFM-11-94, "Surge and Spray Nozzle Design Drawing Transmittal for Turkey Point Units 3 and 4 to Support SIA License Renewal Evaluations,"
   - 4b. Florida Power and Light Co., Drawing 5613-P-766-S, Sheet 1 of 3, Rev. 5, "Turkey Point Nuclear Power Plant Unit 3 Reactor Coolant System No. 41 Inside Containment Stress Problem RCL – 3/041.
   - 4c. Florida Power and Light Co., Drawing 5614-P-766-S, Sheet 1 of 3, Rev. 3, "Turkey Point Nuclear Power Plant Unit 4 Reactor Coolant System No. 41 Inside Containment Stress Problem RCL – 3/041

4d. Crane Company, Technical Paper No. 410, "Flow of Fluids through Valves, Fittings and Pipe," 1976.

5. Loads Data for Turkey Point Units 3 & 4 Pressurizer Surge Nozzle and Hot Leg Surge Nozzle

5a. Westinghouse Document No. LTR-PCSA-11-71, "Westinghouse Data on NSSS Design Transients for Turkey Point Units 3 and 4 as Requested by FPL", PROPRIETARY SI File No. 1100756.216P.

5b. Westinghouse Document No. CN-SGDA-08-55, Revision 1, "Evaluation of Pressurizer for EPU at Turkey Point Units 3 and 4 (NSSS Power 2652 MWt)", PROPRIETARY SI File No. 1100756.214P.

5c. Westinghouse Document No. WCAP-14950, *Mitigation and Evaluation of Pressurizer Insurge/Outsurge Transients,* February 1998, PROPRIETARY SI File No. 1100756.220P.

5d. Westinghouse Document No. WCAP-12959, *Structural Evaluation of the Turkey Point Units 3 and 4 Pressurizer Surge Lines, Considering the Effects of Thermal Stratification*, May 1991, PROPRIETARY SI File No. 1100756.208P.

5e. Westinghouse Document No. LTR-PAFM-11-94, "Surge and Spray Nozzle Design Drawing Transmittal for Turkey Point Units 3 and 4 to Support SIA License Renewal Evaluations," PROPRIETARY SI File No. 1100756.211P.

5f. Florida Power & Light Document No. PTN-ENG-11-0031, Revision 1, "Turkey Point Units 3&4 Surge Line Thermal Stratification Data Transmittal for Structural Integrity Associates for License Renewal Evaluations", SI File No. 1100756.219P.

5g. Teledyne Report TR-5322-135, Book-2, Revision 1, "USNRC I & E Bulletin 79-14 Analysis, for Turkey Point Units 3 & 4 Nuclear Power plant Pressurizer Surge Line (Inside Containment), April 3, 1984" SI File No. 1100756.203.

5h. Heatup and Cooldown Data for Turkey Point Units 3 and 4, SI File No. 1100756.223.

5i. E-mail from Satyan-Sharma, Tirumani (FPL) to Norman Eng (SI), dated November 30, 2011, "Subject: FW: Pressurizer Surge Nozzle Design Loads Calculation," SI File No. 1100756.201.

6. Loads Data for Turkey Point Units 3 & 4 Pressurizer Surge Nozzle

6a. Westinghouse Document No. LTR-SGMP-11-66, Revision 2, "Turkey Point Units 3 and 4 Data Package for Pressurizer Spray and Surge Nozzle Analysis", October 2011, PROPRIETARY SI File No. 1100756.206P.

6b. Westinghouse Electric Co., Dwg. No. SK-10003631, Sheets 1 and 2, Rev. 0, "Series 84 Pressurizer," PROPRIETARY SI File No. 1100756.205P.

6c. Florida Power & Light official transmittal letter FPL-11-276 for the Westinghouse letter report number LTR-PAFM-11-138, "Surge Line Pressurizer Nozzle Reducer Information," PROPRIETARY SI File No. 1100756.216P.

7. Loads Data for Turkey Point Units 3 & 4 Hot Leg Surge Nozzle

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   7b. Florida Power and Light Co. Drawing No. 5613-P-766-S, Sheet 1 of 3, Rev. 5, "Turkey Point Nuclear Power Plant Unit 3 Reactor Coolant System No. 41 Inside Containment Stress Problem RCL – 3/041," SI File No. 1100756.207.

8. W. J. Mills, "Critical Review of Fatigue Crack Growth Rates for Stainless Steel in Deaerated Water – Parts 1 and 2," EPRI MRP-2010 Conference and Exhibition: Materials Reliability in PWR Nuclear Power Plants, Colorado Springs, CO, June 28 – July 01, 2010.